Science & Mathematics Education Centre

A study of the impact of new technology and teaching methodologies on global maritime education and training into the 21st century

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DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

Signature:

Date: 27 June 2003

CONTENTS

ABSTRACT

Global maritime education and training (MET) is currently subject to great change brought about by new international legislation, a dynamic shipping environment, the growing impact of technology, and the challenges maritime institutions face to survive in an uncertain market place.

The aim of the research is to determine to what extent global MET institutions can enhance and enrich traditional practices through access to new technology and the use of innovative teaching and assessment methods` within a sustainable and achievable framework.

The first Chapters of the study investigate the impact of change on the global MET scene by examining how international maritime legislation influences activities of maritime institutions. Ninety institutions from fifty-three countries responded to a survey that examines their intentions regarding the use of satellite communications, Information Technology, computing, multimedia, simulation and distance learning delivery methods. Shipboard operations that impact upon future training needs are also put under the spotlight.

The study analyses the potential use of the Internet, e-mail, simulation and distance education services to determine how these elements can be used to advantage for the education and training of seafarers. An evaluation is made of the use of computers and marine simulators as assessment tools, in the light of international concerns about standards of competence.

The study concludes that maritime institutions can benefit from the use of new technology, but only through rational planning and sustainable staged growth. A series of continua of technical development are provided to assist institutions, from the smallest to the largest, to plan for technical development and growth in a rational and feasible way.

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LIST OF FIGURES

List of Figures continued ...

LIST OF TABLES

LIST OF ABBREVIATIONS

AARNET	Australian Academic Research Network
ADSL	Asymmetric Digital Subscriber Line
AIS	Automatic Identification System
ALAM	Academy Laut Malaysia
ALN	Asynchronous Learning Network
AMC	Australian Maritime College
ARPA	Automatic Radar Plotting Aid
ASCII	American Standard Code for Information Exchange
ATM	Asynchronous Transfer Mode
BBC	British Broadcasting Corporation
BHP	Broken Hill Proprietary Ltd
BIMCO	Baltic International Marine Council
CAL	Computer Assisted Learning
CALL	Computer Assisted Language Learning
CAORF	Computer Aided Operations and Research Facility
CBI	Computer Based Instruction
CBT	Computer Based Training or Competency Based Training
CD-I	Compact Disc – Interactive
CD-ROM	Compact Disc - Read Only Memory
CD-RW	Compact Disc - Read/Write
CERNET	China Education and Research Network
CES	Competency Evaluation System
CGI	Computer Generated Imagery
CIIPMET	China, India, Indonesia and Philippines Maritime Education and Training project
CMC	Computer Mediated Communication
COW	Crude Oil Washing
DGPS	Differential Global Positioning System
DISC	Dialogue, Involvement, Support, Control
DOC	Document of Compliance
DR	Dead Reckoning
DSC	Digital Selected Calling
DVD	Digital Video Disc
EASTMET	Eastern European Maritime Education and Training project
ECDIS	Electronic Chart Display
EDI	Electronic Data Interchange
EGC	Enhanced Group Calling
ENID	EGC Network Identification Code
ESCAP	Economic & Social Commission for Asia and the Pacific
ESSP	English Study Skills Program
EU	European Union
EC	European Community or Commission
GAN	Global Area Network
GEO	Geosynchronous Earth Orbit
GLONASS	Global Navigation Satellite System (Russia)
GMDSS	Global Maritime Distress Safety System
GMT	Greenwich Mean Time
GNSS	Global Navigation Satellite Service

List of Abbreviations continued ...

GOC	General Operator Certificate
GPS	Global Positioning System (USA)
HSC	High Speed Craft
HSD	High Speed Data
HTML	Hypertext Markup Language
IACS	International Association of Classification Societies
IBS	Integrated Bridge System
ICS	International Chamber of Shipping
ILO	International Labour Organisation
ILT	Instructorless Training
IMCO	Inter-Governmental Maritime Consultative Organization
IMDG	International Maritime Dangerous Goods (Code)
IMLA	International Maritime Lecturers' Association
IMN	Inmarsat Mobile Number
IMO	International Maritime Organisation
IMSF	International Marine Simulation Forum
INMARSAT	International Marine Satellite Organization (now Ltd)
INS	Integrated Navigation System
IRORT	Interactive Rule of the Road Tester
ISDN	Integrated Services Digital Network
ISF	International Shipping Federation
ISM	International Ship Management
ISP	Internet Service Provider
ISWG	Intersessional Working Group
IT	Information Technology
ITFU	International Transport Federation Union
ITSOP	Information Technology in Ship Operation Program
ITU	International Telecommunications Union
JANET	Joint Academic Network (UK)
KMSS	Kongsberg Maritime Simulation Systems
KUP	Knowledge, Understanding and Proficiency
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LEO	Low Earth Orbit
LES	Land Earth Station
LNG	Liquefied Natural Gas
MARAD	Maritime Administration (US)
MARCOM	Marine Communications
MARINA	Maritime Industry Authority (Philippines)
MARPOL	International Convention for the Prevention of Pollution from Ships
MARSIM	Marine Simulation
MASSOP	Management Structures of Shipowners and Operators
MBA	Master of Business Administration
MEETS	Mandatory Educational Enhanced Training System
MEO	Medium Earth Orbit
MEPC	Marine Environmental Protection Committee

List of Abbreviations continued ...

MET	Maritime Education and Training
METHAR	Harmonisation of Maritime Education and Training project
METNET	Maritime Education and Training Thematic Network
MIT	Massachusetts Institute of Technology
MOU	Memorandum of Understanding
MPDS	Mobile Packet Data Service
MPEG	Motion Picture Executive Group
MPP	Most Probable Position
MSC	Maritime Safety Committee
MTS	Mission to Seafarers
NEA	National Education Association (US)
NGI	Next Generation Internet
NMD	Norwegian Maritime Directorate
NNSS	Navy Navigation Satellite System
NRC	National Research Council
NSFNET	National Science Foundation Network (US)
NTSB	National Transportation Safety Board (US)
NTU	National Technical University (US)
OHP	Overhead Projector
OILPOL	International Convention for the Prevention of Pollution of the Sea by Oil 1954
OKI	Open Knowledge Initiative
OMBO	One man bridge operations
OPA	Oil Pollution Act
OU	Open University
OUC	Open University of Catalonia
PBA	Performance Based Assessment
PBS	Public Broadcasting System (US)
PC	Personal Computer
PIVOT	Physics Interactive Video Tutor
PPRO	Performance Profile Program
PRC	Professional Regulation Commission (Philippines)
PSC	Port State Control
R&D	Research and Development
RAM	Random Access Memory
RCN	Research Council of Norway
RDF	Radio Direction Finder
SBT	Segregated Ballast Tank
SEA	Simulator Exercise Assessment
SES	Ship Earth Station
SETS	Seafarer Evaluation and Training System
SIRC	Seafarers International Research Centre
SMC	Safety Management Certificate
SMS	Safety Management System
SOLAS	Safety of Life at Sea Convention
STCW	Standards of Training, Certification and Watchkeeping of Seafarers Convention
STW	Standards of Training and Watchkeeping

List of Abbreviations continued ...

SUNET	Swedish University Network
SVGA	Super Video Graphical Array
TAGS	Task and Guided Study
TEC	Training and Evaluation Control
TRB	Training Record Book
USCG	United States Coast Guard
UTP	Unshielded Twisted Pair
VCR	Video Cassette Recorder
VDR	Voyage Data Recorder
VHF	Very High Frequency
VLCC	Very Large Crude Carrier
VSAT	Very Small Aperture Terminal
VTS	Vessel Traffic Services
WAP	Wireless Application Protocol
WEMS	Web Education Management Service
WIG	Wing in Ground
WMU	World Maritime University
WWNWS	World Wide Navigation Warning Service
WWNS	World Wide Navigation System
WWRNS	World Wide Radionavigation System
WWW	World Wide Web

CHAPTER 1

INTRODUCTION AND METHODOLOGY

1.1 Background and literature review

The world of maritime education and training (MET) is being subjected to many changes resulting from new international agreements on global standards of education and training. For example, in recent years the international maritime community through the auspices of the International Maritime Organisation (IMO) has undertaken a major review of a number of Conventions impacting upon safety at sea and protection of the marine environment.

The overarching International Convention for the Safety of Life at Sea, 1974, as amended, (commonly known as SOLAS 74) and generally regarded as the most important of all the international treaties concerning the safety of merchant ships, has recently undergone a review of a number of its chapters affecting the design, operation and safety of ships and their equipment. Many of these changes are brought about because of new events impacting upon the safety of shipping and protection of the environment. It is a dynamic, pro-active on-going process.

A major review of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, (STCW 78) commenced in 1993 following a number of major shipping disasters and failure by the international community to achieve globally acceptable certification standards under the original convention. The revised Convention (known as STCW 95) came into force in its amended form on 1 February 1997 with a five year implementation period ending in 31 January 2002. This revision brought about major changes for maritime training institutions, administrations and shipping companies. As Morrison (1997) has pointed out, the most important element in the safe operation of any ship is in the competence and experience of its master and crew. The revised Convention (STCW 95) has been strengthened with a number of new mandatory provisions together with a set of verification and control mechanisms to help overcome earlier shortcomings regarding the competence of seafarers. However, effective implementation globally still remains a daunting and ongoing task for many institutions and administrations.

The emphasis on demonstration of competence, for example, is causing educators and trainers to consider how best to use new technology such as marine simulators and computer based training to help achieve this. Muirhead (1987), Cross (1996), McCallum (1996) and Meurn (2000) have put forward proposals for a more criterion based approach to assessment particularly in the subjective world of shiphandling. A recently completed European research project METHAR (1998) highlighted, in report 4.1, an apparent reluctance by maritime simulator trainers to undertake assessment of skills on simulators, due to a lack of confidence in the validity of assessment methods. Both Haakansson (1993) and Barber (1996) have emphasised the need for improvements in training methods using marine simulators.

The introduction in STCW 95 of requirements for quality standards systems and properly qualified and experienced instructors and assessors including those using simulators present problems for many in the developing world. Transparency is not always to the fore in many countries and Waters (1996) has noted that getting many institutions to "show that they do what they say they do" requires a change in cultural and social thinking. Recent surveys of both European maritime institutions (METHAR, 1998), of institutions in China, India, Indonesia and Philippines (CIIPMET, 1998) and in Eastern European countries (EASTMET, 2000) indicate that a lack of a formal program of instructional training for new instructors and assessors is not uncommon.

The International Ship Management (ISM) Code, which is mandatory under Chapter IX of SOLAS 74 was adopted in 1994 and entered into force in July 1998 for all oil, chemical and gas tankers, bulk carriers, passenger ships and cargo high speed craft of 500 gross tonnes and above on international voyages. It was extended to other ships in international waters in July 2002. The Code requires a safety management system to be established by the company responsible for operating the ship. This brings new required standards of management practices into play both for the ship and the shipowner and thus for the shipmaster, officers and crew.

In relation to protection of the marine environment, the IMO, in line with its objectives of safer ships and cleaner oceans, adopted 25 years ago the International Convention for the Prevention of Pollution from Ships, 1973, as amended 1978, (MARPOL 73/78). Today, supported by related conventions and protocols, the fight against pollution by ships covers oil, noxious liquid substances in bulk, harmful packages, sewage and garbage. Several of the annexes are currently being reviewed by the IMO. Many maritime training programs lack emphasis in the area of environmental protection.

The operation of ships themselves has changed (Hermouche, 1995) and continues to change in a marine environment where not only is legislation affecting the master and his officers in their daily lives, but the introduction of new ship design and technology and data communications systems are rapidly altering the work environment as well according to an EU research project on management structures of shipowners and operators (MASSOP, 1998). Institutions and shipowners are having to consider new training needs. Telle (1996) described the way in which the Norwegian shipping industry has tackled the problem by enlisting the help of the IT highway, multimedia learning tools and distance learning methods, while Berg (1996) has described a project dealing with company specific computer based training systems. The combination of reduced manning and new technology has led to new concepts in dealing with the man-machine interface.

Companies such as Hapag-Lloyd introduced one man bridge operations (OMBO) in the 1980s and Muirhead (1992) highlighted the need for changes in training philosophies to handle the new circumstances. New rules for OMBO operations were introduced by various classification societies including Det Norske Veritas (Larson, 1993), and the Netherlands maritime colleges introduced new programs in the 1990s to meet ship owners new demands. Ironically, just as the Hamburg Fachhochschule is in the process of phasing out its dual trained officer scheme by 2003, Denmark introduced a new scheme in 2001. One problem that needs to be faced is the training level of the officers when these high technology ships transfer eventually to the developing world market. Are the trained officers and crew available to operate them safely and effectively?

Today ships are being delivered with built in Local Area Networks (LANs) to allow links directly to and from the shipowner's office ashore. The office at sea concept, clearly described by Wilding (1997a,b,c) is based on the growing use of the IT highway (via satellite communications systems) and means that the shipmaster is no longer isolated from the office ashore when he/she sails over the horizon. This coincides with the growing potential use of the Internet and e-mail for information technology services onboard ship for maintenance support, stock control, voyage operations, crew wages, medical care, accident reports amongst many possibilities.

Muirhead (1994) and Brödje (1994) illustrated through trials in Australia that satellite communications and data transfer systems can bring about a realisation that distance education methods can have a place in the scheme of things at sea. Holder (1995) and Osler (1998) have described developments in multi-media technology that are directed specifically to onboard training needs. This potential has been further highlighted by the investigation contained in work package 4.4 of the European Commission METHAR (1998) project. The consequent impact of this upon the maritime institutions charged with producing the well trained human resources for the maritime industry to meet the technical and operational challenges of tomorrow must not be overlooked. In a study conducted in 1997, Davies and Parfett noted the growing demands by crew for access to e-mail and Internet services on board and a marked reluctance by shipowners to provide such services, ostensibly on the grounds of cost and security. Such approaches will need to change..

A major thrust of the revised STCW Convention is to encourage a greater use of marine simulation through the provision of criterion based measurement of competence to perform functions and tasks. The National Research Council (1996) conducted a detailed investigation into the use of marine simulators for training in the USA and concluded that such training was highly effective if conducted in a valid manner. Later research reports by the United States Coast Guard (USCG, 2001) have emphasised the need for properly trained and experienced instructors and assessors.

Some of these changes are in place now, many aspects are currently under development and others remain an untapped and untested vision. The international shipping industry itself is faced with the challenge in the 21^{st} century of manning its fleets of modern technology ships with highly skilled crews. Many in the maritime education and training industry follow traditional teaching and training approaches, lack modern equipment and facilities, and lack an understanding of how to apply new technology and educational methodologies. The study investigates this changing situation and creates a developmental model that will assist institutions to meet these new challenges.

Thus the world of maritime education and training is being subjected to many changes resulting from new international agreements on global standards of education and training. These range from changes occurring in the design and operation of ships and equipment, the growing potential use of the Internet and e-mail information services onboard ship, to the realisation that distance education methods have a place in the scheme of things. For institutions in developing countries, such changes in particular are momentous, and provide them with a considerable challenge in the next few decades.

1.2 Purpose of the Study

The aim of the study is to assess and analyse the current global maritime education and training situation, in regard to the availability and use of modern technology in maritime training institutions, to examine trends in international shipping regarding onboard operations, and to draw conclusions as to how this impacts upon training needs.

Many in the maritime industry follow traditional teaching and training approaches and lack modern equipment and facilities, and an understanding of how to apply new technology and educational methodologies. The potential use of new technology including marine simulation as an assessment medium is discussed, in view of the increased emphasis by international conventions on the need for better evidence of ability to perform job related tasks and functions.

To assist in this process the following objectives have been established for the study:

- To investigate changes in international maritime legislation and determine how such changes impact upon maritime education institutions in the future
- To survey and analyse global maritime education and training institutions in relation to their current and future use of teaching methods and technology
- To investigate and evaluate international shipping in regard to trends in onboard operations in the light of new technology, and the impact of such trends upon future training needs
- To investigate the latest developments in satellite communications, information technology links, use of computers, simulation and distance learning services and examine the extent to which they can be used to advantage in maritime education and training
- To determine the extent to which existing maritime education and training practices can be enriched and enhanced through the use of new technology, teaching and assessment methods
- To develop a recommended developmental model for implementation by maritime education institutions.

New technology is going to have a considerable impact on how ships are operated and managed in the next decade. While satellite position fixing and communications systems, computers and automation have penetrated the market extensively, the potential use of the Internet, the World Wide Web, e-mail, multimedia, simulation and distance education services for training has not yet been realised to any extent.

The study is intended to provide many of the training institutions in developing countries in particular with a clear picture of the availability of and the potential for the use of new technology and teaching methods, so as to enable them to meet the new challenges facing the maritime industry. It is also hoped that seafarers and ship operators will benefit from considering ways in which education and training resources and technology can extend its hand to the ship and personnel at sea.

1.3 Research Methodology

The aim of the study has been to assess and analyse the current global maritime education and training situation in regard to training institutions, taking into account the diverse systems and facilities that exist across the world. Recent changes to international legislation affecting all maritime academies in the 21st century have been examined and analysed, for their role as catalysts for change. The extensive global links of the World Maritime University (WMU) to the International Maritime Organisation (IMO), the international shipping community and the global network of maritime education and training institutions have been utilized to establish both a view of the current situation and future trends.

The initial literature research concentrated on identifying of data and materials in relation to the current and changing situation in the global MET environment. In particular, selected resources were focused on a number of major areas of change including new international legislation, changes in operations onboard ships, satellite communications, the use of computers and the use of distance learning methodologies with a particular emphasis on their potential to influence maritime education and training outcomes both ashore and at sea.

Several research projects have provided a solid foundation for much of the technical research work in this thesis. Reports prepared by Muirhead from the MASSTER, METHAR, and METNET projects have been drawn upon to pinpoint many of the trends taking place in international shipping in regard to new technology and onboard operations.

A major task was to conduct a global survey of MET institutions in order to determine the depth, penetration and use of new technology and teaching methods. Some 191 international institutions in many parts of the globe were targeted, and because of their geographical dispersion, the detailed questionnaire was prepared in English with French and Spanish versions and mailed out in a paper version or e-mailed out in an electronic version as appropriate (Appendices A and B refer). The picture developed from analysis of the more than 5200 individual answers received from the 90 responding institutions formed a key element in the creation of the technical developmental model proposed later in Chapter 9.

A number of European shipping industry research projects impacting upon the MET area, with which Muirhead was directly or indirectly connected with, also contributed to the general survey of the industry. The latest developments in technology including the potential use of satellite communication services, the Internet, the World Wide Web, e-mail, computer assisted learning, simulation, distance learning and delivery methods have been tapped to ensure the thesis remains up-to-date. One consequence of this has been need for constant revisions of chapters to be undertaken to keep pace with changes in technology that have occurred since the research started more than five years ago.

The potential use of marine simulation and computing resources, as training and assessment tools was covered extensively, in view of the increased emphasis by international conventions on the need for better evidence of ability to perform job related tasks and functions. Many sources of information were drawn upon including the conference resources of the International Maritime Lecturers' Association (IMLA) the MARSIM 1978-2000 International Marine Simulation Forum (IMSF) conferences, and from personal experiences gained in running a series of simulator instructor training courses at the Maritime Institute 'Willem Barentz' in the Netherlands between 1999 and 2002.

The results from the research outcomes have been used in Chapter 9 to create a number of continua of technical development based on the surveys, literature research and analysis of findings, in addition to drawing upon practical experiences gained in using computer based training methods and marine simulation systems at various institutions around the globe. A developmental model covering the most appropriate use of modern equipment and teaching methods for different sizes of institution has been proposed, so as to assist institutions and training centres globally to develop their technical capabilities to an advanced stage. The work in particular has focused on the needs of those institutions and centres in the developing world least equipped and funded to meet the challenge of technological change in the 21st century.

The study has drawn conclusions as to the impact of such technical change upon international training institutions and on the ability of the latter to deliver the highly trained human resource required by the shipping industry in the future. Recommendations on the effective use of modern equipment and training methods to help achieve this objective have been provided.

CHAPTER 2
THE INFLUENCE OF INTERNATIONAL STANDARDS ON MARITIME EDUCATION AND TRAINING

2.1 The international nature of maritime education and training

Herodotus recorded that one of the earliest long sea voyages was the three years' journey undertaken by some Phoenician ships in 610 B.C. from the Red Sea, round Africa and into the Mediterranean Sea (Whitfield, 2000). Little more is heard of such ocean feats until Columbus in 1492, and Vasco Da Gama in 1497, began a more 'modern' era of long distance ocean routes.

Maritime education and training (MET) has grown extensively from the days of the Portuguese explorers and the navigation school established by Prince Henry the Navigator in the 15th Century to train Portuguese mariners in the arts and crafts of navigation. To make the journey round into the Indian Ocean and home again from the Cape of Good Hope out of sight of land needed special skills of navigation, and these were a closely guarded secret and fiercely protected from outsiders. As the global exploration by Portuguese, Spanish, Dutch and British seamen expanded, so did the demand for commensurate new skills of seamanship and navigation grow.

Through the 16th to early 20th centuries the teaching of the practice of navigation was in the hands of a few training institutions, founded as a result of trading interests or monopolies. Examples of these are still to be found in the old Hanseatic League cities, such as Hamburg and Bremen, and the centuries old Escola Nautica Infante D. Henrique in Oeiras, Lisbon. As steam power slowly replaced sail, engineering training became increasingly important from the middle of the 19th century. Today, MET is a global training activity involving many of the world's maritime trading nations and associated infrastructures, directly or indirectly.

Today, as a result of international treaties and conventions governing safety at sea and protection of the maritime environment, the education and training of seafarers has become the focus of attention of governments, maritime authorities, education ministries, and the maritime industry, as well as a variety of maritime education and training centres, colleges, polytechnics and universities. With an estimated 300 institutions providing maritime education and training today, the business is truly global in nature.

But we have moved a long way from meeting the training needs of specialised trading interests. Today, the global role of the International Maritime Organisation (IMO) and the spreading impact of its many conventions and codes into all areas of maritime activity, exercises the major influence upon maritime standards covering operational safety. It can be stated, with some justification, that the IMO is the major catalyst for global change in maritime education and training institutions, supporting the changes in technology that the industry has been subjected to over the past few decades.

The IMO itself described the first fifty years' period of its existence as 'a process of change' (Focus on IMO, September 1998). It is most likely that the next fifty years will bring even more dramatic change. Can the world expect the Organisation to continue to provide the impetus needed to keep pace with the profound changes facing everybody in the 21st century? To what extent will this be driven by industry and educationalists? Are they equipped with the means to handle the demands of tomorrow?

An examination of the role of the IMO over the past fifty four years illustrates the influence the Organisation has exerted upon the international maritime community and associated education and training processes, reflecting a period of great change and technological advancement. A look at the ongoing role of the IMO in responding to future changes in the 21st century and their impact upon those charged with education and training is commented upon.

2.2 The influence of international standards

Over fifty years ago, a 1948 International Convention established the International Maritime Organisation (known as IMCO until 1982) with the main aims centred around providing machinery for co-operation between governments relating to technical matters affecting shipping, standards of safety, efficiency of navigation, the development of economic action to promote 'freedom' and to end discrimination in the field of international shipping by taking action to remove unfair restrictive practices. Its function was to be consultative and advisory. Words such as marine pollution and the environment had no place in these aims. It is important to note that, because of strong opposition from major shipping countries, the IMO has never been allowed to tackle those aspects of its aims involving the 'removal of discriminatory action and unnecessary restrictions in international shipping'.

Not all governments or shipping interests supported the establishment of IMO, and the delay in ratifying the Convention was further out of step with other events in the 1950s (the Oil Pollution Convention 1954). As well, a growing number of casualties involving marine pollution of the environment, put pressure on governments for action. The maritime world had to wait until January 1959 before the IMO finally held its first official meeting in London. The long delay meant that much of the early work of IMO was spent in revising its own Convention to meet the enlarged membership of the organisation, a continual process over the past four decades. The 'Torrey Canyon' pollution incident in 1968 highlighted shortcomings in the capabilities of IMO to respond to new threats to safety and the environment and led to a reorganisation of the Organisation and an expanded work program.

A further hindrance to real progress was the cumbersome classical ratification process (requiring two-thirds support) laid down in the early IMO Conventions, many years passing before most amendments came into force, in some cases never. Progress was further hindered by the limits placed upon the IMO under its own Convention, as a body able only to draft new conventions, etc. and to recommend these to governments for adoption under its 'consult and advise' role. A number of amendments to the Safety Of Life At Sea (SOLAS) 1960 Convention throughout the 1960s, which failed to enter into force, highlighted the problem.

As a result of much discussion amongst the parties, it was agreed to introduce a 'tacit acceptance' procedure, to apply only to technical content of Conventions, generally contained within annexes. Under this procedure a fixed time period is set, within which contracting parties have the opportunity to notify their acceptance, rejection or needs of the industry. For example, one significant omission was the lack of any requirement for simulator training, due to a lack of general availability of simulators and trained staff. Since the Convention entered into force in 1984, the only amendments made were for radio communication provisions (1991) and in respect of special requirements for personnel serving in tankers (1994).

A need for change

Over the years many complaints have been levelled at the Convention, mainly because of weaknesses in implementation and enforcement. Whilst the standards themselves were felt to be satisfactory, the emphasis on knowledge and understanding has not necessarily led to all officers being competent to actually perform tasks and functions.

In 1992 the International Shipping Federation (ISF) proposed that the STCW Convention be reviewed through a detailed examination and assessment of current and future trends in maritime training and in the methods used to impart knowledge and skills. The IMO Maritime Safety Committee (MSC) agreed to change the work program of the STCW sub-committee and instruct it to carry out a comprehensive review of the Convention.

Several large casualties in 1992 and 1993 pressured the IMO to complete the task as fast as possible, resulting in the work being completed by July 1995. For the first time IMO made use of a small group of consultants to help speed up completion of the work. Cooperation with the ILO in the revision work was achieved by holding several joint ILO/IMO committee meetings.

Key changes

The revised Convention (referred to as STCW 95) looks quite different to its predecessor in both layout and intent (Figure 2.1). A major change was the transfer of technical detail from the regulations of the Convention annex to a new Code. The

Structure of STCW 1978

Articles 1-17

Annex - Regulations

		Regulations
Chapter I	General provisions	4
Chapter II	Master-deck department	8
Chapter III	Engine department	6
Chapter IV	Radio department	3
Chapter V	Special requirements for tankers	3
Chapter VI	Proficiency in survival craft	1

Resolutions adopted by the Conference

The 23 resolutions adopted by the Conference deal with many aspects intended to improve safety but they are not binding on States who are Parties to the Convention. Governments are urged to give effect to the recommendations contained within them.

* *

Structure of STCW 1995

Articles 1-17 (unchanged)

Annex to the Convention

		Regulations
Chapter I	General provisions	15
Chapter II	Master and deck department	4
Chapter III	Engine department	4
Chapter IV	Radio communication & radio personnel	2
Chapter V	Special requirements for personnel on tankers	3
Chapter VI	Emergency, occupational safety, medical care and survival functions	4
Chapter VII	Alternative certification	3
Chapter VIII	Watchkeeping	2

Code A mandatory requirements

Made mandatory by cross references contained in Annex regulations

Code B guidelines (non-mandatory)

Note: The numbering of Code A and B corresponds with that of the regulations (e.g. Code A-I/10, B-I/10 corresponds to regulation I/10 of the Annex)

Figure 2.1 STCW Convention structure: the transition from 1978 to 1995

Code is in two parts: Part A containing mandatory standards and Part B containing guidance on the implementation, application and enforcement of the convention.

It is important to note that as the Articles themselves could not be changed (for legal reasons), the approach taken was to insert new regulations to cover areas on which the articles were silent and to emphasize interpretations of existing articles. Some key changes affecting the maritime industry in general, and education and training in particular, can be summarized as follows:

National provisions (regulation I/5)

This new regulation requires Parties to prescribe and enforce penalties or disciplinary measures on those failing to comply with Convention provisions. This could include the company or master.

Training and assessment (regulation I/6).

Parties are required to see that the training and assessment of seafarers is administered, supervised and monitored as laid down in the Code. In addition Parties must ensure that those engaged in instruction, training and assessment of seafarers are appropriately qualified and experienced. This applies to both onshore and onboard training regimes. However 'appropriately qualified and experienced' is not defined and leaves open considerable scope for interpretation here. Quality Standards processes should be the medium through which the answer can be determined. Parties are also required to approve all education and training which leads to the issue of a certificate of competency.

Quality standards (regulation I/8)

Some difficulties were experienced in this area, with a number of delegations wary of the proposals for periodic external audits by persons not involved in the activities being evaluated. Although the original draft proposals of the consultants were watered down somewhat, the Code lays out in some detail the processes that are to be followed, both by training institutions and administrations, under a monitoring process, to ensure that a basic level of quality is being achieved. Where onboard training forms part of an approved program of training leading to the issue of a certificate of competency, then the quality standards provisions apply equally to the shipowner or operator. In practical terms, this latter aspect is now also covered by the application of the International Ship Management (ISM) Code to the onboard regime.

Revalidation of certificates (regulation I/11)

The regulation requires masters, officers and radio operators to meet standards of medical fitness and establish continued professional competence at intervals not exceeding five years. Parties were required to compare the standards of competence for certificates issued before 1 February 2002 with part A of the new Code and determine the need for appropriate refresher and updating training or assessment.

By 1 February 2002 there was still a large backlog of serving seafarers who had not revalidated their certificates in time, indicative that many flag state administrations, as well as individual officers, left this issue to the last of their priorities of implementing the new provisions. Many Parties to the Convention also had difficulties in concluding arrangements required to process reciprocal recognition endorsements. The situation was so bad that IMO had to issue advice to Port State Control officers that only warnings should be issued rather than detaining the ship in cases where officer's documentation did not meet the new STCW 95 standards. This was for a six month period of grace only, expiring on 31 July 2002 (IMO News, Issue 1, 2002, p. 7).

However the full force of the law is now being applied, the United States Coast Guard (USCG) issuing a media release (19 July) that stated that full enforcement commenced on 1 August 2002. Similarly the Paris and Tokyo Memorandum of Understandings (MOUs) issued similar statements. The International Shipping Federation (ISF) and the International Chamber of Shipping (ICS) concluded that there was a real danger of many ships being detained. However the general view appears to be positive. Fairplay, in a cover story of 18 July 2002, interviewed Winbow of the IMO who, in noting that accident records had been improving rapidly for years, took the view that the extensive revisions to the STCW Convention have been a successful move in the right direction. From all the evidence, one is entitled to support his optimism.

Use of simulators (regulation I/12)

Simulators became mandatory for radar and Automatic Radar Plotting Aids (ARPA) training as from 1 February 1997. In others cases where simulators are used to assess any competency or where demonstration of continuing proficiency is required by the STCW Code, the simulators have to meet the performance standards contained in the Code and instructors using them must be appropriately qualified and experienced.

Other areas of simulation such as engine room simulators, were good candidates for mandatory use but their lack of availability in many countries produced little support for their mandatory introduction. There has been no change to this situation in the more than five years since.

Responsibilities of companies (regulation I/14)

For the first time companies are defined, and their responsibilities under the Convention are laid out. Thus a company must ensure that seafarers employed are duly certificated, and familiar with the duties, procedures and equipment they are to use before being assigned roles onboard. It also covers responsibilities for ensuring proper manning, and effective communication to handle routine and emergency duties. The training implications flowing from this regulation, particularly in regard to crew familiarization with their onboard duties are considerable. Some shipowners are looking to modern technology to help solve this problem.

Transitional provisions (regulation I/15)

The issue and endorsement of certificates under existing conditions may continue until five years following the entry into force of the 1995 amendments (i.e. 1 February 2002). As discussed in regulation I/11 above, the Convention applied in full to all seafarers from that date.

Code A

A new approach was taken to transfer the knowledge requirements, contained in the STCW 1978 annexes to the regulations, into a new mandatory Code A. The minimum standards of competence and associated knowledge, understanding and proficiency were specified under seven specific functions. This is shown in tabulated form under four columns headed: competence; knowledge, understanding and proficiency; methods for demonstrating competence; and criteria for evaluating competence. Greater emphasis is placed on skill acquisition and this may be achieved through various methods including the use of simulators and onboard the ship. The opportunity for more meaningful skill acquisition in the workplace is there.

Chapter V

This chapter, dealing with tanker training, has been expanded to include mandatory minimum requirements for the training and qualifications of ships' crews on Roll-on Roll-off (Ro-Ro) passenger ships. New amendments were introduced in 1997 to cover other passenger vessels. The changes in this chapter are having considerable impact upon training of ship personnel.

Chapter VI

Dealing with safety training, Chapter VI now consists of four sections. The first requires all persons onboard, other than passengers, to receive basic safety familiarisation training or instruction so as to enable them to respond to emergency needs. Those seafarers with special duties will also require basic training or appropriate instruction in personal survival, fire prevention and fire-fighting, first aid, personal safety and social responsibilities. The second section expands on current survival qualifications to require proficiency in rescue craft where such are operated, whilst the third section provides for standards of competence in advanced firefighting. Finally, requirements for training in medical first aid and medical care are covered. Once again there are considerable training implications for the industry in these developments.

Chapter VII -Alternative certification

This chapter provides opportunity for administrations to issue functional certificates if they so wish. It has been a contentious area of development and remains under review. The competency standards required for functional certificates are the same as that for traditional certificates and are based on the corresponding competencies specified in chapters II or III as appropriate.

In this system three levels of competence are specified, namely, management (Master, Chief officer, Chief and Second Engineer), operational (Watchkeepers) and support (Ratings). Seven functions are grouped under these levels entitled: navigation; cargo handling and stowage; ship control and care of persons; marine engineering; electrical, electronic and control engineering; machinery, maintenance and repair; and radio communications.

The purpose of the alternative certification process is to allow for flexibility of management and operation in a high technology environment without compromising safety. The system is being kept under review by IMO to control its implementation and ensure that it is not used to reduce manning levels, de-skill mariners or otherwise lower safety standards. The principles also need to protect the legal status and responsibilities of the master and ensure "interchangeability" of certificates. To date (2002) there has been little evidence of alternative certificates being issued by maritime authorities.

Chapter VIII – Watchkeeping

This new part includes regulations covering fitness for duty for watchkeeping personnel, mandatory requirements being incorporated into Part A of the Code. In addition, the Convention laid down standards for watchkeeping arrangements and principles to be observed. Code A now covers deck and engineering watches. Radio watchkeeping is covered by the International Telecommunications Union (ITU) radio regulations but further guidance for all three areas can be found in part B of the Code.

2.2.2 The challenge of STCW 95

Perhaps the biggest challenge that faced many maritime education and training institutions was not so much whether they had a quality standards system in place or if they had an approved radar and ARPA simulator for training, but whether they had sufficient qualified and experienced staff to make the necessary changes in order to give the Convention full and complete effect. It is very difficult, for example, to review programs that are poorly or inadequately documented if the experience in teaching and curriculum development and design is missing. Similarly, to examine the standards of competency tables in Code A and develop clear skill and competency objectives within existing programs, is not an easy task if a criterion based training and assessment approach has not been in use before. For many institutions the lack of highly trained instructors and assessors is often compounded by unattractive terms and conditions of employment. Even when qualified and experienced staff are recruited, they are often lost to industry just when they are starting to make an important contribution to institutional standards.

If governments are really serious about meeting their new MET responsibilities under the Convention, then a firm effort is needed to see that the necessary changes to structures, processes and programs are made, as well as ensuring that the human resource is both trained and retained. The concern is not only about raising standards but also of ensuring that they remain in place after gaining access to the 'white list'. As at August 2002 there still remained a number of countries who were excluded from the 'white list'. Human resource development must go hand in hand with implementation of this major IMO initiative.

Approval of education and training

A change of great importance is the requirement that mandatory education and training is required for all master, officer and radio operator certificates. Thus, the practice in some administrations of allowing direct entry to examinations without completing an approved course of education or training ceased from 1 February 2002. Parties may only accept officers for examination in this way if such candidates commenced approved seagoing service before 1 August 1998. There would be few left in the pipeline in 2002.

The requirement that governments must approve all education and training programs and courses for officer certificates has also had a marked influence on standards. Such approval also extends to sea-going training where it contributes to the issue of a certificate of competency and covers the training record books which must be now be kept for each trainee. Examination of the STCW Code A shows that approval is nearly always required, the only exceptions appearing to be in regard to some practical tests for ratings and for practical hospital instruction associated with medical care on board ship courses (Morrison, 1997). In this regard, it is worth noting that Code B-I/9, section 13 on page 184 provides a reminder that the IMO model courses (incorporated by reference into the mandatory Part A) can be used to assist in the development of learning objectives. The latter task is a major challenge for many training establishments in view of the requirement that training and assessment of seafarers must be structured in accordance with written programs.

It is sometimes not appreciated that Parties are required to ensure that the aims and objectives of simulator-based training are defined within an overall training program with the emphasis on objectives and tasks relating as closely as possible to shipboard practices. This can cause difficulties internally in some institutions when instructors try to integrate simulator training into the overall curriculum. What is needed here? The code (A-I/6) refers to methods and media of delivery, procedures and course material. A typical framework will be found in Table 3.1 in Chapter 3.

In conducting its review for approval, the administration may use I/6 elements. Certainly, the word 'written' includes clearly defined goals and learning objectives, curriculum details including entry standards, course structure and syllabus, means of delivery, examination methods including assessment of competency and details of supporting resources. In addition, documentation must include the qualifications and experience of instructors and assessors and clearly identify in which areas of the syllabus they are teaching or assessing.

Morrison (1997) has stated that in regard to onboard training, approval is clearly required also under parts I/11, II/1, III/1, V/1, V/2, A-VI/1 and A-VI/2 of the code. Since the administration is charged with ensuring that seafarer training and assessment activities are administered, supervised and monitored, both ashore and onboard, it makes good sense for ship operators and training institutions to work more closely together, particularly where ship operators do not have approved training programs in place or lack experience in the use of trainee record books.

The writer believes consideration should be given to the development and use of a computer based 'electronic' record book that can use satellite and Internet technology for transmission of data to company training officers, the trainee's next vessel, or a monitoring institution if such arrangements are in place (Muirhead, 1995b). In 2002, several initiatives were under way in Scandinavia and the USA to develop an electronic record book based on the ISF or IMO standard.

Qualifications and experience of instructors and assessors

One of the important outcomes of the Convention was to deal with the establishment of standards for instructors and assessors. Regulation I/6 breaks new ground in requiring parties to ensure that instructors and assessors are appropriately qualified and experienced. In many academic institutions, new teaching staff in particular are given no formal teacher training. Pedagogical training programs should be part of staff development in any MET institution. The Philippines has made a marked effort here, with the assistance of a number of World Maritime University (WMU) MET graduates. Publications from The Nautical Institute (1997) and the WMU (Fisher & Muirhead, 2001) have been specifically produced to help instructors and assessors implement the Convention. The WMU MET specialisation is designed to help graduates train other trainers in pedagogical skills. IMO model courses 3.12, 1.30 and 6.09 should not be overlooked either. Onboard training through distance learning methods, Internet and satellite technology is one possible solution to meeting the onboard training and assessment needs (Muirhead, 1995a).

In the medium term, the quality standards external evaluations should identify such shortcomings. In written documentation submitted to the Administration for approval of education and training programs and courses, details have to be provided by institutions of instructor and assessor qualifications and experience and the specific teaching areas in which such experiences are being used.

The Code requires that seafarer training and assessment be conducted, monitored, evaluated and supported by instructors, supervisors and assessors who are appropriately qualified for the particular types and levels of training or assessment, either onboard or ashore. Trainers must be qualified in the task for which training is being conducted. How many institutions can honestly say that they meet these requirements fully? Section A-I/6 of the Code is even more specific in relation to simulator training and assessment.

There are three important elements here, namely, guidance in instructional techniques, practical simulator operational experience, and practical assessment experience on the simulator. Consider also the new stringent mandatory requirements to be followed by simulator instructors and assessors in A-I/12 of the Code. How are institutions going to meet these needs? The following approaches may be necessary:

- Understudying at another simulator institution. Experienced IMLA simulator operators can greatly assist to raise standards.
- Learning on the job: What do you do if there is little or no experience available locally? Incorrect or inappropriate training techniques may result. What about assessment of competency?
- Manufacturers' training programs: These normally focus on getting started to operate and maintain the system. Pedagogical aspects rarely get much attention.
- IMO simulator model courses, as well as model courses 6.09 and 3.12, offer much useful assistance in developing basic instructional techniques. However, if instructors and assessors follow the guidance provided in the new STCW Codes, they will be following in the footsteps of many experienced IMLA and IMSF simulator instructors, who contributed through the STCW Sub-Committee to the development of such standards.

Competency based assessment

At the core of the revised Convention lies the concept of competence. It is as well to recall the definition in Chapter I of Code A, which states, inter alia:

> ... the level of proficiency to be achieved for the proper performance of functions on board ship in accordance with internationally agreed criteria ... *(as specified in the STCW Code)* ... incorporating prescribed standards or levels of knowledge, understanding and demonstrated skill.

Thus a competence-based qualification is a statement of competence that incorporates assessment of skill, knowledge and understanding, and an ability to apply skills, knowledge and understanding to the proper performance of tasks, duties and responsibilities aboard ship. It is a process of comparing evidence of competence against a standard. The difficulty facing all institutions is in interpreting the standards in the competency tables in Code A. Much will depend upon the resources available to measure performance. Column 3 of the tables reflects a recognition that different methods will be used to satisfy the criteria, as shown in Figure 2.2 below.

- Direct observation
    - -in-service experience
    - -laboratory equipment training
    - -simulation
- Skills/proficiency/competency tests
- Projects/assignments
- Evidence from prior experience
- Questioning techniques
    - -written
    - -oral
    - -by computer

Evidence of performance

Evidence of knowledge and understanding

Figure 2.2: Assessment methods

Effective measurement of a trainee's ability to perform tasks safely and effectively (the criteria for competence) will depend on whether assessment criteria were of an acceptable standard and if performance outcomes met the designed assessment objectives. In the final analysis, the assessor must consider whether the chosen measures of performance are reliable and relevant to the training tasks, and the results are iterative in nature.

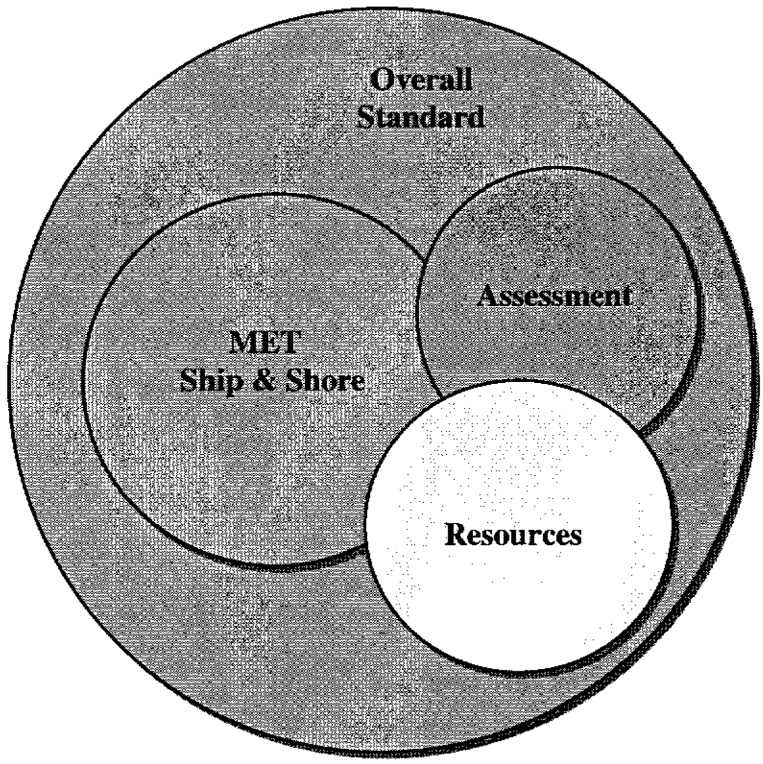


Figure 2.3: Links for overall standards

The onus is on maritime administrations and institutions to see that the necessary steps have been taken to meet the criteria in the Codes before accepting the evidence from such performance measurements for competency purposes. Only then can there be confidence that the overall standards of competence have been achieved. Figure 2.3 above illustrates the linkages for overall standards.

Alternative certification

The evidence in 2002 is that there has been no rush by administrations to issue alternative certificates, a fact supported by the absence of any reports to IMO. However it is important that institutions are aware of the implications for the future. The purpose of alternative certification is to allow the functions associated with the total operation of the ship to be allocated to the ship's personnel in such a way as to make best use of their skills and presence.

The standards of competency required are exactly the same as for traditional certificates, the functions and levels of responsibility being as set out in Chapters II, III and IV, with administrations still needing to approve the programs of education and training. Many institutions have decided to modularise their courses by offering programs in accordance with the functional structure in the Code A tables, a not too difficult task, which offers greater flexibility to customers. Figure 2.4 illustrates the possibilities.

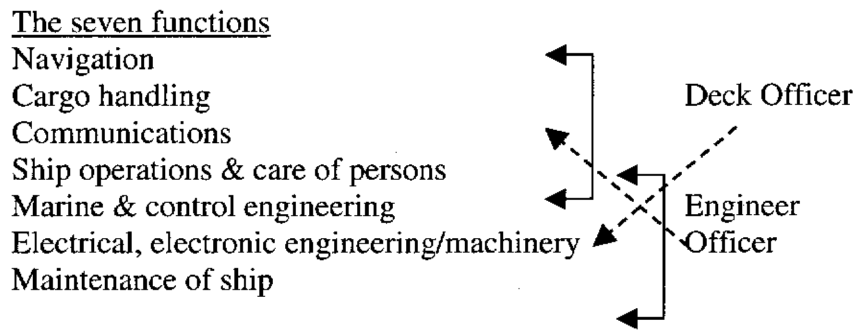


Figure 2.4: The functional approach

A number of safeguards were agreed to, to ensure that Chapter VII of STCW 95 was not used in itself to reduce crew numbers, lower the integrity of the profession or de-skill seafarers, or justify the assignment of combined engine and deck watchkeeping duties to one certificate holder.

Examination and assessment of evidence

One of the major innovations in the revised Convention was to introduce competency criteria and guidance as to the methods that could be used to establish a seafarer's competence. Thus in the Code A tables of competency, column 3 specifies the methods that may be used to demonstrate competence. In most cases the reference is to examination <u>and</u> assessment of evidence from <u>approved</u> training and experience using one or more of a number of methods such as approved sea-service, simulator training, laboratory equipment training, workshop training, practical experience and tests, and training ship experience. The validity and value of such evidence depends upon many factors, but the litmus test is that the instructor or assessor verifies that the trainee concerned has demonstrated an ability to perform a function or task safely and effectively against established criteria. In each case the criteria must clearly relate to those specified in column 4 of the tables of competency. Regarding the use of modern technology such as simulators, the specific requirements of A-I/12 and guidelines in B-I/12 is discussed in the section below.

A not uncommon complaint by maritime instructors is the lack of detailed, objective, quantitative criteria in column 4. The consultant group found it too difficult to achieve consensus on specific performance criteria (IMO: STW-ISWG1, 1993, p. 8). The generic nature of the criteria for demonstrating competence represents a recognition that experienced instructors are best placed to establish quantitative criteria of performance. There is a case for the STW sub-committee to revisit the criteria at some point in the future after experience has been gained in using them in the assessment process. Unfortunately, there has not been a great deal of feedback from assessors on the effectiveness or otherwise of these criteria.

Part of the difficulty may be the complexity of the assessment process within, for example, a simulated environment. The objective and scope of the assessment must assess a candidate's competence, and not just the knowledge base, and evaluate the ability to apply relevant knowledge to performance of practical tasks. In an ideal world, the use of competence criteria that are qualitative in nature, helps to reduce the ever present subjective element, although this can never be eradicated. There is much work to be done here.

Use of simulators

STCW 95 only made the use of simulators mandatory for radar and ARPA training. Performance standards for radar and ARPA simulation are laid down in Part A of the Code and had to be met by all new simulators after 1 February 2002. Existing simulators or those brought into use before 2002 also had to comply with the performance standards from 1 February 1997, unless exempted from full compliance by the party concerned. However, legally, there appears to be to be no time limit on such exemptions. A Party can exempt a simulator under its jurisdiction forever in such circumstances, a weakness in the Convention but not a major threat to standards in Europe, according to Muirhead (1997b).

Some confusion has arisen at times over other provisions. The above mentioned exemptions do not apply to other provisions dealing with the use of simulators by instructors and assessors. These had to be complied with by all simulator users from 1 February 1997 onwards. Similarly, if a party wishes to use simulators for the assessment of any competency or to demonstrate any continued proficiency required by Part A of the Code, such simulators must also comply with the performance standards contained in section A-I/12, unless exempted as before.

The previous comments about the qualifications and experience of personnel using simulators for such purposes are relevant here. Regulation I/12 was drafted to leave the door open to an expanded use of simulation technology in other areas in the future as simulators became more widely available and acceptable.

Thus Part B-I/12 of the Code contains guidance on recommended performance standards for non-mandatory types of simulation equipment used for training and/or assessment of competence or demonstration of skills in five identifiable areas, namely, navigation and watchkeeping; shiphandling and manoeuvring; cargo handling and stowage; radio communications; and main and auxiliary machinery operation. The list is not exhaustive. Five years on, none of these types have become mandatory.

The challenge that has faced maritime institutions is that not only do they have to consider the capabilities of a simulator facility to meet course training objectives, but they also have to consider how they intend using the simulator for assessment of performance, as well as being obligated to see that instructors and assessors are properly trained, qualified and experienced.

While manufacturers' simulator technical specifications vary widely, (the STCW did not attempt to define these for that very reason), the important principle to be observed by course designers and instructors is that their simulator has the capability of providing an acceptable operating environment for the chosen objectives and skills. This is discussed later.

Quality standards systems

Of all the changes introduced into the STCW Convention, the requirement for a quality standards systems provoked most discussion and apprehension amongst those affected, such as MET administrations and training institutions. There is of course nothing new in recognising the need to achieve quality in MET programs and the development of a quality system is not a mysterious or magical process. The mountain to be climbed is more psychological in nature.

Suddenly, those involved in the STCW training and certification process were asked to demonstrate clearly that they met the new Convention standards fully and completely. In other words, they had to 'open the books' to show in a transparent way that they do what they say they do. This was a difficult transformation for many. Even today (2002) there is some evidence (CIIPMET, EASTMET projects) that lip service has been paid to this process, despite some countries being placed on the IMO 'white list'.

Two issues were at the forefront of thinking during the revision process in relation to '*Quality Standards*'. Firstly, the expression '*To the satisfaction of the Administration*' meant different things to different people in achieving standards. The introduction of quality criteria into STCW was designed to improve this situation. Secondly, the change from '*knowledge based training and assessment*' as a measure of competency to a '*skills acquisition*' emphasis meant that the former was no longer an adequate measure. The skills requirement must be heeded in the documentation of national and program objectives. Thus quality assessment became a key element in the challenge of ensuring quality through the STCW Convention.

In regard to MET, quality assurance was interpreted as meaning 'Fitness for Purpose' (STCW A-I/1, section1.6). The emphasis is to demonstrate achievement of the stated objectives which involves four important steps, namely, documentation processes; compliance with procedures, self assessment of the operation; and independent evaluation by an approved quality authority or body.

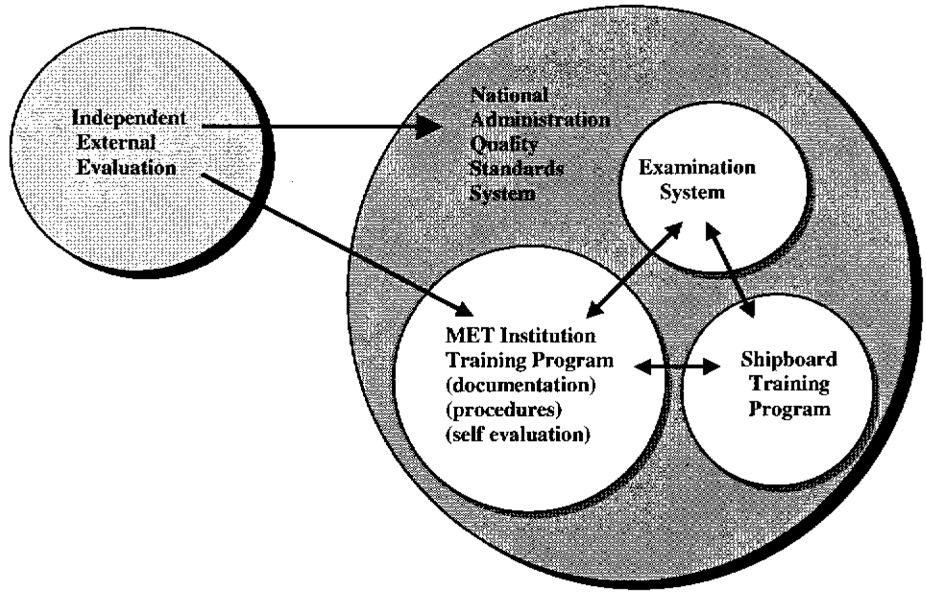


Figure 2.5: Quality standards - links and interactions

STCW did not adopt a standard model, such as the ISO 9000 series, but whatever model is adopted it must enable quality to be achieved (see Figure 2.5 above). It may be a model located within a national scheme for accreditation of quality standards or an alternative model accepted by IMO. The administrative model should be flexible so as to respond to varying needs of industry and technology.

All quality standards systems have key elements which must be tailored to suit the particular program and the standard must be interpreted correctly. At the core of the quality issue is the relationship between 'objectives' and 'achievement' (outcomes) but 'inputs' such as planning, design, program reviews and teaching, learning and communication links are just as important. Preferably the processes, procedures and functions are clearly documented so that everyone is aware of the overall framework and how it works.

The quality standards requirements of the Convention under Regulation I/8 and the associated Codes were drafted so as to encompass all STCW education, training, assessment, certification, endorsement and revalidation activities, as well as the qualifications and experience of instructors and assessors in both governmental and non-governmental areas.

Most of the advice was placed in Part B-I/8 of the Code in the light of the choice of system allowed to Parties. This provides clear guidelines on the development of quality standards, and the establishment of internal quality assurance evaluations involving self-study of the programs. Most Parties have found this one of the most difficult tasks to complete.

Figure 2.6 under illustrates a possible model of a quality standards framework for a typical maritime institution. Notice the importance of having an overriding mission statement providing clear institutional intent regarding quality standards.

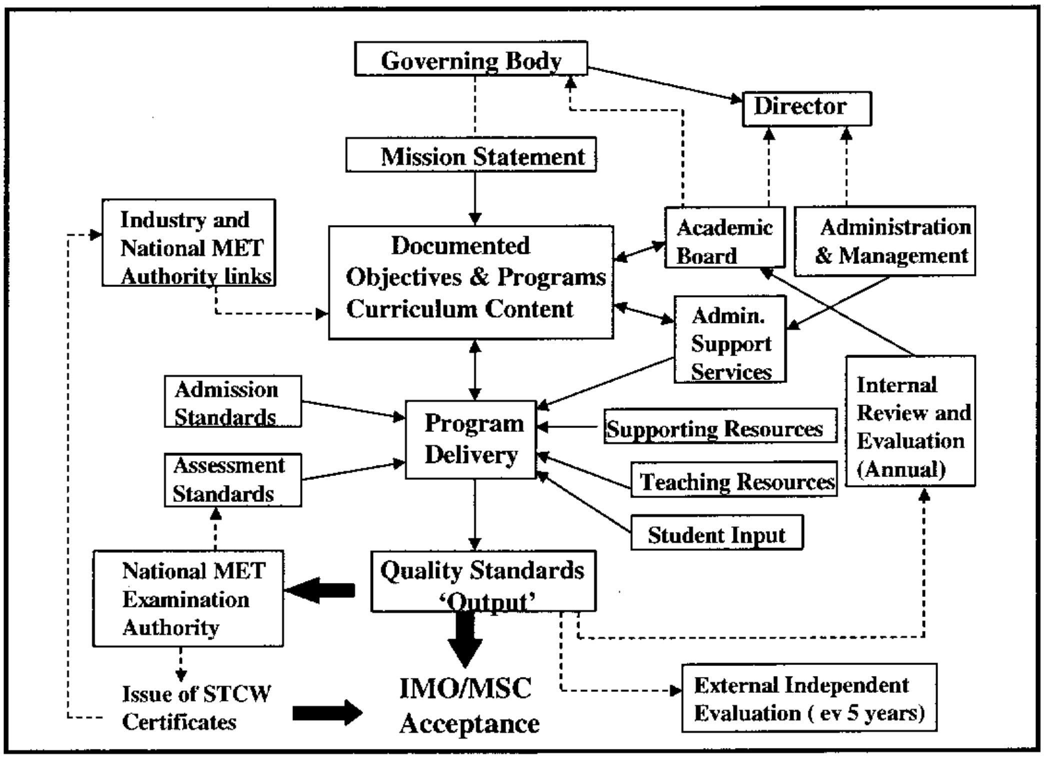


Figure 2.6 Quality standards: A framework of functions, procedures and processes

At five yearly intervals, an external (to the administration or institute) evaluation or audit has to be undertaken by independent qualified persons to verify that all management control and monitoring measures and follow-up actions comply with planned arrangements, that measures are effective in achieving objectives, that results are documented and given to heads of areas evaluated, and that timely action is taken to correct deficiencies. Within six months of completion, the results of each independent evaluation are to be reported to the IMO. For institutions in particular, such external reviews mean putting their house in order as far as quality standards documentation and operations are concerned, as examination of section 7 of B-I/8 indicates. This was one of the big tasks facing institutions before the 1 February 1997 deadline re implementation of the quality standards systems, and the 1 August 1998 deadline when the first report to IMO was due. Parties are currently dealing with the requirement to submit their second external evaluation reports to IMO by the 1 August 2002 deadline, under the five year reporting rule of the Convention.

STCW 95 implementation

Having followed a fast-track pathway to change, it remained to be seen how Parties, Administrations and Institutions would meet the various deadlines. Parties agreed to give the Convention more clout through a new procedure requiring Parties to report to the Secretary General on the steps being taken to implement the Convention. The revised Convention entered into force on 1 February 1997, and Parties had to provide the aforementioned report by 1 August 1998. Many failed to reach the deadline and thus missed the opportunity of being recognised in the first tranche of approvals. A panel of experts was set up to advise the Maritime Safety Committee (MSC) on compliance, as a result of which the MSC would publish the names of those countries found to conform to the Convention (the so called 'White List'), thus providing other administrations with assurance about those Party's standards.

Reviewing the implementation situation in 2000, the IMO made it clear that the recognition process was still far from complete. Of the 82 countries whose reports were submitted to IMO by the 1 August 1998 deadline, representing a little over 50% of IMO membership but over 90% of the world's ships and seafarers, many still remained in 2000 under the scrutiny of the evaluation panels set up by the Maritime Safety Committee (MSC). In order to ensure that all countries that met the deadline were treated equally, the 'white list' was not published by MSC until the process had been completed for all 82 reports. In May 2000, the MSC published its first list that contained the names of 71 countries and one associate member. A further 12 reports, submitted after the 1 August 1998 deadline, were also under consideration during the year (IMO briefing 12 May 2000). At the May 2001 MSC meeting, the names of a further 23 member states were added to the 'white list, bringing the total to 95 countries (IMO News, Issue 3, 2001, p.10). The MSC, at an extraordinary session in November 2001, added a further 8 countries to the list bringing the total to 103.

Problems in implementation

Whilst the amended STCW Convention appeared somewhat daunting to those charged with the task of implementing the new changes, careful planning and organisation helped many to overcome the perceived problems. Additional resources and assistance were provided by the IMO with the focus of effort directed to the maritime labour supplying countries such as the Philippines, China, Indonesia, etc. It meant that some of the lesser players in the maritime field, for example in the Middle East, Africa and the Pacific, had to take a back seat and thus remain part of a small backlog of countries who have not yet made it to the white list.

A number of factors contributed to the seemingly slow progress of implementation. For many administrations and training institutions the revised Convention exposed them to many new concepts and procedures. In many cases the expertise or manpower did not exist in their countries. Not only did national laws have to be amended, but detailed requirements of training schemes, examination systems, use of simulators, qualifications of instructors and assessors and a quality standards system had to be established and documented. The outcome of all this activity, in the form of the report of the administration to IMO, was then exposed to the external probing eyes of the competent persons. On the surface the latter appeared to have done a good job.

For shipowners, STCW 95 has also imposed many new stringent requirements, not without a substantial cost. The new regulation I/14, in particular, places the onus on shipowners to ensure that all seafarers onboard are adequately trained for relevant familiarisation, safety, pollution and emergency procedures requirements. Onboard training programs must be approved by the authority and quality standards established. The special training needs of Chapters V and VI must be met.

Great efforts were made by a great majority of administrations, training institutes, shipowners and operators to meet the new conditions. Many companies tackled this training challenge with enthusiasm and innovation. The Baltic International Marine Council (BIMCO) itself had a very active program designed to assist shipping personnel to meet the new STCW and ISM Code requirements. Several thousand employees attended international seminars and workshops held around the world. The ISF allocated a large part of its resources to assist shipping companies in meeting their own obligations under STCW 95. The ISF onboard Training Record Book (TRB) has become a de facto global standard for many shipowners and operators, large and small, and this initiative has helped to solve the problem of obtaining the necessary approval from maritime administrations for structured onboard training programs. Members of the Norwegian Shipowners' Association are using new innovative approaches to onboard training using modern technology, for example.

Many European maritime administrations offered bilateral assistance to maritime administrations in the developing world to redraft laws and regulations, to set up new certification registries, to approve training programs, and to establish quality audit systems. The latter was particularly important for administrations in monitoring verification of compliance with Regulation I/14 by shipowners operating vessels under the flag state. For example, the IMO, supported by generous donor funds, ran a number of missions to provide assistance with the implementation process, not only to the main labour-supplying countries, but also to Africa to help countries there upgrade their maritime law, training institutions, marine pollution response capability and install port state control regimes. The IMO also contracted out a comprehensive review of model courses, which play a strong role in supporting the revised STCW Convention. The MSC issued a circular that provides guidance on shipboard assessments of proficiency to assist in the implementation of onboard training programs.

Training institutions had a major task of restructuring their curriculum to meet the new standards of competency, ordering new simulators and other equipment and establishing quality standards systems. Many struggled to deal with the latter issue.
Despite all of the foregoing activities, the process of change in the industry attracted considerable pessimism that deadlines could be met. Some comments reported in the press did not sound encouraging. Professor Hadihardjaja, a spokesman for the

Indonesian Private Universities was reported of saying in Lloyd's List of 27 May 1999, that the relatively poor standards of Indonesian ratings and junior officers coupled with the new rigid STCW regulations could have threatened 40,000 seafarers' jobs by the end of 2001. He further stated that there was an urgent need to invest in new equipment including simulators and teaching laboratories and to upgrade the training curriculum to the new standards. Funds promised by the Government for this purpose had not materialised, a not uncommon problem! Even as late as February 2000, an Indonesian spokesman was stating that the 17 private MET Institutions would not comply with the Convention.

Another large supplier of manpower in Asia, the Philippines, was embroiled in its own difficulties at the time. In June 1999 an internal report expressed concern at the ability of the country to comply with STCW 95 requirements, chief amongst which was the lack of clearly defined lines of responsibility for administering STCW and the complexity of existing maritime laws that did not meet the needs of the revised STCW Convention (Lloyd's List, 1999, p.5). The Philippines, with some 200,000 seafarers working in the international fleet, is still the single largest crew supplier in the world. Consider the problems posed if they were no longer employable!

Even more worrying at the time was a report on crew competence conducted by the Seafarers International Research Centre (SIRC, 1999) that asked pilots of 3,701 ships to evaluate crews, using a rating basis. Although somewhat subjective, the conclusion drawn that one in four ship crews was incompetent was somewhat startling! The report argued that poor training in the worst performing countries, rather than nationality, was the decisive factor.

There was firm evidence from other research sources (CIIPMET, 1998) that there existed a clear lack of trained and experienced instructors and assessors, which was aggravating the global situation. Many institutions examined lacked the equipment and resources needed to ensure that seafarers could meet the more demanding requirements to demonstrate their competence. However the lack of trained instructors and assessors is not confined to Asia. METHAR project (2000) also found that many European training institutions had no formal program of training for new instructors or for those staff expected to use practical equipment and simulators to establish the competency (i.e. demonstration of skill) of seafarers.

There have been reports that Korean, Chinese and East European seafarers are increasingly stepping into the shoes of Philippines seafarers. China in particular has a policy of requiring increased proficiency in English language in its seafarers and with 'white list' recognition, it is pushing hard to place many of its annual output of 5,000 officers and 20,000 ratings onto the international shipping stage.

The growing international nature of the industry through flags of convenience and the development of offshore registries also compounded the problem of flag state administrations effectively monitoring all operators for compliance, with their obligations to ensure that seafarers employed on their vessels were properly trained and, where appropriate, certificated.

A further factor that raised its profile, after the 'white list' was published in 2000, was the realisation that the transitional deadline of 1 February 2002 was not far away. The transitional provisions of regulation I/15 only apply to existing certificates and did not apply to new training and certification requirements of the revised convention. Thus by 1 February 2002, all existing seafarers had to have completed any upgrading or refresher training, hold certificates of competency or appropriate endorsements by that date. The picture was one of delayed implementation measures by administrations and shipowners on the one hand, and by individual seafarers leaving things late on the other hand.

The situation was presented as being so serious that STW sub-committee, at its meeting in January 2002, issued a circular requesting port state control (PSC) authorities not to detain ships but issue a warning only, when seafarers' documentation did not meet STCW 95 requirements. This extension of the deadline expired on 31 July 2002. Authorities such as the Paris and Tokyo MOUs and the US Coast Guard indicated that full enforcement of the Convention would commence on 1 August 2002. It remains to be seen whether this creates global problems.

Was the maritime industry complacent about the task it faced? Certainly many underestimated the size of the task facing them. Some administrations lacked expertise to change laws, alter certification systems and install quality assurance provisions. The five year transitional phasing-in period certainly led to many administrations leaving things too late. In encouraging people to take the implementation issue seriously Mr O'Neill, Secretary General of IMO, put the matter most into perspective when he said (Lloyd's List, 1999) that at the end of the day the most telling aspect is that 'the burden of sub-standard ships stains us all'. Muirhead (2000, 4) commented that the burden of allowing sub-standard training institutions to continue operating was also one that the industry could ill afford to carry.

Barriers still remain to achieving global standards of training. Surveys show many personnel are unfamiliar with the workings of quality standards systems, there remains a lack of trained instructors and assessors, and there is a lack of effective means of measuring competency. In the latter case, a lack of simulators, workshop equipment and other technology for assessing practical skills is a stumbling block for some still not on the white list.

The World Maritime University

The World Maritime University has some 1700 graduates working globally in the administrative, maritime education and shipping and ports areas. Many of them have actively assisted their countries to upgrade systems and facilities. Yet even this effort has been very limited. The scale of the task can be measured for example when it is considered that between 1984 and 2002, just 16 Maritime Education & Training (MET) students from the Philippines had graduated and returned to help overcome identified problems in the Philippines education and training sector where some 6,000 instructors are employed in the industry! While short course 'train the trainer' programs for instructors covering such areas as assessment methodology and techniques, simulator instructor skills, and basic teaching skills have been delivered by some of these graduates, more outreach by the international community into the Asia-Pacific basin continues to be needed.

STCW 95 and the impact of new technology

The revised IMO Convention on Standards of Training, Certification and Watchkeeping 1978 (STCW) will have a continuing influence in the first decade of the 21st century on the manner in which the competence of personnel to perform tasks safely and effectively is assessed and assured. The Convention will place much emphasis on the acquisition of skills by demonstration of an ability to perform (i.e. standards of competence). Marine simulators will increasingly be used and recognized for their ability to play an important role in this aspect. The transfer of simulation based training facilities to the ship for use in situ by crewmembers can be anticipated. The trend towards placing and using Computer Based Training (CBT) materials on the ship will accelerate.

Many new approaches and changes in training and assessment methodologies resulted from the revised STCW Convention. Training institutions are being forced to look closely at the way in which they deliver their programs. For example, how can modern teaching methods and new instructional media and technology be employed to assist the training and assessment processes, both ashore and onboard ship? How will institutions ensure that teaching personnel have the appropriate qualifications and experience in this new technological world? These questions remain to challenge those involved in the training and assessment processes leading to the issue of marine certificates of competency.

Using Technology in the implementation process

Growing access to computers, the Internet and Information Technology is allowing innovative training ideas to be developed into practical solutions for shipowners and seafarers. Norwegian research approached the challenge of meeting shipowners' STCW requirements through the provision of company specific onboard Computer Based Training (CBT) modules. Chapter 6 examines this aspect in more detail. CBT is also used as the basis for screening the knowledge levels of seafarers from different cultural backgrounds and work experience before their employment. The purpose is to implement better ship specific training programs and tools for competence assessment. Such tools can provide invaluable help to companies struggling to meet the requirements of STCW regulation I/14.

CBT and multimedia tools can be used effectively to handle much of the familiarisation training demands, especially where large crew changes occur. CBT based programs that can assist shipping companies to implement STCW 95 and ISM Code requirements are readily available today, ISM Solutions being one example. Companies such as Seagull AS and Videotel Ltd with their onboard multimedia library approach are two good examples of the way in which technology is opening up new avenues for solving implementation difficulties.

The increased use of simulation technology for raising safety standards is now extending to the shipboard environment. Star Cruise Line has introduced shore based in-house simulator training programs that provide officers with active duty conditions they will meet on the real ship. Many personal computer (PC) based simulation programs exist today which can be used onboard the ship to further extend the technology to crew familiarisation, basic skills and emergency duties training. The subject of the impact of new technology is dealt with in more depth in Chapters 5 and 6.

Common standards

Besides the aforementioned initiatives by IMO, much time and effort has been expanded by the International Shipping Federation (ISF), International Chamber of Shipping (ICS), the Baltic International Marine Council (BIMCO), International Association of Classification Societies (IACS), and the European Union (EU) amongst others to produce materials, guidance notes and practical advice for implementation. The creation of a quality standard system framework should not have been a difficult task. The introduction of Training Record Books in a shipping company that has no track record of onboard training for its trainees is similarly a relatively easy task.

Yet, after all the tremendous efforts of the past ten years in creating change, is the maritime community any nearer to achieving global standards? The evidence is very strong that the levels of awareness, of what needs to be done to create and maintain the quality standards established by STCW 95, are very high. The maritime industry in all areas, however, cannot afford to rest on its laurels. The real challenge facing the global maritime community is ensuring that the quality standards systems put in place continue to do their job in the future, not just relying on the 'white list' to provide what is only prima facie evidence of compliance with the Convention.

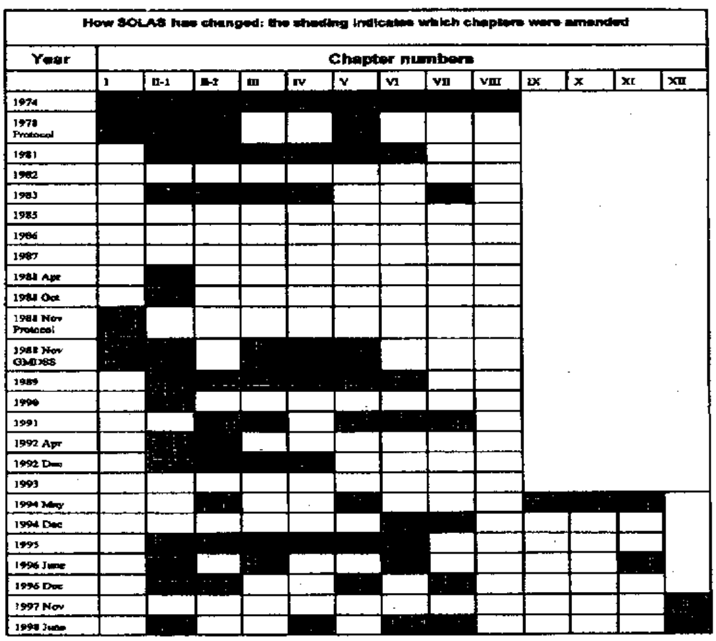
2.2.3 SOLAS

The International Convention for the Safety of Life at Sea (SOLAS) is not only one of the oldest maritime conventions (first version adopted in 1914) but is also the most extensive in regard to its coverage of safety issues and its impact upon international shipping. It has been revised on a number of occasions, newer versions coming into force in 1933, 1952, 1965 and 1980. Amongst the many aspects covered by SOLAS over the years are surveys and issue of certificates, safety of navigation, construction of ships, radio communications, life-saving appliances and fire protection, carriage of cargoes, nuclear ships, and more recently safety measures for high speed craft. Collision avoidance at sea between ships is also dealt with in an annex to the convention. It has also been necessary to revise this annex on several occasions as a result of public concern over casualties at sea, and changing technology (e.g. the use of radar).

SOLAS 1960 was the first conference to be held by the, then new, IMO. A number of safety measures, introduced as part of earlier conventions resulting from concerns about passenger ship safety (e.g. Titanic in 1912) were extended to cargo ships. Construction and fire protection regulations were tightened up, as were the requirements for the carriage of grain in bulk and dangerous cargo. In the latter case this led to the establishment of the International Maritime Dangerous Goods (IMDG) Code five years later. The annex containing the Collision Regulations was revised to take account of the increased use of radar at sea, which had resulted in a number casualties being labelled 'radar assisted collisions'. Many amendments to SOLAS 1960 were made over the next 13 years.

However, as described earlier, the ratification processes to bring the Convention and amendments into force proved to be a slow and frustrating business as membership of IMO grew rapidly and the two thirds target needed to secure entry into force of the amendments grew also. In order to overcome this and to take account of changing technology, a new SOLAS conference was held in 1974. With a new Article VIII incorporating the 'tacit acceptance' procedure it was hoped that changes to technical annexes in particular would benefit from this approach. This has generally proven to be so through the 1980s and 1990s. Table 2.1 illustrates the range of amendments made to SOLAS 1974 over the past twenty years, reflecting the response of the international maritime community through IMO to safety issues.

Table 2.1 Changes in SOLAS between 1974-1998



Source: Focus on IMO, October 1998

The new century opened to no less activity. Extensive amendments to Chapter V of SOLAS 1974 dealing with many aspects of safety of navigation, following a review spread over more than seven years, came into force on 1 July 2002. An examination of topics illustrates the changing technical world seafarers, educators and trainers find themselves facing. New requirements relating to Vessel Traffic Services (VTS), Electronic Chart Display Systems (ECDIS), World Wide Radio Navigation System (WWRNS), the future Global Navigation Satellite System (GNSS), shipborne navigation equipment, ships routeing and reporting systems, standard marine navigational vocabulary and the World Wide Navigation Warning Service (WWNWS) and pilotage, for example, will have a marked affect upon the training activities of MET institutions. Passenger ships and non-passenger ships of 3,000 gross tonnage and upwards, built after 1 July 2002, will have to carry voyage data recorders (VDRs) as part of the new amendments.

In the aftermath of the 11 September 2001 terrorist attacks, the IMO is dealing with the issue of maritime security. The 22nd Assembly agreed to hold a diplomatic conference on maritime security in December 2002 to adopt new regulations to enhance ship and port security. Following a MSC intersessional working group in February 2002, the work was further progressed through MSC 75 meeting in May and an ongoing working group. Any new regulations will involve making amendments to SOLAS chapter XI. There are plans to speed up the final implementation date for the fitting of Automatic Identification Systems (AIS) on all ships of 500 gross tons or more engaged on international voyages, utilising the same conference (IMO News, Issue 1, 2002).

2.2.4 MARPOL 73/78

Marine pollution from ships, strongly perceived by the general public as the main cause of damage to the coastal environment, has increasingly been under the international publicity spotlight over the past 50 years. As the transport of oil and the size of tankers grew in the 1950s, so awareness of the potential of oil from ships to pollute the seas grew. The British government organised a conference in London in 1954, which resulted in the International Convention for the Prevention of Pollution of the Sea by Oil 1954 (OILPOL), coming into force in 1959. The convention was designed to limit the dumping of tank washings at sea and even prohibit it in designated areas. IMO, having just started life in 1958, managed this convention through its Maritime Safety Committee.

In 1967, a tanker called the 'Torrey Canyon' grounded off the Scilly Isles, losing her cargo of 120,000 tonnes of crude oil to the sea. The resulting pollution drew attention to many shortcomings in the measures in place for preventing pollution. The publicity generated was very negative. This one incident was the catalyst for great change in the operational field as well as opening the IMO door to environmental and legal compensatory aspects.

Despite a number of amendments to OILPOL 1954, the IMO Assembly decided in 1969 to develop an entirely new convention, incorporating the amended OILPOL 1954, in response to the rapid growth in the carriage of chemicals, gas and oil as well as to deal with the advent of the very large crude carrier (VLCC). In 1973 a conference adopted the MARPOL 1973 Convention, greatly expanding its scope around five annexes covering oil, chemicals, harmful substances in packaged form, sewage and garbage. However technical problems in complying with Annex II (not in force until April 1987) ensured the ratification of MARPOL was delayed until 1983. The lack of port reception facilities is put forward as one reason why, in the year 2000, several important oil producing and exporting countries have not ratified MARPOL. Other prominent tanker accidents such as the Argo Merchant (1976), the Amoco Cadiz (1978) and the Exxon Valdez (1989), amongst many pollution incidents, have galvanised international action to make further improvements to pollution preventing standards.

Thus in 1978, a new conference adopted a protocol to MARPOL 73, which extended the requirements for segregated ballast tanks (SBT) and the fitting of crude oil washing (COW) systems. The MARPOL 73/78 Convention came into force in October 1983. Annex I is currently under review, the aim being to complete the process by 2003. This will replace the existing annex, incorporating all amendments and new requirements. Annex II is also the subject of review, the completion target being 2003.

A major change resulting from the Exxon Valdez incident was a 1992 amendment requiring double hulls (or alternative) on all new tankers and a phasing-in period for existing tankers. This change very much resulted from USA pressure as a result of their own Oil Pollution Act of 1990 (OPA 90) making it mandatory for all tankers entering US waters to have double hulls. A new Annex VI on 'air pollution from ships' came into force in 1997. Such has been the growth in concern about the marine environment that the MARPOL Convention has been amended almost every year during the last decade. Annex III deals with harmful substances, which are defined as those substances identified within the IMDG Code as marine pollutants. New amendments to the IMDG Code, which thus impact upon Annex III, entered into force in January 2001. At its meeting in December 2000, the MSC decided in principle to make parts of the IMDG Code mandatory, aiming for an entry-into-force date of 1 January 2004.

The current IMO Marine Environment Protection Committee (MEPC) work program focuses on two issues affecting the marine environment, namely the preparation of regulations on 'harmful aquatic organisms in ballast water' and the use of toxic anti-fouling paints. A new International Convention for the Control and Management of Ship's Ballast Water and Sediments is expected to be adopted by a diplomatic conference in 2003.

Prior to the revision of STCW 1978, education and training in the area of marine pollution was fairly low key, relating mostly to those conventions and codes impacting upon daily ship operations. In the future, the treatment of the topic of marine pollution by MET institutions needs to be extended to reflect the expanded IMO treatment of technical aspects of marine pollution and the growing legal and liability issues with which masters and shipowners are faced in the event of pollution from their ship. Further training needs will result from the development of legislation dealing with these new issues of ballast water, maritime security and changes to SOLAS 1974 chapter V.

2.2.5 THE INTERNATIONAL SAFETY MANAGEMENT (ISM) CODE

The perception that new shipboard technology and falling seamanship standards may lead to less effective and safe operational results, was added to by evidence of a lack of care and investment by some ship operators (De Rose, 1995). In 1982 the International Chamber of Shipping (ICS) and International Shipping Federation (ISF) combined to produce a voluntary code of safe management practice, which was further refined after the 'Herald of Free Enterprise' disaster. These efforts by industry were used by IMO through a joint committee with ICS/ISF to develop an extensive safety management systems code for the international maritime industry.

The ISM Code was introduced in 1994 to provide an audited standard of quality management for safety and environmental protection at sea, in other words to ensure that ships are properly managed and operated. The ISM code was adopted by the IMO Assembly in 1993 (Resolution A.741 (18)) and an expanded MSC SOLAS conference agreed to make this mandatory through incorporation into SOLAS 1974 as a new chapter IX.

The Code requires a safety management system (SMS) to be established by the 'Company' as defined. It is all encompassing and requires that the system ensures compliance with all mandatory regulations as well as seeing that other codes and recommended guidelines and standards are taken into account. In addition to the functional requirements onboard, the company ensures adequate support from ashore by designating a person with direct access to the highest level of management. This does not detract from the master's authority in that he/she has the overriding authority and responsibility to make decisions. All procedures required under the Code should be documented in a Safety Management Manual.

The core of the ISM code is to ensure that procedures are in place on the ship that will allow any incident to be dealt with safely and effectively through personnel being aware of their duties and responsibilities and trained in appropriate response measures. With much emphasis in recent years on 'human element' factors behind causal effects of casualties, the Code reflects a serious effort at tackling this aspect.

Chapter IX of SOLAS 1974 entered into force on 1 July 1998 under the tacit acceptance provisions, applying to all passenger ships, tankers, bulk carriers and high speed craft of 500 gross tonnage and above. Other cargo vessels and mobile offshore drilling units had until 1 July 2002 to comply. It is important to note that responsibility for compliance with the Code rests with the Governments concerned. The issue of Documents of Compliance and Safety Management Certificates based on required periodic audits or checks by other delegated bodies remains an Administration responsibility unless delegated to an Organisation recognised by the Administration. To assist this process, the IMO Assembly in 1995 adopted guidelines on the Implementation of the ISM Code as resolution A.788 (19) urging governments to adhere to them regarding the validity of the Document of Compliance (DOC) and the Safety Management Certificate (SMC) required by the code.

Much doom and gloom was forecast regarding the ability of the industry to meet the deadline. During 1997 many speeches and press releases were directed at ship operators urging them to comply before the deadline. The USCG emphasized that vessels arriving in USA ports after 1 July 1998 would be denied entry (Lloyd's List 26 January 1998). Both the European Commission and Australia promised tough treatment through Port State Control measures.

A report by the Paris MOU (Fairplay, 18 November 1998 p. 21) stated that 58 of 722 bulk carriers (8.5%) inspected in the three months since 1 July 1998 were detained because of failings in their SMS. Overall just 5% of 1575 ships were detained for shortcomings, but only three ships were banned from EU ports for failing to have ISM certificates on board or SMS in place. While inspection results are still coming in, the evidence is that a majority of ship operators have made the effort to comply with the ISM Code. It is not clear whether the same concerted effort has been made regarding training of ship and shore staff for practical implementation.

With the second implementation phase coming into force on 1 July 2002, PSC authorities commenced tightening up their surveillance with the Paris MOU detaining its first vessel in that month for lack of ISM certification. According to Lloyd's List (2 July 2002), the Belize register struck off 10 vessels for non-compliance with the code. Perhaps at long last the maritime community is seeing legislation with some teeth to it, which can only forebode well in the task of driving sub-standard operators off the seas.

2.2.6 Other codes, recommendations and guidelines

The important role and contribution made by the International Labour Organisation (ILO) to improving seafarer training and safety standards has been mentioned before. A joint committee of ILO and the Maritime Safety Committee (MSC) of IMO developed a Document for Guidance on the training of seafarers in 1964. It was the first detailed attempt to provide training guidance to masters, officers and seamen covering key areas of operational safety. With three amendments in 1975, 1977 and 1985, it served a very useful purpose until the coming into force of the more extensive STCW 1978 Convention. Close liaison over many aspects of maritime safety and human factor elements continues between the two organisations.

Many codes and recommendations are adopted by the IMO through its Assembly and MSC and MEPC committees. They are non-treaty instruments, the Parties being encouraged to implement the codes etc. as they do not have mandatory force.

Among the many codes and guidelines impacting upon safe ship operations and transport can be found, for example, Carriage of Grain in Bulk, Dangerous Goods, Timber Deck Cargoes, Loading and Unloading of Bulk Carriers, Cargo Stowage and Securing, Dangerous Chemicals in Bulk, Liquified Gases in Bulk, Fishing Vessel Stability, Manual on Oil Pollution, Ship's Routeing, Standard Marine Navigational Vocabulary, Search and Rescue Manuals, Global Maritime Distress Safety System (GMDSS) Handbook, and the Carriage of Cargoes and Persons by Offshore Supply Vessels. The range of technical detail and operational advice offered by these IMO instruments is very extensive. Implementation by the industry through training awareness is a major task.

A feature of much of the work of IMO has been the development of Codes of Practice reflecting the specialised design and operational nature of new ships, their cargoes and trade routes, as well as a need to respond to recent tragedies involving loss of life. The loss of a number of Ro-Ro passenger ferries in the 1980s and 1990s resulted in changes to SOLAS.

The advent of high speed craft led to the introduction of the International Code for High Speed Craft (HSC) which became mandatory (under SOLAS) on 1 January 1996. With vessel speeds of 70 knots currently being achieved and 100 knots predicted in the near future, the operational and training needs for such vessels are different. Wing In Ground (WIG) craft, skimming at high speed above the surface of the water pose a new type of threat to traditional shipping movements. This code is presently under review (2002).

2.2.7 IMO and the new millennium

What improvements to safety at sea and the marine environment can be envisaged for the 21st century? While many aspects are under the IMO microscope at present, it is clear that the industry is already reeling under the difficulty of coping with the mass of new legislation and regulations brought into force in the last decade. As O'Neill (1999, p. 3) put it in his World Maritime Day message "This does not mean that we need more and more regulations. IMO and the shipping industry agree that this is not necessarily the best way to raise standards, but that we should focus on ensuring that existing measures are properly implemented". The key here is implementation and that requires resources and human resolve to succeed.

Entering the year 2002, the IMO focused on a number of matters of concern. Some of these included dealing with fraudulent STCW certificates, bulk carrier safety, piracy and armed robbery against ships, maritime security of ships and ports, formal safety assessment, safe manning and fatigue factors, voyage data recorders, harmful aquatic organisms in ballast water, inadequacy of port reception facilities, air pollution from ships, effectiveness of port state control measures, and revision of MARPOL Annexes I, II and IV (still to enter force). As well, the next few years will see the coming into force of a number of amendments including the Search and Rescue (SAR) Convention annex, a harmonized system of survey and certification, continuing amendments to SOLAS, and to MARPOL 73/78.

Even having reached and gone past final implementation deadlines for STCW 95 and the ISM Code does not mean that everyone can breathe a little easier. The implementation process is never finished and requires ongoing vigilance. It was pleasing to see IMO reasserting the need for a proactive approach to implementation in an Assembly Resolution passed in November 1999. The focus of attention is on people, safety and environmental protection issues, development of a safety culture and the avoidance of over regulation.

Yet the IMO and industry cannot stand still. Whether one agrees or not with change, the onward march of technology will not stop. Later chapters examine many of the aspects affecting maritime education and training in the future. Here it will suffice to identify possible areas that will affect the shipping industry in the future. The maritime industry is not isolated from globalisation influences. Information technology (IT) and others associated with it will greatly influence our lives in the future. New ships today are already being 'wired in' for the IT age with onboard LANs and connected for all services to the office ashore. Ship management, onboard training, crew leisure and self-education aspects will revolutionise future operations and attitudes on the ship. The availability and use of integrated navigation and bridge systems and automation systems is spreading to the global second hand market demanding new approaches to training by many institutions and ship operators.

The huge expansion of the cruise ship industry with 450 metre long ships already on order, and designed to carry 9,000 passengers and crew, are surely going to create a logistics problem not only in training matters, but also in dealing with safety incidents involving such large vessels, as will surely occur one day. Many of IMO's past safety conventions and measures have been prompted by past disasters, and no doubt public and political pressure resulting from larger than life accidents will stimulate further legislative action again in the future. In 2000, IMO decided to take a proactive role in considering the safety issues pertaining to such ships. In an important change in philosophy, the regulatory framework for these ships will aim to place more emphasis on preventing a casualty from occurring in the first place (IMO News, Issue 2, 2001, p. 10). The need for such action is put into perspective when it is considered that the cruise industry carried about 7.5 million passengers in 2001 (The Sea, 2002, p. 8).

At the end of the day, all the regulations in the world will not increase safety standards at sea if the maritime community does not ensure that the human element involved is not trained to respond effectively to a given situation. Sheer growth in the size of ships today allied to an apparent lack of seamanship skills in handling them needs to be dealt with. Modern container ships today carry large deck cargoes of containers. In severe weather conditions, lashing systems are proving inadequate as evidenced by the loss of 700 containers overboard in the North Pacific (Lloyd's List, 6 February 2000). Codes of Practice are of no use if ship design aspects do not reflect the reality of 'at sea' conditions.

2.3 Summary

Maritime safety conventions, regulations, codes, resolutions and guidelines are there in abundance. Most have resulted from a perceived need to improve safety at sea and protect the marine environment. Accidents and tragedies have often been the catalyst for their introduction. The industry sometimes feels it is awash with regulations. Masters and officers struggle to cope with an increasingly hostile world, an easy scapegoat for the wrath of governments, politicians and the public. Yet modern communications place the master in a position never experienced before, able to contact the whole world but less able to make decisions. Ships themselves can be fitted with modern, highly reliable, automated equipment, but is the ship designed to withstand the rigours of the ocean? Many maritime education and training institutions offer excellent courses supported by first class training facilities. Yet still ships are lost at sea, lives are lost and coastlines polluted. One can blame reduced manning, inadequate ship surveys, unscrupulous ship operators, poor training, the human factor or whatever you like.

All these factors come into play at the end, but the most important element is still the human one. Implementation for the education and training community means ensuring, through transparent quality training programs, that seafarers are properly equipped with the necessary skills to safely manage and sail their ships in all foreseeable conditions. In today's 21st century maritime industry infrastructure it becomes essential that training institutions work and co-operate much more closely with ship operators, safety administrations, training boards and even manning agencies, if implementation of standards on a truly global scale is ever to be achieved.

CHAPTER 3

GLOBAL MARITIME EDUCATION AND TRAINING SYSTEMS: A SURVEY

3.1 Background to global maritime education and training

As we have seen in Chapter 2, the international shipping industry is subjected to a range of internationally agreed standards covering all aspects of ship operations, safety and protection of the environment. Most conventions and codes affecting global competency standards of seafarers today are of relatively recent origin, having been enacted over the past 25 years. Codes of maritime law have been around for many years, often enacted by the maritime City States to protect their trade and cargoes. In the eighteenth century many shipmasters and mates were required to comply with codes of law that had been established by merchants who held sway in the Hanseatic League city ports. The recent celebration in 1999 by the Hamburg Nautical School of its 250th anniversary is one example of the long history behind the training of masters and mates. Navigation schools were established that incorporated both academic and nautical subjects. By the time of Captain Cook's explorations in the latter part of the 18th century great advances had been made in astronomical fixing and many good nautical schools were established. Text books were written and skills in the use of instruments such as the sextant, the chronometer and log became necessary in order to command a vessel. These were the days of self regulation, an early example being the East India Company which established its own system of training and examination for its officers.

Maritime Education and Training systems have thus evolved from old traditions and ways, influenced in the main by European countries such as Germany, the Netherlands, France, Spain and Portugal on the one hand, and by the British system on the other hand, mostly as a result of colonial expansion and influence in the 19th and 20th centuries. In addition, the USA has had a considerable influence upon developments in the Far East and Asia.

In Great Britain, the impact of the industrial revolution in the 19^{th} century resulted in a great expansion in shipbuilding and the merchant fleet and the associated pressures to export manufactured goods to all corners of the globe. The resulting growth also brought with it unscrupulous operators and a great increase in unseaworthy vessels and incompetent crews. The concern at the ever increasing number of shipwrecks and accompanying toll in loss of life caused the British Government, for example, to establish in 1836 a select committee of inquiry. Course (1963, p. 200) reported that with average ship losses of 894 in the three years 1833-1835, public feeling ran very high. Amongst the major findings was an admittance of incompetence of masters and officers, the blame for this being put down to a lack of knowledge of seamanship and seamanship. While the Netherlands and Germany had a long tradition of nautical schools, as referred to earlier, Britain had no formal system of nautical education for its seafarers.

Proposals to establish formal qualifications for masters and mates were defeated in parliament in 1837 by shipowning interests. However a voluntary examination system started in 1845 and the Merchant Shipping Act of 1850 legislated for the mandatory carriage of certificated officers on foreign-going ships. Local examination boards conducted written and oral assessment. As a result, nautical schools became established in the vicinity of such examination centres to prepare candidates.

However, it should be noted that there was no similar requirement for officers to undergo a statutory form of training. In general, over the next 100 years, mariners studied at small private or state nautical or engineering schools which often lacked full supporting resources, although the standards of teaching were high. Between 1850 and 1928 little change in syllabus content (seamanship and navigation) took place. In 1928 the UK Board of Trade established a central examining board and a pattern of subjects that remained basically unchanged until 1972. Generally other Commonwealth countries followed suit. Globally, however, each country set its own competency standards and examinations and issued its own certificates, a sure recipe for diverse standards in the future.

The International Labour Organisation (ILO) established the Officers Competency Certificates Convention (No 53) in 1936. This did not establish an international standard of competency but it required masters, chief engineers and officers in charge of a watch to be certificated by a competent authority. Many shipping companies maintained standards well in excess of the statutory requirements. However, as Waters (2000, p, 3) has so aptly put it, 'self-regulation always produces operators who look for the minimum standards that they can get away with'.

At the 1960 SOLAS Conference a resolution on education and training of seafarers was adopted. Key recommendations called on governments to ensure that education and training of seafarers was comprehensive and kept up to date, and for ILO and IMO to cooperate with governments to achieve this. Because of the problems of reconciling the different maritime educations systems that had grown up around the world, a joint ILO/IMO training committee produced in 1964 a 'Document for Guidance' covering the education and training of masters, officers and seamen. Despite several amendments to the document, the IMO Council decided in 1971 to ask the Maritime Safety Committee (MSC) to investigate the establishment of global training standards. Seven years of hard and patient work by the STW sub-committee resulted in the STCW 1978 Convention.

For the first time, internationally agreed standards of training and watchkeeping were put in place that all administrations could use as the basis for recognising education and training programs in maritime training institutions under their control. In particular, the new Convention set out the fundamental knowledge and sea-service requirements for the prescribed certificates of competency. Most training institutions restructured their programs to meet these new minimum standards. There were of course some notable exceptions, the USA being one, in failing to bring the STCW 1978 Convention into force. Despite the six years that passed before it came into force in 1984, Parties were optimistic that it would create a more level playing field globally.

Unfortunately, the earlier difficulty of giving the document for guidance some 'teeth' resulted in leaving implementation to the Parties through the now infamous phrase 'to the satisfaction of the administration'. Standards of training, teaching and availability of resources could vary greatly between institutions yet certificates of competency issued on the basis of such training achieved equal recognition globally. By the late 1980s big changes were taking place in the industry and a Convention formulated by the thinking of 15 years earlier was showing signs of being out of date and inappropriate. A number of major casualties and pollution incidents in the 1980s and early 1990s further spurred the clamour for revision. The resulting revision work and entry into force of STCW 95 in 1997 brought about major changes for the maritime administrations, training institutions and ship operators.

What has been the impact of STCW 95 on the global MET industry in particular? The new provisions have forced MET administrations and training institutions to put in place a quality standards system that clearly and transparently shows that they are doing what they claim to be doing in relation to meeting the requirements of STCW 95 and certificates of competency training and assessment. Table 3.1 below shows in summary the extent of the documentation that needed to be prepared by maritime institutions for submission to their Administrations.

<u>Table 3.1 Approval of programs and written documentation</u>

- <u>Methods and Media of delivery:</u>
  Instructional methods: Breakup of lecture hours, tutorials, practical work, field studies, training vessel, marine simulator time.
  Teaching programs: Use of appropriately qualified and experienced teaching staff in units/subjects and available supporting resources.
  Assessment schedule: Measures to achieve the course objectives through evaluation of students levels of knowledge, understanding and proficiency and demonstrations of ability to perform tasks as per Code A Tables of Competence.
- <u>Procedures</u>
  Checks on teaching programs against written course objectives and syllabus
  Appraisal of examination papers and practical tests for reliability & validity
  Check on practical demonstrations of skill and assessment criteria for relevance to the required tables of competencies
  Checks on qualifications and experiences of lecturers and instructors
  Checks on the training, qualifications and experiences of assessors
  Monitor effective use of simulators against required performance standards
- <u>Course Materials</u>
  Course lectures, texts, notes, workshop manuals and reports, simulator exercise material, audio visual aids are appropriate for achieving overall objectives

Administrations had to decide which of the MET institutions under their control would be part of the country report submitted to IMO for verification that the STCW

Convention was being complied with fully and completely. This process has presented problems for a number of countries and several did not appear on the so called 'white list' published by IMO in December 2000. For example, the Philippines which made the list, has over 160 mostly private colleges and schools involved in varying levels of MET training, but only 12 were selected and submitted by the Philippine authorities to IMO as meeting the requirements of STCW 95. The process of clarification and evaluation continues in 2002-2003 for those not on the 'white list'.

Unfortunately further confusion has been introduced by some countries choosing to make bilateral recognition of selected training institutes in specific 'white list' countries rather than accepting all the institutes put forward in a country's report to IMO. For those countries on the list there is little respite, as it is time yet again for their administrations and institutions to come under the spotlight through an external evaluation of their quality standards systems by August 2002.

In addition, shipowners and operators now have certain mandatory responsibilities in regard to the education, training and qualifications of the crews they employ and this has required for many a considerable rethink on recruitment and training policies. For all the players it can be said that STCW 95 has established a well balanced set of verification and control mechanisms. Implementation is the real challenge.

3.2 MET systems and structures

Education and training in the maritime sphere is conducted within vastly different infrastructures, varied institutional frameworks and course programs using a wide variety of standards in equipment and staff capability. Institutions may be established as vocational training centres, technical or secondary colleges, or tertiary polytechnics or universities. The management of MET may be within a monotechnic institution (e.g. Academy Laut Malaysia (ALAM) or the Australian Maritime College (AMC)) or be a small department within a large polytechnic (e.g. Hong Kong or Singapore Polytechnics) or a specialized maritime university (e.g. Tokyo University of Merchant Marine). Courses for officers may be made through traditional certificate of competency programs, or be part of an accredited diploma or degree educational award. The maritime administration may approve a particular course of study as meeting STCW 95 certificate of competency requirements, or part of a broader educational award that covers it. Some countries utilise front-ended training schemes, some sandwich type, others post-experience programs. There are many options and paths for MET administrators, educators and academics. Thus quality standards may take various forms but all have certain key elements. The framework shown in Figure 3.1 below shows the possible links that may need to be in place in a typical MET institution.

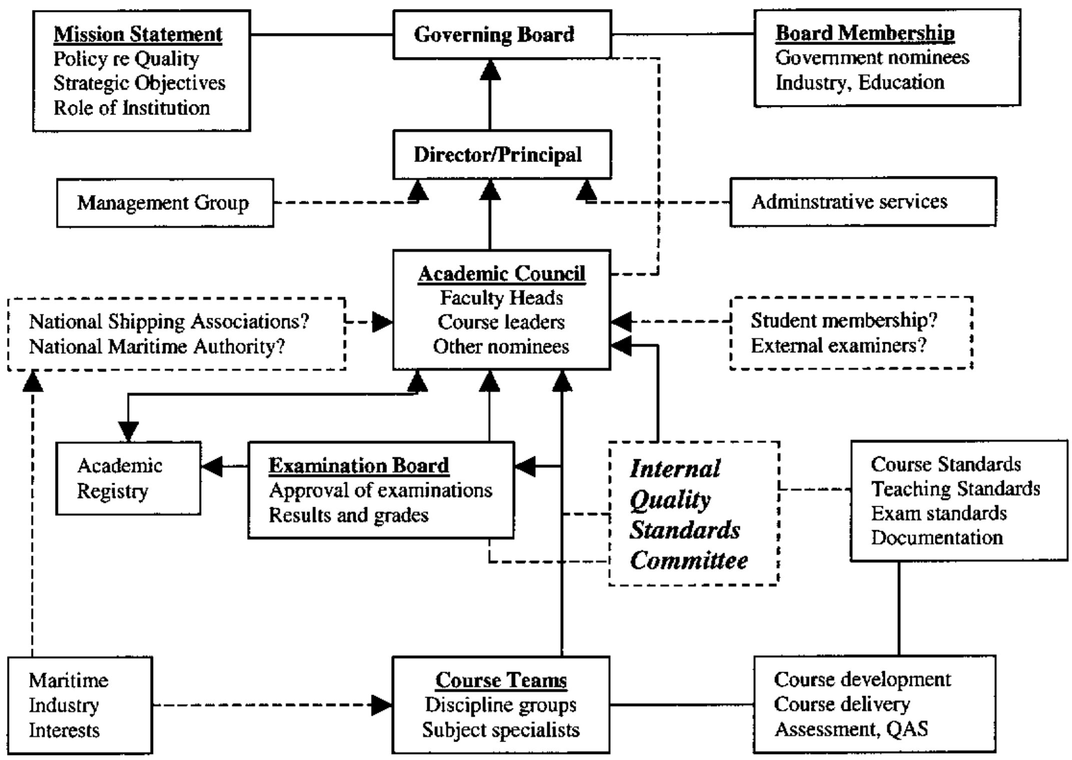


Figure 3.1 General quality assurance framework for maritime institutions

Using the resources of World Maritime University library, IMO and IMLA data, the research estimates that, in 2002, there were over 400 institutions of different levels, sizes and capabilities engaged globally in maritime related education and training of one sort or another. This may range from preparing young school leavers for life at sea as ratings with basic safety familiarization courses, following optional marine studies programs, undertaking courses leading to certificates of competency as master, chief engineer, watchkeeping officer or fisheries officer, or taking a diploma or degree based maritime program incorporating professional certification needs. Specific industry required short refresher and upgrading courses may also be offered by specialized training centres, for example in the area of simulator training, which may not have a statutory requirement but are demanded by the industry. The survey detailed in this chapter targeted 191 training institutions in 86 different countries around the globe whose main activities include offering courses leading to recognition for the issue of certificates of competency under STCW 95 (Appendix C refers).

3.3 Global survey of MET institutions: objectives and methodology

By now the reader will have established that great changes have been and are taking place in MET around the world. Later chapters highlight in detail how the maritime industry is affected by new technology, new equipment, new training methodologies, legislation covering training and the acquisition of skills, and the resultant adjustments to operational practices to meet these changes. The MET institutions play a critical role in providing the industry personnel with the knowledge and skills to perform the functions and tasks demanded by these new factors.

The survey set out to establish the current activities and facilities of the responding institutions and to examine their future intentions as to course development, acquisition of new equipment, and the use of new teaching and delivery methods.

The survey form

The form focused on the identified international MET training institutions, selected on the basis of their known involvement in maritime education and training within their own countries, and for offering particularly courses of training leading to the acquisition of professional certificates of competency. Because of the international global nature of MET, the form was prepared in three core languages (English, French and Spanish). The survey form consisted of six sections with 58 separate items requiring a response or several responses, usually needing a box to be ticked, figures to be entered or a short answer question to be completed. The information sought by each section is summarised as follows:

Section A – General information

Particulars of the institution as to type, staff/student profile, marine certificate of competency courses offered and other maritime related educational award courses.

Section B – Computing resources

Details of networks and staff/student access to the Internet, e-mail, computer and multimedia equipment and IT technology.

Section C – Teaching resources

This section sought details of supporting instructional media to be found in classrooms and laboratories.

Section D – Teaching methodologies

Questions were asked relating to the training of teaching staff in the use of computer based equipment, the extent and use of CBT laboratories and details of courses offered by distance learning.

Section E – Simulation facilities

Details of types of simulation held and used were sought. This form of training is increasingly important under STCW 95.

Section F – Future developments

A view of future developments in the areas of CBT, access to e-mail and the Internet, equipping of classrooms with modern PC projection facilities, new simulation, IT training for teaching staff, and planned involvement with distance learning in future was sought.

Section G – General comments

This section asked for comments on future technology developments in the institution.

The form (produced in full in Appendix A) was also made available in a Web based online electronic form in English only. The form was mailed out in October 2000 (Appendix B refers) and the last returns were accepted in April 2001. A total of 90 responses were received, 16 of which (17.7%) took advantage of using the electronic format provided online. The survey return rate of 47 % was considered to be a sufficiently significant sample to allow valid conclusions to be drawn.

3.4 Global survey of MET institutions: survey results

The results are presented from an overall global picture with comment. An analysis of certain regional aspects using four discrete groupings is also made where appropriate or relevant. The 90 responses have been separated into Europe (41), Asia-Pacific (25), Africa-Middle East (12) and The Americas (12). In some cases individual items were not filled in. The statistics relate to actual responses. The global survey and analysis will be dealt with first.

3.4.1 Institutions: general information

A5 Type of institution

Institutions are represented by type as shown in the following Figure 3.2.

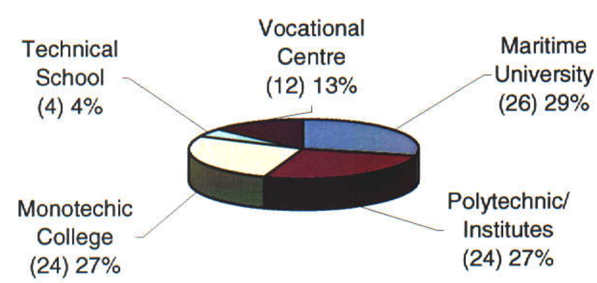


Figure 3.2 Number & type of maritime institutions

Maritime universities are most prominent in Europe and Asia-Pacific where nearly 85% of those putting themselves in that category are to be found. The trend to front ended training and including STCW 95 requirements within educationally recognised certificates, diplomas and degrees, is reflected in the fact that well over 50% of MET competency courses are now offered within higher education institutions. This reflects an identifiable trend in the past ten to fifteen years for many institutions to move away from certificate of competency programs approved by a national maritime administration or authority, and restructure the STCW 95 requirements within nationally accredited diploma or degree awards that also meet professional mariner education and training standards. (METHAR, 1998)

A6 Academic staff profile

The majority of MET institutions (61%) are quite small, employing less than 50 academic staff, with only eight of the 90 (8.8%) having faculty >200 and thus a larger pool of experience to draw upon.

A7-A8 Full and part time students

In looking at the number of students more than half of the responding institutions have fewer than 300 full time students. Of the remaining institutions, 25% can be classed as medium sized (300-800) and 20% as large. Quite a number of institutions do not appear to enrol part time maritime students, but of those that do, 60% have less than 300 such students per annum. As to be expected, all larger institutions also take in large numbers of part time students.

3.4.2 Maritime certificate of competency courses offered

A9 Ratings or seamen training

35 of the 90 respondents indicated that they offered some form of ratings training. With a few exceptions, such courses were confined to the vocational, technical and academy levels.

A10 Watchkeeper

It was interesting to note that very few of MET institutions responding were dedicated to training just deck watchkeepers (5) or engineer watchkeepers (4). 50% of respondents indicated an involvement with both deck and engineering disciplines, whilst more surprising was the fact that a third of them covered deck, engineering and fisheries requirements.

A11-12 Chief mate & master/2nd engineer & chief engineer

Some 53% of institutions surveyed indicated that they offered courses to Master Mariner or Chief Engineer level, with over 90% of this group providing courses for both disciplines within their institution.

A13 Dual trained officers

Dual or polyvalent trained officers refers to those mariners who have followed an integrated course of training covering both deck and engineering STCW 95 requirements which qualifies them to hold a certificate of competency as a deck and engineer watchkeeper and /or combined Chief Engineer and Master Mariner level. Only 14 institutions indicated in the survey that they offer dual or polyvalent program for all levels. They are confined to France, Germany, The Netherlands, Denmark and Sweden. One institution in the UK offers such courses but has no demand for them. Five institutions in Japan, Russia and the USA offer dual training to watchkeeper level only.

3.4.3 Maritime related educational award courses

A14-A16 Undergraduate awards

Educationally recognised certificates are awarded by 47% of the institutions, diplomas by 37% and undergraduate degrees by 30%.

A17 Post-graduate awards

The number of institutions offering maritime related programs at postgraduate Master degree and Ph.D. level is somewhat limited in the maritime education sphere. Although 19 respondents offer Master degree and 12 offer awards at Ph.D. level, there are some interesting regional differences. Thus only three of the 27 European higher education institutions offer mariners the opportunity to study at Ph.D. level, as against seven of the twelve in the Asia-Pacific region and two of five in the Africa-Middle East region.

3.4.4 Computing resources

B1-B7 Access to LANs, Internet and e-mail

82% of respondents have a Local Area Network (LAN) installed, penetration being highest in Europe (95%), the Americas (91%) and Asia-Pacific (80%) but only a third in the Africa-Middle East region. Overall more than 80% of institutions provide academic staff with access to the Internet and e-mail services. For students the level of access is lower, being 70% and 56% respectively.

CBT laboratories are available in three quarters of institutions with some 70% of staff using computers for teaching in the classroom. Penetration and use is highest in the Americas and lowest in the Asia-Pacific and Africa regions. Yet when it comes to looking at the number of laboratories and PCs available, the Asia-Pacific region reported the greatest density of equipment with an average ratio of PC labs/institution of 4.96, compared to 3.58 (Americas), 2.48 (Europe) and 1.5 (Africa-Middle East). Laboratories tend to be largest in Asia-Pacific at 19 PCs per lab followed by Americas 17.3, Europe at 10.3 and Africa-Middle East at 9.8.

B8 Staff access to supporting computer resources

This section sought feedback on the availability and access by academic staff to computing peripherals and multimedia tools for development of teaching resources.

infringement of copyright and plagiarism, rather than any financial constraints, as both items are relatively cheap today.

Table 3.3 Student access to computing and information technology

Region	Europe		Asia-Pacific		Africa-ME		Americas		Global	
Resource	Yes%	No%	Yes%	No%	Yes%	No%	Yes%	No%	Yes%	No%
CD-ROM, DVD	85	15	52	48	33	67	75	25	68	32
IT via Library	83	17	60	40	50	50	75	25	71	29
CD-RW drive	56	44	40	60	33	67	58	42	49	51
Scanners	66	34	48	52	33	67	83	17	59	41
Laser printers	78	22	52	48	42	58	75	25	66	34
Colour printers	70	30	48	52	50	50	75	25	62	38

3.4.5 Teaching resources

An important aspect in relation to access to computing resources is the question of whether the classrooms provide academics with the delivery technology to warrant the teacher spending the time to develop suitable PC/IT based presentation materials. The production of both written material and the selection or creation of supporting graphics, pictures and other learning materials requires special skills, particularly where placing material into an online site. Section C (questions C1 - C10) investigated.

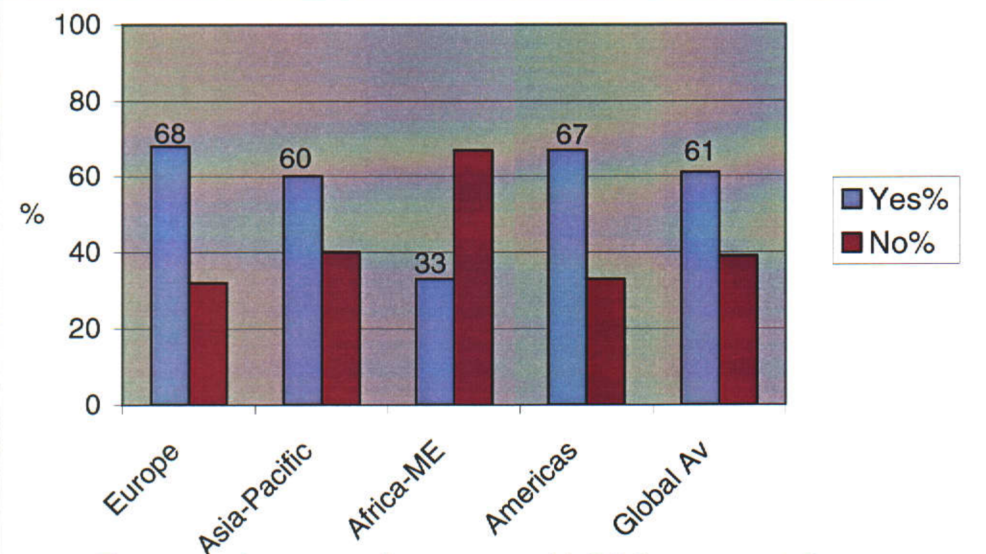


Figure 3.3 Access to classrooms with PC instructor station

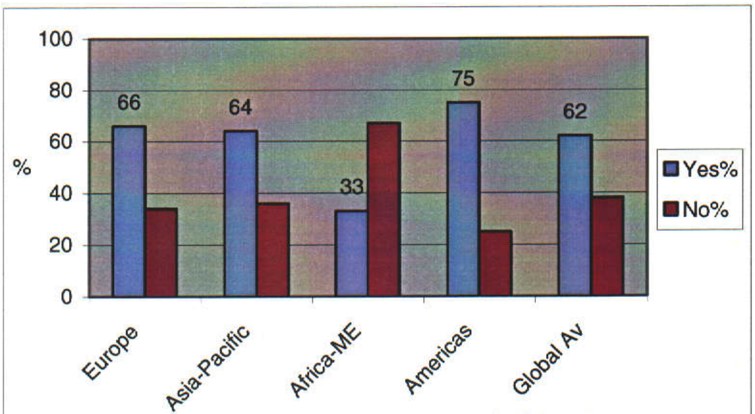


Figure 3.4 Access to classrooms with SVGA projector

Globally 61% of MET institutions surveyed have access to classrooms fitted with a PC instructor station and Super Video Graphical Array (SVGA) projector with an average of 4.3 such classrooms per institution. There is an evident shortage of such technology in the Africa-Middle East region with less than 1.3 per institution, as the low level of installation of such equipment shows in Figures 3.3 and 3.4 above. The returns do not indicate whether projector equipment is fixed or portable, the latter providing flexibility for a range of uses in different locations. However portable projectors are still relatively expensive ($US 3000 and upwards) and require the support of mobile laptop computers and many smaller MET institutions would have limited budgets for such acquisitions.

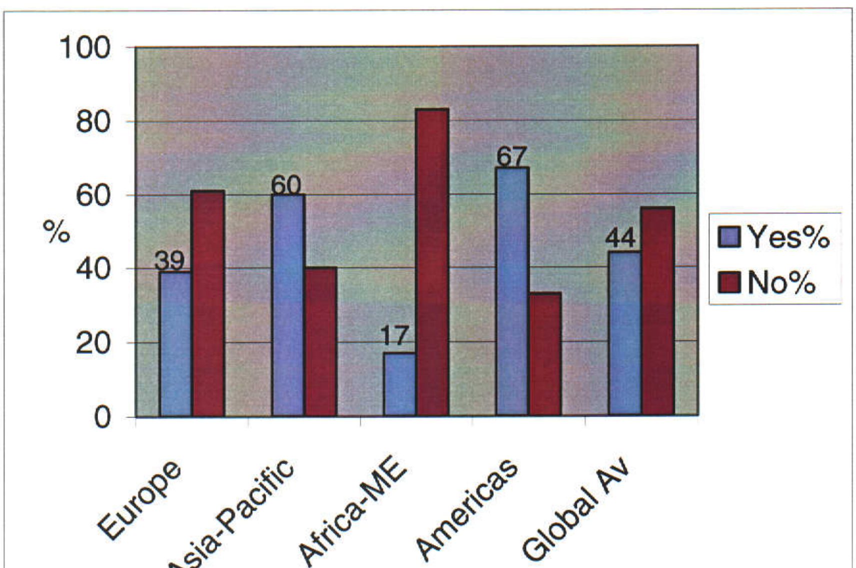


Figure 3.5 Access to video presentation tablet

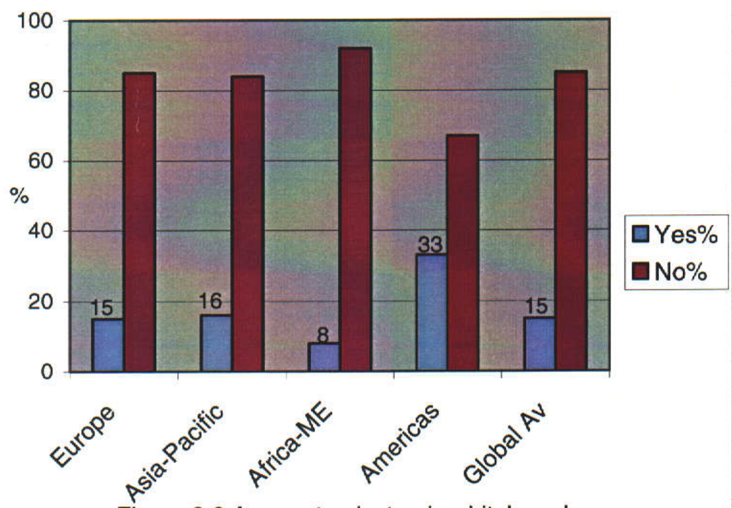


Figure 3.6 Access to electronic whiteboards

New media presentation technology, such as video tablets (Figure 3.5) and electronic whiteboards (Figure 3.6), is not so readily available in MET institutions today. Video tablets, which allow the projection of almost anything from printed material, overheads, slides, negatives or real objects to screen are growing in popularity but are still quite expensive (c$US3000). Institutions in Asia average nearly five each of these units, compared to less than one and a half units in the Americas. The use of electronic whiteboards has been more popular with commercial business for sales conferencing and seminar work, but as Figure 3.6 shows only 15% of the maritime education world has taken them to heart in any numbers, just 14 institutions reported having a total of 18 electronic whiteboards between them. Electronic whiteboards are generally considered most effective from a teaching, interactive point of view in a dedicated computer assisted learning (CAL) laboratory rather than in the typical classroom.

Figure 3.7 indicates that more than half of the responding MET institutions have provision for Internet/Intranet connectivity in classrooms, but this figure is not reflected in the African-Middle East region where Internet technology still has much catching up to do. This is further confirmed by surveys of WMU students from these regions (Olaiya, 2002). Asian institutions, for example, have nearly ten times the number of Internet connections in classrooms than their African-Middle East counterparts.

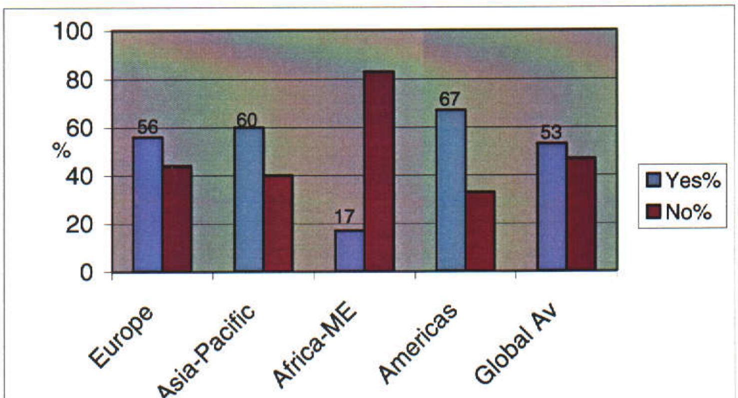


Figure 3.7 Classroom Internet Links

Examination of Netsizer.com web site clearly illustrates the problem Africa has in particular in providing Internet access to its people compared to the rest of the world. This site indicates that there were only 2.5 million Internet users in the African continent in 2000 compared with 124 million in the USA, 48 million in Europe, and 36 million in Asia. However, when the teachers' basic technology for presentation, the overhead projector, is considered, Figure 3.8 below clearly shows how indispensable this relatively cheap piece of equipment is in the general teaching classrooms of all regions.

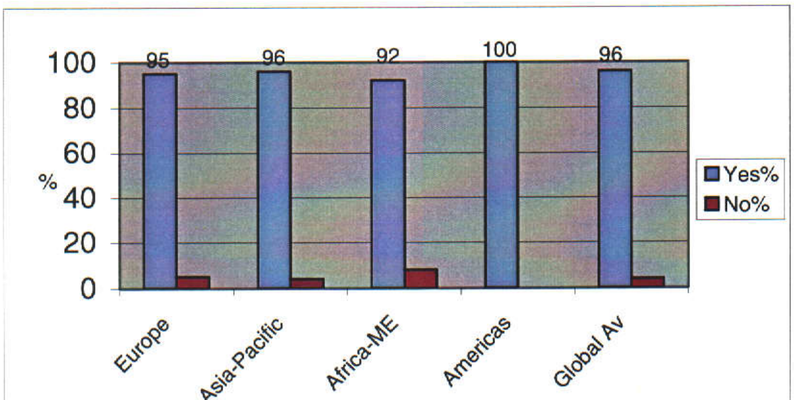


Figure 3.8 Access to OHPs

The ubiquitous television and its accompanying video recorder have supplanted the use of 35mm slide projectors and 16mm movie films in many MET programs, and Figures 3.9 and 3.10 on the following page indicate the popularity of this equipment in MET institutes with a global availability in excess of 83% in all regions. The access level to video cameras (Figure 3.11) is lowest in the Asia and Africa regions with most American institutions possessing them.

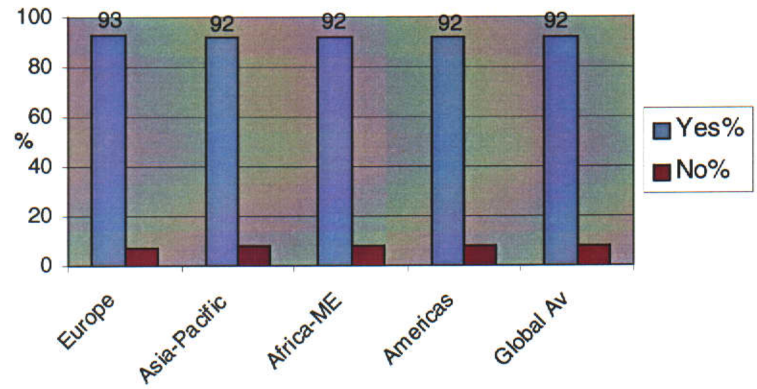


Figure 3.9 VCR in classrooms

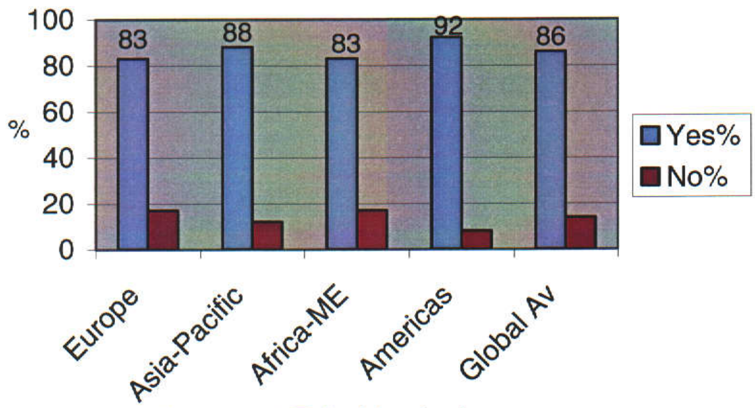


Figure 3.10 Television in classrooms

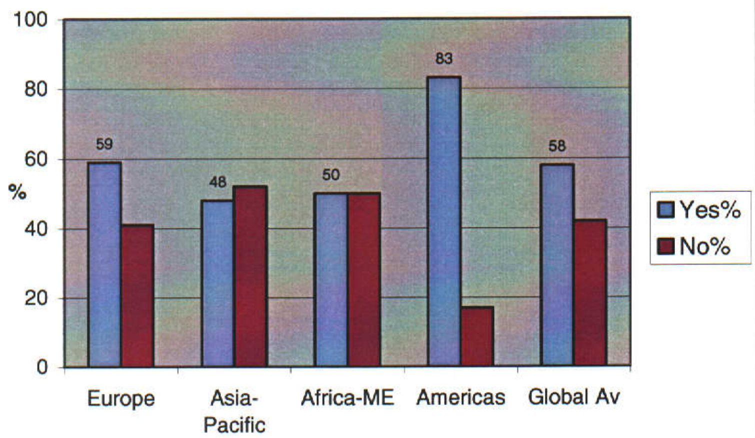


Figure 3.11 Access to video cameras

3.4.6 Teaching methodologies

Whilst the possession and availability of new technology in educational institutions provides one guide to modern developments in maritime education and training, of more importance is the evidence available as to how it is being employed in the teaching and learning process. The first part of this section sought a response as to how staff are trained to use computer based equipment in the classroom and whether CBT laboratories are used for group learning.

D1-D2 Staff training and use of CBT laboratories

The outcomes here, indicated in Figure 3.12, show a high level of use globally of computer laboratories for group learning and CBT (77%) yet only 64% of institutions offer training to academic staff to use such equipment in the learning process, probably indicating some teachers using labs have had no training.

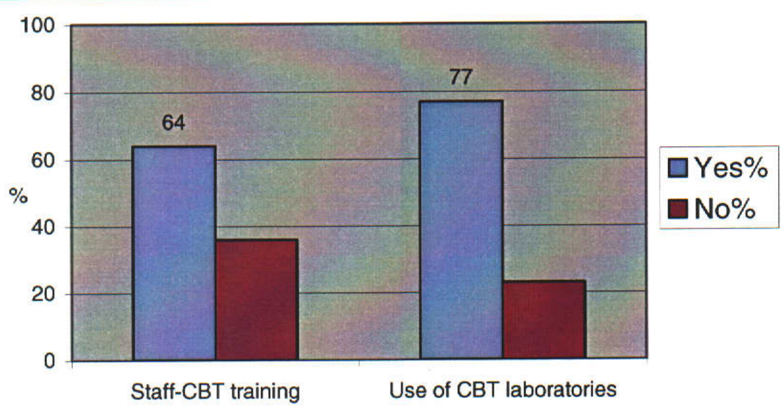


Figure 3.12 CBT training & use of laboratories

Other research (METHAR, 1998) has also brought forth evidence that generally maritime lecturers are not comfortable with the use of computers in teaching, as many lecturers felt they had not been adequately trained in the use of computing technology nor in the didactic skills needed in transferring from a classroom to a computer learning and teaching environment. If we look at the outcomes regionally, the picture is even worse with only slightly more than half of Asia-Pacific and Africa-Middle East institutions offering CBT training to their academic staff. There is clearly scope for action here.

D3 Maritime courses by distance learning

The second part of this section looked to establish the extent to which maritime institutes were offering maritime course using distance learning delivery methods. In view of the relatively high levels of access to multimedia and communications technology evident in the survey so far, perhaps the outcomes would reflect the use of these resources to development and support distance learning.

The transition from computer based learning to distance learning, however, is not an easy one. Both developmental start up time and costs, access to technology and media by external students may be lacking. The market may not be ready for distance learning methodologies, the institution may not be convinced that it is a path to pursue, just yet. It is probably not surprising that distance learning courses are not offered by institutions in the Africa-Middle East region (Figure 3.13 refers), as the survey provides clear evidence of a lack of availability of technical resources to warrant it. Access to maritime distance learning courses is highest in the Americas.

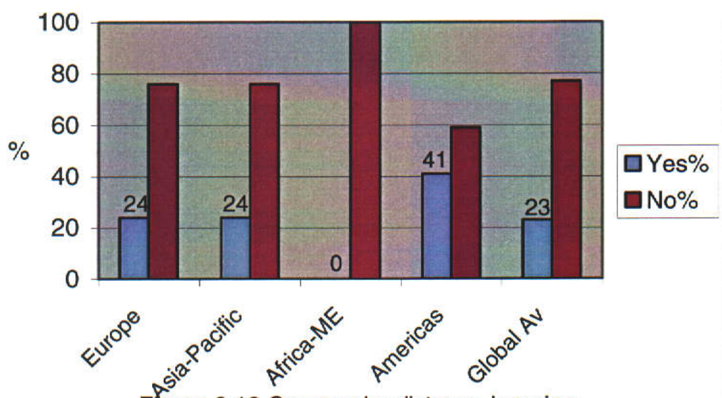
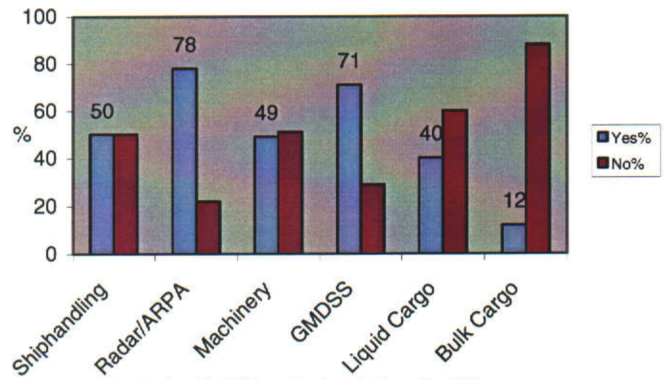


Figure 3.13 Courses by distance learning

Twenty-one institutions indicated in the survey that they offered distance learning courses, and it is helpful to see how they used supporting resources within them. Teleconferencing is used by six institutions (28%), video conferencing by five (24%), e-mail links by twelve (57%), Web based distance learning (DL) management site by six (28%), video tapes by eight (38%), audio tapes by seven (33%) and nine (43%) use their own in-house multimedia materials. No one system dominates although the use of e-mail as a communications medium is shown to be the most popular form by 70% of distance learning students in the USA, according to a survey by the National Education Association (2000).

3.4.7 Simulation facilities

The use of marine simulators in MET has been encouraged for many years, the first radar simulator starting off life in 1959 and later years saw the introduction of navigation (1965), shiphandling (1967), cargo (1976) marine diesel engine (1980) and GMDSS (1992) simulators. However, it was only with the advent of STCW 95 that radar and ARPA simulator training became mandatory in 1997. The use of the technology in the other areas is allowed and encouraged. With more than 1100 marine simulators installed in the MET world (Muirhead, 2002), the survey looked to establish some pattern regarding availability both globally and regionally.



3.14 Availability of simulation facilities

If we consider the regional returns and make allowance for those institutions offering courses in a particular discipline only (e.g. a dedicated marine engineering college is unlikely to have invested in a shiphandling simulator) then the picture is more definitive. Table 3.4 provides a good guide to the distribution of simulation technology. The high level of penetration of radar/ARPA simulators reflects the mandatory requirement since February 1997 for the use of simulators for this type of training.

Table 3.4 Availability of simulators in institutions by region

	Europe	Asia Pacific	Africa-ME	Americas
Shiphandling	71	65	33	78
Radar/ARPA	89	82	75	100
Machinery Space	76	35	25	91
GMDSS	91	75	58	91
Liquid Cargo	65	32	33	63
Bulk Cargo	33	7	0	14

The USA and Europe in particular have a high degree of access to this sophisticated technology, yet the demands for training of seafarers and thus manpower supply today lies in the Asia-Pacific region. In the latter region the availability of machinery space, shiphandling and liquid cargo simulators in institutions lags behind that of its American and European counterparts.

3.4.8 Future developments

This section attempted to gauge future developmental intentions of institutions up to the year 2005, or to ascertain their developmental priorities if funding was made available for them. The section focused particularly on two aspects, that of computer technology and its use in the internal teaching and learning process, and external delivery via distance learning methods using modern communications and multi-media tools. Again it is useful to consider the responses from both a regional and a global perspective. Questions F1-F6 dealing with facilities are examined first.

Table 3.5 Future developments (2000-2005) - by region
(percentage of positive responses)

Questions: Do you plan to:	Europe	Asia-Pacific	Africa-ME	Americas
Create CBT Laboratories?	78	81	100	91
Give all students e-mail access?	64	75	75	100
Give all students Internet access?	68	70	82	100
PC projectors to all classrooms?	59	73	75	80
Give IT/CBT training to teachers?	94	96	92	100
Purchase new simulation facilities?	78	82	73	67

The number of responses to these questions varied due to the fact that a group of institutions already provided some or all of these services to staff and students. The feedback is however enlightening in providing a view of future intentions. For example there is a high degree of unanimity about the need to implement IT/CBT training for their teachers. There is a similar desire to create CBT laboratories with modern PC based equipment. These two aspects go hand-in-hand. Apart from the Americas, there is less than full enthusiasm for giving students access to e-mail and the Internet. The reasons for this are not clear, although site security is often quoted by those opposed. There remains a strong desire to purchase new or upgrade existing simulator facilities. The overall global picture is indicated in Figure 3.15.

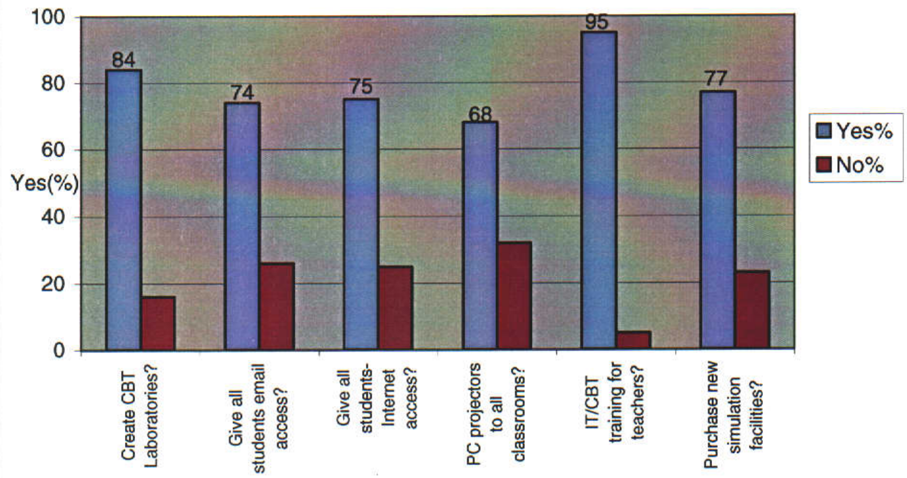


Figure 3.15 Future development (2000-2005) - a global view

The general picture that results from the responses is one of positive optimism by the great majority of institutes, who indicate a clear desire to plan future developments around new technology and equipment. This is also coupled with a realisation that academic staff, in particular, need to be provided with formal training programs if teaching and learning processes are to reap the full benefit from the use of such resources. Expectations however are tempered by concerns at the availability of funding to mount such developments in future (see section 3.4.9)

Sections F7 – F10 examined future intentions in the area of distance learning. The responses are presented in Figure 3.16 below.

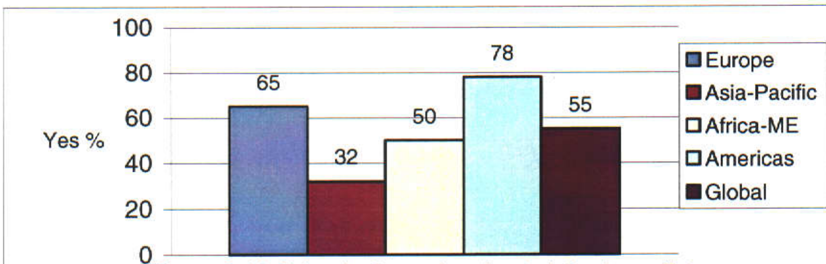


Figure 3.16 % Institutions planning to introduce distance learning courses over next 5 years

Slightly more than 50% of the 80 respondents to this question had a positive view on introducing new maritime courses through distance learning in the future. Generally the Americas and Europeans are more enthusiastic for this means of delivery, while the Asian region in particular does not see it as a major area of development in the near future.

Table 3.6 Plans for developing maritime courses through distance learning
(Percentage of positive responses)

Questions: Do you plan to:	Europe	Asia-Pacific	Africa-ME	Americas	Global Av
Develop DL materials in house?	89	41	83	100	75
Use a Web site to manage DL?	80	43	100	86	72
Develop a multimedia studio?	61	53	71	44	57

Of the 44 institutions which gave a positive response as to whether they planned to offer maritime courses via distance learning in the next five years (question F7), there was a high level of interest (75%) in developing own distance learning materials in-house. Note that those institutions already offering maritime distance learning courses were excluded from this group. The least enthusiasm for this approach was in the Asia-Pacific region. Similarly the use of online sites to deliver distance learning courses shows a high degree of intention. The bigger step of actually developing a multimedia studio to produce supporting audio-visual, online graphics and streaming video learning materials was treated with a little more circumspect.

3.4.9 General comments

A number of views were expressed through section G and these are summarised from a regional basis, as factors influencing development differ markedly from region to region.

The Americas

One institution in the USA noted that for the past three years all incoming students were required to bring their own laptop and printer. This is a growing trend in USA maritime academies and elsewhere. This can be contrasted with the picture in some Central and South American institutions where plans are in place to install a Local Area Network (LAN), seek grants to acquire or upgrade simulation facilities, retool training equipment and retrain teaching staff. In one case, the planned extension to workshops and laboratories is a result of moving into new areas of fisheries and port education and training and the consequent increase in student numbers. The potential of distance learning is recognised by many, but the ability of budgets, manpower resources and time to allow such developments are seen as a challenge.

Europe

A number of comments here also focus on the importance of updating and upgrading technical facilities ranging from safety training equipment to shiphandling simulators. This theme of keeping up-to-date is very noticeable. Others have plans to extend Internet/Intranet links to all classrooms and develop self-learning materials on CD-ROM in the areas of seamanship, oceanography and languages. The latter focuses on the English language skills for mariners. The formation of a collaborative maritime education centre between four institutions in Denmark is a notable development. An interesting comment from Poland, where a modern research/training vessel was commissioned in 1998, reminds us that the day of the training vessel is not considered to be over by some (Denmark however in 2000 moved from training vessel to simulator based training support).

Asia-Pacific

A common thread in comments received is the clear plans of many to make changes in the future, but expressed in a rather hopeful and optimistic way, reflecting the uncertainty of obtaining funding to make such changes. It is noted that the trend to using Microsoft PowerPoint for classroom presentations is increasing and a number plan to extend CBT facilities and make Internet and e-mail more available to staff and students in the future. One Chinese institution has plans to introduce a distance learning system for a specific shipowner, while others think that it will more likely happen for them in the next ten years. Another institution expressed the desire to 'hook up' with other MET training institutions and organisations in multi-media activities in the future. A small institution in the Pacific noted that technology is improving rapidly, and maritime training should be improved by using new technological equipment.

In relation to development of distance education, a word of caution was expressed by an experienced provider of maritime related distance learning courses that stated that "the emphasis must be on the most effective way to assist students to achieve learning outcomes - this includes consideration of the most effective form of delivery. The educational outcome must drive the use of technology in education, not the other way round"

Africa-Middle East

Again the few comments were centred on the need to refurbish and upgrade existing facilities or acquire new technology. One perceptive comment noted that technology was developing so fast that what they had today may not be relevant in five years time. There was a readiness to change with time but lack of funds hindered a positive approach. Thus plans talked about refurbishing computer laboratories, acquiring language laboratories, simulators, PC projectors for classrooms and Internet access. Others focused on providing classrooms with computers, intensifying simulator training and using computer based question databanks for examinations.

3.5 Summary evaluation and analysis

The almost 50% level of response to the questionnaire by maritime institutions around the globe has provided the research study with quite extensive information on the current and future availability and use of facilities, and of teaching and training activities associated with them. While the survey has endeavoured to also provide a regional picture of activity, Europe and Asia-Pacific regions between them represent nearly three quarters of all responses. As the bulk of training and thus manpower supply to the global shipping industry emanates from these two sources, the trends shown by them are more indicative of how institutions are responding to new technology and a changing maritime world than the less developed and equipped Africa-Middle East region.

One feature of the sample is the growing proportion of maritime institutions (56%) that can be considered to be working in the higher education sector. In other words maritime programs are offered within undergraduate diploma or degree courses, which generally go beyond the statutory certification needs of maritime authorities (i.e. meeting STCW 95 requirements). This trend has been noticeable also in Europe (METHAR, 2000) where a growing number of countries are encapsulating STCW needs within nationally recognised undergraduate education awards.

Although rationalisation of maritime academies has taken place in some countries in past years (e.g. UK, Australia, Sweden, Denmark), the survey indicates that many institutions are still very small, nearly two thirds employing less than 50 academic staff and more than 60% having less than 300 students. In looking at the upgrading of equipment, purchase of new technology, and the development of new learning methodologies in the future, a desire expressed by many, economies of scale are lacking and it is difficult to see how many of these smaller centres will ever have the resources to keep up with the rapid changes taking place. There is a clear need, particularly in Europe, for governments to look at how very limited resources can be better used in a more integrated manner. Politically this is difficult in some countries, such as Germany and the Netherlands. In the meantime the reoccurring theme coming out of the survey is a lack of funding to really move ahead in the future. This needs to be addressed.

In the institutions themselves, the general pattern is for the nautical and engineering disciplines to be under the same umbrella, while a surprising feature was the extent to which nautical, engineering and fisheries disciplines are active within the same campus. Placed next to or near to an institution of higher learning, the optimum use of all resources could lead to more effective and efficient development. This model, of which there are several examples in the world, could prove a winner for the rationalists. Dual training programs offered by institutions in the survey represent a minority activity (15%) and clearly many in the shipping industry do not see such officers as the future way. For example, Hamburg Fachhochschule is withdrawing from such programs (2002), but Denmark in contrast in 2000 introduced dual trained watchkeeper programs, and is now proceeding to introduce dual training at the highest certificate levels (2002).

Regarding courses of training for sea-going officers, the camps are divided into two opposing views. Some ship operators only want to pay for training that produces the required skills needed for competent operators. Others take the view that young people today spend a finite time at sea and expect to have a more rounded and fuller education that will enable them to follow a different career ashore later. The trend today is for institutions to offer a broad range of courses in such areas as maritime business, management, economics, law and technology that goes beyond STCW 95 requirements. The sample shows that many institutions are very active in issuing educational awards to students, in addition to offering opportunity to acquire professional competency certificates. At a higher level, Europe lags behind Asia in offering opportunity to study for Ph.D. for example. Because of the ups and downs of traditional mariner training, there is evidence in the survey of more and more institutions offering broader maritime programs orientated towards the needs of the shore based maritime industry.

The availability of computing and Internet facilities is very high everywhere except in the Africa-Middle East region, where a marked lack of resources is the main drawback to advancement. While staff access to IT and computing is pleasingly high, the returns give a picture of a lack of use of the technology by teachers in classrooms and laboratories. Training of staff in the use of such innovations lags behind accessibility of the technology. An effort is needed here, as other research (METHAR, 2000) shows similar concerns by European lecturers at the lack of training in new technology and teaching methods. The reluctance by some to provide students with access to Internet and e-mail services reflects, from the author's experience, a lack of confidence by many maritime lecturers and instructors in the use of the technology. Yet 60% of institutions (question C1) claim to have classrooms fitted with a fixed PC based instructor station (i.e. PC presentations). If we look at the next developmental step, working with groups in an integrated instructor controlled PC laboratory, the response level is over 83%. One must express some concerns as to how effectively such resources are being used in the light of the need for training in the use of such technology.

The penetration of modern instructional media is relatively good and many institutions appear to have plans for the progressive upgrading of classrooms and laboratories with PC projectors and video tablets as prices come down. Many practitioners however do not appear to be convinced yet of the value of the electronic whiteboard for teaching purposes. Traditional tools, such as the overhead projector, television and video recorder, have a very high degree of penetration and acceptability across all regions. Accessibility to newer technology in the form of video and digital cameras is modest but growing. The use of these and other multimedia tools will play a greater role when institutions pursue the development of online learning materials and distance learning delivery systems.

Where to with distance learning? Figure 3.13 clearly indicates that it is still in its infancy in the maritime education sector. As later chapters show, apart from onboard training programs, very few institutions offer full maritime educational courses by distance learning. Developmentally, it is a costly and time consuming step and needs to be considered carefully. The growing accessibility to the Internet and e-mail services ashore and at sea, however, will assist in making such decisions easier in the future. Institutions need to undertake market research to determine the potential of distance learning in their areas before taking the plunge.

Simulation facilities, the use of which has been greatly encouraged by STCW 95 since 1997, have quite a wide variety of penetration. The mandatory nature of radar/ARPA training by simulator is reflected in the 78% global level. An earlier survey by Muirhead (1997) of 99 simulator operators in 15 European countries showed a very high level (96%) of radar/ARPA simulator availability. GMDSS simulators are similarly highly available, and although not mandatory for the training, they are the most popular form of conducting training and assessment in this area as distinct from real equipment. The most noticeable areas lacking simulation training facilities are machinery space simulation in the Asia-Pacific and Africa regions, and generally liquid and bulk cargo simulation in all regions. It is unlikely that IMO will make other forms of simulation mandatory until market penetration achieves much higher levels.

So what of the future? As stated earlier, in section 3.4.8, the future today is perceived as being focused on the use of computer technology, access to the Internet and World Wide Web and utilising these facilities and multimedia tools for enhanced learning and for extending educational opportunities beyond the walls of the institution. Judging from the responses, most MET institutions are very aware of the changes taking place in technology and the challenge it poses to their future survival. The two most supported aspects are the intention to create CBT laboratories (84% of respondents) and to give IT/CBT training to teachers (95%). Although the proposal to provide students with e-mail and Internet access is less well supported by some institutions, thinking is tempered by a lack of access to the technology at present, in some cases.

In considering the responses to the acquisition of computing technology and multimedia capability, there appears to be an interesting dichotomy. On the one hand some 75% of respondents plan to develop distance learning materials in house. On the other hand only 55% plan to introduce distance learning maritime courses in the next five years. Either there will be an over-production of DL material, a use for which has yet to be determined or there will be a wasteful use of human resources in developing such materials.

However, the evidence is there that MET institutions will find themselves increasingly subject to pressure from the maritime industry to develop education and training outreach to seafarers on ships at sea. Shipowners themselves are under increasing pressure to make use of new technology to enhance onboard training and to upgrade the skills and proficiency of crews. As well, the problems of recruiting and retaining personnel at sea will also force them to provide crews with access to the Internet and e-mail services at sea. Therein lies future opportunity for MET institutions to use communication technology in association with distance learning methodology through co-operative links with the industry.

CHAPTER 4
INTERNATIONAL SHIPPING - TRAINING TRENDS

4.1 Introduction

The world is changing rapidly due to technical innovation. Ship management and ship operations today are being greatly influenced by the impact of new international legislation such as the ISM Code, the revised STCW 78 Convention and revisions to the SOLAS Convention. The maritime industry cannot isolate itself from such influences and yet there is still a reluctance by some to go forward and embrace new methods and new techniques that will meet the challenge of change. In addition, governments are increasingly using new technology to enforce global maritime safety and pollution standards. Consider the co-operation between States in port/state control activities where computer networks are playing key roles. Satellite monitoring of pollution from ships and tracking of fishing fleets is now common.

New technology offers the ship operator an opportunity to improve vessel operation efficiency and maintenance. The port, terminal and freight forwarding industries are also making use of new technology in the form of Electronic Data Interchange (EDI). This latter is defined as "the transfer of structured data by agreed message standards from one computer system to another by electronic means" (ESCAP, 1993). In the development of electronic transport documents, Donner (1999) noted that electronic Bills of Lading had been talked about for over a decade, the problem of using the technology being more legal than technical. However, the range of powerful new technologies and the consequent changes in operational practices in the global maritime industry means that those MET institutions that do not invest in new education and training approaches will be disadvantaged and left behind. Other non-MET educational institutions may take the opportunity to offer the ship operator an alternative service.

Many shipowners, of course, recognise the need to change and embrace new methods. Many maritime transport research projects that focus on the impact of technology on shipping in the 21st century are today being funded by the European Commission, shipowner associations, governments and maritime unions. Satellite communications, electronic data transfer, video links and transmission, distance learning, onboard interactive computer based training, CD-Rom, e-mail, Internet and the World Wide Web all have tremendous potential to alter and influence the manner in which ship operations are managed effectively and economically. The shipowner today has new training obligations under the revised STCW 95 Convention and ISM Codes to ensure that all seafarers employed on the company's ships are familiar with all their duties before the ship sails. This creates new problems in ship operations, training and organisation. Can some of this training be done more effectively and economically onboard ship? Many owners are pursuing such a path.

A Norwegian research initiative, led by Berg (1996), called 'Information Technology in Ship Operations' was designed to improve competitiveness through the development of new operating concepts and information systems in shipping companies. It comprised a series of projects relating to performance reporting, maintenance optimisation, training systems and new classification concepts. In one of these related projects, the Norwegian management company Red Band has had Computer Based Training (CBT) systems onboard two of their vessels since November 1994. This has now been installed on all of their post 1988 vessels. Through Marintek of Norway, three Norwegian shipowner/management companies have designed vessel specific training systems, using CBT modules onboard and at specific locations ashore. Experience has shown that officers and crew embrace onboard PC based training with a high degree of enthusiasm. In short sea trades some training may be done ashore beforehand. Research is continuing to develop CBT modules that are part of pre-planned on-the-job training activities. Some consider that putting training videos onboard is generally not so highly effective, but this is unproven by research to date. Both systems have their place.

A follow-up Norwegian project, completed at the end of 2001, was called 'Flexible Learning System for the Shipping Industry' and involved government, the shipowners' association, research council and industry. It was designed to support shipping companies when they implement flexible learning as part of their enhanced training and education system.

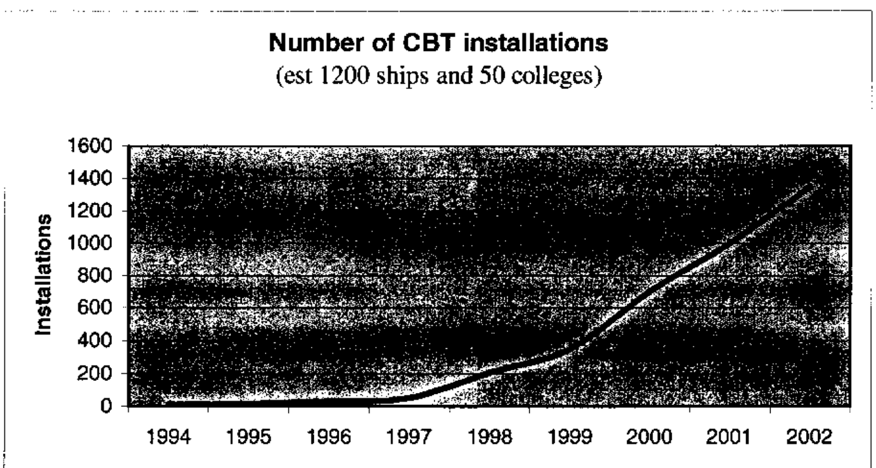
Another initiative established in Sweden in the late 1990s with shipowner association and government support, moved away from traditional classroom methods and was orientated around new training methods, optimising the use of information technology, computers and simulator technology. Trials continue in Scandinavia using Inmarsat satellite communications, CBT and distance learning methods for onboard education and training and leisure activities. Many maritime institutions will in future offer programs to the seafarer via the Internet. E-mail and the Web will become standard everyday tools onboard ship opening up new opportunities in education and training, remote polling and monitoring of ship operations, improved maintenance management and stock control, and cost effective operations.

Consider the problem of attracting young people to sea today. Instant communication to home offers an attractive recruitment inducement to young people today. The human factors element is very much under the microscope at present and the International Transport Federation of Unions (ITFU) and the European Union (EU) are supporting research programs. Another EU research project, covering marine communications (MARCOM, 1999), looked at the problem of onboard communication in ships with multi-national crews. Technology in the form of interactive CBT language programs can help here. Conducting such training ashore is not always feasible or economical.

For the ship operator, however, the major source of officers today has swung to the Asia-Pacific basin. Recent surveys (CIIPMET, 1998) showed that modern computing resources are lacking in many institutions in the region, and traditional teaching methods hold sway. If owners of highly sophisticated modern ships are to take advantage of IT and satellite communications technology, the source of recruitment needs to be carefully thought out. To what extent will the company need to provide training in the use of its onboard systems, for example? Can this be done onboard or in conjunction with a local educational institution?

But must new training requirements be carried out in shore based training institutions? Today technology provides the innovative owner and operator with a window of opportunity to transfer some of the training for required operational skills to the onboard environment. Indeed, new technological developments also provide increasing potential for the assessment of an individual's competence to perform those skills in the workplace.

An example of the new approaches to training, which are possible today, is the work of the Norwegian company Seagull AS. Their ambitious plan to cover the seven functional training areas of the STCW 95 Convention through a CBT database is well under way (Figure 4.1). As at July 2002, more than 60 CD-ROM based training modules, covering STCW 95 related issues, were available. A further nine modules provide computing and language training. All these can be placed onboard the ship or downloaded onto the ship's server and managed via the Seagull Navigator system, while the Seagull Administrator is a database that takes care of recording and storing assessment reports created by each individual trainee. The latter information can be transferred to the company office ashore via built-in export and e-mail function. Similarly, Videotel, a company set up 25 years ago to provide training onboard ships via 35mm films, later using video, can provide its full suite of programs on CD-ROM.



Source: Ringstad, 2002

Figure 4.1 Seagull AS: CBT deliveries to ships and colleges 1995-2002

The challenge is to persuade certifying authorities to accept evidence, from shipmasters and others onboard, that a person is competent to perform certain tasks or functions. In this regard, the potential of satellite communications to provide the links for the monitoring of personnel at sea must not be overlooked, and for training institutions, company training managers and statutory authorities the technology is already in place to permit such an approach. In an interesting breakthrough, it was reported (Seagull News, 2000) that the Norwegian Maritime Directorate (NMD) had officially recognised the use of CBT within STCW 95 required education and training. The NMD has laid down guidelines that state that CBT may be used as a learning tool for all of the theoretical aspects of STCW 985 required training. This is based on the assumption that such CBT is part of any NMD approved program of training. Figure 4.2 illustrates a CBT based program for personnel of a ship.

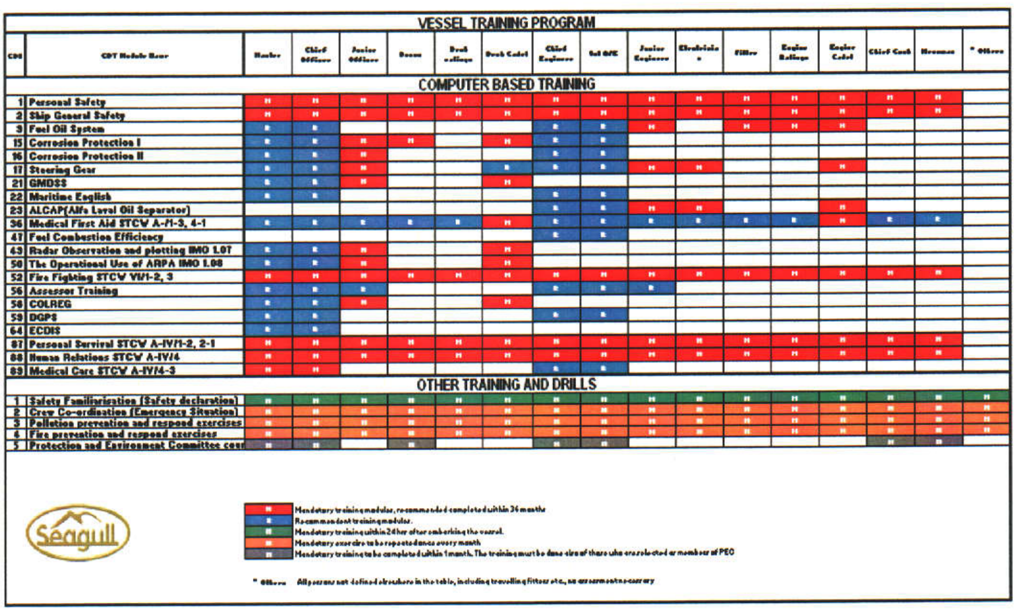


Figure 4.2 Example of a vessel's CBT training program

A competency evaluation system, CES 4.1, a CBT based assessment program from Seagull, aims to assist shipowners to meet their obligations under regulation I/14 of STCW 95 regarding the competence of seafarers they employ. In the latest release (2002) the system uses a large databank of over 5,000 questions to generate an objective test based on rank, vessel type and functional areas. Thus it can be used to screen new applicants, verify the competence of existing crew, assess personnel for periodic compliance with standards, and assist in pinpointing training needs.

4.2 Computer technology and the ship

The shipboard network is here. As long ago as 1995, Bergesen Line made the decision to fit each of its 44 ships with a Novell local area network (LAN) and in the late 1990s Stolt Tankers installed fibre-optic LANs throughout its new ships (Muirhead, 1998). Many companies today have computerized their ships and supplied their whole fleet with ship-shore communication software systems from companies such as Rydex (Rydex Express, RMX2), EasyLink (OceanConnect range), Globe Wireless, Stratos, Bass, and Xantic (AMOS Express etc). A growing area is in electronic procurement systems for maintenance, spare parts, stores, etc. with systems such as Unitor and Shipserv being just a few of the many companies established in this field. For example, Unitor draws upon a database of over 10,000 products, and in 2001 supplied more than 15,000 ships in 1063 ports and 145 shipyards (Unitor.com, 2002).

Some companies such as Wallem Ship Management have set up their own hub to optimise flexibility for owners of their managed ships. Today in 2002, a ship can access online programs covering bunkering, shipbroking, chartering and ship sales. How will the shipowner and shipboard personnel use such facilities? Who will be allowed to use the network and what will the shipowner allow the system to be used for? What are the objectives for such technology? Improved profitability, efficiency and productivity - Yes! Improved safety and operating standards - Yes! Onboard training – Yes! Social services and self education for the crew – Yes, hopefully!

A survey by Davies & Parfett (1997) looked into the possible role of the Internet in improving the welfare and education of seafarers. The report found that unfortunately many companies were opposed to its use by seafarers, often due to a lack of knowledge of how the Internet works and how it affects their systems and costs. However, the new century is seeing a growing realization by many companies of the need to open up communication links to crew members also. The growing availability of hand held satellite telephones on ships in the coming years, promises to create an alternative personal crew calling service, as costs come down.

Some concerns need to be addressed, however. If the Master, officers and crew are to be expected to increasingly use IT for the safe and effective management of the ship, then it is necessary to know the extent to which basic communication and computing facilities and services will be employed. Cost considerations may colour a company's use of the medium. Will satellite video services be used for maintenance purposes? How are High Speed Data links to be used? What range of software will the company employ to conduct business between ship and shore?

Training implications flow in both directions. Communication is a two way process. The potential for improved flows between the ship and the office and vice versa implies the need for a better understanding of each other's role in this increasingly interactive environment. Is this reflected in the company training policy for both seagoing and shore based staff?

4.2.1 IT services survey

In considering some of the aspects raised above, what can the future shipmaster and officer expect to find onboard influencing operational behaviour? The Internet today has become the significant harbinger of the Information Society, using a common language for seamless communication across networks. For ships, access is made easy via PC and satellite links. As a multi-functioning tool it allows access to company databases, downloading of data, pictures, voice and ultimately fast full motion video. Access to e-mail services means the ship never disappears over the horizon out of touch. Crews can maintain contact with families. Telemedicine service means greater peace of mind aboard in the case of accidents. The opportunities for the company for the provision of onboard training programs are boundless. According to Netsizer (2002), the Internet today comprises more than 192 million domain servers or hosts. CyberAtlas (2002) also estimated the number of Internet users at 445 million in August 2001, rising rapidly to 709 million by the end of 2004. The rate of growth speaks for itself.

Communications software companies provide ready made systems to handle ship and shore connections. Can the shipowner afford not to provide these links onboard and ashore? Unfortunately, the spate of consolidations of land earth station operators and software communication developers during 2000 and 2001 produced a rather confusing picture from a training point of view. Digital Ship in its May 2001 edition reported that this process is leading to the emergence of two distinct business models: the one-stop shop and the multi-supplier scenario. An example of a new development is the signing up by Hyundai Line to EasyLink's (formerly GN Comtext) store and forward communications package for its 84 ships and 56 offices (DigiShip 23 June 2001). Figure 4.3 illustrates a range of typical services offered.

Figure 4.3 Maritime communication services from EasyLink Services

Stratos announced a voice communications package that includes Inmarsat, Iridium and Very Small Aperture Terminal (VSAT) services. Looking at more social needs of seafarers, the Mission to Seafarers (MTS) is involved with both companies in developing a crew calling initiative.

Where else is technology going? Although many services are only embryonic, technical difficulties are being overcome. Consider Internet voice technology using local call rates for long distance calls, real time 3D graphical systems, video conferencing, video distribution services, intranets or private company networks, for example. Improvements to high-speed data (HSD) services will continue as the volume and complexity of data transmission grows.

In communications the emergence of global satellite telephone systems, such as Inmarsat phone services and the use of hand-held satellite phones by Iridium and

Globalstar, possibly joined by Odyssey and New-ICO over the next few years, will find a use onboard also, as they provide complete coverage of all the world's ocean areas. The ongoing lowering of charges for the use of Inmarsat A, B, C or mini-M for voice, fax and data calls, where available, provides increasing encouragement for owners to shift to greater use of these systems. Direct links provide for access to training in the workplace. The operation of new equipment can be mastered onboard quickly through the use of interactive multimedia training programs. Programs dealing with new company operational practices and procedures (e.g. ISM Code) can be downloaded. Skill levels can be monitored.

Mention was made earlier of software programs for shipboard use. Ship management applications deal with a variety of operational aspects including crew management, finance and budgets, inventories, maintenance and documentation control, the latter increasingly important in the light of the shipowners' responsibilities under the requirements of the ISM Code and STCW 95 Convention.

The potential use of satellite communications and IT for onboard training using distance learning methods has been discussed before (Muirhead, 1994, 1995, 2000, 2002). For the shipowner, the technology opens a window of opportunity to transfer much training to the shipboard environment. The interactive nature of the medium today means that learning does not take place in a vacuum. IT provides scope for an interactive role between training managers, ship personnel, supporting training institutions, approving authorities and program providers.

4.2.2 Satellite communications and data transfer

This topic is dealt with in more detail in Chapter 5. The Inmarsat-A or B duplex 64 Kbps high speed data (HSD) service allows for multimedia transmissions (video, voice, data) to be used. While the tariff rate for use is approximately twice that of a satellite telephone call, the use of compressed video shows promising results for visual links between ship and shore. The potential for using video technology for maintenance support, and delivering training programs onboard from ashore is considerable. However, for full streaming video capability, broadband connectivity

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In choosing a mode for the transmission of data, consideration must be given to the nature of the material to be sent (text, figures, graphs, still pictures or video), the volume and frequency of exchange and how critical speed of transmission is to the training process, which will influence the cost. In addition, in the case of Inmarsat, the type of terminal facility will have a bearing on the form of transmission. It is an easy process to send and exchange drawings, graphs, sketches and photographs to ships fitted with Inmarsat-A or B equipment and a fax facility. This is not possible with ships fitted only with Inmarsat-C equipment.

A new marine service from Inmarsat that started in November 2001, called Mobile Packet Data Service (MPDS) charges only for data packets sent or received, while the continuous Internet connection eliminates dead-time. This should be more cost advantageous to the ship in the longer term.

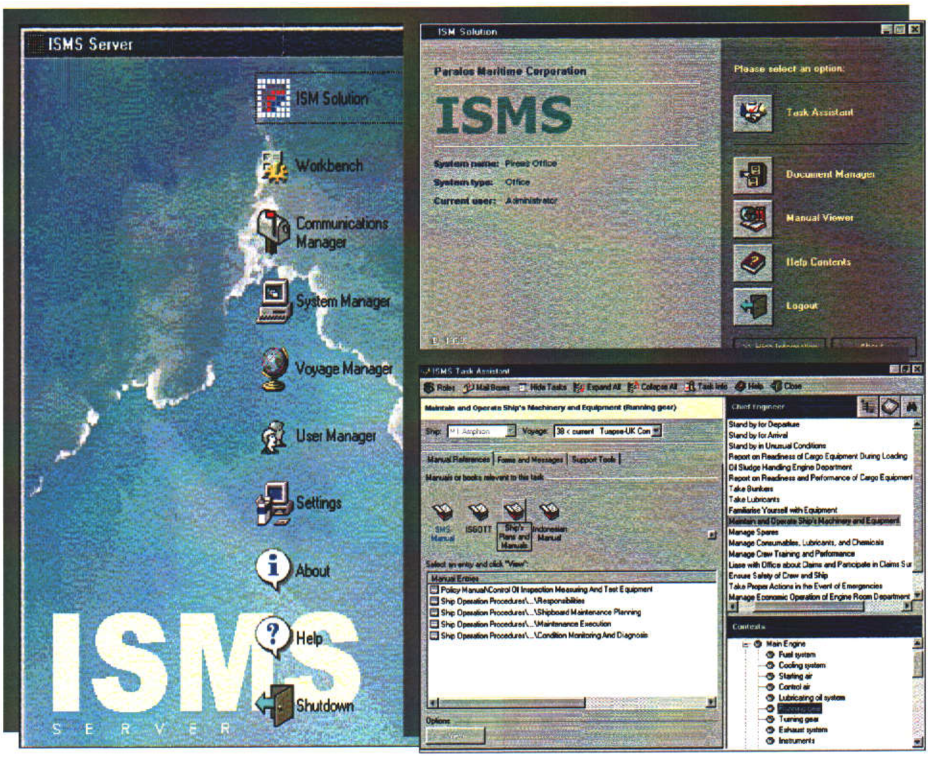
4.2.3 Compact disc technology

As a storage medium, the advent of the compact disc has opened up a new world of opportunity for the mariner to access quickly data and other reference material on the ship. Technology is at a stage where a single compact disc is capable of holding 600,000 pages or 2,000 books! To put it another way the entire Encyclopedia Britannica would fit twice onto one CD-ROM. The opportunities for providing resource material in CD library form onboard for use in training or education are boundless. Some marine examples of CD-ROM material include Lloyds Classification Society Rulefinder, that contains its own and IMO regulations, Fairplay World Shipping Encyclopedia, IMO Dangerous Goods Code and the IMO Vega database. Mention has been made previously of the Seagull and Videotel programs available on CD-ROM. The interactive compact disc (CD-I) allows the development of training packages that combine a high degree of reality of the mariner's operational world with a hands-on interactive involvement by the user. It lends itself to use for skill acquisition in many ways, particularly in relation to emergency response training. Yet will the CD-ROM survive in future? Consider the storage capability of the Internet and on-line multimedia once ships can access the medium. Chapter 5 examines the potential use of computer based training (CBT).

4.3 Current on board training practices

Current technology developments have opened up the possibility of transferring much training to the onboard environment. While this is the ideal place to gain practical experience, many people are concerned at the level of expectation industry has towards training outcomes. A new ship may very well be supplied with CD-ROM programs, developed by the manufacturer of equipment, to assist in familiarisation and operational efficiency, but trade routes and manning levels may inhibit effective use in many cases. The mandatory requirements under STCW 95 for approved training record books for trainees at sea may reap some benefit from technology, but much of the program to be covered relies on experiential outcomes. In this area of training there is great potential for using the electronic medium. Training record book activity could be returned electronically to the company training manager, an institutional assessor or to the master of the trainee's next ship. The provision by Maersk Line of simulation training facilities onboard 16 of its ships, as noted in section 4.5 later, marks a watershed in the transfer of training to the shipboard environment. New ships in the 21st century come fitted with a built-in LAN and computer network, connecting global communications and management software for dealing with total ship operations. Interactive multimedia programs are increasingly being delivered to the ship by the suppliers of bridge, engine room and cargo handling equipment. Companies, such as ISM Solutions, (see Figure 4.4), offer a total software solution to the shipowner and master for meeting obligations under the ISM Code. The training demands of the future relate very much to the degree of familiarisation of officers and masters with computers and computer systems and software.

In addition, computer based training lends itself to crew safety and familiarisation training required under STCW 95 Chapter VI and regulation I/14 respectively. With the quick turn-round time of many ships today (cruise ships, ferries and container ships) crew changes present owners with a particularly difficult problem in meeting the foregoing obligations. Many are turning to self-learning computer based technology and multimedia tools.



Source: ISM Solutions, 2002

Figure 4.4 Meeting the needs of the ISM Code (ISM Solutions)

4.4 Shore based training needs

For the ship operator the major source of officers and crews today has swung to the Asia-Pacific basin. Recent surveys (CIIPMET, 1998) show that many MET institutions in the region lack modern computing resources and well qualified and experienced instructors, in a world where traditional teaching methods hold sway. While serious attempts are being made to upgrade equipment and qualifications of instructors in many institutions, the process will take many years before the global standards reach a satisfactory level.

In meeting the new requirements for standards of training, competence and quality assurance imposed upon them by the ISM Code and STCW 95, shipowners are increasingly looking for new means to assure themselves that the officers and ratings that they hire across the globe do indeed meet standards. More ships are being constructed around an onboard computer based network and this, allied to communication links back to the office through e-mail and the Internet will radically change operational methods and procedures on the ship. The trend toward using CBT assessment packages as part of the recruitment process, and for use to establish continuing proficiency onboard, is becoming more common. If owners of highly sophisticated ships are to operate these vessels effectively through increased use of IT and satellite communications technology, the skills of their existing and future crews will increasingly be a key element.

The evidence is clear. World wide computer networks and communication links are expanding and growing at an extremely fast pace. The ability of the system to handle data and communications quickly, cheaply and securely is not in doubt. It is just a matter of timing.

If MET institutions are to meet such demands, their computer based resources and instructors' skills must be upgraded, if they to are to continue to turn out trainees acceptable to industry. The maritime industry itself can expect growing pressure from technological developments to continue to change the manner in which they operate and manage vessels in the future. Strategic planning for new training requirements is clearly a major key to the future success of the shipping industry and the enhancing of global standards, and should be developed in association with the training institutions and equipment and software suppliers.

Yet training personnel for seagoing careers is only part of the equation. The port, terminal and associated shipping industries ashore employ many thousands of people. A 1996 study by Gardiner & Pettit of the employment of seafarers in shore-based industries in the UK concluded that, of the 17,000 jobs identified, seafaring skills were deemed to be essential in 70% of jobs. Many ex-seafarers are in positions where such experience is still considered by many employers as a desirable qualification. Unfortunately, in many countries, maritime professional certificates of competency are little understood in a general education context. Shore industry increasingly needs other knowledge and skills as well – knowledge of management, logistics, economics and finance, maritime law, business and environmental protection, to name but a few. As Grey (2000) so aptly put it:

> … in a world that increasingly sees a university degree as an absolute minimum qualification for 'life', a shipping industry that continues to recruit cadets, who then do not have the opportunity of a university course, denies itself all but a very small sector of the available workforce.

Grey also reported that research in the UK indicated that 15% of school leavers would have considered a career at sea had they been aware that a degree course was available. However it appears that shipping as a career has disappeared from public consciousness, as evidenced by 40% of school leavers knowing nothing about it. Clearly the maritime industry has much work to do.

Muirhead (2001), in an address to an MET seminar on enhancing career opportunities in Europe, noted that the attractions of modern life and society ashore is a big factor in the time people stay in a career at sea. The resultant reduced levels of sea-going experience may not be sufficient to meet the skills demanded by the shore-based industry. Where will such personnel come from? Will Europe be willing to import its pilots, harbour masters, surveyors, examiners and instructors from external sources?

Figure 4.5 MET Lecturers, trainers and simulator instructors – where from?

Are suitably qualified people readily available from outside the EU? Is it ethical for Europe to 'poach' scarce human resources from the developing world? Even Hong

Kong warns of a looming shortage of local people with the skills and experience for jobs in its shore-based port and maritime industries (Fairplay, 2001). If it is accepted that a career at sea is of limited span, how can the industry retrain, educate and retain such personnel in the maritime industry ashore? There is some evidence that manpower shortages are beginning to negatively affect the quality of services provided by sea and shore-based maritime industries.

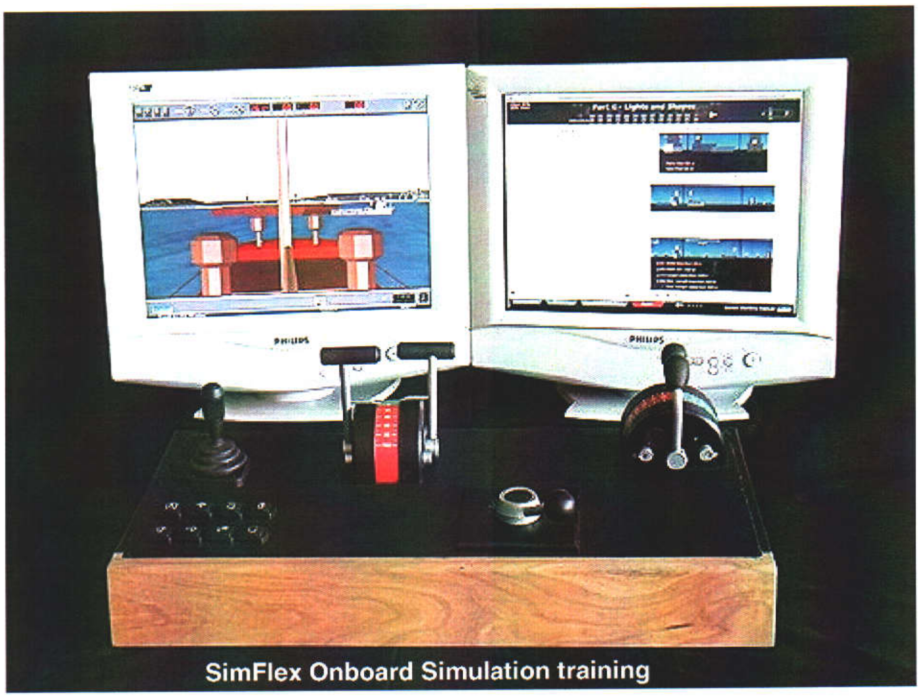
4.5 Cyberspace simulator training concept

Chapter 7 looks at the world of cyberspace and distance learning. Here it is suffice to say that technology is changing the working environment and the rules of operation between ship and shore, creating a seamless world of globalized links.

As stated earlier, technology will allow much refresher and upgrading training to be carried out onboard, replacing many courses delivered ashore. For the mariner, the opportunity for private study at sea, a service long denied him or her, will also become reality as Internet links become common onboard ship. If broadband links are there, then why not use them in the field of simulation, a fast growing and well recognized training medium? Such tools could also support some of the onboard training tasks to be found in the trainee's Training Record Book.

The concept of a computer simply moving data and information from place to place, and comparing it according to a set of prescribed rules or algorithms, leans on the computer's major strength of being able to process information very quickly and accurately. This gives the computer the ability to adapt and respond to the learner's needs, difficulties and progress. As a result of advancing broadband technology in the 21st century, sophisticated simulation training programs will be capable of being accessed onboard (and ashore) via Web Education Management Systems (WEMS). Such single-task or part-task simulator activity could be monitored and recorded by the institution (or company training officer for that matter) in preparation for further advanced training on the simulators ashore. To illustrate the potential, A.P.Moeller, parent company of Maersk Line, fitted the Danish Maritime Institute (DMI) developed SIMFLEX PC based onboard simulator to 16 of its ships in 2001-2002 (Figure 4.6). The system is being used to train cadets in Rule of the Road and general shiphandling skills. An interesting feature of the software is that the training can be supervised by an instructor ashore over a ship-shore communications link. This development resulted from an EU research project on long distance learning called SEAGULL.

Simulation programs, such as 'PortSim' from SSPA Sweden AB could, for example, also be used onboard by officers to develop strategies for pilot boarding and port entry, as part of voyage planning processes.



Source: Force Technology (DMI), 2002

Figure 4.6 DMI Simflex onboard simulation training system

Maritime institutions could also offer access to their web based simulation training centre to other trainees, students or graduates ashore. For example, the growing range of simulator software programs in the areas of safe cargo handling, maritime law, chartering practice, logistics and fleet management to mention but a few, could be made available on the centre's web server as pre-study modules or stand alone units.

In a more co-operative vein, smaller MET institutions could consider pooling their limited technical resources together so as to operate through a regionally based server.

4.6 MET training support for industry

From the foregoing overview, it is clear that for modern fleets, many shipowners and operators are planning for a future increasingly centred around the operation of the 'IT office at sea'. By implication, employers will be seeking to retrain or employ new officers and crew who have a capability to use such equipment, programs and services. Are the training institutions equipped and prepared to provide the necessary communications and computing skills needed onboard in the future? Do companies themselves have plans for upgrading the computing and management skills of existing staff at sea and ashore that become necessary with IT communications and software applications? The survey of global institutions (Chapter 3) indicates that MET institutions are aware of the urgent need to install facilities and train teaching staff to meet these growing needs. However, the pace of development may not keep up with industry demands for enhanced training.

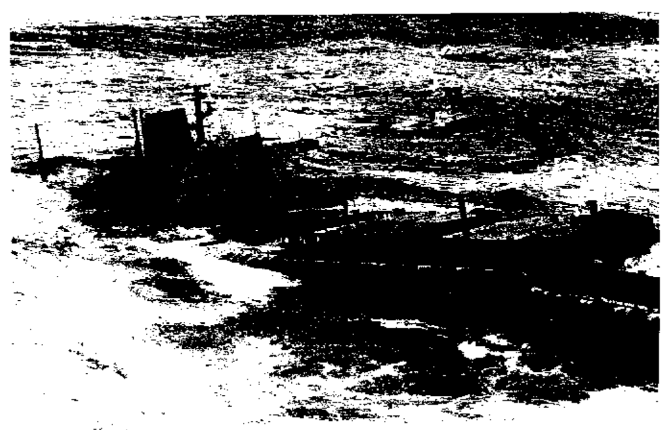
A survey of European Union Maritime Training Institutions was undertaken by the writer as part of a EU research project into the harmonisation of MET systems in Europe (METHAR, 1997). The objective of the particular work package was to provide an overview of the extent to which modern technology and instructional media was in place and being used within European maritime education and training institutions. The report showed not only the extent of overall equipment penetration but how it was being used for training and assessment. The results are explained more fully in Chapter 6 later. However many of the supporting MET institutions are well equipped to provide the industry with links to monitor or interact with trainees at sea. The figure most relevant to this aspect of the discussion was that which showed that 55% of institutions held Internet and e-mail facilities. Although the sources are not directly comparable, there has been considerable improvement in the above regard when compared to the more recent 2001 global survey detailed in Chapter 3. It is evident that increasing access to IT services by staff and students is changing more traditional attitudes and approaches to teaching and learning. The use of computing systems for training can be expected to grow as more institutions equip themselves with this technology.

However, it is the writer's contention that institutions and ship operators need to work closer together to ensure that IT skills provided in training programs match operational needs onboard. This may need to be more company specific. A lack of good training software in many practical areas of ship operations is currently inhibiting further use of the medium, but much research activity is currently underway to overcome this problem.

4.7 Training and bulk carrier safety

During the last decade of the 20th century much discussion revolved around the new structural requirements for bulk carriers and the impact this was going to have on ship design, construction, operating costs and survey and safety standards. More directly, the Code of Safe Practice for Solid Bulk Cargoes provides much wisdom on the operational measures to be followed by those involved in the loading, carriage and unloading processes. The Code states that it provides guidance to administrations, shipowners, shippers and masters on the standards to be applied in the safe stowage and shipment of solid bulk cargoes (excluding grain). To what extent should the Code and other guidelines under development also attract the attention of shore-based personnel involved in bulk carrier operations?

For the shipmaster and officers, education and training in the forces and stresses impacting upon the ship, as a result of cargo distribution both at the berth and in a seaway, have been a required part of their standards of competence. Inexplicable bulk carrier losses at sea have been attributed to many causes including poor weight distribution and overloading, high loading rates, shifting of cargo, structural corrosion and weakness, heavy weather, ballasting operations, and damage during loading/discharging operations.



Source: AMSA, 2001

Figure 4.7 Bulk carrier Sygma (1974)

A lack of awareness within the industry, particularly on ships operated by crews who have had little or no previous experience in operating large bulk carriers, is also a point of concern. This aspect is being examined through proposed amendments to STCW 95 regarding competence standards for all deck officers in relation to bulk carriers The demands of charterers, stevedores and some owners to speed along the loading or discharge of their vessels, without taking prudent precautions in respect to the stresses inflicted on the hull throughout the operation, is another aspect that must be considered.

Ship-terminal co-operation has rightly been identified as another important element in helping to raise the level of awareness of potential dangers and ensuring greater standards of safety and an IMO Assembly Resolution draws attention to this. Basic knowledge about proper cargo distribution, good trimming practices, cargoes that liquefy, and the physical and chemical properties of cargoes should, for example, be understood by all involved in the operational process. Yet stevedores, foremen and other personnel often receive little or no training in these basic fundamentals. Many shipmasters have complained about the difficulties in communicating with shore based personnel and the lack of understanding shown by the latter to the problems facing the shipmaster with the loading of the ship.

Source: AMSA, 2001

Figure 4.8 Loading iron ore

The continuing loss of bulk carriers over the past 20 years on the one hand and the potential threat to port operations on the other led to an awareness amongst some Australian port operators and shipowners of the need to implement a training program for shore based personnel.

Examples of course development in Australia

An initial request for the training of shore operators and personnel was made by Hammersley Iron Pty Ltd, operators of the port of Dampier to the Australian Maritime College (AMC) in the early 1990s. A program entitled 'From the Mine to the Market' (AMC Search, 1991a) was developed covering the commercial, legal and operational aspects of transporting iron ore. This consisted of two categories, the first of which consisted of a basic introductory one day course for crew/operators covering the topics shown in Table 4.1 below (Category I).

Table 4.1 Category I Course (1 day)
Maritime transport chain
Dry bulk shipping
Transport of dry bulk cargo by sea
Ship loading considerations
Construction and layout
Measurement of cargo
Stowage exercises
Some legal implications

A longer three day program for supervisors and other management personnel covered the topics shown in Table 4.2 below (Category II). The aim was to provide an understanding of shipboard practices and requirements and to improve efficiency of ship-shore interface during berthing and loading operations.

Table 4.2 Category II Course (3 days)
Day1.
Introduction to dry bulk shipping
International conventions & national legislation
Transport of dry bulk cargo by sea
Ship loading considerations
Construction & layout
IMO recommendations
Measurement of cargo
Day 2.
Stowage exercises
International sale transactions
Handling the cargo at the port/terminal
Types of shipping arrangements
Unseaworthy or substandard ships
Day 3.
Other parties in the transport chain
Special issues arising in voyage and time charters
The paper chase
Responsibility for cargo

Proper loading practices are important in everyday ship operations and loading is a joint operation. In any casualty inquiry the question of whether the cargo has been loaded properly will always arise. It is an accepted principle that the master is responsible for the stowage of the cargo, even when the ship is on charter to the shipper and the shipper undertakes the function of loading. Under contractual arrangements between shipper and shipowner it is possible to argue that the responsibility for loading rests entirely with the ship. Generally the stevedore has a duty to follow the instructions of the master, failure to do so may mean that he/she is negligent in the performance of his/her duties. If the master's instructions are erroneous then the stevedore must bring it to the notice of the master or agent. Thus it is important that all parties to the operation understand the framework under which they work and interact.

Another interesting approach was the development in 1991 of a 'Ship Operations' course for BHP Ltd iron ore shore based personnel not directly involved in shipping operations (AMC Search, 1991b). The aim of the five day course was to provide participants with an introduction to a wide range of factors affecting the operation of dry bulk carriers. This was achieved through a combination of lecture discussion and practical and experiential learning through the use of the shiphandling simulator.

The program broke new ground in providing a group of people with insights into the world of the bulk trade and bulk carrier operations, supported by experience of the inward passage, berthing and departure from an iron ore port in Australia. Thus theory and practice were brought close together. The main features of the program are shown in Table 4.3.

Table 4.3 BHP ship operations (5 days)

Ship operations - bulk carrier operations
Arriving ship (ETA, communications, port entry requirements)
Demonstration of a planned passage inwards
Ship loading considerations 1 (stability & stress calculations)
Readiness to load (surveys, ballast considerations)
Legal aspects (charters, insurance, CGS Act)
Ship loading considerations 2
Loading and voyage calculation program (bulk loading)
Departing ship
Some operational & legal considerations

The final objective was to enable participants to understand the chain of operations involved in a bulk loading and to appreciate the role of the master with respect to the owner, shipper, charterer, crew and the environment.

Later course developments

Drawing upon those earlier experiences, the Australian Maritime College today offers a suite of programs (three categories) entitled 'Operational and Commercial Aspects of Stevedoring and Terminal Operations' designed to suit the varying needs of customers (AMC Search, 1998a). The courses provide not only an insight into the technical problems of loading container, conventional or dry-bulk shipping but also to place these problems in their proper context, the commercial market place. The several levels are designed to serve not only ship-loaders, but also the supervisors and line managers as well as operational and other staff from related organisations such as port authorities, ships' agents, pilots, marine authorities, etc. The courses have been designed for delivery at the workplace and of a length that will not unduly disrupt work rosters where appropriate.

Category one

A one day (seven hour) basic level course for all terminal staff who interact with the ship such as ship-loader operators, controllers, foremen, supervisors.

Category two

A three day course providing participants with an insight into their place in the overall transport chain. It enables exporters and ships' agents to understand the problems of the terminal operators and allows the terminal to appreciate the constraints under which commercial departments work. The course is intended for stevedoring supervisors, superintendents, shipping officers and operational and commercial executives of maritime related organisations. The Category One topics are expanded, supported by extensive use of case studies.

Category three

This course is conducted at the AMC campus in Tasmania and is intended for managers and other senior executives involved in shipping. As well as the topics previously covered, case studies are used. In addition, use is made of the shiphandling simulator to demonstrate the problems of handling large ships in confined waters and the restrictions that are placed on their movement.

New initiatives for the stevedoring industry

A more recent development has been the development of an accredited education program for stevedoring supervisors as a result of a unique partnership between Patrick, an Australian stevedoring company and the AMC, using a mixture of workshops, distance learning and on-the-job experience (AMC Search, 1998b). Three courses have been developed.

Multi-skill training program for operational trainees

This starter program aims to develop a multi-skilled workforce for Container Terminal Operations and is designed to be completed over a period of nine to twelve months. A three month introductory program utilises a mix of lectures, self study materials and practical work experience, including site visits in different sections of the port and on-board ships. The trainees spend approximately six to nine months gaining experience in a number of areas, incorporating specific guided tasks under supervision.

Certificate of proficiency in stevedoring (wharf foreman)

Participants receive pre-reading material before attending a workshop at the AMC. After the workshop they are expected to continue their studies using provided study material and by engaging in specific activities. Assessment is achieved through exercises during the workshop, assignments based on shipboard activities, and exercises on completion of all studies.

Certificate in Stevedoring Management

This course was designed for a specific customer, Patrick Stevedoring, and can be delivered nationally through the avenue of 'distance learning', a method of educational activity in which the AMC has had considerable experience and success over the past 12 years. It supports the changing role of supervisors today, focusing more directly in managing operations for improved operational performance and level of service provided to customers.

The course has eight subjects, each one designed to be completed within an eight week period. An average student can expect to finish the course over two years, working ‘at a distance’ away from the college environment. The materials consist of a subject information guide, a study guide, a readings book and audio-visual material for each subject.

For shore based personnel, basic knowledge and understanding of ship loading practices, safe weight distribution, stability criteria and longitudinal stress considerations can be presented today through the medium of computer based software programmes. Suppliers of shipboard operational loading programs such as Kockumation (Loadmaster), Kockum Sonics (Loadrite), Maersk Data (Loadstar) and Baron & Dunworthy (Mariner), to name but a few, offer computer friendly packages for bulk carriers. Many of these also lend themselves as excellent teaching and training support tools, as the example displayed shows. Supported by case studies of bulk carrier casualties, the lessons to be learned can be effectively driven home.

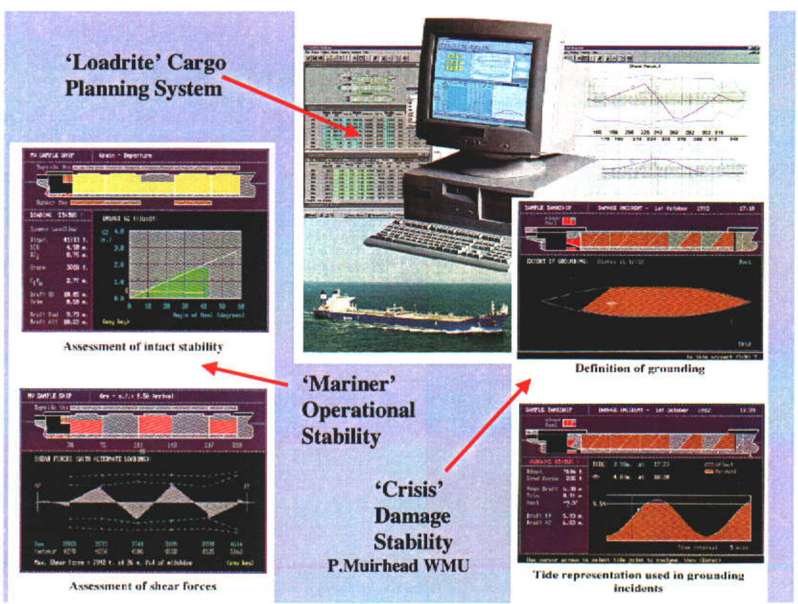


Figure 4.9 Examples of software based bulk carrier loading programs

Such programs contribute positively towards achieving increased understanding by those ashore of the problems faced by the shipmaster in the loading, carriage and unloading of bulk cargoes in particular. Such training also contributes towards improved safety standards through improved interaction and communication between ship and shore. The framework can serve as a model for many ports and terminals. The use of PC based operational programs and simulation packages can further enhance this important area of training.

4.8 Extension and enrichment initiatives

A recent research initiative by the European Commission has been to encourage the use of thematic network projects under its fifth framework program. As a follow up to the earlier METHAR project, the thrust of the Maritime Education and Training Network (METNET, 2000) is to make a comparative analysis of European MET structures and schemes and identify and make recommendations on future MET needs, re STCW 95 and the use of advanced technology. This project will be completed in 2003. Among the reasons espoused for such investigations are the lack of supply of ship and shore personnel, an unused European MET capacity, limited competitiveness, and lastly and most importantly, that the current workforce lacks mobility within Europe. If MET can be made more widely applicable and more attractive as a career then competitive and sustainable growth can be achieved in the maritime manpower sector. The European problem is not isolated and other developed regions of the world face similar problems.

In seeking some solutions to the manpower problems identified in this chapter, a number of tasks will focus on key issues. In particular, by extending the applicability of MET, the project looks to making the career of the seagoing officer more attractive, enhance recruitment, and encourage more of them to stay in the broader maritime industry ashore when leaving the sea. Thus new courses will be developed that extend and enrich MET beyond the statutory needs of STCW 95 Convention. Particular areas targeted are marine environment protection, port operations and costs and shipping operations and costs. In addition, approaches to teaching traditional subjects such as navigation, are being critically examined to see how they can be rationalized in the light of the use of new technology at sea. New train the trainer trainercourses are being prepared to take into account the use of new technology in teaching and assessment, as well as for shiphandling and engineroom simulator instructors. Some of these aspects are discussed further in later chapters.

4.9 Summary

Petersen (2000, p. 80) put the training problem into perspective when commenting on the implication for industry, flowing from the BIMCO 2000 manpower study. The demographics of the maritime industry have become tilted towards those of an advanced age (sea and shore) yet the failure to train and recruit in the 1980s and 1990s will have consequences for all in the early part of the 21st century. He continues to note that:

> ...the supply and demand of maritime labour is a very imprecise science. It is not machinery or computers, or equipment with a finite life that we are talking about but people! They are affected by social trends, by economic pressures ashore. They exercise free choices, to seek a sea career or to diversify into shore employment, to look for jobs in the shore-side maritime infrastructure or disappear altogether from the maritime workforce.

The chapter is concerned with training trends in the maritime industry and places some focus on the role that technology can play in helping industry meet its needs. However, in itself, technology is not an answer, but a methodology to enhance knowledge and skills of personnel required to work within a growing technologically driven working environment. However, if the industry cannot solve the challenge of attracting school leavers to take up a sea going career, then all the technology in the world will not alleviate the problem and the predicted shortage of officers will become even worse in the future. The study concludes that making life onboard more socially connected (home and shore based lifestyle links), more interesting (access to self education, hobby and leisure time interests), more socially interactive (by increasing manning levels) together with extended education and training opportunities through diploma and degree courses is the best long term solution. Technology can play a major part in such a revival of fortunes.

CHAPTER 5
THE IMPACT OF NEW TECHNOLOGY

5.1 Shipboard equipment and operational practices

Today we live in a world of changing technology, the results of which continually challenge the need and justification for fundamental navigational knowledge by the navigator, particularly in the field of position fixing. On the one hand, it can be argued with some justification that the teaching of traditional navigation is in danger of becoming obsolete in the light of the high degree of accuracy and reliability that is available from modern position fixing systems today. Equally, on the other hand some would dispute that new technology can totally replace the practical human navigator. Is it necessary to maintain such knowledge and tradition, carefully handed down over many centuries by skilled practitioners and explorers? If so, how can seafarers be encouraged to practise traditional position fixing skills when knowledge of the ship's position, course and speed is accurately fixed through satellite position fixing systems and the ship's track is automatically controlled by integrated computer based navigation systems. Or should it be accepted that time consuming manual methods have no place on the ship today?

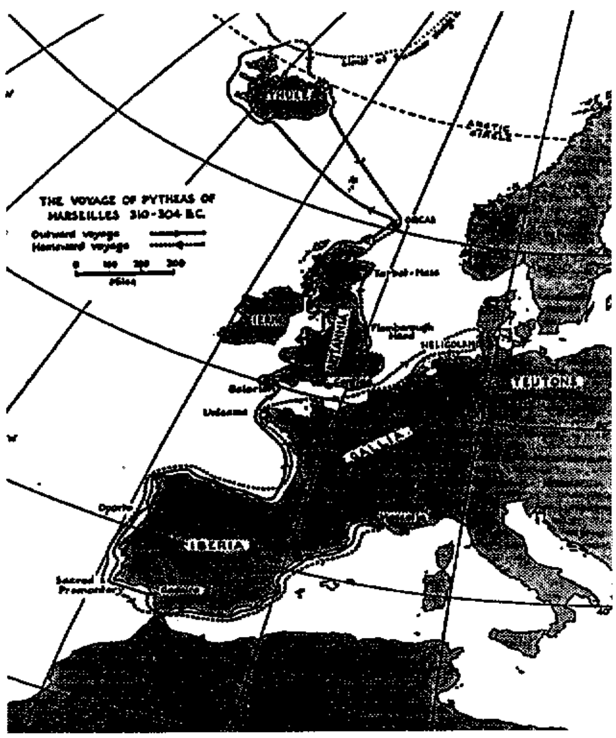
Muirhead (1999) noted that in considering these developments, any arguments in favour of preserving the foundations of navigational knowledge must be weighed against meeting the practicalities of a modern world, where technology provides a degree of accuracy and reliability undreamt of by past navigators. We must therefore either leave traditions behind and embrace new technology or decide whether the two can continue to exist together in some form of harmony. In a recent research project, it was concluded that "present MET syllabuses do not cater enough for ships on which much modern technology is used" (METHAR, 2000, 56). This is partly put down to the fact that there is a marked reluctance by some navigation teachers to change, despite strong evidence of a shift in attitude and practices on board by navigators today. European MET institutions have a considerably higher average age of teaching staff compared to similar institutions in the Asia-Pacific region (METHAR, 2000). What will happen when the older generation of navigation teachers retires, an event fast approaching in the light of the research findings? This situation also contributes to the perception that there is a gap between theory and practice taught in the course ashore and actual onboard practices occurring on ships today. An examination of some of the evolutionary changes, that have led up to the current situation, will be useful in answering some of the questions posed.

5.1.1 Advances in position fixing and track keeping methods

Before looking at the impact of new technology on position fixing on ships, it is important to understand the methods used by navigators for more than 500 years, thus putting into perspective the tremendous changes that have occurred in navigation position fixing in the last few decades.

Dead reckoning

Although the ancient sailors relied much on coastal proximity for finding their way around the known world, others, unrecorded, would certainly have ventured out of sight of land, knowing that in sailing in an enclosed sea like the Mediterranean, land would always be found. Beyond the 'Pillars of Hercules' it was either a case of following the land or Northing or Southing.



Source: Cameron, 1965, p. 44

<u>Figure 5.1 The art of keeping the difference of longitude to a minimum!</u>

Up until the first half of the 15^{th} century, navigation had been conducted by 'dead reckoning' whereby the ship's position was reckoned or arrived at from a record of its continuously changed course and speed. The magnetic compass was first adapted for use on the ship by Flavio Gioia in Naples in 1302, and according to Reis (1992, p. 89), had been further refined in 1537 by being placed in gimbals. The problem the sailor faced was in re-establishing position when reckoning was lost. This meant finding land again to establish accurately a point of reference.

A catalyst for the development of oceanic navigation was, according to the Italian mariner Cadamosto, the introduction in about 1440 of the Portuguese 'new caravel', which he viewed as the best ship to sail in the Ocean Sea (de Macedo, 1992, p. 70). Reis (1992) noted that both the mariner's astralobe to measure the sun's altitude, and the quadrant to observe the stars to obtain latitude, were used from at least the time that the Azores were settled in 1439. The two instruments, as well as the later cross-staff (the first instrument to use the horizon) were abandoned when double reflecting instruments, such as Davis's quadrant and the octant, were introduced in the 18th century (Cotter, 1968, p. 72).

A serious obstacle to greater exploration south of the equator came in 1482 when, as explorers neared the equator, they lost the reliance on fixing a position from heavenly bodies due to the fact that the Pole Star could no longer be seen. As de Macedo (1992) notes, it was only after this matter was resolved with the help of Martin of Bohemia that the great explorations south of the equator continued. The next 35 years saw Gomes and Dias rounding the Cape of Good Hope, Columbus crossing the Atlantic, Da Gama sailing to India and Magellan crossing the Pacific Ocean. Thus did the Portuguese gain much experience in navigating out of sight of land, and so also were the world's oceans opened up to communication by sea.

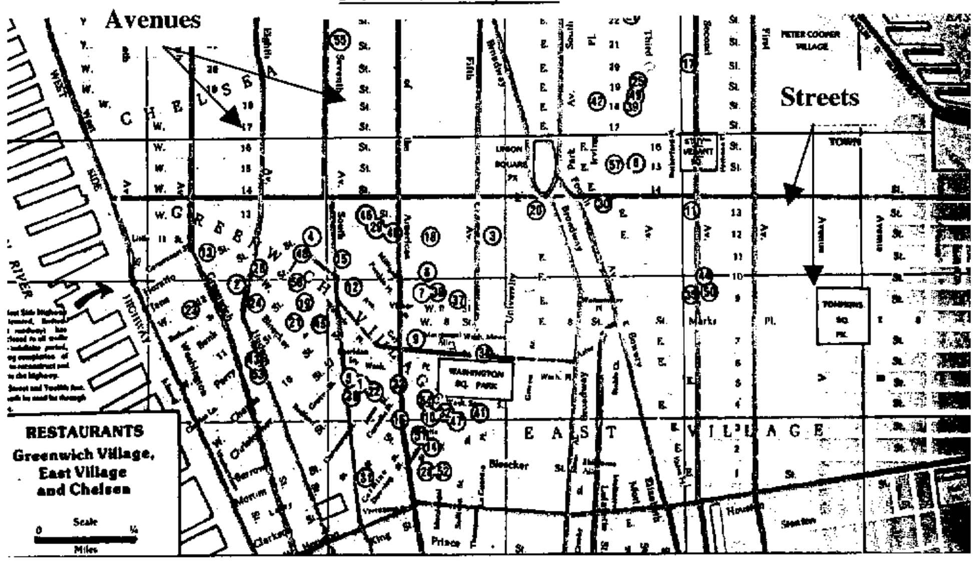
It can be said that the 15th and 16th centuries saw the start of scientific navigation through the evolution of observing instruments, charts, almanacs, nautical tables and methods of fixing latitude. Yet knowledge of longitude continued to escape the ocean navigator. This lack of means of determining position has been aptly described by Sadler (1968, p. 4) by drawing an analogy with a stranger arriving in a large city.

> ...being without the means to determine his longitude was like a stranger in a vast city, such as New York with a grid-iron system of streets and

> avenues, from which all the avenue names had been removed. He could find which street (parallel of latitude) he was on from the number (equivalent to a meridian altitude observation), but the only way of finding the avenue on which his hotel lay (the longitude as it were!) would be to walk up and down, and then along the appropriate street until he recognised the hotel.

The sailor called this 'running down his latitude' and making a wrong choice, as whether to go East or West along it, was an extremely risky business! Figure 5.2 below illustrates the analogy.

New York City Grid



Legend: Streets (E/W) = parallels of latitude
Avenues (N/S) = meridians of longitude

Source: Sadler, 1968

Figure 5.2 The problem of determining longitude

In 1514, a German astronomer, John Werner, suggested that longitude could be established through the use of lunar distances, i.e. by measuring the angle between the moon and a fixed star lying in the Moon's monthly path around the celestial sphere. This method became a standard with the publication of the first British nautical almanac in 1767. Despite it being a time consuming practice, lunar tables were published until 1906. The story of John Harrison's chronometers is well known. Sadler (1968) noted that Gemma Frisius first recommended, in 1530, the use of a clock set to the time of a standard meridian, as a means of finding the difference in longitude between a given meridian and the standard meridian. It was not until

1759 that Harrison achieved a level of predictable accuracy with his fourth chronometer that enabled it to be carried and used onboard a ship.

Astronomical position fixing

When navigators discuss practical skills in sight taking and position fixing, then the two names of Sumner and Marcq St Hilare come to the fore. These famous navigators evoke memories of techniques that are rapidly disappearing from the repertoire of today's 'high tech' navigator.

As reported by Sadler (1992, p. 14), more than 160 years ago, in 1837, Thomas Sumner, an American shipmaster sailing up the George's Channel, Ireland in bad weather, made the discovery that all positions obtained from a series of sun sights using different dead reckoning (DR) latitudes lay on a straight line – a tangent to a circle of equal altitude. It seems strange to navigators today that it took so long to 'discover' the position line concept – it is so easy a concept to grasp. It was known as the Sumner Line for many years. Prior to this, latitude and longitude had been calculated from bodies lying North or South and East or West respectively, being calculated independently of each other. Sumner's methods allowed any astronomical sight to be used effectively.

Nearly 40 years later between 1873-1875, a French Naval captain called Marcq St Hilare published something he called the 'intercept' method of position fixing. His hypothesis was that any position could be used as a basis for calculating the altitude of a body and plotting the 'intercept', the difference between the true and calculated altitudes. Under his method, two or more position lines can be used to obtain a 'fix', provided Greenwich Mean Time (GMT) is known. The principle is based on the premise that the observation of the altitude of a star determines a circle of position on which the observer must lie. Thus, with two or more such observations, selected for their good angles of cut, it is possible to determine position, and thus both latitude and longitude. For more than 125 years, many generations of practical navigators have used the method with great skill and to a high degree of accuracy compared to previous methods.

Technological developments in position fixing

Technological developments in the 19^{th} century were slow in coming forward to cause any great change in the accuracy and reliability of course steering and position fixing. The introduction, in 1873, of Lord Kelvin's magnetic compass was the only event of note. Between 1904 and 1912, the birth of the gyro compass (by well known makers Anschutz, Sperry and Brown) and the bottom log greatly improved the accuracy of dead reckoning navigation. More accurate course and track keeping by ships resulted from the further introduction of the gyro auto-pilot in 1924. Over the same period the discovery of radio waves resulted, by the mid 1930s, in the extensive introduction of shore based radio beacons and shipborne radio direction finders. For the next 50 years, fixing position by means of direction bearings was commonly used as an alternative by navigators, particularly when weather conditions prevented fixing the ship's position by traditional astronomical methods.

Up until the middle of the 1980s, celestial navigation remained the primary means of fixing the ship's position when out of sight of land. The accuracy of coastal navigation was, however, much improved after the war from the 1950s onwards with the ready availability on merchant ships of radar and the extended coverage in coastal and near offshore waters of hyperbolic systems, such as Decca and Loran-A (both now defunct) and the later Loran-C and Russian Chayka systems.

Offshore position fixing took a new turn towards greater accuracy when the US Navy Navigation Satellite System (NNSS) known as Transit, became available for non-military ships in 1977. Although the system provided almost total global coverage, the time between passes could be anywhere between one and a half and sixteen hours. However, it brought with it a level of accuracy much beyond position fixing systems available at that time. Another system, Omega, developed initially in the USA in 1927, offered global offshore navigation coverage with an ocean accuracy of around six nautical miles, but this system was dogged by political factors in some countries and was closed down in 1997. Because of the time between fixes, in the case of Transit and the level of accuracy from Omega, neither system lent itself to use in restricted waters, harbour approaches or for precise coastal navigation.

Yet change continued to move forward at a dizzying pace with the assistance of growing computer and satellite technology. Suddenly, traditional offshore position fixing methods and levels of accuracy were under threat from the availability of a new phenomenon on the scene, the highly accurate and reliable satellite based Global Positioning System (GPS). With a general offshore accuracy level of 100 metres and capable of being improved further, down to less than a metre through differential corrections, the world of position fixing, as we have known it for the past 120 years was about to change. With accompanying improvements in chart accuracy and clear moves towards the establishment of a global system of reference (WGS84), the navigator has entered a technically supported world of navigation, which is radically altering the way in which precise position can be established. The International Maritime Organisation, through revised Assembly Resolution A.815 (23), is pursuing a global collaborative approach through the World Wide Radionavigation System (WWRNS) to recognise suitable radio navigation systems under the control of member states, that meet specified reliability and accuracy standards, as component parts of the whole. Such standards are designed to ensure safe navigation in both harbour and coastal waters, as well as in the oceans.

The European Union is supporting a collaborative project with governments and industry to develop a civilian controlled global satellite navigation position fixing system codenamed Galileo, which is expected to come into operation in 2008. The system will enable the user to establish position to within a few metres, with a guarantee of continuity of transmission not provided by GPS.

Further technical support has come in the form of advanced radar and ARPA collision avoidance systems, digital electronic charts display systems (ECDIS) and ECDIS systems with radar picture overlay, and the harnessing of differential position fixing techniques for the high levels of accuracy needed in restricted waters and port confines. The 21st century opened with a new international agreement to phase in Automatic Identification Systems (AIS) from 2002 onwards (IMO, MSC 73). The world of the navigator in the 21^{st} century can thus be summed up as one comprising:

Instant fix

Instant knowledge of position

Instant perspective regarding margins of safety.

The navigator today

In such an exact world the role of the navigator has moved from one of human calculation to one of human systems management. This poses several questions. To what extent does the ship's navigator need a background of traditional navigation theory and practical hands-on position fixing skills today? Is it necessary to practise the ancient skills that enabled man to circumnavigate the globe with the aid of a sextant and chronometer, for example?

Consider the challenges facing the navigation teacher today. In the light of such technical change should traditional methods be discarded? If not, how can existing methods that are increasingly becoming little used in practice at sea, be justified? The modern navigator can observe at a glance the position of the ship (updated every few seconds), superimposed accurately over a digitised electronic chart. Has this made the use of celestial navigation techniques for offshore position fixing redundant? One can make a good argument that traditional skills may still be needed in an emergency, as even electronic systems can fail.

Consider the case of the Panamanian registered cruise ship 'Royal Majesty', which grounded on a shoal off Nantucket Island, Massachusetts, in June 1995, while on passage from Bermuda to Boston. Shortly after leaving Bermuda, the Integrated Navigation System (INS) system lost input from the Global Positioning System (GPS), causing the INS to switch to Dead Reckoning (DR) mode. This was not noticed over the next 34 hours. As the USA National Transportation Safety Board (NTSB) report noted, apart from the GPS, there were three radars, a radio direction finder (RDF), a Loran-C unit and an echo-sounder. Despite the availability of these and other means, no effort was made to verify the reliability and accuracy of the vessel's position, which turned out to be 17 nautical miles in error when the vessel grounded. The main causal factors behind this casualty, as determined by the NTSB report, included an over-reliance by officers on the automated features of the integrated bridge system and a

The ship today, whether under reduced manning or not, requires highly skilled operatives to interact with and interpret data displays within a total ship control environment. Practical navigation skills are but a small part of the whole. Naturally, much emphasis on acquiring skills in the use of modern navigational systems and equipment, as well as their limitations, is made within the curriculum of deck officer courses today. If we accept that the officer of the watch must be the back-up system (a hypothesis not necessary supported by all), must we adhere to current SOLAS statutory requirements? Is the growing lack of interest in navigation as an art a reflection of the decline in interest in sea-going as a career?

Within maritime education and training institutions, many programs have been revised to take account of these changes in technology, and rightly so. Adjustments have been made to the subject of navigation to make room for many of these new approaches. However, resistance to change is often marked in an industry where the average age of lecturers in many academies is high. Today, entrenched attitudes to maintaining the status quo in the teaching of celestial and coastal navigation is reflected in the long hours still devoted to the subject in many institutions. A research survey of 15 European MET institutions (METHAR, 1997, WP1.2, 59) showed that the time devoted to the subject navigation (in all its forms), for the deck officer unlimited certificate, ranged from between 300 and 1013 hours. One institution still spent 170 hours in the teaching and practice of celestial navigation, adherents arguing that traditional skills must be maintained. While accepting that traditional skills have a place, albeit of an increasingly limited nature, a number of key questions centred around the following aspects need to be answered:

- Officers at sea are increasingly relying on GPS and DGPS to provide a most probable position through an integrated navigation system of high reliability and accuracy.

- Practice in the use of the sextant and chronometer to fix the position of the ship is becoming the exception rather than the rule today.

- The reduced emphasis on practical sight taking skills by both training institutions ashore and officers on board for trainees under their supervision is aggravating

The human role that the navigator plays in interacting with technology and people must not be forgotten. The making of decisions involving the safe navigation of the ship is still reliant upon many of the basic principles of navigation handed down from generation to generation. The shipping industry and the navigation profession need to examine carefully the impact of these past principles and traditions on modern day operational needs and the input of the navigator. It would be folly indeed to totally cast away knowledge and practices solely on the basis that technology in the 21st century is totally reliable and foolproof. The evidence, produced by accidents involving technology based causal effects, shows that real life just isn't like that.

There is strong evidence today that old methods will be phased out by new technology simply because practical shipboard operations are being totally focused around integrated automated bridge systems, supported by fail-safe backup systems. It is certain that human error will continue to exact a toll on safety at times, as officers become totally reliant upon electronic and automated bridge equipment. However, teachers and trainers still have a role to ensure that practitioners remain aware of the fallibility of human designs and the need to retain some form of fallback method. It is probably inevitable that change in the workplace will eventually consign the practice of celestial navigation in particular to a category of specialised studies for those students interested in the history of navigation!

5.1.2 Operational safety

A number of high profile maritime accidents and casualties, in the past few decades in particular, have had a profound influence on the operational safety of ships in many ways. The loss of life associated with the sinking of such vessels as The Derbyshire (1980), Herald of Free Enterprise (1987) and Estonia (1995), pollution incidents caused by the Torrey Canyon (1967), Argo Merchant (1976), Amoco Cadiz (1978), Exxon Valdez (1989), Braer (1992), and Erika (2000), and the collision between the Orapin Global - Evoikos in the Singapore Strait (1997) are but some of the many benchmark examples where public pressure on governments has resulted in political pressure on the international shipping community to improve its operating standards. Thus the IMO reviewed the STCW 1978 Convention between 1993 and

1995, leading to new emphasis in STCW 95 on ensuring that licensed seafarers demonstrate their competence to perform functions and tasks in the workplace. By 1 February 2002 all seafarers had to comply with the new standards. Similarly, ship operators have been required to meet new safety management procedures through mandatory compliance with the ISM Code and regulation I/14 of STCW 95. These and other requirements forced upon the international shipping industry have been described more fully in Chapter 2. The loss of the ferry Estonia in 1995 led to changes in international training standards for the operation of Roll-on Roll-off passenger ferries.

New requirements for the safe and effective transportation of cargoes, the continuing introduction of automation and new technology in new vessels, the desire for improved cost effectiveness by operators faced with greater market competition through faster turn round times, are clearly having an impact upon the design of new ships and the manner in which they are, in general, operated today. Adequate manning levels themselves, although governed by so called ‘minimum safety manning’ levels, are much at the whims of individual operators. The level of training and depth of skill required by officers to serve safely on such vessels have not, in many cases, been achieved to meet the changing operational circumstances. Consider three relatively recent technical innovations in bridge equipment, namely, GMDSS, ECDIS and computer based track control systems.

The Global Maritime Distress Safety System (GMDSS) became mandatory in February 1999. Many thousands of shipmasters and navigating officers were required to be issued with certificates to use the equipment by the deadline. For existing seafarers, this often meant attendance at a two or three days’ conversion course. Training institutions provided General Operator Certificate (GOC) courses for newcomers that ranged in length from one to three weeks. One result of this haphazard approach to training has been a high incidence of false distress alerts at sea.

A second example of recent advanced technology is a new aid to navigation called the electronic chart display system (ECDIS). This is a real-time co-ordinate information system capable of integrating chart information, radar, GPS, echo-sounder and gyrocompass data into one display. It is capable of automatically continuously determining and displaying the ship's position relative to land, charted dangers and other ships. It represents a totally new perception for the navigator. The IMO has just introduced model training course 1.27 for ECDIS. How should training be conducted for this new environment - onboard or ashore? Rodrigues (2001) is of the view that ECDIS training has got off onto the wrong foot, exposing seafarers to a new technology in a short course classroom environment, producing often a poor understanding of the nature of ECDIS. He argues that experienced navigators must be exposed to the real environment to fully appreciate it. If resources are available, then a staged development using labs, simulator and training vessel for real experience should be considered. How often does the opportunity arise for real life experience with new equipment be it ARPA, GPS, or Integrated Navigation and Bridge Systems, for example?

A third major change in the past decade has been the increasing use of automatic track control systems. The growing power and availability of computing on ships has been accompanied by a growing ability to remote sense any aspect of ship operations. Linking positional information from GPS, Radar, ARPA and gyro compass to devices such as the Doppler log, adaptive auto pilot and rate of turn indicator, enables a computer to control the track of the vessel very accurately. The modern track control system is designed to keep a ship automatically on a pre-planned track over the ground, in all but the most severe environmental conditions, and within limits imposed by the ship's manoeuvrability. The navigator only overrides the system when danger threatens (risk of collision) or malfunction in the system occurs. It represents a different kind of watchkeeping training or level of alertness.

In 2002 we have the mandatory introduction of a further safety device for ships, the Automatic Identification System (AIS). Fundamentally a transponder using a very high frequency (VHF) modulation technique, AIS is designed to make one ship fitted with it 'visible' to another ship also fitted with a transponder. Being 'visible' is used in the sense that key manoeuvring information about own ship, such as identification, accurate position (from GPS or DGPS), heading, speed and rate of turn, can be exchanged with another ship (the target) continuously and automatically.

It can be stated with some confidence that in the matter of collision avoidance at sea, AIS represents the last piece of technology in the safe navigation jigsaw.

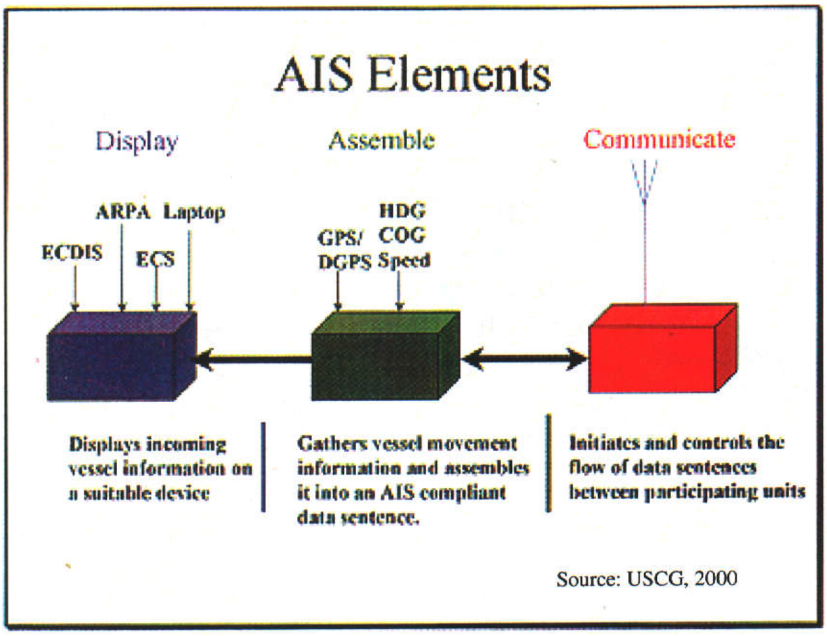


Figure 5.3 AIS structure

Broadcast-AIS is a digital data packet radio communication system using a VHF modulation technique in the maritime mobile VHF band. Four main fields of application are:

- Collision avoidance: an autonomous display of key navigational data onboard
- VTS: a means of obtaining a traffic picture independently of radar
- Pilotage services: AIS can be configured as a portable transponder package.
- Ship Reporting Systems and fleet polling.

Today, the modern ship is fitted with an Integrated Navigation System (INS), which is designed to collect and filter data from individual equipment so as to produce a Most Probable Position (MPP). The INS system in turn is a sub-part of the Integrated Bridge System (IBS) that incorporates all operational needs for controlling the ship. Using sensors and other measured parameters, the INS provides the shipmaster, pilot and navigator with an intelligent situation-awareness picture of position and level of risk, thus enhancing the decision making process needed for safe ship operations. Much of the process today is automatic with little human intervention. Yet despite all the advances in technology, designed to reduce the load of the modern watchkeeper, 'human error' still remains the greatest causal factor behind ship casualties today.

What impact will all these new developments have upon training in the future? Too often in the past the mariner onboard has been left to find his/her way by reading the instruction manual. Today, simulation and multimedia technology have the capability of providing onboard interactive working models, replicating a real time situation from which the mariner can gain a much clearer understanding of the purpose and role of the technology. In the future, virtual reality systems will enable much familiarization with new equipment and systems to take place onboard the ship. Many shipowners are investing in onboard training programs.

Yet, is it safe to assume that the training load can be transferred to the onboard environment? Reduced manning in itself may lead to increased levels of fatigue, unless proper procedures are put in place to prevent this. While Chapter VIII and section A-VIII of Code A of STCW 95 endeavour to provide an operating framework to reduce the risk of fatigue, other factors such as bad weather, emergencies, crew sickness, port turn round time, the trade route, and experience level of the watchkeeper, for example, may thwart the best laid plans of the master and the shipping company. Frequent crew changes, coupled with non-standardization of ship layout and equipment, demand a high level of adaptability and flexibility by officers and crew. The revolution in shipboard communications, that has occurred in the past ten years, started with the introduction of satellite based communications established for the Global Maritime Distress Safety System (GMDSS). The latter, a mandatory component for most ships from 1 February 1999, led to the replacement of the traditional radio officer (whose special skills focused on morse code transmissions) by the officer of the watch. As a result, watchkeeping officers today have to acquire new operating skills for using the GMDSS and VHF-Digital Selective Calling (DSC) communications station. Some view this additional load, imposed upon the already busy watchkeeper, as another factor to be concerned about regarding possible watchkeeper overload, stress and fatigue.

So can the MET system prepare seafarers effectively for such an operating environment? Are global training standards such that shipowners can find, with confidence, seafarers who fit this requirement from any of the labour supplying sources? The evidence from the BIMCO/ISF 2000 manpower update, indicating a future shortage of at least 16,000 officers, is that this is not likely to be the case (Bimco, 2000).

5.1.3 Summary

The last two decades has witnessed the continuing development and installation of new maritime technology of an increasingly sophisticated nature, demanding high levels of knowledge and skill from onboard personnel. This, in its turn, requires the support of specialised training programs to ensure that ships will continue to operate safely and efficiently and provide the general community with the assurance that good quality standards are being maintained. For IMO, the objectives of 'safer ships' and 'cleaner oceans' can only be met if the worldwide maritime industry is prepared to establish standards of training that will meet the challenge of modern technology.

Traditionally, much of the core training requirement has been focused around courses at shore-based training institutions or centres. But in the light of new technology does all such training have to be carried out ashore? It can be argued with some justification that technology today is providing the innovative owner and operator with a window of opportunity to transfer much of the training for required operational skills to the onboard environment. Indeed, new technological developments also provide increasing potential for the assessment of an individual's competence to perform those skills in the workplace, as mentioned in section 4.5 of Chapter 4. How to persuade maritime certifying authorities to accept the judgement of shipmasters and officers, that a trainee onboard is competent to perform certain tasks or functions, is another problem to be faced. There is also the problem of persuading officers themselves to take on the role of assessor! In this regard, the potential of satellite communications to provide the links for the monitoring of personnel at sea must not be overlooked, and for training institutions, company training managers and statutory authorities, the technology is already in place to permit such an approach.

5.2 Satellite communications

The science fiction writer Arthur C. Clarke originally conceived the idea of communication satellites back in 1945. This became a reality in 1957 when a man-made satellite, 'Sputnik', was launched by the Russians into orbit around the earth, thus starting the modern era of satellite development. Today there are thousands of satellites orbiting the earth, many of them providing different types of communication services.

An artificial orbiting satellite follows an elliptical path and can be classed as being either a Geosynchronous Earth Orbit (GEO), Medium Earth Orbit (MEO) or Low Earth Orbit (LEO) satellite. It can be placed in an equatorial orbit (inclination 0°), polar orbit (90°) or inclined at any angle between these two, depending upon the purpose of the satellite.

Geosynchronous Earth Orbit (GEO)

These satellites are placed approximately 36,000 km above the equator and take exactly 24 hours to make one orbit of the earth. They thus appear stationary to an observer on earth. Designed to provide global coverage using a minimum of three satellites, the time delay between transmission and reception (0.25 secs) makes them less suitable for mobile voice communication. Examples of this type are Navstar GPS, Inmarsat and Intelsat systems. Power requirements for transmission are highest.

Medium Earth Orbit (MEO)

Also known as intermediate circular orbit satellites, they may be placed anywhere in the range 5,000 – 12,000 kms from earth. Although the time delay is reduced, more satellites are needed for global coverage (10-12) and the tracking and control system is more complex as the satellites tend to hang over a given region for a few hours, but are not in stationary orbit (Elbert, 1999, p. 24).

Low Earth Orbit (LEO)

The main advantages here are the reduced power requirements for transmission and the negligible time delay incurred. This means that such systems are more suitable for the use of smaller devices, such as hand-held telephones and data transfer needs. According to Spoo (1998), the big disadvantages are the need for fifty to seventy satellites to provide global coverage, the reduced lifespan (orbital heights between 500 and 1000 kms) and the precise tracking and control systems needed. Examples of LEOs are Iridium, Orbcomm and Globalstar Systems.

In 1962, Telstar 1 was the first communication satellite to send live TV pictures and voice transmissions across the Atlantic Ocean using a 6 Ghz receiving frequency and 4 Ghz transmitting frequency (C-band), which could support either a one-way television signal or multiple two-way telephone conversations. Its low orbit meant it had limited access time above the horizon.

Commercial satellite communications commenced in 1965 with the launch of INTELSAT 1. Later satellites were put into GEO orbits, but the 0.25 second propagation delay makes it awkward for two-way communication. The later generation of INTELSAT 6 satellites, launched from 1989, could support 35,000 two-way digital voice circuits. Modern GEO satellites have a number of transmitting and receiving antennas that allow for wide area beams for broadcasting or 'spot beam' for point to point links.

Today (2002), the number of GEO, MEO and LEO satellite network operators continues to grow. The range of services provided, or due to be introduced in the next few years to provide global or near global communication links, extends to wireless telephones, fax, e-mail, data services, the Internet, pagers, television and links for cable TV companies. It has been estimated that there are more than 4,000 satellites in orbit around the earth. Many satellites provide important services to the maritime community such as tracking hurricanes, fish finding, fishing vessel and fleet management, coastal zone monitoring and marine pollution prevention and control. With new concerns over maritime security in the aftermath of the 2001 terrorist attacks on New York, surveillance of ships to combat piracy, terrorist threats and illegal immigration, can be expected to increase. For ships, the benefits are seen in many other practical forms, such as improved search and rescue and ship reporting services, emergency medical care, voyage planning, weather routeing, tracking of cargo containers and improved family links for crewmembers.

Table 5.1 indicates the major operators in the satellite communications world.

Table 5.1 Major satellite communication operators

Major services	No	Type	Comment
SES-Americom	29	Geo, Leo	
Panamsat	20	Geo	
Intelsat	20	Geo	10 new being added
Eutelsat	18	Geo	covers 48 countries
Loral: *Skynet (9), Satmex (2), Europe*Star (3) Skynet Brasil (2)*	16	Geo,Leo	incl Telstar satellites
Inmarsat	9	Geo	3 new in 2004
New Skies	5	Geo	Ex Intelsat (part)
Orbcomm	36	Leo	Data comms
Teledesic	30	Leo	A future 'Internet in the Sky' (2005)
Satellite hand phone systems			
Iridium	66	Leo	
Globalstar	48	Leo	
NewICO	12	Meo	Under development

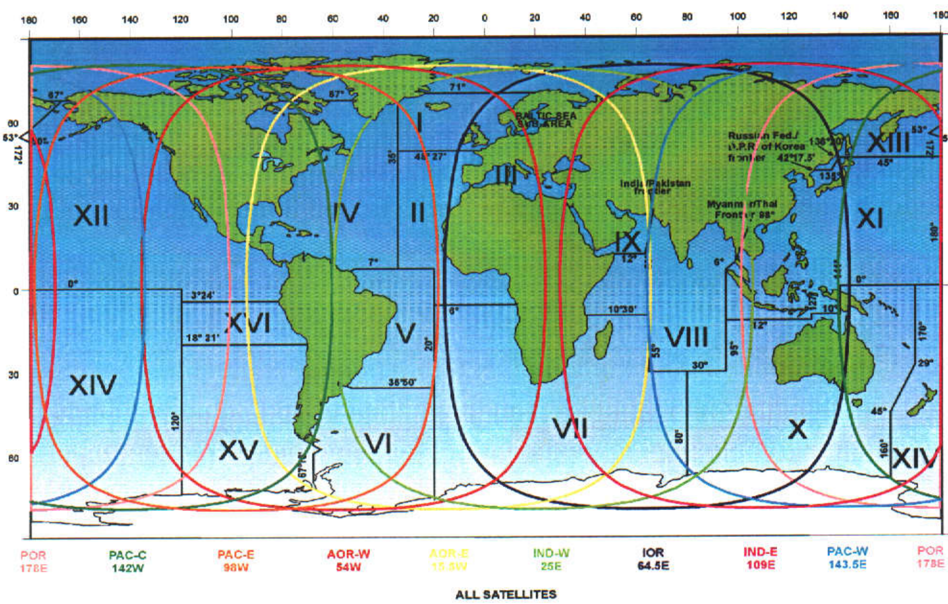
Sources: World Wide Web sites, September, 2002

5.2.1 Inmarsat and maritime services

A major advance in satellite technology was brought about by the introduction of the Global Maritime Distress and Safety System (GMDSS), that was implemented in 1992 and became fully effective on a worldwide basis from February 1999. This IMO initiated project was designed to improve emergency safety communications for international shipping and enhance rescue coordination operations. The management of such a system was entrusted to the International Maritime Satellite Organization (INMARSAT), a treaty based entity established in 1979 with the prime tasks of improving communications for safety of life at sea and efficient fleet management.

Inmarsat was turned into a corporate entity called Inmarsat Ltd in 1999, with the main purpose of providing a space segment for improving maritime, aeronautical and land mobile communications. The International Mobile Satellite Organization (IMSO), established by a Convention in 1979, came into being in 1999 on the privatization of Inmarsat, with the role of ensuring that the public service obligations of Inmarsat, in relation to the operation of the GMDSS system, are being observed.

Inmarsat today provides many satellite communication services in addition to its GMDSS obligations. Its range of communication systems A, B, C, Mini M, D/D+, Fleetnet and E, added to by the new Mobile Packet Data Service (MPDS) and FleetF77 in 2002, provide a comprehensive family of voice and data services to the global community. Ships at sea are disadvantaged in not being able to access high speed undersea fibre-optic cables and are dependent upon satellite links for this segment. So what sort of services can such technology provide to the ship, the shipowner and the seafarer? Although the capabilities of each system vary, the possibilities cover telex, fax, telephone, e-mail, compressed video, slow scan TV, data transmission, differential GPS corrections, distress alert, position reporting, group calling, polling and paging services.



Source: Imarsat Ltd (2002)

Figure 5.4 Inmarsat satellite coverage

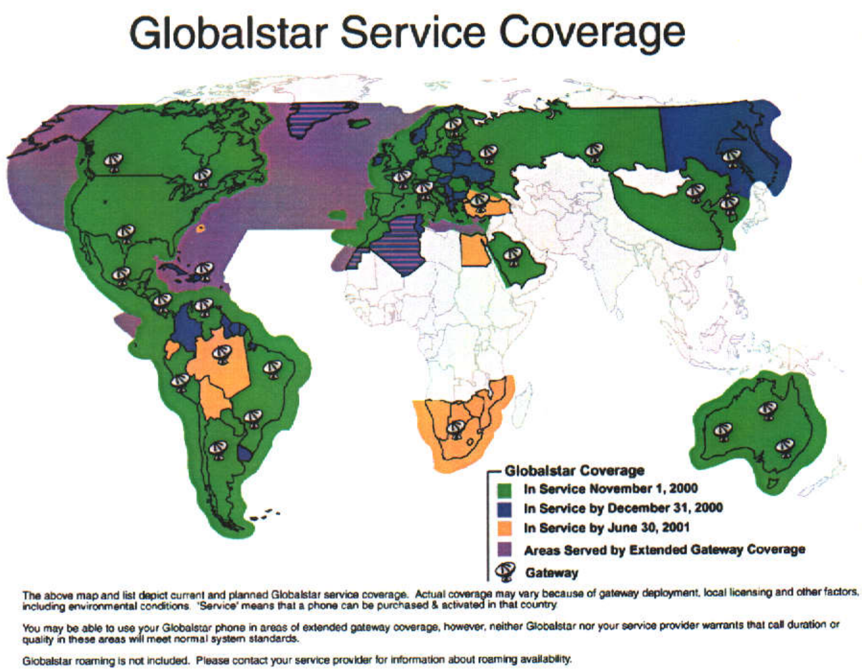
The latest offering, FleetF77, offers general business applications, including secure access to information online, image transfer and video communications. The potential for adoption for onboard education and training purposes is thus extended. An example of how such services can benefit seafarers has been the introduction of pre-paid calling cards that work with cost effective and compact terminals. Satcom tariffs are still relatively high for personal use by seafarers and the card system is one means of stimulating contact with families through leased or bought terminals. This may help in retention of staff at sea. According to Fuller (2001), costs can be brought down by bulk buying of airtime, as illustrated by a new system called 'CrewLink', in which communications provider company, Stratos, bulk buys Inmarsat airtime for selling on to end users. ITF has provided seeding money of US$1 million to buy the first chunk of airtime. Calls are being charged at a flat rate of US$1.85 per minute and consideration is being given to adding e-mail and offline Internet in the future. Xantic has launched ChatCard, which works over Inmarsat A, B, M and GAN. A 500 unit card costs US$70 and can be used for 12 months after the first phone call.

5.2.2 Hand held satellite phones

This technology started off life full of optimism but soon became a victim of its own marketing strategy. Iridium launched a series of 66 LEO satellites up to 1997, but ended up filing for USA Chapter 11 bankruptcy protection in 2000 with debts of US$5 billion, after achieving a target of only 60,000 customers compared to its planned one million. A group of investors acquired Iridium in late 2000 and has commenced operations again with slimmer handsets and lower prices. The technology of bouncing calls from one satellite to another is complex and replacing the satellites in a few years will be expensive.

Another competitor, Globalstar, has experienced similar difficulties in establishing a scale of activity for sustainable profitable operations (66,000 customers in 2002) and also filed for USA Chapter 11 bankruptcy protection in February 2002. Phones retail for as low as US$600, with calls offered for US$1.50 a minute. It still remained trading in the latter part of 2002, raising optimism that this form of convenient global communication would survive the turmoils that have hit the telecommunications sector during 2001-2002. However, the long term future of many of these companies must still be questioned.

However, it is most probable that such hand held satellite systems will find a ready use on board ship in the future as a result of their ability to provide complete coverage of most of the world's ocean areas, an example of which is shown in Figure 5.5 over.



Source: Globalstar.com

Figure 5.5 Globalstar coverage – April 2002

Other operators, such as Orbcomm, offer two-way global wireless data and messaging communication services (like 2-way paging or e-mail) via LEO satellites and ground infrastructure. The application of this technology is probably more limited in the maritime environment. Unusually, Orbcomm sells exclusively through value-added resellers who provide the hardware, software and airtime to end users.

A future development, described in section 5.3, is the proposed global 'Internet in the Sky', being launched by Teledesic for startup in 2005. This will provide a wide range of data, voice and video communication capabilities from a 30 satellite configuration.

5.2.3 Data transfer systems and the mariner

One major disadvantage experienced by the mariner at sea is the lack of connectivity to land based communication links, such as telephone, Asymmetric Digital Subscriber Line (ADSL), co-axial cable or fibre-optics. Links for ship-company business are very dependent upon satellite links for part of the communication chain. This can make it expensive for small volume data transmissions. The previously mentioned Davies and Parfett (1997) study of the possible use of the Internet by seafarers, made a number of recommendations, such as providing access in the Missions to Seafarers premises ashore, and developing seafarer gateway sites on the Internet. Several initiatives have already been acted upon, funded by the International Transport Federation (ITF). The main factor affecting cost of transmission is speed. This is dependent upon the type of information to be sent (text or graphics), the volume of information, the rate of data compression, and the transmit/receive facility available.

An early approach in the 1990s utilised the Inmarsat-C system. A maritime training institution ashore would need to be a licensed Inmarsat LES in order to communicate. To send information to a particular ship or group of ships, the institution would obtain both the Inmarsat Mobile Number (IMN) for each ship (listed in the Inmarsat Ship Directory) and the Inmarsat Ocean Regional Access Code. To transmit to a group of ships in a fleet, the institution would register as an authorised FleetNET information provider. The ships of a fleet would be registered with a FleetNET service and have stored in their ship earth station (SES) an enhanced group calling (EGC) Network Identification Code (ENID). When the institution sends out the message, only those SESs storing the ENID code receive the broadcast.

Communication could be activated via the following routes:

- Institution → Telecom landline → LES → Inmarsat Satellite → SES
- Institution → Satellite → LES → Satellite → SES by-passing the telecom network.

Facsimile transmission

It is an easy process to send and exchange drawings, graphs, sketches and photographs to ships fitted with Inmarsat A or B equipment and a fax facility. This is not possible with ships fitted only with Inmarsat C equipment.

The availability of the Inmarsat A and B duplex high speed data (HSD) service allows for multimedia transmissions (video, voice, data) to be used, where the terminals at LES and SES handle this. Past EU funded research by Schwantke (1993) and work into the use of compressed video by Wärtsilä (1993) showed promising results for visual links between ship and shore experts. This has been further explored in later research projects and through new technology such as Very Small Aperture Terminal (VSAT) transmissions. The potential for using streaming video technology in delivering training programs onboard from ashore is considered to be impractical at present until both the technology is in place on the ships and costs of such transmissions fall dramatically.

Data communication using Inmarsat-C.

One possible approach to developing an economical data transmission system is to make use of data compression techniques utilising computer based software, a computer terminal, modem and the Inmarsat system (A, B, C or M). Participating ships would need a PC with appropriate file transfer software and a data modem of at least 9,600 bits per second (bps) using protocol V32. At this rate the average A4 page of 500 words of text (2,500 characters = 20,000 bits) will take two seconds or more to transmit. If the Inmarsat high speed data (HSD) service at 56 and 64 Kilobits is used, the rate can be speeded up six or seven times. However, this is primarily to cover the needs of users with large amounts of data (e.g. Seismic surveys) and is probably not appropriate for the level of use envisaged for training and education.

The compatibility of the Inmarsat-C system with the Packet Switched Data Network (PSDN) using X.25 protocol, however, still makes Inmarsat-C virtually accessible to anybody with a PC and modem. This means that a trainee could compile and convert a textual assignment into an ASCII file format and connect and transmit the file via modem and an Inmarsat terminal to the institute's computer. This could later be retrieved in textual form by the staff member responsible for marking.

Alternatively, the institute may initiate the connection and transmit a marked assignment as a data file to the trainee on the participating ship. If an assignment is to be sent out to a number of students onboard different ships, then it would be more economical to use the EGC FleetNET service. Nowadays, proprietary data communication management software programs could be utilized.

Currently, in 2002, many shipping companies use marine communications software applications to manage links between ship and shore. These may be real-time or store and forward services. EasyLink, for example, offers through their Ocean–Connect range airtime services via Inmarsat, graphical fax solutions, shipboard e-mail options, as well as private e-mail facilities for crew members. Rydex Express and others offer similar services.

5.2.4 Summary

It is evident, from the foregoing that new technology is opening up a broad vista of opportunity for new approaches to be made in maritime education and training at sea. Naturally, such a dramatic shift from traditional methodology brings with it a number of questions, foremost amongst which are:

What are the priorities for onboard training and education?
Who will pay for the service?
What sort of data should be transmitted?
How should data be transmitted?
Will it be cost effective compared to current shore based training?
Could it be used for meeting specific shortcomings?

- Improving English communication skills
- Improving operational skills (e.g. ECDIS)
- Improving the quality of training
- Refreshing and updating skills
- Developing maintenance skills
- Assessing onboard competence of mariners
- Managing new operational procedures (e.g. ISM Code)

The author's experiences and this investigation lead to a conclusion that priorities fall into three categories:

1. Onboard training obligations of ship operators under the revised STCW Convention, ISM Code and other associated quality control measures;
2. New technical or operational skills and the communications and technology medium demonstrating its potential to provide more effective training in situ onboard, as against ashore;
3. Access to further education and knowledge by shipboard personnel, whether leading to an accredited award or just for leisure or interest purposes.

Costs should be borne by the operator in the first two cases, while in the third case individuals should expect to pay a fee (full or subsidised) for use of the service.

The most attractive use of this technology is in upgrading and refreshing the knowledge and skills of personnel onboard, particularly where new equipment or operational procedures have been introduced. The opportunity to carry out such training on the ship and to monitor the involvement and performance of personnel in this way provides the responsible owner/operator with the means of having close management control of standards across the whole company.

With the increased emphasis on skill acquisition, satellite and computing technology is well placed to provide an important link for onboard education and training, as the maritime world strives to improve standards of safety in the workplace in the face of a growing demand for well trained crews at an affordable cost.

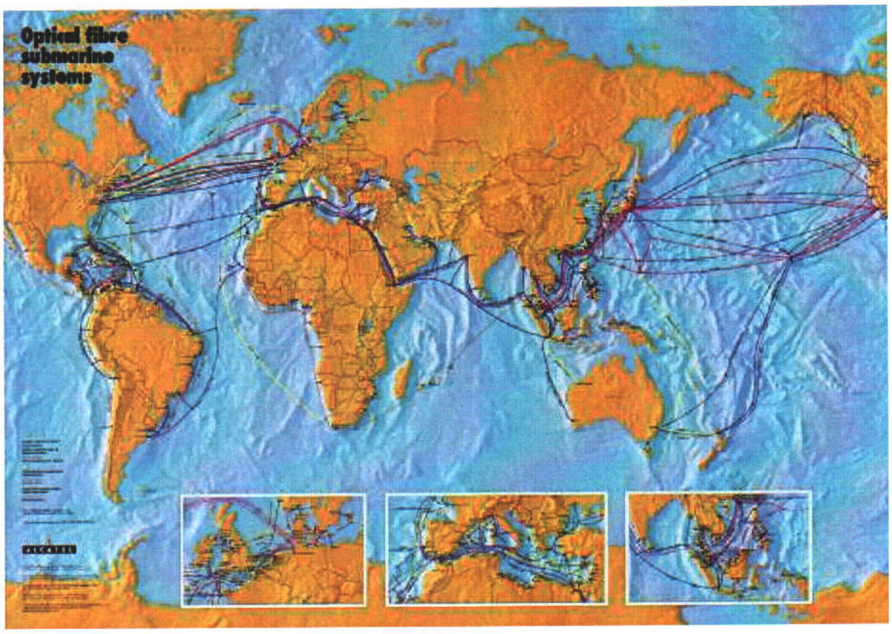
5.3 Information Technology (IT)

Research and observation indicates that the greatest catalyst of change affecting the maritime industry in the last decade of the 20th century has been the growth and development of new communication links, both land and satellite based. This section identifies the major changes taking place with new technology that have the greatest potential to influence future directions of maritime education and training.

5.3.1 Global connections

Communication links to and from ships at sea are dependent upon satellite systems for coverage of the ship to shore leg of the communication chain. There are no connections at sea to fibre-optic cables on land or on the ocean bed for high speed data and video transmissions. It is often overlooked that many communications go through undersea cables (see Figure 5.6 over).

Today (2002), there are more than 600,000 km of fibre-optic cable on the floors of the world's seas. The International Herald Tribune (10 March 1998) reported that project 'Oxygen', bringing together 30 international telecommunications providers, aimed to establish a super Internet that will link up 175 countries through 320,000 km of fibre-optic cable to handle the demands of Internet and video transmissions. Alcatel in March 2001 awarded a contract to Cable and Wireless to lay another 13,000 kms of fibre-optic cable across the North Atlantic Ocean, one of the world's heaviest portals for data traffic.



Source: Cybergeography.org (2002)

Figure 5.6 Global fibre-optic submarine cable systems

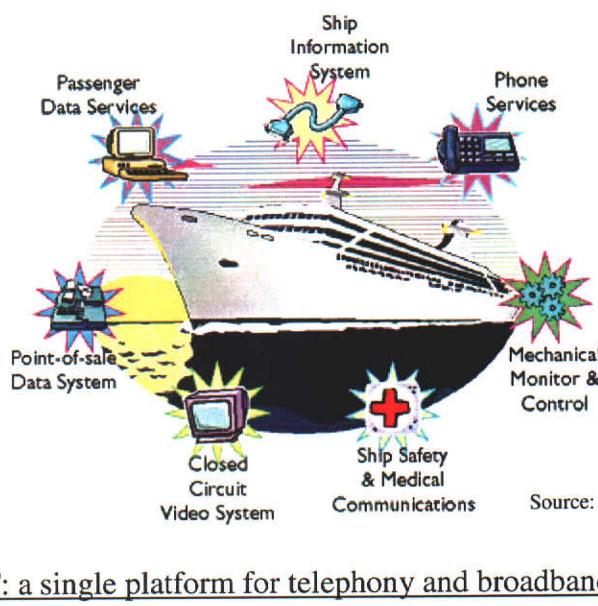
Information Week (2001) reported that Lucent Technologies' Bell Laboratories had developed fibre-optic lines that could handle up to 100 terabytes of data per second (that is 1,000 million Gigabytes per second). To put that into perspective, this is enough to transmit as many as two billion phone calls or 20 billion one-page e-mails! The current land-speed record for data transfer was set on 9 April 2002 by teams from the Universities of Alaska and Amsterdam and SURFnet in the Netherlands. Using various networks, including the Internet2 Abilene backbone network, a speed of 401 Mbps was achieved.

Most satellite communications today were established to handle voice, telex and fax and a little data traffic, generally for a low speed volume market. The Inmarsat B system provides a maximum HSD 56-64 Kbps throughput with compression at 80 kbps. Smith (1998) described how International Radio Traffic Services Ltd had taken the more limited Inmarsat C system (store and forward messaging at 0.6 kbps with a limit of 32 Kbytes of ASCII data) to create a more powerful e-mail system using a compression factor of eight to reduce costs, which are based on volume. It remains however a limited service when looking at moving data in any sort of volume. The fourth generation Inmarsat satellites, coming on stream from 2004 onwards, will offer a full range of personal multimedia communications at a faster 144-432 kbps.

Companies, like Sea-Tel Inc, are supporting the growing demand for satellite TV and video at sea, made possible by the improved stabilization and tracking technology in the antenna on the ship.

A possible solution for ship and seafarer communications, and potentially one of the most exciting developments, is the proposed 'Teledesic' system ('Internet in the Sky'), that plans to use 30 satellites to roam the Internet worldwide (Teledesic, 2002). Designed to support millions of simultaneous users, it will provide up to 100 Mbps of capacity on the uplink and 720 Mbps on the downlink. The potential to provide access to distance education programs and leisure pursuits from any position in the world could change the face of onboard life as well as the activities of shore based training institutions. The targeted start up date is 2005, and initial satellite building contracts have been let in 2002 to get this ambitious project off the ground in order to meet this target.

At present, the most viable approach to developing an economical data transmission system is to make use of data compression techniques utilising computer based software, a computer terminal, modem and the Inmarsat system. Nera Satcom, Norway, has developed its future systems around ISDN signaling and multiple 64kbps channels. An older system in renaissance is VSAT technology. Although high in terminal cost, communication costs are low from a service that offers 64-512 Kbps.



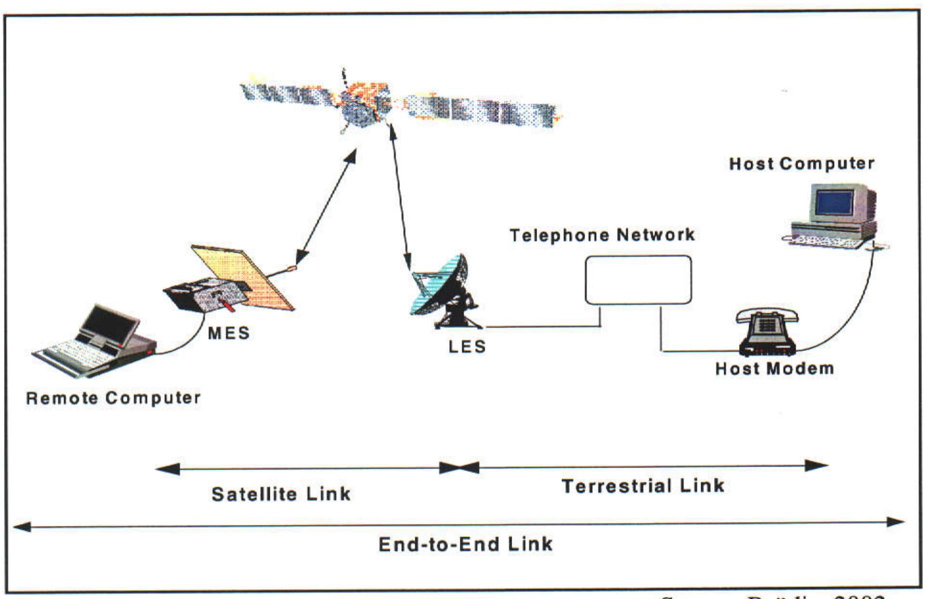
Source: Brödje, 2002

Figure 5.7 VSAT: a single platform for telephony and broadband services

Brödje (1999) noted that the future wave of broadband K-band satellite systems promised to alter the economics of satellite business, but this could be costly to establish, bearing in mind the experiences with Iridium. Foley (1999) reported that both Astrolink and Spaceway planned to start a service in 2002/2003 with data speeds between 400 Kbps to 20 Mbps, where the use of spot beam and multi-carrier frequency techniques will allow data services to be maximised between beams.

However, as noted above, the growing use of e-mail and the demand for Internet access is leading to initiatives to provide low cost links to ships via Inmarsat C by hub providers, such as Rydex, EasyLink, Stratos and Xantic and others. These providers are opening up an improved avenue for ship-shore communications for ship's business on board. The willingness of many ship operators to make such services accessible to crew for education and training use was in question, according to Davies & Parfett (1997).

There is growing evidence in 2002 of greater access to e-mail services by ship crews, as ship operators try to attract personnel to careers at sea by providing such links to families. The doors to Internet access, however, with potential links for distance learning, are opening more slowly.



Source: Brödje, 2002

Figure 5.8 Typical data communications link

An analysis of developments to date allows a view to be taken that the future picture is an optimistic one, with considerable potential for interaction between personnel onboard and shore based training programs and tutors (shipowner or institutional).

5.3.2 The Internet and Information Technology

The main catalysts for change have been the growing power of the computer and the spread of a global information highway, called the Internet. What is this Internet? The Internet can be described as a network of computer networks originating in the USA defence system in the 1960s, but it started to grow further only from the mid 1980s. Examples of typical networks are NFSNET, SUNET, JANET, AARNET, etc. However it was only from 1993 onwards that 'THE NET' started to spread in the exponential way it is today.

As previously mentioned, according to Internet research company Netsizer (2002), the number of domain servers or hosts has grown from a mere 1.3 million in 1993 to an estimated minimum of 192 million in 2002. CyberAtlas (2002) reported that the number of users with access to the Internet in August 2001 was approximately 445 million, and estimated to grow to 709 million by the end of 2004. Some people are worried that the Internet is going to suffer overload and perhaps there are already signs of this. The Internet uses a 32 bit address, which theoretically gives it a limit of about 4.3 billion addresses, that the designers saw as more than adequate for many years. To overcome the concern that Internet will soon run out of addresses, a new protocol called Internet Protocol New Generation will expand the address from 32 to 128 bits. This creation of a reservoir of 10^{38} addresses should, in theory, last for many decades.

Consider also highly time sensitive services such as those that exploit audio and video. The invention of the World Wide Web (WWW) by Tim Lee at CERN in Geneva opened the way up for the transmission of graphics, pictures, sound and video. The arrival of Internet phones and the use of video streams are greatly increasing such traffic. One answer is to speed up the data flow.

Consider the typical V.92 modem today that has a transfer rate of 56 kilobits per second. Few companies have links that run at more than two megabits per second. The Integrated Services Digital Network (ISDN) offers 128 kilobits/second. Twisted pair cabling run by telephone companies using unshielded twisted pair (UTP) category 5 cabling can handle 100 BASE-T Fast Ethernet at 100 Mbps, whilst cable companies using fibre-optics can offer up to 10 megabit/second. Internet Service Providers (ISP) are installing capacities of 100 megabits per second. Many Telecommunication companies are getting in the act, keen to sell capacity to ISPs. The 21st century has opened with a spate of mergers and takeovers of Internet communication providers by telecommunication companies, as they seek to consolidate their position for this growing market.

How can all these new links take place? In the early days of the Internet the designers allowed different types of network to be patched together without complex planning or approval procedures. Indeed, there are no limits to the number, size or type of networks that can be added, provided they conform to basic Internet protocol standards. Theoretically capacity and demand should be matched (potentially 4.3 billion addresses can exist). Providing clear 'data pipes' is one thing, forwarding the data (via the routers) at a few gigabits per second is another thing. As the thirst for greater 'broadband' capacity by users grows, ISPs are having to install new routers that will handle a minimum of 50 gigabits or more of data per second.

Section 6.1.1 in Chapter 6 illustrates the development of computer technology in detail. Power and transmission speed linked to a computer distribution network has allowed communication interaction to reach what was thought to be impossible levels. Whether it is the number of transistors on a chip, its speed in Megahertz (MHz), the rate of calculation in millions of instructions per second (mips), growth in memory capacity or bandwidth, the desktop computer today is a more powerful tool than most main frame systems of ten years ago. It is quite astonishing.

5.3.3 Development of selected Internet and e-mail services

Today the world lives in an 'age of progress', surrounded by a world of technical terms - computers, Internet, e-mail, satellite communications, World Wide Web, high speed data transfer, laser discs, CD-ROM, DVD, interactive video, distance learning, Local Area Networks (LANs), to name but a few, all interactive in some way with the so called information superhighway. The MET world cannot isolate itself from such changes. An examination of some Internet and e-mail links will assist in understanding this growing web of connectivity.

Asynchronous Transfer Mode (ATM) communications networks are developing rapidly around the globe, as illustrated by Monash University in Australia which completed a network across five campuses to give students and teaching staff access to broadband applications. It was planned to serve more than 10,000 external students by 2002 (Mulcaster, 1998).

The Swedish government is spending $US 1.8 billion on a national action plan for IT in schools. It also announced plans for a broadband network that will give every home in Sweden, even in the remotest corner, broadband connectivity to the Internet within two years (George, 2000) although this timeframe has now drifted back to 2003 or 2004. The Financial Times of 22/2/2001 reported that Denmark had similar plans to achieve 97% broadband coverage of its population by the end of 2002. Many other governments around the world are upgrading their broadband computing capabilities in anticipation of growing demands for video based learning services, although in many cases targets are slow in being met.

The increasing installation of Local Area Networks (LANs) on ships reflects a slow but growing realisation by some ship managers that the linking of the total ship to the company LAN ashore can increase interaction between both and lead to improved efficiency, safety and cost effectiveness. However, in planning such links, it should be borne in mind that there are no convenient fibre-optic lines out to the ship and the use of the Internet, e-mail and data transfer services is going to be very dependent upon the satellite segment of the network architecture for the foreseeable future. This, of course, means higher costs initially until the growing volume of traffic brings down the unit price of audio, video and data transmission. This influences thinking in the industry as to the potential use of computing and information technology (IT) in the future.

The foregoing developments are but the tip of the iceberg. Why not a maritime based cyber gateway for seafarers on ships or persons in the maritime industry ashore? There are no real technical impediments to simulation training in the workplace or at home after work. The main problem is one of access to broadband capability and cost at present. Such training activity could be run by a consortia of maritime partners bringing industry and education services together. What is clear from the survey of global MET institutions and from the investigation into developments in technology is that the maritime education and training community will not be immune from such changes and needs to face up to challenge posed by this new cyberspace world.

5.3.4 Multimedia developments

Storage of Information

Since 1995 there has been an explosion in the use of CD-ROMs when the 650 Mb capacity disc came onto the market, enabling large quantities of data to be stored on it. Sources of IT based maritime reference material are now increasing rapidly. Examples of CDs include Lloyds Classification Society 'Rulefinder' which contains its own and IMO regulations, Fairplay World Shipping Encyclopaedia, IMO Dangerous Goods Code and the IMO Vega database. One disc can contain 600,000 pages or approximately 2000 average sized books - no longer need the seafarer be isolated from library resources. The Digital Video Disc (DVD) has so much more memory it can play moving images at a much higher audio-visual quality on TV or PC screens.

The advent of the information highway provides scope for a greater interactive role between maritime training managers, ship personnel, training institutions and approving authorities. If institutions, for example, do not upgrade their computer hardware and software resources and methods of training so they can provide industry with the skilled personnel required, companies are likely to contract with other readily available service providers in the computing field to provide such services.

Video transmission

Global connectivity today has been established at a level that provides users with the necessary links for e-mail, telex, fax, telephone, data and still picture transmission. As we have seen in the earlier preview however, access to broadband services is still very limited and costly. Only large commercial organizations and government entities are in a position to use video services at sea on a regular basis. Even on land where fibre-optic networks are increasingly being laid as part of national policies, it is still quite costly to use such facilities for streaming video. Video conferencing is increasingly being used by business and by educational institutions for distance learning delivery but it remains a costly medium for academic purposes.

The government of Sweden considers broadband as a transmission capacity in excess of two Mbps (George, 2000). It has already been stated that services available to ships at sea are currently limited to satellite links of 64 Kbps (Inmarsat A/B HSD service), INVSAT (up to 512 Kbps) and Seatel 'TV in the Sky' service up to 1544 Mbps, although the latter is generally confined to cruise ships, because of cost. It is worth remembering that broadcast television transmits 30 frames per second, each frame contains about one Mb. From a memory storage point of view, eighty CD-ROMs would be needed to hold an hour long movie! Using MPEG-2 data compression techniques (Quick Time or Video for Windows), it all fits onto one CD-ROM.

If the 'Teledesic' project gets off the ground in 2005, then the opportunities to utilize video links between ship and shore will rise dramatically as costs come down. The possibility of using video conferencing techniques for training, education, and operational needs onboard ship will be that step closer to reality.

5.3.5 Summary

The evidence is clear. World-wide computer networks and communication links are expanding and growing at an extremely fast pace. The potential of systems to handle data and communications quickly, cheaply and securely is not in doubt. New services in the next few years will provide greater bandwidth to allow expansion of audio, video and multimedia transmission capability as well as more cost effective links for maritime education and training purposes.

With the global communications industry now focused on putting in place increased broadband capacity, such moves will allow institutions to rethink their strategy in relation to the effective use of information technology in all its shades and colours.

For the ship operator the major source of officers and crews today has swung to the Asia-Pacific basin. Current surveys (CIIPMET, 1998) show that many institutions in the region lack modern computing resources and well qualified and experienced instructors, in a world where traditional teaching methods hold sway. While serious attempts are being made to upgrade equipment and qualifications of instructors in many institutions, the process will take many years before the global standards reach a satisfactory level.

In meeting the new requirements for standards of training, competence and quality assurance imposed upon them by the ISM Code and STCW 95, shipowners are increasingly looking for new means to assure themselves that the officers and ratings, that they hire across the globe, do indeed meet standards. More ships are being constructed around an onboard computer based network and this, allied to communication links back to the office through e-mail and the Internet, will radically change operational methods and procedures on the ship.

The trend toward using CBT assessment packages as part of the recruitment process, and for use to establish continuing proficiency onboard, is becoming more common. If owners of highly sophisticated ships are to operate these vessels effectively through increased use of IT and satellite communications technology, the skills of their existing and future crews will increasingly be a key element.

If MET institutions are to meet such demands, their computer based resources and instructors' skills must be upgraded, if they to are to continue to turn out trainees acceptable to industry. The maritime industry itself can expect growing pressure from technological developments to continue to change the manner in which they operate and manage vessels in the future. Strategic planning for new training requirements is clearly a major key to the future success of the shipping industry and the enhancing of global standards, and should be developed in association with the training institutions and equipment and software suppliers.

CHAPTER 6

COMPUTER BASED TRAINING AND SIMULATION

6.1 Computer based training

Perhaps the most momentous change in the education world in the 21st century is the ease of access to computing technology by academic staff and students. While coverage is not uniform, the next decade will see increasing penetration of and accessibility to computers, the Internet and e-education in the less developed parts of the world. As the survey results enumerated in Chapter 3 show, there are many MET institutions with a lack of e-education capability at present, but most have plans to achieve advances in technology in the future. This chapter examines some of the trends and developments in technology and its current and potential use in training.

6.1.1 Computer technology today

In many developing countries, personal computers have still to penetrate the maritime world, the Internet and e-mail have not arrived and the expression dot.com has no meaning. As noted in Chapter 4, even in the year 2002 in the author's own institution, some new WMU students have not used a computer before their arrival. This presents faculty with an additional challenge in raising computer awareness skills quickly so that the advantages of Computer Assisted Learning (CAL) and Computer Based Training (CBT) can be quickly realised. For lecturers, this underpinning knowledge is essential before attempting to put software programs to use in the learning and assessment process. The problem of raising computer literacy skills amongst officers and ratings recruited from some developing countries must also be taken into account.

It is worth also considering today's PC technology, costs and maintenance aspects. At the beginning of 1997, in Sweden, the World Maritime University could buy a PC with a Pentium II 200 MHz processor chip, 16mb RAM, 5 Gb Hard Disc drive with 14" colour monitor for around $US 2000. For the same money in 2002 WMU could buy a computer with a Pentium 4 processor at 2.2 GHz chip speed, 512Mb DRAM, 120 Gb Hard Disc Drive, 64MB graphics card, CD-RW or DVD drive, 17" colour monitor, with printer, scanner and digital camera thrown in.

Power and speed linked to a computer distribution network have allowed communication interaction to achieve what were thought to be impossible levels. Consider Table 6.1 below showing the growth in the power of the microchip.

Table 6.1: INTEL processor development

Chip No	Year	Mhz	No Transistors	Datatype (bits)
8008	1972	0.5-0.8	3000	8
8080	1974	2-3	4500	8
8086	1978	5-10	29,000	8/16
80286	1982	10-16	130,000	8/16
80386	1985	16-33	275,000	8/16/32
80486	1989	25-33	1.2 million	8/16/32
Pentium	1992	60,66	3.1 million	8/16/32
Pentium	1994	100	4.1 million	8/16/32
Pentium	1995	200	7.5 million	16/32
Pentium II	1997	233-400	8 million	16/32
Pentium III	1999	500	10 million	32
Pentium III	2000	800	12 million	32
Pentium 4	2001	1-1.4 GHz	42 million	32
Pentium 4	2002	2-2.8 GHz	55 million	32
Itanium	2001	7-800 MHz	EPIC	64
Itanium2	2002	1 GHz	EPIC	64

Source: P.Muirhead (2000) Intel.com (2002)

The 2002 Pentium 4 chip rated at 2.53 GHz has 55 million transistors, 18 times the number of transistors than the Pentium 66 processor of 1992. This means 2.5 billion electrical pulses go through the processor every second. The potential benefits for simulation, graphics and video developments are tremendous (Muirhead, 2000).

When we look at data storage demands in the light of digital needs, capacity has increased 100% every 18 months since 1991. Future databases are talked of in terms of Terabytes (1000 gigabytes), Petabytes (1,000,000 gigabytes) and Exabytes (1,000 million gigabytes) and beyond. Data storage centres are being established to offer customers a data storage service, such is the volume of data being generated today! How can the maritime industry use such technology, particularly simulation technology, in the service of education and training?

Table 6.2 The growing size of memory

1 kilobyte	=1,000 bytes
1 Megabyte	= 1,000,000 bytes
1 Gigabyte	= 1,000,000,000 bytes
1 Terabyte	= 1,000 Gigabytes
1 Petabyte	= 1 million Gigabytes
1 Exabyte	= 1,000 million Gigabytes
1 Zettabyte	= 1 million Petabytes or 10^21
1 Yottabyte	= 1,000 million Petabytes or 10^24

Source: Webopedia.internet.com

Such is the speed of technical enhancement and software development that today's hardware purchase may not handle tomorrow's software. Increasingly many programs are being developed for network use. This has many advantages for the instructor, as well as avoiding copyright problems. Today, if computers are going to be used in MET, the provision of a networked computer laboratory is essential if lecturers are going to gain any benefits of scale from group learning, monitoring and polling of activity.

Stand alone PC

The most suitable use is in the mediation of information flows (e.g. library databases), and the use of software programs requiring individual interaction or self-tuition. The use of interactive software, related closely to workplace operations, allows the instructor (whether ashore or onboard) to check and evaluate the ability of the officer or trainee to perform to the specified training objectives.

Network Laboratory

The linking of a number of PCs to a file-server within a local area network (LAN) system (e.g. Novell) provides flexibility by enhancing the learning process for the student and providing lecturers with new ways to achieve learning and assessment objectives. Planned carefully, the programmed use of networked computers can lead to considerable economies of scale in the use of computer resources. Students can access a range of programs for use within the curriculum without lecturer involvement whilst maintaining copyright standards. Student performance can be monitored from the lecturer's own PC. Information and databases can be accessed directly from a library, CD-ROM stack. E-mail provides communication links. Information and databases can be accessed directly from a library, CD-ROM stack or via the Internet for education and training purposes. The shore LAN can be linked directly to the ship LAN with the obvious potential for more effective use in ship operations. In the future, such conduits will be used for crew recreational and leisure purposes as well as onboard training. However such technology demands considerable skill on the part of the student.

6.1.2 Computing technology at the World Maritime University

The quality of academic standards and credibility is dependent upon many factors. In today's modern educational world, the provision of up to the minute computing and Internet services is crucial (Muirhead, 1999). As an example, all staff and students have had access to and use of e-mail and the Internet by links from WMU through the Swedish University network SUNET since 1997. Throughout 1998 and 1999 the WMU network was upgraded and all computers in the WMU were replaced. Printing and scanning services have been extended. A new multi-functional multimedia interactive computing laboratory holding 20 computers for both language learning and Computer Assisted Learning (CAL) opened in 1999, creating new avenues for the instructor and teaching methods.

During 2001, a second laboratory of 25 computers was modified, to provide the instructor with a similar interactive capability. A small multimedia studio is planned for 2003 so that, in future, WMU can produce educational materials for internal access and external delivery. The student hostel building has a further laboratory with 12 computers for group activity, and these are linked by fibre-optic cable to the WMU network. January 2002 saw all 200 student rooms and 12 visiting professor apartments in the University Hostel equipped with a desktop computer and linked to the WMU network.

A multi-functional computer laboratory

This new PC-based laboratory today provides all the IT and multimedia support required for the highly acclaimed WMU English Study Skills Program (ESSP), as well as supporting Computer Assisted Learning (CAL) in general academic programs. Figure 6.1 provides a general view of the laboratory.

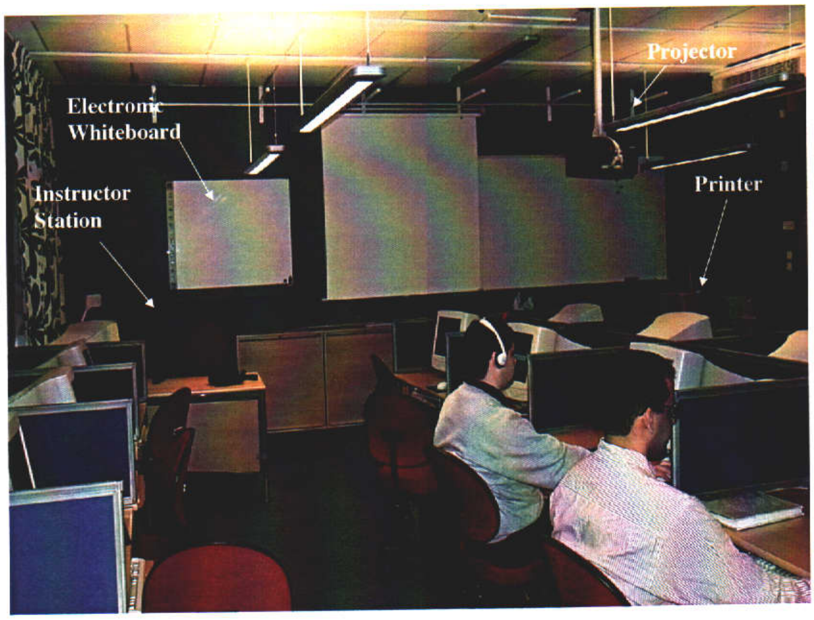


Figure 6.1 A modern PC networked multimedia teaching laboratory

The technical design allows data or digital signals to be taken from the Network, Internet, electronic whiteboard, Pointmaker, Canon RE350 video visualizer camera, VCR, TV and other sources through the instructor PC to the students PCs via ComWeb. Data can also be sent to the large screen via the SVGA projector and to the VCR or TV. The RE350 is a particularly versatile tool which, when used in conjunction with a TV monitor or video projector, allows for images of documents, overheads, slides, and negatives to be presented at a very sharp level of image. Figure 6.2 below illustrates the schematic layout of the multi-functional laboratory.

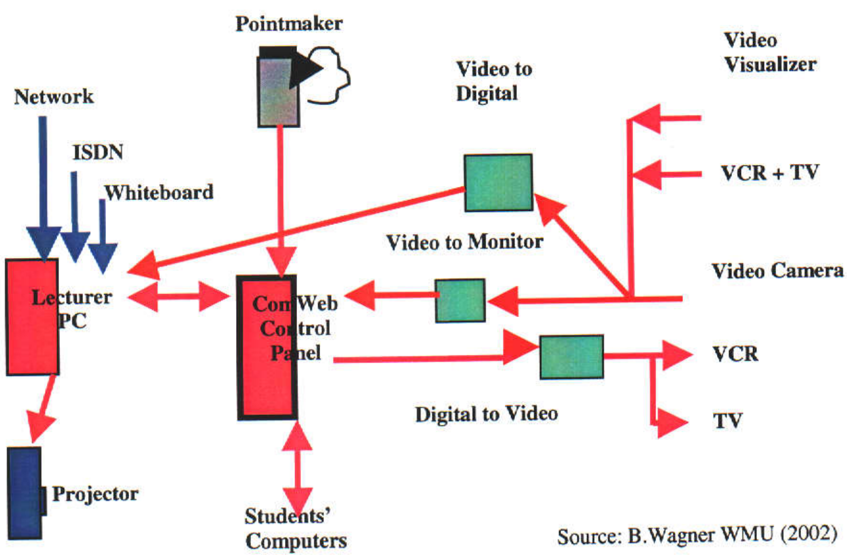


Figure 6.2 Laboratory schematic layout

The instructor can communicate to any combination of the 20 student computers in the room, show any form of media display on the monitors, on the large screen, interact directly on student screens or allow students to take control of classroom activities. This is achieved using the ComWeb 'KnowledgeWeb' system shown in Figure 6.3. This is a special-purpose, hybrid, monitoring, keyboard-mouse and audio-video-data switching device controlling an array of analogue and digital sources and functions.

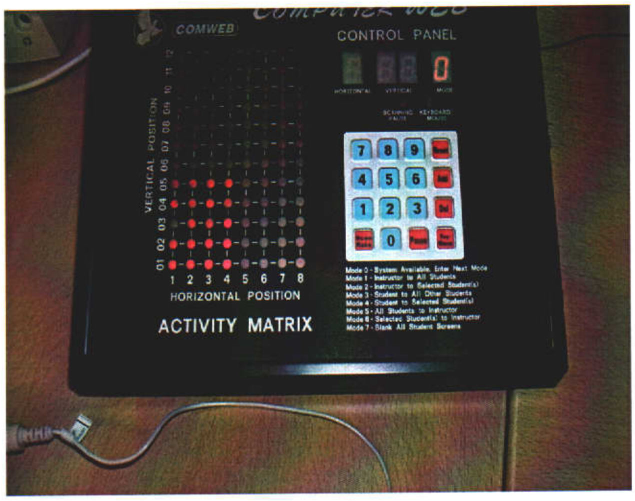


Figure 6.3 ComWeb control panel

The ComWeb control provides the instructor with a number of communication modes to select from as follows:

Mode 0	System inactive-enter mode number
Mode 1	Teacher to ALL students
Mode 2	Teacher to designated student or students
Mode 3	Student to ALL students
Mode 4	Student to designated student or students
Mode 5	Mode 5 Teacher scans all students screens
Mode 6	Teacher scans designated student or students
Mode 7	Blank ALL student screens
Mode 8	Student(s) to Teacher (Help queue)

Using three digit numbers, the instructor can quickly identify students by identity numbers on the control panel (e.g. 101). In Mode 8, a student can press a red button at his/her station, which beeps at the instructor station. At the same time the student's screen is displayed on the instructor's screen and two way audio is enabled.

The real challenge facing the instructor is how to adapt from working in an ordinary classroom teaching environment to one focused around an audio-visual multi-communication based environment. What adjustments need to be made? Two particular aspects will be described firstly, teacher training processes using computer technology and secondly, experiences with English language acquisition

Didactical skills for MET lecturers

The WMU M.Sc. program, majoring in Maritime Education and Training (MET), includes a number of modules dealing with pedagogical aspects of teaching. It provides MET students with coverage of curriculum development and design processes, delivery of lessons through lectures, small group teaching, the use of workshops and computer assisted learning, and finally assessment of courses, teachers and students. New emphasis is directed towards the preparation of computer-based materials and their delivery through computer-based technology, including the use of multimedia tools.

As part of the process of examining how computer based technology can be used in the education and training process, WMU students are required to develop a practical 'presentation' using computer generated Microsoft PowerPoint slides supported by other associated applications and instructional media. Stepping from the world of delivering conventional classroom lectures to delivering a presentation through a computer based instruction station is a challenging and daunting task. The student is faced with a number of questions:

- How to prepare such forms of presentation?
- How to develop effective links between visual materials and verbal explanations?
- How to engage the attention, motivation and involvement of the students?
- How to use the communication options provided by ComWeb effectively?
- How to best combine the instructor station tools such as the video visualiser, pointmaker, electronic whiteboard and communications mode selector for optimum effect?

The answers much depend upon the nature of the topic and the objectives of the presentation. The approaches taken and tools used vary between presenters. Some use the medium to provide understanding of a broad topic such as the MARPOL

Convention, others may take the student group through a step-by-step navigation or marine engineering calculation or problem. Figure 6.4 shows a student using the video visualiser at the instructor station in the computer laboratory environment.

Figure 6.4 The instructor station

Based on the author's experience in the use of the laboratory over the past four years (1999-2002), the following observations have been made and conclusions drawn:

Design of materials: Students have a tendency to overuse colour on slides in the belief that it will better focus attention to the text or drawing being shown. This is true up to a point, but when used in a multi-coloured context this can produce a negative effect. The use of pictures and other coloured material as background often leads to poor contrast when overlaying materials and text, and is not always picked up by students.

Communications: The change from eye contact with students to screen communications is difficult to adjust to at first. Combining a monitor view of what the student is seeing with voice explanation/guidance and supporting this with the Pointmarker or mouse pointer in a cohesive coordinated way is the most difficult task facing the new instructor. It requires concentration. Mode 1 is the usual environment setting in this process. If students have been set a task then switching to mode 6 (scanning all students) and mode 8 (student to teacher help) are the most appropriate environments.

Visual visualizer: This tablet allows any form of material to be presented. It is most useful for reproducing illustrative pictures or drawings relative to the topic, blow ups of tables for interpretation or interpolation (such as extracts from the Nautical Almanac) or where use of the large screen is advantageous (e.g. 35mm negative).

Dialogue: A subtle change in approach is needed. The assumption is that students have their eyes on their monitors. It is noted that often they look at the instructor. Constant cues are needed to direct their attention back to screen to follow action by the instructor. In step by step explanations a mixture of animation effects and Pointmaker achieves the best outcome. PowerPoint notes, structured in point form, are then most useful in supporting delivery and dealing with queries.

Weaknesses: The most common shortcomings are associated with the use of controls and ensuring that the class understands collectively. The waving or circling of pointers or leaving a trail of lines or pointer marks on screen is not unusual. Tables or graphs can be too small in scale on slides. Switching between students seeking clarification of points requires some practice with the ComWeb mode control.

Computing and English language acquisition

The WMU uses the English language for all instruction and this means that WMU graduates, who come from a diverse multinational background, must achieve a level of proficiency in the language, if they are to succeed in their Master's degree program. In addition to high entry standards, the university has put in place a carefully considered system of screening and support. The core of this is a four month pre-sessional English and Study Skills Program (ESSP), which is normally attended by at least half of the new intake each year. In addition, all students are required to attend an extensive credit bearing course in Academic Writing and Study Skills during their first year of study.

Cole (2000) has observed that, noting their restricted exposure to English in the local (Swedish) surroundings, students are tempted to use their home language with colleagues from the same region. One way to overcome this disadvantage to English language acquisition has been to integrate the new computer facilities into language learning activities, resulting in an attractive and productive English language (training) environment.

Computers have been used for language teaching since the 1960s. In the beginning, practice was based on the behaviourist learning model and featured repetitive drills suitable for the many tape-based language laboratories of the era. Cole (2000) notes that in the 1970s and 1980s, as the behaviourist approach waned and cognitive theories took over, communicative Computer Assisted Language Learning (CALL) became the fashion. For many CALL advocates, the focus was on the interaction with each other while working at the computer, rather than with the machine itself. Cole further states that "although communicative CALL was seen as an advance, its critics argued that the computer was being used in an ad hoc and disconnected fashion and was thus of only marginal use in the language learning process".

A different approach developed at WMU relies on a more social or socio-cognitive view (task, content and project based), which places greater emphasis on language use in authentic social contexts. This new perspective, termed integrative CALL, seeks to integrate the four language skills of listening, speaking, reading and writing with technology in the language learning process.

In considering the use of computers for language acquisition, Cole (2000, p.9) has summarised the change in approach as follows:

> ... if the mainframe was the technology of behaviourist CALL, and the PC the technology of communicative CALL, then the multimedia networked computer available to all WMU students via the new laboratory is the technology of integrative CALL. In other words at WMU students are today provided with a range of informational, communicative and publishing tools which provide not only the possibilities for much more integrated uses of technology, but also provide the imperative for such use as learning to read, write and communicate via computer.

This makes sense for WMU graduates where technology is an increasing feature of modern life in the shipping industry and thus impacts upon the students' future careers. Despite the availability of specialised language software, WMU experience shows that use of the Internet and e-mail communication have proven to be the most popular learning tools! With MS Word for written tasks and MS PowerPoint for oral presentations, students willingly spend further hours in the laboratory working in what Cole calls "a disguised English environment". The consensus is that language learning relying on a modern technology laboratory environment has proven to be very successful.

Computer based presentations

The ability to deliver teaching programs directly from the computer via colour projection tablets or RGB projectors to large audiences is becoming more common place. The design and projection of slides using for example PowerPoint, Lotus Notes or Harvard Graphics however must take into account room and audience size (detail and contrast) and the mode and purpose of the presentation. A darkened room used for lengthy periods may reduce the effectiveness of the presentation compared to traditional classroom methods.

High Speed Data and Video Links

Any discussion of CAL must include an awareness of the enormous potential to MET of the growing high speed technology links between CAL, high speed data and video transmissions, the use of the Internet and the World Wide Web and distance learning methods.

6.1.3 Computer Assisted Learning (CAL)

The concept of computer assisted learning or CAL centres on the ability of the powerful personal computer (PC) of today to mediate in the flows of information in the learning and training process. The speed of processing linked with high resolution graphics gives the PC the ability to adapt and respond to a learner's needs, difficulties and progress by comparing student responses to a set of prescribed rules (the software program).

Programmed learning can be described as the control of trainee cognitive (and psychomotor) responses to acquiring knowledge, skills and routines using structured teaching algorithms. The use of internal and external feedback is an instinctive feature of such programmed learning. In developing software programs, a key element lies in the sequence of presentation that should provide an ever increasing level of difficulty and favour the motivation of knowledge and skill.

A feature of well designed software is the balance of learning frames and concepts that will allow for effective transfer of knowledge, understanding and skill to the long-term memory. Another important factor relates to the type of programmed learning developed by the software creator. Yakushenko (1993) identified three fundamental types of programmed learning, which differ according to how progression is permitted through to the next sequential step.

Type 1. Linear

A pre-determined sequence of frames dictates progress by the student, his/her actions during learning not affecting the sequence of frame movement. Student answers are not taken into account.

Type 2. Intrinsically controlled

Student progression to the next step is resolved by noting the answer given to the verifying question in the previous frame. The answer determines advancement or repetition.

Type 3. Extrinsically controlled

In this case the overall pre-history of a student's answers is subject to an extrinsic control facility before a decision is made on progression of the student through each step. This is considered to be the best learning type as the pedagogical routines correlate most closely to teaching practices.

If it is considered that the computer is simply moving data and information from place to place, combining it, and comparing it, according to a set of prescribed rules or algorithms, then the computer's major strength is its ability to process information very quickly and accurately. The set of software rules can be very complex yet the PC completes the calculation process almost instantaneously. This gives the computer the ability to adapt and respond to the learner's needs, difficulties and progress.

Programmed learning by itself is of limited value in developing mental and creative abilities. It is probably at its best as a tool for repetition, consolidation and review of information, and thus knowledge and understanding. The creation of a dialogue or interactivity between man and machine through gaming or simulation programs can, however, extend the ability of CAL beyond the mere acquisition of knowledge and understanding produced by linear type programming.

Outline instructional design determines the program objectives, method and mode to be used and the links between the software and supporting hardware. Student interaction with the program leans heavily on the designed learning sequence, presentation of data and how student responses are to be processed. Key points for designers are:

(a) Keeping the amount of displayed data to a minimum
(b) Letting the users know, through clear instructions, what is expected of them
(c) Knowing what options are available to control progress through the learning sequence.

Maritime lecturers need to understand these software development processes and be able to recognise particular structures in software packages when considering both the purchase of programs and the extent to which they can be used effectively as teaching, learning, training or assessment tools.

Computers can thus be used to great effect to enhance student knowledge and understanding if careful thought is given to the selection and use of appropriate software and hardware configurations. In some circumstances, the software may also allow student performance to be measured and evaluated. For maritime education and training, it can be said that a new technological frontier of learning and discovery through the use of computers envelops the lecturer, and all concerned must be ready to grasp the opportunity to use the medium to its full potential.

Using CAL

There are a number of recognised learning modes of which the lecturer needs to have a clear understanding if optimal use and outcomes are to be achieved with software.

Not only do you need to understand the structure of the software but also to understand which mode of delivery will produce the best outcomes. Consideration must also be given to individual student capabilities, familiarization levels, the learning or training objectives, time constraints and available hardware facilities. The most common modes are Inquiry, Tutorials, Drill and Practice, Simulations, Instructional Games, Assessment.

Inquiry: A method of using data retrieval systems to obtain necessary information from an organized database for specific learning objectives. Student perception determines the degree of effectiveness. Good examples are on-line databases, structured information systems such as dictionaries, and encyclopaedias, as well as hypertext and hypermedia reference systems.

Tutorials: The best types allow the user to understand about the topic, provide a demonstration and then let the user learn by carrying out the process personally. They are useful for teaching new concepts and processes.

Drill & Practice: The computer delivers self-paced exercises in which responses are required from the learner. Feedback is immediate after each response. Previously learned concepts are thus reinforced in a structured way.

Instructional Games: These are similar to simulations. However, games may not necessarily simulate reality but provide challenging environments with an instructional component. Example: TankerSim (Ship Chartering Game), SCUSY (Container Terminal Planning)

Simulations: Emulating real-life conditions or situations to develop learning experiences. Today most simulations are based on interactive computer graphics and provide the learner with the ability to visualise a process, and explore the effect of changes in parameter on the operation of the system. These modes represent the best type with a high degree of interaction. There are many MET examples available, such as those from Transas, PC Maritime, Poseidon, SSPA, SIS Radar, as illustrated in Figure 6.5.

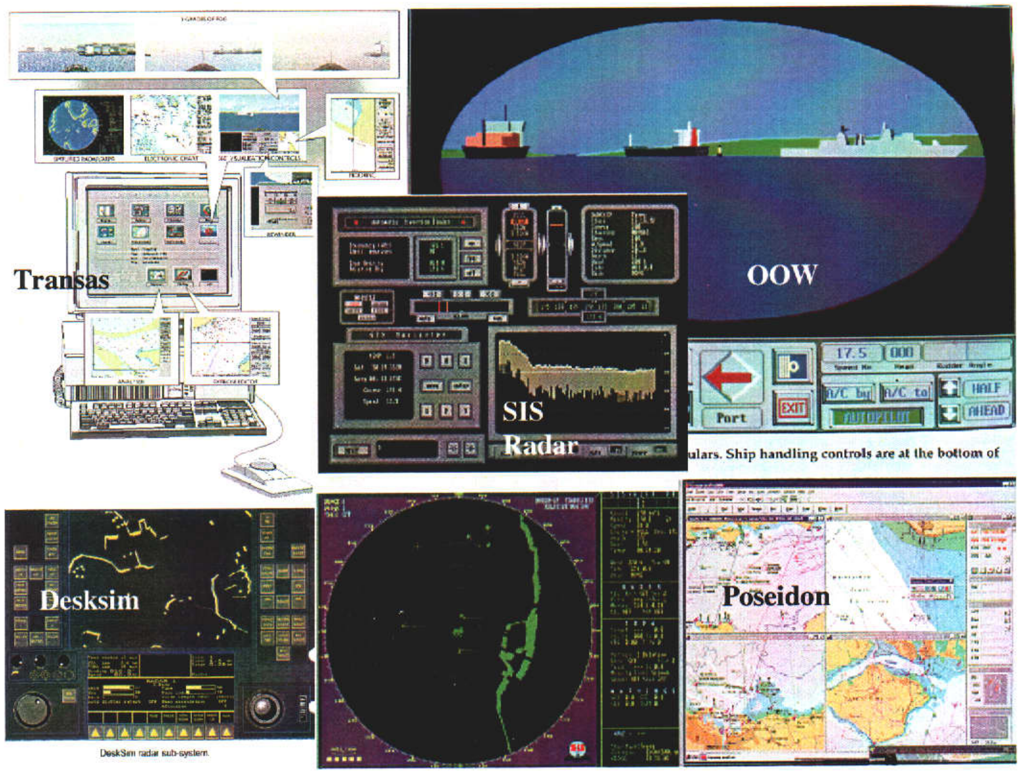


Figure 6.5 Simulated navigation training programs

Assessment: Computers can be used to both construct the test and administer it. Objective test item banks are the most popular. Questions can be generated automatically and randomized for tests. The trend is also towards using PC networks for open (essay) type examinations, as conducted at the World Maritime University.

The question arising for the teacher is what mode is seen as most appropriate to the maritime learning context?

Examination of one major source, the 2000 Fairplay Marine Computing Guide, shows some 384 companies offering 1268 software packages. Much of it is directed to commercial shipping, ports and maritime infrastructure operations. The number of listed software products suitable for effective use as learning, training or assessment tools is somewhat limited however. In Appendix G, a selection of programs being used successfully in MET institutions, is shown. They range from straight linear type 1 programs to interactive extrinsically controlled type 3 programs. Many of these software based training programs utilize simulation techniques to provide realistic 'hands on' experience, before the trainee moves to the real world environment.

6.1.4 Factors in the selection of software

Some of the best software available in the maritime market at present relates to shipboard operational practices, resulting from developments for specific ship needs. Examples include loading and ballasting calculations and associated stability and stress outcomes, voyage management, electronic navigational aids operations, collision avoidance procedures, and specialised training programs for such areas as GMDSS communications, tanker operations, firefighting, to mention but a few. The introduction of the Compact Disc-Interactive (CD-I) player has opened up new horizons of reality, mixed with the advantages of programmed learning using an intrinsic and/or extrinsic controlled approach.

It should be noted that many programs are designed for commercial operations, not as teaching tools, are expensive and are unsuitable for use in the classroom. Other programs, particularly in the navigation and cargo handling areas, vary greatly in quality and in ease of use. Some programs have been designed specifically for onboard operations and generally will be found to be excellent teaching tools because of their applied nature. The use of colour graphics has enhanced many of the latest products on the market and improved their user friendliness, the latter being an important consideration.

So how do maritime lecturers pick their way through the minefield of diverse products, often marketed with glossy brochures and impressive demo discs, but in the main sight unseen by the potential user? A number of questions should be answered before decisions are made on purchasing new teaching software.

1. What type of CAL program is it?
2. What are the teaching objectives of the program?
3. In what way can the software program enhance the teaching and learning process within the subject?
4. How can it be used to meet STCW 95 needs today, for example?
5. What type of computer hardware is required and what is available? (e.g. Chip version, amount of RAM, graphics cards, video cards, network version, printing and plotting facilities, etc.)
5. What sort of site licence is needed? Single or multiple user or network version?

6. Is a demonstration disc and program description available for evaluation?
7. Can a full working version be accessed (minimum time version of 30 days) to examine points 1-4 above?

On that basis, provided satisfactory answers are forthcoming, the lecturers are in a good position to make a rational decision. It should be noted that many suppliers will provide educational institutions with discounts, which may range from 10% to 50%. Some companies may supply software without charge, seeing it as an opportunity to market themselves, however such software is often of limited educational value. Since topics may be covered by several dozen different versions, choice is important. A great deal of precious software funding is wasted by hasty selection, poor evaluation processes or simply by staff being attracted by the aesthetics of a program. The key objectives are to enhance the teaching and learning processes and optimise the acquisition of knowledge, understanding and skill where appropriate.

Using software

The lecturer, having obtained the software program, now has the real challenge of determining an effective strategy that will ensure that planned learning objectives are achieved.

How will students become familiar with the program?

What are they to do with the program? Do they have clear instructions?

Is it based on self tuition or group learning activity?

Does it require instructor input and monitoring?

Will it be used through a network?

Is it to be used for assessment purposes?

If so, how will this be achieved?

Working in MET institutions, consideration may need to be given as to whether the software has potential to be used to meet competency requirements laid down in Code A of the STCW 95 Convention. Are the objectives clear? Can skills be acquired? If so, how can individual performance be measured and evaluated?

Twenty-five years of personal experience in the maritime education field has provided ample evidence that it is very easy for teaching staff to fill disc storage boxes and hard disc drives with computer software. Such experience has shown that most of it will sit there unused or be greatly under utilised. It is poor capital investment on the one hand and a waste of valuable student learning time on the other, if the use of the software is undirected or left to find a niche for itself. The best safeguard is to ensure that the individual lecturer clearly justifies the need for it, on sound educational grounds in the first place.

6.1.5 Computer Based Training (CBT)

Good instructional skills and learning methods in the classroom or onboard, may not necessarily transfer to the computer medium without careful thought and evaluation of the software program objectives and the methods to be employed to achieve them. Much depends upon the experience and flexibility of the teacher and the attitude to change. Research has indicated that little gain is achieved if the same teacher is responsible for both classroom and computer assisted learning materials. The advantages and disadvantages of CBT over traditional classroom group teaching need to be considered in determining the potential use of computing in maritime education and training.

Advantages

- Learning can be focused to individual needs, levels and capabilities
- Programs can be directed to specific learning objectives
- CBT lends itself to enhanced acquisition of knowledge and understanding
- Student response and progress can be better recorded, monitored and evaluated
- Learning materials are more uniform and consistent using group learning situations
- Interactive software programs enhance learning and skill acquisition possibilities
- Subjectivity is reduced in computer based assessment processes
- Simulation of applied operational tasks is possible
- Access to computer facilities extends the time window of learning.

Disadvantages

- CBT involves teaching students to follow fixed rules and procedures, rather than to think for themselves
- The computer lacks cognitive thinking power of classroom groups
- Students tend to become isolated from the peer group, by working in a vacuum
- There is little software in the maritime area suited for CBT
- Computing facilities are costly to buy and maintain
- The technology is constantly changing, requiring costly re-investment and re-training.

Ship managers and maritime lecturers need to understand these aspects and be able to recognise particular structures in software packages when considering both the purchase of programs and the extent to which they can be used effectively as operational, teaching, learning, training or assessment tools. Consideration must also be given to individual trainee capabilities, motivation, familiarisation levels, the learning or training objectives, time constraints and availability of hardware facilities. The most common modes are drill and practice, browsing, calculation, tutorial, and simulation.

Training is the systematic development of the skill behaviour pattern required by an individual in order to perform adequately a given task or job. By exposing the individual to relevant experience through the performance of tasks selected to meet specific training objectives, meaningful outcomes can be achieved in an enhanced, intensive manner. In this way it can substitute for a range of on-the-job training. Through careful monitoring procedures, performance standards can be measured against established training criteria to an acceptable level.

The STCW 95 Convention now places greater emphasis through Part A of the Code on assessing the ability to perform tasks or functions for competency purposes. To what extent, however, can such concepts be applied to software programs with built-in assessment facilities? A number of limitations may exist such as:

- Variable student characteristics
- The element of luck

- The unknown reasoning activity of the student
- Structure of computer based questions re the learning/assessment objectives.

From the flow of information and analysis of student responses it is necessary to determine that the information is relevant and to evaluate which analyses are appropriate. There is no doubt that well structured software programs with built-in evaluation programs, such as Transas 'Navi-Trainer' and PC Maritime 'Officer of the Watch', enable the level of knowledge and understanding to be effectively gauged. However, one would have to be wary of claims that the student was capable of performing applied skills in practical situations. Consider programs, such as Turbo-Diesel or the Unitest engine simulator, which deal with the sequential operations of starting, running and stopping a diesel engine. The evaluation of such a criterion based and objective operation is much more feasible, since specific limiting parameters can be set by the instructor and performance outcomes based on sequential learning processes measured against them. Some confidence in repeating such steps on a real engine is merited.

In using CBT in the classroom or onboard ship, some basic questions also need to be considered if the student or trainee is to gain full benefit from CBT software.

- Is the student aware, as a learner, of the advantages and disadvantages of using CBT materials, particularly for self study?
- How will the student or trainee become familiar with the program?
- Are there clear instructions of what to do with the program?
- Is it based on self-tuition or group learning activity?
- Does it require instructor input and monitoring?
- How will the outcomes be evaluated and used?

Consideration may need to be given as to whether the software has potential to be used to meet competency requirements laid down in the tables of Part A of the STCW Code.

- Is it to be used for assessment purposes?
- Are the assessment objectives clear?
- Does the program environment allow skills to be acquired?

- If so, how can individual performance be measured and evaluated?

CBT materials are often used as essential supporting tools for self-paced learning. Berg (2002) has summarised the main advantages of studying in that way, as follows:

- A self-paced learning approach allows the learner to make many of the decisions about when, where, what and how quickly to learn.
- Learners can learn information and skills when they need them.
- Assuming control of the learning process is highly motivating for many learners.
- Each learner has the same level of participation in the learning process. Participants are active rather than passive, and assume greater responsibility for their own learning.
- Because most self-paced learning courses allow participants to begin and end a segment of the training course at any time, it is an efficient use of training time and resources.
- Learning activities can be organized sequentially, because each component in a self-paced course has objectives that must be met before proceeding to the next component.
- Self-paced learning provides trainers with the time to focus more attention on participants who need assistance.

There are, of course, many disadvantages and limitations to studying alone through the medium of the computer, and this aspect is covered in more detail in Chapter 7 under distance learning. Again, reference to Berg (2002, p13) illustrates some of the main limitations that both instructor and student need to be mindful of when using this medium.

- Most participants have not learned this way before, so they may feel uncomfortable with learning on their own.
- Participants may lack the necessary motivation to work independently.
- Participants may have poor reading skills, especially when the language of the reference materials is different from their primary language.
- Participants may possess poor time management skills. Procrastination may make the self-paced learning process less effective than it can be.

- Most instructors did not learn this way and therefore need training to become effective facilitators of self-paced learning.
- Instructors may feel that they do not have time to design, produce and manage a self-paced learning system.
- It may be challenging and time-consuming to design and develop the appropriate learning materials, in either print or electronic format.

Judging from information obtained from both the survey of European Institutions (METHAR, 1999) and of China, India, Indonesia and Philippines (CIIPMET, 2000), there is both a clear lack of training in the use of CBT being made available to instructors, as well as a shortage of basic equipment and resources needed to fully utilise the new technology. Some results pertaining to this topic from the METHAR survey are of relevance.

The use of Personal Computers (PCs) for computer assisted learning (CAL) and computer based training (CBT) within networked systems, supported by Internet and e-mail services is quite widespread in Europe. Two thirds of the 36 institutions (from 14 European countries) responding to the survey are well supported with computing equipment and resources (Figures 6.6 and 6.7 refer).

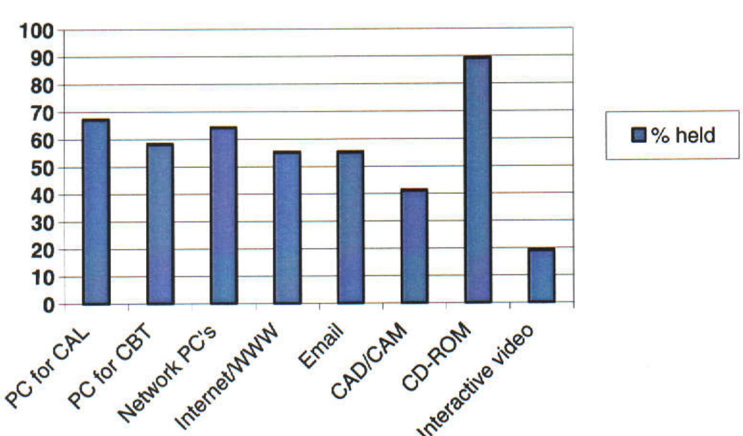


Figure 6.6 Computing Facilities held by European Maritime Institutions

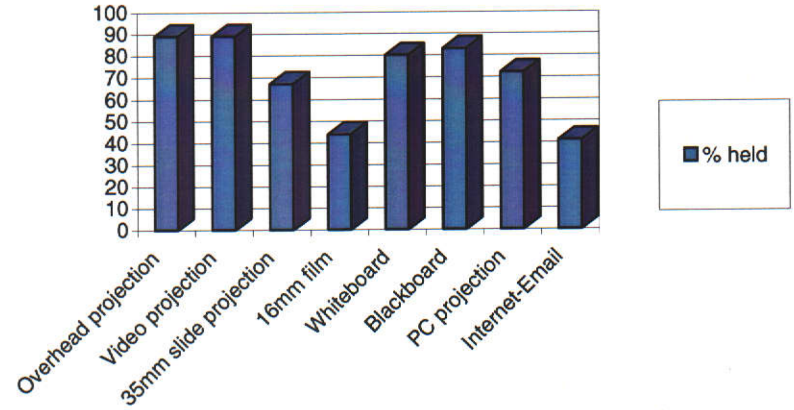


Figure 6.7 Instructional media facilities held and used by European Maritime Institutions

The use of such facilities for training, however, shows a distinct lack of confidence on the part of instructors. While Internet and e-mail penetration levels are at 55%, the usage of these facilities lags at 41% only. However, increasing access to IT services is changing more traditional attitudes and approaches to teaching and learning.

In many cases a lack of good training software, in many practical areas of ship operations, is currently inhibiting further use of the medium. This is aggravated by the fact that training institutions are generally hampered by a lack of funds to purchase commercial onboard application packages. This disadvantage could be overcome through institutions and shipowners working closer together to ensure that IT skills, provided in training programs, match operational needs onboard. A good example of such cooperation is the Norwegian based Information Technology in Ship Operation Program (ITSOP), led by Marintek over the period 1997-2001. The courses developed are being used by shipowners, utilising the latest IT and satellite communications, to improve ship operations and maintenance.

Personnel, in the many areas of the shipping industry, both at sea and ashore, will however need to have a fundamental grounding in computing skills. Whilst STCW 95 does not specifically lay down computing as a required topic, the requirements of the functions for the various levels of certification demand familiarity with computers today. Europe is well equipped to provide such basics, however many institutions need to re-focus their program objectives, and provide special training for instructors in the use of computer assisted learning methodologies. The global MET survey, undertaken as part of this research project (Chapter 3 refers), further reinforces the conclusions reached here, this time from a larger global perspective.

6.1.6 Summary

It is clear that many shipowners and operators are planning for a future increasingly centred around the operation of the 'IT office at sea'. By implication, employers will be seeking to retrain or employ new officers and crew who have a capability to use such equipment, programs and services. At the same time MET institutions are increasingly developing the capacity to utilise computer-based technology for education and training delivery.

There is strong evidence, too, that there are insufficient numbers of instructors in training institutions equipped and prepared to provide the necessary communications and computing skills needed by the industry in the future. It is not yet clear whether the players in the training environment have plans in place to meet any of the identified shortcomings.

What is clear is that there is great potential for both sides in the equation to consider how best to use modern computer technology developments to advantage. The two most striking features of computer technology today are the speed of change in computing power and the growing accessibility to such facilities by those previously disadvantaged, i.e. seafarers and people in developing countries. As the infrastructures are extended, the demands for access to and use of computer based training and education systems will become more and more critical as these sectors of society see the potential as well.

6.2 The use of marine simulation

Simulation has been used successfully as a medium for training and assessment in the aviation industry for over 60 years. The maritime industry has also been using marine simulation in limited ways since the late 1950s, but its acceptability has been somewhat tardy and its use for assessment purposes even less well accepted. As Waters (1994) has pointed out, "the collective attitude of maritime administrations to the use of simulators appeared to be, at best, ambivalent", a situation still existing in many minds today.

A review of the background to marine simulation is appropriate. Waters noted that it was the installation of radar on merchant vessels in the 1940s and 1950s and the consequent difficulties of interpretation of the radar information which produced the term 'radar assisted collisions', and this latter became the catalyst for the spawning of a significant development in the training and assessment processes. Many maritime administrations also saw the need for formal training in the use of radar navigation equipment, which led to the consequent development and use of simulators for maritime training and assessment.

Experience gained onboard ship through 'learning by doing' was traditionally seen as the best approach to training, supported by necessary guidance from more experienced officers. But with the introduction of radar it became necessary to establish special 'hands-on' training and, for the first time, the effect was to put increasing emphasis on practical training, utilising simulators for the first time. According to Burger (1991), the first specification for a radar simulator was approved by the UK authorities in 1959 and the first radar simulators came into being in London, Southampton, Glasgow and Hull. For many years this was the only approved form of simulation used and when the 1978 STCW Convention standards were being developed only radar/navigation simulators were established in any number. Since then the need for simulator training in the use of ARPA has been widely accepted.

The use of training simulators increased over the years, covering training in ARPA, propulsion, cargo-handling, ballast control, and vessel traffic management systems, and as computer technology developed in the 1970s, extended to computer-generated imagery (CGI) for shiphandling training and research work. However, making marine simulator training mandatory for seafarers has always been a troublesome issue. Despite many perceived benefits of simulator training, delegates revising the STCW 1978 Convention (STCW 95) were unwilling to extend the mandatory requirements beyond radar and ARPA training, a situation unchanged in 2002.

The growth and spread of marine simulators, particularly in the areas of GMDSS, radar/ARPA and to a lesser extent navigation and shiphandling simulation has been quite marked in the past five years, a demand fuelled by the STCW 95 implementation date of 1 February 2002. This expansion has been very beneficial to the simulation manufacturing industry, but the demand placed upon simulator operators by STCW 95 performance standards, regarding the use of simulation for training and assessment, has not been so well supported. Training in instructional skills and assessment techniques for the many new instructors and inexperienced assessors still leaves much to be desired. There is also evidence of inconsistency between instructors, regarding the fundamental training methods used. When it comes to assessment, there is a clear lack of confidence in using simulation facilities to assess the competence of seafarers (ISSUS, 1998).

Since the advent of STCW 95 there has been clear evidence of a discernible shift in marine simulation technology away from the larger more expensive CGI based 'full mission' systems (see Appendix D) to smaller less expensive modular PC based systems of so called 'single or multi-task' type. Some manufacturers use the latter technology to market their products as 'full mission' systems, although others would challenge such assertions. However, technology is advancing so quickly that the modest 'desktop' or 'work station' computer can form the basis of very sophisticated, flexible and realistic training tools, capable of meeting many of the designated functions and tasks specified in the STCW Convention. The greatest danger lies in simulation technology being used for training and assessment purposes and tasks for which the simulator is clearly not suitable or capable. A second problem is a lack of instructor experience in designing, running and evaluating simulator programs, where reliability and validity of training and assessment outcomes have become much more important with the increased global emphasis of determining competence of individual mariners. Nevertheless, the world of simulation has been brought closer to the training and assessment workface for many institutions, which have previously found themselves left outside of such technology, due to cost considerations.

Although technical standards were not included in STCW 95, ongoing attempts to provide some form of technical guidelines and classification of simulators have continued, through the work of the International Marine Simulator Forum (IMSF) and individual manufacturers. Whether a simulator is allocated a particular classification is less important than the need to ensure that the particular specification provides the instructor or assessor with the developmental and monitoring tools needed to achieve the specific training or assessment objectives. Personal experience shows there is too much diversity and lack of standardisation regarding the design of instructor stations, recording equipment and debriefing facilities. A helpful initiative has been the development and publication by Det Norske Veritas (2000) of a standard for certification of maritime simulation systems. This is aimed at marine administrations in particular which have a responsibility to approve simulators used within their jurisdiction. The section dealing with instructor/assessor facilities could however be more prescriptive regarding the range of equipment that should be standard items.

6.2.1 A global view of marine simulators

Examining the current availability of simulators in maritime training institutions, over 1000 simulators of varying types are in use around the globe (Table 6.3).

Table 6.3 Estimates of global marine simulator types
(As at 30 October 2002)

	Number
Simulators with a visual ship manoeuvring capability	167
Radar and Radar Navigation	360
Engineroom	160
Navigation Instrument	60
Cargo & ballast control	50
Fisheries	35
GMDSS	315
Oil Spill Management Trainer	5
VTS	10
High Speed Craft	8
Riverboat	3
Total	1173

Sources:
IMO Survey of Member Governments 1993-2000; IMSF annual reports on member's simulator facilities 1984-2002; IMLA simulator operator reports; Simulator manufacturer reports; EU MASSTER, METHAR and METNET research projects; P.Muirhead: database 1980-2002.

Nearly three quarters of this total relates to visual and blind navigation/radar manoeuvring simulators and engine room simulators. Recent technological developments have also resulted in visual effects becoming more accessible and affordable to many operators of 'blind' radar and navigation simulators. Simulators for the handling of hazardous liquid, bulk and container cargoes are widely available, with the growth of GMDSS simulators and PC based systems accelerating the degree of acceptance of the technology.

The European Commission has directed funds into transport research over the past few years to assist in developing cost-effective transport systems that meet the general objective of sustainable mobility, increased competitiveness and improving safety. The 4th Framework program (1996-1998) for the waterborne sector consisted of around 54 projects covering maritime transport, inland navigation, maritime operations and human resources. Two projects of particular interest to those involved in maritime education and training, and simulator training were METHAR and MASSTER. In addition to increasing quality and efficiency and improving safety, the research work is expected to develop operational systems which integrate and assess the potential benefits of new technologies, standard procedures, organisational factors and human resources. The above mentioned projects, as they impact upon the use of simulators, are examined in the following sections.

6.2.2 The METHAR project

The METHAR (MET harmonization) project commenced work in June 1996 and delivered its final report in December 1999. It took stock of existing education and training facilities in Europe and identified those areas where improvements were needed. The process took on greater relevance with the entry into force of STCW 95 in 1997. The project was led by the WMU, supported by a number of partners and representatives from maritime administrations and MET institutions throughout Europe working together under a concerted action framework.

In relation to the use of simulators, Muirhead (1999), through METHAR work package 1.4, conducted a survey of 56 European MET institutions and responses were received from 36 institutions representing 14 countries. In particular, the survey sought information on the marine simulation facilities held by these institutions and how the equipment was being used for STCW 95 related training and/or assessment (see Figure 6.8).

Radar and ARPA simulators were held by 97% of respondents and had a high degree of usage for training (91%) and assessment (73%). They were, thus, well placed to handle the new compulsory training requirements of STCW 95 in this area. Navigation simulators, which generally cover instrumentation such as GPS, Loran-C, gyro compass, etc. were available to 83% of those responding.

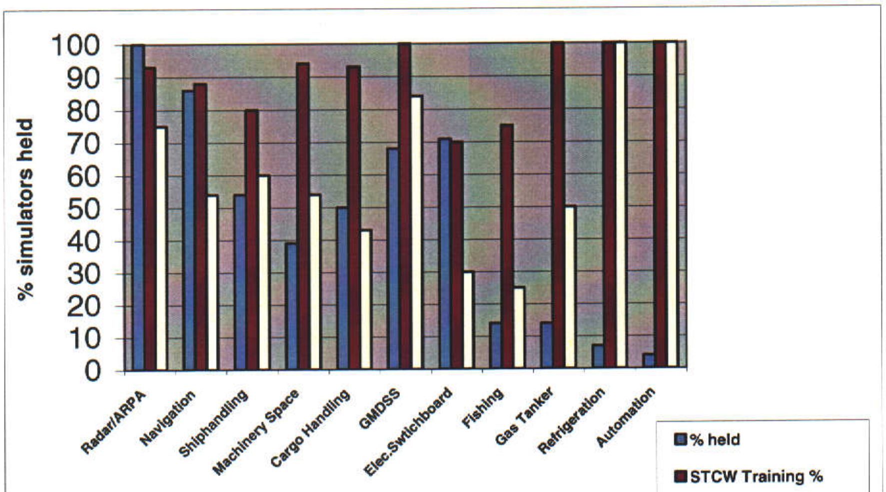


Figure 6.8 EU Simulator Facilities (1997)

This did not necessarily imply a shortage in an institution, as most modern radar/ARPA simulators come fitted with much of this equipment. Both these areas have been covered by simulation means for many years.

Simulators for shiphandling training were less readily available (58%) but it is an area of growth, as less costly equipment is now on the market. Whilst they had a high usage for training, assessment of shiphandling skills was obviously a somewhat newer and more difficult area of activity. This has changed little since.

Perhaps more surprising in the survey was the lack of engine room, cargo handling and GMDSS simulators in many institutions. With GMDSS compulsory for all ships since 1999, a considerable backlog of training still remained and there appeared to be room for further installations in EU institutions where one third of them did not possess such equipment. The STCW transition deadline of 1 February 2002 for existing seafarers has, however, led to further acquisitions of this equipment over the period 1999-2002. GMDSS simulators are interesting from the fact that they have a high degree of acceptability for both training and assessment purposes by licensing authorities, despite the fact that the use of GMDSS simulators is not mandatory.

This was reflected in the high levels of usage for both training (100%) and assessment (82%). Engine room simulation training is not compulsory under STCW 95 (only 39% of institutions were so equipped), growth in this area being inhibited in the past by the cost of such facilities and by the fact that many centres use machinery space workshops for such experience. This was also evident in the cargo handling simulation area (47% availability). Very few centres had access to automation, inert gas or refrigeration simulation facilities. No centre possessed an oil spill simulation trainer. With the increased availability of more cost effective computer based part-task simulation of many practical ship operations, penetration of simulation systems in these areas is expected to grow rapidly in the future.

Overall, amongst users, simulation equipment was and continues to be used to a high degree in meeting training needs under STCW 95. The evidence from METHAR (1999) and more recent work (METNET, 2002) shows less confidence in using such facilities to assess candidates for certificates of competency to meet STCW requirements.

Other aspects impacting upon the use of simulators were the generally high average age (47) of teaching staff in European MET institutions, and the problem of recruiting new instructors. Another important result was the fact that very few of the European countries offer any form of pedagogical training for lecturers at MET institutions in METHAR countries. In many cases it is a case of learning by doing. Other surveys undertaken in 1999, of the Chinese, Indian, Indonesian and Philippines MET systems (CIIPMET, 2000), clearly indicate an even greater lack of such training in many institutions.

In summary, the evidence shows that the use of simulators as an assessment medium is at a low level and an investigation into more effective use of simulators in this way is called for. METNET project has taken up this aspect, in part, through the development of a series of 'train the trainer' courses for instructors. This matter is referred to further in Chapter 7.

6.2.3 The MASSTER project

The Maritime Standardised Simulator Training Exercise Register (MASSTER) project, which was concerned with the harmonisation of maritime education and the standardisation of simulator exercises in particular, was co-coordinated by ISSUS, Germany, and undertook its investigations between 1996-1998. The work was supportive to the broader METHAR project. Muirhead (1997) conducted an initial review of the capability of European shiphandling and navigation simulators, with responses received from 68 different centres.

From the survey, Muirhead concluded that many simulators generally did not have the means for recording trainee activity by video or aural means, or allow direct observation of trainee activity on the bridge. More seriously was the evidence that a number of simulators lacked dedicated debriefing areas, printers and playback facilities, which inhibited effective monitoring of trainee performance. Over the period 1997-2002, many existing simulators have had their facilities upgraded and thus are better placed to meet the requirements of STCW 95 than before the revised Convention came into force.

In developing a standard register of training exercises for the simulator, several drawbacks and difficulties stood in the way of reaching a consensus:

- the diversity of equipment standards
- the diversity of operational capability of listed simulators
- diversity of approach by instructors in training and assessment
- the many functional tasks at master and watchkeeper level that could be covered by the use of simulators.

It is worthwhile noting that the NRC report published in 1996 by the USA National Research Council on 'Setting Simulation Standards - ship to bridge simulation training' also highlighted a number of deficient areas in many simulators today. In particular, it noted the lack of feedback on the effectiveness of the application of the knowledge and skills acquired through simulator based training. The associated NRC publication "Simulated Voyages" (1996) also provided supporting insights into simulator training and assessment. The USA and Europe continue to follow similar pathways.

The review also noted that a number of changes in equipment and navigation technology would have an increasing affect upon the use of simulators for assessment. The importance of using effective monitoring and debriefing techniques and facilities was highlighted. The problems and challenges facing all simulator instructors and assessors on the need to shift to a more objective or criterion based assessment approach was discussed.

The main work of the project was to develop a register of standardised simulator training exercise scenarios for different types of simulators in a variety of environmental and operational situations for different levels of trainee experience. The exercises, of a generic nature, are designed to be used by any simulator operator against a comprehensive catagorisation of STCW 95 based tasks. In addition the project, in emphasising the instructor as part of the system, identified a number of clear training objectives for instructor training. The work has been seen as an important catalyst in encouraging simulator instructors to work towards a more co-coordinated and common approach to the effective use of simulators for training and assessment. Use has been made of exercises from the register in running a number of simulator operator training courses in the Netherlands since 1998. The register represents the collective experience of many of Europe's most experienced operators and instructors. However, feedback from instructors indicates that many instructors still rely on their own sources. Achieving harmonisation or even a more common approach by users of simulators in maritime education and training continues to be a difficult challenge.

6.2.4 The METNET project

The research activity undertaken in the MASSTER and METHAR projects involved many people in a concerted effort over a three year period. Yet many questions remained unanswered. Practical solutions and their implementation remained unfulfilled. The EU took up the challenge by seeking to use a cooperative thematic network approach to further open up the situation. Reference groups from governments, maritime industry and MET institutions are key partners in the network approach. A current EC 5th framework project (1999-2002), METNET, aims at improving standards and achieving further harmonization of MET, including increasing mobility and employability of maritime personnel. The policy objective is competitive and sustainable growth in the maritime personnel sector with an emphasis on:

Quality - higher maritime safety and environmental protection standards; and,

Quantity - the supply of sufficient number of national personnel for work as officers on ships and in positions in the shore based maritime industry, where shipboard experience is essential.

Of particular interest to the broader needs of the maritime industry is the work being done by METNET on extension and enrichment subjects, that go beyond the needs of STCW 95 certification requirements.

<u>Extension</u> covers subjects needed at sea but not covered by STCW 95. Technological change has created a demand for better educated and trained personnel onboard, particularly in the area of computing and data communications, for example.

<u>Enrichment</u> subjects are considered to be those that facilitate the transfer of officers from onboard positions to positions in the maritime industry ashore where shipboard experience is considered essential. The chosen enrichment subjects are shipping operations and costs and port operations and costs.

Simulation can have a role here too. There are a number of excellent simulation gaming tools available for MET institutions, such as TankerSim (ship chartering), SCUSY (Terminal Planning) and PortSim (Port design) that can support any plans to extend and enrich the curriculum.

Either element could be part of a certificate of competency course leading to a higher education award, or a discrete post graduate level course, delivered perhaps by distance education methods. Programs should however provide career opportunities in the maritime sphere for a range of educational entry standards.

It will be recalled in Chapter 5 that one outcome of the METHAR project was that "there was a strong consensus for a harmonised approach to pedagogical competence of lecturers". METNET work package 8 deals with the development of four train the trainer courses for maritime lecturers and instructors.

- 8.1 The framework for developing sections 8.2 to 8.5
- 8.2 Development of a course and course material on modern technology used in teaching
- 8.3 Development of a course and course material on modern technology used in assessment
- 8.4 Development of a course and course material on shiphandling and navigation simulator operators
- 8.5 Development of a course and course material on engine simulator operators

The work involves a number of European MET institutions developing a model course framework for peer review and validation. Each program has been delivered in the form of a one-week workshop at an appropriate campus of a METNET participant. The need for teacher training in the use of computer based technology and multimedia tools is of pressing concern, particularly for the older generation of maritime lecturers. Work package 8.2 resulted in two courses being delivered, entitled Computers in Education, and The Virtual Classroom and Distance Learning. The METNET train the trainer courses are being distributed on CD-Rom to institutions throughout Europe, Eastern Europe and the Mediterranean late in 2002.

The project also involves a series of meetings in the accession countries in Eastern Europe and a number of selected non-EU countries of the Mediterranean to assess the standards and disseminate the findings of METNET, with an aim of raising levels to a common standard across the EU countries. The World Maritime University, supported by a number of principal contractors and associate contractors, was successful in bidding for the Thematic Network on Maritime Education, Training and Certification (METNET). The project commenced in April 2000 and concludes in March 2003.

6.2.5 Impact of STCW 95 Convention on the use of simulators

As discussed earlier, international acceptance of simulators for maritime training and assessment has been a long slow process. The important training role marine simulators can play in raising safety standards has been given increased recognition through the incorporation of this advanced technology in the recently amended International Standards of Training, Certification and Watchkeeping for Seafarers Convention, 1978 (STCW 95).

Table 6.4 below illustrates how the revised Convention has been worded through regulation I/12, in regard to how and when simulators are to be used for training and the assessment of competence of seafarers. The focus is on the application of defined simulation performance standards and other provisions.

Table 6.4 Regulation I/12: Use of simulators

1. The performance standards and other provisions set forth in section A-I/12 and such other requirements as are prescribed in part A of the STCW Code for any certificate concerned shall be complied with in respect of:

    .1 all mandatory simulator-based training;

    .2 any assessment of competency required by part A of the STCW Code which is carried out by means of a simulator; and

    .3 any demonstration, by means of a simulator, of continued proficiency required by part A of the STCW Code.

2. Simulators installed or brought into use prior to 1 February 2002 may be exempted from full compliance with the performance standards referred to in paragraph 1, at the discretion of the Party concerned.

Source: STCW 95

The impact of regulation I/12

STCW 95 in its new form only makes the use of simulators mandatory for radar and ARPA training. Performance standards for radar and ARPA simulation are laid down in the mandatory Part 1 of section A-I/12 of Code A, and had to be met by all simulators after 1 February 2002. Existing simulators or those brought into use before 2002 also had to comply with the performance standards from 1 February 1997, unless exempted from full compliance by the Party concerned. Similarly, if a Party wishes to use simulators for the assessment of any competency, or to demonstrate any continued proficiency required by Part A of the Code, such simulators must also comply with the performance standards contained in section A-I/12, unless exempted as before.

However, it should be noted that Part 2 of A-I/12 Other Provisions is not covered by this exemption and had to be complied with by all instructors and assessors from 1 February 1997, when using simulators for any of the three purposes laid down in regulation I/12. In all cases, personnel using the simulators have to be appropriately qualified and experienced, as required under regulation I/6 and section A-I/6 from 1 February 1997.

In addition to the mandatory use of Radar and ARPA simulators for training, engine room simulators and other types of simulation are increasingly finding their way into the world of maritime training. This is reflected by the inclusion in the Part B guidelines of the new STCW Code of a number of recommended performance standards for non-mandatory types of simulation. This includes navigation and watchkeeping, shiphandling and manoeuvring, cargo handling and stowage, radio communications and main and auxiliary machinery operations simulation. As technology develops in the future, such guidance will be extended by the STW sub-committee.

Performance standards for simulation training

In developing requirements for simulation training in the revised Convention, early work by IMO (ISWG, 1993) indicated that it would be very difficult to establish technical performance specifications for different types of simulation. Development then centred around an approach of defining standards of performance for simulators used in training and assessment, thinking being much influenced by the new emphasis on draft Convention documents for mariners to clearly show that they were competent to do the job for the certificate or licence issued. In other words, that they could actually demonstrate an ability to perform the functions and tasks laid down for the particular grade of certificate, and not merely have the knowledge and understanding.

Application of the performance standards

Section A-I/12 of the STCW 95 Convention Code A consists of two important parts. Examination of Part 1 shows that this deals with general performance standards for simulators, used in both training and assessment of competence, as well as covering specific additional performance standards for radar simulation and ARPA simulation. In deciding to use a particular simulator, an operator must ensure that it is:

- suitable for the selected objectives and tasks
- able to simulate the environment and equipment in relation to such objectives and tasks to an appropriate level of realism
- capable of providing an effective interface between trainee, environment, equipment and instructor or assessor
- capable of permitting an instructor or assessor to control, monitor and record exercises for the effective debriefing of trainees or effective assessment of a candidate's performance, as appropriate.

This implies that the instructor has carefully analysed the training needs, determined the optimum operating environment for such purposes, and considered how to use the supporting facilities (plotters, printers, audio-visual, aural devices, etc.) for the most effective evaluation of trainee performance.

Part 2 (other provisions) deals with both the conduct of mandatory simulator-based training by instructors and the assessment of competency of candidates by assessors. As such it is concerned with the relevance of the programs, the roles of the instructor and assessor, and the methods they employ to see that training objectives are met satisfactorily. The procedures identified here are clearly now concerned with trying to achieve common standards of approach by all instructors and assessors, as well as looking at the validity of performance. Note particularly, the responsibility imposed upon Parties to the Convention.

> Each Party shall ensure that the aims and objectives of simulator-based training are defined within an overall training program and that specific training objectives and tasks are selected so as to relate as closely as possible to shipboard tasks and practices.
>
> (STCW 95, A-I/12, 22)

6.2.6 The use of simulators for training

Critics of marine simulator training state that it is no substitute for real 'hands on' experience onboard a ship, a view one cannot disagree with when taken at face value. However, research (METHAR 1999) shows that many watchkeepers and senior officers are not getting the opportunity to acquire key practical skills for good safety and operational reasons. The simulator, if used effectively, provides an alternative medium in which to acquire these operational skills in a risk free environment.

The increased use of marine simulators for training means that instructors must ensure that simulator training is effective. As a first move, it is necessary to understand the role of training. Stammers (1975, p.10) defined it as 'the systematic development of the skill behaviour pattern required by an individual in order to perform adequately a given task or job'. In the simulator context, skill implies a combining of mental and physical dexterity in the face of audio and visual cues to perform tasks to meet specific objectives, with the implication that such skills will transfer to the real world. The transfer of such skills is only a valid assumption provided that the validity of training is satisfactory. Although considerable research has been carried out by the United States Airforce in the past with positive indications of skill transfer from simulator training to the real environment, research in the maritime field is sparse. Work by Reeve, Multer, Smith and Froese, as reported by Muirhead (1987), seems to support it, with the research findings of Froese (1987) offering the most positive practical evidence.

To support this, it is important that training tasks relate to typical shipboard practices and that the simulator is capable of providing the appropriate operating environment. In this context it is important that the instructor remains up to date with current onboard operational watchkeeping and shiphandling practices. There is strong evidence however (CIIPMET, 2000) that many instructors lack the shiphandling experience necessary to conduct effective training in this field, particularly in some developing countries, where the low salaries paid to maritime lecturers fail to attract senior experienced officers into such posts ashore. This has serious implications for both the validity of the training and claims to be meeting STCW quality standards provisions.

It is necessary to be aware that the use of specific learning objectives for shipboard competence measurement in maritime academies has its limitations where 'hands on' facilities are not available. Institutions need to be mindful of this in following the revised STCW Convention. Simulators must only be used as a method for demonstrating competence within the limits of their capability, otherwise the validity does not exist. Using the Codes and supported by relevant IMO model courses (1.09, 1.22, 2.06, 2.07 and 6.09 are good examples), a simulation program structure can be developed and designed to ensure that it meets the desired training objectives and results in optimum performance.

Training validation

The marine simulator as a training tool has the potential to improve training efficiency in many different tasks. The validation of a training program relates to the measurement of outcomes of training to ascertain whether the behavioural objectives specified in the program have been met. Internal validation is determined by measuring the performance of trainees against established criteria (behavioural objectives) to be achieved by the trainee. The steps to be taken are shown in Figure 6.9 and summarised as follows:

- Undertaking a task analysis to specify the behavioural (training) objectives to be attained by the trainee
- Selecting tasks relevant to the training purpose
- Setting an appropriate simulator training environment
- Preparing the trainee or candidate (briefing, familiarisation)
- Running the exercise (guidance, cueing)
- Monitoring, measuring trainee performance (observation, recording, feedback)

- Gathering relevant information (pre/post tests, recording, plotting)
- Analysing and evaluating performance (debriefing, peer review).

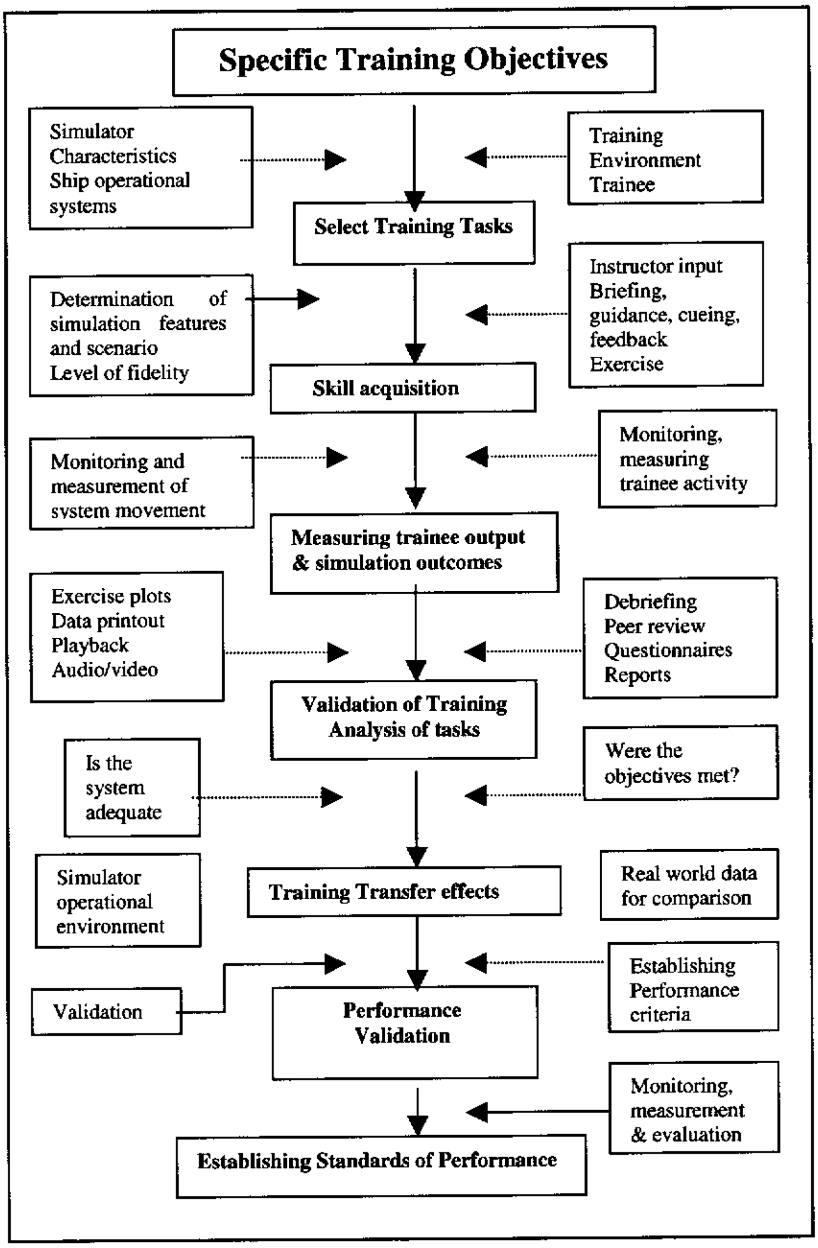


Figure 6.9 Key processes in training validation

Analysing the process

Was the exercise conducted as planned?

Did it meet the training objectives?

Were the system characteristics and levels of fidelity appropriate?

Were there any variable factors distorting training outcomes?

Did the trainee respond to exercise stimuli?

Did the trainee consider all available alternatives?

Was all relevant information considered?

Did the trainee use the system and equipment in a valid manner?

Did the trainee meet specified safety and operational criteria?

The results are brought together by the instructor to develop an overall measurement of training outcomes, from which a positive response is sought to the last question posed above. Where training proves to be ineffective, the instructor must consider whether the stated objectives are inappropriate or if there are inadequacies in the instruction process itself. There is some evidence (METHAR, CIIPMET) to suggest that many simulator instructors are unaware of the importance of following such validation processes.

If instructors fail to consider such fundamentals in developing and operating their simulator programs, it will be difficult to accept the validity of claimed outcomes. The new performance standards in the Code are designed to help ensure greater acceptability of simulator training and assessment in the future.

6.2.7 Training and the STCW Code

As shown on page 22 of the STCW Code in part A-I/12, Parties are required to ensure that the aims and objectives of simulator-based training are defined within an overall training program with the emphasis on objectives and tasks relating as closely as possible to shipboard practices.

On the same page of the STCW 95 Code, a comprehensive list of training procedures to be followed is provided. The focus is on the need to ensure that trainees are given adequate pre-briefing and exercise planning time, simulator familiarisation time and clear guidance, in order that monitoring and debriefing of trainees is effective. It also emphasizes that the exercises must be tested so as to make certain that they are suitable for the specific training objectives.

Clearly then, the Convention states that effective simulator based training is reliant upon several factors:

- The development of specific training objectives

- The selection of tasks relevant to the training purpose and operational skills needed on board
- The effective briefing and debriefing of trainees
- The need for exercise pre-briefing, control, monitoring and de-briefing techniques to be understood and used effectively by the instructor
- The provision of a suitable simulator operating environment for the selected objectives and training tasks.

The onus is clearly placed upon an instructor to see that the tools to achieve the above are in place. It has been seen in previously mentioned surveys that this is not always the case. Access to plotting, recording and viewing devices and knowing what techniques to use are key elements to successful and valid training and assessment.

6.2.8 The role of the simulator instructor

Over 20 years ago, the CAORF research facility in New York looked at the role of the instructor, and concluded that:

> The instructor has a greater impact on the effectiveness of deck officer simulator based training than any of the specific simulator characteristics investigated. Hence the training device should directly address and assist the instructor in conducting training.
>
> (Hammell, 1981)

This still holds true today, and much attention has been directed by the MASSTER, METHAR and METNET research projects towards developing a better understanding of the role of the instructor. The instructor wields considerable influence upon the factors that enhance the learning rate of the trainee, by setting the exercise parameters and task objectives. However, experience shows that the instructor can easily introduce extraneous variables that can influence the task or performance beyond that conceived by the original training objective. Thus the training of simulator instructors has assumed some importance. Most instructors are aware that the following elements are keys to improving the acceptability and validity of simulation training by the maritime community.

Briefing

Experience has shown that the initial briefing and good preparation by trainees are fundamental keys to successful simulation training outcomes. Familiarity with the simulator and its equipment (see following section), and with all facets of the exercise environment, needs to be balanced by the degree and intensity of the briefing so that trainees remain highly motivated to prepare themselves for the challenge. Much depends upon the level of experience of the trainee and the complexity of the exercises. Course programs sometimes indicate a temptation to get this phase over and done with quickly so as to get down to the real job of providing hands-on experience with practical simulator exercises. Examination of different block short courses (Muirhead, 1990) indicates a wide variety of approach to time allocation for such a task. Simple pre-training tests or questionnaires are useful support tools to help this process. Based on the author's many years of simulator experience, the real purpose of the briefing is to ensure that participants understand the training objectives, are clear about their role, and have sufficient familiarity with the equipment so that they have a high degree of confidence both in the system and in their own interaction with it.

Table 6.5 Briefing-key elements

- Participation and motivation
- Preparation
  - Level of experience
  - Exercise complexity
  - Pre-planning activity
- Exercise environment
  - Roles, responsibilities
  - Purpose and objectives
  - Use of equipment
  - Intervention
- Demonstrations
- Repetition

Simulator familiarization

Experienced simulator instructors know that it is most important, at the beginning of a simulator course, that users be given adequate time to familiarize themselves with the features, equipment, and operation of marine simulators, as well as understanding the limitations of the specific type of simulation. If the confidence of the user in the system is not gained early, there is a continuing struggle to convince users that realistic training activity can be conducted in such an environment.

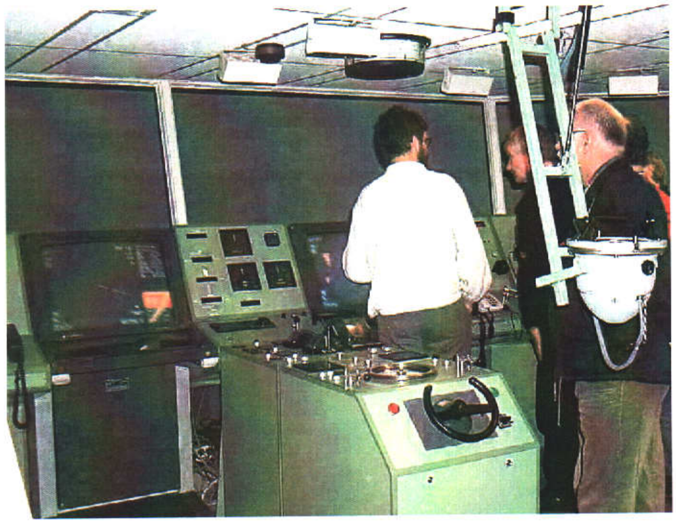


Figure 6.10 Familiarisation before the exercise

Again the common problem facing instructors is finding adequate time. How much time should be allowed for trainees to become familiar with, say, a complex shiphandling simulator when the course runs for five days? Today technology can provide an answer. The power of a modern computer workstation, combined with flexible software, has led to an increasing use of such facilities for pre-task training.

Figure 6.11. Part-task shiphandling simulator (HW-FSW, Germany)

The replication of many of the full-mission simulator capabilities, for example, allows trainees to access a pre-familiarization program before a course starts. A lack of familiarisation can often be the cause of shortcomings in trainee performance, not the trainee. This may lead to misinterpretation by the instructor.

Figure 6.11 shows an example of a part-task training console, where a trainee can follow a pre-familiarisation program before being allowed to progress to the full-mission simulator. It comes equipped with helm and engine controls.

Whilst many machinery space simulators can closely replicate the real engine room, the same is not necessarily true of the bridge simulator. In particular, with visual shiphandling simulators, a number of limitations exist.

- Estimating distance to objects
- Effects of parallax when moving off the focal point of projection
- Lack of 3 dimensional depth of perception
- Limited horizontal field of view
- Inability to walk out to the bridge wing
- Inability to estimate wind force and direction accurately
- Poor identification of approaching targets, except when close to them.

Some of these constraints can be overcome by the instructor providing exercise cues and distances from objects (role play), or using a stern view monitor. Others need to be allowed for, hence the importance of familiarization (or pre-training) sessions before starting simulator training exercises.

Table 6.6 Simulator familiarization – key elements

- Main features, equipment and operations
- Limitations of the environment
- Acceptance as a 'real ship' of typical behaviour
- The need for adequate familiarization time
- Support of pre-reading material
- Use of part-task training devices
- Use of compensatory cues to overcome lack of reality
- Confidence in the transfer of acquired skills

Familiarization will be specific to each particular simulator, but key elements are a feature of all systems (see Table 6.6).

Conducting and monitoring exercises

Comment has already been made on the important role the instructor plays in the success, or otherwise, of simulation training. Bole (1988) showed the importance of developing a balanced interaction between the exercise and trainees. It is very easy for an instructor to under or over react to what is happening in the simulator environment. The former may lead to boredom and disinterest, the latter to unrealistic stress conditions. Getting the balance of appropriate stimuli and cues necessary for scenario and environmental realism comes from experience. Purposeful intervention plays an important part in helping to create the 'real atmosphere' for training tasks, but excessive intervention by the instructor may lead to trainees not performing tasks using their own skills and experience.

How to deal with group training is another challenge facing the instructor. Observational and monitoring skills are often stretched to the limits. STCW demands demonstration of ability to perform tasks and functions. How can an individual's effort be measured or assessed within a team training environment? This aspect is discussed in more detail in Chapter 7.

Most experienced instructors consider their role in the context of a moderator, a mentor or a facilitator, providing a realistic training environment in which participants can relate to real workplace conditions where they will return later for ongoing experience.

Figure 6-12 Monitoring the exercise-Machinery Space Simulator

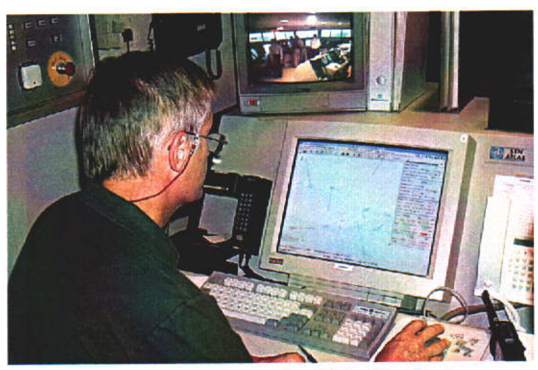


Figure 6.13 Monitoring the exercise- Shiphandling Simulator

As mentioned before, the manner of monitoring trainee activity on the simulator is very dependent upon the facilities available. The use of plotters, printers, data recorders and the instructor's log are key tools. Surveys have shown that not all simulators are so equipped, which makes the task of judging performance more difficult and leads to a more subjective and thus less reliable outcome.

Table 6.7 Conducting & monitoring an exercise - key elements

- A balanced interaction between trainee and the exercise
- The use of stimuli and cues
- The role of purposeful intervention in creating a 'real atmosphere'
- Avoidance of excessive intervention
- Avoidance of excessive stress
- Avoidance of 'gaming' atmospheres
- Instructor's role as mentor, moderator, facilitator
- Monitoring - purpose and intent of data collection
- Nature of the observational process
- Planned use of recorded data and information in the debrief

Technology in the form of video and aural recordings of bridge or engineroom team activity are increasingly becoming available to the instructor. Such information is increasingly being used to evaluate team effort (Meurn, 2000). The exercise elements that need to be observed and recorded provide the foundations for the final phase, the conduct of the debriefing.

Debriefing

The purpose of this very essential element in simulation training is to examine active learning activity, with a view of determining whether the specified aim and objectives of the exercise have been achieved. Peel (1998) has noted that while simulation training is an experiential learning process, a trainee needs to have this experience continue beyond the actual run-time of the simulation. Unfortunately there are many different approaches taken by instructors at the debrief stage. There is a strong temptation by the instructor to dominate and give a 'lecture' on how the exercise or task should have been done. To overcome this natural tendency, Peel suggests adopting a student facilitated debrief. Peer review by the participants is a major element of the debrief, through the sharing of each trainee's background experiences.

A student observer may manage the discussion and explore the group's experiences. Douglas & Wass (1993) encouraged the use of peer review methods, where the instructor plays a low key role in encouraging participation, highlighting key points and using collected exercise data to assist in the discussion. Real life situations, or experiences illustrating similar incidents or situations, are then used to illustrate the lessons to be learned.

Figure 6.14 Debriefing the trainee group

Figure 6.15 Debriefing - peer review group

Section A-I/6 of STCW 95 Code A, page 14, is quite specific in relation to simulator training and assessment and states, inter alia:

> *Qualifications of instructors, supervisors and assessors*
>
> *In-service training*
>
> Any person conducting in-service training of a seafarer ... shall:
>
> *if conducting training using a simulator:*
>
> - have received appropriate guidance in instructional techniques involving the use of simulators; and
> - have gained practical operational experience on the particular type of simulator being used.

The emphasis on obtaining guidance in instructional techniques and acquiring practical simulator operational experience shows that drafters of the legislation were well aware of such weaknesses globally. Of course this is not an easy task. The best solutions, in the author's experience, are to understudy with an experienced simulator instructor at another institution, use the IMO simulator model courses to get started, or ensure that a simulator delivery contract includes provision for training in instructor skills.

Table 6.8 Debriefing – key elements

- Purpose and objectives of the debrief
- Exercise strengths and weaknesses
- Lessons to be learned from errors and mistakes
- Use of peer review technique
- Use of supporting exercise data, recordings and observations
- Real life examples - improving performance
- Avoid blaming individuals or giving 'lectures' on how to do it
- Use a tactful approach
- Good communications are very important

In the final analysis, the role that the instructor plays is a crucial one. A highly sophisticated simulator is wasted if it is supported by a poorly skilled instructor. However, a skilled instructor can take even the most basic of simulators and produce meaningful and valid training outcomes on it.

6.2.9 Summary

The issue of a certificate of competency is prima facie evidence that the individual is capable of performing certain practical tasks and functions onboard ship in a safe and effective manner. Yet many current forms of assessment generally do not relate to demonstrations of actual on-the-job skills. The latter forms the new emphasis of the revised STCW Convention. Ideally much of this evaluation would be better carried out *in situ* onboard, but limits imposed by ship safety requirements and reduced manning mean that much of the onus for training and evaluating competence rests with the maritime training institutions ashore. The need to narrow the gap between training for knowledge and onboard skill acquisition has become of paramount importance.

The development of marine simulation systems can, however, help to bring maritime training closer to shipboard practices and allow these facilities to be used to measure students' performance in a range of tasks provided the safeguards mentioned previously are observed. By ensuring that relevant performance standards are followed and training and assessment processes are validated, the instructor is in a strong position to both influence practical safety standards and raise the confidence of the maritime community in the use of such technology for training and competence purposes.

The role of simulation as a maritime education and training medium has gained greater acceptability by industry, administrations and institutions over the past decade. The evidence shows, however, that there is still some skepticism around about the value and validity of training by simulator. Many weaknesses are evident in some parts of the world. However, instructors and assessors now have available to them clear guidance on the functionalities needed to conduct training and assessment effectively and validly through marine simulation. Combining this with good instructional practices and skills will allow institutions using simulators to contribute more effectively to the IMO vision of global standards of competence of seafarers.

This chapter has focused on two key areas of technology, namely, the use of computers and simulation systems, that increasingly form a core element of maritime education and training programs. While much experience has been gained in the use of these tools for training and the acquisition of knowledge and skills, the requirement of STCW 95 that seafarers also demonstrate their ability to perform tasks and functions safely and effectively in order to ensure competence in the workplace, has been focused on facilities in shore based training establishments.

However, as Chapter 5 illustrated, communications technology is also opening up new opportunities to extend the learning and training environment onboard the ship at sea, and many of the computing and simulation tools and methods examined in this chapter, have the potential to be used in the workplace. Chapter 7 examines some possibilities in this new world of the virtual classroom and distance learning.

CHAPTER 7
CYBERSPACE AND DISTANCE LEARNING

7.1 Cyberspace and education

The word cyberspace is a metaphor for the non-physical terrain created by computer systems, the term being coined originally by Gibson in his 1984 science fiction novel, "Neuromancer", as "an encompassing medium of communication and control" (Webopedia.com, 2002). Within this cyberspace, people can communicate with one another, undertake research or explore the virtual environment. Objects such as mail messages, files, graphics and video can be transported and delivered to almost any point on the globe or even to space craft beyond. The advantage is that it requires no physical movement other than using a computer keyboard or mouse. Benedikt (1991) quotes McFadden as further refining the concept as "an inhabitable new parallel universe created and sustained by the whole world's computers and telecommunication infrastructure".

Today, this cyberspace environment is made up of an extensive world of technology: computers and powerful work stations, satellite communications, the Internet, the World Wide Web, broadband data transfer, laser discs, CDR/DVD read-write, multimedia tools and interactive video, wireless networks, remote polling, and the information superhighway, to name but a few. Much of this development has happened in the last 10-15 years! It took a little more than a hundred years to make remarkable progress in the field of biotechnology, genetic engineering, lasers, radio astronomy, artificial intelligence, atomic power and much more.

Has education moved on with the same speed or urgency? Some 2,500 years after Socrates developed his basic educational paradigm of discourse, its survivor the lecture still forms the essential backbone of educational delivery. Lecturers in medicine and surgery have long used demonstration as part of the lecture. By the 19th century the use of blackboards and pictures, as well as demonstrations, were common tools for science lecturers. Most teachers in secondary and tertiary education are active users of modern audio-visual aids today. However, lectures still remain the most popular form of teaching delivery in universities, by reason of tradition and economics.

Despite education giving the appearance of being locked in a time warp, momentous change is underway in the 21^{st} century. The technological keys to unlock the system to free students to pursue lifelong learning anywhere, anytime, are rapidly becoming available on a more global basis. To many, the task and challenge of reforming and extending quality education to the entire global population is huge. Anyone who has tried to reform traditional educational models with new and dynamic approaches understands the difficulties of shifting an entrenched, conservative system.

However, the pace of technological progress is so fast and the global spread and access to it growing so quickly that it is not a case of if, but when, it will happen. Institutions are scrambling to enter the cyberspace educational world because of a fear of finding themselves declining into irrelevance. A typical maritime education institution of today consists of buildings with classrooms, libraries, workshops and laboratories. To operate, it requires power and energy, transportation systems, students and academic staff. Technology is altering all the traditional ground rules. Cyberspace education operates without frontiers, walls or barriers. It is an interactive learning environment, globalized by technology links. It is a concept that can find a ready home at sea as well, in the future.

7.2 Distance learning – a perspective

As seen in Chapter 6, technology has created new opportunities for delivering education and training through the medium of computers, software programs or simulators within an institution, at home or on a ship. But we have also seen that the advent of the Internet, the World Wide Web and satellite communications systems extends the possibility of delivering education and training services directly between institution and student anywhere, anytime. It can be synchronous or asynchronous in form.

This potential to deliver learning at a distance (distance learning) has led to a global revolution in education. Many institutions are hurrying to get a foothold in the distance learning marketplace, both locally and globally. Dunn (2000) suggested that as many as 50,000 University level courses were available through distance learning delivery systems, a figure growing every day.

Before looking at the availability and use of distance learning in general and the maritime community in particular, it is helpful to understand what is meant by the terms 'distance learning', 'distance education' and 'open learning'. The term distance learning (education is very nearly the same) was coined within the context of a continuing communications revolution, largely replacing a mixed bag of nomenclature such as correspondence course, home study, guided study and external study. 'Open learning' refers more to the learner than to the learning process and is concerned with making the courses accessible to all, without regard to educational qualifications and, providing a more "open" choice of program, organisation of learning time and duration.

Many of the task and guided study programmes (TAGS) used onboard ships by cadets can be classed as forms of open learning. 'Correspondence courses', popular forms of self study and self improvement in the pre-1970s, should not be confused with distance education programs for two reasons, first they lacked structured learning material and second, and most importantly, the means of communication was extremely limited and slow.

Many definitions of distance learning (education is synonymous) exist. Two good examples are:

> Distance education *(i.e. learning)* is defined as an educational system consisting of the methodologies and technologies that support learning when the learner and learning resources are separated by time and/or space.
>
> (IDE, 1998, p.5)

> At the basic level, distance education *(i.e.learning)* takes place when a teacher and student(s) are separated by a physical distance, and technology, i.e. voice, video, data and print is used to bridge the instructional gap.
>
> (Willis 1994, p.4)

Keegan (1990) refined earlier definitions and developed concepts of distance learning that are centred on:

1. Participation in a very structured, rigid educational bureaucracy
2. Quasi-permanent separation (note Willis above) of teacher-student over the period of study
3. Quasi-permanent separation of the student from any peer group in the period
4. Content delivery via mechanical (print/mail) or electronic communications
5. Provision of some means of synchronous or asynchronous communication.

A comprehensive global survey of the development of virtual education by the Commonwealth of Learning (Farrell, Ed, 1999) also noted that the growing practice of virtual institutions to accredit distance learning study programs through the issue of an institutional educational award had taken the process away from the earlier held perception of distance learning as being a type of self study or correspondence course.

What are noticeable are the key aspects of distance learning, namely, physical separation of teacher and student, and the use of communication technology to bridge the physical gap. Of course, there are other factors of importance, including the design of learning materials, to be taken into consideration. The latter, whether delivered in printed format by mail or placed on-line for direct access by the student, must be created in an instructional format that has embedded within it the act of teaching, i.e. a virtual 'parallel sense of communication' is established. Selection of the best available forms of communication technology, such as e-mail, fax, telephone, tele and video conferencing, Web based Netchat and bulletin boards, and Netmeeting software, helps to overcome any feelings of isolation by the student and avoid early drop-out from a course.

The Open University (OU) (2002) in the UK pioneered open learning on a national scale in the early 1970s. Few higher education institutes had the expertise to develop and manage open and distance learning materials. In the early days many universities and colleges produced material of such tedium and poor quality that they proved to be a disincentive to learn. By the late 1980s Strathclyde, Warwick and Aston Universities and Henley Management College in the UK had modelled themselves on the pioneering work of the OU, providing a range of courses and programs for delivery to students, living outside of their local boundaries, using structured distance education methods.

Distance education has also been provided to the general public for many years by many institutions in the USA, the Public Broadcasting Service (PBS) educational satellite network and the National Technical University (NTU) in the USA being good examples; in India (since 1985 the Indira Gandhi Open University), Netherlands, Thailand, Korea, Canada (The Commonwealth of Learning) and by a number of Australian University distance education providers. Chen (2001, pp. 54-55) noted that in China, some five million students were enrolled in self-study programs in 1997 using university based radio and television channels, but the system lacked communications for feedback to tutors. Since that time the government has made the provision of distance learning a priority development, with the establishment of the China Education and Research Network (CERNET), which today links 71 large universities and institutes in 140 cities. Plans are to improve the network backbone to 622 Mbps. Over 67 universities are engaged in major distance learning projects.

More recently, national Open Learning Centres in Singapore, Australia and Spain have been developed. Based on a virtual campus, the Open University of Catalonia (OUC) has moved from a start-up level of 200 students in 1995 to more than 4,000 today and has exported its successful model to Peru and Argentina. Assignments are set and handed in via e-mail. A number of institutions in Sweden offer courses to external students through the Internet, Luleå University being one good example.

Seafarers, as a result of their environment, have long been denied access to effective education and training opportunities at sea. Many educational institutions now provide a range of courses and programs for delivery to students living outside of their local boundaries, using structured distance education methods. These programs can be developed and be instructionally designed for the workplace. Ashore, access to a tutor is normally provided by fax, telephone, tele-conferencing and attendance at summer schools. Access to a tutor when at sea is difficult. Feedback to the student can be haphazard and take months.

Satellite communication provides a unique link between student at sea and the tutor ashore. Assignments can be transmitted, marked and returned within a very short period of time. Queries can be responded to in a matter of hours by either fax, telex or telephone. The student benefits from the early response and feedback and the links developed with the tutor; the teacher benefits from a rapid perception and understanding of the student's difficulties and rate of progress. Examinations may be arranged to be taken onboard, as has been the case with students enrolled on the Graduate Diploma schemes offered in external study mode by the Australian Maritime College. Even at ratings level, distance learning programs onboard are now available.

This could equally apply to a company running its own in-house onboard training program. An owner may require a ship's crew to undertake refresher or upgrading training, covering onboard equipment or operations at regular intervals. Both programs and individuals can be monitored to ensure that onboard safety standards and levels of skill are maintained. 'Train the trainer' programs can be developed for interactive use between company management and the onboard deliverer or between training institution and the onboard trainer.

Despite the disadvantages arising from the 'tyranny of distance' and lack of direct supervision, distance learning, when used in conjunction with communications technology for personal education purposes or for onboard training, has the potential to open up new avenues of knowledge and skill relevant to changing workplace needs.

However, distance learning programs must be planned carefully and be instructionally designed and edited by professionals so they are suitable for the market. This means producing relevant and qualitative units with effective and speedy feedback mechanisms. Computer aided learning and computer based resources can provide interactive support to the learning process.

Lewarn (2002) has pointed out that, in this world of flexible learning, networks offer opportunity to create alliances and joint ventures to develop a new educational paradigm. In Lewarn's view (2002, p.23) flexible learning can be seen as "the provision of valid and reliable learning experiences by utilising the best pedagogical mix of location, study pattern, teaching method, study material and delivery medium". One result of this has been the shift to outsourcing many of the processes of educational preparation and delivery, which in turn has impacted upon the traditional role of the academic. The elements of flexible learning, as modified from Lewarn in Table 7.1, clearly illustrate the range of processes involved in this new paradigm. This delivery is described by him as a shift away from a scholarship ethos towards commercialisation.

Table 7.1 Elements of flexible learning

Element	Variable
Location	On campus
	Off campus
Study Pattern	Full time
	Part time
	Combination of above
Teaching Method	Lecture
	Tutorial
	Workshop
	Distance learning
	Simulations
	Discovery techniques (labs, site visits)
Study Material	Print (books, notes)
	Audio (tapes) and Visual (videos)
	Multimedia (CD Rom, DVD)
Delivery Medium	Personal (face to face)
	Teleconferencing
	Videoconferencing
	Radio/TV
	Computer (e-mail, Internet, Intranet)
	E-documentation

Source: Modified from Lewarn (2002, 22)

This concept of being in the business of selling a commercial commodity, resulting from mass delivery of education on a global scale, is concerning many traditionalists. Not least is the question of quality of the product. With many hands on the developmental wheel, there are concerns that traditional controls within institutions openly issues in class. Teacher response may be delayed, depending on the communication links available.

For example, how valid and reliable is the course content? Table 7.2 highlights some of the issues that would be explored in considering these aspects.

Table 7.2 Evaluating distance learning course content
Objectives: are they appropriate?
Content: has material been chosen for its relevance rather than aesthetics?
Is it balanced between subjects, modules, sections, topics?
Level: is it set at the right level? (diploma, degree, etc.)
Level of difficulty: does it challenge the students effectively?
Writing & content treatment: are there equal opportunities for all?
Are the experiences of all students affirmed by the activities?
Support: is the range of readings and expert sources adequate?
Students: have they achieved understanding of content? have they met the objectives?
Linkages: how does it link to other distance learning modules?

The distance learning provider has to decide how answers to these key questions will be obtained. It is very difficult for a tutor to easily ascertain information about the learning styles of the individual students, to know their levels of language and writing skills, or their ability to comprehend and understand the delivered written materials (in print or electronic format). How proficient are they at using supplied multimedia materials or in using their skills to access and use an online Web based Education Management System (WEMS) site effectively? As has been noted before, communication links are a key element in the success of any distance learning program. Consider the following questions:

Did the student use the means of communication provided as planned for in the course scheme?

Could the student communicate with the designated tutor when required?

Could the student access course information on-line when needed?

Were the provided communication facilities effective in supporting the student's learning environment and experience?

What improvements could be made to communication facilities in the light of the student's learning experience?

This unknown picture of the student is particularly acute in the first few weeks of any distance learning program, before the student has returned any work. It is the time when most students drop out of a course.

The main tool used by faculty for distance learning course feedback is the structured questionnaire, supported by asynchronous interviews via mail or e-mail. Questionnaires take on a more important role as a tool for obtaining feedback from students, on not only the course itself, but on student attitudes and views to the learning environment encountered. Instructionally designed learning materials (whether mailed out in printed form or posted to an on-line site) form the core of many distance learning courses. A student may be using a variety of learning materials including on-line lecture notes, readings, study guides, texts, e-library, Internet, audio visual, computer and simulation packages. Views on the quality, relevance and accessibility of materials, and their ability to motivate and generate interest and develop interactivity with the learning process, would be very useful to the course evaluator. Determining their effectiveness will require special care in constructing questions in a questionnaire.

More difficult to arrange, but becoming increasingly possible, is the use of synchronous teleconferencing or videoconferencing meetings (after an assignment or examination) or making similar arrangements online via the Internet through Netmeeting or Netchat facilities. If the institution uses WEMS then such a system should have these communication tools built into its operational features.

Table 7.3 Delivery and teaching feedback

- Actual student workloads in studying the module
- Approaches taken by students to meet tutor expectations
- Effectiveness of telephone, teleconferencing, or e-mail contacts
- Feedback of assignment results and response
- The format and quality of interactions for students
- Availability and ease of access to learning resources
- Administrative: dispatch schedules, assignment schedules, turn-round times, ease of contact
- Studying problems: access to counselling services

Table 7.3 highlights a number of course delivery and teaching feedback aspects. Once again the course evaluator cannot call students in for individual face-to-face meetings, or schedule class debriefing sessions, in the traditional way. A further matter to be considered is how effective were the administrative support services to the program, in general, and to individual students in particular?

The foregoing issues and points serve to illustrate the many different features that exist when the choice is made to deliver courses of study using distance learning methods, multimedia tools, and modern communications technology.

7.3 The nature of distance learning

As stated earlier, the term "correspondence course" should not be confused with "distance learning programs". In broad conceptual terms the nature of distance learning can be described in a simple way: teaching and learning, with few exceptions, involve two elements. The first is pre-prepared course materials that have embedded within them the act of teaching, (printed or electronic format) while the second is non contiguous communication between teachers and students. Thus distance learning programs consist of professionally developed and instructionally designed units with built-in teaching and learning mechanisms for student interaction, feedback and evaluation, and provision for tutor contact.

A typical distance learning unit may consist of a unit guide, a study guide supplemented by a book of selected readings. A textbook, computer software, or other media such as audio or video tapes, CD-ROM , DVD, laser discs or Web based electronic materials may support it. Units may also be accompanied by related television programs, offered at specific times, through a national broadcaster (e.g. the BBC Learning Zone) or a public broadcast network (PBS in the USA). The use of teleconferencing and video conferencing mediums and attendance at summer schools may be a feature of the program.

E-learning links for tutor interaction are an increasing feature of modern approaches. The unit may be typically assessed through written assignments and/or time-limited open book examinations. The study guide units are instructionally designed so as to provide the student with the sense of communicating and interacting with the delivering institution and the designated tutor (see Figure 7.1).

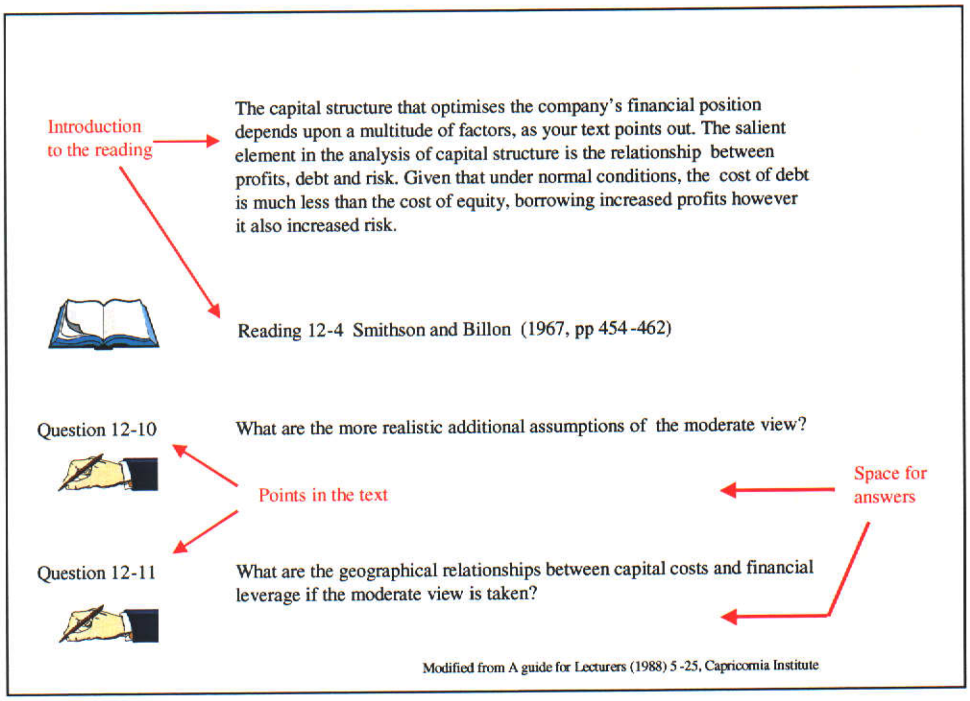


Figure 7.1 Text + study guide layout

The convergence of increased demand for access to educational facilities and innovative communications technology is increasingly being exploited, despite criticism that it is an inadequate medium when compared to learning alongside others in an institution. The advantages of studying at home and the cost savings to both student and institution have also been powerful catalysts.

However, distance learning programs must be planned carefully and be instructionally designed and edited by professionals so they are suitable for the market. This means producing relevant and qualitative units with effective and speedy feedback mechanisms. Computer aided learning and computer based resources can provide interactive support to the learning process. However, it should be noted this study does not advocate that technology can totally replace the teacher, or that the tactile language of human contact can be replaced completely by IT.

Drawing on 12 years' experience at the AMC, Lewarn (1998) noted that a number of critical issues stand out in developing and delivering distance education courses:

- Material must be of good quality and easily updated

- Good communications with students are essential
- Responses to inquiries and requests for help must be speedy
- Turn around time for assignments/exams must be rapid
- Administration must be effective (tracking material, exams, etc)
- Technology must be used to improve delivery and interaction, not because it is trendy.

Despite the disadvantages arising from the 'tyranny of distance' and lack of direct supervision, distance learning, when used in conjunction with communications technology for personal education purposes or for onboard training, has the potential to open up new avenues of knowledge and skill, relevant to changing workplace needs. Williams, Paprock & Covington (1999, p.4) show, in Figure 7.2 under, how the availability of technology in the last 120 years has influenced delivery at a distance.

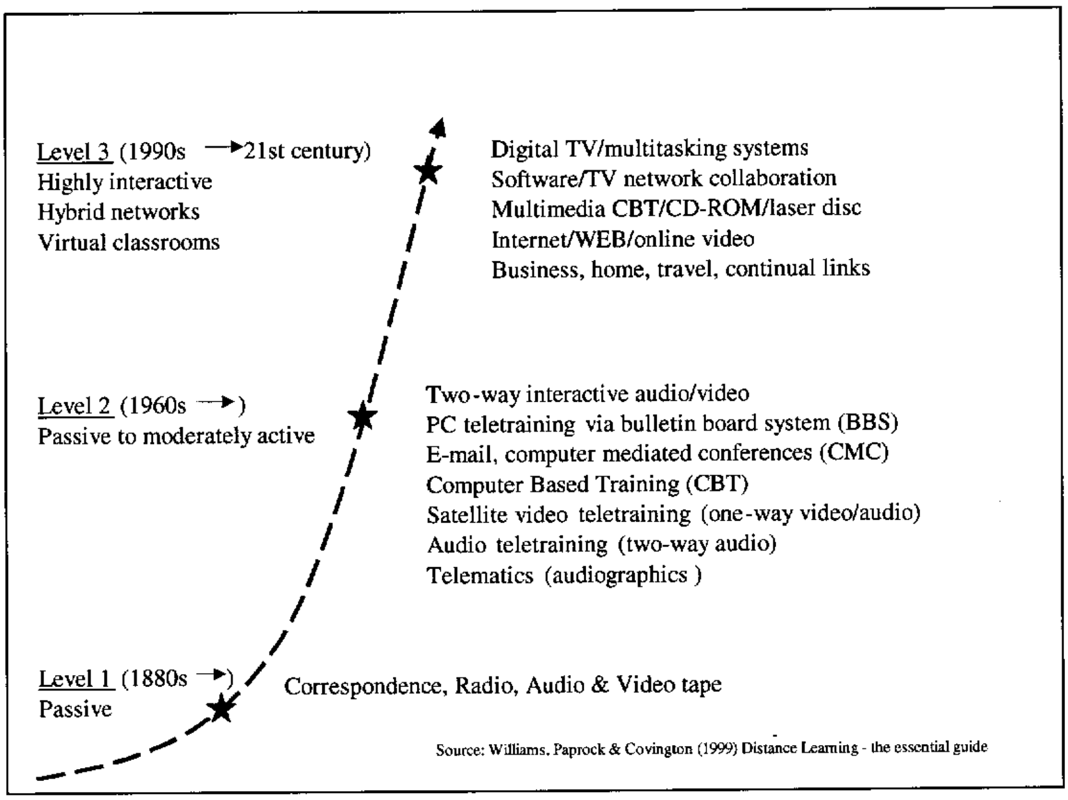


Figure 7.2 Distance learning continuum

However, MET institutions have generally been extremely reticent in embracing this very flexible form of education and training delivery. The need for closer links with the shipping industry, in regard to onboard training required by STCW 95, emphasises the important role that distance education methods and technology can offer in the next century.

7.4 Educational methodologies and new technology.

As a rule of thumb, it is often stated that we learn 20% of what we see, 40% of what we see and hear, and 70% of what we see, hear and do (IMO, 1991, p.55). If that is the case, the combination of computers, networks and multimedia capabilities is clearly a formidable educational medium. But distance learning is more than just sitting at a computer terminal accessing Internet's World Wide Web. The characteristics of distance learning can be described as enhanced access to resources, program delivery, outreach, and student interactivity (either with the material or with a tutor). Outreach means that learning can take place anywhere, at anytime. Interactivity ensures that a student does not learn all alone, due to steps taken to provide him/her with the appropriate communication resources.

Consider some current activities. For example, the British Open University (2002), the foremost distance learning institution in the world, currently has over 160,000 students using the university's on-line e-mail conferencing system. 178 OU courses require the student to have on-line access. In 2001, the university produced 773,000 CD-Roms, 30,000 Floppy discs and 3,000 DVDs. The University of Phoenix (2002), the largest private University in the USA with 116,000 students, has on-line plans to convert itself into a 'bookless college' through the use of 'e-textbooks. Some 60% of its 37,600 distance learning students have their course fees reimbursed by their employers, reflecting growing acceptance of online learning. Athabasca University (2002), which for 30 years has been Canada's leading distance education specialist, now has some 24,000 distance education students, 550 distance education courses, and 60 distance education programs. Dunn (2000) suggested that more than 50,000 University level courses were available through distance learning delivery systems, a figure growing rapidly as more institutions offer on-line courses.

The University of Washington (2002) offers abbreviated versions of its short courses on-line at no charge. Massachusetts Institute of Technology (MIT) Knowledge

Updates (2002) broadcasts live and synchronous ten minute segments via satellite and Internet, using PIVOT (Physics Interactive Video Tutor). Students can access PIVOT 24 hours a day, every day. Even more momentous was the decision by MIT, in April 2001, to place all of its more than 2000 courses on-line by 2010 through its Open CourseWare Project (Goldberg, 2001). Work commenced in November 2001. These materials will be freely available on-line to anyone.

The National Technical University (NTU) in Colorado, USA transmits advanced technical and managerial telecourses via satellite to high profile companies. The interactive programs enable participants to communicate with instructors by phone, fax, e-mail. The number of downlink sites is over 1000 and short course enrolments exceed 100,000. Of course the corporate sector is much better placed to carry such costs. Penetration of such technology in academic institutions is small due to the current costs involved. The Internet offers many attractions to the educational world, not least the cost element.

Taking the USA as an example, a number of articles in Educause (2001-2002) noted a number of trends predicted for the USA workplace:

- 75% of the current workforce needs to be retrained to just keep up with changes taking place in industry and business. Fewer people are left to do more things!
- It is estimated that the shelf life of a technical degree today is only five years!
- It is estimated that 50% of the USA working population is employed in home based businesses. Telecommuting is a way of life.
- 61 million people in the USA will use interactive TV by the end of 2006 (Carmel Group) - what potential does this use of TV lend itself for educational purposes in the home?

Asynchronous learning networks (ALNs) allow students to learn at their leisure through instructional CD-ROMs, electronic conferencing software, and Internet e-mail communication, the latter providing the important interaction with the institution and tutors. The challenge of communications and computing technology and its impact on access to, and the delivery of, educational services has led many institutions to recognise that traditional methods will not be the only answer into the 21st century. Consider the developments described in section 7.5.

7.5 Globalisation of education

The trend towards globalisation of business has spread to the international education sector in the last few years. The cyberspace world of education is no exception. Recently announced initiatives in e-university developments include proposals by the Higher Education Funding Council for England to set up a consortium of UK and overseas partners to create a virtual e-university without a physical campus, at a cost of £200 million. Goddard (2000) reported that News International has formed a partnership with 21 Scottish Universities to market and distribute distance learning courses. Sweden passed a bill at the end of 2001 to combine the on-line courses of several of the 39 state universities, with education free for students at the Net University (CHE, 2001).

Educause (2001a) reported that Thomson Learning and Universitas 21 (a consortium of 16 universities) had agreed to put up $25 million each to develop degrees in business and technology for the Asian and Latin American market. Centred in Asia, it will draw upon Thomson's textbook division and 100 e-learning courses from the constituent members. The Global University Alliance (2002) is another global university group with ambitious plans. Hardly a day passes without another cluster of educational establishments announcing their arrival on the distance learning scene. Some institutions have developed off-campus cyberspace centres to provide a potentially larger student population with a gateway to ongoing education.

To effect distance learning delivery today, many institutions employ a Web based Education Management System (WEMS) using ready-made platforms such as Blackboard, WebCT, Lecando or Luvit, to mention but a few. These are actively used to deliver and manage institutional distance learning programs. However, not everyone involved in distance learning considers that such platforms are satisfactory for academic purposes. While WMU plans to develop its own system, MIT and Stanford University (2002) are developing, through their Open Knowledge Initiative (OKI), a free on-line course management system. It is expected to be available in late 2003 (MIT, 2002). This aspect is discussed in more detail in section 7.10.

Such is the pace of growth in distance learning delivery that it has been predicted by the Association of Governing Boards in the USA that as many as one third of the existing independent colleges and universities will close in the next ten years (Educause, 2001). Eduventures.com Inc., a leading independent e-Learning industry analyst firm, projects that the USA higher education e-learning market will grow from $4 billion today to $11 billion by 2003 (Blackboard, 2002).

7.6 Maritime distance learning

For many years a number of shipping companies provided their deck and engineer trainee watchkeeper trainees with a form of self study or correspondence based training program, whilst onboard ship. This was later supplemented by various forms of Task And Guided Study (TAGS) programs, which the ships' officers supervised and commented upon. Unfortunately, the practice was not uniform across the globe and poor standards of supervision, lack of motivation by individuals and lack of opportunity often hampered the effective completion of the range of practical tasks and projects. As mentioned previously, STCW 95 now requires a Training Record Book to be kept by all prospective watchkeepers during their onboard training periods. This form of distance study has now been developed in a more structured way through the development of standard programs, such as the ISF booklets and the IMO model Training Record Books. Some countries, such as Australia and the UK, have had a standard TRB in use for many years. For others, new models need to be developed, unless the IMO or ISF models are used. The aforementioned problems still remain, but there is scope for new technology to assist with this very important element of practical experience undertaken in the workplace.

An examination of global maritime institution web sites does not reveal any evidence of widespread activity in delivering maritime distance learning courses, a view supported by this research. In Australia, a leading proponent, students have had access to maritime distance learning courses through the Australian Maritime College since 1987. Market research showed a clear desire by many individuals, working in maritime related jobs ashore, to pursue further qualifications. Today they can enrol in postgraduate certificate, diploma and Master degree distance learning programs in maritime management, maritime business, stevedoring management, and marine surveying, utilising printed and on-line instructional material, the Internet, e-mail and tele-conferencing, without having to step inside the institution. Most students are employed in jobs ashore. New areas under development include certificate of competency courses for deck watchkeeper and shipmaster (AMC, 2002).

A number of centres in Britain, including the Centre for Advanced Maritime Studies in Edinburgh, the North West Kent College and the Institute of Chartered Shipbrokers in London, between them offer a range of courses by distance learning, covering ship and port management and operations, marine surveying, ship agency and maritime law. The FUMAR project in Norway started in 1997 and involves the collaboration of four maritime academies, offering nine subjects between them by distance learning including management, navigation, GOC, finance, law, etc (Fumar, 2002).

7.7 The seafarer and technology

At sea, technology has the potential to allow much refresher and upgrading training to be carried out onboard that currently require seafarers to attend a course ashore. Chapter 4 has described previously a new innovation by a shipowner, of placing computer based simulation training systems onboard ships for use by trainees while at sea. Increasingly, seafarers are gaining access to Internet and e-mail services on the ship. Even at ratings level distance learning programs for career advancement to watchkeeper level have been available onboard ships in Australia for some years now. For the mariner, the opportunity for private study at sea, a service long denied him/her, will become reality as Internet links become more common onboard ship. Access to web based communications, such as net-chat, net meeting and news groups has further extended the range of possibilities. Why shouldn't the mariner be able to take an educational award program at sea via an Open Learning University or from a delivering Maritime Cyberspace Education Centre, in future?

Surveys by NEA (2000) showed that e-mail is the preferred mode of communication by over 70% of distance learning students in the USA. There is no reason why students at sea should not develop similar level of access to course tutors. Support through CD-ROM and on-line marine databases ensures that library information can be readily available. Software companies, such as Videotel and Seagull are leading the way in providing maritime related learning resources in an easily accessible format at sea.

Overall then, there is no technical reason why many aspects of education and training could not be carried out on a ship, as well as on shore, through the supportive medium of distance learning. The real constraints are developmental costs of materials, access to computing and communications technology, course fees, availability of learning time and self motivation. The motivational aspect of persuading crew members to use CBT methods to enhance their knowledge and skills needs careful attention. However, distance learning methods combined with IT resources have the potential to extend the regime of learning to both the shipboard environment and the shore based workplace.

Many large commercial businesses today run their own internal 'training centres', utilising distance learning methods, IT and communications technology to full advantage. The potential for a greater collaborative effort between the maritime industry and MET institutions to offer and deliver quality training and/or educational services to those at sea and ashore remains great.

7.8 The seafarer and global connectivity

The growth in the use of the Internet continues at a fast pace. Plans for replacing the current Internet with Next Generation Internet (NGI) are already gathering momentum as the current Internet capacity of IP addresses is rapidly used up. Broadband development has reached the stage where the entire USA Library of Congress could be transferred in just seven seconds! The maritime industry is making great efforts to develop ways of using cyberspace connectivity and multimedia technology for Computer Based Training (CBT) at sea. Many governments have initiated national projects to provide access to broadband technology by the broader community. The capabilities of fibre-optics today almost defy belief. Consider the undersea FLAG Atlantic dual fibre-optic cable with a capability of sending 200 hours of video or 30 million simultaneous clear-voice calls every second! (Hudson, 2000).

Can ships expect to have access to Internet, e-mail and streaming video links anywhere, anytime in the future? Section 5.3.1 provides an overview of the extent to which undersea fibre-optic cables are encircling the globe. But communication links to and from ships at sea are dependent upon satellite systems for coverage of the ship to shore leg of the communications chain. Section 5.3.1 also indicates how future new satellite services have the potential to offer increased broadband capability for ships at sea.

However, the growing use of e-mail and the demand for Internet access is leading to initiatives to provide low cost links to ships by providers such as Rydex, Stratos, EasyLink, Bass and others. This will provide an improved avenue for communication onboard, once ship operators make such services accessible to crew for education and training use.

7.9 Distance learning trials in the maritime environment

The advent of onboard computers for operational needs opens new avenues for learning and skill acquisition. The ability to handle practical tasks and problems can be demonstrated on board. Many practical training programs previously carried out ashore can be transferred to the workplace. Companies and operators can assure themselves that their crews are receiving training with equipment, facilities and procedures on the ship through the introduction of interactive processes for monitoring safety standards via satellite. In the early 1990s, an onboard computer based Liquefied Natural Gas (LNG) interactive training program was jointly developed by the ship operator and the teaching institution for crews of LNG ships operating from the North West Gas Shelf in Australia. Levels of knowledge and understanding of operational procedures shown could be recorded.

The potential for using video technology in delivering training programs onboard from ashore is limited, due to lack of streaming video capability and its cost, although some experiments with video (Wärsilä, 1993) have looked at maintenance and ship operational aspects. The National Technical University (NTU) in the USA, for example, transmits advanced technical and managerial telecourses via satellite to participating companies and their staff, supported by phone, fax and e-mail links to the instructors. In the past decade the number of downlink sites has grown from 16 to in excess of 1000, such spectacular growth being achieved in a cost effective way by digitally compressing their signals at ratios of as high as 12:1 using satellites to deliver across the USA.

A pilot program to monitor onboard deck cadet training programs on selected Australian owned ships commenced late in 1992, with financial support of both Inmarsat and Telstra Australia. Inmarsat/Telstra links and the Enhanced Group Calling (EGC) Fleetnet system were used to monitor the progress of trainees in their onboard task and guided study programs forming part of the watchkeeping officer training through direct links to the Australian Maritime College communications centre. The technical aspects are described in section 5.2.3 on page xxx). The use of Inmarsat-C SES systems on the Australian ships (Inmarsat-A is generally not fitted) meant that messages had to be transmitted either by telex or by data compression techniques. This was quite expensive. In addition, there was resistance by senior officers on the ships to cadets using the Inmarsat system to transmit compressed ASCII files back to the college for marking. However, it did provide speedy feedback to cadets on their assignments and projects in their guided study program (Muirhead, 1994).

The trials showed that, today, in 2002, with the greater flexibility of e-mail and the Internet, such techniques have the potential to be used successfully. There is a large global market for onboard training and education, waiting to be tapped in future using modern technology links, once shipowners and others provide seafarers with the necessary e-mail and Internet links.

7.10 Management and delivery of distance learning via the Internet

As discussed earlier, the classroom is our traditional medium for communication. In the cyberspace learning environment there are no walls, whiteboard, teacher or fellow students! Meanwhile teachers and instructors around the world are grappling with fundamental issues arising from all these technology changes.

- How can we achieve communication if the classroom is taken away?
- Where is our 'virtual' classroom?
- How does it function (for student and teacher)?
- How does the institution support it?

We have seen earlier in sections 7.2 and 7.3 that, for distance learning to be conducted successfully, two key issues are: the creation of relevant and well designed instructional materials (print or electronic format), and the provision of two-way communication. The latter must focus not only on tutor-student links, but also on student-institution links. With the advent of wider accessibility to the Internet and e-mail, the provision of these and other services through technology has led to the creation of the virtual university. As a result, courses delivered via the World Wide Web are increasingly being managed in the fullest academic sense through proprietary software programs.

These systems, coined Web based Education Management Systems or WEMS by Muirhead (2000), come with many of the tools needed to create and distribute online learning materials, to manage enrolments, tuition, conferencing, assessment, feedback, and other registry and administrative functionalities.

One such platform is Lecando, a Swedish system (in English as well as Swedish) that creates an e-learning infrastructure, using either Lecando's server or the institution's server as host. This is used by a number of large businesses and educational institutions. The World Maritime University conducted trials of this system between 2000-2002, and the experiences gained are discussed later. Other systems well entrenched today include Blackboard, WebCT, One Touch, WBT systems (TopClass), LearnDirect, Course in-a-Box, eCollege, Convene, Embanet, WeMentor, and Site4Learning, the latter being focused on the oil and gas industry. In order to establish some form of consensus on what constitutes the necessary features and functionalities of such a system, the section will examine several WEMS products.

Blackboard

According to Blackboard (2002), it was founded in 1997, beginning as a collaboration among a team of students and faculty at Cornell University. Today it has grown into a user base of more than 5.4 million individuals in thousands of institutions in 145 countries worldwide. *Blackboard Learning System* is a Web-based server software platform, that offers course management, an open architecture for customization and interoperability, and a scalable design that allows for integration with student information systems and authentication protocols. Whether it is installed on the institution's server or hosted via Blackboard, the present version includes functionalities such as course management, building block architecture for inter-operability and customization, and advanced integration and system management. The product powers a total "e-education infrastructure" for schools, colleges, universities, and other education providers, using the potential of the Internet .

WebCT

WebCT, which is available in ten major world languages, is the preferred partner of more than 2,500 institutions in 81 countries (WebCT, 2002). *WebCT Campus Edition* is a course management system that enables the institution-wide delivery of on-line education. It features a set of teaching and learning tools, supported by customization and personalization capabilities, student performance tracking features, content management, and scalable standards-based technology (WebCT, 2002)

The advantages of WEMS based course delivery

Based on the experiences of the AMC, and surveys of institutional Web sites offering distance learning, a number of advantages accrue to studying at a distance:

- It overcomes the tyranny of distance and geographical isolation
- It provides ready access to a campus for those committed to a job, at home, at sea or disabled.
- It allows an individual to study at his/her own pace.
- It provides an opportunity for lifelong learning from the home.
- It offers opportunity for further career or income enhancement.

- Virtual universities can offer access to world renowned experts via the virtual auditorium (e.g. Open University-UK offers online lectures for 100,000 users or more)
- The concept of Boxmind (see Figure 7.3) brings expertise in the way of dialogue and supporting multimedia directly to the student.

It should be borne in mind that, however virtual the various offerings are, group and social interactions between students must be retained in some way.

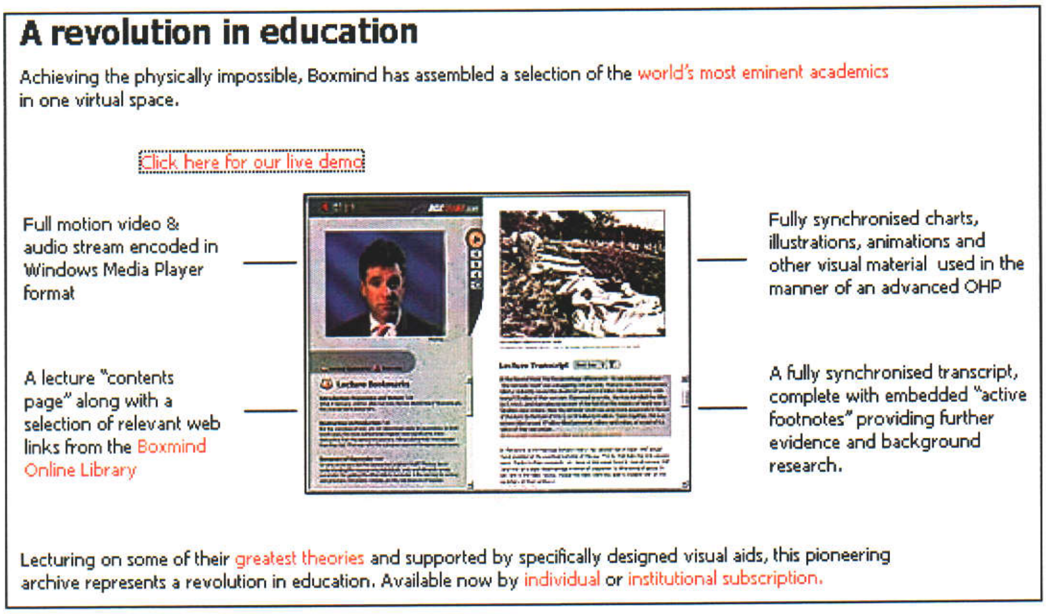


Figure 7.3 The E-lecture (Boxmind.com)

Bearing the foregoing in mind, Internet based communications technology has created new opportunities and strategies for learning in a changing environment by:

- Delivering materials direct online in a user friendly, dynamic and interesting format through the use of graphics, sound and multimedia tools
- Pooling the skills and resources of educationalists, instructional designers and equipment vendors to create a shared platform of knowledge and experience
- Encouraging collaborative learning and teaching processes online
- Creating a link between global sources of information that enhance the needs of the learner.

The disadvantages of WEMS based course delivery

A number of factors were discussed earlier in section 7.2 that mitigate against institutions delivering courses by distance learning. These factors and others may disadvantage delivery through the Internet in the following way:

- On-line instructional materials require special expertise in their creation. Previously mentioned research has shown that few lecturers have been specially trained to create good distance learning materials.
- Students lack awareness of how to study successfully via the Internet. The external learning environment involves 'isolation'.
- Many lecturers are uneasy at dealing with students they cannot see, cannot hear and have little interaction with.
- Lecturers find it difficult to get a feel for the learning styles and attitudes of individuals.
- There is uneasiness about the quality of the delivered product (students).
- Intellectual property rights and copyright restrictions may inhibit sharing or access to learning resources.
- Not all may have access to broadband connections, Internet, e-mail and computing resources.
- Insecurity and lack of validity of examination processes.
- Student access to support offered by the lecturer may be constrained.
- Students take greater responsibility for own learning compared to on-campus students.

It can be concluded that the selection of functionalities for a Web based delivery platform must hinge on certain key elements, such as style of learning (material creation), interaction, student access, assessment and student support services, if the platform is to be effective.

Style of learning requires built-in creative processes for course design to take account of the style of discourse in study guides and supporting learning materials. This should be **individualised** so as to create a communication and interactive environment conducive to self learning (i.e. the provision of personal advice, guidance, explanation and discussion in print, whether in printed mailed form or in electronic form on-line).

Interaction is perhaps the key to successful completion of a course by distance learning. Without it, students can easily become de-motivated, lose their sense of direction to studies, get frustrated and of course become more susceptible to withdrawing from the course.

Student access. What form should it take? How will a student contact a tutor and how is a tutor to arrange links between student(s) and self (e-mail, netchat, netmeeting, etc.). What provision should be in place for those students who lack access to Web based technology for net meetings, net chat? What arrangements can be made for access to library resources via electronic downloads, library loans, etc?

Assessment

The system should be capable of creating test items in various open or closed formats (ranging from essay to multiple choice types) that are most suitable for the learning medium, course objectives and student situation. It should also be able to create examination papers from stored banks of questions. It should consider the reliability, validity, practicality and security issues.

Student Support Services are seen as a central pre-condition to delivery via the Internet. External students have 'less of a voice' regarding their needs and thus interventions may be required on behalf of students. The system should provide a mechanism for prompt response with constructive feedback.

7.11 WEMS systems compared

So how do proprietary Web based systems, available on the market today, compare? What features do they provide and how effective do they appear to be? Drawing upon the previous research of Hall (1999) and Siekmann (2001), Okonna (2001), under the supervision of Muirhead, examined the on-line Web based features of three systems, namely, Blackboard, WebCT and Lecando. For this, access to the Swedish Lecando system at WMU was leased for this research, while Blackboard system. Hall's research shows remarkable consensus between different vendors of what are considered to be key features of WEMS. What Okonna shows in his evaluation of the three systems is that there is some difference in the quality and ease of use of certain features between the systems.

Table 7.4 Rating a WEMS system

System Feature	Blackboard	WebCT	Lecando
Customisation	4.0	4.5	3.5
Course content organisation	4.0	4.0	3.5
Communication tools	4.5	4.0	4.0
Collaboration tools	4.5	3.5	4.0
Assessment	4.0	4.5	3.5
Course and student management tools	4.5	4.5	3.5
Multimedia applications	3.0	3.0	2.0
Language application	2.0	2.0	4.0
Ease of use	4.0	3.5	3.5
Social environment & learning support	4.0	4.0	3.5
Average	**3.85**	**3.75**	**3.45**

Note: 1=low strength; 5=high strength Source: Okonna, 2001, p59

The Lecando system was examined in some detail, as it was subjected to a working course model under trial conditions, using academic staff and students at WMU. A number of concerns were raised and are summarised below:

Faculty

- Time and effort was needed to prepare materials
- Producing educational packages for the Web required personnel experienced in distance learning development
- A large proportion of potential students may not be able to access technology that would allow them to undertake distance learning
- Credits earned for distance learning should be the same as for full-time on-campus courses
- Academic staff may want financial compensation for placing their intellectual property in the public domain.

Students

- Many were concerned at the lack of access to Internet technology in developing countries
- Maritime industry would benefit from delivery of courses via such a medium
- Web based education would be an additional load on work and home demands
- The matter of electronic fraud is of concern.

Several points above illustrate the international nature of the WMU student body and reflect one of the features of the survey in chapter 3, the low level of interest in delivering maritime courses by distance learning in the Asia-Pacific region. The lack of provision of enabling technology is a major inhibitor to extension of such services in many parts of the globe.

The overall impression from the research is that WEMS systems available in the market place are generally well structured and supported by a good selection of functional features, with some having more developed or enhanced features than others. Following the trials, Lecando made a number of improvements to their program. It is worth reiterating at this point, the announcement by MIT and Stanford University in April, 2001, to put on-line a free academic version of a Web based education management system. This is expected to be available at the end of 2003. This could be the catalyst for smaller institutions to consider their involvement in distance learning delivery in future.

7.12 Summary

Many education institutions are aware of the need to change and are experimenting with new approaches, as discussed earlier. Many are trying multimedia based programs, both on and off campus. Digitized versions of conventional courses are being prepared. Students solve problems in a smaller and more intimate learning environment, instead of sitting in an impersonal passive learning environment in a large lecture hall. In Australia, students can already enrol in postgraduate distance learning programs in port and shipping management utilising instructional material, Internet, e-mail and tele-conferencing, without having to step inside the institution. Video links are now common in the large remote areas of Australia and Northern

Sweden, for example. The trend towards the virtual campus is accelerating daily. Why should the mariner not be able to take a degree at sea via an Open Learning University or delivering maritime academy in future?

An institution such as The World Maritime University is considering the impact of technology upon its methods of delivering its programs. For example, special lectures by its visiting experts could be transmitted via the web to regional maritime centres around the world. Semester 1 foundation study subjects and modules could be taken by a student via distance learning in a home or regional environment, thus reducing the time spent on campus in Sweden. Today, in 2002, the university has the technology in place. What it does not have yet is the expertise to design and produce electronic on-line study materials suitable for delivery through cyberspace. This has been identified by many MET institutions as the biggest drawback to further progress. Human resource training and development of these skills is the next step for WMU and global MET institutions in general.

Overall, there is no reason why many aspects of training on a ship cannot be carried out through the supportive medium of distance learning. With clearly structured self-study guides, supported by a range of multimedia instructional materials, the real constraints are developmental costs, access to computing and communications technology, availability of time and self motivation. Although the argument of communication costs will invariably arise, the signs are that economies of scale, resulting from the introduction of new communications and information technology will soon negate such arguments. The need by shipowners to meet training requirements in the ISM Code and STCW 95 raises the opportunity for the industry to engage in some innovative thinking!

The immediate benefit to the maritime community of using technology is the greatly reduced cost of such programs and training, and the ability to transfer many training aspects back to the shipboard environment. The motivational aspect of persuading crew members to use CBT methods to enhance their knowledge and skills in off watch time probably has received less attention than is warranted. How individuals can be monitored for competency standards presents a further problem, but distance education methods combined with IT resources, have the potential to extend the regime of learning and training to the shipboard environment and help raise safety standards as well as crew morale.

The means of delivering courses by distance learning is moving steadily from a traditional print and mail out system, to an all encompassing on-line web based electronic system, complete with communication tools, access to libraries and built-in assessment and feedback facilities. Many vendors are increasingly incorporating the administrative and registry tools to manage enrolments, results and grades. Many vendor systems were developed initially with businesses in mind and structures reflected these needs. Academic requirements, additionally focused on assessment and grading were late in being attended to. This led to the previously mentioned initiative by MIT and Stanford University to develop a free on-line academic WEMS model. As the cost of leasing some systems is quite out of reach for many small maritime institutions, this is a welcome initiative. WMU plans to develop its own WEMS, building on the excellent Intranet developed since 2001. Figure 7.4 illustrates the working features of the system that provides information to both staff and students on studies, results and progression.

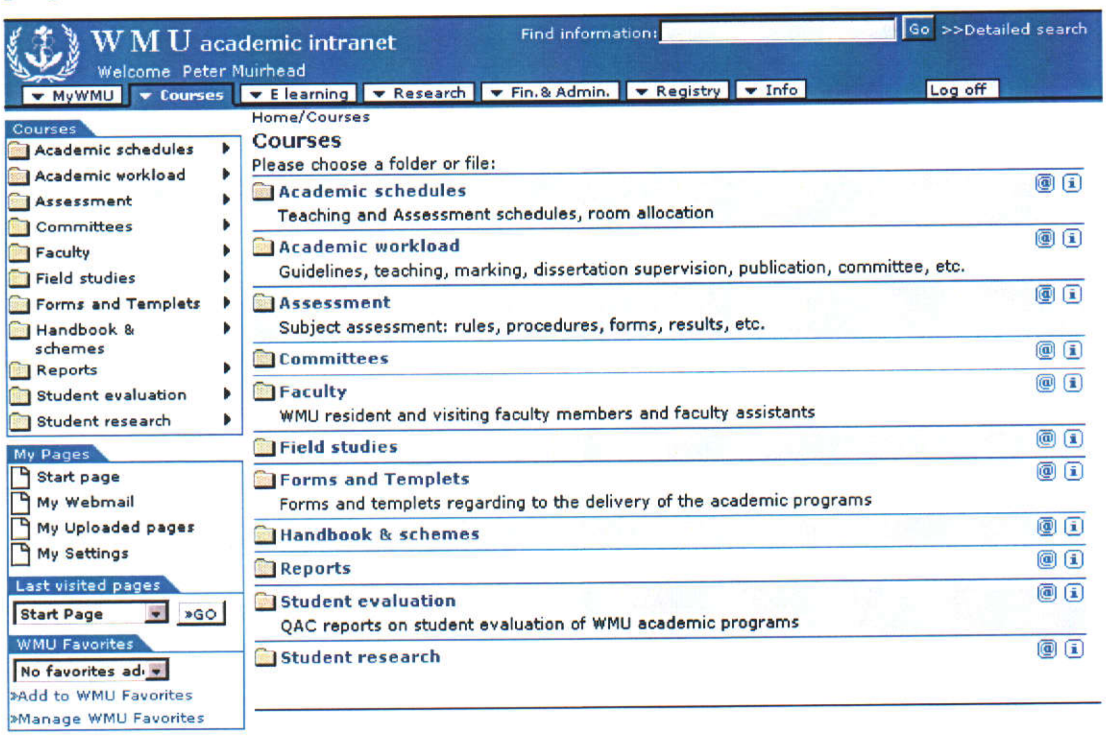


Figure 7.4 World Maritime University Intranet (September 2002)

Thus, the picture painted is one of challenge to existing educational methods, concepts and ideas. It is said that education should never stand still. Based on the evidence, the study concludes that reforms of present educational thinking and practices will grow exponentially in the next few years, with cyberspace learning systems increasingly overtaking traditional university approaches to delivery of education and training.

One interesting result of this likely paradigm shift is the impact this is having on traditional assessment methodologies and procedures. What role will technology play in the scheme of things? Already there are considerable misgivings and rumblings by many in the academic community regarding the issue of assessment, and of how quality can be assured in this brave new learning environment. Chapter 8 examines some of the issues of using computers and simulation for assessment purposes.

Chapter 8

ASSESSMENT AND THE USE OF NEW TECHNOLOGY

8.1 Introduction

A key aspect of any training course structure is considering how to assess and evaluate the performance of trainees. As Fisher (2001, p.18) has pointed out, this task is made easier if the course objectives are clear and point the way to selecting the most appropriate form of evaluation. What is important to remember is that the assessment of trainees must be aligned with the course content and the objectives. What the instructor aims to teach, what is actually taught, and what trainees achieve and demonstrate in the evaluation process should match as closely as possible.

It needs to be borne in mind that poor performance of trainees may be the result of objectives that were too difficult or inappropriate, poor content selection, inadequate teaching methods or learning materials, or unsuitable assessment methods. The latter is often a major reason behind the apparent uncertainty surrounding the use of modern technology to assess performance. Whether delivered in a classroom setting, or used by a student individually through pre-prepared self-study learning materials, the fundamental principles remain the same.

The increasing need for appropriate assessment methods in marine simulation, for example, was one of the subjects of a special STCW seminar in 1994 at the World Maritime University, at a time when the review process of the STCW 1978 Convention was in full swing. The long tradition of acquiring experience (and thus competence) through completing practical training time at sea was made increasingly unworkable in the 1980s and 1990s by factors such as reductions in mandatory sea service, smaller crews (officers having less time to supervise trainees), faster turn round times and the reduced availability of dedicated training vessels. As Zade (1994, p. 4) pointed out, training for and assessment of shipboard competence rested more than ever with maritime academies.

Zade also noted that the switch to front-entry maritime training systems had further widened the gulf between acquired training experiences and demands of the workplace, and put increasing pressure on maritime academies to find new ways and means to ensure that trainee officers could take over shipboard duties as soon as possible following graduation. A spate of serious marine casualties and loss of life at sea in the 1980s and early 1990s also lent urgency to the task of narrowing down any training and assessment disparities between those used at maritime academies and the consequent standards required for safe operations at sea.

While recognising that the training-workplace division will never be completely closed, both Zade and Muirhead (1994) put forward the argument that marine simulators can be used to provide training in many practical areas that are so close to real shipboard practice that a transfer of training becomes possible. From this, it also follows that simulators have a high potential to be used for the assessment of competence. This is further strengthened by the increased trend for maritime academies to use criterion-referenced, rather than norm-referenced forms of assessment in their certificate of competency courses. As Zade (1994, p. 4) points out, “a student's performance in safety subjects should be assessed with reference to a minimum standard of performance rather than to the trainee's previous performance or the performance of other students”.

Teachers have a variety of methods of measurement available to them. The mastery approach, in which the instructor sets up pre-established competencies and acceptable levels of attainment, has commonly been used to assess competence in many practical maritime subjects. Skills based training techniques normally utilise such principles. Success in the subject may be partly or totally determined by the performance level (i.e. mastery) attained by the trainee.

The use of computer based training (CBT) methods for assessment raises other issues. Many developers of CBT software are incorporating self-assessment or test modules within the programs. Using tests as a tool to establish that training objectives have been met is very important. Using such tools to measure a level of performance or competence, an ability to perform to standards or acquire practical skills, however, needs to be considered with great care. Is the chosen methodology appropriate? Have the questions been subjected to independent review for reliability and validity? Who has conducted the process? Have the assessment programs been subjected to academic quality assurance processes? In the case of certificate of competency recognition, are the programs approved by the relevant maritime training authority? Who is going to oversee assessment programs onboard – ships' officers, company training managers, academic institutions or maritime authorities? The previously mentioned DMI onboard simulation training system called 'SimFlex' has the potential to allow cadets on ships to be supervised by an external instructor. How can this connectivity be exploited effectively to assess competence onboard the ship? The issues of reliability and validity of CBT created tests are very important if the methods employed are to be widely acceptable, and are considered in the next section.

8.2 Reliability, validity and practicality

Based on personal experience, gained from examining a number of maritime software assessment programs, it is evident that the issues of reliability, validity and practicality in relation to built-in test items are not given sufficient attention. Whatever the form of assessment employed, the methods must be as reliable, valid and practical as possible, if the quality of the methods used is to be ensured. A brief examination of these three important elements illustrates their important role in underpinning any practical tests or assessment conducted through modern technology.

Reliability

The reliability of a practical test is the consistency with which the test measures what it set out to measure. Reliable assessment gives confidence that the outcomes of performance are applied consistently from trainee to trainee and from situation to situation. Major causes of poor reliability of a test are a lack of reliability of the practical test process itself and inconsistency in assessing outcomes.

Validity

A practical test is valid if it measures what it is supposed to measure. By closely relating assessment tasks with course objectives and content, it is possible to ensure that all measurement methods are valid. A close match will ensure validity of tests. Fisher (2001, p. 89) has described the options with the two factors as follows:

If reliability and validity are considered together, it is possible to have four combinations of the two terms. When a test is invalid and unreliable it does not measure what it is supposed to measure nor does it give the same result on different occasions. Obviously, it would not be a good idea to depend on the results of such a test. If the test is invalid but reliable it is consistently measuring the wrong thing and again is of little value. It is really not possible to have an unreliable and valid test because, if the test is producing different results each time, it means it must be measuring something different each time, and is therefore, almost never measuring what it should be measuring. Thus, it must be invalid. A valid and reliable test is something for which to aim.

Figure 8.1 illustrates clearly the difference between an event being reliable, valid or neither reliable nor valid.

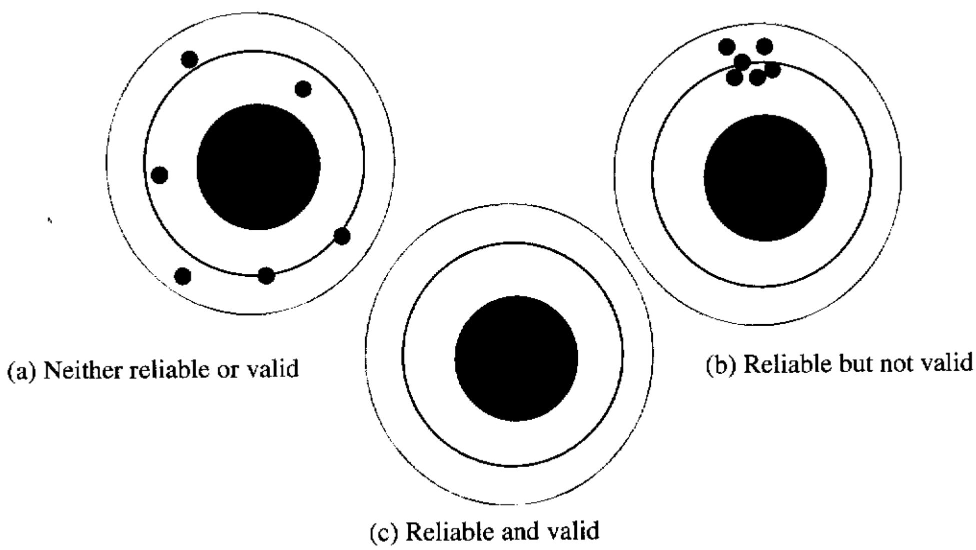


Figure 8.1 Aiming for the target: A picture of reliability and validity

Practicality

This aspect requires careful thought when it comes to using computers or simulators for assessment. Are the proposed assessment tasks and functions possible (i.e. availability of scenario, ship models, environment, operational fidelity) with the resources available? Will the facility be available when required? How many students are there to assess? Is this to be carried out individually or in groups? Time constraints are also an important consideration. Can trainees complete all performance tasks expected of them in the time allocated? Can the instructor validly observe, measure and evaluate performance in the conditions set or available? Can a student be assessed and be provided with effective feedback in a computer based learning environment?

Some of these aspects were considered by the consultant group in drawing up the relevant STCW 95 Regulations and Codes covering the use of simulation and are discussed later.

8.3 Computer-based assessment

The advent of computer-based instruction (CBI) has also resulted in computer-based measurement and assessment. This may be for the purpose of feedback to the student, recording of formal performance for progression through a course of study, or assessment of competence. This may take the form of computer-marked multiple-choice test papers, which take away the tedium of identifying marks on answer sheets. By reading and recording the correct marks via an automatic form, computer scanning devices can score the results and carry out any required data analysis. Computer databases can also be used to generate alternative versions of papers from question item banks by randomly selecting questions from defined topic areas, as described later. The development of computer generated problems and interactive teaching programs with built-in recording of student responses overcomes the difficulty of the instructor finding the time to devise and set a large enough number of unique problems and solutions. Such programs can also be used to provide feedback to students by not only providing correct scores, but by offering solutions to those they got wrong.

Tests are available which are highly objective in structure, and which are aimed at subject or topic mastery. Such skills, or task-based training, ensure that each stage is mastered (high pass marks are set) before the student is permitted to progress further. Software programs now available allow the development of sophisticated computer aided learning (CAL) or computer based instruction (CBI) programs, with a high degree of interaction between student and the program. Authoring tools, such as Macromedia Authorware and Director 8.5, and WEMS programs, such as Blackboard, WebCT and Lecando, provide built-in assessment platforms where objective test items can be entered, solutions provided for feedback, or examinations randomly generated from a databank of questions. Increasingly, software developers of maritime CBT programs include self-testing facilities for a trainee or student to establish how they are doing. Some examples will be examined later.

Arguments for a Global Computer Based Question Databank

The matter of developing and distributing an examination question bank to maritime institutes around the world has been considered for some years. Some countries have used a databank of multiple-choice or short answer questions in examinations for certificates of competency (e.g. United States Coast Guard), or for internal assessment (Arab Academy, Egypt). IMO technical funding sources and private commercial interests have aided individual projects, such as the Government examination system run by the Professional Regulation Commission (PRC) and the Maritime Industry Association (MARINA) authorities in the Philippines. However, many of the older questions in the databanks show signs of being either out of date, having been left behind by the changes to STCW 95 Convention, or having been developed for particular customer needs.

In 1996, following the completion of the revision process of the STCW Convention, the IMO considered the possibility of establishing a global databank and examination system to serve as a minimum STCW benchmark standard for those countries lacking either an examination system or the administrative infrastructure to operate and administer a secure system (Muirhead, 1997). Unfortunately, a number of difficulties, such as national priorities, problems of varying language requirements, access to and control of a standard global database, and lack of funding, got in the way of creating such a system. However, it is relevant to this chapter to examine the fundamentals of such a global system, which could contribute towards a benchmark for global standards of competency.

Of course, for a global system to work effectively, users must both accept it and have confidence in the reliability and validity of examination outcomes. Some form of international board of management of a database would be required. In addition, the system would have to be regularly reviewed and updated through a central manager, using feedback from users, and taking into account changes in operations, technology and legislation as the years passed. This raises the further problem of committing further funding for regular upgrading and distribution of revised databases to users.

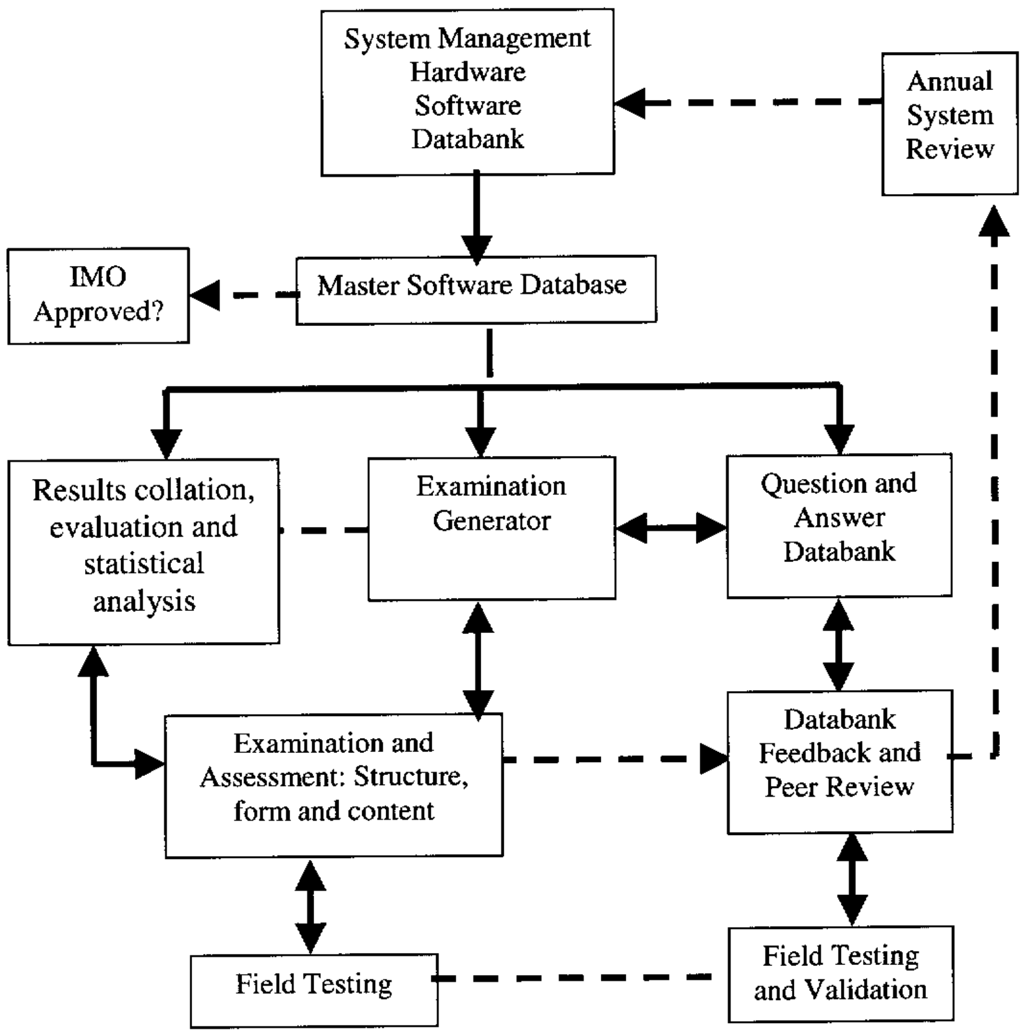
For a system to be both secure and of uniform global STCW standard (i.e. a minimum level), changes to the database could, practically, only be carried out under the auspices of the contracted system manager. Password protection would provide authorities with security from unauthorised entry to data and records held.

Muirhead (1997, pp. 1-2) considered that the objectives of such a system would be as follows:

1. To provide developing countries in particular, and other users, as required, with a standardised global computer-based question and answer bank and examination generator to assist in implementing the competency requirements of the revised STCW 78 Convention.
2. To provide users with a secure examination system.
3. To provide academic administrations and/or examination authorities with a statistical record of results for incorporation within a records registry.
4. To assist in the establishment of global quality assurance standards.

Question and answer design and structure would be focused on providing coverage of knowledge and understanding competencies, but with particular emphasis on evaluating ability to perform tasks and functions, where the subject and database technology permit this. However, its main function would be as a random or selective examination generator in specific functional safety and operational subjects and topics.

It was estimated that a total of 49 subject areas could be developed as sub-sections in the database for both STCW 95 deck and engineer operational and management levels. Some could be merged into a common area. It was also estimated that some 6,000 to 8,000 questions and answers would need to be placed into the database, if effective coverage was to be achieved. The main considerations of any system were considered to be global usage, ease of use, system flexibility, acceptability and validity, low maintenance, easy to update and minimal capital cost. Figure 8.2 shows a schematic layout for such a system.



Source: Modified from Muirhead, 1997

Figure 8.2 Schematic framework for a global computer based question databank

The system functionalities identified by Muirhead (1997, pp. 4-5) were as follows:

1. Computer testing of knowledge and understanding
2. Computer testing of ability to perform tasks or functions
3. Creation of various forms of assessment:
   - written examination papers (open type: essay, short answer)
   - written examination papers (calculations, problem solving)
   - written examination papers (closed type: multi-choice, true/false)
   - combinations of the above

- oral examination questions

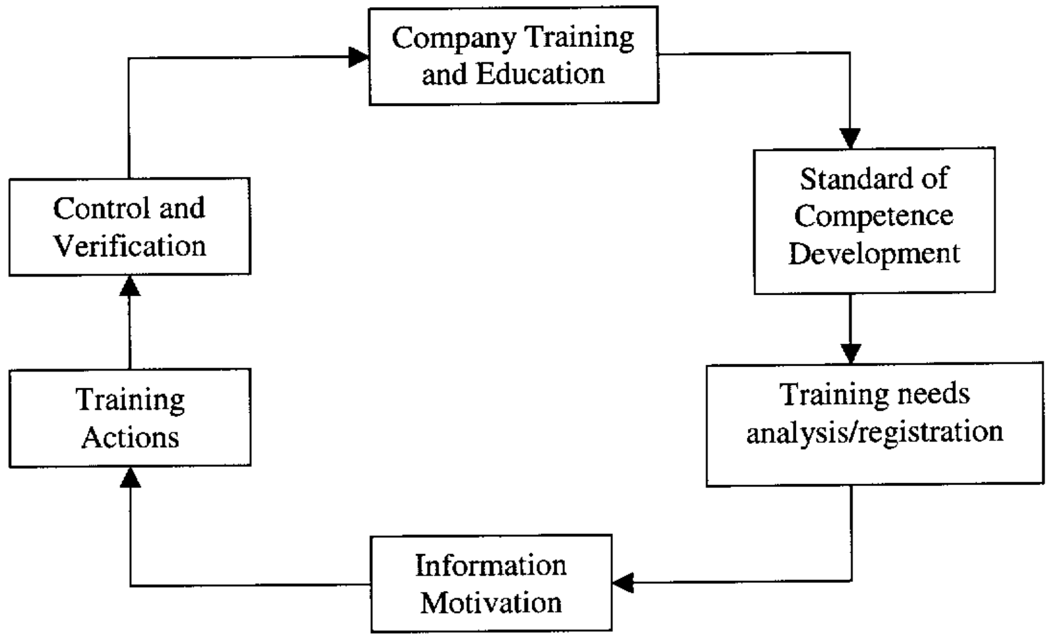
4. The importation of bit images (drawings, figures) for Q and A
5. The selection of questions by function, type, subject, section or item
6. The use of random selection processes for assessment items
7. Printout of exams, by function, type, subject, section, mix, or item
8. Edit and update the database through addition/deletion/transfer/ modification of subjects, sections, questions and answers.
9. Provide results in statistical and/or graphical format for evaluation and record purposes by examination, subject or item. (administrative tool)
10. Support the assessment of applied skills where appropriate and valid
11. Provide for system security.
12. Provide a databank of questions and answers to cover identified functions and tasks relating to levels and grades of certificate of competency required by STCW Chapters II-III and Code A tables.
13. Be produced in the English language.
14. Capable of use within Windows XX environment or networks.

Developments in maritime CBT

Other important CBT developments were taking place during the 1990s. Norwegian shipowners have always been at the forefront of developing new technology for more effective and safer ship operations. In 1994, the Research Council of Norway initiated a three year project called Information Technology in Ship Technology involving shipowners, suppliers, Det Norske Veritas, Norwegian Maritime Directorate, Marintek and education institutions. Among the various activities was a sub-project called Training, Recruiting and Selection, the objective of which was "to develop and implement better ship specific training systems and tools for competence assessment" (RCN, 1995).

Shipping companies Barber International, T.Klaveness & Co and Stolt-Nielsen (Manila), participated in a user evaluation of reliability and validity of the then Norcontrol developed Competence Evaluation System (CES 2000). One outcome of this project, reported by Berg (1996, p. 3-4), was the implementation by the shipowners of new training activities to fulfil policy statements made under their Safety

Management Systems regarding personnel competence. Figure 8.3 shows the baseline developed for an improved training system.



Source: Berg (1996, p. 4)

Figure 8.3 Baseline for an improved training system

First experiences evolved around the use of some 20 CBT programs by vessels of the Red Hand shipping company. Officers and crews viewed the materials with some suspicion at first, especially crew members, in regard to achievement scores from the module questions. However, once it was noted that scores were provided as measures of knowledge gained from the programs, and did not inhibit further attempts, confidence improved. The main advantage observed from the project was that CBT modules were used to enhance on-the-job training, while the placing of assessment tests into the program was seen as part of the training, the latter apparently making assessment seem less daunting to crew members. As a result of the five year program, it was reported in 1999 (Marintek, 1999) that the project had resulted in two companies, Red Hand and Bona, using CBT onboard in a big way, while Bergesen and Klaveness decided to introduce CBT on all their ships. In 1997, Seagull AS took over the CBT business of Norcontrol, and has continued to develop CBT modules for the industry, as noted earlier in Chapter 6. Much of the operational experiences gained by Red Hand and other Norwegian companies with these early modules has led to further improvements in the CES 2000 evaluation program, resulting in version CES 4.1 today (2002). A group of shipowners, led by Bona, developed a performance profile program (PPRO) containing special question sets for main categories of ship personnel. The purpose was to provide competency evaluation in job situations. This concept is now embedded into CES 4.1. Chapter 6 noted that a second project called the Information Technology in Ship Operation Program (ITSOP), led by Marintek over the period 1997-2001, continued many of these foregoing developments.

Edmonds (1992) described how situation feedback was provided to the student by access to an expert system in an innovative PC based training program, called 'Officer of the Watch' (PC Maritime). By responding to questions as they were generated during an exercise, further feedback could be obtained from an activity log where the results were recorded. This model has been adopted in different guises by others (e.g. Transas, Poseidon) today. McCallum et al (1995) described research into the development of an Interactive Rule of the Road Tester (IRORT) designed to replace the USCG multiple choice licensing exams, by creating a real-time operational context, thus enhancing the validity and diagnostic value of USCG examinations. The following conclusions were noted by McCallum et al. (1995, p. 9-10):

1. PC simulators can support the development of an IRORT
2. Scoring procedures are best managed by using a structured modified Delphi technique to performance criteria
3. The use of automated scoring routines was feasible for a wide variety of secondary performance measures
4. PC based testing allows complex scoring algorithms to be used, further enhancing validity
5. An IRORT measures additional aspects of knowledge and skills, not measurable in a writtten exam.

Videotel Ltd has a well established program, called the Seafarers Evaluation and Training System (SETS), which incorporates computer based testing features. The Mandatory Educational Enhanced Training System (MEETS-STCW), also by Videotel Ltd, is another very extensive CBT program, based on the ISF training record book. Each module is provided with a self-testing facility. Other vendors offering maritime related CBT modules on CD-Rom today with built-in assessment programs (usually based on closed, objective, multiple-choice test items) include companies such as Poseidon, MGI-International, Corifs and Boxer Technologies.

There is no doubt that the maritime industry has taken a quantum leap in the past five years in accepting that CBT training and assessment is capable of producing enhanced value in training, as well as providing further assurance of the competence and operational capability of both new and existing seafarers it employs. Johansen (2001, p. 10) summed it up recently from both a customer and developer perspective, when he said:

> Computer based training and assessment is a unique tool to cover parts of the training needs in today's maritime industry. It offers more efficient learning in some areas and reduced costs in others. It may help shipping companies to identify training needs and to identify seafarers who should not be on their ships at all. In order to succeed, however, the shipping companies must do their homework, prepare carefully, demonstrate to the seafarers that the plan for the use of CBT is well thought out, demonstrate long term persistent support from the senior management, set goals and evaluate results. The developers of CBT must be able to demonstrate that they are aware of the immense strengths, as well as the weaknesses of CBT. They must demonstrate they are reviewing the evaluation reports from the users and that they have the resources to continuously improve the product.

Perhaps the best indication, that CBT has achieved acceptability in the maritime training sphere, is the recognition by the Norwegian Maritime Directorate in 2000, that CBT can be used within STCW 95 required education and training.

Examples of CBT assessment

Most assessment programs to be found in CBT modules are reliant upon objective test items, constructed from a range of multiple choice, true-false, matching, completion (drag and drop technique may be used here) and short answer response types. The format, while providing good coverage of knowledge of a subject, does not lend itself to any marked cognitive understanding of why a student chose a particular response. While easy to mark, multiple choice items, for example, are the most difficult to construct, the quality of distractors being noticeably poor in many of the examples to be found. There is a need to improve reliability and validity processes.

Videotel

SETS is a powerful Windows based tool designed to test and evaluate seafarer knowledge in support of recruitment, promotion and periodic assessment aspects. The package asks seafarers questions from a very large question databank. Questions can be selected to a candidate's position onboard, according and focused on particular subject areas such as radar, basic marine engineering and rule of the road. Responses are recorded and displayed in a variety of layouts. Questions can be enhanced by the addition of graphics, drawings, pictures and video clips. SETS offers three modes, namely Test, Tutorial and Administration. In TEST mode, all questions have to be answered to complete a test module. In TUTORIAL mode, two chances are provided to respond to a question before the correct answer is shown. The question databank has been developed by practising seafarers and trainers.

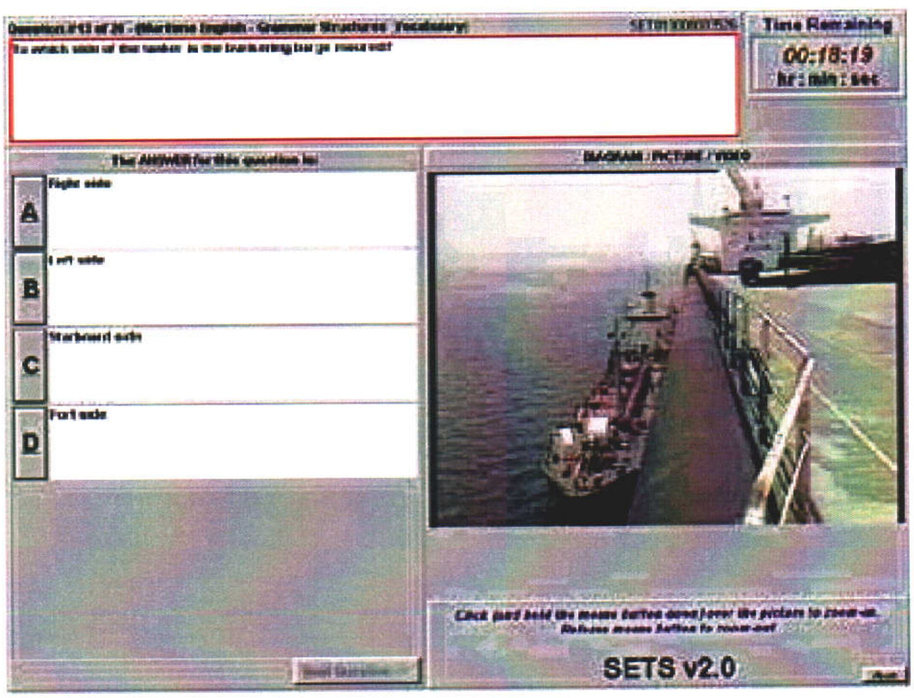
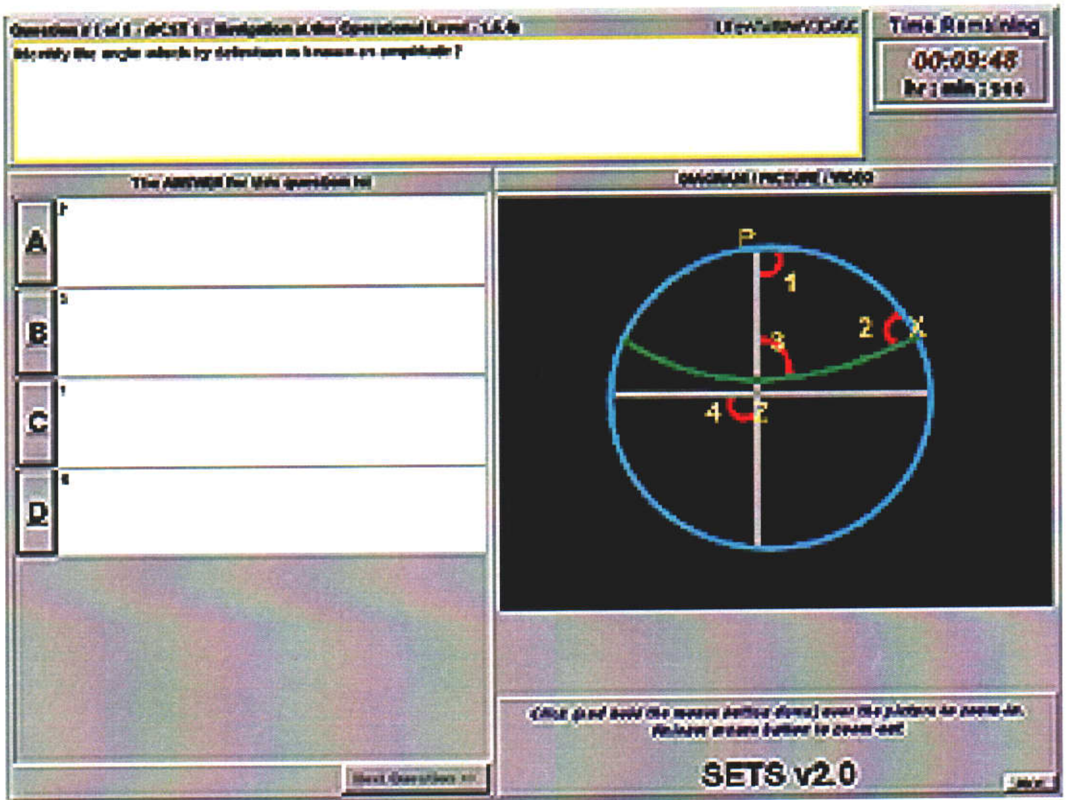


Figure 8.4 SETS self-tests using video

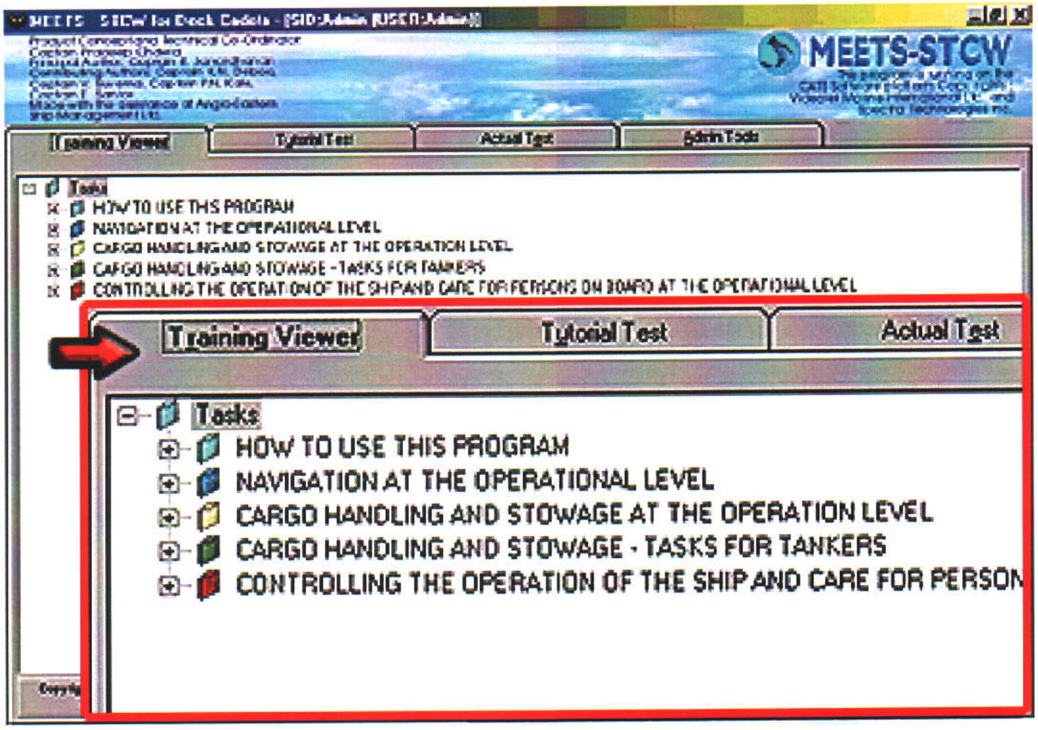
The system is also supported by a Question Designer tool that allows the user to construct questions and answers. Two structural examples from Videotel's SETS program show built-in assessment questions using a video clip (Figure 8.4 above) and graphics (Figure 8.5 below) as a basis for making a response.



Source: Videotel Ltd 2002

Figure 8.5 SETS self-tests using graphics

MEETS, mentioned earlier, is another innovative Videotel approach to onboard training using CBT. This extensive program, with more than 430 chapters, and using a mixture of 1700 text pages, 2,100 pictures and 60 video clips, has been structured around the ISF cadet training record book as a self-study training program. The extent of coverage is impressive, with all 360 tasks relating to STCW functional needs for deck watchkeepers included. Self-test questions, either in tutorial mode or as a topic test, are provided for all tasks the trainee has to complete. Although the computer records the trainee's progress as tasks are completed, the tests appear to be more focused on providing feedback on trainee understanding of completed tasks and for recording progress, rather than assessing a trainee's ability to perform tasks and functions safely and effectively (the STCW test of competence).

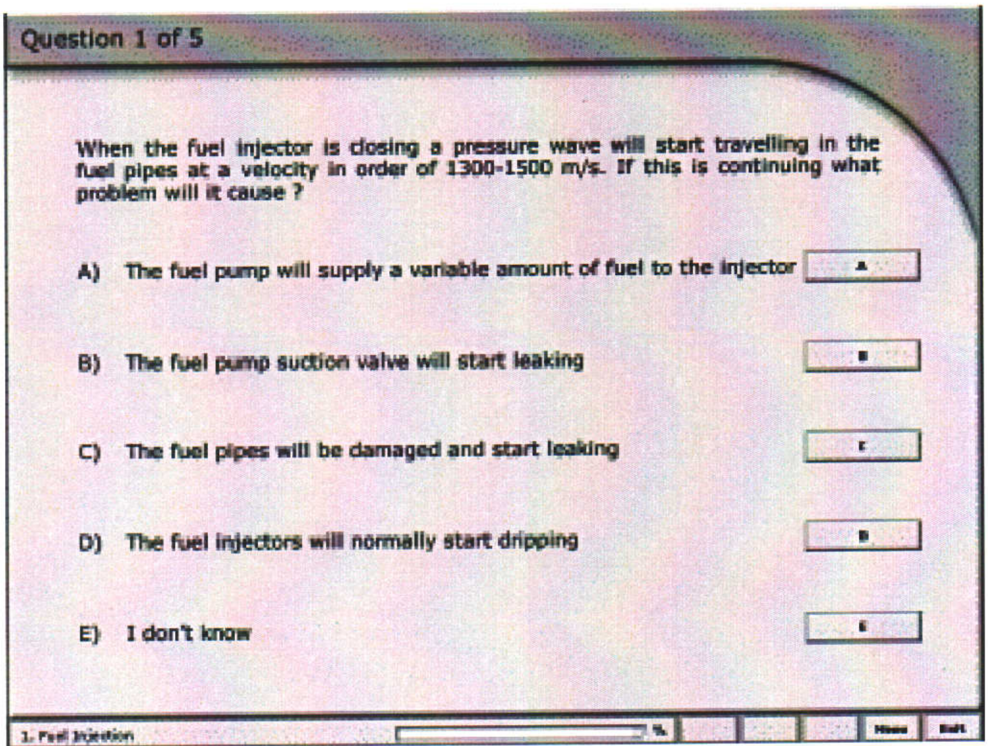


Source: Videotel Ltd, 2002

Figure 8.6 MEETS-STCW Window to training and assessment modules

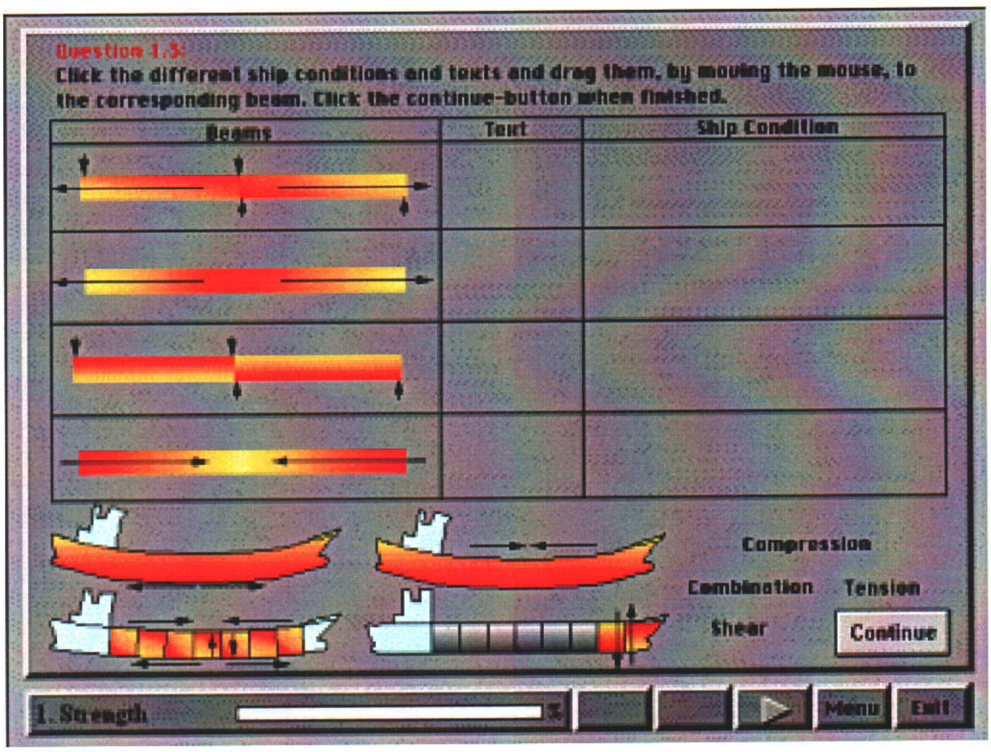
Seagull AS

As mentioned in Chapter 6, this company has followed a clear plan, since 1997, to create and put onto CD-Rom a suite of course titles that provides coverage of all STCW functional requirements as well as additional areas such as maritime English. Directed towards Norwegian shipping companies initially, over 90 titles were available by November 2002 with further offerings in the pipeline. Many of these programs have been produced in cooperation with the shipping industry and manufacturers of marine equipment. Users can lease or buy individual sets to suit particular training needs. Over 1200 ships and 50 academies are using a range of the programs. Most titles are provided with self-testing modules, leaning particularly on multiple-choice questions or mix and match. Figures 8.7 and 8.8 from Seagull and Figure 8.9 from UNITEST illustrate three further approaches taken to testing knowledge and understanding using CBT. Examination of other CBT modules offered by different developers reinforces the earlier stated view that there is still scope for improvement in the reliability and validity of questions and answers provided.



Source: Ringstad, 2002

Figure 8.7 Multiple-choice test item

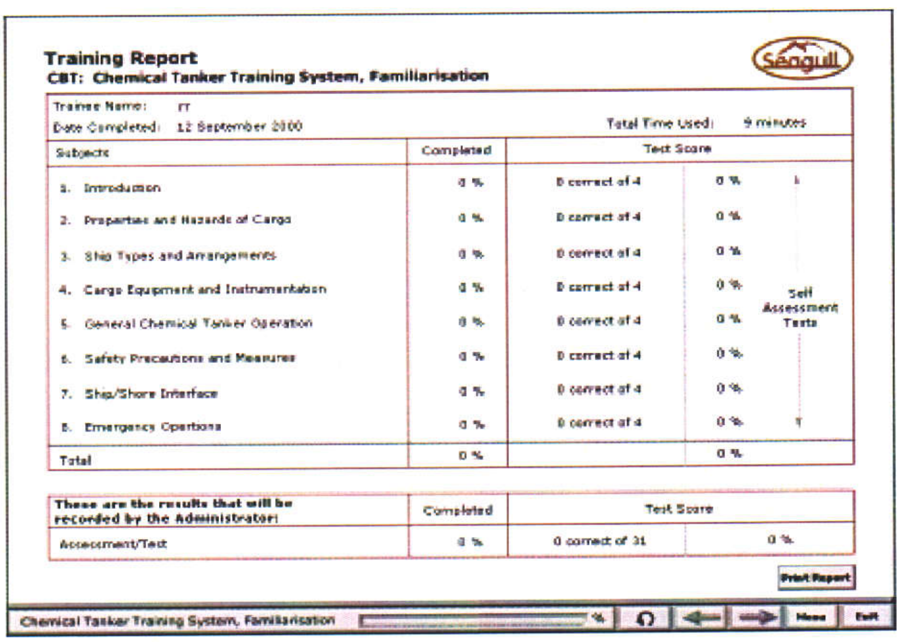


Source: Ringstad, 2002

Figure 8.8 Matching item: drag and drop

Figure 8.9 Multiple-choice test item from UNITEST

The Seagull training report, shown in Figure 8.10, provides a record of each individual trainee's activities in relation to the subjects undertaken, extent of personal progress and levels of achievement. The record also notes what has been completed and what remains outstanding.



Training Report
CBT: Chemical Tanker Training System, Familiarisation

Seagull

Trainee Name: IT
Date Completed: 12 September 2000
Total Time Used: 9 minutes

Subjects	Completed	Test Score		
1. Introduction	0 %	0 correct of 4	0 %	Self Assessment Tests
2. Properties and Hazards of Cargo	0 %	0 correct of 4	0 %	
3. Ship Types and Arrangements	0 %	0 correct of 4	0 %	
4. Cargo Equipment and Instrumentation	0 %	0 correct of 4	0 %	
5. General Chemical Tanker Operation	0 %	0 correct of 4	0 %	
6. Safety Precautions and Measures	0 %	0 correct of 4	0 %	
7. Ship/Shore Interface	0 %	0 correct of 4	0 %	
8. Emergency Opertions	0 %	0 correct of 4	0 %	
Total	0 %		0 %	

These are the results that will be recorded by the Administrator:	Completed	Test Score	
Assessment/Test	0 %	0 correct of 31	0 %

Print Report

Chemical Tanker Training System, Familiarisation % Menu Exit

Source: Ringstad, 2002

Figure 8.10 Seagull training record - trainee progress

8.4 Simulator based assessment

Simulators offer close-to-reality training for many important safety and operationally related tasks without any physical risk to the ship or trainee. Without such practical facilities, competence in such tasks is often accepted by examiners on a demonstration of knowledge but without any hands-on proof of ability to perform. In other words, it is assumed but not demonstrated. However, in deciding to use simulators to measure performance, the danger is that in judging the competence of an individual to perform tasks effectively, the assessor relies too much on subjective, and not objective, criteria.

It greatly assists the validation of any performance if clear criterion-based objectives are in place. The difficulty in the formulation of a competent performance standard is its mainly qualitative nature. For many tasks a mix of quantitative and qualitative parameters needs to be applied. Comparison with shipboard operations is necessary in setting the assessment criteria, if confidence in the ability of the candidate to use such skills onboard is to be achieved.

The assessor will need to ask the following questions:

- Did the individual performance meet the designed assessment criteria?
- Did interaction with others on the team meet designed behavioural objectives?
- Has the candidate demonstrated that he/she can perform the given tasks safely and effectively?

In the final analysis, the assessor must consider whether the chosen criteria of performance is reliable and relevant to the training tasks, and the results are iterative (i.e. repeatable) in nature.

It is worth remembering, however, that an important element of real life tasks, stress, may be missing, usually because it is difficult to simulate successfully. Whilst high fidelity simulation systems today allow for many 'extra' features to be provided and thus the enhancement of the scenario, instructors should be careful in using them to develop unrealistic stress levels. No matter how high the level of reality, on the job experience afterwards is most desirable.

Background to simulator assessment

By 1970, radar/navigation simulators had been in operation for a decade, the focus being very much centred on training in the correct use of radar (later ARPA as well) and the interpretation of information derived from it. Early developments with shiphandling simulation started in the late 1960s in Japan and Sweden, with television projection systems. The Netherlands and the UK installed shadowgraph nocturnal systems between 1968-1978. Modelboard systems, derived from the airline industry, made their mark in the 1970s in New York and in the Netherlands. Slide projection systems were also in vogue in Germany, Norway, Netherlands and Japan, at this time. The emphasis was on training, particularly as many of the systems were constrained to this role by technical limitations of the simulation technology (Muirhead, 1985). The advent and growing availability of high powered computers and increased memory led to the establishment by the US Maritime Administration (MARAD) of the first computer generated imagery (CGI) shiphandling simulator system, called Computer Aided Operations Research Facility (CAORF) at Kings Point, New York in 1975. Considered a watershed in evolution as the world's first 'full mission' shiphandling simulator, CAORF led the way to other similar systems being installed in many parts of the world (Puglisi, 1987, p. 11). The table in Appendix D shows the growth of 'full mission' or visual computer generated image (CGI) simulators over the past 25 years. Figure 8.11 shows a typical example.

Figure 8.11 Full mission shiphandling simulator (STN-Atlas, ISSUS, Hamburg)

As simulators became increasingly sophisticated, resulting in a greater functionality and capability, training activities were extended, and the potential of simulation as an assessment tool started to be considered more seriously by researchers and operators. Gynther, Hammell, Grasso & Pittsley (1982) concluded, early on, that it was difficult to establish reliable objective performance measures in relation to shiphandling. Their view was that precise characteristics of good shiphandling were difficult to define. Reeve and Hurst (1984, p. 113) had some difficulty in quantifying achievement levels in some scoring schemes (on a performed/not performed basis) that they had tested with British Royal Navy officers. Other work by Tin Hlaing (1984) further reinforced the view that monitoring performance by scoring was a problem. While agreeing that shiphandling was not an exact science, Muirhead (1987) argued that a professional performance carried out in a seamanlike manner could be gauged against a careful selection of criterion based objectives, supported by subjective experiences of the assessors. His extensive research centred on establishing criteria of performance, against which the seamanlike quality of the manoeuvre, or manoeuvres, could be judged.

Gardinier and Hammell (1981, p. 5) examined the important link between system design and the effectiveness of a training program in achieving training objectives (or performance criteria). They noted that, in any assessment of shiphandling performance, multiple performance measures were called for, which could conflict with each other. This could create a complex monitoring task for an assessor. Hussem et al. (1984) concluded that before performance tests were executed on shiphandling simulators, it was important to establish that the objectives could be fulfilled. The previously described validation process in Chapter 6 covers many of these aspects, as does the STCW Code A-I/12 guideline on assessment by simulator. Another important aspect of simulator assessment is assurance that the skills acquired, under measurable conditions, transfer to the real world. A number of research reports, funded by CAORF (Miller, 1982; Multer, 1983), by Hurst and Reeve (1984) and Froese (1987), gave support to the view that a positive transfer effect can take place under controlled conditions.

The literature shows little further research activity in the field of simulator assessment between 1984 and 1993, when review of the STCW 1978 Convention commenced. The latter, since its finalisation in 1995 (STCW 95), has been a catalyst for further investigations into the use of simulators for assessment purposes. This is not a surprising outcome, noting that the new emphasis of the revised Convention is to require seafarers to demonstrate an ability to perform functions and tasks safely and effectively. Cross (1993) argued that the power of the computer could be used to ease the monitoring burden of the instructor/assessor by taking over certain tasks. One role could be that of an objective evaluation of performance, recording actual exercise data and comparing it against predefined performance parameters. This Training and Evaluation Control (TEC) would be much more applicable to a 'closed' process, such as main engine operations, than to an 'open' navigation process, which is subject to more random variables. Jenkins (1993) concluded that using an engineroom simulator as part of an examination system, and relying on the testing and measuring methods of terminal performance (supported by clear objectives), could offer a solution to the problem of assessing skills competency. As seen in Figure 8.12 below, an assessor is able to follow and record the functioning of the machinery as it responds to the actions of the candidate, while at the same time, being able to observe and record the movements and activities of the candidate (Figure 8.13 over). Designs such as this provide the assessor with an excellent environment from which to assess performance.

Figure 8.12 ER simulator instructor console

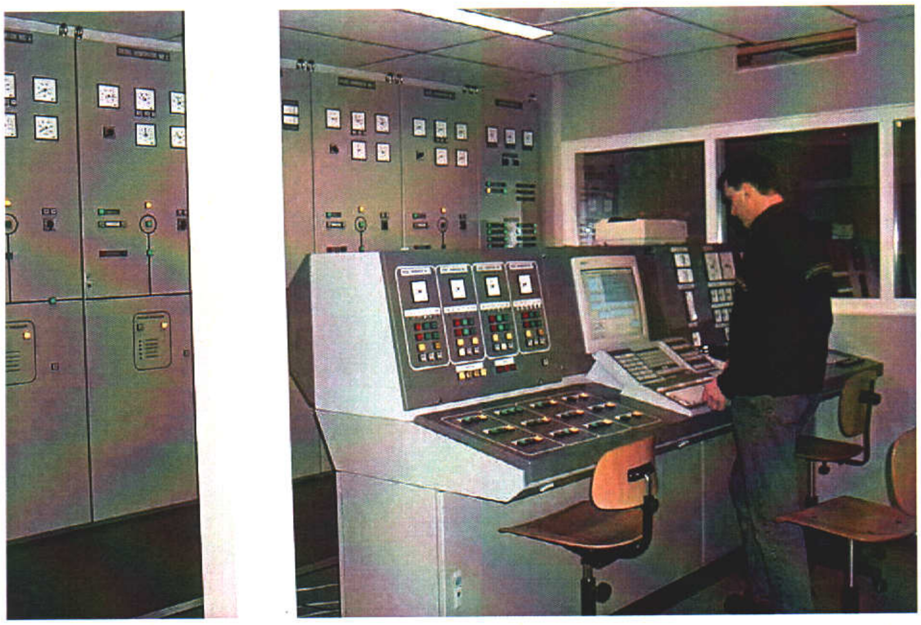


Figure 8.13 ER simulator control room

Meurn and Sandberg (1993), who have carried out much pioneering work on simulator training of cadets, developed their first weighted deck watchkeeping marking sheet, containing 47 tasks or criteria, against which performance was to be observed and recorded on a scale of 0-2. An example is shown in Appendix E. With up to four cadets on the bridge, some considerable subjectivity must have remained, but it was a step forward. Schaafstal et al. (1993) also investigated the feasibility of developing a methodology to conduct proficiency testing in an objective way. Analysing the system, in terms of the functions to be performed, has value for coordinating the activities of system engineering functional descriptions. Task analysis was focused on pilot's and master's tasks with emphasis on perception, information processing, handling characteristics and interface with the workspace. It was noted that the validity of the simulator and scenario would be keys to any successful outcomes, affirming what earlier studies by Hammell (1981) had concluded.

Following on from his earlier paper, Cross (1996) further described the development of a Simulator Exercise Assessment (SEA) system. In essence, it represented an automatic system that would continuously monitor selected exercise parameters and compare them with criterion values. Any deviations from the norm could be counted and weighted. One advantage envisaged was its potential to provide support to the evaluation process by measuring and recording trends in performance, either of an individual or of a group. The system disciplines the instructor to set clear learning objectives, identify key parameters, set acceptable criterion values for them, and judge their importance. The difference to previous intuitive approaches is that now all is revealed at the debriefing, producing a more objective outcome.

The importance of monitoring and feedback to the assessment process is also illustrated by the increasing interest by other researchers in testing automatic monitoring and feedback systems. Hooper, Witt, & McDermott (2000) described a pilot study utilising hypertext and web tools to deliver exercise advice and feedback in electronic format. This has affinity with the expert system of 'Officer of the Watch', for example. Future trials are looking at embedded online assessments.

Smith I. (2000) described the development of Instructorless Training (ILT), where a trainee can start, undertake and stop the simulator exercises, without any referral to the instructor. Data via printer is then provided to allow the student to compare personal performance against a model response to the exercise. There is a need to recognise, however, that such approaches have limitations as to how the final judgement about the reliability and validity of the performance against the set criteria is to be made. While technology can be helpful in giving a trainee immediate feedback, the assessor cannot become disengaged from the assessment process entirely. To what extent do cognitive, affective and psychomotor skills form part of the measure of performance? Visual perception by an experienced assessor must be mandatory, in most cases, when determining competency to perform tasks or functions. There is a danger that technology becomes the yardstick rather than being seen as another supportive tool to the evaluation process.

Continuing their work with simulators, Meurn and Sandberg (2000) further refined their approach to the assessment of watch standing skills. In association with other US academies, a list of Knowledge, Understanding and Proficiencies (KUPs), drawn from table A-II/1 of STCW 95, was created in 1999. Several KUPs have been designed to be assessed during the CAORF Bridge Watch Standing Course. The mariner assessment consists of five steps, namely: identifying test objectives, determining test modes, specifying test conditions, developing performance measures and standards, and preparing test materials. A performance measure indicates how a trainee's performance will be observed and recorded. A performance standard represents the level that is established as acceptable. The method is currently under trial (see Appendix F). However, drawing on their experiences, the authors observe that the effort of seeking more objectivity results in some loss of validity, their view being that the use of experienced mariners, trained in simulator assessment techniques, is the best way of minimizing such loss of validity.

In the aftermath of the changes wrought by the introduction of STCW 95 in 1997, the United States Coast Guard (USCG) recognised the need to provide guidance to assessors on assessment techniques, if the latter were to affirm the ability of mariners to demonstrate practical skills and knowledge. In 2000, the USCG National Maritime Centre (through the USCG Research and Development Centre) sponsored a research project, that was designed to build on earlier efforts that had produced a specification for a Performance Based Assessment (PBA) method for creating mariner assessments (McCallum, et al, July 2000). The intention was to further refine the PBA method (which also addresses the conduct of assessments), and provide practical support to assessors in the USA. Through cooperative workshop activity, a manual for assessment developers was created, and several sample assessment procedures were developed.

From a quality assurance point of view, an interesting approach is the requirement by the USA authorities that an expert assessor will be qualified as a designated examiner. Muirhead (1996) has commented before that maritime administrations should take more positive steps to train and use experienced personnel, both at sea and ashore, as assessors in the wake of STCW 95. Again, the project emphasises the need for specification of performance measures, performance standards and proficiency criteria, if the outcomes are to be reliable and valid. A particularly vexing question that arose centred on the level of detail required to assure reliability and validity. Another difficulty is obtaining consensus from a group of experts conducting validation of processes and procedures, where personal experiences and subjectivity may hold sway at the expense of objective criterion approaches. Similar problems were experienced in earlier research when validating shiphandling performance of trainees using a criterion referenced approach to establishing competence (Muirhead, 1987).

A USCG Research and Development (R&D) centre report (January 2001), described a process that would evaluate the capability of simulators to support performance based assessment of mariner proficiencies. If a simulator lacks the design features to cover the functionalities being assessed, then any performances measured must be both unreliable and invalid. The Det Norske Veritas simulation certification standards, described below, are also designed to minimise the risk of such situations arising. Among a number of recommendations made in a final USCG R&D report (July 2001, p. vi), perhaps the most important one was the following:

> Those in the industry who are responsible for training and assessment of mariner proficiency in academies, training schools, and shipping companies should make use of the method and the materials presented here as a guide for their own development of assessment procedures.

Should it be so strange an idea, to require those charged with the task of assessing the performance of mariners, to be themselves licensed, as being fit and proper persons to conduct such assessments? The previously mentioned surveys in this research have indicated that there is a hesitancy to use simulators for assessment purposes. Also, there is strong circumstantial evidence that lack of knowledge of technique is one factor inhibiting instructors from doing more. Although section A-I/6 of Code A of STCW 95 clearly requires an assessor to have had practical assessment experience on a similar simulator before conducting assessment, there is little evidence outside of the USA, Netherlands and the UK of Parties ensuring that both present and new generations of simulator instructors have been trained to conduct the assessment function. Hence the low level of activity. A convincing case can be made to require all simulator instructors to undertake formal mandatory training in assessment techniques.

8.5 Simulator classification and functionality

The International Marine Simulation Forum (IMSF) has attempted, for a number of years, to classify simulators by type and relate that classification to the functionality needs for assessing competence. In 1993, a working group of IMSF submitted to IMO, proposals for a simulator classification system based on three types of simulator on four levels of functionality (Table 8.1). This was further refined into four classes of simulator by the consultants to the STW sub-committee (only navigation and shiphandling shown here). However, for various technical reasons, the proposals were not incorporated into the revised STCW Convention. Recognition that agreement on this and other technical issues would not be reached easily led to other approaches being made.

Table 8.1: Simulator classification system (bridge)

For descriptive purposes, and to facilitate cross-reference between the relevant sections of the Code, the types of training simulators to which the performance standards in parts A and B apply are categorized as follows:

Classification Category or Short Description	Bridge (Navigation and shiphandling)
Category I or FULL MISSION	The facility shall be capable of simulating: full visual navigation bridge operations, including capability for advanced shiphandling and pilotage training in restricted waterways - in accordance with the performance standard set out in paragraphs ....
Category II or MULTI TASK	full visual navigation bridge operations, as in Category I above, but excluding the capability for advanced restricted-water manoeuvring - in accordance with the performance standard set out in paragraphs ....
Category III or LIMITED TASK	limited (instrumentation, or blind) navigation and collision avoidance - in accordance with the performance standard set out in paragraphs ....
Category IV or SINGLE TASK	operation of particular bridge instruments, or a limited navigation/ manoeuvring scenario but with the operator located outside the environment (e.g. a desk-top simulator utilising computer graphics to simulate a birds-eye view of the operating area) - in accordance with the performance standard set out in paragraphs ....

Source: STW 26th Session, consultants information paper STW 26/INF 7.

Cross (1998) proposed creating a model linking the functional requirements of the Convention to the classification work done by IMSF. In a following paper, Cross (2000), noting that STCW 95 identified the learning objectives required to be met for the different levels of officers, functions and subjects, considered how this could be reconciled with the requirements of regulation I/12 (see page 179) of demonstrating competence through approved simulator training. Any competence based assessment system has measurable standards of performance and under quality assurance requirements of STCW these must be approved by the administration. Where a simulator is being used to assess any competence then it too must meet the performance standards laid down.

Cross rightly pointed out that not all manufacturer's simulators of a described type had the same facilities or capabilities, and thus could not be relied upon to measure the same functions or tasks. Taking this functional approach as a basis, Cross asked the question; "which functions can be performed and demonstrated on what level of simulator"? Taking knowledge of the collision regulations (Colregs) as an example, Cross undertook the considerable task of examining the relevant Code A tables to identify which functions and tasks could be completed using a simulator. This information was then correlated against the relevant collision rules and IMO model courses. For example, while some maritime authorities (UK, Norway) have recognised certain desktop simulation products such as 'Officer of the Watch' and 'Navitrainer' as being suitable to cover certain training functions at watchkeeper level, they do not recognise them as systems capable of offering functionality for shiphandling skills, even though the systems provide manoeuvrable ship models.

Table 8.2 Bridge simulator applicability

Type of Simulator	Colreg Rules	STCW 95	IMO Model Course
Full Mission	5-10 12-19 20-31 34-37	Table A-II/1 item 1-6 Table A-II/2 item 1-8 Table A-II/3 item 1-5 Section A-VIII/2 Section B-V/3	1.07 1.09 1.08 1.22
Multi-task	5-8, 10	Table A-II/1 item 1-6 Table A-II/2 item 1-6 Table A-II/3 item 1-5 Section A-VIII/2	1.07 1.08 1.09 1.22
Limited task	6-10 19	Table A-II/1 item 3-6 Table A-II/2 item 6 Table A-II/3 item 3-4	1.07 1.08 1.09
Single task	19	Table A-II/1 item 3	1.07
CBT	23-31	-	-

Source: Cross, 2000, p. 20

A simulator must have a functionality capability to meet the training or assessment objectives, otherwise performance will be neither reliable or valid. In that case, any assumptions made regarding the transfer of skills to the real workplace, will also be invalid.

Taking up the challenge, Det Norske Veritas published a set of standards for the certification of maritime simulator systems, in 2000. Using a configuration of four classes of simulator and four function areas, the standards focus on providing users and administrators with the framework to establish that defined training and/or assessment objectives can be fulfilled. While the standards target the simulator system, being just one of three key aspects (the others the instructor/assessor and the approved program), they provide an excellent link between simulator capability, assessment objectives, functions and tasks and STCW competencies. As such, the approach to assessment by simulator has been enhanced and clarified. (Cross & Olofsson, 2000).

8.6 The impact of STCW 95 on assessment

Codes A and B

Page 23 of Part A-I/12 of the STCW 95 Code provides assessors with a comprehensive list of assessment procedures that they are to follow. Compared with training, the emphasis is somewhat different. Candidates must know what the performance criteria is and be clearly briefed on the tasks and or skills by which competency is to be determined. Assessors must ensure that assessment criteria have been selected with optimum objective measurement and evaluation in mind, keeping subjective judgements to a minimum. Assessors are also warned to use scoring or grading methods with caution, until such methods have been validated.

As stated earlier, a number of studies have looked at the use of scoring methods to establish competency, for example, Meurn at al (1993, 1996, 2000), McCallum (1996, 2000) and Smith C. (2000). In further trials with weighted performance, Muirhead ran, between 1998-2002, a series of simulator instructor training courses in the Netherlands, where performance criteria were judged as either being essential (E) or desirable (D). It can be seen from Table 8.3 that a number of specific quantifiable parameters or limits were set against the assessment criteria. The purpose was to ensure that the outcome was measured against both quantitative and qualitative criteria, to reduce reliance on more subjective judgements made on the basis of 'good seamanship'. The latter observations are, however, still important.

Table 8.3 Weighted criterion referenced scores

Performance values** Weighting

Assessment criteria (Demonstration of Tasks)	Specified Parameters or limits	Actual Outcome	Competence Factor E-essential (0-5) D-desirable (0-3)	0	1	2	3	4	5
1 Safe navigation position at all times	Not <3 nm to land	> 3 nm	E						5
2 Acquire & plot ARPA targets			E						5
3 Maintain min. CPA to all targets	Not < 1 nm	Least 0.8 nm	E				3		
4 Interpret radar info correctly			E					4	
5 Compare gyro/magnetic compasses	Every hour	Not done	D	0				X	X
6 Check GPS position by radar	Every 30 mins	OK	E						5
7 Check GPS by visual means	Every 60 mins	OK	D				3	X	X
8 Keep a visual lookout			E						5
9 Change chart to largest scale			D				3	X	X
10 ETA pilot at 1700 hours	On time	20 min late	E				3		
11 Call pilot cutter	30 before ETA	OK	E						5
12 Select appropriate VHF chan			E						5
13 Comply with Master's Standing Orders			E					4	
14 Call the Master	30 mins pre ETA	5 mins late	D			2		X	X
15 Prepare the pilot ladder			E						5
16 Maintain the bridge logbook		No action	D			2		X	X
			Totals	**0**	**0**	**4**	**12**	**8**	**35**

Competency Score = Number of E factors x 5 + Number of D factors x 3 x 70/100
Competency Weighted Score = 49 Actual Performance Score = 59

The outcomes from these courses indicate that the mix of quantitative measures, qualitative observations, reports and the use of a peer review process at debriefing have helped to reduce the subjectivity of the judgement process, and provided instructors with increased confidence in their ability to use this extended range of tools to better assess competence in a more reliable and valid way. This is even more marked when using the engine room simulator.

The Convention states that the prime criterion in assessing competency is that the candidate demonstrates the ability to carry out a task *safely and effectively to the satisfaction of the assessor.* An examination of the specifications for minimum standards of competence laid down in Chapters II, III and IV in Part A of the STCW 95 Code, for example, clearly shows where simulators are acceptable as a method for demonstrating competence.

Table 8.4 shows clearly that the mandatory method for demonstrating competence, in relation to radar and ARPA training, is by simulator and by at-sea experience. Those responsible for course design must decide to what extent simulators available within their training institutions can contribute to the training process, commensurate with meeting any of the appropriate standards.

Table 8.4: Extract from Table A-II/1- Minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tonnage or more.

Competence	Knowledge, Understanding and Proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Use of radar and ARPA to maintain safety of navigation. Note: Training and assessment in the use of ARPA is not required for those who serve exclusively on ships not fitted with ARPA. This limitation shall be reflected in the endorsement issued to the seafarer concerned.	*Radar Navigation* Knowledge of the fundamentals of radar and automatic radar plotting aids (ARPA) Ability to operate and interpret and analyse information obtained from radar, including the following:	Assessment of evidence obtained from approved radar simulator and ARPA simulator training plus in-service experience	Information obtained from radar and ARPA is correctly interpreted and analysed taking into account the limitations of the equipment and prevailing circumstances and conditions

The role of the assessor

Section A-I/6 of STCW Code A (STCW 95, p.15) is similarly specific in relation to simulator assessment and states, inter alia:

Assessment of competence

> Any person conducting in-service assessment of competence of a seafarer ... shall:
>
> .5 if conducting assessment involving the use of simulators, have gained practical assessment experience on the particular type of simulator under the supervision and to the satisfaction of an experienced assessor.

Research projects mentioned earlier (MASSTER, METHAR, EASTMET), have shown that there is a marked reluctance amongst instructors to use simulators to assess the performance of individuals. This stems from a lack of understanding about assessment techniques (now emphasized in STCW 95) and the often subjective nature of the training and assessment tasks. This hesitation can be overcome by establishing clear criteria of performance for assessment based on specific objective, quantitative and qualitative grounds. Of course, the subjective nature of practical assessment can never be eliminated, but, with careful preparation and scenario development, it can be greatly reduced. Criterion referenced methods may be supported by scoring methods but the latter should be validated before use.

The nature of engine room simulation, involving training in specific processes and procedures and set operating parameters, lends itself, on the one hand, to an objective form of assessment. Ship and navigation simulation tasks, on the other hand, are much less predictive and more open to subjective interpretation. Thus it is very important that both the assessor and the candidate are clear on what is being assessed and how it will be assessed. If possible such criteria should be validated against real world experiences using experienced practitioners as previously discussed on pages 183-184.

In analysing and evaluating performance, assessors will need to have established which information, activities and actions should be recorded during the assessment exercise. Comparison between pre-set criteria and actual performance, supported by other evidence such as from oral interviews, peer review processes and post test questionnaires, will enable an assessor to arrive at a valid judgement of the candidate's competence, as evidenced by the ability to perform specified functions and tasks against set criteria.

8.7 Summary

The last decades of the 20th century saw considerable change to the shipping industry, resulting from, among other things, new ship designs and operational procedures, manning arrangements, amended or new Conventions and Codes, and the impact of new technology. It has also been shown that maritime institutions are having to take on a greater role in assessing the competence of seafarers, as a result of trainees having less time to acquire practical skills at sea, and officers having even less to time to supervise and monitor their programs.

In looking for new ways to assess students outside of traditional examinations, workshops and laboratories, computer based training (CBT) and marine simulation systems are increasingly being selected to provide enhanced training and experiences of the real world. The step from a training environment to an assessment one, however, is not an easy path to take. The literature discussed in Chapter 2 and this research study indicate that most practitioners accept that competency involves a mastery or skills based approach, two key requisites being pre-established competencies and knowing the acceptable levels of attainment. Most CBT training programs delivered on CD-Rom today incorporate built-in self-testing programs that may control user progression, or provide feedback on how well the user is performing. Other approaches include the use of expert systems, graphical record of responses and scoring routines. Moving to determine whether the user can actually perform functions or tasks safely and effectively (i.e. competently), using computer or simulation based tools, involves other factors such as the reliability and validity of test items, the relationship between the functionalities and capabilities of the system being used, and the actual assessment criteria. What is evident is that program developers, trainers and assessors need to be clear on what it is they are measuring and whether the computer or simulator system being used provides a valid environment for it.

Reviewing the use of technology to assess the competence of seafarers in the last twenty years shows that developments have ranged from the creation of quantifiable criteria of performance (Muirhead, 1987), weighted scoring methods (Muern & Sandberg, 1990), an automated comparative approach between weighted exercise parameters and set criterion values (Cross, 1996), the use an iterative process of review, discussion and consensus by subject matter experts (Meurn et al, 2000), the development of a model for Performance Based Assessment (USCG, 2001), and the use of weighted criterion reference scores (Muirhead, 2002). The efforts of IMSF in the 1990s, and Det Norske Veritas (2000) in producing a classification of simulation systems based on the link between simulation functionality and capability, and competency requirements of the STCW 95 Convention, provide another very important step in creating a reliable and valid assessment process with technology.

Although earlier research reports from MASSTER (1997) and METHAR (1998) projects identified a general lack of knowledge of assessment technique by instructors, the evidence from the more recent research activity is that clear guidance on the procedures and processes to be used to assess the competency of seafarers using modern technology is now available.

It can be stated, with some confidence, that positive measurement of skill acquisition can be made on simulators, subject to the provisos that the criteria for performance measurement is clearly specified, the simulator provides an appropriate operating environment, the assessor is properly trained and experienced, effective recording and monitoring equipment is available, and that the assessment functions and tasks selected relate to the real world of ship operations. The onus is on maritime administrations, institutions and simulator operators to ensure that the necessary steps to meet such criteria have been taken, before accepting such performance measurements for competency purposes.

CHAPTER 9

IMPLICATIONS AND SOLUTIONS FOR MET INSTITUTIONS

9.1 Idealism v realism: making change

The growth in new technology emanates, in the majority of cases, from funded government, industrial and commercial research and development, which may or may not find a niche or home in the market place or the working environment. In many cases technology leads, and application methodology arise, from initiatives taken by users, as the result of new technology being introduced. Today, it can be said with some confidence that the introduction of new technology is often the catalyst for applied innovation in technique or methodology. New technology, of course, may raise expectations by those working in the related field that such developments will lead to the accruing of advantages, such as increased productivity, greater efficiencies through cost savings, increased employee motivation and job satisfaction, the creation of innovative concepts and ideas, and the sheer excitement of developing new ideas and ways of achieving specific objectives.

It may also have the opposite effect for traditionalists, who see the introduction of new technology as a threat to their existence and their tried and proven ways of doing things, which have withstood the tests of time, man and machine! Making change is difficult at the best of times, particularly when initiating new systems or methods. The innovator is likely to receive only half-hearted support from those who would prosper under the new regime, while the innovator puts offside all those who do nicely under the old regime. The latter may have designed the current system, but probably opposed it when the idea was first introduced! The innovator must therefore depend on his own resources, be well armed with a firm belief in the new direction, and pursue the goal with a single minded purpose. Such innovators are seldom endangered.

One of the problems with the arrival of new technology is that advertising persuades everyone that they need to have it, regardless of whether it fits the purpose or needs of the user or the organisation. Consider the power of advertising and the marketing of new cars, mobile phones, recordable digital video disc (DVD) or third generation (3G) phones. In maritime education and training institutions, radar simulators became a desirable system to acquire throughout the 1960s, 1970s, and 1980s because they were seen as a symbol of having arrived technically despite the fact that they were relatively expensive to buy and run. Yet radar simulators did not become mandatory until 1997. In the mid 1980s, the major manufacturers of computer generated image (CGI) visual simulation systems started to market visual full mission shiphandling simulators much more aggressively (see Appendix D). However, such systems were much more expensive and only large training and research institutions or those funded from government sources could afford them. Regardless of this, it unleashed a growing desire by many training centres to have their own full-mission simulator, despite the clear lack of finances and expertise to do so. Suggestions for collaborative regional solutions to simulation training have generally fallen on deaf ears. This has resulted in funds being so thinly spread that many cannot afford advanced technology, leading to an increased world of haves and have nots. Such narrow national perspectives further hinder attempts by IMO to raise global MET standards. As earlier surveys have shown, the penetration and availability of simulation technology, outside of the mandatory radar and ARPA simulators, is very uneven globally. The upgrade of older 'blind navigation' simulators, through the add-on of visual projectors in the 1990s, has extended shiphandling training capability in a limited way, but even this is not a cost effective solution for many small training institutions.

One pleasing development in recent years has been the growth in computer based simulation software systems, such as those developed by Transas, Poseidon, SSPA, PC Maritime, Unitest and MarineSoft, for example, where powerful workstations and networked computers provide a cost effective training tool within financial reach of many smaller institutions. This has forced the major manufacturers of simulators to develop products for this end of the market (e.g. KMSS with their Polaris model).

In the world of computing, technological development continues to proceed at an astounding pace, and even the larger, well funded institutions find it difficult to replace equipment that is considered to have a shelf life of only three to four years. To introduce Internet, Intranet and e-mail links involves considerable investment in systems ware and human resources. To use the technology for the delivery of learning materials and courses takes one into the world of specialised instructional design, the creation of multimedia tools and the use of distance learning methods and management systems. Not only is technology expensive, but manpower support for development and maintenance has now become more of a critical factor. The need to design, build and equip specialised computer laboratories, as teaching increasingly revolves around the use of computer assisted learning (CAL) and computer based training (CBT) also results from pressure from the demands of today's students, who expect institutions to provide such technology in their learning environment.

In this bewildering and fast paced world of development, MET institutions are faced with difficult decisions in the future, regarding the role of technology in teaching. Strategic planning becomes an important issue if valuable and limited resources are not to be wasted. For many, funds to develop are very limited, yet if changes are not made, an institution runs the risk of being left behind by competitors, or even of failing to keep up with international standards, increasingly governed by access to technology (e.g. mandatory radar/ARPA simulators). Many smaller training institutions, in particular, are in grave danger of closing in the future unless managers develop clear plans to meet the challenge posed by new technology. Market assessment, planned development, compromise, collaboration and regional co-operation are words that increasingly need to enter the vocabulary of planners and operators.

9.2 Technology and its role as a value-added educational tool

Although the focus of this research is on the role of technology in maritime education and training in the 21st century, it does not imply that technology is to supersede traditional teaching methodologies and practices. The traditional teaching skills of the well trained lecturer and instructor remain the foundation of any quality based education system. New technology must be viewed as a complementary methodology to traditional means, not a replacement. The challenge facing the lecturer and practical instructor is to determine where technology can enhance or improve the learning situation of the student, in an interesting and cost effective manner. The student of the 21st century is increasingly quite at home in using computers and software applications, the Internet, intranets and e-mail. The mere presence of computing technology in an institution is no guarantee however that the learning environment will be enhanced.

There is great pressure on the teacher today to engage students in the learning process through the use of computing resources, and this requires careful planning and organization on the teacher's part. For many this is a daunting prospect for two reasons. Firstly, MET institutions have generally failed to provide the teacher with the didactics training necessary to use new technology in the classroom or laboratory effectively and confidently, as the METHAR project referred to earlier showed. Secondly, many students have greater computer skills and knowledge than many of their teachers. These two key factors are the inhibitors to the more widespread understanding and use of computer technology and simulation in the MET learning environment.

The key is better awareness of the potential of technology in education and increased training of teachers. Figure 3.12 earlier clearly showed a discrepancy between the claimed level of use of CBT laboratories and the number of staff who had received training in using such facilities. MET institutions have to consider how to close this training gap which impacts upon both quality and validity of training, as well as the motivation levels of the teaching staff.

A further advantage worthy of consideration by both MET institutions and monitoring administrations is the potential computer based training brings to increased efficiency and security of the assessment process. While computer question and answer data banks have limited cognitive use, they can be used to enhance the knowledge aspect of learning in a very efficient and secure way.

In what way can technology provide added-value in education and training? One of the shortcomings of STCW 1978 was that, while it provided good coverage of knowledge and understanding of relevant subjects, the acquisition of practical skills was left to the onboard seagoing regime. The demise of the traditional shipowner and the in-house cadet training program, coupled with the reduction in sea-going experience, led to STCW 95 placing much greater emphasis on the acquisition of practical skills. Many training functions and tasks cannot be undertaken in the workplace for good safety and economic reasons. Many tasks can, however, be undertaken in a risk free simulation environment ashore in a training centre. Although radar/ARPA simulators remain the only mandatory form of training, Table 6.3 in Chapter 6 indicated that there are over 1173 marine simulators available around the globe, with much of that growth occurring in the past decade, reflecting the strong influence of STCW 95 on the use of simulators.

Although not mandatory, many MET institutions are using such facilities in their training programs, though less so for assessment of competency. Over the years there is ample evidence that simulation can be most effective in enhancing practical skills in many areas of safe watchkeeping, cargo operations, machinery and plant management, communications and pollution control. Simulators can add considerable concrete value to classroom theory, although their use is often limited in scope, due to the large numbers of students to be trained and a shortage of well-trained simulator operators.

Computer based training (CBT) is increasingly being utilized in maritime education and training. Chapter 6 illustrated how computer based laboratories are being used to enhance group and individual learning. Today, with careful planning, an instructor can use the latest mode control tools and communication systems to manage quite large groups, with different levels of ability, speedily and in an interesting and motivated manner. Using step-by-step programs, students can be brought to a desired level of understanding and performance rapidly. Problems can be solved quickly through communicating technology. Resources can be easily accessed electronically. Many items of marine equipment today can be replicated digitally in a computer with touch screen controls. Students can acquire hands-on skills in using radar, ARPA, GPS, ECDIS, machinery, auxiliaries, pumping and ballast lines, etc.

Part-task training tools using powerful stand alone work stations, enable students to build up basic knowledge and skills in a cost effective manner. CBT self-paced materials with built-in feedback systems are improving in both scope and quality through the efforts of developers such as Seagull, Videotel, Poseidon, PC Maritime, MGI, MarineSoft and Unitest. Chapter 8 illustrated how competency evaluation programs, such as CES 4.0 and SETS 6000, are increasingly being used by shipowners and manning agencies as an initial check on the basic knowledge and skills of applicants.

Referring back to the survey of institutions in Chapter 3, it will be recalled that the target of the survey was 191 MET institutions around the world. Most of the 101 not responding are small training centres or colleges. Of the 90 institutions responding 56% were higher education institutions and 44% were smaller monotechnic colleges or vocational training centres. Evidence from the METHAR, MASSTER, CIIPMET and EASTMET research surveys further shows that many of the smaller training centres have limited technical and human resources. The failure of many governments to provide or support the maritime education and training sector with adequate developmental funds, and the lack of a supportive industry market place from which to generate other funds, leaves many in the industry with a sense of foreboding for the future. The Chapter 3 survey showed a strong desire by many to develop new technology and methodologies, but an equally clear awareness that for many institutions such plans are likely to remain unfulfilled for many years without a change of attitude by governments, industry and donors.

9.3 Changing the status quo

If the maritime education and training community is going to have an impact on raising future global training standards in the 21st century, using new technology and teaching methods more fully, it is going to have to be more pro-active in persuading governments, industry, aid donors and research bodies to contribute seeding funds to the process of technical development, staff training and program delivery. Collaborative approaches between neighbouring academies or regional centres must also come to the fore in a number of regions, East and West Africa being prime examples. National pride and status must take second place to pragmatic possibilities. The reality of the situation must also be recognized by many of the smaller training institutions, that need to move away from equipment wish lists to the real world of what is possible, in order to grow in the local MET environment. If a fundamental 'needs analysis' can be established then it should be possible to create a strategic plan, based on the resources needed to meet the required training objectives, human resource needs and required funds. Institutions will then be in a stronger position to put forward a case to the aforementioned bodies for funding support to develop such infrastructures.

With this view in mind, it is proposed that the following step by step approach to the development of technology, teaching and delivery methods in MET institutions could follow a series of continua of development. Each institution would conduct a needs analysis and evaluate its role and technology needs, in the light of market demand for its programs and courses.

For example, a small institution with few resources will find itself at the starting point of the developmental cycle, a medium sized institution may fit somewhere along the continuum, while a larger maritime university may be well endowed with technical equipment and supporting teaching staff, and be in a position to develop and use more advanced techniques and methods. The latter institution may also be able to offer training and backup support to assist smaller or new training centres to develop their technological infrastructure.

9.4 A continuum of technology development for MET institutions

The research has drawn upon the experiences gained from using computer and simulation systems at the World Maritime University and at training institutions around the globe, and research surveys of European simulation training centres and global maritime academies covered in this research, to create several continua of development. These have been divided into five main functional areas, namely computer systems, multimedia support, simulation systems, communication systems and educational delivery.

9.4.1 Computer Systems

Considering that many developing countries still lack basic computing technology (Olaiya, 2002), there is a need to recognise that it is necessary to built up the computing infrastructure gradually, commensurate with the availability of funds and technical staff support. This also allows for the staged and orderly integration of the technology into the curriculum. The time needed for staff and student familiarisation and training must also be taken into account.

Basic functionalities would start with stand alone desktop PCs for staff, with relevant black and white printing services, leading to special accessories such as scanners, CD-RW, zip drives and colour printers (for overhead transparencies). Special workstations may be required for CAD/CAM and graphics, digital cameras, video editing, modelling and simulation. Internet and e-mail access could be made through a modem.

The next level of development opens up the world of interactivity, for which the institution needs to develop a local area network (LAN) with server or servers covering faculty, registry, administration, students and library. The institution may also create a web site on a separate server.

As staff develop skills with computer based applications (e.g. PowerPoint), there will be an increasing trend to using computer presentations in lectures. As a result, internal course delivery will need to be supported by computer based projection systems. This could range from portable liquid crystal display (LCD) tablets or portable PC projectors to fixed projection systems in classrooms, depending upon availability of funds.

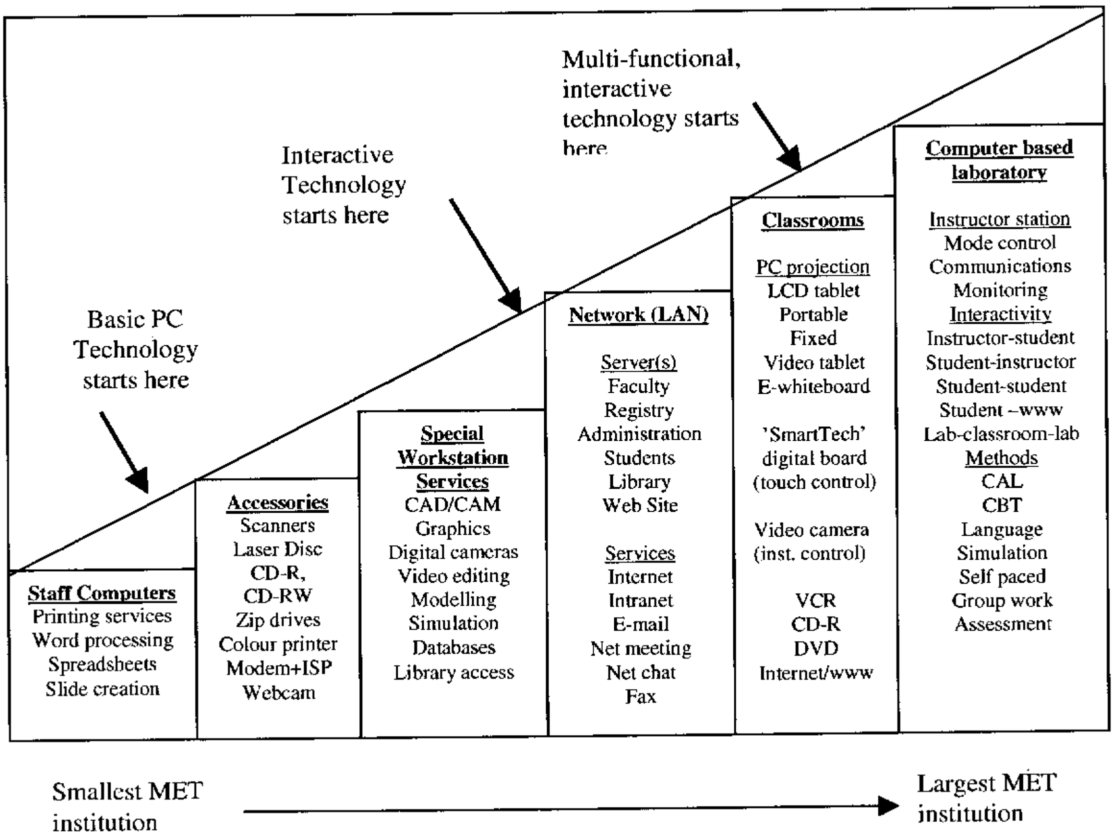


Figure 9.1 A continuum of computer technology development.

The final stage of development involves the creation of a multi-functional, interactive teaching environment. This calls for the design and building of special computer based laboratories with instructor-student, student-student, student-instructor, Internet, Intranet, and e-mail links. Communication is an important feature of this stage. In some institutions interactivity can be further extended through access to the network via student laptop computers. Figure 9.1 illustrates the developmental options for institutions.

9.4.2 Multimedia support

Many MET institutions throughout the world have made use of audio and video tapes in support of their training programs for many years. Typical subjects have including survival, firefighting, medical first aid, cargo, stability, radar and emergency safety training, the major supplier being Videotel with their discontinued U-matic format and the more modern VHS format. Increasingly Videotel and others (e.g. Seagull, MGI, Poseidon) are providing such training materials on CD-Rom, as the computer becomes more common on ships. The advent of digital technology has enabled the growing use of digital cameras and video cameras, and the consequent transfer and storage of data via computer systems. Proprietary tools such as Toolbox, Macromedia Authorware, Viewlet Builder and Director 8.5 have extended the possibility of creating interactive, animated and dynamic programs capable of generating high levels of motivation, interest and response by students. Stages of development are seen in Figure 9.2.

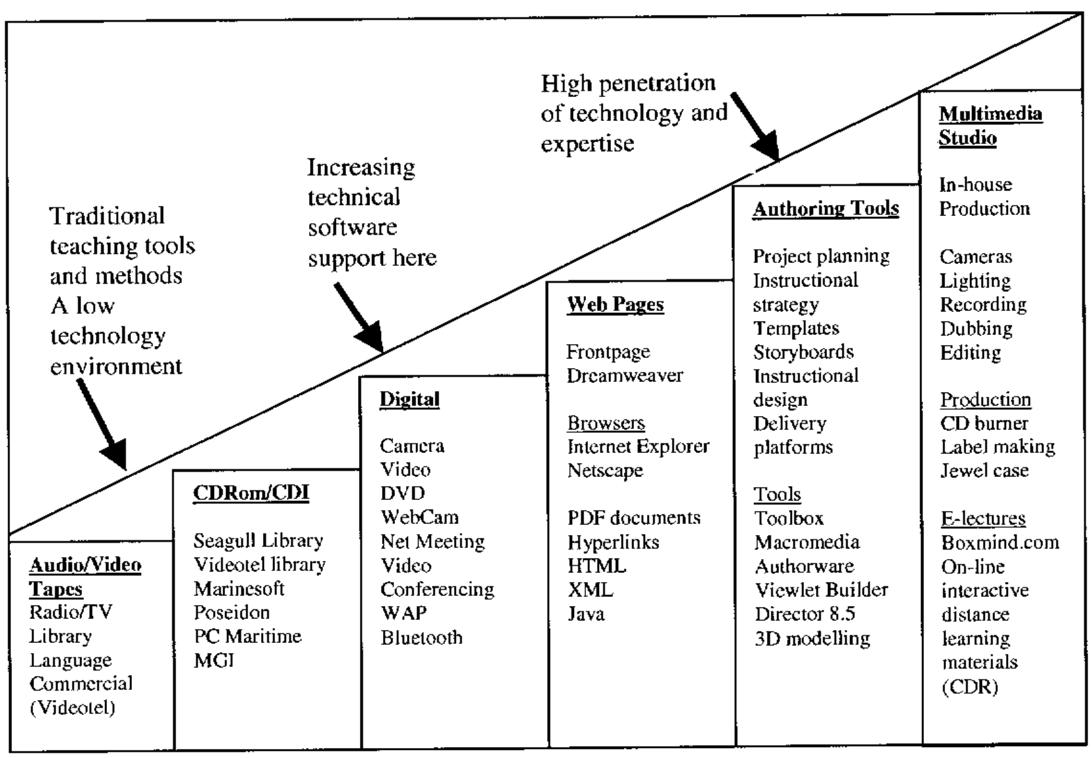


Figure 9.2 A continuum of multimedia development

While there may be an urge to get to the top end of the continuum here, some words of caution are necessary. It requires considerable skill to create multimedia programs, work on which is often carried out by specialist providers or contractors, as the cost of self development would be prohibitive to most MET institutions. Taking a step into the realm of interactive e-learning, via the Internet and the World Wide Web, places further demands for instructional design services and skills. These latter steps are best contracted out to specialist providers. The ultimate goal for a larger institution would be to develop a dedicated multimedia studio with an ability to create on-line e-learning materials using its own trained staff. The upper end of the multimedia continuum will demand considerable investment in technology and human resources and should be costed out carefully. Much would depend upon an institution's strategic plan and the emphasis to be placed on the e-learning market.

9.4.3 Simulation systems

Chapters 6 and 8 explained how marine simulation has become a key practical part of maritime training programs. STCW 95 places great emphasis on seafarers demonstrating that they have acquired practical skills to perform their functions and tasks onboard safely and effectively. Although the Code A tables of STCW 95 allow for many of the listed competencies to be demonstrated using marine simulators, a combination of time constraints, student numbers, functionality of simulators, and availability of qualified instructors and assessors, limits the number of functions and tasks that each student can be exposed to in any training program. A compromise is necessary.

Today, technology permits many aspects of simulated life to be run on PC workstations and computer laboratories. Many software programs allow a trainee to obtain a fundamental understanding of many operational aspects, either working alone on a PC or in a group in a small laboratory environment. Examples of manufacturers of large simulator systems providing desktop versions of instructor operating systems include KMSS, STN-Atlas, Transas, Poseidon and Ship Analytics. Chapter 8 described how, during the revision of STCW Convention in 1993-1994, the IMSF created a

Table 9.1 A three category simulator classification system

For descriptive purposes, and to facilitate cross-reference between the relevant sections of the Code, the types of training simulator to which the performance standards in parts A and B apply are categorized as follows:

Classification Category	BRIDGE SIMULATOR (Navigation and shiphandling)	ENGINE SIMULATOR (Propulsion and power plant operation)
FULL MISSION	The facility shall be capable of simulating: full visual navigation bridge operations, including capability for advanced shiphandling and pilotage training in restricted waterways - in accordance with the performance standard set out in Code A-I/12 and B-I/12	The facility shall be capable of simulating: Full control room and engine room operations with the use of local and mimic panels for the operation of all systems generally available on the installation being simulated - in accordance with performance standard in Code A-I/12 and B-I/12
MULTI TASK	full visual navigation bridge operations, as in Full Mission above, but excluding the capability for advanced restricted-water manoeuvring - in accordance with the performance standard set out in Code A-I/12 and B-I/12	Control room and engine room operation representation with use of local and mimic panels but with (audio and visual cues providing computerized controlled access to all operational systems generally available on the installation being simulated) - in accordance with performance standard in Code A-I/12 and B-I/12
SINGLE TASK	operation of particular bridge instruments, or a limited navigation/ manoeuvring scenario but with the operator located outside the environment (e.g. a desk-top simulator utilising computer graphics to simulate a birds-eye view of the operating area) - in accordance with the performance standard set out in Code A-I/12 and B-I/12	Specific control room or engine room operations with/without the use of local and mimic panels for the operation of specific propulsion systems and sub-systems. (Audio and visual cues providing computerized and/or local controlled access to the operational system. All other systems may be isolated or 'fixed' to have no affect on the operation of the installation) - in accordance with performance standard in Code A-I/12 and B-I/12

Source: Muirhead as modified from IMSF (1994)

Muirhead (2000) put forward proposals for a Web based simulation centre whereby students could access simulator training programs and exercises from home, from ships or colleges. The tests described above bring such ideas nearer to reality. The advantages for small MET institutions that do not have the resources to acquire and run their own simulation systems are obvious. Paying a fee for access and service would enable many to extend the quality of the courses by giving students access to simulator training. Such developments would also extend the window of opportunity for single and part-task training, outcomes of which could be recorded and monitored to ensure that students had completed the tasks satisfactorily before being enrolled on a full mission training course. The method opens up possibilities of providing such services in many fields such as watchkeeping, cargo operations, emergency response, GMDSS, machinery space operations and navigation equipment, for example.

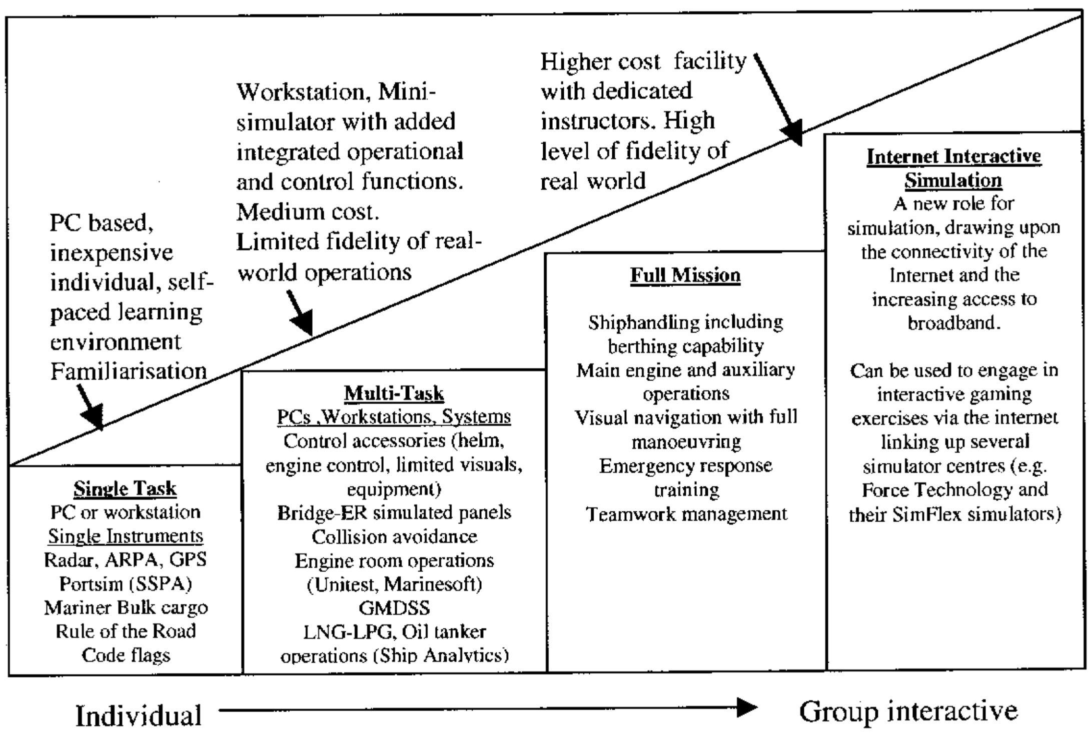


Figure 9.3 A continuum of simulation technology development

9.4.4 Education methods and services

In most institutions teaching didactics have changed little over the past 50 years, still dependent on the traditional classroom approach - the lecture/tutorial. Verbal delivery is supported by the blackboard or whiteboard, supplemented with handmade transparencies presented on an overhead projector (OHP). Photocopiers allow for drawings and diagrams to be enlarged or reduced, as required. The growing availability of the computer and printers has resulted in use of this medium to create more professional looking presentation materials. Increased access to colour inkjet printers has enhanced the clarity of figures, graphs and drawings. Presentation applications, such as Harvard Graphics, Lotus Notes and PowerPoint, have provided the teacher with the means of generating greater interest and motivation in classes. The use of computer based slides has picked up momentum in the past few years, as both the weight and price of projectors has come down markedly.

The biggest change in didactics has been the transition of the teacher from classroom to computer laboratory. The teacher has to develop new strategies in an environment where learning is increasingly becoming student centred. Developing exercises and activities for interactive learning (i.e. with computer programs or with other students) is a time consuming business. Monitoring a room with 20-25 students, who are often more advanced in the use of the technology than the teacher, is daunting for many faculty members. Controlling the pace of learning, where the class may be working individually (self-paced), in groups or collectively, is difficult. Making timely interventions, verbally, via the whiteboard or on the screen needs careful consideration. The laboratory may have access to Internet, e-mail, net chat and net meeting tools. Video conferencing technology opens up new vistas. Growing availability of supporting multimedia presents the teacher with the challenge of making appropriate choices of the best materials.

The institution may decide to move into delivery via distance learning. This could commence with mail out to students of printed study guides, readings and audio-visual materials. Communication and tutorial support needs would be established. The ultimate stage would be to deliver such programs on-line. This requires a delivery platform, an Intranet. The delivery technology needs to be established, e-learning materials developed, staff trained, tutorial support put in place, assessment procedures determined and student support services provided. This continuum also represents a considerable investment in time, funds and human resources to deliver programs in this manner. The survey results in Chapter 3 show that MET institutions have much work to do if they are to develop an outreach using such methods.

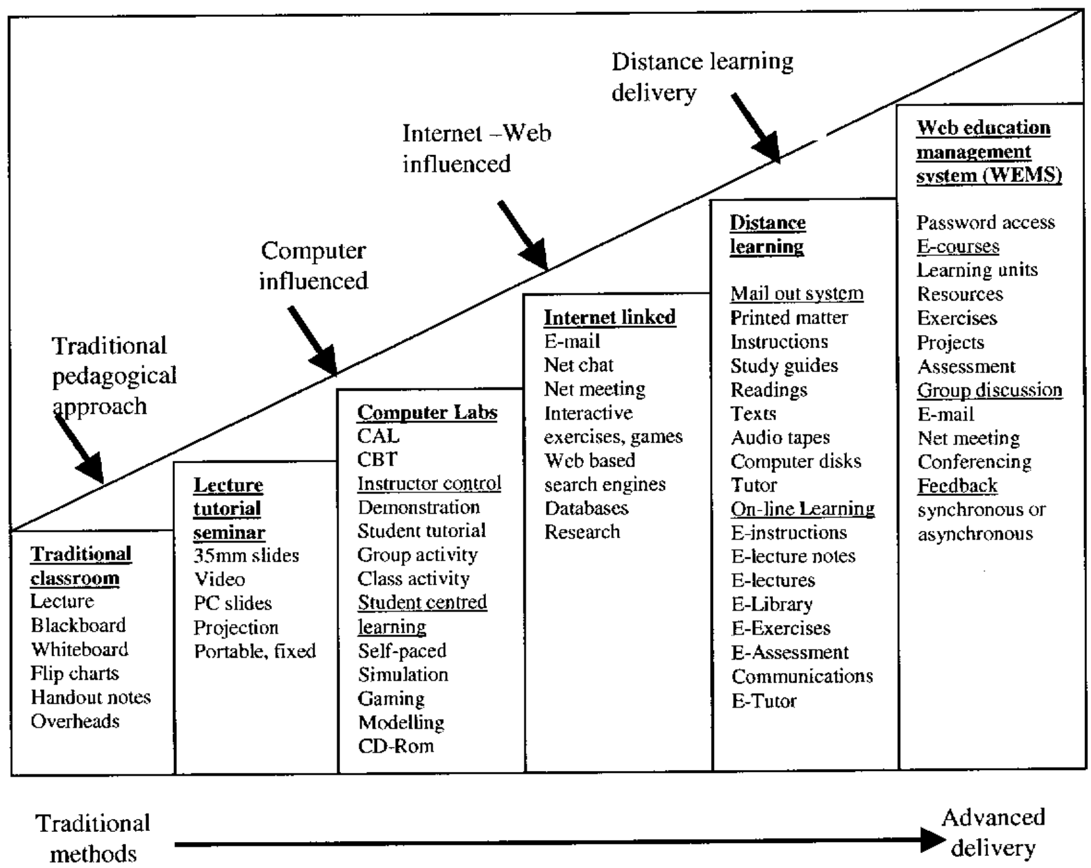


Figure 9.4 A continuum of educational delivery methods

9.4.5 Communications

Earlier, the important role that communications plays in delivering learning at a distance was discussed. Good communication has always been a primary criterion for the successful teacher. In the world of the virtual classroom, communication plays an even more critical role. Chapter 5 also highlighted the different advances made with technology. Many developing nations are still struggling to provide even low technology links such as telephone and modem connections, while mobile phone links are growing very slowly in some countries. Figure 9.5 over illustrates the communication options open to the teacher, but in many cases the ability to deliver courses via distance learning is going to be frustrated by a lack of access to technology by both teachers and students.

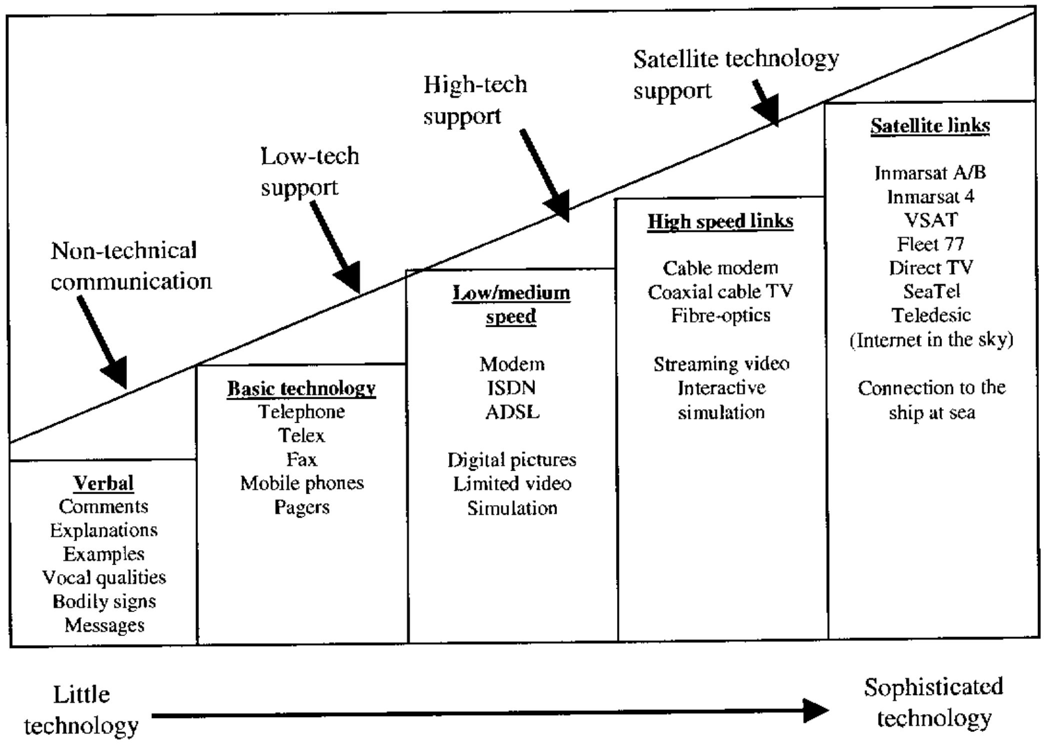


Figure 9.5 A continuum of communications

9.5 New technology and training solutions

The previously mentioned METHAR research project identified a lack of pedagogical training for many maritime lecturers and instructors in Europe, with both the CIIPMET and EASTMET projects affirming a similar state of affairs globally. The following extracts from METHAR Work Package 8 report, dated February 2000, illustrates the situation.

> There is an obvious lack of pedagogic training for lecturers at MET institutions in METHAR countries. (this lack also exists at most universities). Learning by doing is the approach used most often.
>
> (METHAR WP 8, p. 94)

> There are four areas in which most lecturers at MET institutions ... could profit from attending an updating course. The areas are:
> 1.the use of modern technology in teaching
> 2.the use of modern technology in assessment
> 3.the use of shiphandling – navigation simulators
> 4.the use of engine room simulators (METHAR WP 8, p.97)

> there is a strong case for implementation of a common policy to improve teaching qualifications and experience and to update the professional skills of maritime lecturers on a regular basis. (METHAR WP 8, p. 100)

This aspect has been picked up by the subsequent METNET research project, during the period 1999-2003, which has resulted in the creation of four 'train the trainer' courses covering the topics described above. The introduction of new technology in MET institutions in the 21^{st} century has highlighted the need to make available supportive training programs for all faculty members, so that they are better able to understand and apply technology in the new learning environment. It is proposed that the course dealing with modern technology in teaching, divided into two specific topic areas, is an ideal vehicle for institutions to adopt for the upgrading and updating of their faculty members. The 'train the trainer' course complements the developmental continua described in this chapter.

9.5.1 Familiarisation courses for instructors

One of the specific objectives of the EU 6^{th} framework METNET project was to create model pedagogical training programs for maritime instructors, to encourage the development and application of sustainable Pan-European quality standards in training and the use of new technology. Work Package 8.2, completed in September 2002, focused on the creation of a course and course materials on the use of modern technology in teaching. In developing the framework for WP 8.2, the development team, led by Muirhead, decided to create a structure based on two one-week course segments.

This allows faculty members to focus, during the first course, on developments taking place in fundamental computer technology and associated teaching didactics (Computers in Education) before plunging into the world of the Internet, broadband and satellite communications, in the second course (Distance Learning and the Virtual Classroom).

The aim is to provide maritime instructors and lecturers with insights into the application of new technology, multimedia materials and delivery methods in the maritime teaching environment. The work involved a number of experienced European MET personnel working to develop model course frameworks for peer review and validation. The latter took place in the form of a one-week workshop in May 2002, when peer review of the course presentation materials was undertaken by a group of European MET lecturers. The workshop was a compression of the two one-week courses.

The prepared course materials, which consist of session presentations (PowerPoint slides and notes), exercises, CBT and simulation demonstrations, and instructor guidelines for running the courses, were finalised in September 2002. They are being distributed on CD-ROM throughout Europe, initially to maritime academies. The intention is that the materials will encourage other instructors to run courses in their institutions on the use of new technology in teaching, thereby raising awareness levels in colleagues, and encouraging teachers to experiment and gain confidence in new developments. Users will have the freedom to translate session materials into their own working language if desired. The availability of computers with Windows 98SE (minimum), PowerPoint 2000, Internet Explorer v5.0, video graphics card, and connections to the Internet are essential requirements to run the course. Access to a computer laboratory is desirable.

In order to establish the links between the described continuums of technological development and identified training needs, the following detailed breakdown of the specific training sessions is provided and shows clearly the need for technical acquisition and instructor training to be developed hand in hand. It was identified earlier in Chapter 3 and in several research reports that many maritime lecturers lacked formal training in the use of new technology.

9.5.2 Computers in education course

The objectives of this course are to provide participants with an understanding of the nature, potential and limitations of computer based instruction, learning and training. In addition, through the session exercises and CBT demonstration materials, the course attempts to provide participants with an appreciation of the potential of multimedia tools to create computer based instructional materials. The course is self-contained with each session holding the presenter's PowerPoint slides and accompanying notes and any linked demonstration programs.

Table 9.2. Computers in education: course outline

Session	Instructor, course and session guidelines
1.	Instructional media (PowerPoint 2000)-optional
2.	New techniques & methods: Challenges
3.	Computer Based Instruction (CBI)
4.	Self-paced learning
5.	Computing in education: key features
6.	PC learning environment
7.	Communication modes for CMC
8.	CBT demonstrations
9.	Multimedia workshop
10.	Course discussion forum

Instructor, course and session guidelines

This PDF document contains guidance for the instructor on how to set up the course, using the enclosed pro-forma timetable and provided session materials. It also provides advice on the basic equipment needed to run the program successfully.

Session 1: Instructional media

For those who have little or no experience in using PowerPoint presentations then this session will get you started. It is designed to be used directly in PowerPoint itself as a step-by-step self-tuition tool and comes in two modules, namely, basic fundamentals and further techniques. It is also designed to be run as a full one week course in its own right, using an interactive computer laboratory. Much depends upon the background experiences with PowerPoint of the instructor and course participants, and is therefore listed as optional. This is very much a practical, hands-on session.

Session 2: New techniques and methods: challenges

This explores the challenges facing the teacher resulting from the growth in the use of CBT, computers in classrooms and laboratories, and in the light of global developments.

Session 3: Computer Based Instruction

The fundamentals of CBI are explored, including planning method, learning process, characteristics of good CBI materials, types of software integration, course re-design issues, practical aspects and the benefits of CBI. The session is supported by two demonstration CBT programs.

Session 4: Self-paced learning

A great majority of CBT materials are designed for self-paced learning and this important aspect is covered in this session. Experiences to date with self-paced learning are drawn upon and the pros and cons discussed. Several practical exercises involving Internet and CBT materials are included in the session.

Session 5: Computing in education: Key features

Building on sessions 2, 3 and 4, the advantages and disadvantages of Computer Assisted Learning (CAL) versus traditional classroom methods are explored. The session touches on the potential use of computers and the assessment of skills. The problems faced by the instructor in choosing and using software are examined.

Session 6: PC learning environment

What are the keys to good design? This session attempts to unravel some of the good and bad points to be considered in designing and creating a computer laboratory. Two modules explore classroom/laboratory configurations and the associated tools needed for mediated learning. Access to a working laboratory is essential.

Session 7: Communication modes for CMC

If CBT is to be successful, then careful attention must be paid to instructor-student and student-student links. This session examines the issue of communication modes for computer mediated communication (CMC) and uses a proprietary ComWeb instructor control system to demonstrate the potential use of such a system. Access to an interactive, instructor controlled computer laboratory is desirable.

Session 8: CBT demonstrations

The session opens by examining the basic aims of CBT interactive programs, their application possibilities and requirements. The instructor then uses supplied demonstration simulation based software from a Polish company UNITEST, to illustrate the points made. The demonstrations are based on marine engineering CBT programs.

Session 9: Multimedia workshop

A step-by-step overview of a popular tool for creating multimedia materials (Macromedia Authorware) is provided. This is supported with a brief overview of a more interactive design tool called Macromedia Director 8.5 Shockwave studio. Several short demonstration programs accompany the session.

Session 10: Course discussion forum

Some documentation is provided to assist the instructor running the course to conduct a post-course discussion and evaluation.

9.5.3 Distance learning and the virtual classroom course

The objectives of this course are to provide participants with an understanding of the nature, use and limitations of distance learning outreach (distributed learning), and to be aware of the potential of communications technology and Information Technology (IT) to use the Internet and World Wide Web as an environment for managing distance learning systems. The course is self-contained with each session holding the presenter's PowerPoint slides and accompanying notes and any linked demonstration programs.

Table 9.3: Distance learning and the virtual classroom: course outline

Session	Instructor, course and session guidelines
1.	Instructional media (optional)
11.	Distance Learning
12.	On-line learning and instructional methods: a model
13.	Communications for learning
14.	The Virtual Classroom
15.	E-learning: electronic materials
16.	E-learning: multimedia materials
17.	Interaction strategies
18.	Practical laboratory: interactions
19.	Evaluation of distance learning courses
20.	Web Educational Management Systems
21.	Course discussion forum

Instructor, course and session guidelines

This PDF document contains guidance for the instructor on how to set up the course using the enclosed pro-forma timetable and provided session materials. It also provides advice on the basic equipment needed to run the program successfully.

Session 1: Instructional media

This session, also available in the Computers in Education course, can also be used in this course if required. Much depends upon the background experiences with PowerPoint of the instructor and course participants, and is therefore listed as an option. This is very much a practical, hands-on session.

Session 11: Distance learning

An overview of distance learning starts the week. This session explores the topic using four modules that focus on the fundamentals of distance learning, the impact of change on teacher and student, the role that technology plays, and the application of distance learning at sea and ashore.

Session 12: On-line learning and instructional methods: a model

In looking at what works well on-line, the session examines the approach taken by Coomey & Stevenson (2001), using their DISC model (Dialogue, Involvement, Support, Control) to understand on-line learning paradigms. The use of the paradigm grid (NW, NE, SW, SE) in a maritime context is discussed, as well as transition strategies, and the migration to learner-managed learning. It is supported with a practical exercise.

Session 13: Communications for learning

Developments in communications technology are exposed. Broadband potential and applications are examined ranging from satellite communication systems down to fibre-optics, cables and telephone modem connections. Access via the Internet, Video conferencing, Interactive TV, Multicast, Wireless LAN, Wireless Application Protocol (WAP) and the onboard training environment are examined.

Session 14: The virtual classroom

For those unfamiliar with the importance of communications to distance learning, this session explores the options of communications for learning, examines in detail the main features of the Internet and the World Wide Web, and looks at issues affecting learners at a distance, such as tutor-student-tutor links, Internet drawbacks and advantages, plagiarism and copyright and on-line enrolment.

Session 15: E-Learning: electronic materials

For those who have little understanding of Web Pages and how to create them then this session will get you started. The first module is a step-by-step self-tuition tool covering Web Page fundamentals using the Microsoft Frontpage application. A second module examines the world of the on-line Electronic Library, showing how to find information on the Internet, gain access to commercial and free abstract databases, library catalogues, e-documents, e-journals and contents pages, and on-line tutorials. This is very much a practical, hands-on session.

Session 16: E-learning: multimedia materials

Using STCW 95 and the ISM Code as a platform, the session asks what is CBT and provides a picture of how one developer, Seagull AS, has responded. The advantages and disadvantages of training at sea with CBT are looked at in the light of learning objectives, interactivity, assessment and evaluation and the administration of training by CBT. Two demonstration multimedia programs are provided by Seagull to assist the instructor.

Session 17: Interaction strategies

How can you prepare and engage students to study and learn through a distance learning environment? The session examines key concepts relating to course materials, interaction styles, models for student involvement, student attitudes, asynchronous learning networks, training workshop strategies and institutional strategies, drawing upon experiences to date.

Session 18: Practical laboratory; interactions

The session is designed to provide experience of separated interaction and communication between an instructor in one laboratory and the participants in another classroom, using multimedia connectivity. A live e-lecture (by the instructor) is delivered to the group, followed by a post-lecture tutorial discussion, all 'at a distance'. The technology needs to be available to carry out this demonstration.

Session 19: Evaluation of distance learning courses

It is most important to understand how successful or otherwise you were in delivering the course. The normal methods of obtaining feedback in traditionally taught courses may not be suitable here. The session examines the issues and techniques that can best assist the course evaluation process, when delivering courses by distance learning methods.

Session 20: Web based education

This session discusses aspects influencing the selection and use of Web based training and management platforms. In shopping for a platform, consideration needs to be given to student, teacher content, creation, technical, cost, implementation and administrative aspects. A number of on-line demonstrations can be shown using the suggested sites.

Session 21: Course Discussion Forum

Some documentation is provided to assist the instructor running the course to conduct a post-course discussion and evaluation.

9.6 A matrix for a progressive approach to technology development

The survey detailed in Chapter 3 indicated that MET institutions range in size from the very small training centre to the large maritime university. Access to capital and recurrent funding also follows very varied patterns in different countries, depending upon the educational and governance structure. The research has attempted to highlight the continuums of technology development that could be used by small, medium and large MET institutions to create and develop a workable strategic plan. Facilities could be introduced and expanded in a balanced way over a number of years, as learning objectives and market demands dictate.

Table 9.4 provides a summary picture of the inter-relationships between size of institution and continuum of development. This does not imply that an institution is constrained in development at its level, but illustrates that technical development should be considered against the key factors of scale of operation, demands of the market place, availability of experienced staff, and funds available. In this way, a progressive and realistic approach to future development can be taken, thereby ensuring that the venture will more likely be assured. Obtaining adequate funding to develop a sustainable platform for delivery of programs via such alternative means will be the biggest challenge for institutional managers.

Table 9.4 A developmental matrix for MET institutions

Continuums MET Institution	**Computer technology**	**Multimedia development**	**Simulation technology**	**Delivery methods**	**Communications**
Training Centre	Computers for staff	Audio-visual Library	PC desktop	Traditional classroom	Basic
Vocational Training Centre	Added accessories	CDR –CD-I Advanced	Single task	Classroom plus limited technology	Low speed links
Small MET academy	Special workstations	Digital technology	Part task	Computer laboratories	Medium speed links
Medium sized MET college	Networks LAN	Web Page site	Full mission	Internet links	High speed links
Large Institute Polytechnic	IT equipped classrooms	Authoring tools	Full mission Internet interactive	Distance learning	High speed links
Maritime University	Interactive PC laboratories	Multimedia studio production	Internet interactive	Web education management system	Satellite links Fibre-optics

Having determined the learning objectives of the institution and the faculty (the result of a strategic planning exercise), the matrix can be used to establish a starting point (or a continuing point) for institutional technology development. In this way available resources (funding and human) can be matched against agreed developmental needs by ensuring that the most economical and effective pathway is selected. Plans for staff training, both technical and teaching, can also be put in place at the same time.

9.7 Summary

The Chapter has drawn upon the investigations into technical developments in the 21st century undertaken by this thesis, and concludes that institutions need to plan carefully for the future, when considering adding new technology to the range of facilities they offer. The background to the development of computer technology and distance learning delivery by educational institutions already has a chequered history of success and failure. In many cases, the lack of a clear analysis of market demand, and a failure to appreciate the time and cost involved in creating and delivering such courses appear to be behind such failures. Careful consideration needs to be given to the impact on human resources when expanding education and training activities into the field of simulator training, creating computer based networks and developing outreach through distance learning. The proposals contained here will assist in orderly and progressive development, matched against financial and human resource capability.

CHAPTER 10

CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

The purpose of this study was described in Chapter 1, section 1.2, where six objectives to be achieved during the course of the research program were established. This final Chapter examines those objectives, evaluates the research undertaken in pursuant of them, and draws conclusions from the work.

The very nature of the global shipping industry demands adherence to both international laws and safe operational standards if chaos is not to be the result of a free-for-all world. The industry is very much subject to political and public pressure to comply with established standards of operational behaviour, and as we saw in Chapter 2, this is reflected in the abundant regime of international maritime conventions, protocols, regulations, codes, resolutions and guidelines. As a consequence, the maritime education and training community finds itself very much under the influence of legislation introduced or changed by the body responsible, the International Maritime Organisation. The rate of technical change in the shipping industry has also gathered pace in the last few decades, as a result of many contributing factors.

The implication for global maritime education and training institutions has been far reaching, impacting upon program and course structures, teaching staff and supporting facilities and services. In an era of reduced interest by many young people in a seagoing career, all institutions have had to adjust their course offerings to meet the demands of the STCW Convention, while seeking to develop a broader educational profile that will enable them to survive in a shrinking maritime market. Yet, the evidence is that funding continues to be a problem for many MET institutions trying to open up new market opportunities based on using new technology and methodologies. The research highlights again a lack of formal training of maritime lecturers and instructors to use new technology in many MET institutions.

The interesting aspect that Chapter 3 brought out, as a result of the well supported global survey of MET institutions (nearly 50% response level), was that there remains a very diverse level of access to computing and simulation technology and staff expertise. Europe and Asia-Pacific regions represented nearly 75% of responses, indicating that these areas are still the powerhouse for the supply of maritime education and training services and trained personnel. Manpower supply is rapidly moving away from Europe, however, to the Asia-Pacific region, this trend being countered to some extent, for example, by indications that European institutions are starting to move into distance learning delivery, at a rate twice that of their Asia-Pacific colleagues. Such developments are very much dependent upon the penetration of, and access to, modern computing and communications technology, a fact highlighted by the returns from the Africa-Middle East region.

There is a strong case for providing systematic support and assistance to many of the smaller institutions, if they are to survive in a growing technically based and reliant MET world. The survey indicates a clear appetite by MET institutions to develop new forward programs around the new technology, but it is equally clear that the funds and expertise to do so are sadly lacking in many cases. Yet, if shipowners wish to attract and retain personnel at sea, it is in their interests to see that the training institutions that supply seafarers to them are equipped with the best facilities and teachers. The research concludes that a more collaborative, cooperative approach between industry and educational services is a key to producing a more satisfactory solution to this problem in future.

The shipowner is, of course, caught in somewhat of a dilemma. If the standards of education and training are raised for a more effective and efficient management of ships and shipping, the risk is that more personnel will be better qualified to leave a seagoing career for a position ashore. This is good for the needs of the shore-based industry. If the standards are kept at the minimum vocational level (i.e. STCW 95) needed to operate a ship safely and effectively, it will not be so attractive to young people as a long term career either. Chapter 4 illustrated the many changes that are occurring onboard ship, resulting in a demand for officers with higher levels of technical skill and proficiency. How to achieve a balance is a problem that European shipowners, in particular, are having to face as they seek a solution to the increasing reluctance of young Europeans to take up a seagoing career. Norwegian shipowners have been among the most pro-active in this regard, looking to technology to help solve the problem. The collaborative efforts being made between Norwegian ship operators, government administration, industry and education and training institutions could very well serve as a model for others across the globe in the 21st century.

Technology, whether in the form of onboard CBT packages or simulation systems, increasingly is being developed in a form that can be used in the shipboard environment. There is strong evidence that, as broadband connectivity becomes increasingly common on the ship at sea, the opportunity for the crew to access onboard training programs, personal education and leisure pursuits will open up a new vista for them, and thus enhance the attractiveness of life at sea as a career. The signs are that industry is slowly becoming aware of the need to pursue such a path. MET institutions are also increasingly aware of the need to work and serve the whole of the maritime industry, whether it be for shipping, ports, terminals or maritime administrations, through the development of extension and enrichment programs. The research efforts funded by the European Commission to increase the mobility of the European seafarer through more flexible education and training programs show that governments are aware of the need to force change in the technology driven 21st century. While technology in itself is not the total answer, it can play a major part in reviving the fortunes of the industry and make sea-going an attractive career path once again.

So how has new technology impacted on the industry? Chapter 5 investigated changes that have occurred in positional fixing accuracy and how the role of the officer of the watch has changed markedly in the past two decades. The advent of very accurate and reliable integrated navigation and bridge systems today provides the 21st century navigator with a world of instant fix, instant knowledge of position and instant perspective of margins of safety. There is some doubt, however, whether all maritime institutions have the required facilities or expertise to meet such training demands. Traditional methods of fixing are rapidly being put aside in favour of integrated technology, yet, as the 'Royal Majesty' grounding case on page 115 showed, technology is not infallible. It can be concluded that MET institutions have reached a watershed, caught between the old and the new, with the future direction of teaching and training in this topic area still unclear due to entrenched traditional attitudes. There is growing evidence of a shift in training from a shore-based learning environment to a shipboard self-paced CBI training environment, as new equipment is installed onboard. Concern has been expressed that shipowners are expecting too much from their officers in this regard, in the light of reduced manning and changed operational demands. There is a need for the MET community to create a more common approach to handling change, so that global standards can be further enhanced and trained personnel provided to suit all modes of operation, both traditional and new.

Another big change affecting the industry has been the development of, and growing access to, satellite communications, Information Technology, multimedia and the Internet. Chapter 5 examined in some detail how such technology had the potential to change ship operational practices, both onboard and in the office ashore, as well as creating a new social environment for the seafarer. Yet many MET institutions lack the computing, multimedia and teaching resources required to support the standards demanded of personnel in the workplace today. There is evidence that many training institutions in the Asia-Pacific region (the major supplier of manpower) lack such resources. If such resources and trained instructors are to be available to meet operational standards of the future, there is clearly a need for a more collaborative approach to training needs between the shipping industry, MET authorities, MET institutions and equipment and software providers, if the needs of a more technology driven society are to be met successfully.

A further objective was to examine the extent to which computers and simulation could be used to advantage in maritime education and training. Chapter 6, in a comprehensive survey of the technology, found clear evidence that shipowners and operators were increasingly moving towards an 'IT Office at Sea' working environment, with implications for both seagoing and shore-based office personnel. This implies that officers with new computing and communication skills will be increasingly in demand by the industry. The ability of many MET institutions in labour supplying countries to meet such demands is in question, in the light of a lack of access to relevant equipment, shipboard operational software, and most importantly, teaching staff with the necessary skills themselves.

In the area of marine simulation, the research shows that, since the introduction of STCW 95 on 1 February 1997, there has been a marked upsurge in the number and type of simulation installations. There is more acceptance by the international maritime community today, five and a half years later, of the value of simulator based training, bringing as it does a focus on hands-on practical experience. Weaknesses remain, including still some skepticism about the validity of the training being undertaken on the simulators. This is partly due to a lack of formal training in pedagogical skills for instructors and assessors in many institutions, with learning on the job still too strong a feature. The human resource (i.e. the instructor) is still the most important element in the effective use of simulators, and more emphasis needs to be placed on meeting the requirements of STCW 95, in this regard.

The biggest challenge facing the industry in the future, brought about by new technology and global connectivity, is the growing cyberspace learning environment. The ability to access data, information, MET courses, on-line resources and to communicate with people anywhere, anytime, as the Internet allows ashore, will soon be within unlimited reach of the ship at sea. In the near future, more broadband satellite links will also provide personnel on a ship with similar 'always on' high speed links, as their compatriots ashore enjoy today. The real drawback to quick progress is lack of such avenues of communication in many developing countries, and as indicated earlier, a lack of IT infrastructure in many MET institutions. The research shows that most institutions are aware of the need to change, if they are not to be left behind in the technology race. There is much potential for onboard learning using CBT and distance learning methods. The advantage to the ship operator of having a better connected, better informed and better trained crew provides a powerful incentive to the industry to engage in some innovative approaches to onboard training needs, while providing an opportunity to overcome the isolation that modern life at sea imposes on crews.

With delivery of courses, by distance learning, moving increasingly to using an electronic on-line format via Web based management systems, the future role of MET institutions in managing education and training services needs further examination. Traditional approaches to assessment will change and technology will be employed more extensively in this regard. The MET community will need to consider the quality assurance aspect too.

Using computer and simulator technology to assess the competence of seafarers presents the greatest challenge for users. Chapter 8 focused specifically on this issue, as research surveys have shown that few simulator instructors have been using simulators to establish the competence of individual trainees. The growing use of CBT programs to incorporate forms of self assessment, on the basis of 'how am I doing?', aims to provide the user with feedback for motivation. Determining whether a user can actually perform functions or tasks in a competent manner is a different task. It can be concluded that a close examination of many CBT programs leaves the reliability and validity of many of their test items somewhat questionable. There is a need for more quality control here.

As Chapter 8 noted, it is evident that clearer guidance on assessment procedures and processes is now available to instructors and assessors. While noting that considerable efforts have been made in the 1990s to measure skill acquisition on simulators, there is still lack of confidence by users in applying the techniques. Future research should be directed towards establishing a more common methodology in using simulators to assess the performance of seafarers, and ensuring that instructors receive appropriate training in assessment methods, as required by STCW 95.

The body of the work has examined the changing MET scene in respect to new technology and teaching methods, with a focus on how this will impact upon MET institutions in the future. In any changing environment, there are proponents for change and opponents. The study shows that the MET environment is no stranger to such opposing views. However, the general response is a positive one, with most MET institutions quite prepared to make the necessary changes. In many cases, steps have already been taken to upgrade facilities and train staff to meet future demands. Yet there is also compelling evidence of a failure by many smaller, financially constrained institutions, to pool their limited financial and physical resources through regional cooperation.

Chapter 9 concludes that careful strategic planning, in relation to the acquisition and use of modern technology, is the only way for many smaller MET institutions to survive in an increasingly technically dependent sector. Looking at technology, as a value-added educational tool, needs to be the first priority. Conducting a 'needs analysis' is a second one. With that focus in mind, it is submitted that a step-by-step approach to the acquisition and use of technology is the best solution, using a series of technical development continuums as a guide. Needs can be matched to financial capability. A mentor approach by larger MET institutions, more fully equipped and developed, to assist smaller institutions to grow technically could be one supporting solution. The provision of IT training workshops is another. The conclusion is that orderly and well planned development is more likely to meet with success with funding authorities than presenting wish lists of equipment.

10.2 Implications for training institutions

The advent of new technology, the Internet and global connectivity is exposing MET institutions to competition as never before. Many general educational institutions are investing in distance learning delivery methods at an increasing rate, offering a growing choice of courses on a global basis. Internet based education alliances are being formed. Ship operators are collaborating with software program developers to make CBT training materials more readily available onboard the ship. Links to training officers ashore are increasingly becoming a feature of new software programs, as Internet links become available on the ship. Shipowners can contract for delivery of training onboard without the expense of releasing personnel to attend short courses ashore. The provision of management, finance and computer training, for example, can just as easily be supplied by a non-maritime education institution. To survive, many MET institutions must undergo a radical change of vision for the future. New mission, new technology, new partners, new programs, new methods, new attitudes will demand a new perception of their role in the 21st century. Traditional and modern ways must find a means of working together in a more globalised MET world.

10.3 Implications for the shipping industry

Change is no less momentous for the shipping industry. 'Always on' communications are opening up a host of operational possibilities. The modern ship has become a floating network, linked via satellite to the head office 24 hours a day. Monitoring of onboard activities, including crew training is taking on a new dimension. What role for the company training manager? What role for the institutions? How can they collaborate more effectively? Technology also opens the door to some innovative social engineering for ships' crews, traditionally isolated from family, friends and their home environment, and most often, a common reason for leaving a sea-going career today. The study illustrates that technology presents the ship operator with a unique opportunity to reverse the manpower drain of recent years. The cost of access to Internet and e-mail services for the crew is far outweighed by the cost of replacing personnel lost to the industry.

10.4 Limitations

The world of technology under investigation in this work has shown itself to be one subject to rapid change and development. As a result, the spotlight has been focused on those aspects of technology impacting upon the delivery of education and training, the teaching process, and ship operations in general. It has not attempted in gauge the impact of automation on power plant operations, for example. Although the rate of return to the survey was very good (47%), certain geographical areas and countries responded poorly to the survey (see Appendix C). The results extrapolated from the survey returns and conclusions drawn may not necessarily be an indication of the specific situation in those areas or countries.

10.5 Implications for future research

Experience in the use of new technology and delivery methods within maritime education and training is still at a fledgling stage. The work illustrates that there is much scope for research into how to develop and apply new technology and methods to full advantage in the future. The traditional ad hoc approach by funding bodies towards research in the MET sector needs to be replaced with a more formal collaborative mechanism. Section 10.6 highlights a number of directions to take that will help a diverse and globally scattered maritime education and training community to achieve positive cohesive outcomes.

10.6 Recommendations

The research has identified a number of factors that are considered to be critical to the future sustainable growth of many MET institutions in an increasing technologically based maritime education and training world. The following recommendations are made to further sustain the ongoing and future effectiveness and prosperity of the global maritime education and training sector:

- Formal programs of training in the use of new technology and teaching methodologies be established for all maritime lecturers and instructors.
- International and national funding mechanisms be created to provide systematic support and assistance to smaller MET institutions, so as to develop a technical support infrastructure appropriate to their demonstrated needs.
- The global maritime industry note the collaborative effort being made by Norwegian shipowners, as an example of how to use new technology for increased effective and safe ship operations.

- The shipping industry examine how new technology can be used effectively to help solve the problem of recruitment and retention of seafarers, especially in European countries.
- MET institutions work together more closely to determine how best to integrate the consequences of new technology and delivery methods into the teaching curriculum.
- MET institutions and the shipping industry examine closely the computing and communication skills needed by the modern seafarer.
- MET institutions and shipping industry examine the potential use of cyberspace for the education and training of both seagoing and shore based personnel.
- A quality assurance mechanism be established to monitor and validate CBT programs, where these are approved for use in STCW 95 recognised courses of training.
- Further research be conducted into establishing a common methodology or approach to assessing seafarer competence using marine simulators.

While this work has focused on the impact of technology on the MET sector in the 21st century, it needs to be remembered that, without human inspiration and innovation, technology in itself achieves nothing. As Galileo once put it " You cannot teach a man anything, you can only help him find it within himself" (Henry, 1959, p. 226). The human resource still remains the most valuable asset that MET institutions hold, and they need to ensure that their learning and teaching environments inspire personnel to develop and use the newly acquired technology to its best potential.

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APPENDIX A

Global Survey of MET Institutions

Availability and use of new computing technology and teaching methods in the 21st Century: A survey of current & future directions

QUESTIONNAIRE

Your support is requested in completing this questionnaire, information from which is designed to assist the global MET community to better meet the challenge of using new computer based technology and teaching methods in the future.

Your answers will be handled in the strictest confidence and no institution will be individually identified in the summary report. Your answers will be tabulated with those of others to provide an overall global picture of MET and technology. The form is also available in French and Spanish should you prefer either of those languages.

To help me evaluate the forms, please indicate your responses either by placing a 'X' in the relevant boxes ☐ provided, or by completing the open questions as appropriate.

SECTION A: GENERAL INFORMATION

A1. Name of MET Institution: ______________________________
A2. Contact Address: ______________________________
A3. Country: ____________________
A4. Contact Person (Optional): ______________________

A5. Type of Institution: (select one only)

Maritime Vocational Training Centre: ☐
Maritime Technical School: ☐
Monotechnic Maritime Academy, College or Institute: ☐
Polytechnic College or Institute: ☐
University or Technical University: ☐

Staff/Student Profile

A6. Number of Academic Staff:	1-50	☐	51-200	☐	>200	☐
A7. Number of Students (Full time):	1-300	☐	301-800	☐	>800	☐
A8. Number of students (Part time):	1-300	☐	301-800	☐	>800	☐

Maritime certificate of competency courses offered

A9. Ratings or Seamen training:		☐		
A10. Watchkeeper:	Deck	☐	Engineer ☐ Fishing	☐
A11. Chief Mate:		☐	Master Mariner (unlimited)	☐
A12. Second Class Marine Engineer:		☐	First Class Marine Engineer	☐
A13. Dual Trained:	OOW	☐	Master/Chief Engineer	☐

Other Maritime Related Educational Award Courses

A14. Certificate level ☐
A15. Diploma level ☐
A16. Undergraduate Degree ☐
A17. Post-Graduate: Diploma ☐ Masters Degree ☐ Doctorate ☐

SECTION B: COMPUTING RESOURCES

	Yes	No
B1. Does the Institution have a dedicated computer network (LAN)?	☐	☐
B2. Is the Internet available to all academic staff?	☐	☐
B3. Is the Internet available to all students?	☐	☐
B4. Is e-mail available and used by all staff?	☐	☐
B5. Is e-mail available and used by all students?	☐	☐
B6. Do staff use computers for teaching in classrooms?	☐	☐
B7. Do you have dedicated Computer Based Training (CBT) laboratories?	☐	☐
If YES, state number of laboratories and computers in them: ____/_____		
B8. Do staff have access to any of the following resources?		
Data sources on CD-ROM, DVD etc.	☐	☐
CD-R/RW drives	☐	☐
Computer scanning devices	☐	☐
Laser printers	☐	☐
Colour printers	☐	☐
Digital Camera	☐	☐
Multi-media recording and production facilities	☐	☐
B9. Do students have access to any of the following resources?		
Data sources on CD-ROM, DVD etc.	☐	☐
Information Technology (IT) through the library	☐	☐
CD-R/RW drives	☐	☐
Computer scanning devices	☐	☐
Laser printer services	☐	☐
Colour printing services	☐	☐

SECTION C: TEACHING RESOURCES

Are classrooms fitted with any of the following equipment?

		Yes	No	If Yes, number available
C1.	Fixed PC based Instructor station	☐	☐	☐
C2.	Fixed SVGA/VGA PC projector	☐	☐	☐
C3.	Video Presentation tablet	☐	☐	☐
C4.	Electronic whiteboard	☐	☐	☐
C5.	Direct Internet/Intranet links	☐	☐	☐
C6.	Overhead Projector (OHP)	☐	☐	☐
C7.	Video Player/Recorder (VCR)	☐	☐	☐
C8.	Television	☐	☐	☐
C9.	Video camera	☐	☐	☐
C10.	Other Audio-Visual (state) ____________________			

SECTION D: TEACHING METHODOLOGIES

	Yes	No
D1. Do you provide training for academic staff on how to use computer based equipment in the classroom?	☐	☐
D2. Do you use specially equipped PC laboratories for computer based training (CBT) with groups of students?	☐	☐
D3. Do you offer any maritime courses by distance learning?	☐	☐
If YES, do you use any of the following resources?		
Tele-conferencing links	☐	☐
Video-conferencing links	☐	☐
e-mail communication links	☐	☐
Web based distance learning management software	☐	☐
Video tapes	☐	☐
Audio tapes	☐	☐
Own in-house multi-media materials	☐	☐
Other (state) ____________________		

SECTION E: SIMULATION FACILITIES

Do you possess and use any of the following forms of marine simulation?

	Yes	No	If yes, manufacturer
E1. Shiphandling (> 180° horizontal Field of View)	☐	☐	____________
E2. Radar/ARPA/Navigation	☐	☐	____________
E3. Machinery Space	☐	☐	____________
E4. GMDSS Communications	☐	☐	____________
E5. Liquid Cargo Handling	☐	☐	____________
E6. Solid Bulk Cargo Handling	☐	☐	____________
E7. Other (state type)	☐	☐	____________

E8. Desktop PC based (state type)____________________
____
____

SECTION F: FUTURE DEVELOPMENTS (FIVE YEAR PERIOD 2000-2005)

Depending on your answers to sections A-E, please respond to the following questions:

	Yes	No
F1. Do you plan to create Computer Based Training (CBT) laboratories?	☐	☐
F2. Do you plan to provide all students with e-mail access?	☐	☐
F3. Do you plan to provide all students with Internet access?	☐	☐
F4. Do you plan to introduce PC projection facilities into all your classrooms?	☐	☐
F5. Do you plan to upgrade the instructional skills of teachers in the use of Information Technology (IT) and CBT in the classroom?	☐	☐
F6. Do you plan to purchase any new marine simulation facilities?	☐	☐

If YES, state type: ____________________

	Yes	No
F7. Do you plan to offer maritime courses via distance learning in the next 5 years?	☐	☐
If YES, please answer the following questions:		
F8. Will you develop distance learning materials in-house?	☐	☐
F9. Do you plan to acquire and use Internet Web based software for management of the distance learning programs?	☐	☐
F10. Do you plan to develop a multi-media studio to create in-house distance learning materials and other supporting audio-visual aids?	☐	☐

SECTION G: GENERAL COMMENTS

If you would like to add further comments regarding future technology developments in your institution please include them below.

____

____

____

____

____

____

____

I would like to receive a copy of the survey summary when completed.

Yes ☐ No ☐

RETURN OF FORMS

Please return the completed questionnaire as soon as possible and not later than **1 December 2000** to:

Professor Peter Muirhead
World Maritime University
P.O.Box 500
S-201 24 Malmö, Sweden

Alternatively you can **Fax** the forms to Professor Muirhead at **+46 40 12 84 42**

If you are using the electronic version of the form this can be returned to me by e-mail.

peter.muirhead@wmu.se

My sincere thanks for your support and cooperation

Peter Muirhead
WMU. Malmö, Sweden

APPENDIX B

Dear Colleague, Research into the use of new technology and teaching methods in MET in the 21st Century- a global survey.

I am writing to you to seek your personal support and assistance with a research project I am undertaking, part of which involves a global survey of maritime education and training institutions and centres. The survey focuses on two aspects namely the current state of technology and teaching methods used at your institution, and your plan or vision for the future introduction and use of new technology and teaching methods into your system.

We enter the new millennium with tremendous changes taking place in computing, simulation, Information Technology, communications and delivery methods. MET is not isolated from such changes and must adapt to the cyberspace world if it is to survive and continue to grow.

The survey form consists of a series of short concise and precise questions, most of which only require a box to be ticked. I would be most grateful if you (or one of your associates) would spare a few minutes to complete the form with as much of the requested technical and pedagogical information about your MET institution as possible.

Please return the form to me by mail at the address below:

Professor Peter Muirhead
World Maritime University
P.O.Box 500
S-201 24 Malmö, Sweden

Alternatively you can fax the form to me on +46 40 128 442.

The form is also available on the web in English at www.wmu.se/metsurvey.htm

Please return your responses to me by **1 December 2000**, latest.

If you are interested in the results of the survey please tick the box on the form and I will ensure that a summary copy is forwarded to you when completed.

My thanks and appreciation to you for supporting this important future development.

Sincere regards

Peter Muirhead
Inmarsat Professor of Maritime Education & Training
World Maritime University

APPENDIX C

List of Maritime Institutes targeted by the Questionnaire

(* indicates responded to the survey)

Algeria
Institut Superieur Maritime, Bou-Ismail
Ecole Technique de Formation et d'Instruction, Route du Port de Bejaia *
Argentina
Escuela Nacional de Nautica, Buenos Aires
Australia
Australian Maritime College, Launceston, Tasmania *
South Metropolitan College of Technical and Further Education, Fremantle *
Sydney Institute of Technology, New South Wales
Bangladesh
Marine Academy, Chittagong *
Belgium
Hogere Zeevaartschool, Antwerp *
The Nautical Centre, Zeebrugge
Brazil
Instruction Centre Admirante Graca Aranha, Rio de Janeiro
Canada
Nova Scotia Community College, Port Hawkesbury, Nova Scotia *
Pacific Marine Training Institute, North Vancouver,
The Marine Institute of Memorial University, St John's, Newfoundland
Institute Maritime Du Quebec, Drimouski, Quebec
Cape Verde
ISECMAR, Mindelo, St Vincent
Chile
Maritime Instruction & Training Centre, Valparaiso *
China
Dalian Maritime University, Dalian *
Guangzhou Mariner School, W Guangzhou,
Jimei Navigation Institute, Xiamen, Fujian Province
Qingdao Ocean Shipping Mariners' College, Qingdao *
Shanghai Maritime University, Shanghai *
Colombia
Escuela Naval "Almirante Padilla" *
Cote D'Ivoire
Academie Regionale des Sciences et Technique de la Mer, Abidjan *
Croatia
Rijeka College of Maritime Studies, Rijeka
Cuba
Instituto Tecnologico para el Transporte Maritimo, La Habana
Cyprus
Higher Technical Institute, Nicosia *
Denmark
Aalborg Marine Engineering College, Aalborg,
Marine Engineering College, Aarhus

Frederikshavn Marine Engineer College, Frederikshavn *
Copenhagen Marine Engineering College, Copenhagen *
Esjberg Marine Engineer College, Esjberg
Fanoe Navigation School, Fanoe *
Marstal Navigation School, Marstal
SIMAC ProcessTechnic, Copenhagen *
Svendborg Seafarers School, Svendborg

Ecuador

Escuela Superior Politecnica del Littoral, Guayaquil

Egypt

Arab Academy for Science & Technology, Alexandria *

Estonia

Estonia Maritime College, Tallinn *

Fiji

Fiji Instiute of Technology, School of Maritime Studies *

Finland

Kotka Polytechnic Maritime College, Kotka *
Maritime College of Rauma, Rauma
Maritime Institute of Turku, Turku *
Åland Nautical College, Mariehamn, Åland Islands

France

Ecole Nationale Marine Marchande du Havre, Le Havre *
ENMM du Marseilles, Marseilles
ENMM du Nantes, Nantes *
ENMM du St Malo, St Malo *

Germany

Hamburg Fachhochschule, ISSUS, Hamburg-Altona *
Fachhochschule Oldenburg, Elsfleth *
Fachhochschule Oldenburg, Wilhelmshaven *
Fachhochschule Ostfriesland, Leer *
Hochschule Bremerhaven, Fachbereich Nautik, Bremerhaven *
Bremen University of Applied Sciences, Bremen *
Hochschule Wismar, Warnemünde *
Staatliche Seefahrtschule, Cuxhaven
IFS Flensburg University, Flensburg *

Ghana

Regional Maritime Academy, Accra *

Greece

The National Merchant Marine Academy, Attica,
Merchant Marine Centre for Further Education, Piraeus
The National Merchant Marine Academy of Macedonia, Thessaloniki

Hong Kong

Department of Maritime Studies, Hong Kong Polytechnic University
Seamen's Training Centre, Hong Kong

Honduras

Escuela Tecnica Naval, Puerto Cortes

Iceland

Navigation College, Reykjavik *

India

Indian Maritime College, Madras *

Lal Bahadur Shastri Nautical & Engineering College, Mumbai
The Maritime Training Institute, SCI, Powai, Mumbai *
Directorate of Marine Engineering Training, Calcutta *
Indonesia
Ujung-Pandang Merchant Marine Academy, Ujong-Pandang *
Sea Communication Education & Training Centre, Surabaya
Iran
Noushahr Nautical College, Tehran
College of Nautical Studies, Chabahar *
Marine Training Centre, National Iranian Oil Company, Ahwaz *
Ireland
Cork Regional Technical College, Cork
Israel
Centre for Maritime Studies, University of Haifa, Haifa
Maritime Training Institute, Akko *
Italy
Istituto Tecnico Nautico Statale "Duco di Genova", Trieste
Collegio Nazionale Patentati Capitani, Genova
Istituto Tecnico Nautico Statale "Nino Bixio", Napoli
Istituto Tecnico Nautico Statale "Sebastiano Venier", Venezia
IMO International Maritime Academy, Trieste
Jamaica
Jamaica Maritime Institute, Kingston *
Japan
Hiroshima Mercantile Marine College, Hiroshima
Institute for Sea Training, Chioda-Ku
Kobe University of Merchant Marine, Kobe *
Marine Technical College, Ashiya-city *
Tokyo University of Merchant Marine, Tokyo *
Toyama National College of Maritime Technology, Toyama
Toba National College of Maritime Technology, Toba-Shi
Kenya
Bandari College, Kenya Ports Authority, Mombasa
Latvia
Latvian Maritime Academy, Riga
Lebanon
Institute for Higher Studies, Beirut
Liberia
Maritime Training Institute, Monrovia
Libya
Faculty of Maritime Studies, University of Tripoli
Lithuania
Maritime Institute and College of Klaipeda University, Klaipeda
Madagascar
Ecole Nationale d'Enseignement Maritime, Mahajanga *
Malawi
Malawi Marine Training College, Monkey Bay *
Malaysia
Akademi Laut Malaysia (ALAM), Melaka

Marshall Islands
Fisheries and Nautical Training Centre, Majuro
Mexico
Excuela de Marina Mercante de Mazatlan, Mazatlan, Sinaloa *
Excuela de Marina Mercante de Veracruz, Veracruz *
Excuela de Marina Mercante de Tampico, Tampico
Morocco
Institut Superieur des Etudes Maritimes, Casablanca *
Mozambique
Escola Nautica de Mozambique, Maputo
Myanmar
Institute of Marine Technology, Yangon
Netherlands
Amsterdam Polytechnic, Amsterdam
Nautical School "Abel Tasman", Appingedam
Hogere Technisch en Hoger Nautisch Onderwijs, Rotterdam
Hogere Zeevartschool, Amsterdam
Maritiem Instituut "Willem Barentsz", Terschelling *
Technisch Onderwijs "T Noorderhooft", Den Helder
Stichting Scheepvaart en Transport College, Rotterdam *
Maritime Institute "De Ruyter", Vlissingen
New Zealand
New Zealand Maritime School, Manakau Polytechnic, Auckland *
Nigeria
Maritime Academy of Nigeria, Oron
Norway
Trondheim Navigation School, Trondheim *
Arendal Maritime Tekniske Skole, Arendal
Vestfold College, Tonsberg
Bergen Maritime Videregaende Skole, Bergen
Bodin Nautical College, Mörkved
National College of Safety Engineering, Haugesund
Oslo Teknisk-Maritime Skole, Oslo
Nautical College, Tromso *
Stavanger Maritime College, Stavanger
Pakistan
Pakistan Marine Academy, Karachi *
Panama
Columbus University, Nautical Institute, Panama *
Escela Nautica de Panama, Paitilla
Papua-New Guinea
Papua New Guinea Maritime College, Madang
Peru
Escuela Nacional de la Marine Mercante "Almirante Miguel Grau", Callao *
Philippines
Cagayan Capitol College, Cagayan de Oro City
Magsaysay Institute of Shipping, Cavite
Magsaysay Training Centre, Manila
National Maritime Polytechnic, Cabalawan, Tacloban City
Norwegian Training Centre, Manila

Philippine Merchant Marine Academy, Zambales
University of Cebu, Cebu City

Poland

Wyzsza Szkola Morska, Szczecin *
Gydnia Maritime Academy, Gdynia *

Portugal

Escola Nautica Infante D'Henrique, Oeiras *

Republic of Korea

Korean Maritime Institute, Seoul

Romania

Merchant Training Centre, Constanta *
Constanta Maritime University, Constanta *

Russia

Admiral Makarov State Maritime Academy, St Petersburg
Far Eastern Higher Marine Engineering College, Vladivostok *

Saudi Arabia

Coast Guard Training Centre, Jizan

Senegal

Ecole Nationale de Formation Maritime, Dakar

Seychelles

School of Maritime Studies, Mahe

Sierra Leone

Marine Training School, Freetown

Singapore

Ngee Ann Polytechnic, Singapore *
Maritime Technology Department, Singapore Polytechnic, Singapore

Slovenia

Marine School, Portoroz *
University of Lubljana, Portoroz *

Solomon Islands

School of Marine and Fisheries Studies, Honiara *

Spain

Escuela Superior de la Marina Civil, Santander
Escuela Superior de la Marina Civil de Tenerife, Tenerife *
Escuela Superior de la Marina Civil. La Coruna
Escuela Superior de la Marina Civil de Bilboa, Bilbao
Escuela Superior de la Marina Civil, Barcelona
Maritime Safety Training Centre "Jovellanos", Gijon
Facultad Ciencias Nauticas Cadiz *

Sri Lanka

Goodwill Maritime Academy, Colombo
Institute of Maritime Studies, Colombo
Moratuwa University, Division of Maritime Studies, Moratuwa *

Sweden

Chalmers University of Technology, Göteborg *
Merchant Marine Academy, Kalmar *
World Maritime University, Malmö *

Tanzania

Dar-es-Salaam Maritime Institute, Tanzania

Thailand
Merchant Marine Institute, Chulalongkorn University, Bangkok *
Merchant Marine Training Centre, Samutprakarn *
Tonga
Tonga Polytechnic Maritime Institute, Nukualofa *
Tunisia
Ecole de la Marine Marchande, Sousse
Turkey
Istanbul Technical University, Maritime Faculty, Tuzla, Istanbul *
Anatolian Maritime School, Besiktas
Ukraine
Odessa State Maritime Academy, Odessa
Odessa Marine Engineering Institute, Odessa
United Kingdom
Blackpool & Fylde College, Dept of Marine Operations, Fleetwood *
Glasgow College of Nautical Studies, Glasgow *
South Tyneside College, South Shields *
Southampton Institute, Maritime Faculty, Southampton
Warsash Maritime Centre, Warsash, Southampton *
Department of Maritime Studies, University of Ulster, Jordanstown
Uruguay
Escuela Naval, Felipe Carape *
USA
California Maritime Academy, Vallejo *
Maine Maritime Academy, Castine *
Massachusetts Maritime Academy, Buzzards Bay
SUNY Maritime College, Throggs Neck
Texas State Maritime Programs, Texas A&M University, Galveston *
United States Merchnat Marine Academy, Kings Point *
Venezuela
Escuela Nautica de Venezuela, Caracas
Viet Nam
Vietnam Maritime University, Hai Phong *
Western Samoa
Samoa Polytechnic, Apia *

APPENDIX D

SURVEY OF SHIPHANDLING SIMULATORS 1967-2002

SHIPHANDLING/NAVIGATION SIMULATORS (WITH A VISUAL CAPABILITY)

No	Name and location	Year	Type	Maker
1. *	SSPA, Göteborg, Sweden	1967	CGI/TV	SSST
2. *	SMS, TNO-Delft, Netherlands	1968	Shadowgraph	TNO
3. *	MARIN, Wageningen, N'Lands	1969	Shadowgraph	TNO
4.	SSS, Hiroshima Uni, Japan	1971/88	Slide/CGI	Uni [1]
5. *	Bremen Poly, W.Germany	1975	Slide projectn	VFW
6.	IHI, Tokyo, Japan	1975/92	Slide/CGI	IHI/NAC [2]
7. *	SHS, Osaka Uni, Japan	1975	Shadowgraph	Uni
8. *	Navy, DenHelder, Netherlands	1975	Nocturnal	Navy
9. *	TNO-Soesterberg, Netherlands	1976	Modelboard	TNO
10.	CAORF, K.Pt, New York, USA	1976	CGI	Sperry
11. *	Marine Safety Int, NY,USA	1976	Modelboard	Sperry
12. *	MARIN, Wageningen, Nethlands	1976	Nocturnal	TNO
13. *	Warsash College, S'Ton, UK	1977	Nocturnal	Decca [3]
14. *	TUMM, Tokyo, Japan	1978/83	Shadow/CGI	NAC/Uni [4]
15.	Bremen Poly, W.Germany	1978	Nocturnal	VFW
16. *	Mitsubishi, Nagasaki, Japan	1978	Slide Projectn	MHI
17.	Ship Analytics. N.Stonington,USA	1979	CGI	Ship Analytics
18. *	SMS Trondheim, Norway	1979/95	Noctl/CGI	VFW-Norc
19. *	Danish Mar.Inst, Lyngby,	1980	CGI/TV	DMI
20. *	Warsash College, S'Ton, UK	1981	Nocturnal	Decca
21.	MITAGS, Baltimore, USA	1981 #	Nocturnal (2)	VFW
22. *	Shipsim, S.Shields College, UK	1982	Nocturnal	Decca
23. *	CASSIM, UWIST Cardiff, Wales	1982	CGI/Tepigen	Marconi [5]
24.	SUSAN, Hamburg, W.Germany	1982/97	CGI	Krupp Atlas
25. *	Shipsim, Glasgow, Scotland	1982	Nocturnal	Decca
26. *	SMS, Trondheim, Norway	1982	Slide Projectn	VFW
27. *	RSSC, Leningrad, USSR	1983	Nocturnal	Norcontrol
28.	Marin, Wageningen, Netherlands	1983	CGI/Graphic	TNO
29.	Toledo, Ohio, USA	1983	CGI	Ship Analytics
30.	USAAEWES, Vicksburg, USA	1983	CGI	USAEWES
31	Flanders Hydraulics, Belgium	1984	CGI	MSCN/Sindel
32.	Navy, Sydney, Australia	1985	CGI	Krupp Atlas
33.	AMC, Launceston, Australia	1985	CGI	Krupp Atlas
34.	TUMM, Kobe, Japan	1985	CGI	Uni
35.	Taiwan Maritime College, Taiwan	1985	CGI	Krupp Atlas
36.	Piney Point, Maryland, USA	1985	CGI	Ship Analy
37.	USCG, New London, Ct, USA	1985	CGI(2)	Ship Analytics
38.	Finsim, Espoo, Finland	1986	CGI	Racal/Mconi
39.	MTC, Ashiya, Japan	1986	CGI	MTC
40.	Navy, Kiel, W.Germany	1987	CGI	Krupp Atlas

Simulator Table continued ...

No	Name and Location	Year	Type	Maker
41.	Plymouth Polytechnic, UK	1987	CGI	Racal/Decca
42.	Ship.Res.Inst, Tokyo, Japan	1988	CGI	SRI
43.	Korean Mar. T.I. Pusan,Korea	1988	CGI	Norcontrol
44.	FETI, Vladivostok, Russia	1989	CGI	Norcontrol
45.	Petropavlovsk, Russia	1989	CGI	Norcontrol
46.	Instituto Osservatori, Genoa	1989	CGI	Sindel
47.	Nova Scotia Nautical Inst., Canada	1989	CGI	Norcontrol
48.	ENMM, St Malo, France	1989	CGI	Norcont/Thom
49.	Sakhalin Shipping Co, Russia`	1989	CGI	Norcontrol
50.	Chabahar, Iran	1989	CGI	Norcontrol
51.	Bulgarian MTI, Bulgaria	1990	CGI	Norcontrol
52.	Haugesund Mar.Colleg, Norway	1990	CGI	Norcontrol
53.	NIOC, Teheran, Iran	1990	CGI	Norcontrol
54. **	Danube Shipping Co, USSR	1990	CGI	Norcontrol
55.	Danish Mar.Inst,Lyngby, Dmark	1990	CGI	Norcontrol
56.	KMTRC, Korea	1990	CGI	Ship Analytics
57.	Inst. Tecnico Nautico, Venezia, It	1990	CGI	Sindel
58.	Kesen Inst., Piraeus, Greece	1990	CGI	Sindel
59	Sakhalin Ship Co, Russia	1991	CGI	Norcontrol
60.	SUNY, New York	1992	CGI`	Norcontrol
61.	Seamans Ch. Inst, New York, USA	1992	CGI(2)	Norcontrol
62.	MSCN, Wageningen, Netherlands	1992	CGI	MSCN
63.	Marine Inst, Newfoundland, Can	1992	CGI #	Norcontrol
64.	Vestfold Poly,Tonsberg, Norway	1992	CGI	Norcontrol
65.	World Trade Centre,Singapore	1992	CGI	Norcontrol
66.	Indian Navy, Bombay	1992	CGI	Ship Analytics
67.	Kotha, Finland	1992	GI	Sindel
68.	SMS, Trondheim, Norway	1992	CGI	Norcontrol
69.	Britannia RNC, UK	1992	CGI	Norcontrol
70.	Maine Maritime Academy, USA	1992	CGI(2)	Norcontrol
71.	Inst.Tecnico Nautico,Palermo, It	1992	CGI	Sindel
72.	Kotka Inst.Naut Studies,Finland	1992	CGI	Sindel
73.	Yusen Marine Sc. Tokyo, Japan	1992	CGI	Yusen
74	CEDEX, Madrid, Spain	1992	CGI	MSCN
75.	Kalmar Marine Academy, Sweden	1993	CGI	Norcontrol
76.	Nizhny Novgorod Russia	1993	CGI	Norcontrol
77.	Far Eastern T.I., Vladivostok	1993	CGI	Norcontrol
78.	Mariehamn, Finland	1993	CGI	Norcontrol
79.	STC, Sydney, Australia	1993	CGI	Norcontrol
80.	Port of Singapore, Singapore	1993	CGI	Ship Analytics
81.	State Uni. St Petersburg, Russia	1993	CGI	Sindel
82.	Southampton Inst H.E, UK	1993	CGI	Norcontrol
83.	W.Japan Dynam Inst, Sasebo,Japan	1993	CGI	na
84.	Star Centre, Dania, Florida, USA	1993	CGI(2)	Norcontrol
85.	MSTC, Terschelling, Netherlands	1993	CGI	MSCN
86.	SMS, Trondheim	1993	CGI	Norcontrol

Simulator Table continued ...

No	Name and Location	Year	Type	Maker
87.	FMSS Navy, Brazil	1993	CGI	Ship Analytics
88.	Panama Canal Commission,Panama	1993	CGI	Ship Analytics
89.	Tromso College, Norway	1993	CGI	Norcontrol
90.	STAR, Toledo, Ohio USA	1993	CGI	Norcontrol
91.	KRISO, Taejon, Korea	1993	CGI	KRISO
92.	IHI High Speed,Tokyo, Japan	1993	CGI	IHI
93.	IHI Compact,Tokyo, Japan	1994	CGI	IHI
94.	WSM, Szczecin, Poland	1994	CGI	Norconrtol
95.	PDV Marine, Venezuela	1994	CGI	Norcontrol
96.	MSR, Rotterdam	1994	CGI(2)	MSI
97.	Turkish Navy	1994	CGI	Ship Analytics
98.	HMS Dryad, Portsmouth,	1994	CGI	Norcontrol
99.	West Coast STAR, Seattle,USA	1994	CGI(2)	Norcontrol
100.	US Navy, San Diego	1994	CGI(2)	MSI
101.	Bombay, India	1994	CGI	Ishikawajimi
102.	R.T.Navy, Thailand	1994	CGI	STN Atlas
103.	Volgo Tanker Company, Russia	1994	CGI	Norcontrol
104.	CCG,Sydney NS,Canada	1994	CGI	Norcontrol
105.	Danish Mar.Inst, Denmark	1994	CGI	NorcontDMI
106.	RNN, Den Helder,Netherlands	1994	CGI	MSCN
107	Marconi, Genova,Italy	1994	CGI	Sindel
108.	Nautical Sch., Palermo, Italy	1994	CGI	Sindel
109.	Singapore Water Police	1995	CGI	STN Atlas
110.	Gijon, Spain	1995	CGI	Norcontrol
111.	TNCMT, Toyama, Japan	1995	CGI	AME
112	TAMU, Galveston, Texas,USA	1995	CGI	ShipAnl/TMO
113	SNSS Texas A&M, USA	1995	CGI	Ship Analytics
114	Svendborg Nav.Sch, Denmark	1995	CGI	Norcontrol
115	Sydney Tech.Coll, NSW,Australia	1995	CGI	Norcontrol
116	Singapore Police, Singapore	1995	CGI	Ship Analytics [6]
117	AMTA, Alexandria, Egypt	1996	CGI	Ship Analytics
118	Turku Mar.Inst, Finland	1996	CGI	Sindel
119	Navy, Chittagong, Bangledesh	1996	CGI	Sindel
120	Sticheting Coll,Rotterdam, Holland	1996	CGI	Norcontrol
121	DMI,Lyngby, Denmark	1996	CGI	Norcontrol
122	Högskole,Alesund, Norway	1996	CGI	Norcontrol
123	Suez Canal Authority, Egypt	1996	CGI	Norcontrol
124	ENMM, Nantes, France	1996	CGI	Norcontrol
125	CIAGA/CIABA, Brazil	1996	CGI	Ship Analytics
126	SCANTS, USCGA, New London	1996	CGI	Ship Analytics [7]
127	Taiyo Electric, Yokyo, Japan	1996	CGI	Norcontrol
128	M.O.Consulting, Hiroshima,Japan	1996	CGI	MO Consult
129	NAROV, Curacao, N.Antilles	1996	CGI	Norcontrol
130	SHS University Alicante, Spain	1996	CGI	STN Atlas

Simulator Table continued ...

No	Name and Location	Year	Type	Maker
131	Navy, Victoria, BC, Canada	1997	CGI	Norcontrol
132	Kobe M.U, Kobe, Japan	1997	CGI	Norcontrol
133	Navy, Brest, France	1997	CGI	Norcontrol
134	Navy, Sydney, Australia	1997	CGI	Norcontrol [8]
135	USCGA, New London,USA	1997	CGI	Ship Analytics [9]
136	SOS AMC, Tasmania, Australia	1997	CGI	STN Atlas
137	SUSAN, ISSUS, Hamburg	1997	CGI	STN Atlas [10]
138	Warnemunde Polytechnic, Germany	1997	CGI	STN Atlas
139	RTN Bangkok, Thailand	1997	CGI	STN Atlas
140	Seamans C.I: Inland Waters Paducah	1997	CGI IW	Norcontrol
141	South Shields Marine College,	1998	CGI	Norcontrol
142	HMS Dryad, Portsmouth,	1998	CGI	Norcontrol
143	Massachusets Mar.Academy, USA	1998	CGI	Adv.Mar.Ent
144	Italian Navy, Livorno	1998	CGI	STN Atlas/Sindel
145	Norwegian Navy, Bergen, Norway	1998	CGI	STN Atlas
146	SHS IMSFT, Korea	1998	CGI	STN Atlas
147	SHS Bremen, Germany	1998/2000	CGI	STN Atlas
149	Star Cruises SHS, Malaysia	1998/2000	CGI	STN Atlas
150	US Centre for ME Kentucky, USA	1999	CGI	Norcontrol [11]
151	AMOSU, Philippines	1999	CGI	Norcontrol
152	Bridge Sim Italian Navy, Italy	1999	CGI	STN Atlas
153	Glasgow CNS	2000	CGI	Transas
154	Evergreen Marine, Taiwan	2000	CGI #	KMSS
155	Liverpool Lairdside Mar.Centre	2000	CGI #	KMSS [12]
156	Seaman's Church Inst. USA	2000	CGI #	KMSS
157	Royal New Zealand Navy	2000	CGI #	KMSS
158	OOCL, Zhoushan,,,, China	2000	CGI	Transas
159	FHS Oldenburg, Germany	2001	CGI	KMSS
160	KTU, Tabzon, Turkey	2001	CGI	Sindel
161	Hellenic Navy, Athens, Greece	2001	CGI	Sindel
162	G.Marconi Institute, Genoa, Italy	2001	CGI	Sindel
163	ENMM, Le Havre, France	2001	CGI	Sindel
164	Gyeong Sang Nat.Uni, Korea	2001	CGI	KMSS
165	BCIT, Vancouver, Canada	2001	CGI	KMSS
166	Alaska Vocational Training Centre	2001	CGI	KMSS
167	Tromso Maritime Polytechnic	2001	CGI	Poseidon
168	M.I. 'Willem Barentz', Netherlands	2001	CGI (4)	KMSS
169	Naval Academy, Varna, Bulgaria	2001	CGI	Transas
170	IDES Maritime Centre, Philippines	2001	CGI #	Transas
171	SHS Cimar, Chile	2001	CGI	STN Atlas
172	SHS MITAGS, Baltimore, USA	2002	CGI	STN Atlas
173	Star Centre, (Diesel Elec) Florida	2002	CGI	KMSS
174	Maritime & Port Authy, Singapore	2002	CGI # (2)	KMSS
175	Panama Canal Authority, Panama	2002	CGI #	KMSS
176	SHS Sim Centre PSC, Malaysia	2002	CGI	STN Atlas

Simulator Table continued ...

No	Name and Location	Year	Type	Maker
177	Royal Malaysian Navy	2002	CGI	STN Atlas
178	Centro EP Costas, Spain	2002-2003	CGI	KMSS
179	Polish Naval University, Gdynia	2003	CGI	Transas
180	Novorossiyak S.Co, Russia	2003	CGI	KMSS

Comments.

* Simulators thus marked have since been replaced by Computer Generated Imagery (CGI) systems or closed down.

** Simulator thus marked is a riverboat simulator.

\# 360° Horizontal FOV

IW Inland Water simulator

Notes.

1. 1971 Film projection system replaced in 1988 with a CGI based system
2. 1975 Slide projection system replaced in 1992 with a CGI based system
3. This first Warsash nocturnal simulator was closed down in 1993
4. 1974 shadowgraph system was replaced in 1983 with a CGI based system
5. Closed down in 1985.
6. Radar tactical trainer.
7. Upgrade of existing simulator
8. System changed from Atlas to Norcontrol.
9. 2nd simulator being installed.
10. The simulator has been extensively upgraded with a new system.
11. Inland Waterways simulator for towboat operators, with two ownship bridges with visuals.
12. Konsberg Maritime Simulation Systems (KMSS) formerly Norcontrol

Sources:

IMSF/SNAME reports 1984-2002; IMLA reports; IMO surveys 1992-1996
Manufacturers returns and press releases; Current relevant journals and newspapers
Internet data sources

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Date: 13 November 2002

APPENDIX E

USMMA CADET WATCH TEAM GRADING SHEET

Date: 5/6/93 **Team:** B-2	**Arrival** Cristobal: **Day** X **Night** (anchorage in Limon Bay)
Watch Officer: Frost	Range and bearing of anchor position
Navigator: Dostie	arrived at from the planned anchor position
Radar Obs: Marlow	
Helm: Plebe	**Time let go Anchor:** 0655 < 2 cables short

EXECUTION		**APPRAISAL & PLANNING**	
Total 40 points – 2 points per item		Total 30 points – 2 points per item	
01 Compliance with Masters standing orders	1.5	01 All relevant publications studied	2
02 Proper preparation for arrival	2	02 Satisfactory plan on form	2
03 Proper internal communications	2	03 Tracks and courses on chart	2
04 Proper VHF procedures	2	04 Dangers and margins of safety marked	2
05 Master/engine room kept informed	2	05 Tidal times and heights calculated	2
06 ETA's maintained	1.5	06 Sufficient UKC/Squat ascertained	2
07 Proper helm orders given	2	07 Critical wheel over marked correctly	2
08 Frequency and method of position fixing	2	08 ETA's and distances planned	2
09 Margins of safety maintained	2	09 VHF channel noted and response points marked	2
10 Optimum use of all navigation aids	2	10 Frequency and method of fixing planned	1
11 Compliance with port regulations	2	11 Relevant port regulations considered	2
12 Safe speed maintained at all times	2	12 Weather expectations and forecast	2
13 Efficient visual lookout maintained	2	13 Ship's manoeuvring capabilities considered	2
14 Anchoring properly prepared & executed	2	14 Contingency plans made	2
15 Optimum use of bridge personnel	2	15 Effective anchoring plan made	2
16 Bell book properly maintained	2	**APPRAISAL AND PLANNING SCORE**	29
17 Logbook properly maintained	2		
18 VHF log properly maintained	2	**ORGANISATION & TEAMWORK**	
19 Anchored in correct anchorage	2	Total 10 points – 5 points per item	
20 Ship satisfactorily manoeuvred	2	01 Watch Officer composure	5
EXECUTION SCORE	39	02 Teamwork	4
MONITORING		**ORGANISATION & TEAMWORK SCORE**	9
Total 20 points – 2 points per item		**SUMMARY**	
01 Track (Charted fixes and position)	2	Appraisal and Planning (30)	29
02 Depths	2	Execution (40)	39
03 Traffic	2	Monitoring (20)	18
04 VHF	2	Organisation and teamwork (10)	9
05 Helm	2	Total Points (out of 100)	95
06 Instruments RPM indicator	1	AUTOMATIC DEDUCTIONS	
07 Visibility/weather	2	1 point for each minute late 0655	5
08 ETAs 8 mins late at breakwater	1	15 points for extremely poor navigation/grounding	0
09 Passing information	2	**ADJUSTED (FINAL) SCORE**	90
10 Watch Officer	2		
MONITORING SCORE	18		

COMMENTS:
Planning: Include frequency of fixes
Execution: Master desired the anchor to be let go at 0650, and late at three way points.
Monitoring: Keep an eye on the RPM indicator, EOT at stop after test – had no RPMs from 0606 until 0621 and resulted in late ETAs.
Overall however, well done, erred on the side of safe speed and kept good control of arrival.
Instructor: R.J.Meurn

Source: Modified from Meurn & Sandberg (1993)

APPENDIX F

USMMA STCW Assessment methods using CAORF simulator

Competence	Knowledge, Understanding Proficiency	USMMA STCW Table	USMMA Method of assessment	Where assessed in USMMA program
1. Plan and conduct a passage and determine position	(j) Ability to determine errors of the magnetic and gyro compass, using celestial and terrestrial means, and to allow for such errors	(A-II/1) – 1 – KUP (j)	*Terrestrial means*: Graded practical exam in CAORF simulator	*Terrestrial means assessed*: "Bridge Watchstanding" TRB 10.1.1.10

Candidate's Name ________________

STCW Assessment control sheet DN460-6C

STCW requirement	STCW Table A-II/1 (Specification of minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tons or more)
STCW Function	Navigation at the operational level
STCW Competence	Plan and conduct a passage and determine position
STCW Knowledge, Understanding and Proficiency (KUP)	Ability to determine errors of the magnetic and gyro compass, using terrestrial means, and to allow for such errors. Note: Ability to determine errors of the magnetic and gyrocompass, using *celestial* means, and to allow for such errors, will be assessed in the Second sailing navigation sea project.
Assessment method	Graded practical exam in the CAORF simulator
Training Record Book (TRB) Ref. (if applicable)	Compass Error –determining 10.1.1.10B
Course/Designated examiners	Bridge Watchstanding (DN460) Meurn, Sandberg

EACH OBJECTIVE MUST BE SUCCESSFULLY DEMONSTRATED

Assessment Objective	Performance Measure/Standard	Pass	Fail	Date
Determines errors of the magnetic and gyro compass, using terrestrial means, and allows for such errors.	Determines gyro and magnetic compass error within 0.5 degrees of the actual error and orders a course to steer that allows correctly for this error within 0.5 degrees.			

Comments
Midshipmen must pass all three measures found on the assessment worksheet to pass this KUP. A midshipman who fails a KUP must be informed of his/her error and given instruction on how to improve his/her performance before a retake is scheduled.
A Midshipman who fails the KUP will have the opportunity to pass it during a second exercise. The retake must be passed to satisfy STCW requirements.
A Midshipman who fails a retake shall be referred to the Academy's Professional Review Board for further action.

IMO/STCW ASSESSMENT WORKSHEET

Performance Measure	Performance Standard	Pass	Fail
1. The Midshipman takes a visual bearing on a range and determines gyro error in a timely manner	+/- 0.5° of actual gyro error within 2 minutes		
2. Compares gyro compass with magnetic and determines magnetic compass error	+/- 0.5° of actual magnetic error		
3. Adjust gyro/magnetic course to compensate for compass error and steer appropriate true course	Course ordered to be steered is within +/- 0.5° of appropriate course		

Instructor's Signature: ______________________________ Date: ________________

Note: Midshipman must pass all three measures to pass this KUP.

Modified from Meurn R.J and Sandberg G.R. (2000, 220-225)

APPENDIX G

Selected MET teaching and simulation software

Developer	Education and training purpose
Baron & Dunworthy	CRISIS damage stability
Baron & Dunworthy	MARINER bulk and container ship loading and unloading
Boxer Technologies	Shipmaster 2000 – ship administration
Cobalt	Marine engineering operations
Today Pubs	CORIFFS Deck and engineering self examiners; stability
Focus Essential	Teach Yourself MS Word, PowerPoint, Excel, Access
Force Technology	SIMFLEX: Shiphandling/navigation simulation
Marinesoft	Engineroom simulation
Marinesoft	Maritime English
PC Maritime Ltd	Electronic Chart
PC Maritime Ltd:	OFFICER OF THE WATCH – Deck watchkeeper
Poseidon AS	GMDSS operator simulation
Poseidon AS	Radar-ARPA training
SCUSY	Container terminal planning
Seagull AS	CES 4.1 seafarer competence assessment
Seagull AS	Stability and damage stability
Seagull AS	CBT CD-Rom suite (all STCW 95 functions)
Seamanship Intl	STCW examinations and short courses
Ship Analytics	WISE CARGO: Double hull tanker operations
SSPA Sweden	PORTSIM - shiphandling simulation in port
Transas Ltd:	NAVITRAINER – Deck watchkeeping
Unitest, Poland	Marine engineering operations
Videotel Ltd	Colregs Rule of the road
Videotel Ltd	MEETS Cadet training program
Videotel Ltd	SETS 6000 Seafarer evaluation system
WMU-Scinapse	TANKERSIM - Ship chartering business