7th Annual General Assembly
and Conference
AGA-7
October 16-18, 2006
The International Association of Maritime Universities
IAMU

PROCEEDINGS
of
Globalization and MET

Editor in Chief Wang Zuwen

第七届国际海事大学联合会年会论文集

DALIAN MARITIME UNIVERSITY PRESS

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第七届国际海事大学联合会年会论文集

Dalian Maritime University Press

图书在版编目（CIP）数据

第七届国际海事大学联合会年会论文集＝Proceedings of Globalization and MET/王祖温主编．一大连：大连海事大学出版社，2006. 10
ISBN 7-5632-2002-X

I. 第… II. ①王… III. 海上运输一国际学术会议一文集一英文 IV. U6-53

中国版本图书馆 CIP 数据核字（2006）第 120431 号

大连海事大学出版社出版

地址：大连市凌海路 1 号　　邮编：116026
电话：0411-84728394　　传真：0411-84727996
http://www.dmupress.com　　E-mail:cbs@dmupress.com
大连海大印刷有限公司印装　　大连海事大学出版社发行
2006 年 10 月第 1 版　　2006 年 10 月第 1 次印刷
幅面尺寸：185 mm×260 mm　　印张：26.75　　字数：468 千字
责任编辑：杨子江　　版式设计：天　水
封面设计：王　艳　　责任校对：沈荣欣
定价：150.00 元

Foreword to the Proceedings

On the occasion of the 7th Annual General Assembly of International Association of Maritime Universities (IAMU), as Head of Local Executive Committee of the Assembly, I would like to take the honor, on behalf of Dalian Maritime Univeristy and IAMU, to express the warmest welcome and sincere greetings to all the guests from all over the world.

IAMU was founded by seven universities representing the five continents of the world in 1999. Since then, IAMU has significantly expanded its membership, and now boosts 45 members, including 44 institutions of the world's maritime education and training universities/ faculties, and the sponsor The Nippon Foundation.

Following the first six annual assemblies, the 7th Annual General Assembly of IAMU will be held from October 16th till 18th, 2006 in Dalian, a port city in Northeast China. "Globalization and Maritime Education and Training" is the main theme of the 7th Annual General Assembly with the three sub-themes: "International Cooperation", "Demand and Supply of Maritime Human Resource" and "Maritime Development and Maritime Education and Training". After being reviewed by relevant experts in the maritime fields, 4 project reports and 37 academic papers are included in this book. Papers under the sub-theme of "Maritime Development and Maritime Education and Training" are more than those under the other two sub-themes.

We believe that this book and the Assembly itself will be useful for those who are involved in related fields of Maritime Education and Training both in ideas and in practice. Taking this opportunity, I would like also to deliver my sincere gratitude to IAMU Secretariat, to the sponsor The Nippon Foundation and all the authors who contributed papers to the Assembly.

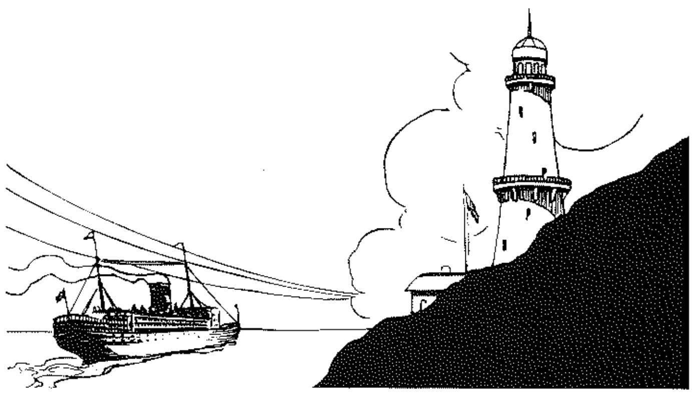
Prof. Dr. Wang Zuwen

President, Dalian Maritime University

Head of Local Executive Committee

of the 7th Annual General Assembly

Content



Part One

PROJECT SYSTEM PRESENTATION

Internet Based Integration of Multiple Shiphandling Simulators

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Abstract Shiphandling simulators (SHS) are efficient and useful facilities for training and education of cadets and seafarers. Most of the maritime universities and many maritime training institutes all over the world have installed shiphandling simulators, which play important roles in maritime education and training. However, most of the shiphandling simulators are standalone facilities and the trainees in the training programs usually come from the same country or from the same company, which differs from the real situation. To improve the situation and enhance the application of shiphandling simulators, research has been carried out on internet based integration of multiple shiphandling simulators. A multi-agent based system, including necessary hardware, has been developed. The system consists of a web server linker, local simulator agents and an internet based VHF communication system. With this platform, cadets and seafarers trained on local SHS can conduct shiphandling and communication practice together with trainees at SHSs in other countries or regions. The integrated training on this platform will set up more realistic and versatile scenario for the trainees, and it can be performed effectively and economically.

Keywords system integration; shiphandling simulator; maritime education and training; multi-agent system; internet communication

0 Introduction

It has been well proved that shiphandling simulators (SHS) are efficient and useful facilities for training and education of cadets and seafarers. Because of high expense and risk for the shiphandling practice on real ship, shiphandling simulator training has been carried out in most maritime education and training (MET) institutions. Typical applications includes handling of larger ships, training of bridge resource management[7] or bridge team management, as well as course related training programs such as standard maneuvering tests and collision avoidance scenarios. It is also found useful in maritime English practice for cadets to improve both on-board and external communication skills[8-9]. With the development of the technology in recent years, SHS has been improved greatly on shiphandling model and scene image. However, most of the SHSs are standalone facilities and the trainees in the training programs usually come from the same country or the same company, which differs from the real situation. Navigation is an international activity, and there may be many ships from different countries sailing in the same sea area. There are some training institutes having seafarers from different countries or regions trained together as a team. This method proves to be costly. Integrating SHSs internationally through Internet is an effective way to solve the problem. On integrated SHSs, cadets and seafarers trained on local SHS can conduct shiphandling and communication practice together with trainees at SHSs in other countries or regions. The integrated training will set up more realistic and versatile scenario for the trainees, and it can be performed effectively and economically. The more detail reasons why we need to integrate multiple SHSs internationally were demonstrated in[1].

Internationalization of SHS training will enhance seafarers' technical and operational abilities effectively. In this paper, we report the design and realization of an internet based platform, which is referred to as SHSLinker, to integrate multiple SHSs. A multi-agent based system, including necessary hardware, has been developed. The system consists of a web server linker, local simulator agents and an internet based simulated VHF communication system. The web server linker manages and coordinates the integrated simulators in the system. It also displays the necessary information and provides general functions for monitoring and controlling the system running. The local simulator agent communicates with local simulator and the server linker. The simulated VHF system performs communication functions between simulators linked to the internet. We also compose drafts of relative technical protocols for the integration interface and data exchange.

This paper is organized as follows. In Section 2 of the paper we present the architecture of SHSLinker. The main components of the platform are described in Section 3. Section 4 illustrates the communication protocol between the platform and terminal SHSs. Section 5 presents an experiment to show the usage of the platform. Finally, Conclusion and consideration of future research are offered in Section 6.

1 Architecture

The SHSLinker is based on Multi-Agent System (MAS) technology[2-3] to implement the integration of multiple SHSs from different countries or regions. MAS is one of the mainstream technologies in distributed computing and Computer Supported Collaborating Work (CSCW) area.

There are four advantages to use MAS to realize the integration of multiple SHSs, they are:

- Existing SHSs can be easily adapted to the system.
- Existing software platforms for MAS programming can be employed as the foundation for the integration of multiple SHSs.
- The integrating of SHSs can be easily expanded.
- Agents could adjust the communication according to the available bandwidth.

To realize the integration of the SHSs by using MAS technology, we set up a Management Center as a Server. Three Agents runs in the Server: (1) Name Server Agent which is in charge of recording the names of the active SHSs and their network addresses. (2) Facilitator Agent which record information of each Virtual Sea Area (VSA) and the SHSs joining it. (3) Visualizer Agent by which the administrators can visually manage the cooperation among several SHSs.

To implement the interaction between terminal SHS and the above Management Center, an SHS Agent is built for each SHS. SHS Agent will take an intermediate role between SHS and Server. SHS Agent collects relevant information from SHS and sends it to the Server, as well as receives information from the Server and forwards it to the SHS. Both are in real time.

To realize VHF communication on Internet, we built a VHF Agent for each simulated VHF terminal. VHF Agent receives all voice data and channel information, and then forwards them to SHS Agent. When VHF Agent receives any voice data from SHS Agent, it will forward the data to VHF terminal.

The communication between SHS Agent and the Server is implemented by HTTP protocol so that the communication can pass through the firewall of the LANs.

Fig. 1 shows the architecture of the whole platform.

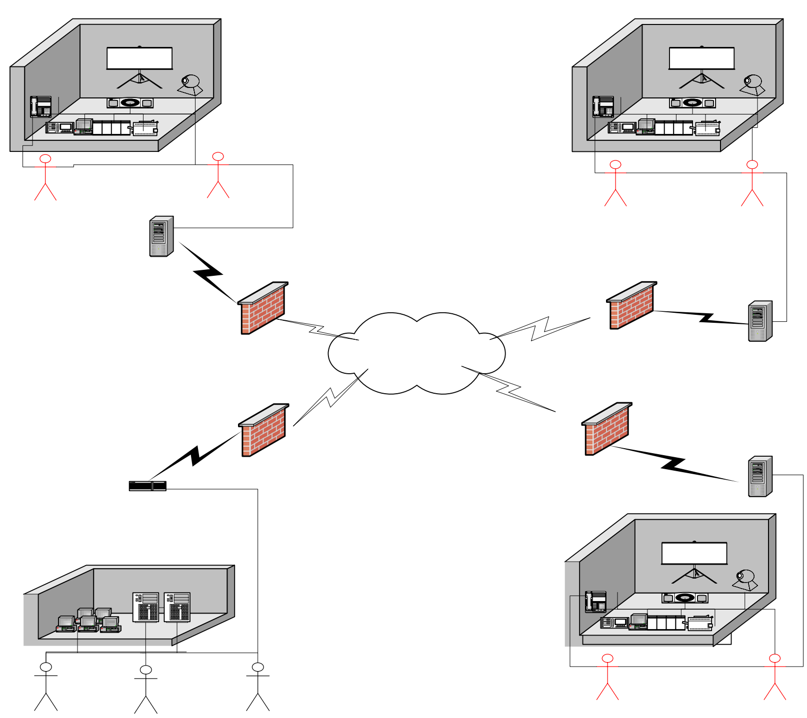

Fig. 1 Architecture of the SHSLinker platform

When an SHS starts up, its Agent will register related information, such as SHS name and its network address, to Name Server Agent, and then the instructor can select an existing VSA or create a new VSA to join. When an SHS enters a VSA, it can exchange ownship data and VHF audio data with other SHSs in the same VSA through the Server. According to the information received, the SHS will create the ship's model and display its movement in the virtual scene.

After the connection among agents has been established, seafarers can handle the ship, perform watch-keeping, and communicate with trainees at remote SHSs. Voice communication can be conducted via Internet based VHF system.

2 Main components

2.1 Facilitator agent

A Facilitator Agent is the agent running on the server for cooperation and communication management. It is active when the system starts up and responds to the request SHS Agents at terminal simulators momentarily. Its main functions include:

Provide VSA creating, joining and quitting service for SHS agents. When an SHS intends to join a running VSA, the Facilitator Agent will check whether the position of the SHS conflict with those of other SHSs in the VSA. If it is, the Facilitator Agent will prevent the SHS from joining the VSA at that moment. Another condition on joining a running VSA is to acquire the acknowledgements from all SHSs operating in the VSA, Facilitator Agent will coordinate and ensure this condition to be met.

Be responsible for forwarding messages among SHS agents properly. SHS data and voice data should be broadcasted among SHS agents in the same VSA.

Provide several data lists to save real time data, for instance, the name of each running VSA, data of navigational environment, number and names of own-ships and real time data of all ships.

2.2 SHS Agent

An SHS Agent plays the role of communicating with local simulator in the system. At the runtime of the system, an SHS Agent forwards local simulator's data to the Facilitator agent, forwards update data received from Facilitator Agent to local simulator, and responds to instructor/user's control.

As an "Agent" of the simulator, the SHS Agent is in charge of communicating with Server and delivering relative information to the simulator. Its main functions include:

Exchanging information with the simulator. Collecting simulator's runtime data, informing local simulator when remote SHSs enter or exit the current VSA, forwarding the update information of VSA to its simulator.

Interacting with the Server through Internet. Inquiring VSA list from the Server, applying for joining/quitting VSA on the Server, or opening/closing a VSA and receiving the feedback from the Server, receiving and processing the update data from the Server.

Supplying a Graphical User Interface (GUI) for instructor/user. Through the GUI, instructor/user could control the SHS Agent, send commands, get information, and manage local ownships (add or delete ownships).

Fig. 2 shows a snapshot of the GUI.

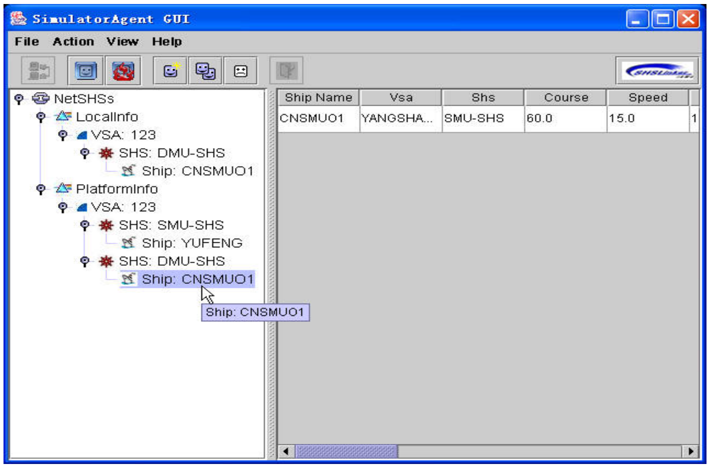

Fig. 2 A snapshoot of the operating GUI

2.3 Simulated VHF terminal

The simulated VHF terminal is used by the trainees for voice communications. Its function and operation are very similar to real VHF set used on board. Since not all VHF terminals used in current SHSs could output digitized voice data, we developed a set of simulated VHF terminal, as shown in Fig. 3. It can be connected to the computer at local SHS, and then linked to the SHSLinker platform.

Fig. 3 Simulated VHF terminal

The architecture of simulated VHF system includes the voice sampling and reconstruction unit, the encoder and decoder unit, the data processing and transmission unit, the clock synchronous unit, the keyboard and display unit, and the RS-232 converter unit. Fig. 4 illustrates its basic architecture.

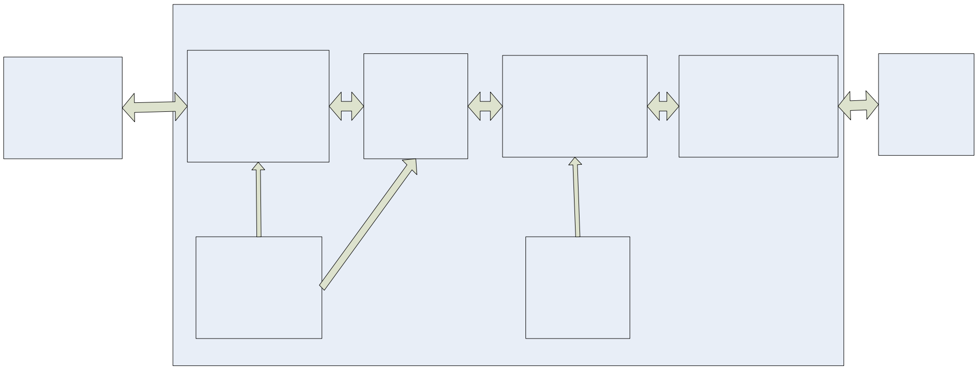

Fig. 4 Block diagram of the simulated VHF terminal

2.4 VHF Agent

The VHF Agent is the functional agent attached to the SHS Agent, and its lifetime relies on that of the latter. Through VHF Agent, SHS Agent can exchange voice data with VHF. The main functions of the VHF Agent includes:

- Receiving channel data and voice data from the VHF terminal;
- Transmitting the received voice data to other VHF terminals in the same SHS and listening on the same channel;
- Converting the voice data to a data type that can be accepted by SHS agent and sends to the SHS Agent for forwarding;
- Receiving and processing the channel data and voice data received by the SHS agent from other SHS Agents or the Facilitator agent, and then transmitting them to the local VHF terminals listening on the same channel.

2.5 Visualizer agent

Visualizer Agent requests the running data of the whole SHSLinker platform from Facilitator Agent and provides a graphical interface to present them. By the Visualizer Agent, the administrator could view the running status of the platform, e.g. the number of SHSs that are connected to the SHSLinker system, the identification of the SHSs, VSAs of those SHSs, the number of vessels running on every VSA, etc.. It also can be used to disconnect an SHS when the administrator feels necessary.

Fig. 5 shows one graphical interface of the visualizer agent.

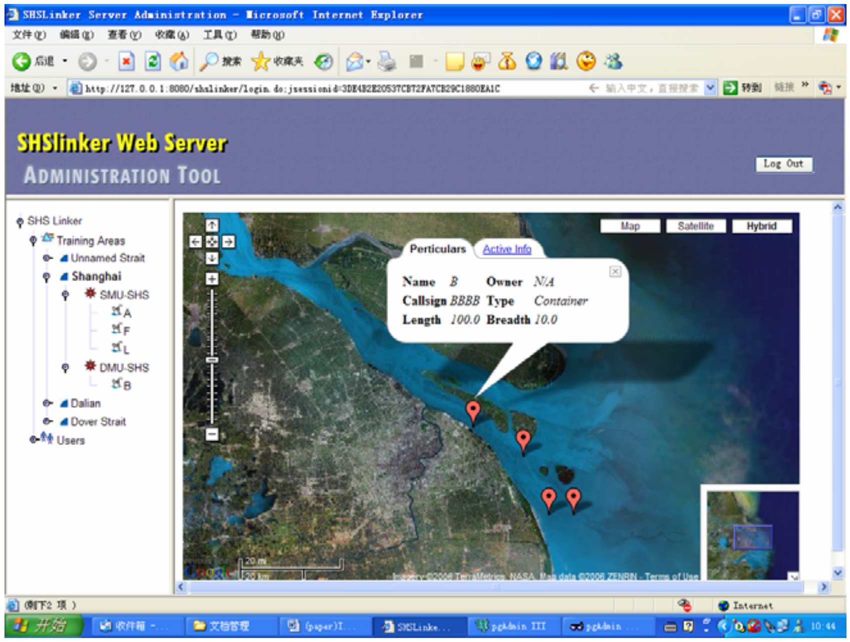

Fig. 5 Graphical interface of visualizer agent

3 Communication rotocol to the local SHS

Through an SHS Agent, a terminal SHS could communicate with and interact with the SHSLinker platform and other SHSs. This Section defines the communicate protocol between the SHS Agent and the terminal SHS. It includes three parts, the first summarized all types of the message, the second explains the structure of each type of message and its interpretation and the final defines the update rate for each type of message. As long as an SHS can receive, interpret, generate and output the messages defined in this platform correctly at required rates, it will be able to be connected to the SHS Agent and to the SHSLinker platform.

3.1 Message types

The communication protocol should implements the following functions.

- Make SHS agent and SHS capable to exchange ship static information and dynamic information;
- Make SHS agent and SHS capable to exchange SHS information and the virtual sea area information;
- Make sure a massage is correctly sent and received.

We defined thirteen types of message for communication between an SHS and an SHS agent. Table 1 shows all of the defined message types, their sender, their receiver and their content.

Table 1 Message types and their interpretations

No.	Type	Sent by	Received by	Reply with	Content
1	SHS	SHS agent	SHS	-	Description of one SHS
2	RSHS	SHS agent	SHS	SHS	Inquiry of the description of the local SHS
3	VSA	SHS agent	SHS	-	Description of a training area
		SHS	SHS agent		
4	STV	SHS agent	SHS	VSA	Inquiry of the current training area of the

					local SHS
5	SSP	SHS agent	SHS	-	The static data of the ships running on the local or remote SHSs
		SHS	SHS agent		
6	RSSP	SHS agent	SHS	SSP	Inquiry of the information of ships on the local SHS
7	SAS	SHS agent	SHS	-	The static data of a newly-added ship on the local or remote SHSs
		SHS	SHS agent		
8	SRS	SHS agent	SHS	-	The static data of a newly- removed ship on the local or remote SHSs
		SHS agent	SHS		
9	SUS	SHS agent	SHS	-	The updated static data of the ships on the local or remote SHSs
		SHS	SHS agent		
10	DSP	SHS agent	SHS	-	The dynamic data of a ship on on the local or remote SHSs
		SHS	SHS agent		
11	DAS	SHS agent	SHS	-	The dynamic data of a new ship on the local or remote SHSs
		SHS	SHS agent		
12	DUS	SHS agent	SHS	-	The updated dynamic data of a ship on the local or remote SHSs
		SHS	SHS agent		
13	VOI	SHS agent	SHS	-	Voice data and channel information
		SHS	SHS agent		

3.2 Message format

The message format defined in our communication protocol is similar to that of AIS message formats[4]. The message type and contents are tailored to the needs of integrated operation of SHSs.

The structure of one of the message type, SSP message, is shown in Fig. 6, as an example. This message provides information about the static data of a ship and is sent to the SHS Agent by the local simulator. The information of the message includes callsign, name, virtual sea area, simulator, length, breath, type, draft, and destination. When a simulator in one virtual sea area practices with other simulators, it sends all ships' static data to its agent at regular intervals. When the SHS Agent receives the message, it will send out the message to all the other simulators so that a ship in all simulators is in the same situation. In this way, a ship's information in the simulator can be updated at regular intervals. All the data of the message is in *char* type.

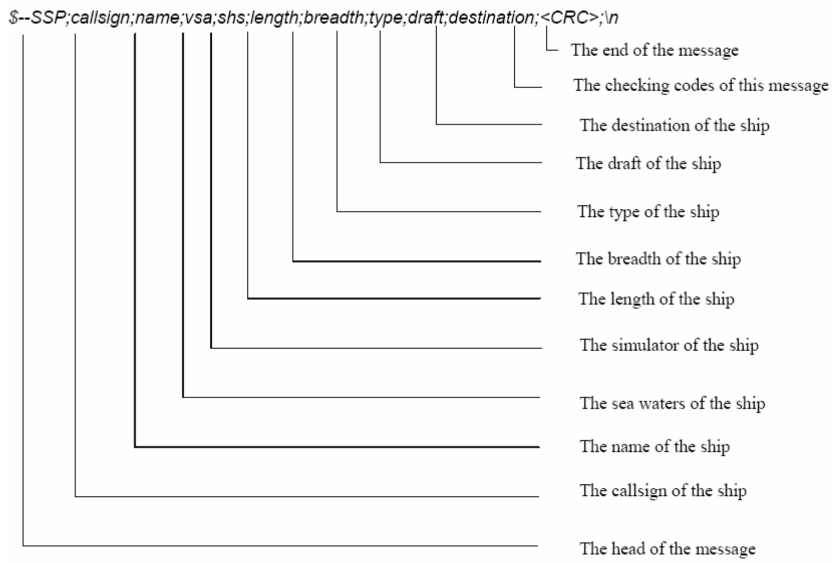

Fig. 6 The format of message SSP

For other message types, interested readers are referred to [5] for details.

3.3 SHS message rates

When the SHS agent starts up, it will inquiry the local SHS of the description, current VSA and the ownships of the SHS, then the SHS will reply the corresponding messages (SHS, VSA and SSP).

When the local SHS connecting to the SHSLinker platform through the SHS agent, the SHS should update the static information of the ships every 6 minutes and update the dynamic information of the ships every second. That is, the local SHS should send message SSP every 6 minutes and send message VOI and DSP every second.

When the instructor of the local SHS adds, removes or changes the static or the dynamic information of a ship, the SHS should send out the corresponding messages (SAS, SRS, SUS, DSP, DAS and DUS) to the SHS agent immediately.

4 Experiments

The SHSLinker platform was developed with Jade[6], which is one of the software platform for developing multi-agent system.

We set up two SHSs in Shanghai Maritime University to test SHSLinker platform. The two SHSs linked via Internet and both are running in Yangshan port. Each SHS has only one own-ship. Fig. 7 to Fig. 10 show the results.

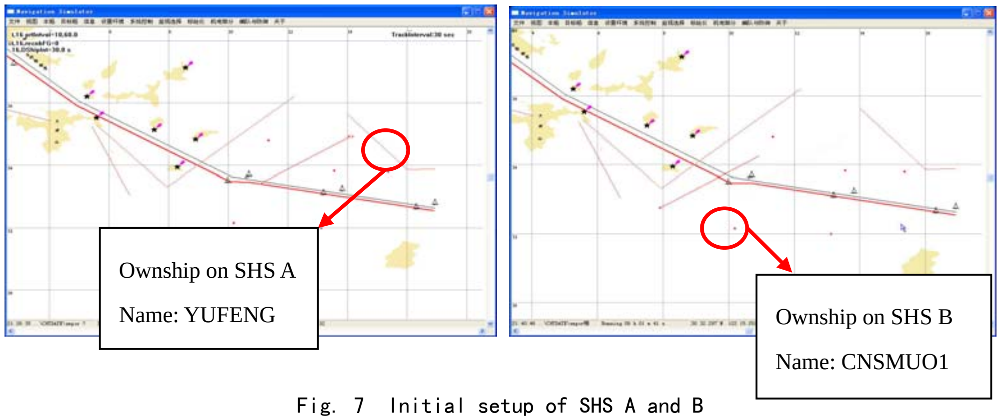

Fig. 7 Initial setup of SHS A and B

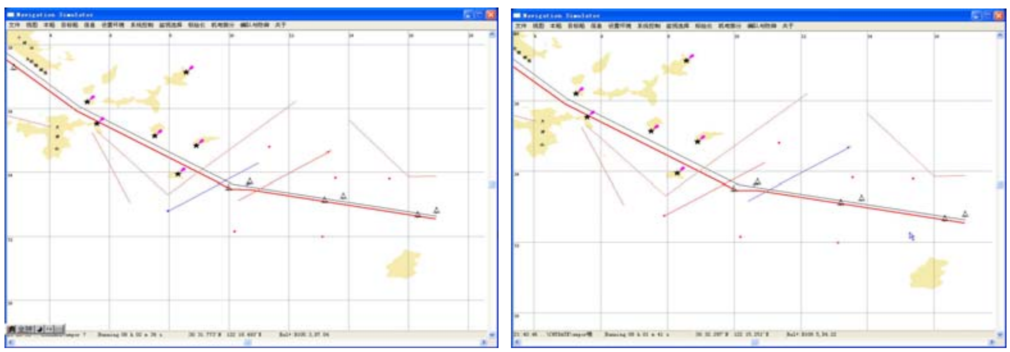

Fig. 8 SHS A and B, when connected by the SHSLinker platform

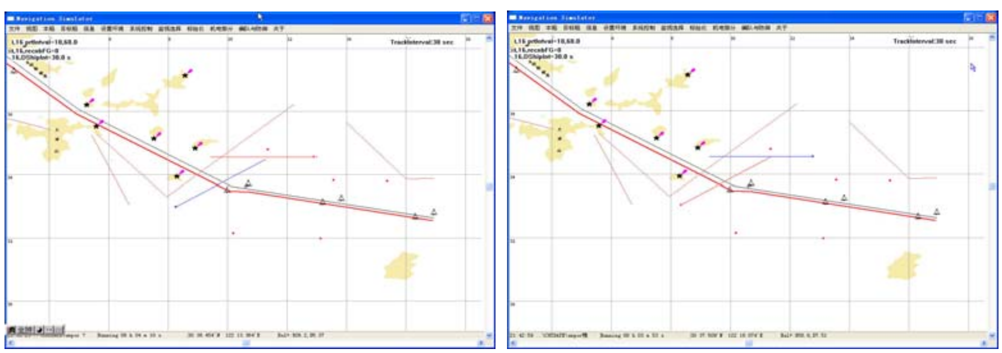

Fig. 9 SHS A and B, when ship “YUFENG” on SHS A changes course to 270

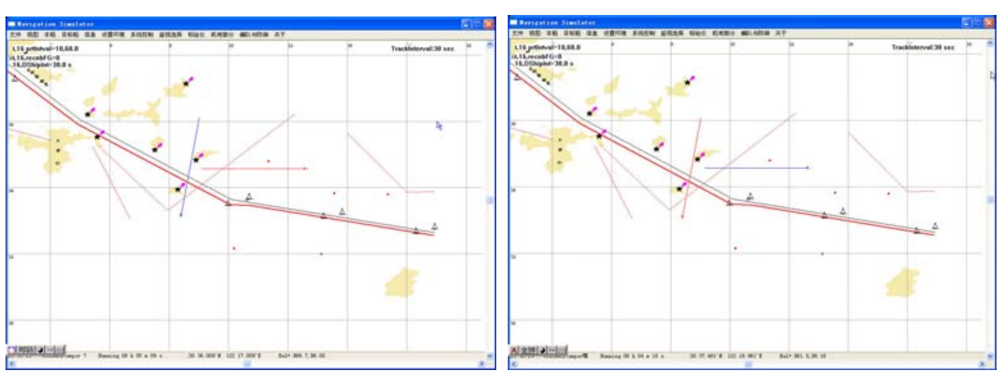

Fig. 10 SHS A and B, when ship “CNSMU01” on SHS B changes course to 010

5 Conclusion and future work

In this paper, we report the research work of SHSLinker platform to integrate the SHSs from different countries or regions based on Internet. Major modules have been accomplished, and the platform works well when linking several SHSs produced by SMU on the Internet environment. However, further refinery is necessary. First, Interface standards to the SHSs need further discussion among the SHS manufactures and users, and an agreement should be made. Second, an experiment should be done to link the SHSs which are from different countries or regions and produced by different manufactures.

It is worthwhile to link VTS simulators to the platform, thus the trainees could learn how to cooperate with the VTSs to complete their voyages. Moreover, a training assessment or scoring system can be built in the management center to assess the performance of trainees. When they finished their voyage on the integrated platform, they could access the website to see their grades. Building model courses for the integrated training also needs consideration.

Acknowledgement

The research work in this paper was sponsored by the International Association of Maritime Universities (IAMU) and Nippon Foundation, through the IAMU project, *Internet Based Integration of Multiple Shiphandling Simulators*.

The research team members of the project include: Shi Chaojian, Hu Qinyou, Huang Zhenmin, Zhang Yi and Yu Lili from Shanghai Maritime University; Adam Weintrit, Przemyslaw Dzuila and Andrzej Bomba from Gdynia Maritime University; Chae-Uk Song from Korea Maritime University; Gyei-Kark Park from Mokpo National Maritime University.

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Study in Standardizing of Undergraduate Marine Engineering Curriculum

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Abstract Although mandated by the STCW Convention, the undergraduate marine engineering programs still differ in their duration, content, onboard training, specific requirements, etc. Analysis of various curricula reveals quite substantial discrepancies, especially in the program structure and the academic courses that are included into the program.

The content of this paper is based on the results of a research project sponsored by the IAMU: analysis and assessment of undergraduate marine engineering programs in various countries for possible standardization. The curricula of 27 maritime educational centers has been reviewed, classified, broken down into components and analyzed. As a result, a standardized distributions by curricula elements for both, license oriented and license/degree oriented curricula, have been developed. Further analyses and statistical evaluation of the weights of the curricula elements allowed to propose the sound and justifiable average values for the weights of those components. An appropriate assortment of academic courses for each of the proposed building blocks of a standard curriculum has been identified, accompanied with a set of alternative courses. Standard curricula materials require much more space than this paper allows: for detailed information the reader is referred to the final report provided to IAMU.

In the summary a series of practical recommendation is offered.

Keywords marine engineering education; curriculum; programs; license and degree components of programs; program accreditation

0 Introduction and background

Although mandated by the STCW Convention, the undergraduate marine engineering programs offered in various maritime educational institutions still differ in their duration, content, onboard training, specific requirements, etc. Analysis of over 30 curricula reveals quite substantial discrepancies, especially in the program structure and the academic courses that are included into the program.

Any attempt to standardize the marine engineering curricula has to start with sorting all program by their type, objective and other specific features. Several hundred maritime educational institutions in the world provide various types of maritime education. All of them might be subdivided into four groups, of which the first two are the objects of this paper:

a. Maritime academies offering complete program leading to a license of a marine engineering officer

b. Maritime academies and universities offering programs leading to an engineering license and to an academic degree

c. Maritime schools, union schools and training centers offering individual marine engineering courses.

d. Vocational maritime schools (sail boats, motor boats, etc.)

Maritime academies and universities are offering two distinct types of marine engineering programs: mariner license oriented programs, and mariner license and academic degree oriented programs. According to STCW, the first engineering license is an officer in charge of an engineering watch. Some school curriculum identify the first license as Engineering Officer Class 4. American maritime institutions, in accordance with the Code of Federal Regulations CFR 46 identify the first license as Third Assistant Engineer.

Other schools and academies offer shorter programs leading to a Junior Engineer or Assistant Engineering Officer certificate. Normally, after a certain at sea training, the former cadet sits for a full scale first engineering license. Therefore, this type of a program should be considered in assessment of the college type license curriculum. Although the two types of programs, license oriented and degree/license oriented, differ in content and duration, the core of license related courses should be identical, or at least similar. The main difference should be in the scope and content of academic subjects.

Not many publications have been devoted to the subject. In this research conference proceedings and magazine articles, and also the Government maritime and licensing institution materials have been reviewed. Very limited activity of the IAMU members in providing their documentation affected the reliability of the results. Only 12 institutions supplied complete sets of the curricula. Additional data has been assembled from various sources including the websites, various publications and accreditation reports.

Total of 27 sets of program curricula have been reviewed and scrutinized. The most detailed information has been collected from the principal maritime universities and academies in the US, Canada, Australia, Philippines, Japan, India, Singapore, Taiwan Province, PR China, Egypt, Turkey, Croatia, Norway, Denmark, United Kingdom, Netherlands, Poland, Belgium, Estonia, Ukraine and Russia. This list makes an adequate representation of the variety of marine engineering programs.

1 Analysis of marine engineering programs

1.1 Program duration

Engineering programs are normally more condensed, and a common believe is that there is not enough time for anything else but the established curriculum. The average length of a program, which leads to the Third Assistant (or just Forth Engineer) license, is four years, including about a year of sailing. However, there are three- year programs, on one side, and five-plus-year programs, on the other side, like in Russia and Ukraine. The diagram below presents an approximate distribution of the duration of the marine engineering programs among 76 maritime schools.

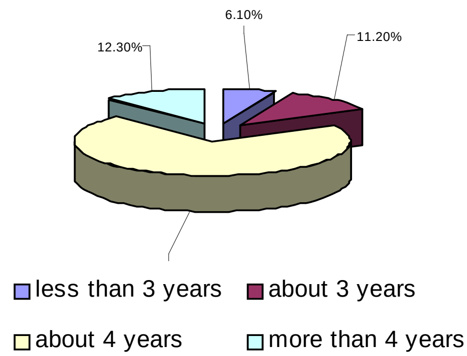

Fig. 1 Duration of marine engineering programs in various countries

The three and less year durations are typical for the non-degree oriented programs and also for the programs where an associate engineering degree is obtained. The basic educational component of such a program requires normally between 80 and 100 credit hours, which includes about 40-60 credit hours of applied engineering courses. This is actually complies with the basic STCW requirements as per the IMO model course that is based on a 59 credit hour curriculum. With a normal academic load of 40-45 credit hours per year, the in-school portion of the program requires about two years, or four semesters. The remaining components of the program are sailing on board training or commercial ships (6-8 months) and internships/workshops.

With the adaptation of the Bologna accord, the European countries have agreed that getting a BS degree in Engineering in three years should be a normal practice. As a result, the European maritime schools have developed BS in Marine Engineering requiring three years to complete, with or without a half-year sailing practice.

Majority of maritime academies and universities in Asia, America and Australian that offer a BS degree oriented program, employ a three-and-a-half and four-year schemes. Fig. 2 shows two programs at the US Merchant Marine Academy in New York: one program is ABET accredited (in front), another one is a regular non-accredited program. This four-year programs include almost a year of seagoing service, which accounts for about 15% of the tgotal academic load. Similar programs are found in the Philippines, in India (Tolani Maritime Institute), and others.

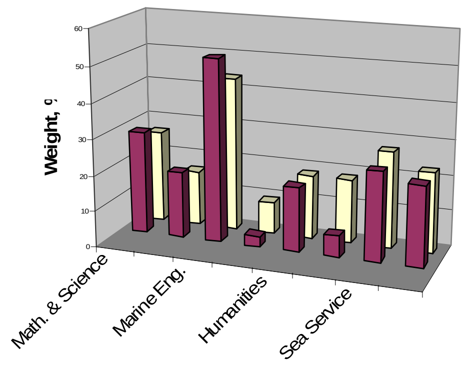

Fig. 2 Structure of marine engineering programs at USMMA, New York

A substantially different type of engineering programs is offered in Russia, Ukraine, and other countries whose higher education system has been influenced by the former Soviet Union. Their college degree does not have a direct analog in the educational system of the Western World. The degree is titled Specialist (bachelor-plus), or Diplome-Engineer, or Diploma of Higher Education, which in essense is very close to a Master degree. As a result, the degree-oriented marine engineering program requires five and more years to complete. The marine license component of the program is normally exceeds the STCW requirements by scope. However, the subject of the admission requirements requiers additional investigation due to the fact that the secondary school provides a graduation certificate after 10 years, not 11 or 12 as in many other countries. Therefore, some of the freshmen year courses might serve to compensate for the insufficient school education. The Table 1 shows the program components with the time allocation for the ME Program at Baltic State Academy in Kaliningrad, Russia, which is as a typical example of this group of maritime schools.

Incidentally, this program allows for almost a year of sea-going training and industrial internships, and also for a 13-week long development of a comprehensive capstone project, or diploma project, which culminates the vast engineering training by combining the principal knowledge and skills obtained during the previous five years of schooling.

Table 1 Duration of ME Program Components at Baltic State Academy, Russia

Year of Studies	Duration of activities in weeks							
	Academic Courses	Exams	License & State Exams	Training Ship Cruises	Commercial Ships & Industrial Internships	Diploma Project	Holidays and Vacations	Total per Year
I	36	6		4			6	52
II	33	6		7			6	52
II	31	6		9			6	52
IV	35	6	1		4		6	52
V	28	6	1		13		4	52
VI			2		11	13		26

1.2 Program composition

Every program might be looked upon as a combination of the building blocks. The distribution of time among the components of a program and the list of academic courses vary quite substantially from country to country, and even among different schools of the same country. The Table 2 below presents the comparison of marine engineering programs at three schools in very different areas of the world – India, Estonia and Canada:

Table 2 Comparison of program structure at three maritime schools

Curriculum Components	Credit Hours		
	Tolani Maritime Institute	Estonian Maritime Academy	Institut Maritime du Quebec
Math. & Science	12	12.5	40.5
Eng. Science	42	34	28.5
Marine Eng.	63	44	49.5
Ship Operations	8	8	8
Humanities	9	9.5	27.5
Management	10	17	5.5
Phys.Education	0	6	4
TOTAL	144	131	163.5

While the marine engineering component in the programs is in the comparable limits, some other topics are quite different in scope, especially Mathematics & Science and Humanities. It is worth mentioning that the Estonian Academy, in addition to regular economics 101 offers several special management courses including Management Psychology, Informatics and a short course in Project Management.

The two principal components of a license/degree program are the license courses and the academic courses. Another subdivision is found in the strict license oriented programs – by the license courses and the general education courses.

1.3 Program license component

STCW requirements are a base for the analysis of the license component of the marine engineering program. An appropriate guidance document for assessing the required training is the IMO Module Course 7.04 developed for IMO by the Norwegian Maritime Directorate. Table 3 contains the list of minimally required courses and academic credits for the Module Course.

Table 3 IMO Module Course 7.04 Curriculum

Course Name	Credits	% to Total
Properties of Fuel and Lubricants	1	1.7%
Chemistry and Physics of Fire and Exstinguishers	1	1.7%
Mechanics and Hydromechanics	4.8	8.3%
Materials Technology	2.9	5.0%
Marine Electrotechnology, Electronics and Equipment	5.8	10.0%

Properties of Fuel and Lubricants	1	1.7%
Thermodynamics and Heat Transmission	3.4	5.9%
NARC and Ship Construction	3.7	6.4%
Operational Principles of Diesel Plants	3.1	5.3%
Operation and Maintenance of Machinery	1.8	3.1%
NARC and Ship Construction	4	6.9%
Marine Electro-technology, Electronics and Equipment	6	10.3%
Automation, Instrumentation and Control	4.1	7.1%
Operational Principles of Diesel Plants	4	6.9%
Operation and Maintenance of Machinery	2	3.4%
Chemistry and Physics of Fire and Extinguishers	1	1.7%
Life Saving	1.25	2.2%
Medical Emergency and First Aid	1	1.7%
Maritime Law	2.25	3.9%
Personnel Management	1.9	3.3%
Materials Technology	3	5.2%
Total	58	100.0%

Yet one more guidance material, specific for the American maritime academies, is the list of subjects for engineering licenses which is included in the Code of Federal Regulations 46 CFR Ch. 1 #10.950 (see Appendix 2 in the Final Report).

1.4 Academic degree component

The IMO Module Course 7.04, and also the American 46 CFR identify certain subjects which belong to the academic degree component of the program. However, while the license component might be easily standardized based on the above mentioned guidance documents, the academic component allows a much wider variation in the content and scope. The only feasible way of building a uniform academic component is statistical analysis of a large number of programs.

An important factor in setting the academic component of a marine engineering program is the requirements of the accrediting institutions. Even if the program is not intended for accreditation, many of the requirements should be evaluated and incorporated based on the available time space in the curriculum. As an example of the requirements, the Table 4 contains the subject areas considered by the U.K. Institute of Marine Engineers in their accreditation of the marine engineering programs. Other accreditation bodies include Classification Societies, like DNV and Lloyd, American Accreditation Board for Engineering and Technology (ABET), National Educational Authorities, and others. In the final report the results of evaluation of the accreditation requirements as a factor in the development of the uniform academic component of marine engineering curricula will be presented.

Table 4 Subject Areas for Specific Learning Outcomes expected from BEng Degrees

No	Subject Area
1	Mathematics and Science
2	Engineering Analysis
3	Design

4	Economic, social, and environmental context
5	Marine Engineering Practice
6	Economic, social and environmental context
7	Engineering Practice

2 Developing a uniform marine engineering curricula

2.1 Program components and group subjects

The very first step in development of a standardized marine engineering program is curricula breakdown: it is necessary to agree on the definition and titles of the building blocks of the program. The following hierarchy of the program elements (Fig. 3) has been decided and accepted in this study:

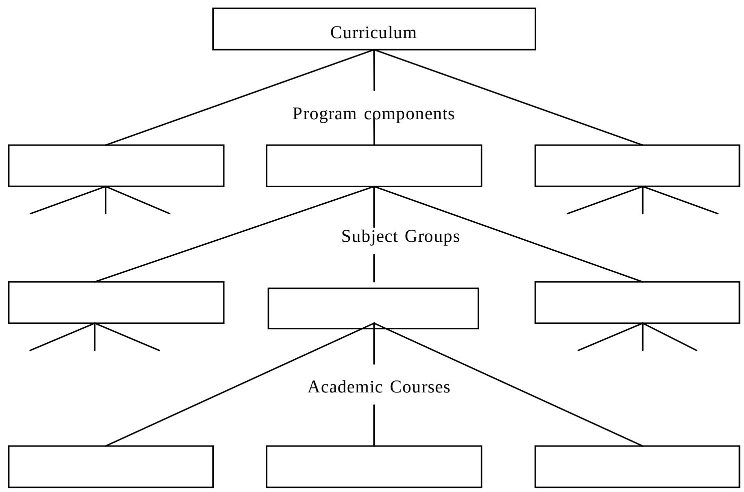

Fig. 3 Hierarchy of the Curricula Elements

The structure of the license oriented program using the above building blocks might be presented in the following format (see Table 5 below).

For the license and degree oriented programs a revised version with expended content of the engineering science has been set as it is shown in the final report.

Table 5 Building Blocks for License Oriented Program

Program Building Blocks	
Curriculum Components	Subject Groups
I. Mathematics & Science	1. Mathematics
	2. Science
II. Engineering Science	
III. Marine Engineering	1. Drafting
	2. Propulsion Plant
	3. Machinery
	4. Practical NARC
	5. Electrical/Electronic Engineering
IV. Operations	1. Repair and Maintenance

	2. Ship Operations
V. Safety & Medicine	
VI. Humanities & Social Sciences	1. Social Sciences
	2. Humanities
VII. Economics & Management	
VIII. Physical Education	
IX. Sea Training & Internships	1. Sea Training
	2. Internships
X. Final Examinations	

2.2 Proposed structure of beng curriculum in marine engineering

While the license component might be easily standardized based on the above mentioned guidance documents, the academic component allows a much wider variation in the content and scope. An important factor in setting the academic component of a marine engineering program is the requirements of the accrediting institutions. Even if the program is not intended for accreditation, many of the requirements should be evaluated and incorporated based on the available time space in the curriculum. The only feasible way of building a uniform academic component is by doing statistical analysis of a large number of programs..

Reasonably reliable result has been achieved with the license/degree oriented program. By an in-depth review and analysis of 10 degree oriented curricula available the following distributions by curricula elements have been estimated (Table 6) . Further analyses and evaluation of the weights of the curricula elements allowed to develop the sound and justifiable average values for those weights, presented in Table 6.

Table 6 Average Academic Credit Hours by Curricula Components and Subject Groups

Bachelor of Science in Marine Engineering (BSMarE)						
Total required time for program - 4 years						
Curriculum Components		Curricula Component		Subject Groups		
No	Subject Groups	Weight, %	Credit Hours	Weight, %	Credit Hours	
I. Mathematics & Science		10.8	19.0			
1	Mathematics			7.5	13.2	
2	Science			3.3	5.8	
II. Engineering Science		17.0	29.9			
1	Mechanics			3.9	6.9	
2	Materials			2.9	5.1	
3	Electrical			2.5	4.4	
4	Fluids			0.8	1.4	
5	Thermodynamics			3.6	6.4	
6	Naval Arch.			1.0	1.7	
7	Computer Science			2.3	4.0	
III. Marine Engineering		24.6	43.4			

1	Drafting			2.5	4.5
2	Propulsion Plant			5.2	9.2
3	Machinery			7.2	12.6
4	Practical NARC			2.6	4.6
5	Electrical Engineering			2.6	4.7
6	Electronics Eng.			3.2	5.7
7	Engineering Design			1.2	2.1
IV. Operations		7.7	13.6		
1	Engineering Operations			4.1	7.2
2	Ship Operations			3.6	6.4
V. Safety and Medicine		1.0	1.7	1.0	1.7
VI. Humanities and Social Sciences		11.0	19.5		
1	Social Sciences			2.6	4.5
2	Humanities			8.5	15.0
VII. Economics and Management		4.0	7.0		
1	Economics			1.2	2.2
2	Management			2.7	4.8
VIII. Physical Education		2.2	3.9	2.2	3.9
IX. Sea Training and Internships		16.5	29.2		
1	Sea Training			14.3	25.2
2	Internships			2.3	4.0
X. Final Examinations		4.0	7.1	4.0	7.1
XI. ROTC (Naval Science)		1.2	2.2	1.2	2.2
PROGRAM TOTAL		100.0	176.5	100.0	176.5

As per Table 6 the average credit load on the program is about 176.5 hours which is accepted as a uniform program credit load. Bearing in mind that the compatibility of the curriculum data is far from perfect, an expert analysis of the statistical results has been undertaken. Based on the assessments made by several prominent educators, the adjustments have been made and the final Curriculum Components values accepted. Using the Curriculum Component values as a guidance, the Marine Engineering Program leading to an Engineer at the operational level license and a BEng. Degree has been developed (presented in the Table 7). The table contains the proposed subject groups and corresponding academic loads.

Table 7 Proposed License/Degree Oriented Program

Bachelor of Science in Marine Engineering (BSMarE)			
Total required time for program - 4 years			
Curriculum Components		Subject Groups	
	Subject Groups	Weight, %	Credit Hours
I. Mathematics & Science		11.6	20.0
1	Mathematics	8.1	14.0
2	Science	3.5	6.0
II. Engineering Science		17.4	30.0

1	Mechanics	3.5	6.0
2	Materials	2.9	5.0
3	Electrical	2.9	5.0
4	Fluids	1.2	2.0
5	Thermodynamics	3.5	6.0
6	Naval Arch.	1.2	2.0
7	Computer Science	2.3	4.0
III. Marine Engineering		25.6	44.0
1	Drafting	2.6	4.5
2	Propulsion Plant	5.2	9.0
3	Machinery	7.0	12.0
4	Practical NARC	2.6	4.5
5	Electrical Engineering	2.9	5.0
6	Electronics Engineering	3.5	6.0
7	Engineering Design	1.7	3.0
IV. Operations		7.0	12.0
1	Engineering Operations	3.5	6.0
2	Ship Operations	3.5	6.0
V. Safety and Medicine		1.2	2.0
VI. Humanities and Social Sciences		10.5	18.0
1	Social Sciences	3.5	6.0
2	Humanities	7.0	12.0
VII. Economics and Management		3.5	6.0
1	Economics	1.75	3.0
2	Management	1.75	3.0
VIII. Physical Education		2.3	4.0
IX. Sea Training and Internships		17.4	30.0
1	Sea Training	15.1	26.0
2	Internships	2.3	4.0
X. Final Examinations		1.2	2.0
Program Total		100.0	168.0

Several hundred of academic courses have been analyzed with an intent to satisfy the suggested distribution by the curricula elements. Eventually the adequate assortment of academic courses has been selected (see the final project report). The suggested academic courses for each subject group are presented in the shaded rows. The white rows contain alternate or additional courses. Obviously, if the new program is being developed in a given maritime institution, or an existing curriculum is upgraded, the proposed list of courses should be considered first. The alternative courses might be applied as trade-offs, or when the total academic load exceeds the suggested one.

2.3 **Content** and scope of subjects in marine engineering license program

STCW requirements are a base for the analysis of the license component of the marine engineering program. They provide minimum required list of subjects (knowledge, understanding and proficiency), needed for marine engineering function on the operational level (Table A-III/1 from the STCW Code). As it was noted above, another guidance document for assessing the required training is the IMO Module Course 7.04 developed for IMO by the Norwegian Maritime Directorate. Based on the above, the structure of a non-academic Marine Engineering Program has been developed. Table 8 contains data from IMO course and from two curricula: from Institut Maritima du Quebec and from the University of Rijeka.

Table 8 Comparison of Curricula and Model Course

School/Program	U. of Rijeka, associate in science diploma in ME		IMO model course		Institut Maritime du Quebec, associate degree and engineer license	
Curriculum Components and Subject Groups	Group	Component Total	Group	Component Total	Group	Component Total
I. Mathematics & Science		7		2		40.5
1 Mathematics	7		0		27	
2 Science	0		2		13.5	
II. Engineering Science		22		21.6		28.5
1 Mechanics	11.5		4.8		9	
2 Materials	0		2.9		5	
3 Electrical	0		5.8		5.5	
4 Fluids	2.5		1		0	
5 Thermodynamics	5		3.4		6	
6 Naval Architecture	0		3.7		3	
7 Computer Science	3		0		0	
III. Marine Engineering		38.5		19		49.5
1 Drafting	2		0		4.5	
2 Propulsion Plant	6		3.1		11.5	
3 Machinery	15.5		1.8		13.5	
4 Practical NARC	2.5		4		11	
5 Electrical Engineering	9		6		6	
6 Electronics & Automation	3.5		4.1		3	
IV. Operations		5.5		8.3		8
1 Engineering Operations	2		6		8	
2 Ship Operations	3.5		2.3			
V. Personal Safety and Medicine	0		1	1		0
VI. Humanities & Social Sciences		8		0		27.5
1 Social Sciences					9.5	
2 Humanities	2				18	
VII. Economics and Management		2		4.1		5.5
1 Economics					2.5	
2 Management	2		4.1		3	
VIII. Physical Education		4	0	0		4
IX. Sea Training, Internships, Workshops		3.5		3		1 year
2 Workshops	3.5		3			

X. Final Examinations				
Program Total	90.5	59		163.5

Based on the statistical analysis of the above data, and the STCW minimal requirements, the uniform curriculum has been developed (see final report). It contains the academic loads by the curricula elements and by suggested academic courses. The assortment of courses is a result of an in-depth selection among a substantial number of courses in the analyzed institutions. In addition to the suggested courses (shown in the shaded rows), some alternate or additional courses have been also selected. The curricula structure is presented in the Fugure 4 and the content of the Marine Engineering component is shown in Fig. 5.

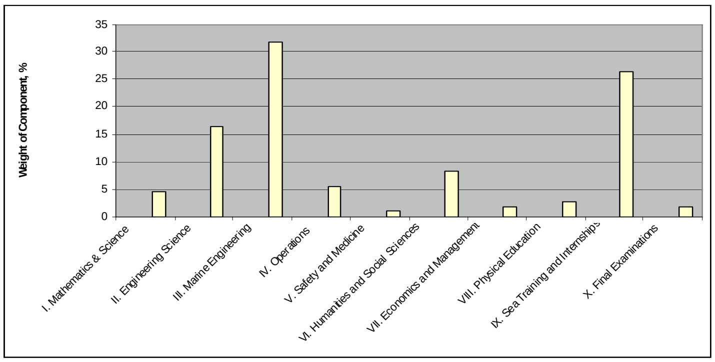

Fig. 4 Structure of the License Oriented Standard Curriculum

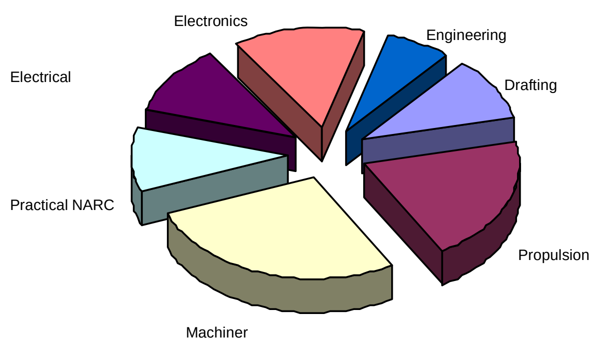

Fig. 5 Marine Engineering Component Structure (by Subject Groups) in the Suggested Uniform Curriculum

3 Standard curriculum and program accreditation

The principal objectives of an accreditation of the engineering program is improving its quality, on one side, and bringing it on the level with the other engineering specialties like mechanical, civil, aeronautical, and others. Standardized curriculum provides an excellent foundation for accreditation. Due to specifics of the marine engineering programs, some of them undergo a triple tier accreditation: as college level programs, as a marine engineering license programs , and as an engineering program. Various types of accreditation and certification are discussed below and some specific recommendations are provided.

3.1 Certification of license component of programs

The component of a marine engineering program which contains the subject courses and other educational activities required for a mariner's license is a subject of a substantial scrutiny by national and international organizations. First of all, it has to comply with the regulations and requirements of the National Maritime Authority, like Ministry of Transport in some European countries, Transport Canada, USCG and similar Government bodies in other countries. These authorities approve the programs (and individual courses, when required, mainly for the continuing education), initiate and conduct the license examinations, set the requirements for training institutions. For instance the Commission on Higher Education of the Republic of Philippines has created a Technical Panel for Maritime Education which in turn formed several inspection teams to evaluate the compliance of maritime schools with the new policies and standards for maritime education programs.

The international certification of the license component of marine engineering programs has been initiated by IMO. The IMO has developed a comprehensive series of conventions to establish a framework of international law covering the subject. Bearing in mind that the most important element in the safe operation of any ship is the competence and experience of its crew, a key component of this legal framework is the STCW. This Convention lays down minimum standards of competence for all ranks of seafarers. The international maritime training and certification requirements of the STCW Convention were introduced into legislations of all maritime countries, setting the minimum level of training of seafarers. For instance, 64 Phillipines Maritime Institutions have been accredited for STCW compliance, 36 of them are the full program schools

Very substantial part of the world commercial tonnage is sailing under the foreign Registry Flag. The Maritime Authorities of these countries like Panama, Liberia, Cyprus, Bahamas, and others are involved in accrediting the maritime educational centers for compliance with STCW requirements. Such accreditation makes it easier for the graduates of the accredited schools to obtain employment with the companies whose ships are sailing under the jurisdiction of the Authorities.

Another type of certification, which has become quite popular, is provided by the Classification Societies. For instance**, DNV has developed a standard for certification of Maritime Academies. This standard has been developed in close co-operation with several institutions.**

Many Maritime Universities and Academies are applying and receiving several various accreditations and certifications of their Programs. Most likely, this tendency will expand in the future while the school will try to make its graduates more sellable. On the other side, more Government and non-Government bodies will become involved into the accreditation process. Other classification societies are developing their accreditation documents, various professional organizations are looking for their niche in the maritime education.

3.2 Accreditation of degree oriented component of programs

The principal method of accreditation, or rather certification, common for most maritime academies and schools is the mandatory approval of a program by the Governmental or non-government accreditation agency. In most of the countries a Ministry or a Department of Higher Education evaluates programs for compliance with the set requirements and allows their implementation. They use quite different approach in their effort to stimulate improvement of the engineering programs, as it might be seen from the following examples:

a. The Philippines Commission on Higher Education (CHED) has established 275 Centers for Excellence to promote quality and excellence in higher education. The Philippines Maritime Academy has been established as such a Center for the maritime community.

b. Different approach is accepted in India. The Directorate General of Shipping, based on the recommendations from the National Assessment and Accreditation Council, has initiated a rating system for maritime programs conducted by three independent rating agencies.

c. In the U.S. a non-government body assesses the engineering programs. Actually, there are several such bodies formed base on the territorial principle. The U.S. Merchant Marine Academy, for instance, is accredited by the Middle States Association of Colleges and Schools. This accreditation is founded on the program outcome assessment, and in this regard it is similar to the process carried out by the engineering accreditation boards and/or councils in some countries.

d. Another very interesting development has been described in the Estonian Maritime Academy's Report on Accreditation of their two marine engineering programs by an Ad-Hock Panel of experts from two neigbourging countries (Finland and Latvia), and also from Hungary. During the visits to Tallinn the Panel (called in the Report an Evaluation Committee) reviewed various elements of the programs, including transcripts, students' reports on sea training, course outlines, course syllabi, textbook material, and the course material produced by the faculty of the programs. As it appears from the report, the evaluation was a comprehensive one, in a great degree following the procedures used by ABET and IMarEST. The Committee have made several very useful recommendations and finally suggested full accreditation for the programs.

e. The accreditation commission for engineering programs in Poland - Komisja Akredytacyjna Uczelni Technicznych (KAUT) was established by Conference of Rectors of Polish Universities of Technology 17 February 2001. The accreditation procedure, in brief, consists of the following steps: application, definition of accreditation criteria, preparation of self-assessment report, peer review evaluation and review, final report and accreditation(five years, or conditional for two years)

Engineering programs in the U.K. are accredited by the Engineering Council (ECUK) through 36 engineering Institutions (Licensed Members), who are licensed to put suitably qualified candidates on the ECUK's list of accredited engineering programs. The Institute of Marine Engineering, Science and Technology (IMarEST) is one of the most active members. IMarEST is accrediting marine engineering academic programs in the United Kingdom, as well as in other countries. Quite a few Maritime Academies and Universities, especially European ones, have applied to IMarEST for accreditation, and received the approval of the high quality of their programs.

Accreditation Board for Engineering and Technology (ABET) is the American counterpart of ECUK. ABET is the organization that accredits engineering, engineering technology, applied science and computer science programs in the United States. ABET is not an agency of the U.S. government, but a private organization made of members from over 20 professional societies. Society of Naval Architects and Marine Engineers (SNAME) is the one that is responsible for accreditation of marine engineering programs. ABET publishes a set of criteria developed by representatives from the member societies that programs must satisfy. Accreditation by ABET involves periodic (not less than every six years) audits that include preparation of documentation by the institution and an on-site visit by a team of volunteers from the member societies. There are over 30 marine engineering programs which are ABET accredited in the U.S..

The ABET and IMarEST accreditations are actually based on a program outcome assessment by a group of experts, although very structured and formalized. The industry uses less formalized and structured approach, although also based on the expert evaluation. For instance, DNV has created a SEASKILL Committee of Experts made up of members from the Industry with in-depth knowledge and experience in the specific areas and in STCW standards. This Committee is involved in certification of the maritime educational programs "with an objective to ensure uniform quality of training in the maritime industry, regardless of location, operation and training methods".

To be accredited by ABET, IMarEST or a similar institution a substantial ground work has to be carried out. The programs must have defined Program Educational Objectives developed with input from their key constituents (typically current students, alumni, and employers); they must regularly evaluate their progress at achieving those objectives; and must continuously improve their educational program based on that evaluation. The core of the assessment process is the evaluation of the general engineering outcomes, which are common for all engineering programs. As it has been mentioned above, because the ABET relies in the accreditation process on the professional societies, in the case of marine engineering programs the Society of Naval Architects Marine Engineers (SNAME) adds several specific Program Outcomes.

Institutions should provide this information to ABET Headquarters prior to the campus visit. It means that a very thorough and tedious assessment work has to be performed. In spite of the amount of that work the successful result of the accreditation process brings substantial benefits. As a result, almost half of engineering programs in the US are ABET The following are some specific suggestions to be used if the decision is made to apply for an accreditation:

a. First of all, a permanent Committee has to be established with a task to define the procedures and to set a system of continuous assessment of objectives and outcomes, and for applying the results for the program improvement,

b. The next step is to develop a set of the program objectives. This task requires to clearly identify the constituency, to survey the constituency in order to find out what the needs are, to create the Industry Advisory Board to steer the program in the direction of continuous assessment of the objectives and re-emphasizing the specific areas when the change is required

c. It is most likely that substantial changes to the program and the way it is presented should be implemented at this stage, such as:

- Developing a comprehensive senior capstone design project that incorporates many skills and knowledges gained by students during the years at the college
- Developing new courses and/or augmenting the existing courses with the subjects that are required by the Accreditor, such as design element in the courses, specific applications of some subjects (math, science, ethics, economics, etc.)
- Developing elective courses to satisfy the specific requirements of the Accreditor

- Improving the laboratories, libraries, computer system, etc. in order to satisfy the requirements for a modern equipment and comprehensive support of the academic process
- Evaluating the teaching staff for adequacy of the required skills and training, making improvements in the faculty development and industry involvement

d. The longest and the most labor-consuming component is the actual development of the system that reflects the specific requirements of the Accreditor, including the development of the outcomes themselves and the tools for their assessment.

e. When the above is complete, the assessment process might start, and in two-three years the application should be submitted.

The decision to develop a program suitable for accreditation might appear a very painful one because the very limited number of academic hours available will be further reduced to give room to the capstone project, design courses, and some other needed changes (see above, item c.). It is especially difficult to accommodate the additional requirements when the existing program is a four-year BS program. It might require to increase the program duration in order to accommodate the needed additions, and still maintain a year-long sea training.

3.3 Summary and recommendations

The lessons learned while the project has been developed might be summarized as follows:

a. Much more active participation of the members is required while this type of practice oriented projects is undertaken.

b. The differences in the programs are not limited to their duration, course assortment and credit loads - it includes also the various level of admission requirements, or rather uncertainty in the admission requirements. Secondary school graduates enrolling in the Marine Engineering Program have very different level of readiness. If this subject is considered globally, the problem becomes even more drastic – secondary educations in different countries varies quite substantially, not only in duration, but also in content and in intensity. As a result, colleges are forced to offer various watered down math and science courses, and in many cases what is called a college math course is in reality an advanced secondary school subject. It appears necessary to set certain admission requirements in conjunction with the college curricula.

c. The definition of a credit hour or other method of unifying the curriculum load is required. The Bologna Accord and the establishment of ECTS (European Credit Transfer System) have simplified the task for the European countries, but at the same time has made it even more complicated and uncertain. Without coming to a consensus on the subject of how to measure the academic load, the principal value for any program appears uncertain.

As a principal recommendation, a wide discussion on the proposed program content is required. Much wider expert opinion should be solicited in order to create a useful material which might become a guidance in future program improvements and developments. It is a firm opinion of this researcher that the continuous curriculum analysis should become a permanent task of IAMU. A type of a working group or a Committee might be formed with the following tasks and assignments:

- to assemble as many as possible program documents from the IAMU members
- to analyze the industry trends, new requirements and regulations, and assess the methods of incorporating them into the programs
- to analyze the admission requirements and to set a certain level of knowledge expected from a candidate
- to collect data and set a uniform academic load for specific marine related training activities, like sea training, industry internships, practical lab work, etc.
- to analyze the existing system of continuing education and to set standards for its development
- to develop a standardized approach to the career-long education:
  - the scope for the initial license and no further advanced training
  - the scope for the initial license and additional training for the license advancement

It is vitally important for the IAMU members to be able to get information and guidance re accreditation and certification from IAMU: it should become one of the principal IAMU activities. Moreover, IAMU should become actively involved in the process, same as the professional associations involved in ABET and IMarEST activities. As an additional benefit of such involvement, further growth of IAMU membership might result. A type of a Panel of Experts or a Committee that should be involved in the curricula standardization, might be assigned the following additional tasks and assignments:

a. To initiate accreditation of the STCW component of the programs on behalf of the IMO. The following actions should be carried out:

- To analyze the standards used by the STCW approving (license granting) agencies in order to eliminate possible discrepancies
- To review and assess the standards used by other accrediting bodies like DNV, Panama Maritime Authority, etc.
- To develop the STCW standards based on the Model Courses and the proposed standard curriculum (see my Report for thr Project #1)

b. One of the most important reasons for the accreditation of a marine engineering program is an ability of the graduate from the Program not only to serve on the ship of another country, but also to be able to continue his education in the maritime college of another country. If IAMU is involved in accreditation, it will assure that the members will be able to recognize each other credits. What the Panamanian Maritime Authority can accomplish, is much easier for the IAMU to accomplish

c. To assemble a Panel of Educators and Industry Professionals with high reputation and substantial knowledge in the specific program related subjects to render an expert opinion on the program content and quality. This Panel might eventually be turned into an Accreditation Body similar to the Committee that accredited the marine engineering programs at the Estonian Maritime Academy.

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THE MARITIME SECURITY MANAGEMENT SYSTEM

—PERCEPTIONS OF THE INTERNATIONAL SHIPPING COMMUNITY

Summary Report–IAMU Project System 2004

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Abstract This paper presents the findings of a research project on the Maritime Security Management System (MSMS) conducted at the Australian Maritime College (AMC) in 2005-2006. The main objectives of this study are to identify key shore-based and near shore activities associated with maritime operations that are currently not covered by the ISPS Code and players involved in these activities; to explore and analyse important relationships among them which can affect the management of security; to investigate the key criteria of a good/effective security management system; to explore the perceived effectiveness of some major aspects of security activities in a MSMS; and to identify the perceived importance of essential elements in a MSMS. Based on this identification and analysis, essential inputs which should be included in the curriculum of maritime universities and training institutions are proposed. This study applies a two-stage methodological approach, in which a focus group discussion is utilised first to explore the initial ideas from maritime experts, followed by a mail survey to reflect the perceptions of the international shipping community. The findings of this study provide essential insights to the formulation of such a global Maritime Security Management System for the sake of safer and more efficient maritime transport.

Keywords maritime security management system; security culture; shore-based activities; security relationships; security elements; security education and training

0 Introduction

In recent years, the issue of maritime security has become a major concern on the international maritime agenda. In fact, maritime security dates back to early maritime history under the themes of piracy and cargo theft. This issue's coverage has also included stowaways, people and drug trafficking. There have been growing fears that terrorists can also use ships or their cargo as weapons to attack vulnerable points in the maritime chain just as aircraft were used in the terrorist attack in the United States. Terrorism, thus, becomes the new dimension of maritime security.

There have been a number of responses to this issue. The International Maritime Organisation (IMO) has recently adopted the International Ship and Port Facility Security (ISPS) Code which came into force on July 1st 2004, aiming at the establishment of an international framework so that 'ships and port facilities can co-operate to deter and detect acts which threaten security in the maritime transport sector'. Although there has been some research done to address the issues of maritime security from different angles, there are some gaps that need to be taken into consideration. First of all, the coverage of ISPS Code is basically within the traditional interactions and relationships between ships and port facilities. In addition, only port facilities serving ships engaged on international voyages are covered in the scope of the Code, while other dimensions of security such as cargo theft, stowaways, etc can exist in all ports no matter what type of ships they serve. Secondly, security threats can come from activities on the shore side. These have not been sufficiently addressed. In the transportation chain, however, maritime security also involves other shore-based activities which can provoke the critical issue of security management connected to maritime transport and operations. For instance, the links with stevedoring companies, road and rail transport companies, freight forwarders, etc and the relationships among them need to be explored. These are some examples of shore-based activities which are associated with maritimetransport and have important implications in the establishment and implementation of security management system.

A lack of security management policy and, on the top of it, a 'security culture' of such shore-based activities will certainly have direct and induced impacts on maritime transport as a whole. A formal research on this aspect is, therefore, considered necessary and useful both from academic and practical perspectives. The following sections describe an IAMU-funded research project, which aimed to identify all shore-based and near shore activities associated with maritime operations and include them in a global Maritime Security Management System (MSMS), conducted at the Australian Maritime College in 2005-2006.

1 Research design and methodology

There are two main research methods applied in this study. First of all, a focus group discussion through e-mail was utilised to explore ideas and obtain perceptions of experts and operators in the field. Based on this, a postal survey was conducted by sending a questionnaire to the international maritime community. Prospective participants in the focus group were selected from the contact database of the Australian Maritime College. Ten maritime experts in Australia and New Zealand, with their background and expertise being port authorities, harbour masters, marine pilots, port operators, maritime consultants, VTS managers and maritime administrators, were contacted. An e-mail containing the project's background, objectives and methodology was then sent to all participants. Upon confirmation of acceptance, a ten-question questionnaire was sent to all participants. The open-ended questions included in the questionnaire aimed at exploring the experts' perceptions of issues such as whether security initiatives such as the ISPS Code have covered all shore-based and near shore activities, their effectiveness, dimensions of security activities to be included in the MSMS, relationships in the system, criteria for a good/effective system as well as what should be incorporated in the contemporary curriculum of maritime universities and other training institutions in order to address the full aspects of maritime security. Other inputs which they felt were necessary for the MSMS were also invited.

The responses of the participants were subsequently collated with author-related links removed, then synthesised and analysed into a single document. This was then sent around to all participants for their comments and additional inputs before being finalised. Upon completion of this process, the final version of the discussion analysis was devised. Based on this analysis, a detailed postal questionnaire was developed and sent around to participants again as a pilot study for their comments. It was then verified and finalised for being sent out to the international shipping community, together with a cover letter explaining the background and objectives of the study. The postal questionnaire contains seven questions addressing issues identified through the analysis of the focus group discussion, and four general questions asking about demographic information of the respondents. Since the topic of this study is exploratory in nature, the questions designed are purposely of both close and open-ended types so as to provide respondents an opportunity to expand upon or explain their answers. Space was also provided on the questionnaire for additional written comments, with the purpose of encouraging the respondents to contribute as much additional details for their answers as possible. Most questions are measured using Likert and numerical scales, since the main purpose of the questionnaire is to explore the attitude of respondents towards related issues being surveyed. Measurement is constructed on five-point scale, ranging from 1 (Strongly agree, most effective, very important) to 5 (Strongly disagree, least effective, not at all important).

The design for the postal survey was decided through the analysis of the focus group discussion. The potential respondents targeted by the survey included port authorities/harbour masters, port operators/stevedoring companies and shipping companies. The sampling frame for this survey was thus chosen from World Shipping Directory of Fairplay[1]. Using the simple random probability sampling method, a mailing list containing 298 target respondents, of which 67 are port authorities, 112 are shipping or ship management companies, and 126 are port operators/stevedoring companies was finalised for the postal survey. In an effort to increase the response rate for this postal survey, the questionnaire was also posted on the website of the AMC. By the cut-off date, there were 60 returned answers to the questionnaire received via both mail and electronic means (on-line questionnaire). This represented a 20% response rate.

2 Perceptions of the MSMS

The main findings in this research, synthesized both from the focus group interviews and survey, are provided below.

2.1 The need to extend current security initiatives

The starting point of a study on the Maritime Security Management System is to investigate whether current security initiatives in place, such as the ISPS Code, need to be extended to cover the shore-based and near shore activities which affect the management of maritime security. The ISPS Code aims at enhancing maritime security on board ships and at the ship/port interface by providing a standardised and consistent framework for the evaluation of risks. As mentioned earlier, the main focus of the ISPS Code is on the sea leg where the ships are at sea and face many security threats, as well as the interface between ships and port facilities when ships are at berths. The coverage of the Code does not reach the shore-based and near shore areas whereas many activities can provoke security threats to the whole maritime transport chain.

This can also be seen clearly in the issue of container security. Because of the critical importance of container transport system in maritime transport industry and potential security threats that they pose, the security of containers is thus extremely vital. There has also been a paradigm shift of focus regarding the perception on security of containers. Before the security threat of terrorism in maritime transportation is recognised, the traditional approach to container security is keeping the goods that were supposed to be in the box, in the box. Given the terrorist threats, especially the scenario that terrorists can use containers to conceal and deliver WMD, there is added responsibility to ensure that things that are not supposed to be in the box are actually kept out of the box Eyefortransport[2]. To ensure the integrity of containers is thus critical as a matter of security, since the integrity of container will affect the security of cargo inside containers, and therefore, the security of maritime transport services RAND[3]. However, characteristics of the container transport system also create some difficulties for security efforts. For example, the movement of each container is part of a transaction that can involve up to 25 different parties: buyers, sellers, inland freighters and shipping lines, middlemen (customs and cargo brokers), financiers and governments. A single trade can generate 30-40 documents, and each container can carry cargo for several customers, thus multiplying the number of documents further Economist[4]. Such a complexity of the container transport system triggers the need to address the security of this system with a comprehensive intermodal framework integrating measures across the entire container transport chain. While such a framework may exist covering ports and maritime transport, there is not yet an analogous framework for inland transport RAND[5], OECD[6]. This implies the fact that while there has not been any such a framework, it is critical to promote a self-regulation culture involving security as similar as what the ISM Code is aiming for safety in maritime transport.

There is a high level of consensus among members of the focus group regarding this issue as they agreed that the ISPS Code should be extended to cover other shore-based and near shore activities in the whole transport chain. There are several justifications for this. The most prevailing reason behind the consensus is that the contemporary security paradigm does not seamlessly interface all other modes of transport, since they focus mainly on the ship–shore interface point. This is aligned with the current literature on maritime security. Specifically, it is argued that many security threats can actually materialise ashore in the hinterland of ports and with other land transport modes rather than shipping. As can be seen earlier in the case of container security, this provokes the issue of security of the whole maritime transport chain rather than the shipping leg and the ship–port interface alone. Furthermore, most of the focus group members felt that there are still some omissions that prevent the current security initiatives from being effective in implementing effective security management ashore. In this connection, most focus group members argued that the current initiatives rely on the detect and deter philosophy therefore the capability to respond to security incidents is reliant on arrangements in counter terrorism response which are beyond the ISPS code. Besides, the effectiveness of the ISPS Code depends upon the integrity of the various security plans and the arrangement made by the custodians of these plans. The effectiveness of the security management system depends very much on the continuous review and update of security plans. Another guiding perception throughout the focus group discussion is that maritime security should be increasingly placed in the context of total transport security, or supply chain security in that the coverage of the security management system spreads out from the point of origin to the point of final destination of the cargo shipment. It is with this in mind that, when assessing the capability and effectiveness of the current security initiatives, some members argued that they are only effective if the point of origin of an export shipment is based within the port precinct, otherwise there is no supply chain security mentality.

Clearly, from the above, the perception is that current security initiatives need to extend their coverage, including other shore-based and near shore activities which can lead to security breaches. It is also affirmed that, when researching the issue of maritime security management system, one needs to take a holistic approach considering maritime security in the broader spectrum of total transport security or supply chain security including all modes of transport and the interfaces between them.

2.2 The issue of security in maritime organisations

To begin the survey of the international shipping community's perceptions of related issues in a MSMS, respondents were asked to indicate their general view on the issue of maritime security in their organisations. The purpose of this question is to explore respondents' general perceptions of this issue after a period that maritime security was given much focus. Answers to this question also indicate the magnitude of the research problem in this study and stress the importance of issues being investigated. Indeed, respondents of this survey expressed a high consensus toward the issue of maritime security, in which 70% view it very important and a top priority, while the remaining 30% perceive it a quite important issue in their organisations. It is evident that maritime security is a very important issue in shipping organisations, and thus a thorough investigation of related aspects in a maritime security management system would prove to be worthwhile.

2.3 Activities to be included in a holistic MSMS

In formulating any operation and management system, the identification of related activities in such a system is probably the very first task to be completed. In this survey, the activities which should be included in a holistic MSMS were identified from the review of related literature, as well as synthesised results from the focus group discussion. Results of descriptive statistical analysis are presented in Table 1 below.

Table 1 Attitude toward activities in a MSMS

Activities	Mean	STD
Stevedoring (Cargo handling in all operation systems within port and terminal area)	1.30	0.56
Ship operations at sea	1.42	0.65
Ship operations while in channel	1.42	0.70
Ship berthing/Unberthing	1.43	0.62
Cargo operations at transport interfaces	1.62	0.56
Cargo operations in the port's hinterland	1.70	0.53

Note: 1=Strongly agree, 5= Strongly disagree

It can be seen from Table 1 that all activities which should be included in a MSMS as identified in the literature and focus group discussion are confirmed by survey respondents with all mean answers smaller than 3, which is the neutral point of the scale. In this list, *stevedoring, consisting of cargo handling activities in all operation systems within port and terminal area*, receives the highest consensus from respondents, while the activity which has the lowest mean score in the list is *cargo operations in the port's hinterland*, yet it is still evident that this activity is closely related with and can be a source of maritime security problems. The above results prove that activities to be incorporated in a MSMS should be viewed from the holistic perspective. These activities encompass not only ship operations at sea, but also the navigation of ships in channels, cargo operations in port and terminal areas and are extended to the points where cargoes are transferred from one to another mode of transportation and operations of cargo at nodes in the port hinterland. In other words, the MSMS should cover all activities in the maritime transportation chain, or from the point where cargoes are placed in the custody of a transport operator until they are delivered to the consignees.

Many respondents proposed some additional activities to be included in the maritime security management system, such as access of visitors, passengers and crew to port and terminal areas, ship operations in coastal waters of civil war countries, ships operations in anchorage, and ship operations in dry-docks or repair yards. While these additional activities are all associated with maritime security problems, ship operations in coastal waters of civil war countries could be included in the ship operations at sea activities, whereas ship operations in anchorage would actually be covered in the scope of ship operations while in channel. The initial two activities of ship operations can therefore be modified to incorporate the additional suggestions. The other two activities, access of visitors, passengers and crew to port and terminal areas, and ship operations in dry-docks or repair yards are valid and can be taken into the list as new activities to be included in a holistic MSMS. This is because many governments do not consider dry-docks and repair yards as ports or port facilities to be covered in the ISPS Code, and the management of access to port areas of passengers, visitors and crew is important to assure security as well.

ANOVA and post-hoc test using Tukey test procedure were employed to analyse respondents' perceptions according to their business sectors. Significance values are used to decide whether there is at least one significant difference among groups of port authorities, shipping companies and port operators in their perceptions of these activities. The results revealed that there are two activities, *cargo operations in the port's hinterland* and *cargo operations at transport interfaces*, in which there is at least one significant difference among the three groups of respondents. Regarding the activity of *cargo operations in the port's hinterland*, there is significant difference between the port authorities and shipping companies in that shipping companies tend to agree on this activity more than do port authorities and port operators. There is also significant difference between the port authorities and shipping companies regarding *cargo operations at transport interfaces*, in that shipping companies tend to agree on this activity more than do port authorities and port operators. These findings are summarised in Table 2.

Table 2 Activities in the MSMS with significant differences between groups of business sectors

Activities	SO		PA		PO	
	PA	PO	SO	PO	SO	PA

Cargo operations in the port's hinterland						
Cargo operations at transport interfaces						

Note: 1. SO: Shipping companies; PO: Port operators/stevedoring companies; PA: Port authorities.

2. The shaded area in a column indicates that, for a specific activity, the group on top of the other(s) in that column agrees on it more significantly than do the other(s).

2.4 Players involved in a holistic MSMS

The next important task is to explore the key players in such a system. Again, by conducting literature review and analysing the result of focus groups discussion, a list of players who should be involved in a holistic MSMS is proposed to the international shipping community. Table 3 presents a summary of descriptive statistical analysis of respondents' perceptions of the proposed players in the system. It shows that all proposed players in a MSMS are supported by respondents from the international shipping community as those who should be involved in the management system of maritime security. This result implies that there is a high consensus between survey respondents and focus group members toward the proposed players in the MSMS. The survey indicates that all transport operators involved in the cargo operation chain, e.g. land, sea, and air transport operators, should be the key players in the management of maritime security. Survey respondents least agreed on cargo owners as involved players in such a security management system, however the mean response to them indicates that these players have an important role in the management of maritime security. This is valid since cargo owners are the very first players who deal directly with cargo security in the whole maritime logistics chain, and thus their positive attitude toward the issue is critical to make security management effective. This is also the key argument in the U.S. C-TPAT (Customs-Trade Partnership Against Terrorism) program.

Table 3 Attitude toward players in a MSMS

Players	Mean	STD
Transport operators	1.20	0.40
Government authorities	1.28	0.49
Port authorities	1.33	0.48
Security service providers	1.48	0.77
Cargo owners	1.53	0.54

Note: 1=Strongly agree, 5= Strongly disagree

While all proposed players to be involved in a holistic MSMS were accepted by survey respondents, they also indicated some other additional players to be included in such a system. For example, some respondents argued that law enforcement agencies such as customs, health and sanitary services, and other maritime industry participants (MIPs) play an important role as well in dealing with maritime security effectively. Other respondents suggested that shipping agents and port agents should also be included in the system, as their awareness of the maritime security issue has a great implication on whether the management of maritime security could be effectively conducted. Indeed, the maritime security chain is only as strong as each link in the chain, thus irresponsible behaviour of a single player could jeopardise the effectiveness of the whole system. Therefore, shipping and port agents are also included in the MSMS as key players involved.

When grouped according to business sector categories, the views of these respondent groups are different from each other in terms of response mean scores. These differences are not statistically significant though. This result further emphasises the high consensus among respondents in the international shipping community when it comes to their perceptions of players who should be involved in the management system of maritime security.

2.5 Importance of major organisational relationships

The relationships among players in any management system are critical since the effectiveness of the system is closely associated with the strength of these relationships and whether the players in the system cooperate and coordinate with each other to smoothly solve any arising problem. In fact, virtually all relationships among players directly and indirectly involved in the MSMS are important; however, survey respondents emphasised their perceptions of the importance of a number of organisational relationships between key players as in Table 4. These relationships encompass the organisational connections both between the transport operators and their external stakeholders, as well as between the management and operational staff levels within each organisation involved in the MSMS. It is evident from Table 4 that the relationship between each transport operator and their security service providers is perceived as the most important in the MSMS having the greatest impact on the effective management of a maritime security management system, while the least important relationship in the security management system, as perceived by survey respondents, is between each transport operator and their stakeholders. Nevertheless, the mean score of responses to this relationship is 1.72, implying that the cooperation and coordination between each transport operator and their direct and indirect customers also play a critical role in resulting in effective management of security problems in maritime logistics operations.

Table 4 Importance of relationships in a MSMS

Relationships	Mean	STD	Rank
Between each transport operator and their security service providers	1.47	0.50	1
Between the government (regulator) and transport operators	1.50	0.50	2
Between players in the MSMS	1.58	0.59	3
Between management and staff within the organisation regarding security accountability and responsibility	1.62	0.58	4
Between each transport operator and their stakeholders	1.72	0.64	5

Note: relative ranking based on mean scores; 1 = very important, 5 = not at all important

When it comes to the importance of relationships in the MSMS, it is worth noting that although there are some differences among these groups they are not statistically significant to be generalised. This result also highlights that there is a high level of consensus among survey respondents toward the importance of organisational relationships between key players in the MSMS.

2.6 Effectiveness of key security aspects/dimension

A maritime security management system would include many aspects or dimensions of the security management practice, and the focal point is that the effectiveness of each dimension should be clearly identified. This is essential, since it helps to set the prioritised security areas which governments and organisations should concentrate on and allocate their scarce resources effectively. Since maritime security is nothing but another type of risk governments and organisations involved in the maritime logistics operations are facing everyday, the assessment and mitigation of security threats should closely follow the standards of risk management practices, in which all dimensions of the risk should be clearly identified and prioritised. Indeed, the identification of security aspects/dimensions and their effectiveness can play an important role in the management of maritime security.

Literature review and analysis of focus group discussion conducted earlier suggest that there are a number of security aspects which governments and organisations in the MSMS should focus upon. Results of descriptive statistical analysis are presented in Tables 5 below.

Table 5 Perceived effectiveness of security dimensions in a MSMS

Dimensions	Mean	STD	Rank
Security awareness education and training	1.23	0.53	1
Access control	1.28	0.49	2
Physical security	1.57	0.59	3
Procedural security	1.58	0.62	4
Personnel security	1.67	0.48	5
Information security	1.88	0.45	6

Note: relative ranking based on mean scores; 1 = most effective, 5 = least effective

It is evident from Table 5 that education and training about security awareness is the most effective aspect in managing security in maritime logistics operations. Information security is seen as the least effective security dimension, yet its mean score also implies that the management of this security dimension would also be effective in governments' and organisations' strategies to good security management results. Results from this table also confirm that, while the role of 'technical aspect' in security management is increasingly important, the human factor is still the decisive element for the success of the maritime security management system. Indeed, as people are the centre of any operations and management system, the education and training of human awareness, play the critical role. As human awareness is enhanced, all other security aspects in the system such as access control, physical or procedural security can be appropriately and effectively managed, and the synergy of all these aspects/dimensions would contribute to the success of the system as a whole.

Analysis of survey respondents' perceptions also revealed that there are significant differences among them toward the effectiveness of security dimensions when grouped according to their business sectors. In this respect, respondents of various business sector groups are significantly different from each other in terms of their perceptions of the effectiveness of *procedural security* and *access control*. For *procedural security*, there is a significant difference between shipping and ship management companies and port operators/stevedoring companies, in which the former perceived it as more effective than do the latter. For *access control*, there is a significant difference between shipping companies and port operators in which port operators tend to rate this dimension as more effective than do shipping companies. These findings are summarised in Table 6 below.

Table 6 Key aspects/dimensions in the MSMS with significant differences between groups of business sectors

	SO	PA	PO

Activities	SO		PA		PO	
	PA	PO	SO	PO	SO	PA
Procedural security		[shaded]				
Access control		[shaded]				

Note: 1. SO: Shipping companies; PO: Port operators/stevedoring companies; PA: Port authorities

2. The shaded area in a column indicates that, for a specific activity, the group on top of the other(s) in that column rates it as being more significantly effective than do the other(s).

2.7 Importance of essential security elements

The maritime security management system is a network of various elements which have reciprocal relationships with each other. The review of relevant literature and analysis of focus group discussions conducted in the early stages of this study revealed that several essential elements, and a number of their combinations, would be very important for the purpose of effective management of security in maritime logistics operations. Table 7 provides the summaries of descriptive statistical analyses of these elements' perceived importance. It is noted that all elements of the security system identified in the literature and focus group discussions were confirmed by the survey respondents.

Table 7 Importance of security elements in a MSMS

Elements	Mean	STD	Rank
People	1.18	0.39	1
Communication	1.20	0.40	2
Policy	1.30	0.46	3
People and communication	1.40	0.49	4
People and processes	1.43	0.50	5
Processes/procedures	1.45	0.50	6
Systems/Technology	1.67	0.54	7
Communication and technology	1.72	0.45	8
People and systems/technology	1.77	0.43	9
Processes and systems/technology	1.85	0.52	10

Note: relative ranking based on mean scores; 1 = very important, 5 = not at all important

It is evident from Table 7 that *people* are the most important element in the maritime security management system. The combination of *processes* and *systems/technology* is ranked the least important element in the MSMS, however the high mean score of this element also emphasises its importance for the successful management of maritime security management system, and implies that there is a high consensus among survey respondents. It is interesting to note that the human factor is placed at the centre and is the focus of maritime security management system. It is consistent throughout the survey results that the human factor is always seen as the most important dimension and element in the security management system. Earlier, it is revealed that *security awareness education and training* is seen as the most effective security aspect/dimension, meaning that security control and management must start from the education of security awareness for the people who are directly and indirectly involved in the maritime logistics operations. Concurrently, the importance of *people* and a number of combinations of this element, such as *people and communication*, *people and processes*, *people and systems/technology* are highly perceived. It is thus evident that maritime security is, by nature, about the people and it should begin with the people. The effectiveness of the maritime security management system is thus very much related to how people view security in their organisations, and whether sufficient education and training are provided to people so that they can effectively identify, analyse, assess and treat maritime security risks.

When it comes to the perceptions of important elements in the MSMS, there are some significant differences among business sector groups of port authorities, shipping and ship management companies, and port operators/stevedoring companies. There are two system elements whose importance is significantly different between respondent groups: *policy* and *processes/procedures*. In the 'policy' dimension, there is a significant difference between shipping companies and port operators, in that the former tends to rate this element as significantly more important than do the latter. Shipping companies, meanwhile, see 'processes/procedures' as significantly more important than do port operators. This is summarised in Table 8 below.

Table 8 Key security elements in the MSMS with significant differences between groups of business sectors

<table>
<tr><th rowspan="2">Activities</th><th colspan="2">SO</th><th colspan="2">PA</th><th colspan="2">PO</th></tr>
<tr><th>PA</th><th>PO</th><th>SO</th><th>PO</th><th>SO</th><th>PA</th></tr>
<tr><td>Policy</td><td></td><td style="background:cyan"></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Processes/procedures</td><td></td><td style="background:cyan"></td><td></td><td></td><td></td><td></td></tr>
</table>

Note: 1. SO: Shipping companies; PO: Port operators/stevedoring companies; PA: Port authorities

2. The shaded area in a column indicates that, for a specific activity, the group on top of the other(s) in that column rates it as being more significantly important than do the other(s).

2.8 Key criteria of a good/effective MSMS

Literature and focus groups discussions conducted in the early phase of this study have revealed a number of criteria to be considered when assessing whether a maritime security management system is good or effective. They were also incorporated into the postal questionnaire for the purpose of surveying the international shipping community. Table 9 summarises the descriptive statistical analysis of responses to the proposed 15 criteria of a good/effective MSMS, showing that all proposed criteria are valid and should be considered as essential for assessing the effectiveness of a MSMS.

Table 9 Attitude toward criteria of a good/effective MSMS

Criteria	Mean	STD
Effective communication among the participants of the security system	1.17	0.38
Good security information and intelligence	1.23	0.53
To be holistic in the consideration of the risk assessment at appropriate intervals	1.27	0.45
Constant reviewing of security processes, procedures and available technology	1.40	0.49
Security should become part of the wider safety management system	1.42	0.62
Meaningful government inputs in terms of resources support and legislative guidance	1.48	0.50
Adequate funding and government guidelines	1.58	0.72
Frequently conducting security drills and exercises	1.58	0.53
Legislative background and policy formation	1.62	0.61
Developed and effective relationships within the organisation and between organisations in the security management system	1.65	0.55

Consistency in application of systems, processes and protocols–to the extent that it is possible, as in other regulatory matters, in the global context	1.67	0.66
Security management should be integrated within the spectrum of risk management, quality management, environmental management and other safety systems	1.72	0.52
Auditable metrics, monitoring and reporting procedures in place	1.73	0.45
Regular security training	1.75	0.79
Designated and adequately equipped emergency control centres	1.78	0.45

Note: 1=Strongly agree, 5= Strongly disagree

Respondents most agreed that an effective MSMS should have *effective communication among the participants of the security system*. The importance of *good security information and intelligence* is also highlighted, while respondents least agreed that *designated and adequately equipped emergency control centres* a criterion of a good/effective MSMS. However, the high mean score of this criterion also implies that it should be retained in the list of criteria for assessing a good/effective maritime security management system.

When it comes to the respondents' perceptions according to business sector groups, it is interesting to note that there are significant differences among respondent groups regarding the criterion *designated and adequately equipped emergency control centres,* which is the least agreed criterion. In this respect, there is a significant difference in perceptions between port authorities and shipping companies in that the former tends to agree more on this criterion than does the latter. The port authorities in this survey also agreed more than do port operators when it comes to this issue. Results are summarised in Table 10 below.

Table 10 Criteria of a good/effective MSMS with significant differences between groups of business sectors

Activities	SO		PA		PO	
	PA	PO	SO	PO	SO	PA
Designated and adequately equipped emergency control centres						

Note: 1. SO: Shipping companies; PO: Port operators/stevedoring companies; PA: Port authorities.

2. The shaded area in a column indicates that, for a specific activity, the group on top of the other(s) in that column agrees on it more significantly than do the other(s).

2.9 Essential inputs in the curriculum of security education and training

Having identified all essential components, together with the criteria of a good/effective MSMS, it is critical that governments and organisations involved in security management in maritime logistics operations clearly see the requirements imposed on such a system. In order to have sufficient and adequate resources in effectively managing maritime security risks, education and training plays an important role. This provokes the question of how maritime universities and other training institutions design their curriculum to respond adequately to the demand from the industry regarding maritime security management. Literature review and analysis of focus group discussions showed that there are various inputs to be incorporated in the contemporary curriculum of maritime universities and other training institutions in this respect. It is now important to explore whether there is consensus among the international maritime community. Survey respondents in this study were asked to indicate their perceptions of the proposed inputs in the contemporary curriculum of maritime universities and other training institutions so as to meet the demand from the industry practices. Table 11 below indicates the summary of descriptive analysis of responses.

Table 11 Attitude toward inputs of curriculum for education and training needs

Inputs	Mean	STD
Holistic risk management principle applied to international supply chain and intermodal transport	1.65	0.58
An approved course based on guidelines from IMO involving all aspects of a Maritime Security System	1.73	0.61
Security in current maritime and logistics management course, including port and terminal management	1.80	0.80
International and national issues relating to security management in international supply chain and maritime transport, including security initiatives and strategies to effectively implement them	2.05	0.79
Transport security in a broader perspective of international supply chain and intermodal transport	2.20	0.82

Note: 1=Strongly agree, 5= Strongly disagree

Firstly, it is evident from Table 11 that all proposed curriculum inputs are accepted by respondents as essential for the development of relevant courses addressing maritime security issues. Furthermore, there is the highest consensus among survey respondents toward the curriculum input of *holistic risk management principle applied to international supply chain and intermodal transport*. The least agreed curriculum input is *transport security in a broader perspective of international supply chain and intermodal transport*. Nevertheless, this curriculum input should be retained on the proposed list, since its mean score is sufficient to justify its presence in the curriculum. Secondly, regarding respondents' perceptions of the proposed curriculum inputs for the education and training of maritime security management system, it is revealed that respondents' perceptions according to their business sector groups are significantly different from each other when it comes to *transport security in a broader perspective of international supply chain and intermodal transport* as an input of the contemporary curriculum. In this respect, there is a significant difference between port authorities and shipping companies, in that the former group tends to agree more on this curriculum input than does the latter. Results are summarised in Table 12 below.

Table 12 Curriculum input for the education and training of the MSMS needs with significant differences between groups of business sectors

Activities	SO		PA		PO	
	PA	PO	SO	PO	SO	PA
Transport security in a broader perspective of international supply chain and intermodal transpor						

Note: 1. SO: Shipping companies; PO: Port operators/stevedoring companies; PA: Port authorities.

2. The shaded area in a column indicates that, for a specific activity, the group on top of the other(s) in that column agrees on it more significantly than do the other(s).

The scope of components to be included in a global Maritime Security Management System, together with criteria of a good/effective MSMS and necessary curriculum inputs for education and training are summarised in Fig. 1.

3 Conclusion

In this paper, we present the findings of a study investigating basic elements of a global Maritime Security Management System. These elements have been identified, analysed and discussed, taking into consideration the need to extend the ISPS Code which is currently applied only for the ship operations at sea and ship/port interface. The results of this study reveal that there is a high level of agreement between members of the focus group and respondents from the international shipping community with regards to key issues raised in this study, indicating that its findings are reliable and helpful for the subsequent formulation of such a Maritime Security Management System for the sake of safer and more efficient maritime transport.

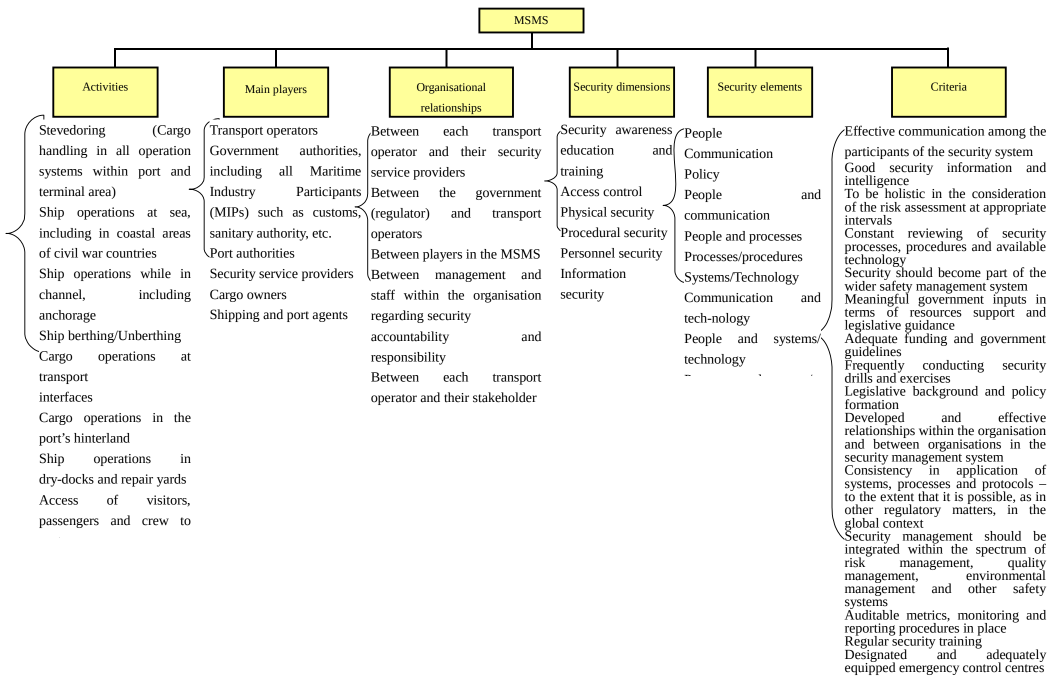

Fig. 1 Features of a Maritime Security Management System (MSMS)

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Maritime Physics: Developing Interactive Teaching Materials Connecting Physical Laws and Principals with Maritime Applications

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Abstract This paper presents preliminary results of an ongoing research project. We present working examples of Physics problems and classroom teaching presentations which are based on real life video clips of maritime activities and/or on routine activities performed by mariners navigating the ship. We discuss interdisciplinary connection between general education Physics and Mathematics courses and maritime subjects taken by maritime students.. We also present here a method of using video documentation of events in a maritime setting, and employing digital analysis of the video using inexpensive commercially available software called VideoPoint to obtain useful data. This data can be then successfully used by Physics instructors at Maritime universities in order to explain students the theoretical basis for motion demonstrated on the video and to produce their own maritime related activities for general Physics classrooms.

Keywords general education; physics; maritime applications; software; video analysis; digital

0 Introduction

All Maritime Universities students, including California Maritime Academy (CMA thereafter) cadets, specializing in any kind of Engineering or in Marine Transportation are required to take at least 1 semester of college level Physics during their freshman year . This course is usually included in general education requirements and taught using standard College or Engineering Physics textbooks which rarely show applications of Physics relevant to professional occupations of future mariners. First year cadets have little appreciation of the relevance of mathematics and physics to the maritime profession. Students are exposed to the physics and mathematics concepts (for example vectors) during their first year of maritime education, but are usually not presented with examples of maritime applications of these concepts until at least the second year. Most students are not able to link the skills and knowledge they learn in physics class with professional courses such as Radar, Navigation, Ship Stability, Static, Dynamics and various technical courses they will take later in their course of study. This lack of understanding of the importance of physical laws and principles to Maritime applications leads on the one hand to students' low interest and motivation in studying Physics and as result to a relatively unsatisfactory learning outcome; on the other hand the faculty members teaching maritime courses (where the level of students' motivation is usually much higher) have to spend time to review and often to teach again the knowledge and skills students are supposed to have after successful completion of their Physics course. The development of computerized teaching materials which use routine operations of ships to illustrate the concepts of general physics would help to establish the missing link between Physics as a general education course and professional maritime studies. These teaching materials can be used in teaching both Physics and various maritime courses.

1 Learning physics in context

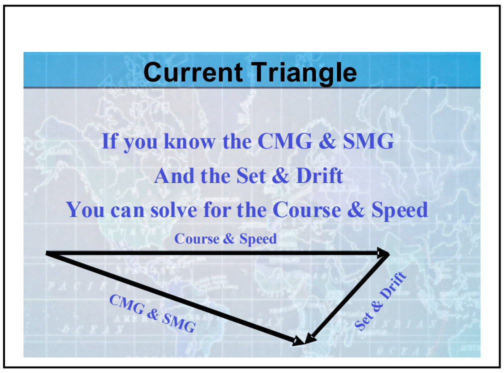
Researchers in the field of education have been investigating students' difficulties with learning mathematics and physics for many years. Educational researches and successful practitioners have placed great importance on the teaching of these subjects in context by demonstrating their 'real world' applications (see for example, Mazur[1], Lye, et al.[2]). Students' understanding of mathematics and physics is enhanced when they see the applicability of what they are learning. Putnum[3] wrote that "For them (*students*), an important part of what it means to understand mathematics is knowing how to use various mathematical tools to solve problems encountered in everyday life." The work of Roth and Roychouldhury[4] and of Stinner[5] showed "that appropriately designed contexts which attract students' interests have been shown to create great motivation to learn science." Wilkinson[6] wrote of the necessity "to place physics learning in real life contexts so students could learn that physics wasn't about Abstract concepts that had no place in their out-of-school lives, but that an understanding of physics led to an understanding of the way things work in real life." Hart[7] reported that "contexts were an important device for engaging and motivating students, communicating the relevance and purpose of physics, and increasing student enrolments in the subject." Rennie and Parker[8] wrote that "…physics needs to be practiced in contexts which enhance understanding through direct relevance to the real world." For our cadets, 'real world' and 'everyday life' is their future maritime environment.

Teaching in context and the descriptive use of real world applications are indispensable instructional tools that enable maritime students to better understand generic math and physics concepts. However, it is unlikely that the instructors of these subjects would have the necessary background to successfully create realistic example problems in math and physics that relate to the maritime field. Therefore, the authors of this paper would like to suggest some ideas and present general education instructors with sample problems with a maritime flavor that could be used in first year college physics courses. Our first example deals with the use of radar plotting to explain the concept of vector subtraction.

2 Use of navigation and radar topics in teaching relative motion and vector manipulations

Most college level physics and mathematics textbooks devote many pages to the subject of vector addition and multiplication. Both graphical and analytical methods of vector manipulation are usually presented to the student with sufficient numbers of example problems drawn from real-life situations. Typical problems demonstrating vector addition or multiplication deal with simple summation of displacement vectors, finding the resulting force on an object given the magnitude and direction of several independent forces acting on the object simultaneously, finding the torque on a rotating shaft, determining the force on a charge moving through a magnetic field, etc. The understanding of vector addition and multiplication is greatly enhanced by these and other examples of using physics to describe the world around us. For maritime students many 'real life' examples of vector manipulations can be found in Radar and Navigation classes. For example Fig. 1 shows vector diagrams used to determine resultant course and speed made good when a vessel is affected by a known current.

In teaching of general physics courses vector subtraction is usually dismissed by converting the problem into vector addition, i.e., simply stating that vector **A** minus vector ***B*** is the equivalent of vector ***A*** plus the opposite of vector ***B***[***A*** – ***B*** = ***A*** + (-) ***B***]. No attempt is usually made to provide examples of practical applications of the vector subtraction concept and as result students routinely do not understand the idea behind this concept. However, to convey the meaning of relative motion or relative wind in Radar and Navigation classes, students' understanding of vector subtraction is required. Maritime students can become easily confused and frustrated when they fail to intuitively grasp the meaning behind the math or physics concepts. In his essay "Introducing Vectors" John Roche[9], a physics professor at Linacre College, Oxford, England pointed out what 'A common complaint about physics is that we do not explain why we are introducing certain concepts: we simply introduce them mathematically, without any justification.' Unfortunately, the above description is often true when applied to the presentation of the vitally important to a maritime officer concept of relative motion in general physics courses.



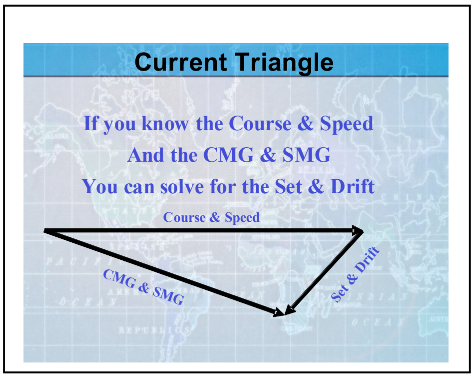


Fig. 1 Vectors addition and subtraction in form of 'Current Triangle' from Navigation course.

The proper understanding and analysis of the relative motion between two ships is the foundation of effective collision avoidance. While nearly everyone instinctively uses their sense of relative motion in everyday life to avoid collisions with common objects, other pedestrians, automobiles, etc., the determination of relative motion between two ships at sea, particularly when observed on a radar screen, is not nearly as intuitive. The somewhat elaborate and cumbersome methods of manual plotting, developed over the last half century by radar schools throughout the world, provide the mariner with effective tools to avoid collisions with other vessels. However, these methods rely on rote memorization of steps to be followed in conducting what is essentially the vector analysis of an encounter by one or more vessels. For students who need to have a more complete understanding of what they are doing before they can do it effectively, the traditional teaching methods of manual plotting may prove to be inadequate. First time failure rates of between 10 - 50% have been observed for radar students at the California Maritime Academy over the last five years. Greater success in the radar course may be obtained by the introduction and more thorough explanation of vector subtraction in a first year physics course.

So how can we ensure that relative motion concepts are effectively introduced through an enhanced study of vector subtraction in freshman physics? The first step is to make certain that the student completely understands vector addition. Once the student has a grasp of the graphical method of vector addition, it is easier to explain the related concept of vector subtraction. The standard explanation of vector addition follows the **triangle rule** as shown on Fig. 1. The triangle rule is perfectly adequate for explaining vector addition. Problems involving set and drift calculations taken from primary navigation courses in piloting provide students with practical examples of the importance of vector addition to the mariner. However, if we wish to give our maritime students a better understanding of vector subtraction and relative motion, the **parallelogram rule** (Fig. 2) for vector addition is more suitable.

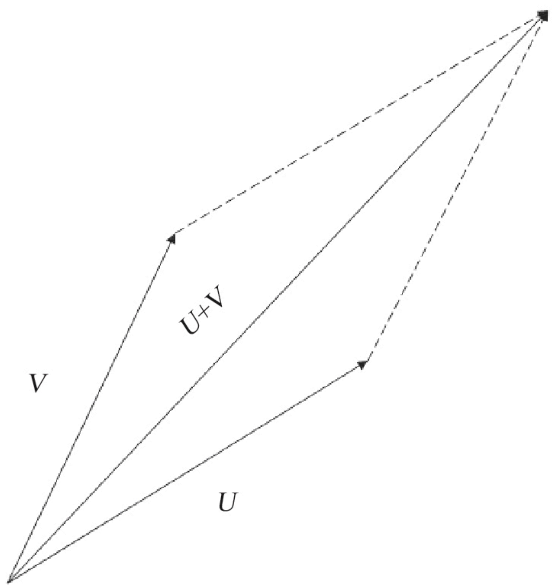


Fig. 2 Parallelogram rule for adding vectors *U* and *V*

With the parallelogram rule, the student can see at a glance the relationship of vector addition to vector subtraction. The large diagonal of the parallelogram represents the addition of the associated vectors forming the sides, and the small diagonal represents the subtraction of the same two vectors (Fig. 3). The direction of the difference vector of course depends on whether we wish to find $\boldsymbol{V} - \boldsymbol{U}$ or $\boldsymbol{U} - \boldsymbol{V}$.

After the student learns how to manipulate vectors confidently, we can then begin the discussion of the phenomena of relative motion between objects and how this is mathematically explained by vector subtraction. It can then be shown that the direction of the difference vector, i.e. the direction of relative motion, depends on which of the original vectors represents the subtrahend and which the minuend. The vector representing the subtrahend also represents the true course and speed vector of own ship in a radar plotting problem. The vector representing the minuend is then the true course and speed vector of the other vessel. In the standard radar plotting problem, the difference vector (relative motion) and the subtrahend vector (own ship true course and speed) are given and the minuend vector (other vessel true course and speed) is the unknown for which to be solved.

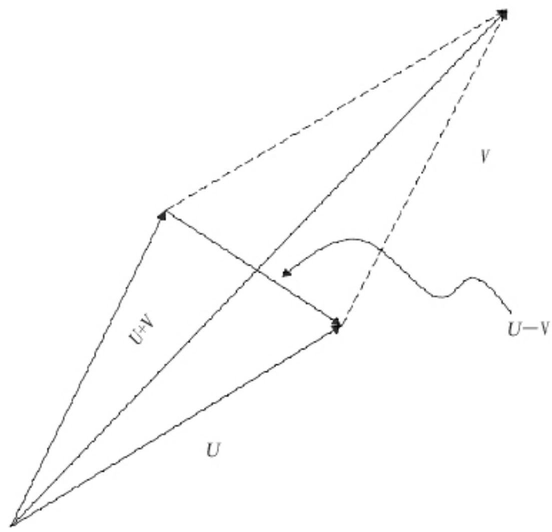


Fig. 3 Parallelogram rule showing the relation of addiion and vector subtraction

So what type of motion information is actually presented on a relative motion radar screen? Pseudo-motion that can be described by vector subtraction and represents the difference between the motions of the ship and any other object shown on the screen. And so, the relative motion radar display can be said to provide a graphical, practical, and indeed vital example of the concept of vector subtraction.

3 Physics in ship stability course

The previous section described in detail one topic where Physics and Radar course are closely overlap. This interdisciplinary overlap can and must be used in teaching of general Physics courses at Maritime Universities and Academies. In this section we present in Table 1 a preliminary list of Physics and Ship Stability courses topics which are closely related. The marine applications are taken from the Stability and Trim for the Ship's Officer[10] textbook used in teaching of NAU 205 Ship Stability course at CMA.

Table 1 Overlapping topics in General Physics and Ship Stability courses.

Physics Topics	Ship Stability Topics

Vectors, relative motion:	
a. vector addition graphically	effect to the center of gravity of the vessel by cargo movements (load, discharge, shift)
b. vector addition by component vectors	indirect determination of the Righting Moment: GZ = GM x *sin* (Angle of Inclination)
c. vector addition for relative motion	value of the righting arm (GZ) at large angles of inclination
1 and 2 dimensional kinematics:	
a. velocity vectors b. acceleration vectors c. displacement vectors	moment to trim 1 inch of a vessel at a given waterplane
Newton's laws of motion:	
a. static forces	bending moments and shearing
b. conservative forces c. non-conservative forces d. friction	the position of the center of buoyancy at various small angles of inclination
e. normal force f. tension	hull strength (hog and stress numerals), strength of materials
Equilibrium, Energy, conservative and non-conservative forces	vessel equilibrium (positive, negative, neutral)
Rotational Kinematics	angular acceleration due to rolling and resultant racking stresses
Rotational Dynamics:	
a. Torque b. levers c. angular momentum d. moment of inertia	transverse and longitudinal stability about the longitudinal axis, transverse axis, vertical axis; free surface effects
Archimedes Principle	displacement of the vessel in salt/fresh water; specific gravity effects, change of salinity

4 Digital video analysis in teaching maritime physics

4.1 Software and limitations

After extensive research and comparison, we found and purchased an inexpensive commercially available video analysis software package called ***VideoPoint*** Physics Fundamentals, Version 1.0.0 Copyright 2005 Lenox Softworks, Inc. designed to teach the fundamental laws of physics using video analysis. The software uses a video analysis process in which position and time data are collected from digital videos. The practical use of this way of video analysis involves some limitations. The time base for video documentation is determined by the video camera frame rate. This time base is either 20 frames per second, when using inexpensive digital cameras, or 30 frames per second, when using more expensive equipment. This is adequate for many applications but is inadequate for applications such as electric motors running at 3600 rpm. Such a speed would yield 60 revolutions per second. Even at shutter speeds of 30 frames per second, there would be 2 revolutions during each frame.

Other limitations include a stationary frame of reference. At sea, the motion of the vessel is continually changing, and the movement of the activity that is being observed, such as use of a block and tackle, would be affected by the motion of the reference frame. However, if the video is of short duration, these affects can be minimized.

4.2 Digital analysis procedure and example of rotating winch on the ship

(1) Several seconds or minutes of an action are filmed with the camera mounted on a tripod. The tripod is necessary to maintain a stationary frame of reference. The action that is being filmed must fit within the frame of view because the camera should not be moved during the action.

(2) The video camera is then connected to a computer. S-video connection is preferred. If the computer does not have connections, an interface may be required. We used a SIIG AVTuner-PVR to connect the S-video port of the camera to a USB port on the computer.

(3) Different manufacturers use various codes for the digital video signal. VideoPoint Physics Fundamentals requires videos to be in the Sony QuickTime format (files with extensions .mov). Some conversion programs such as the AVTuner that we used, employs the mpeg format.

(4) A program to convert the mpeg or wmv to mov is often required.

(5) We used ConvertMovie 4.1 by Movavi to convert between file types.

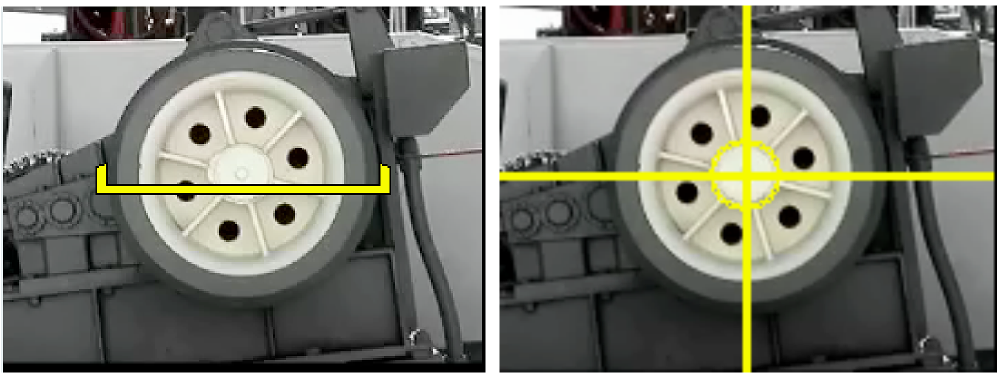
(6) Analysis software required video in the Quicktime movie format (mov)

(7) Once the camera is connected to the computer, the program VideoPoint Capture by Lenox Software Inc. is used to review the video and capture the segment of the video that is going to be used for analysis. Video files are quite large and it is useful to keep the segment of film for analysis very brief. Typically a five-second video is sufficient. This length will provide 150 frames. This will yield 150 data pairs in 2-dimensional analysis

(8) Once the video segment is captured (in Quicktime format) it is opened in the VIdeoPoint analysis software. The steps for analysis are;

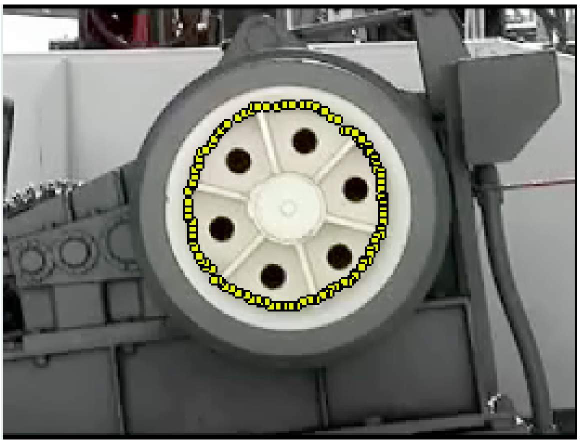
a. preview

b. Calibrate-This is where the frame of reference is established. For example an x,y coordinate system centered at a particular point on the frame.



c. Set up for analysis- reference frame can be rotating, time base can be set to zero.

d. Analysis- a point is traced as it moves through 2-dimensional space.

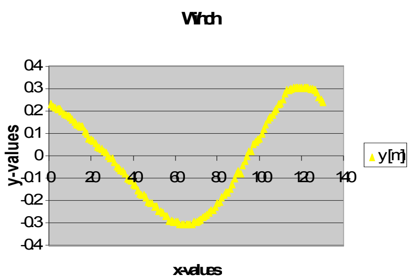


e. Data collection- at this point the data from the 2-dimensional analysis can be saved, analyzed with the software in VideoPoint Physics, or exported to an Excel file for analysis.

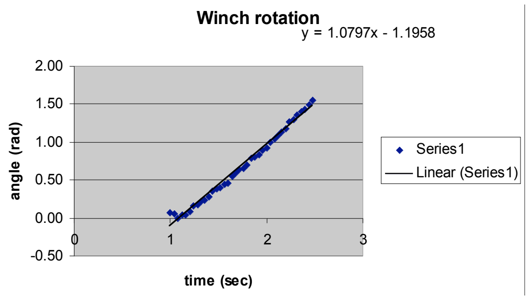
From the data set given we can do a large amount of analysis. First, we may look at the raw data plot of x,y. We know that a plot of a point on a rotating circle will provide a sine wave. Here we see such a plot and the resulting sine wave.

Table 2 Raw data collected from digital analysis of rotating winch

Frame	Time (s)	*x* (m)	*y* (m)	Frame	Time (s)	*x* (m)	*y* (m)
1	0	0.202	0.2323	26	1	0.303	0.0202
2	0.04	0.207	0.2222	27	1.04	0.303	0.0151
3	0.08	0.2121	0.2171	28	1.08	0.303	0
4	0.12	0.2222	0.2121	29	1.12	0.308	-0.0101
5	0.16	0.2272	0.2121	30	1.16	0.303	-0.0101
6	0.2	0.2272	0.202	31	1.2	0.303	-0.0252
7	0.24	0.2424	0.1919	32	1.24	0.2929	-0.0454
8	0.28	0.2474	0.1818	33	1.28	0.2929	-0.0505
9	0.32	0.2525	0.1767	34	1.32	0.2878	-0.0656
10	0.36	0.2525	0.1717	35	1.36	0.2878	-0.0707
11	0.4	0.2525	0.1616	36	1.4	0.2828	-0.0808
12	0.44	0.2626	0.1515	37	1.44	0.2727	-0.101
13	0.48	0.2676	0.1414	38	1.48	0.2676	-0.106
14	0.52	0.2676	0.1363	39	1.52	0.2676	-0.1111
15	0.56	0.2727	0.1313	40	1.56	0.2626	-0.1262
16	0.6	0.2727	0.1313	41	1.6	0.2626	-0.1313
17	0.64	0.2828	0.1111	42	1.64	0.2525	-0.1515
18	0.68	0.2878	0.101	43	1.68	0.2474	-0.1666
19	0.72	0.2929	0.0808	44	1.72	0.2323	-0.1717
20	0.76	0.2929	0.0757	45	1.76	0.2272	-0.1717
21	0.8	0.2929	0.0707	46	1.8	0.2222	-0.1868
22	0.84	0.303	0.0555	47	1.84	0.207	-0.207
23	0.88	0.303	0.0404	48	1.88	0.202	-0.2121
24	0.92	0.303	0.0353	49	1.92	0.1919	-0.2121



A plot of the position of a point on the winch vs time



A plot of the angle of the winch vs time. The slope of the curve is the velocity which is 1.08 rad/s.

Other analyses that have been done include, angular rotation of small craft about long axis, the trajectory of a heaving line, and the use of a block and tackle.

4.3 Student problems based upon rotational dynamics

After the students have observed the video clip and the analysis including data capture, a number of similar questions can be posed for the student to answer based on the scenario.

As you see in the video, Peter started the winch. We observed that after 4.0 seconds, the winch was moving with an angular velocity of 2.0 rotations/s.

(a) Find the angular velocity in radius/s.

$$2 \text{ rotations/s} = 2 \cdot 2\pi \text{ rad/s} = 4\pi \text{ rad/s} = 12.56 \text{ rad/s}$$

(b) Find the angular acceleration (i) in radias/ s^2 (ii) rotations/ s^2

$$\text{(i) } a = \frac{w - w_o}{t} \square \frac{12.56 \text{ rad/s}}{4.0 \text{ s}} = 3.14 \text{ rad/s}^2$$

$$\text{(ii) } (3.14 \text{ rad/s}^2)\ (1 \text{ rot}/2\pi \text{ rad/s}) = 0.5 \text{ rot/s}^2$$

(c) The winch needs to be stopped. It took 2.0s for the winch to come to rest from the velocity of 12.56 rad/s or 2 rev/s. Find the deceleration presuming the winch was decelerating uniformly.

$$a = \frac{0 - 12.56}{2.0 \text{ s}} \text{rad/s} = -6.28 \text{ rad/s}^2, \text{ or } = \frac{-1 \text{ rot}}{s^2}$$

(d) If the moment of inertia of the winch was 100 kg • m^2. Find the (i) accelerating torque (ii) decelerating torque.

Torque = (Moment of Inertia) (Angular acceleration)

$$\text{(i) Torque (accelerating)} = (100 \text{ kg} \cdot \text{m}^2)\ (3.14 \text{ rad/s}^2) = 314 \text{ N} \cdot \text{m}$$

$$\text{(ii) Torque (decelerating)} = (100 \text{ kg} \cdot \text{m}^2)\ (-6.28 \text{ rad/s}^2) - 628 \text{ N} \cdot \text{m}$$

(e) Suppose you wanted to stop this winch from the angular velocity of 20 rad/s in 0.5 seconds. What should be the magnitude of the decelerating torque?

T = (Moment of Inertia) (deceleration)

But deceleration in this case = $\frac{0-20\text{rad/s}}{0-5}$ = -40 rad/s2

Torque = (−40 rad/s^2) (100 kg • m^2) = −4,000 N • m.

(f) The winch is 2.0m in diameter. What tangential force is going to produce this 4,000 N • m. torque?

Torque = (Radius) (Tangential force which is perpendicular to the radius)

4,000 N • m = (1 m) (Force)
Force = 4000 N

(g) For simplicity, presume that the winch is a solid cylinder rotating about its axis and has mass of (100kg) and radius of 2.0m. Find the moment of inertia.

Moment of Inertia of a solid cylinder about its axis

= 1/2 MR^2 = (1/2) (100 kg) (2 m)^2
= 200 kg • m^2

(h) If the torque of 4000N • m. is acting for 1.5 seconds, how much angular displacement is produced during these 1.5 seconds.

Angular acceleration = Torque

Moment of Inertia

a = $\frac{4000 \text{ N} \cdot \text{m}}{200 \text{ kg} \cdot \text{m}^2}$ = 20 rad/s^2

θ = Angular displacement = Wot + 1/2 a • t^2

where Wo is initial angular velocity and "a" is angular acceleration.

θ = (1/2) (20 rad/s^2) (1.5 s)^2
= 22.5 rad.

(i) What is the final angular velocity (w) in rad/s?

$w = wo + t$

w = o + (20 rad/s^2) (1.5 s) = 30 rad/s

(j) Why flywheel and winches are heavy at the rims.

Because moment of inertia (I) depends on the distribution of mass around the axis of rotation = I = $\int x^2 \cdot dm$

Heavier is the object around the rim, more will be the moment of inertia. (Cheaper to have more mass around the rim)

(k) What is the kinetic energy of the winch when it is moving with 30 rad/s?

$$k \cdot E = 1/2\ Iw^2 = (1/2)\ (200\ \text{kg} \cdot \text{m}^2)\ (30\ \text{rad/s})^2$$
$$= 90000\ \text{J}$$

(l) What is the source of this increase in kinetic energy?

Work done by the torque increases the kinetic energy.

$$\text{Work done} = (\text{Torque})\ (\text{Angular displacement})$$
$$= \text{Change in } K \cdot E$$

$$(4000\ \text{N/m})\ (22.5\ \text{rad}) = 90000\ \text{J}$$

Another scenario that we filmed was the use of a block and tackle.

The video was calibrated (Fig. 4), axes were established (Fig. 5), and digital analysis of the hand and the weight were performed(Fig. 6). These are summarized in the following images and tables.

Table 2 Raw Data from Block and Tackle

Frame	Time (s)	*X* (m)	*Y* (m)	*Y* (m)
1	0	0.1935	-1.3064	-0.3709
2	0.04	0.2016	-1.2822	-0.379
3	0.08	0.2096	-1.2741	-0.387
4	0.12	0.2096	-1.25	-0.387
5	0.16	0.2096	-1.2419	-0.387
6	0.2	0.2258	-1.2177	-0.4032
7	0.24	0.2258	-1.2096	-0.4032
8	0.28	0.2258	-1.1854	-0.4112
9	0.32	0.2258	-1.1854	-0.4112
10	0.36	0.2258	-1.1854	-0.4193
11	0.4	0.2338	-1.1854	-0.4193
12	0.44	0.2338	-1.1774	-0.4193
13	0.48	0.2419	-1.1612	-0.4354
14	0.52	0.2419	-1.1532	-0.4354
15	0.56	0.2419	-1.1451	-0.4435
16	0.6	0.2419	-1.1209	-0.4435
17	0.64	0.2419	-1.1209	-0.4516
18	0.68	0.258	-1.0967	-0.4516
19	0.72	0.2741	-1.0322	-0.4516
20	0.76	0.2903	-1	-0.4758
21	0.8	0.2983	-0.9919	-0.4758
22	0.84	0.2983	-0.9677	-0.4758
23	0.88	0.3064	-0.9516	-0.4838
24	0.92	0.3064	-0.9354	-0.4838
25	0.96	0.3225	-0.9193	-0.4838
26	1	0.3225	-0.9032	-0.4838

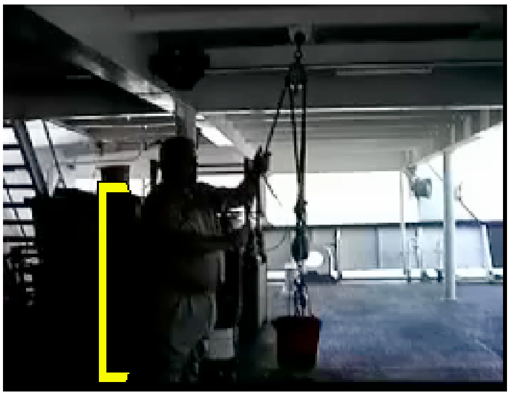


Fig. 4

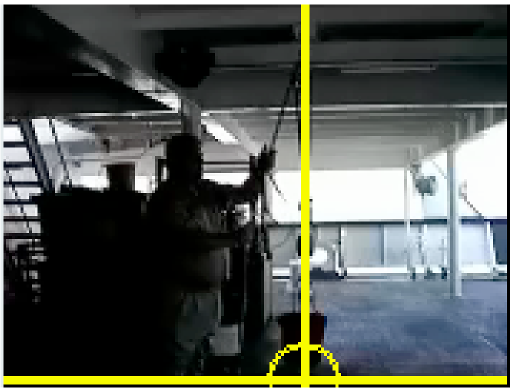


Fig. 5

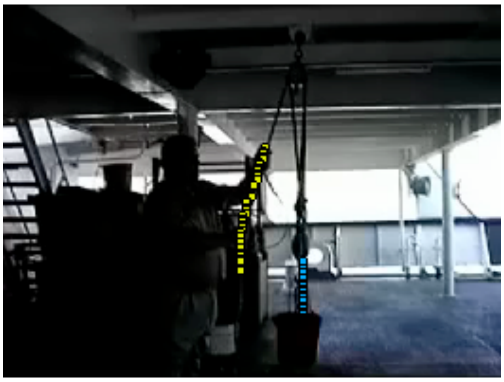


Fig. 6

5 Conclusion

We foresee developing a library of video clips of many maritime operations that can be analyzed with this software. The video clips and the raw data obtained from them would then serve as the basis for a set of student activities and questions. In this way, many of the concepts of first semester physics can be demonstrated to students with maritime examples.

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Situation Awareness at Sea—Vessel Traffic Service Support

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Abstract Influence of Human Element in shipping industry is rapidly increasing. Human error costs the maritime industry $541m a year, according to the UK P&I Club. From their own analysis of 6091 major claims (over $100,000) spanning a period of 15 years, the Club has established that these claims have cost their members $2.6bn, 62% of which is attributable to human error, NI[1].

More serious and egregious attributions involving SA occur when "Bridge or Shore based Personnel" error due to loss of SA" is listed as a cause of accidents, M.R. Grech et al[2]. The results from maritime operations literature survey revealed that 71% of human errors were Situation Awareness related problems.

SA,from the view point of VTS operator, includes some Human Factors (psychological constructs), but we concentrate in this paper on navigational aspect and one of them is assessment (measuring) of navigational situation in certain area, which is highlighted and investigated in the proposed paper. The techniques to measure the situation closeness to approved standard from the view point of safety level are proposed.

Keywords Vessel Traffic Service(VTS); Situation Awareness(SA); Situation Assessment (SASS); Safety of Navigation

Situation Awareness is "the accessibility of a comprehensive and coherent situation representation which is continuously being updated in accordance with the results of recurrent **situation assessments**" Smith and Hancock (1994).

0 Introduction

The most critical situation for a safety of navigation develops in approaches to ports. It explains enhanced attention to development of VTS (Vessel Traffic Services) that is expressed in realization of not only national, but also the international projects. The decision of SA problem, thus, is beyond one vessel and should to be considered in wider aspect. VTS personnel decision making procedures directly contribute to navigational safety.

There have been numerous attempts of developing both adequate definitions and formal models of SA in different industries. None of the more widely accepted approaches to defining and explaining SA are without flaws. At the same time, numerous techniques have been suggested for the assessment of SA, for example in aviation, and each of these techniques has relative strengths and weakness associated with them. The main first step of SA by VTS operator is Situation Assessment (SASS) which is to be visualized and measured.

1 Situation awareness and situation assessment

Endsely[3], defines three levels of situation awareness: perception, comprehension, and projection. Perception is the basic level of situation awareness (SA level 1). This level of awareness is achieved if VTS operators are able to perceive in the user interface information that is needed to do their job. The next level is comprehension (SA level 2). Not only must the information be perceived, it have to be combined with other information and interpreted correctly. The third level (SA level 3) is projection or the ability to predict what will happen next based on the current situation. As situations are dynamic, time is critical to situation awareness as well. User interfaces need to be designed to facilitate the continuous acquisition of SA.

Two elements are needed to support SA, W. Zhang et al[4]. The first is a representation of the situation. The representation needs to include information about relevant objects in VTS area (ships, dangers, weather,…), their features and logical, organizational and spatial relationships, actions for supporting and understanding the situation, and possible actions for responding to different perceptual input and external events. Here we use terminology introduced in W. Zhang[4], and call such a representation as *situation* (*navigation*) *template* or *template* for short.

The second element to support situation awareness of VTS operator is a set of tools for situation assessment. Situation assessment has at least three objectives. It is to correctly identify the relevant objects in a visual or audio fields from such information sources as radar, e-charts, AIS, communication aids…etc.; find association relationships among the perceived objects and create a structured representation of the objects and map the structured representation to possible situation templates and identify the most similar ones. We use partly this ideology and call a structured representation of a set of identified objects (vector) a *pattern*, W. Zhang et al[4].

In this paper a *situation* (*navigation*) *template* is the set of navigation regulations and safety standards covered the navigation area. Situation assessment is assessment of *pattern* against the appropriate template. The deviation of current situation from the template we call as a *safety level* and fix it from 1 (full compliance) to 0 (full incompliance).

Here we understand for purposes of clarity that the *Situation Assessment* is an active process of seeking information from the environment and assessing the level of safety linked with SA level 1 and SA level 2 to support the SA level 3.

The concept of SA is of great interest in research how the OOW or Master on board the vessel could be supported by VTS operator in their watchkeeping duties to maintain the highest safety of navigation level.

The main difficulty of SA and SASS is to "measure" the situation. In order to do it the criteria is to be appointed. In our paper this criteria is a *safety level* of current navigational situation at time t_i.. We investigated some conceptions which are not mentioned in known to authors literature.

1.1 Situation Assessment by template vector

By angle between vectors

The most simple template vector $\boldsymbol{S}_\mathbf{i}$ of navigational safety may be constructed as follows:

$$\boldsymbol{S}_\mathbf{i} = (s_1\ s_2\ s_3\ s_4\ s_5\ s_6\ \ldots) = (\ x_i,\ y_i,\ COG_i,\ SOG_i, RB_i,\ D_i \ldots) \qquad (1)$$

where the vector components are: x_i,y_i –coordinates of a vessel; COG_i–course over ground; SOG_i –speed over ground; RB_i–relative bearing to a danger; D_i –distance to danger;

The standard template vector of vessel's state in the navigation area has all the components equal to 1:

$$S_\mathbf{i} = (1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 1\ldots) \qquad (2)$$

it means that in this case the vessel movement is completely meets the area regulations.

The pattern vector of vessel's running state can be expressed as follows:

$$\boldsymbol{R}_\mathbf{i} = (r_1\ r_2\ r_3\ r_4\ r_5\ r_6\ \ldots) = (\ x_i,\ y_i,\ COG_i,\ SOG_i, RB_i,\ D_i \ldots) \qquad (3)$$

So, cosine of the angle β between vectors $R_\mathbf{i}$ and $S_\mathbf{i}$ is assumed as a "deviation to danger" from regular vector $S_\mathbf{i}$ and can be expressed in $2D$ space. Moreover it can be detected, decoded and indicated to VTS operator or navigator, Fig.1 (d), so:

$$SASS = \text{cosine}\ (\beta) \qquad (4)$$

Some limitations of the proposed technique are as follows:

- if the vectors are collinear it is not working;
- if the angle between vectors is small (up to 10^0) then the cosine is non sensitive to reflect the proper deviations.

By relative deviation of pattern from standard template vector

The components of relative deviation vector $D_\mathbf{i} = (d1\ d_2\ d_3\ d_4\ d_5\ d_6 \ldots)$ are formed as follows:

$$d_i = [\Delta_i - abs(s_i - r_i)]/\Delta_i, \qquad (5)$$

then, for n-dimensional vector $\boldsymbol{D}_\mathbf{i}$**,** Fig.1 (C):

$$SASS = \Sigma d_i / n \qquad (6)$$

where Δ_i- is the i-th maximum allowable deviation from standard of every parameter in navigation area and then we use arithmetic mean from all components to calculate SASS.

Fig.1 shows SASS as a cosine of angle β between four-dimensional vectors $\boldsymbol{R}_\mathbf{i} = (r_1\, r_2\, r_3\, r_4)$ and $\boldsymbol{S}_\mathbf{i}$

=($s_1\ s_2\ s_3\ s_4$) and SASS for the same vectors computed by formula (6). We can observe the very close similarity of curves. The example is based on simulated pilotage pattern to port of Boulogne using TRANSAS full mission navigation simulator.

The technique conceptually shown above works and can serve for the current assessment of situation, i.e. for measurement of *SA* level 2-comprehension if the vessel's parameters of movement and as their deviation from recommended standards are known.

Vector $\boldsymbol{D}_i$ can include the other components which define the current deviation of vessel state in navigation area from the established safety standards, for example:

- Weather conditions of navigation;
- If the voyage plan is in place or not;
- The geometrical size of ship and her draught;
- Crew competency, performance and its fatigue levels;
- Communication skill of the crew and VTS operator
- Condition of navigating equipment and charts;
- If the pilot is on board the vessel or not;

MOU on PSC target factors … etc.

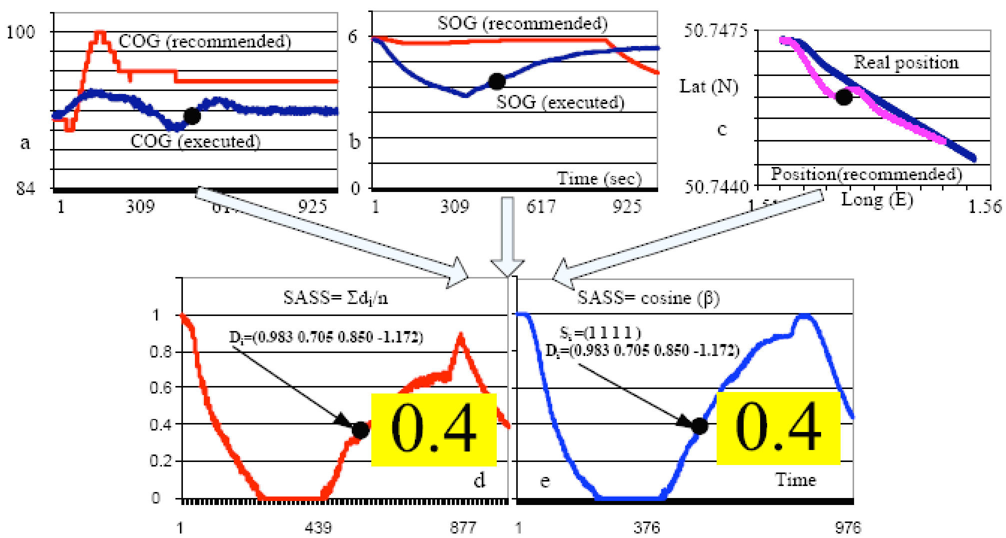

Fig. 1 SASS: a, b, c. input parameters; d. average sum of relative deviations of components;

e. consine of angle between vectors

1.2 Situation Assessment by Fuzzy Inference System (FIS)

The main idea to use fuzzy logic is to avoid the shortcomings associated with possible non proper functional dependency of parameters describing the navigation area in mathematical models and to use language which is the instrument to construct the regulations, V. Loginovsky et al[5].

Let us suppose that in some navigation area restricted by coordinates (x, y) for vessel proceeding southward alongside the reference line it is necessary to comply to some navigation regulations, that means to keep recommended COG=135^0 and SOG=8 knots. Deviations from this COG and SOG equal to more than 5 degrees and 2 knots are prohibited. Additional requirement is the following: any danger should appeared within relative bearings of 20 degrees at distance at not less than 25 cables. If the distance to danger is shorter it means that the navigation situation is not meeting the area regulations. So this is the standard template vector of vessel state.

The following conceptual FIS is applied for SASS:

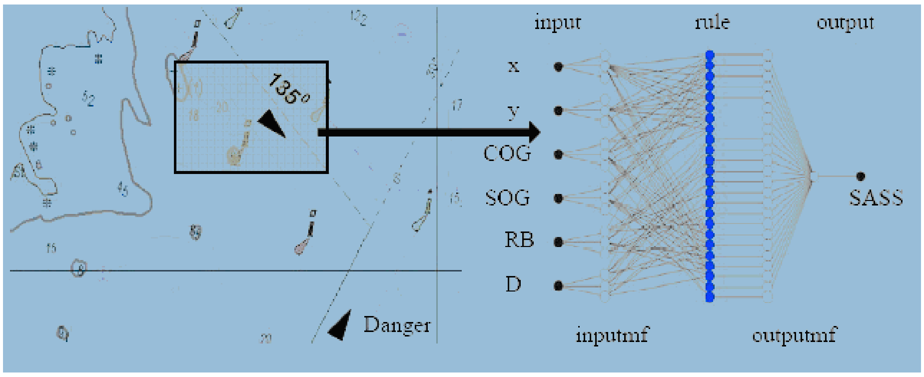

Fig. 2 SASS area and it's FIS model

The triangular membership functions and fuzzy rules are presented in Fig. 3. Sugeno algorithm is used for FIS construction.

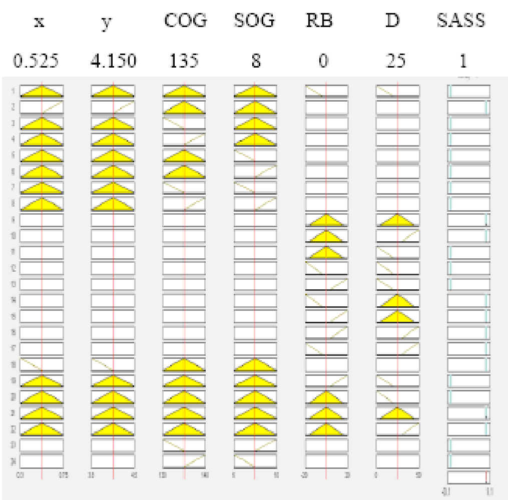

Fig. 3 Fuzzy rules demonstrate the SASS at standard state

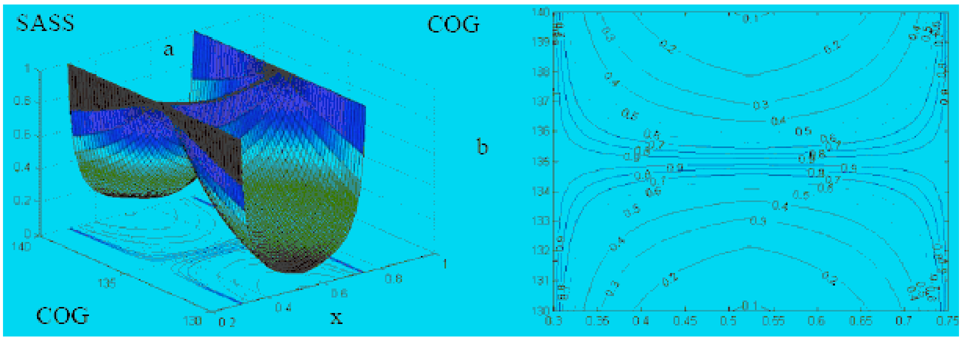

Fig. 4 a. SASS=(x-4.15 COG 8 0 25) as a function of COG and x; b. SASS contours

Here, as an example, we show some findings and results from FIS, representing SASS as function x and COG, Fig. 4:

- Safety regulations can be presented in graphical format by fuzzy rules, so we can see their action in appropriate navigation area using different coordinates systems;
- FIS may be used to construct regulations and to monitor their level of flexibility and rigidity, so FIS can be a very important addition to Formal Safety Assessment procedures;
- VTS operator (or OOW), switching on such pictures on e-chart, can observe the dangerous parts of an area and make appropriate effective decisions;
- Here the standards are generated for central (reference line) part of a navigation area;
- A degree of affinity to area regulations is a safety level in this area (SASS);
- Density of contours of safety level (a gradient of SASS) shows the rate of the situation change in area.
- The situation changes in the most quick mode are near the recommended *COG* in the central part of an area. Here the regulations are the most rigid ones.

Receding from the reference line, the regulations become less strict, i.e. safety level is high enough when entering the area with a *COG* deviation ± 5° and at recommended *SOG* with a deviation ±2 knots. And, central part of an area is to be proceeded with parameters $\boldsymbol{R}_i$=(*COG*=135° ; *SOG*= 8 knots; *RB*=0° ; *D*=25 miles);

The additional information can be mined from graphs on Fig. 5.

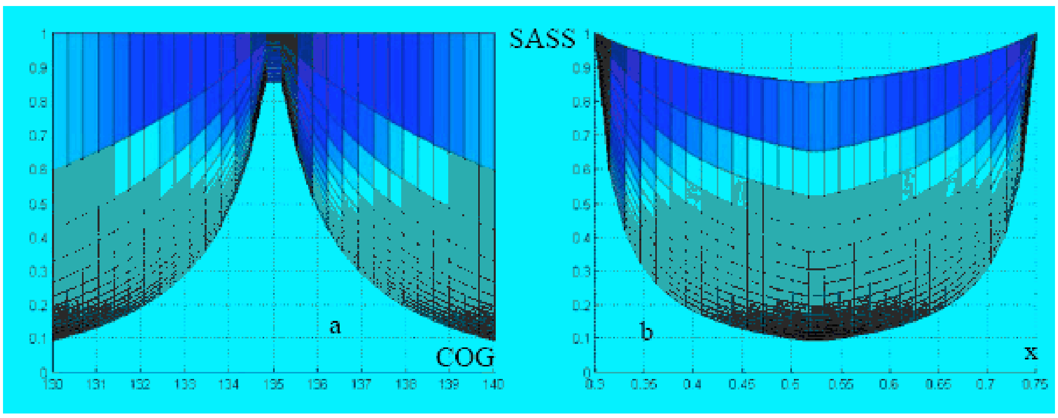

Fig. 5 a. SASS as a function of COG; b. SASS as a function of x

2 Conclusion

Situation Assessment made by VTS operator can be formalized and it supports the operator and Bridge Team on board the vessel in Situation Awareness and decision making. Relative deviation of pattern from standard template vector is the most simple technique but Fuzzy Inference System is more rich and flexible, that may give it more opportunities in construction of Situation Assessment algorithms. These techniques can be merged in optimum way to obtain the more plausible results.

Safety regulations can be presented in graphical format by fuzzy rules, so we can see their action in appropriate navigation area using different coordinates systems.

FIS may be also used to construct regulations and to monitor their level of flexibility and rigidity, so it can serve as a very useful addition to Formal Safety Assessment procedures.

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The Exploration of High-quality, Internationalized and Sustainable Maritime Education and Training

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Abstract The relevant analysis from BIMCO, IMO and other authorities in recent years have indicated increasing difficulties in recruiting high quality seafarers, especially senior officers. In fact, the number may be less than the statistics already obtained, due to the rapid development of maritime technologies, faster vessels, higher safety standards and pollution prevention requirements, and tighter supervision network based on Port State Control and Flag State Control mechanisms. Some evidence show that the quantity of qualified seafarers may further decrease.

So it is really a contemporary urgent task for maritime universities and institutes to educate and train seafarers with integrative knowledge and master the mature know-how and skills to fulfil the industrial requirements. The paper introduces practices at Shanghai Maritime University on her way toward higher quality, internationalized and sustainable MET on the basis of the importance of seafarers and their contributions, the trends of the maritime industry, and the features of Chinese MET.

Keywords seafarer; shipping industry; quality seafarer; Maritime Education and Training(MET); Shanghai Maritime University（SMU）; sustainable MET

1 The seafarers and their contributions

1.1 Seafarers' contributions to maritime safety, pollution prevention and maritime economy

High quality seafarers mean safer shipping, cleaner oceans and fewer economic risks. Many maritime accidents such as "ESTONIA" in 1994, and maritime pollution accidents such as the oil spill by M/V *valdiz* in 1989 indicate that human errors are the key factors leading to loss of lives and maritime pollution. M/V *valdiz* caused an expenditure of over 8 billions USD on oil pollution compensation and oil clearance, and the "Eric" accident in the coast of France cost a compensation of 0.168 billion English pounds. Those tragedies caused social panic as well.

Recently, the Philippine's worst and largest ever oil spill was also shocked by the maritime world, which about 50,000 gallons of oil have already leaked from the Solar I tanker, carried about 500,000 gallons of bunker oil and sank on August 11,2006 off the central island province of Guimaras. More than 20,000 people, or about 15 percent of the population of Guimaras, and many marine species have been affected by the oil slick. The serious accident was caused by the captain of the tanker who was not properly trained to handle the ship.

Furthermore, seafarers contribute also to maritime economy. Their negligence, omissions and defaults in cargo-caring and operations, in performing maritime contracts on the owners' behalf, in executing the orders of ship-owners and observing laws and regulations of a port of the flag state may result in huge economic losses, which in the shipowners' point of view are equivalent to the damages or losses arising out of physical damages of their vessels.

1.2 Seafarers' as an important human resource in the maritime industry

Against the background of economic globalization, intermodal transportation and integrated logistics, the maritime industry now involves more branches and components (see Table-1), which make it more influential to the whole economy than ever before. However, such a role relies greatly on maritime human recourses, particularly in high-level maritime activities such as maritime consultancy and maritime insurance. Ideally, those jobs should be assumed by maritime professionals, i.e., those who possessed navigation knowledge and skills, and have sailing experience. The seafarers as important human resources are not only directly involved in maritime transportation because of their personal maritime services onboard, but also are making contributions to the maritime economy ashore through their employment ashore, which could be very important for some shipping countries since they have stronger shipping industries ashore. With the involvement of seafarers, the potential of the shipping industry could be further explored.

Table 1 The composition of modern maritime services

	Types	Domains
maritime services	shipping transaction services	maritime financing
		maritime insurance
		maritime arbitration
		maritime average adjustment
		shipping trading
		maritime consultancy
		notary public
		shipping organizing
		professional maritime organizations
		ship management
	maritime services	cruiser economy
		cargo transportation
		chartering
		towing services
	port services	wharf services
		container yard services
		warehousing

		shipping agency
		cargo forwarding
		port formalities
		cargo-tallying
		inland transportation
		ship victualling
		crew-manning

Source：www.istis.sh.cn

1.3 The contributions to society and economy

The crew-manning economy is one of the highlights in the national economy. In China, the manning services support the national policy of “developing western China”, creating more job opportunities, and educating the citizens. The maritime administrative organizations of China know the significance and roles of such crew-manning services, and are now implementing a series of plans and steps to make the Chinese crew-manning business serve the international maritime industry better. China, with a huge population, good basic education, rich maritime tradition, believes in her capability of achieving this goal.

2 “High quality”, “internationalization” and “sustainable develop- ment”

These are the key concepts of the paper and should be the trends of the future world MET. First of all, the “competency” presented by STCW is a basic requirement for quality seafarers, which is essential for “high quality”. Further understanding of “high quality” must be achieved amid the latest development of the maritime industry and maritime profession. Today, the general trends of the industry are that ships are becoming larger and faster, using more automatic apparatuses, and having more values, and that navigation is becoming a much more professional and specialized career. Therefore, modern seafarers should master the traditional and modern seamanship and safety management as well as the skills of operating computers. Seafarers should have a good command of English, strong ability for leadership and decision-making and good capability of handling interpersonal relationship in their management onboard. In terms of professional requirement, seafarers should have extended experiences on board, good professional ethics, devotion to the maritime career. Lastly, from the point of view of shipowners, particularly those ambitious and competitive companies, additional individualized and dynamic requirements should be formulated for seafarers working for their fleets, which shall be reviewed by the MET system from time to time.

To sum up, “high quality “ in this article means a person with rich experience on board as well as his abilities and quality in various aspects such as seamanship, computer, English, shipping management, interpersonal communication, leadership, professional ethics and devotion to the maritime career.

In the Chinese system of maritime education and training, “Internationalized MET” is not a completely new concept. It usually means that some international aspects and features are introduced into the MET system. For instance, an MET institution uses international maritime textbooks and learning materials. However, although Chinese MET institutions and universities have launched many international cooperative projects, their work has achieved only a low level of internationalization. The paper will extend the understanding of "internationalized MET" to such aspects as the involvement of international MET students and the international financing of MET.

"Sustainable development" means that MET systems continuously provide sufficient high-quality seafarers to the industry. Nowadays, many traditional shipping countries are abandoning the crew-manning business due to their rapid and successful economic development, which, from the maritime industry's point of view, may harm the normal operations of the maritime industry. This should be remedied by proper MET systems.

The above three concepts are closely linked with each other. "High quality" makes it possible to make MET more international, and international MET activities, in turn, improve the quality of MET. Also, "high quality" and "internationalized" MET are fundamental for "sustainable MET".

3 The strategies and goals of Shanghai Maritime University

3.1 The strategies

The above concepts are important since they can guide an institution in MET activities. SMU reviews from time to time the role, functions and requirements set up for seafarers in the modern maritime industry. SMU clearly understands the strategies and policies of Chinese MET, and actually participated in their formulation. The university developed some concepts and practices of her own during the aforesaid process. They could be summarized as emphasizing maritime features, constantly seeking high quality, being devoted to internationalized MET, ensuring sustainable development of MET, balancing different types of MET, encouraging "systematic MET", and closely following the development of the world maritime industry.

The university intends to participate more in international MET and international maritime industry since Shanghai is striving to construct an international shipping center and the world economy requires a more capable shipping industry.

3.2 The goals

Here are SMU's tasks for the 11th five-year plan (2006-2010):

By 2010 it will basically grow into a teaching-research university featuring maritime and promoting growth of various disciplines. By 2020 it will become a world-level maritime university. In those five years, SMU will improve its teaching and research simultaneously. While its main task is undergraduate education, it will also enlarge its postgraduate education. The disciplinary development will focus on maritime technology, economics and management. Meanwhile, attention is paid to interdisciplinary development to ensure balanced growth of such disciplines as engineering, management science, economics, law and liberal arts. Thus, SMU will be able to produce senior applied shipping specialists who are strong in shipping, relying on Shanghai, serving the whole country, and having a global vision.

4 SMU's practices

4.1 Promoting its maritime features

SMU survives and becomes competitive due to her maritime and shipping features. So it gives priority to enhancement of those features. This is evidenced in every aspect of MET activities such as maritime discipline development, maritime research, and course designing. Currently, the university offers 35 bachelor degree programs, 12 associate degree programs, 30 master degree programs, and 5 doctor's degree programs. Most of those programs are related to the maritime or shipping industries business.

4.2 Sticking to the "high quality MET" policy

The university attaches great importance to MET activities and reviews from time to time different factors affecting the quality of MET by constantly following the philosophy and mechanism of the Quality Assurance System. In the eleventh five-year plan (2006-2010) of Shanghai Maritime University, the quality of MET is to be guaranteed. The university has obtained some exciting results and experiences in this respect. For instance, SMU students ranked first in the competency certificate examination organized by the Chinese MSA in the past five successive years.

4.3 Encouraging "systematic MET"

SMU continuously raises the quality of education, develops various disciplines, improves the teaching staff, and betters the overall quality of the students. It takes the teaching quality as its lifeblood, and raises the teaching and academic level through disciplinary and research development. Now SMU' is authorized to award the PhD degree in electronics and electric drive and in carrying vehicles. Moreover, the discipline of port machinery and electronic engineering, logistic management and engineering, carrying vehicle engineering, and maritime law have been cited as Shanghai's unique disciplines for further development.

The importance of "systematic MET" lies in the cross-reference or utilization of multidisciplinary knowledge. Then new maritime knowledge and new applications may arise. Therefore, the students can be offered more systematic maritime knowledge. For example, students can be given combined knowledge of navigation, logistics, and maritime laws. Hence the university will make more contributions to the development of MET and become more competitive.

4.4 Devotion to internationalized MET

In its eleventh five-year plan, SMU set up an aim towards internationalized MET. Some measures are to be taken for this purpose.

Establishing the guest professor system: maritime experts from abroad and shipping enterprises are invited to provide their expertise;

Encouraging more use of international maritime textbooks and other learning materials such as IMO model courses;

Building up an accurate maritime English evaluation system, which is more suitable for Chinese seafarers.

Seeking international partners in MET activities and researches;

Other ways helpful for internationalized MET.

4.5 Improving MET hardware

On the basis of its current MET infrastructure, SMU will enlarge and improve the infrastructures in the course of the construction of the Shanghai international shipping center and the new SMU campus. The new campus, which covers an area of 133 hectares on the coast, is capable of accommodating 20, 000 students. It is scheduled to be ready in 2007. Meanwhile, the university decides to construct an international seafarer training center with more than 6, 000 square meters in the new campus for the purpose of raising SMU's MET activities to the international level. Those places and facilities will enable SMU to meet the quality and quantity requirements.

4.6 Balancing different types of MET

The university knows the importance of providing a full range of MET services, that is, developing a comprehensive and systematic MET framework. Currently the university provides the following for MET: seafarers' on-the-job training, sino-foreign jointly-run associate-degree classes, and bachelor degree programs. The on-the-job training is heavily influenced by the market, but could be the type of MET most closely linked to the latest development of maritime science and practices. For example, there is an MET program for 9,600-TEU containerships and for seafarers involving in chemical carriers. SMU knows MET is a way to follow the trend of the industry. The jointly-run classes and the bachelor degree programs are mainly under the control of the university, which can formulate its quality requirements.

Jointly-run classes SMU and NYK worked together in October, 2005 to launch a joint class. A feature of this cooperative project is that the owners (future principals), manning agents and SMU cooperate closely. They jointly select new students, formulate the curriculum and teaching contents, arranging visiting professors, developing the corporate culture, etc,. Meanwhile, based on the STCW Conventions, the program pay more attention to the owners' requirements. This type of MET has attracted more and more large companies such as COSCO, V-SHIP, SNC and SINOCHEM in addition to NYK.

It is helpful to have a stable supply of quality seafarers who are loyal to the company. In addition, it contributes to the improvement of Chinese MET and the professionalism of seafaring in China, because the program aims to develop students' commitment to their careers, professional ethics and devotion to the maritime career.

Thanks to the above MET philosophy and practices, the students of this program have had a a high passing rate in the MSA examination, and are good at maritime English. Currently, the program runs smoothly, and the university will gradually increase the enrolment of this program.

The bachelor degree program The four-year undergraduate students majoring in navigation are educated according to the requirements of the bachelor degree program. They have good knowledge of the basic subjects, especially mathematics and physics. They are proficient in theories, sophisticate knowledge, and comprehensive knowledge in shipping management. They also have professional certificates for their future employment onboard.

The features and advantages of such a program are that the students usually have systematic knowledge in the maritime industry and shipping. It is highly possible that they will work in the maritime industry ashore such as the pilot stations, MSA, maritime research institutes, cargo agencies, maritime courts, VTS management, and shipping companies after they have served onboard for 5 to 10 years. The maritime industry ashore needs them in the aforementioned maritime operations.

4.7 Closely following the advance of the world maritime industry

Maritime technologies, legislation and practices are changing, so MET institutions and universities have to follow up closely. MET has to do this to stay competitive. SMU is taking substantial measures to get involved in maritime affairs. It has participated in international organizations, attended international shipping conferences, invited maritime experts and professionals to introduce the latest maritime technologies and management, etc,.

5 Conclusion

The above-mentioned experiences and practices are just for your reference due to our limited practice. However, the university is always ready to learn from others' success and experience.

Meanwhile, many difficulties and challenges will undoubtedly arise on our way forward. For instance, large, high-value and specialized vessels and ocean engineering installations such as VLCC, chemical vessels, LPG and LNG vessels, large ro-ro vessels, reefer cargo vessels, ferries and oil drilling vessels will be popular in the market in near future. Many new technologies are applied on vessels with the intelligent diesel engine, automatic navigation system, automatic engine-room, and automatic cargo-handling system. Those advanced ships and equipment call for high-quality crew with specialized knowledge and skills, which in turn place a high requirement on the university's teaching staff, training, labs and teaching materials.

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Changing Ideas to Raise the Quality of Maritime Education

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Abstract The quality of maritime education comes from the principle of the older generation of Dalian Maritime University graduates, long-term hard work and satisfaction from parents, students and the society. The quality of maritime education should develop with and continuously adapt to the development of science and technology. Guaranteeing the quality of maritime education and the construction of quality culture is the requirement and the key to the further development of the quality of maritime education. The quality culture should become the core strategy of the maritime education development.

Keywords maritime education; quality; changing of ideas; core strategy

0 Introduction

Raising the quality of maritime education, meeting the internationalization of high education, making higher education develop continuously, wining more quotas in international education market, and playing more important roles in domestic society and economy construction is the hot topic that the maritime educators of all countries are concerned. As the member state of STCW78/95 Convention, the Chinese government, the education authorities and the maritime colleges always attach great importance to maritime education and adopt positive policies and measures. Based on ISO9000, Dalian Maritime University has built up a management system since 1998, taking into consideration the quality control system of seafarer training of the China MSA. The System symbolizes that the maritime education has already changed from the stage of experience management to the stage of science management. Through 8 years' practice, we have achieved a lot in the maritime education. Meanwhile, we have further deepened our understanding of quality assurance and quality culture construction. We would very much like to take this opportunity to exchange ideas with our colleagues.

1 The introspection of the quality of maritime education

The quality of maritime education works throughout students' enrollment to employment, and the quality originates from planning, rather than the afterwards perfection. The quality is composed of excellent talents, excellent equipments, carefully selected raw material (students) and the commitment for trying the best. The quality lies in each student and in each service, and each member of Dalian Maritime University has the opportunity to contribute to the society.

Roman is not built in one day, and so is the quality of maritime education. It contains the quality accumulation of members of Dalian Maritime University for centuries. From enrollment, education, training to quality management, each process and each link coagulates the perseveringly pursuit of members of Dalian Maritime University.

1.1 The quality derives from the principle of the older generation of Dalian Maritime University graduates.

Dalian Maritime University attaches great importance to quality. Offering quality product and educating talents is the goal of Dalian Maritime University ever since its establishment. The outstanding quality has become the core competencies of Dalian Maritime University, and the basis for continuous development.

1.2 The quality comes from the hard work.

In order to insure the consistent quality, Dalian Maritime University increases the investment in basic facilities and the experiment equipments year by year. At the same time, it introduces the overall quality management system into the students' whole process of development. From enrollment, education and training, quality control and investigation with graduate students, each link is to guard a pass to the work quality strictly, and to succeed to pass the ISO9001 Quality Control System, the Quality Control System of the seafarer education and training of China MSA. These authority attestations not only provide the standard of operation norm to pursue perfection continuously and to promote the quality management, but also impress each member of Dalian Maritime University with the concept of "Everyone contributes to quality control."

1.3 The quality lies in the consumers' satisfaction

Dalian Maritime University tries its best to ensure the best quality. It is responsible to the parents, to companies and to society. The pursuit provides a best explanation to the development of the talentsof the University; and the University wins the excellent new students and good reputation in the society.

2 The change of quality in the maritime education

2.1 The change of the education quality value

The maritime education faces rigorous challenge of" the quality culture" construction. It is the core issue in maritime education reform and development, which is different from elite education. The quality of maritime education is a concept of many dimensions. It should cover the understanding of teaching quality, research quality and the social service quality etc. The quality of maritime education is an unite of subjective and objectivity, relativity and absoluteness, Abstractness and concreteness. Maritime education quality evaluation has already headed for body diversification, object diversification and standard diversification.

2.2 The change of cognition of university product.

The product of the university was once thought as "student", and the students' quality was the quality of the university. The product of the university is special. It is “the comprehensive exaltation of students’ knowledge, ability, morals quality and psychological and physical health...etc.”.

Organizations of all scales produce and provide products, and the products of university are the result of education.

In addition, ever since China joined WTO, education has attracted the attention of the society as a branch of service trade. The openness of education will extend gradually, and China will join in the international education system and international education competition. The opening of education, market includes that: The education is brought into the category of service trade; We will open our education market; and education is a kind of business existence. The risk that education service treade brings to education should be judged from the aspects such as student enrollment, funds, market standard provided by multinational trade, qualification attestation, credit transformation, quality control and attestation, transfer of professional talents and culture blend, etc. This also provides more space and background to better understand the special points of university products.

3 Quality control and the quality cultural construction

3.1 The quality culture is an important software and a part of the university culture

The “people-oriented" quality culture is one of the competitiveness the university. The campus culture has already become the important standard by which high school graduates choose universities. This standard lies in university quality culture. The talents competition of Dalian Maritime University is a competition under the international background. Universities must regard quality as life in order to survive in the competition. Free competition of market system and the principle of “survival the fittest” have enhanced value that universities put on quality.

3.2 The core and the content of the university quality culture

The quality culture is an important part of university culture." Quality" is to satisfy customers and "culture" is common value and behavior patterns. The quality of the graduates is the core body of the university quality. The university quality is a culture itself, a working way and attitude. It requests us to do everything from the customers’ needs, to pursue excellence and perfection. The core of the quality culture should include the following:

.1 The customer drive

It is necessary to make clear who is the customer. The customers of university are parents, students and companies. We should set up the principle of serving our customer. All the work must be customer-oriented, and the performance evaluation should base on customer drive.

.2 Constant improvement

The view of customer drive determines that every process asks for constant improvement, because customer needs are always dynamic. Employee must keep a sharp eye on the existing process and believe firmly in "long-lasting improvement".

.3 Pursuit of outstanding

Regardless to zero blemishes or other management modes, its essence is to pursue outstanding.

.4 People-centered

The quality culture is shown in employees' behaviors. Therefore, it is not an empty concept, but a behavior pattern. A high university staff member must be aware of who my customer is, what is my customer's needs, and how I can exceed the customer's expectation, How to make customer satisfied? How to outrun the expectation. These questions seem simple, but they can project the strength and determination of a university in its quality construction, and reflect the core value of university culture.

3.3 Establish the quality culture to create the core competitiveness

Establishing the quality culture is of great importance for a university to promote the competitiveness and carry out constant development. Therefore, it is of great significance to analyze quality culture, explore quality construction, and provide reference for university quality culture. Education management experts holds the same opinion in establishing quality culture, that quality culture needs the push from leadership; quality culture needs training; quality culture needs a long construction process. There are several key points to be discussed:

.1 The quality culture and leadership

In some sense, quality culture can show the concept of university leadership. Therefore, in the establishment of quality culture, the push from the management level determines the actual results of quality culture.

.2 The quality culture and prize and punishment system

The change of the culture begins from the change of attitude. Besides education, another way to change one's attitude is the strict prize and punishment system, which is a key point in establishing and keeping a good quality culture.

.3 The quality culture and quality management system

The quality culture is the existence environment for quality management system. A sound quality management system is the solid guarantee of the enforcement of quality culture.

.4 The quality culture and teamwork spirit

Strictly speaking, teamwork spirit is an aspect of quality culture. In the establishment of the quality culture, teamwork cooperation can make the staff understand that the quality is the result of teamwork, and the quality system will work with the effort of teamwork.

.5 The quality culture and quality tool

The quality culture and the quality tool are like soil and sowing machine. An excellent university will make best use of" fertile fields" and "sowing machine" to sow outstanding seeds and to win reputation. Good quality culture and quality improvement mechanism should complement each other, and work together to push the university's development.

4 Quality construction as the core strategy of university development

4.1 Enhance the ethics consciousness and social responsibility of the university

In the Policy on the Reform and Development of Higher Education, UNESCO equalizes the three concepts “internationalization” “adoption” and “quality”, and regards them as three majors aspects in higher education reform and development. An important social responsibility of a university is sto solve the contradiction between the university and consumers. Experts think that on one side university quality management system must meets the requirements of international standards, and obtain the licensee from authorities; on the other, university should meet or even exceed the satisfaction and expectation of parents, companies and the society.

At present, social responsibility of the university has become a key point in university performance evaluation. Therefore, education institutions are aware that good reputation of the university has already exceeded talents training itself, and it has risen to the standard of sharing cultural achievement with the society.

4.2 Enhance" enhancing quality" consciousness

“Enhancing quality”, refers to the constant enhancement of the quality and standardization of a university in the process of competitiveness enhancement. It is a guidance and creativity in the pursuit of excellence.

The development in technology pushes forward the development of human society, and the living standard and demand level of people keeps rising. This has proposed even stricter requirements for the development of universities. It urges university to pursue perfection and provide the products that exceed the customers’ expectations. So the university can keep its edge and survive in the competition.

Therefore, many excellent universities consider “Enhancing quality” as the core in quality construction. And the best quality is a constant improvement process.

4.3 Raise the person's consciousness on quality

A typical point both home and abroad on university quality culture is that quality culture is the common value and belief among the university staff in order to achieve the goal of quality development. The quality culture consists of surface layer, intermediate layer and core layer. The first is the material layer, namely surface layer. It includes the e facilities and environment of the quality management. The second is system layer, namely intermediate. It represents various regulation system, the morals norm and employee's behavior standards of special features. The third spirit layer, namely the core layer is the employees’ consciousness on quality, which is the core of quality culture.

The spirit layer determines the material layer and system layers. Once formed, the spirit culture will be stable. Therefore, spirit layer must be emphasized in establishing university quality culture, which is the training and strengthening of one’s consciousness on quality. Any advanced management or regulation will not work properly without staff’s active and positive attitude, a quality management environment and sound quality culture.

Therefore, we can draw the conclusion that it is of great significance to enhance quality culture consciousness in order to build up excellent university culture, improve university management and enhance a university's overall competitiveness. I believe that along with development of quality consciousness, university ethics and university social responsibility, the quality consciousness of the whole society will enhance.

There is still a long way to go in establishing quality culture. Facing the severe market competition, the quality culture is the only way for university to win the competitors and realize constant development, to win the customers and the market, and to win the reputation as well as benefit. Dalian Maritime University aims not only to raise the quality of maritime education, but also in many other related fields such as maritime law and ocean logistics management etc. Dalian Maritime University will play an even more important role in the world shipping industry through the exchange and cooperation with other universities all over the world.

How Maritime Education Should Change in Order to Help the Industry Reduce the Gap between Demand and Supply of Qualified Officers?

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Abstract Shipping has changed significantly in the last 30 years and one of the most predominant issues is the fast turn around in ports. Not surprisingly, this issue together with increased workload on lower crew complement has made the job not anymore attractive to the young generation. During the last three years the freight market has passed the best period in the entire history of shipping and consequently it is expected that the fleet will increase with over 30 percent up in 2014 compared to 2004. One of the main problems identified is that graduates do not see sailing as a long term career and many of them retire immediately after getting their Master license. This paper is trying to identify what Maritime Universities can do in order to help the industry to fill in the present gap between demand and supply of qualified officers.

Keywords ship; maritime education; university; training, MET

0 Introduction

In the past, maritime education and training worldwide has focused mainly on preparing people to pass examinations to obtain deck or engine licenses and perform their job at sea. Consequently all training was focused on delivering practical courses for a practical vocation. However, in recent times there has been an increased demand for people working in the maritime industries to perform more than just the practical aspects of their jobs. Now maritime personnel need to be more professional in their approach, think about their work and how they can operate in alternative and better ways and have developed, inquiring minds. This leads to the need for knowledge in the disciplines of management, economics, logistics, maritime environment protection, maritime safety sciences and maritime administration. Schroeder[9] Accordingly maritime universities, trade associations and independent training and consultancy firms have developed a range of professional and master degree courses in ship management, shipping business and safety and security.

Working today in the maritime industry means to work in truly global market and apart from state owned companies in the less developed countries all shipping companies employ people coming from different countries, with different background and culture. In such a diverse environment there has to be a common point and this may be education and training. That is why a lot of effort has to be put into delivering an education that is broader than the traditional vocational training courses used to provide.

1 Current and future gap between supply and demand for ship officers

BIMCO and ISF (International Shipping Federation) are publishing every five years, starting with 1990, the most comprehensive assessment of global supply and demand for merchant seafarers. The report describes the current worldwide demand and supply situation and make predictions for the 5-10 years ahead to assist the industry to anticipate changes and take appropriate action.

Conclusions of the last study are more optimistic than for the previous years and estimate that current shortage of officers is only of 10,000 officers or 2 per cent of demand and surplus of ratings is estimated at 135,000. Although the shortfall is not significant, in practice it is more problematic since cultural and language barriers, lack of international experience and restrictions imposed by some flags prevent surpluses of some nationalities from compensating shortages elsewhere. Also some specialized ships and certain ranks are experiencing severe shortages.

What is interesting to note is that based on the benchmark identified by BIMCO and ISF supply of vessels will increase with about 1 percent over the next 10 years, but as the present situation stands this is a no longer true since last year supply increased with 6% and almost all shipyards around the world are not able to take new orders before 2010. In the author's opinion between 2004 (the moment the market reached the highest freight rates ever) and 2014 the fleet will grow with an average of 2.5% per year, with higher levels in the first five years and lower level in the next five years, which means that unless training efforts are increased the demand will overpass supply by 2014 with minimum 40,000 officers considering that many of the new vessels will have modern engines not requiring 24 hours watch and consequently not requiring minim three engine officers.

Anticipating demand increase Constanta Maritime University has increased the number of new trainee from 180 in 2004 to 500 in 2005 and 650 in 2006 with over 70 percent of the new trainees opting for deck section. However the success of this effort depends very much on the University's ability to help graduates get a place on board foreign vessels to complete their cadetship and thereafter obtain their first job on board vessels. After the successful completion of first international voyage as deck or engine officer the graduates have much more opportunities to develop their seagoing career. In fact in the last three or four years the Romanian crew market has evolved with important ship management companies opening their own branches and participating actively to training process. In the same time, with Romania Joining EU as from 1st January 2007 there will be more and more opportunities for shore based jobs for Romanian officers.

2 Factors affecting the supply of officers

For many years various studies suggest that seagoing career is no longer attractive for the young generation and this is more obvious in the OECD countries. Supply is influenced by inflow of new officers and wastage of present officers. The prime input of the industry is through new trainees although small numbers of inflow can join from alternative sources such as naval personnel, engineers and ratings who aspire to improve their qualifications and skills and become officers.

Main factors influencing the number of trainee can be considered below:

- Wage–in a competitive labor market dominated by shortage of officers, wages are determined by supply and demand conditions. For many OECD countries wages are not the main factor in choosing a seagoing career, as there are enough shore based alternatives offering even better payment terms, but for less developed countries from Far East, Middle East and Eastern Europe wage is main factor attracting new trainees. The main problem is that once a country or region is developing there appear some new shore based jobs in the IT, banking, telecom that offer comparable salaries with what a junior officer is receiving and then it starts to become more difficult for maritime university to recruit trainee with grades over average. Good examples in this respect are East European countries joining EU and Chinese developed coastal areas;
- Long term career prospects in the maritime industry–in many developed countries new trainees consider on board jobs as an intermediate career before they get a shore based job requiring shipboard experience. The imbalance between supply and demand between different regions of the globe creates significant problems to the developed countries as there are not enough persons with seagoing experience to be recruited and this why special courses have to be developed for people willing to work in the maritime industry;
- spirit of adventure–in the past this was one important factor attracting new trainees to the maritime industry, but nowadays due to fast turnaround in ports and increased workload many seafarers do not have time to visit any port during the four or six months they spend on board ships and this has a negative impact on motivation.

On the other hand there are a few factors that negatively affect the inflow of trainees:

- little or no security of employment–many companies prefer to employ seafarers on a voyage by voyage basis with monthly wage while at sea including overtime, leave and do not contribute to social security, pension and other taxes;
- boredom of life at sea away from friends and families - one possible solution to this issue would be the use of modern information technologies (e-mail for example) which could enable seafarers to keep in touch with their families. It would thus be necessary to contemplate providing computer rooms on board ships and providing seafarers' families with computers. Providing reading, music and video rooms is also a possibility. However, the most important step is to organize appropriate periods of rotation between activities at sea and on land;
- poor image of the seagoing with small social standing and limited understanding of the peers of what a seagoing entails–the trend to criminalisation has already had a negative effect on ship's crews' morale, and has made harder the job of retaining good staff, especially senior personnel and recruiting new men and women in to seagoing careers;
- opportunities for training are somehow restricted due to operational demands–on many vessels employed in the shore sea trade officers do not have too much free time due to increased work and paper load.

The second element influencing the supply of officers is wastage and there is no any standard methodology of evaluating wastage. Some studies suggest that the medium period spent at sea by an officer is six or seven years and not surprisingly this the minimum period required by maritime administrations in different countries to obtain the master license. From the author's point of view wastage can be considered:

- graduates of maritime university with deck or engine licenses not able to obtain a job on board the ships (usually they are reported by maritime administrations as being active on labor market since they have valid seaman books and deck or engine licenses);
- officers choosing a maritime or not maritime shore based career (they are also reported for some time as being active on labor market);
- normal retirement due to age, and forced wastage due to ill or death.

3 Maritime education changes for the next decade

Maritime Education and Training (MET) institutions can be classified as 1E, 2E, 3E or 4E:

- A '1E' MET institution offers the Essentials i.e. its syllabi meet the minimum requirements of STCW95;
- A '2E' institution offers the Essentials (as described above) plus Extensions. Extension in this context means offering shipboard-related courses that are more detailed and comprehensive than required by STCW. The extension subjects may, but need not be, STCW related;
- A '3E' MET institution offers the Essentials and Extensions (as above) but also Enrichment. Enrichment refers to that part of the syllabus that is necessary to meet the academic requirements for a degree. Typically, it also prepares ship's officers for employment at some stage in a shore-based role;
- A '4E' MET institution is a '3E" institution that also offers Elevation, i.e. also offers postgraduate courses at Masters Degree or higher level. (Otway, 2004)

From the above classification it may be considered that '3E' and '4E' institutions are offering the students an adequate training program for their entire sea and shore based career, but this is not completely true since many seafarers feel that extra skills are required in areas such IT and management.

In order to attract more people to the seagoing career, they have to see that there are options to continue working in the shipping industry if they decide to end their seagoing career and they are prepared to fill in available positions on the market. With increased requirements for mandatory training of seafarers it is difficult to offer trainees a complete education program during the three or four years of studies including sea training. There are also some subjects like business administration, finance and budgets, marketing and public relations that are difficult to understand for trainees with limited seagoing experience and this may be one reason why universities should prepare their education programs in a way that they cover during the studentship years subjects areas like safety and technical training, with emphasis on using IT equipments and software, while areas like commercial training and management training should be covered in brief, at this stage.

Many universities consider that their role has ended after the graduates finish their studies and get their license, but this is not true since junior officers can not become good senior officers without management and commercial studies and although some of them do learn by themselves or from their senior officers there is no better option than an organized framework for conducting the studies and maritime universities are best placed for continuing the process.

Many reputable universities from developed countries have their own postgraduate programs which are accepted and recognized by industry while universities in less developed countries are having difficulties in developing and conducting postgraduate studies. This is an area of future strengthening of cooperation between IAMU member universities or between IAMU and non IAMU members. One possible solution to this problem would be establishment of a working group within IAMU to supervise and approve training programs of maritime universities in less developed countries and IAMU to get a small fee from each student enrolled. After designing a new education program training methods available on the market should be evaluated and compared. Main training options available are:

- structured system of nautical training–this is the most common method of training for seafarers and it can not be replaced for the beginning of the seafarers' career; but it is not always appropriate for the postgraduate degrees as they are time consuming and delay junior officers' promotion to senior positions;
- short courses - many regulatory qualifications can only be obtained through attendance at a short course, these 5-10 days courses provide specific information and knowledge in the most economical period;
- seminars and workshops - tend to be more generic covering specific issues from a broader viewpoint and are designed for all areas of the industry, so they can only be used as informative tools;
- distance learning–today, the concept of distance education is fairly well-understood, and the potential importance of distance education in the future of education is also generally acknowledged. With advances in multimedia and communication technologies, distance education is being adopted by companies as well as universities. Almost all distance learning education programs have replaced text books with computer based applications delivered either on CDs or via E-mail. Distance learning has a great potential for development in the maritime industry as most of the seafarers look for a future job on shore. The main barrier against development of distance education in the shipping industry is the increased workload which is in common place on almost all types of ships;
- computer based training (CBT)–as an alternative to distance learning education is used by many shipping companies on board their ships and results are transmitted to the master and training office for appraisal. This is usually a cheap training alternative, but its effectiveness depends on owners' and seafarers' ability to chose the right products;
- mentoring–it is one of the most effective way of transferring practical knowledge and skills, especially for maritime personnel, as every trainee is assigned an instructor and the student can call upon for assistance and help. The main disadvantage of this method is that it is very expensive and time consuming and from these reasons there few chances it will be used in the future.

In conclusion, in order to meet the demand of officers, maritime universities worldwide have to increase their training efforts and in the same time extend their curricula and diversify the methods of preparing trainee for a sea and shore based career. For achieving this objective there is a need for cooperation at international level between training institutions,. shipowners, shipmanagers and international organizations. In other words it can be said that maritime universities have to solve the paradox of maritime education: the broader the education the more trainees attracted to seagoing career and the better the education the easier shore based jobs are obtained and wastage is increased.

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Modern Marine and Maritime Teaching and Research Training in UK Higher Education Establishments

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Abstract Teaching methods in UK higher education establishments are under constant change. The needs of student and their requirements dictate that flexible delivery is available to satisfy an increasingly diverse student population coming from differing backgrounds. Current methods increasingly take advantage of developments in IT particularly the Internet and Intranets. Simultaneously teaching in groups and a variety of project work both within HEs and using industry contacts allows the development of both the students and programmes. This latter contact allows industry to interact with the work of the HE and offer suggestions for update of syllabi and further skills that students should be developing.

Research is an important part of the suite of activities undertaken by any marine and maritime group and this underpins the teaching activities as well as providing valuable academic development for both lecturers and students.

This article outlines both modern teaching and research training activities in maritime and marine related fields at Liverpool John Moores University (LJMU). The taught programmes and current modes of teaching deliveries at both the undergraduate and postgraduate levels are analysed. Maritime research activities are described in detail using several on-going and completed research projects at LJMU.

Keywords teaching methods; Higher Education; flexible delivery; projects; syllabi

0 Introduction

Teaching in higher education (HE) establishments especially universities is constantly evolving. The wide development of computers and the Internet mean that students no longer have to obtain all their understanding from lectures or printed text but that much information is available electronically. Many firms, most institutions and HEs have their own Intranets and this enables complex electronic structures and menus to be developed to allow a variety of teaching and learning material to be available both for the lecturer and the student. LJMU has adopted the "Blackboard" electronic learning environment, which allows a vast array of opportunities for lecturers to place easily available electronic teaching material for use by students immediately or at some specified time in the future. Students are quick to grasp this provision and lecturers are under pressure to ensure that the majority of their modules can be studied at a distance in this way. A problem does lie in that students may feel they no longer have to attend classes however that should not undermine the benefit to be gained by having information available to students in this virtual environment.

Other developments include CDs and DVDs as well as the widespread use of e-mail. The latter is now so common that it is for many people the most convenient form of communication particularly to a mass audience. Information and instructions are easily sent via e-mail and recipients view the messages in their own time, in an environment of their choice and in a situation conducive to them. Thus assignments are easily sent via this route. The Internet is also now a great learning environment with vast amounts of material is at a student's fingertips whether or not this information is appropriate, useful or correct. The Internet offers great challenges to educationalists as well as dangers and will be progressively more widely used over time.

Links with industry are very important. Maritime and seagoing departments have always had very strong industry links not least because the programmes of study have been so closely aligned with the legal requirements of seagoing whether on deck or in the engine room. Students studying maritime business subjects also need close links with their section of the industry and as these programmes become more widely available, whether at the undergraduate or postgraduate level, their place in the industry setting is vital. All LJMU programmes now have to explicitly show workplace learning thus where maritime business programmes have shied away from this aspect they now will need to become involved.

1 Literature review

Literature referring to teaching is widely available and this applies also to maritime disciplines.

The IAMU Journal and the AGAs in particular have made a major contribution to this debate by provision of their forums and encouragement of this important subject. Many aspects have been covered including the need for maritime education providers to develop their own teaching methods or have them imposed (Lewarn)[1]; a student centred approach (Tuna et al)[2]; measuring the quality of maritime education (Paine-Clemes)[3] and the reorganisation of courses (Nishikawa)[4]. Elsewhere CBT (Computer Based Training) is covered particularly with regard to simulation (Muirhead)[5], low-cost PS based software (van Tassel)[6], successful adoption (MacNeil)[7], interactive programmes (Tomczak)[8], development of a Virtual Maritime Academy (Mantel)[9] and new approaches to training provision (Addis)[10].

All these authors refer to the teaching of seafaring aspects and in particular to training rather than education. The Internet is becoming a widely used medium for educational purposes (Williams)[11] and universities have harnessed this mode in the form of the world wide web and locally as an Intranet. Efficiency in learning (Broad et al.)[12] is one of the benefits of the Internet as this can lead to an integrated virtual leaning environment. This, as claimed, can enhance a student's critical thinking (Rogers G)[13] and develop also the quality of cognitive thought. A virtual education environment has the advantages of cost and portability (van Tassel G)[6] and ease of access (MacDonald R)[14] and certainly present students use the web for research purposes in an ongoing fashion. One problem with the web is plagiarism (Evans R)[15] and the use of computer generated work has developed a cut and paste culture which without care on the part of the student can lead to plagiarism.

Project work forms part of undergraduate study (Haas & Wotrubo)[16] with this sometimes being in groups (Reardon et al.)[17]. The work is normally for assessment purposes only, which can mean that is does not go forward for publication and as such it is sometimes considered to be performed in isolation (Cronk)[18]. The projects can have a work-based learning element (Pascoe)[19] and this is useful as on an increasing basis in the UK, university programmes are required to have work-based learning embedded in the curriculum.

2 Electronic teaching

Teaching using IT in all its forms has been increasing for many years. Most lecturers are becoming familiar and adept at using electronics in the dissemination of their information usually using laptops and ceiling projectors. CDs and DVDs are developing however production of quality discs is both time-consuming and expensive. The ability to display a range of photographs and images is helpful in explanatory terms and in making comparisons.

The use of videos is good as often their production is professional. A problem does arise with dated material. Videos like books are dated to the time of their production however this is rarely apparent when the video is shown. It is tempting to show videos on a regular basis year on year however data and techniques change and these changes will not be accounted for in the video presentation.

2.1 CBT

Much on board training is carried out by CBT and in the University use is made of this mode in teaching cargo stowage and stability as well as navigation using electronic charts. Cargo stowage is limited to bulk carriers both dry and liquid with students working though loading and discharging procedures to ensure that the shear force and bending moments are not exceeded. The graphical representation of this is helpful to students particularly those not experienced with ship profiles.

The development of electronic charts and ECDIS (Electronic Chart Display and Information System) has provided a valuable source of interactive teaching available to the navigation technologist.

2.2 The virtual learning environment

The Internet and Intranet are two major components of any virtual learning environment. CDs and DVD may also be involved at a lesser level. Universities all have Intranets and many if not all will have embraced this technology to provide for students and lecturers the ability to interact through a virtual environment. At LJMU the “Blackboard” system has been provided. The architecture of this system is based on modules and student/lecturer academic profiles. Thus each student is able to access the modules on his/her programme and similarly with each lecturer for the modules that they teach. Within each module on Blackboard there are areas for module and staff information; module content and assignments; communication, external links and an area called “tools”. This tools area contains items such as a calendar, glossary and user manual for the system. The lecturer develops the first two whilst the latter is part of the system help. Students also have a “My Grades” section of the tools menu, which gives them on line information about their module grades provided that lecturers input the information to the system for modules under their control.

The module content section is where any online notes are developed. Clearly here presentations and diagrams can be lodged as well as text notes. All these can be time barred so that they are only available to students at a period suitable to the lecture profile. Assignments can be organised online or for students to print off and submit by hard copy. Again these can be time barred so as to be available only when the lecturer deems that it is necessary for the work to be completed. This may be particularly important if the common system of zero marks is in place for work submitted after the due submission date. The practice of a reducing penalty for late submission seems to be being replaced by the much harsher system as the requirement for students to conform to rules is adopted.

The announcement section is useful and can act as another information board to e-mail for notification of assignment availability and feedback sessions as well as seminar timings. Announcements can be permanent or temporary and again can be time dependent being available on a weekly or monthly basis.

2.3 Powerpoint

This has been a common teaching aid (Essex-Lopresti)[20] for more than a decade and its use is now commonplace or even expected within the classroom at University level. Powerpoint presentations might have additional items such as audio (Maloney & Paolisso)[21] however complicated presentations are not necessarily liked by students (Blokzijl & Naeff)[22]. PowerPoint does allow lectures to interact with online notes through virtual learning environments such as Blackboard as the presentation is available in the VLE as well as given during the lecture. Providing students with notes and presentations beforehand does allow them to prepare questions and to develop the lecture process in the age-old method of university tutorials. It does however put the lecturers on their mettle, as they need to be constantly ahead of the game. Presentations once made can of course be passed over to future years however currency of information needs to be assured. PowerPoint notes are also rarely sufficient in their own right and students need to take further notes from the information provided by the lecturer. There is a tendency for students to consider that any hardcopy notes whether they be copies of PowerPoint sides or not are an end in themselves. This proves dangerous and can lead to students learning in a “bullet point” fashion indicative of Powerpoint slides and is perhaps a reason for “exam answers that are feeble and not properly thought through.

The addition of diagrams and tables is one of the joys of PowerPoint from the lecturers’ viewpoint. It does allow clear analysis of reasonably complicated diagrams and involved tables to large numbers of students. Connections between data and trends are reasonably easily presented and explained.

3 Casestudy material

Case studies are a valuable way of presenting concepts in a practical sense. Theories are often more easily explained and shown if a case study can be developed. This is particularly appropriate if students are familiar with some aspects of the case study. These can be true or devised and based on true events. Either way is valuable with no particular way being more effective.

3.1 Seagoing

There is not necessarily a difference between case studies for seagoing and non-seagoing students, however there is perhaps more opportunity to utilise technology with seagoing case studies than non-seagoing. The use of bridge watch keeping simulators for instance has more effect for seagoing students than non-seagoing. The non-seagoers may see the simulator as a gigantic walk in video game because they are never going to have to use the situation professionally. Deck Officers on the other hand are familiar with the layout and bridge scene and are aware of the dangers and consequences of the situations presented and thus are able to treat the experience in a much more professional way.

Case studies for seafarers outside of the bridge simulator will of course consist of electronic and paper based exercises devised around the vast variety of activities that take place in the seagoing arena. Over the years lecturers build up banks of case studies even if these are only known as exercise sheets. These in their own way are case studies although perhaps they are not discussed in the formal way of presenting an actual problem; then a solution followed by an analysis of the actions taken and finally the outcomes achieved. Teaching of the seagoing subjects is very much concentrated around the demands of a syllabus dictated by a national authority thus lecturers are constrained in the scope of their teaching by conforming to the rigorous learning outcomes required by Certificates of Competency. With regard to non-seagoing case studies lecturers generally have more control over the syllabus and therefore have a much wider scope and flexibility in the form and outcomes of their material.

3.2 Non-seagoing

The non-seagoing maritime disciplines tend to be maritime business, logistics and technology. The latter is often taught to students who aspire to a more technical and mathematical degree than those taking the business and logistics routes. Case studies in these areas are individual or worked on in groups. Except for "Bridge Watch keeping" seagoing case studies are usually individual as they are designed to develop individual competencies rather than the ability of the student to work as part of a group.

Table 1 Examples of case studies

	Case Study Name	Associated Module	Level
1	Ship Scheduling	Integrated Activities	UG 1
2	Containership Loading	Integrated Activities	UG 1
3	RoRo Terminal Break Even Analysis	Integrated Activities	UG 1
4	Shipping Company Development	Business of Shipping	UG 2
5	Bulk Terminal Operation	Port Operations	UG 3
6	Container Terminal Operations	Maritime Transport Systems	M

Non-seagoing case studies (Some used at LJMU are itemised in Table 1) are designed to illustrate both general and specific concepts in a practical setting. This can be actual or generic and adapted to bring to life concepts that may be clear to the seagoing student but are opaque to the non-seagoer. These case studies are often timed to last for one teaching session of one or two hours and may be preceded by a taught session. Where the learning outcome is not necessarily clear to students then the taught session is essential however as the case study develops and the meaning is clear then the taught session can be reduced to outlining the scope of the case study before it begins.

4 Work based learning

In UK Universities this aspect of degree programmes is fast becoming required. At LJMU work based learning has been a part of non-seagoing programmes for many years. It takes different forms from visits to industrial sites and offices to short 20-hour group projects, whole semester group projects, sandwich years and work associated with final year dissertations.

4.1 Short term

Under this heading the industrial visits, short 20-hour group projects and whole semester projects can be considered. The latter two project types differ from the former in the involvement of the students. In the former students are shown the work of a firm and perhaps are introduced by lecture to the details of the operation. The latter two involve activities in which the students become personally involved, as they have to work through the project in a given time frame. The project brief is developed with the firm who choose a topic area in which they have a development need or are interested in getting the input of thoughts of degree level students. The remit to the firm however is that this project is a learning curve for the students and whilst a commercial outcome is useful the main emphasis is on the learning outcomes of the students. Local Liverpool firms have been very good in taking this aspect into account.

All student academic activities at LJMU must be credit based, which means that the study and assessment must result in credits towards the students' final award. This puts pressure on the lecturer to develop work based learning activities that are embedded in core modules taken by all students, as they must now be exposed to learning in this form. The difficulty comes in the layout and assessment of the tasks. Two modules have been developed in the LJMU Maritime & Transport programmes to harness this aspect of learning. The layout and assessment of each of work-based elements of these modules is similar however one is studied for longer. On the Maritime programmes at level 2 all students undertake a group project for 20 hours in semester 2 between mid February and April. The group size is 3 or 4 students and all must make a contribution. Table 2 lists some of the projects undertaken with a success rating attached to each project.

Table 2 Short 20 hour work based projects

	Project Name	Year Completed	Success Rating 1~5 (1 is low)
1	Reviewing and Assessing the Induction Process of New Employees	2003,4&5	3/4
2	Design/ update of company Web Site	2003&4	2
3	Reviewing the Process of Shipping a Heavy Lift from the UK to South East Asia	2003&4	3/4
4	The Business Opportunities for Coastels	2005	4
5	The Business Opportunities for Local Ferries	2005	4
6	Scrutinising the Database of a Freight Forwarding Company	2005	4/5

An important aspect of project work is the assessment. These short projects, in line with the longer semester long projects, require the students to present their findings and Conclusion to industry managers. The 20-hour project presentations are made to all industry managers and academic staff in the form of a seminar. This then requires students to develop presentations of an industry standard and over the three years of the present module life has proved to be successful and worthwhile to both students and the firms. The success rating, listed in Table 2 is not based on any formal methodology but on the impressions of the academic staff supervising the projects. It serves to indicate that some project types have not been successful. Web-based design projects are not liked by students who feel that this is not developing their maritime skills but is something that should be carried out by students trained in this discipline. Lecturers or those in the firms who set the projects do not hold this view as they feel that students having a maritime background can add some valuable comment to a generic skill such as web-based design. Certainly a knowledge of the maritime scene is an advantage in organising the material on a maritime website so as to ensure that the right material is available in the correct order.

The other work-based learning module lasts for 2 semesters in level 3 of the BSc (Hons) Management, Transport and Logistics. These projects are studied at 3 hours per week over a semester: There being 2 projects studied each year. The projects can be much more involved and occupy much more of the students' time. Often two student groups will investigate different aspects of the same project. The main brief will be the same for each group with a separate individual brief to indicate the alternative perspective to be analysed. Assessment is similar to the shorter projects in that they will be delivered to industry managers in an industrial setting rather than in the University.

Table 3 Semester long work-based projects

	Project Title	Year Completed	Success Rating 1-5 (1 is low)
1	Greater Manchester Transport (Light Rail Study)	2001	4
2	Business Link (Opportunities in Logistics)	2002	3
3	Liverpool Airport	2003	3
4	British Coal Logistics	2003/4	4
5	Lairdside Maritime Centre. Future Possibilities	2004	3

Table 3 shows projects studied under the transport and logistics heading. The learning outcomes are listed in Table 4 and this shows that the longer project has more onerous outcomes. Both project types require production of a report but of varying lengths. The semester long project has a report of around 10 pages whereas the 20-hour project's report is 1000 words or about 3 pages. Both do serve to test the students' ability to work as part of a team and to critically analyse information researched from an industrial base. As the shorter project is studied at level 2 it serves to underpin the induction to the level 3 Dissertation Project whereas the semester long project report is completed alongside the development of the level 3 Transport Project.

Table 4 Learning outcomes of short work-based peoject

	Learning Outcome	Project Type
1	Understand the key issues affecting transport managers and policy makers in the present day transport environment.	1 semester
2	Analyse critically the actions of transport businesses and regulatory bodies.	1 semester
3	View transport policy and operations in the light of external social and economic implications.	1 semester
4	Work as part of a team to produce a commercial report	20 hour

4.2 Long term

Longer-term project work usually entails a year out of the main degree study and lengthens the course from 3 to 4 years. This form of project often known as a "Sandwich Year" has been a common option for degree students for many years and whilst it is still possible it has become harder recently to find these work placements. Maritime and Transport firms are reluctant to take on students owing to cost and training commitments. Some firms feel that a student will only be of use after the year's training, thus just at the time when they leave they become of most use. This is a short-sighted view as history has proved that students who study a sandwich degree perform better in their final year, possibly gain a higher degree and find it much easier to gain good employment after graduation. That is due to their confidence level and their ability to quickly become valued members of a firm. Some recent Maritime and Transport sandwich placements at LJMU are listed in Table 5.

Table 5 Sandwich placement projects

	Sandwich Placement Project	Year

1	International Container Logistics Management	2004/5
2	Bus management	2004/5
3	Local Container Logistics Management	2002/3
4	Freight Ferry Terminal Management	2001/2

4.3 Dissertation project work

All level 3 students studying an honours degree at LJMU Maritime have to complete a dissertation project. The preparatory work to this occurs at level 2 with the short 20-hour work-based project mentioned earlier. Other preparatory work takes place simultaneously with the work-based project in semester 2 allowing the student to study and collect data over the summer vacation period between levels 2 and 3. Students have a free hand in choosing the project subject as long as it is within the maritime or transport field depending on the speciality of the degree studied. Some students have problems deciding on a project area and it is important for them to choose a topic that has a research element rather than one that merely a long description. The research element often requires that they make contact with firms in order to obtain new and current data and then the analysis of this data allows them to provide their addition to knowledge. This is often difficult at the bachelor level, however if they can obtain their own data this is a good way of overcoming this problem.

Table 6 Undergraduate dissertation projects

	Project Titles	Year
1	An Analysis of the Factors Affecting the Cycle Time of Quayside Gantry Cranes in Container Terminals	2005/6
2	Bank Loans as a Source of Fund Raising for the Shipping Industry	2004/5
3	A study into the in-service training provided to UK Cadets at sea	2004/5
4	The Charterer's Role within the "Safety Chain"	2001/2
5	Recreational Boating in the UK. Education v Legislation	2000/1
6	New Applications for X-Band Radar	1999/2000

Table 6 shows the variety of areas studied by undergraduates in their final year projects. Those undertaking projects of a mathematical nature tend to find it easier to obtain data than those of a qualitative nature although many students will use questionnaires and interviews for comparison and synthesis.

5 Research education and activities

Research degrees include an element of research training although this is more apparent at the Masters degree level than at PhD. At Post Doctoral level it is assumed that research skills are already honed and thus further training is not required.

5.1 Postgraduate

The Maritime and Transport section of LJMU offers postgraduate courses taught in Liverpool and also in a distance learning form overseas from the UK in Greece and Iran. Both forms of delivery offer the same course however in the UK the course has six modules running concurrently whilst overseas each module is taught on a block basis with the teaching being carried out over a two week period. Whilst this is intensive students are able to continue working and just attend classes in the evenings and at the weekend whilst the lecturer is available. It has been very successful with many students studying in this way over the last few years.

One third of the Masters degree is taken up by the individual project and it is this element that provides many students with the hardest aspect of their studies. The research element here is covered in a preparatory module called Research and Communications Methods. This module presents to the students methods of developing projects and laying out the written work. It also covers important elements such as the literature review and critical analysis. The development of aims and objectives to underpin the research forms a skeleton on to which the project is built. The uses of different methodologies are covered as these often provide students with problems.

5.2 Research activities

The Marine, Offshore and Transport Research Group (MORG) at LJMU was set up in 1998 and has since been actively engaged in research. It currently consists of 7 academic members and 14 doctoral and postdoctoral members (for details, visit: http://www.ljmu.ac.uk/eng/researchgroups/morg/). The research members in MORG come from many countries including Britain, China, Greece, Iran, Korean, Malaysia, Nigeria and Sri Lanca. MORG has attracted external funding of more than £1m from the UK EPSRC (Engineering and Physical Sciences Research Council), EU, HSE, industry, etc., and completed a number of doctoral and postdoctoral research projects supported by both internal and external funding. MORG is equipped with a wide range of risk modelling and decision making software tools including *ITEM and IDS* (intelligent decision system). Several research projects have been conducted closely with the Lairdside Maritime Centre (LMC), which is an autonomous centre within the Faculty of Technology and Environment at LJMU. LMC has the UK's only 360° ship simulator for research and advanced ship-handling/bridge teamwork training (LMC 2006).

MORG has the following research interests at both the doctoral and postdoctoral levels:

- Electronic charts.
- Formal ship safety assessment.
- Human error studies.
- Marine and offshore system design.
- Navigation studies.
- Offshore safety analysis.
- Offshore structural assessment.
- Port safety assessment.
- Port studies.
- Safety based design/operation decision-making.
- Safety-critical software assessment.
- Simulator-based research.

➢ Transport studies.

Any industrial organisations and government agencies have collaborated with MORG in research. These include AMEC Process and Energy Ltd, Vectra Technologies Ltd, NNC Ltd, Shell Global Solutions, UK Offshore Operators Association (UKOOA), American Bureau of Shipping, Maritime and Coastguard Agency (MCA), Lloyds Register and HSE Offshore Safety Division. MORG has also collaborated in research with many universities world-wide including India Institute of Technology, Loughborough University of Technology, Salford University, Staffordshire University, Shanghai Maritime University, Technical University of Lisbon, Technical University of Gdansk, The University of Manchester and Wuhan University of Technology. MORG has hosted international visiting scholars for research collaboration of 6 to 12 months from Chosun University in Korea, Dalian Maritime University, Shanghai Maritime University and Wuhan University of Technology in China.

Some typical doctoral and postdoctoral research projects within MORG are briefly described as follows:

5.2.1 A Selected List of Some Current Projects

.1 An advanced tool for safety-based offshore operations (2004-2007)

Safety is of paramount importance in offshore operations. Human and organisational factors (HOFs) play a critical role in offshore operations and are often at the root of many major failures with disastrous consequences. Research in this area poses a significant challenge and is so far very limited. This may be due to the unique characteristics of offshore operations in harsh environments and with many innovative features, the high level of uncertainty in failure data, and the difficulties of integrating HOFs into overall risk assessment together with other failure events as well as factors in finance, the environment, etc. This postdoctoral research project is funded by the UK EPSRC and deals with such problems in a rational and integral manner. It is aimed to develop a novel decision support tool for offshore operations. The project includes an initial investigation into the generation of best operation strategies, development of an advanced risk-based framework for modelling HOFs, formulation of Bayesian networks and a linguistic approach, and development of a novel group decision analysis methodology for supporting overall multiple criteria assessment of offshore operational strategies. The collaborators of the project are Shell and HSE.

.2 Logistics performance of liner shipping (2003-2006)

An appropriate liner shipping performance measurement can only be achieved by closely integrating the internal functions within carriers' companies with the external operations of shippers' and consignees' companies. In this regard liner shipping performance measurements will encompass not only internal operation efficiency parameters, but also measures of customer-facing services effectiveness. This doctoral study will develop a conceptual assessment framework of the logistics performances of liner shipping and provide suggestions for using validated measures in substantive research and practice in the context of the marine industry with particular reference to safety assessment. The collaborators of this project include Shanghai Maritime University and Mersey Docks and Harbour Company.

.3 Risk-based inspection of large oil tankers (2003-2007)

Recent isolated and highly publicized incidents have undoubtedly cast a shadow on international maritime safety affairs. The benefits of a comprehensive regulatory system applied uniformly and controlled by an international body (IMO) need to be recognized. However, following the loss of oil tankers "Erika" in December 1999 and "Prestige" in 2002, the operations, engineering and management sectors involved in tanker safety have been subjected to intense criticisms from the media and the public. Leading Figures in the classification industry have recently called for a "re-invention" of the industry's primary self-regulation system in response to these developments. Another observer encapsulates the fundamental problems with the present system of international rule-making. The system is to a large extent reactive, responding to accidents rather than proactively preventing them. There is a lack of transparency and the process of developing the rules is insufficiently systematic. This doctoral research looks at this important topic area.

5.2.2 A Selected List of Some Recently Completed Research Projects

.1 Application of approximating reasoning approaches in offshore engineering design (2002-2004)

To improve competitiveness companies must reduce cost and environmental impact whilst improving safety, quality and maintainability in design and manufacture of their products. Such multiple criteria have to be considered in design assessment at various design stages. The difficulty in conducting design assessment comes from the fact that limited reliable data is available to measure criteria at the early design stages where vague information or subjective judgement is often used. Advanced approaches that can address the above issues need to be developed. In this postdoctoral research project funded by the UK EPSRC, several pragmatic modelling techniques, a rigorous assessment methodology and software were developed. They can be used to facilitate assessment of offshore and other made-to-order products even in situations where conventional approaches cannot be applied with confidence due to the lack of data and the high level of vagueness and subjectivity. The outcomes of this project can be used to significantly improve the design assessment processes in conceptual design, design validations and requirements definition. The collaborators included AMEC Process and Energy Ltd, Vectra Technologies Ltd, NNC Ltd, HSE Offshore Safety Division and UKOOA.

.2 Cyprus and Mediterranean Cruise Market: A financial and economic appraisal (2000-2004)

This doctoral research proposed a "financial and economic" methodology for a cruise product. The developed methodology consists of seven distinct sections including consolidation and globalisation; market segmentation; evaluation of consumer attitudes and competition; marketing analysis; formal safety assessment; cost and risk assessment and investment risk analysis. It was used as the basis for the development of more scientific and objective financial and economic methods and safety modelling techniques applicable to the operation of cruise ships in the Cyprus and Mediterranean regions. A generic cruise ship and anonymous cruise companies operating in the Cyprus and Mediterranean regions were used to demonstrate the methodology developed. Finally the results of the project were summarised and the areas where further research could be focused were identified. This research was conducted via a distance-learning mode. The collaborators of this research included several leading cruise operators in Cyprus such as Louis Cruise Lines and New Paradise Cruises.

.3 Formal safety assessment of fishing vessels (1998-2001)

This PhD project was concerned with the application of formal safety assessment to fishing vessels. Fishing vessels are generally smaller than most merchant vessels and the amount of data available to carry out an extensive safety assessment for this type of vessel is lacking. The failure and accident data available for fishing vessels are associated with a high degree of uncertainty and are considered unreliable. As such the work carried out in this research was directed to look at the development of novel safety analysis methods to address this problem. This research developed several subjective safety analysis methods for fishing vessels within the formal safety assessment framework. A fishing vessel was used to demonstrate the methods developed. The industrial collaborators of this project were Boyd Line Ltd and MCA.

6 Conclusion and future development

It is inevitable that the future lies in the greater use of IT in teaching, with much of this involving the Internet. The ability for students to learn at their own pace in their own time enabling them to mix learning with work is going to be the education of the future. It is already clear that distance learning is available in many subjects, however this method of learning is not very widely available. In the UK and elsewhere for many years there has been an “Open University” that offers all programmes in a distance-learning mode. They are able to harness the mass media of television as well as video and this will be beyond the resources of most universities. Nevertheless many universities will find ways of offering potential students this learning method.

Short courses in universities will also develop allowing students the opportunity of studying elsewhere whilst obtaining their main qualification from the home establishment. Greater emphasis on learning in the workplace will allow closer cooperation between academia and industry consequently a variety of ways of achieving this will develop.

This paper has set out the ways that LJMU has developed to harness modern teaching methods to provide a more attractive learning experience and one that is attuned to student requirements. The scope of research at LJMU has also been covered in the resume of some of the projects previously studied and some of those at present being studied in Liverpool.

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Marine Engineers' Training System in the Maritime State University Named after Admiral G. I. Nevelskoy

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The world economy development nowadays is inconceivable without further growth in the volume of transportation by sea; therefore safety and security of merchant shipping as a major constituent of international trade is one of the top priorities for the international shipping.

A special feature of the international shipping is a continuing growth in number of specialized superships which are on a large scale equipped with marine propulsion plant automated control systems and cargo handling automated control systems, namely chemical carriers, gas carries, car carriers and container ships.

The ever increasing intensity of navigation, while shipboard equipment is sophisticated and its upgrade rate tends to be shorter lead to some grave consequences resulting from accidents at sea due to the so called "human factor". In these circumstances it is the human factor, first of all seafarers' qualification and competency, that becomes the key factor for the safety of navigation.

In this connection the need for renovation of the structure and the content of maritime education and training, its instructional support and introduction of modern teaching technologies is much more pressing.

At present maritime education is developing in conjunction with profound reforms in the field of seafarers' professional training initiated by the adoption of the revised version of the Annex to the International Convention on Standards for Training, Certification, and Watch-Keeping (STCW-78/95) and of the STCW Code.

Compared to its earlier version the Convention's structure and the content have been considerably changed as to the requirements to the marine specialists' competency level as well as to the required competency provision and maintenance control system.

The independent foundation DNV has inspected 300 maritime educational institutions that provide education, training and advanced services. The inspection results have revealed the fact that neither training facilities nor education and training programs' content, nor the qualification level of the teaching staff meet the standards in approximately 50% of the institutions that provide educational services.

The Russian Federation being a participant to the STCW 78/95 has also signed the Bologna Convention on specialists' training that implies the unification of bachelor degree and master degree certificates.

The two above-mentioned factors of decisive importance have necessitated fundamental reforms in the structure of maritime educational institutions as well as in the content of their training programs.

At the first stage of the reforms the whole system of maritime education was tailored to comply with the STCW 78/95 requirements.

Results of reforms in the RF seafarers' training and certification system were reported at the IMLA 2002 Conference held in Shanghai and at the AMETIAP 2004 Conference held in Vladivostok.

Having accomplished the first stage of reforms we have proceeded to the next one, namely establishing a maritime university complex.

At present the University complex consists of more than 16 institutes. The leading one is the "Maritime Academy", where the unified programs of continuing multi-level education for seafarers are being introduced.

Maritime Academy includes:

- Basic Vocational Education Institutions (providing training for ratings);
- Secondary Professional Education Institutions (providing training for operation level specialists, with certain restrictions laid on ships' deadweight and BHP);
- Higher Professional Education Institutions (providing training for operation level specialists, with no restrictions laid on ships' deadweight and BHP; also providing training for management level specialists);
- Maritime Training Center for conventional simulator training.

While introducing amendments into curricula and training programs and taking the above into account, emphasis was placed on teaching practical skills.

In its turn obtaining practical skills in operating shipborne equipment featuring high degree of automation is only possible through the use of up-to-date simulators, that very closely imitate the real operational situation.

In order to achieve this goal a Simulator-based Training Center was started at the Marine Engineering Faculty, the "Marine Academy" Institute, incorporating 2 simulators used in teaching practical skills in operating slow-speed and medium-speed main engines, and a NORCONTROL-made (Norway) colorgraphic simulator for training purposes, as well as simulators of a marine power plant MODEQ-100, MODEQ-300, manufactured in UK.

As the rate of shipborne equipment upgrade tends to increase the existing simulators become outdated in a shorter period of time, while timely substitution is rather questionable due to simulators' high cost.

Under the circumstances the way of improving training in practical skills based on the use of simulators may be found through the integration of education, science and industry i.e. through participation of shipping business in the training process, as it was noted at the 2005 Conference in Manila.

A vivid example of such an approach to tackling the problem is cooperation between the MSU and one of the world's leading shipping companies MITSUI O.S.K Lines, LTD (MOL).

In August 2005 the MSU and the MOL signed an agreement for establishing a Seafarers' Training Center at the University (MOL TC RUSSIA). MOL has supplied the Center with an up-to-date ME Remote Control System Simulator and Reefer Container Simulator, manufactured by NABCO, Japan.

Thus, the Marine Engineering Simulator Complex makes it possible to provide complete cycle of training marine engineering officers in practical skills in consequent steps commencing with studies at PC-based (colographic) training simulators followed by training at physical simulators such as the ones manufactured by NORCONTROL or NABCO. The final step is a joint training at the NABCO-made Engine Room Simulator conjugated with the bridge and the Ship Handling and Maneuvering Simulator which will allow trainees to accomplish practical tasks in simultaneous handling the ship by the bridge team and the engine-room team.

The next step in developing the seafarers' training system is that of establishing the LNG Specialist Training Center.

In accordance with the STCW78/95 Convention and ISO 9001-2001 standards, the MSU has designed and introduced its own Quality System Management (QMS).

By the time being as a part of the University preparations for international certification according to DNV standards the MSU QMS's internal auditors have passed an approved training in DNV programs in Taiwan Province, PR China.

Reconsidered Scholarship—A Utilitarian Paradigm for Maritime Education

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Abstract In Scholarship Reconsidered: Priorities for the Professoriate (1990), the Carnegie Foundation for the Advancement of Teaching delivers a powerful challenge: ...the work of the scholar... means stepping back from one's investigation, looking for connections, building bridges between theory and practice, and communicating one's knowledge effectively to students.

Maritime colleges are in a unique position to affect the constantly changing nature of teaching and learning as well as the challenges surrounding the future of "faculty work." Scholarship Reconsidered should be the catalyst for redefining maritime education, with a focus on a seamless and interdependent relationship of learner centered activities. Maritime education, with its effective degree productivity and assessment, should serve as an exemplar for other professional preparation programs as well as for the traditional arts, sciences and humanities disciplines on comprehensive campuses. But, this will require that our faculties possess the same "intentionality" we strive to imbue in our students. And, if our faculties are to be able to intentionally share best practices with their students and peers in a two-way efficacious manner, our maritime institutions need to support their professional development, particularly in terms of addressing any shortcomings associated with narrowly focused or otherwise limited preparation for an academic position.

Keywords scholarship; faculty; development; education; teaching.

In examining the 21st century challenges for maritime universities, permit me an initial observation: This is the wrong time for navigating into the future with our eyes astern.

1 The times: they are a cha(lle)ngin

What can we expect to see as the 21st century unfolds? For higher education, it is a recognition that new and dynamic patterns in the economy, demographics, government spending policies, the use of technology and the expectations of the public we serve ensure that higher education will never be the same. For the maritime campus, it is an expansion in the diversity, severity and complexity of the professional, industrial and economic/environmental/political issues we accept as our milieu; it is the effect of competition for precious resources in what is fast becoming an age of “triage”; and it is a telecommunications explosion that will alter forever how we communicate, educate and practice.

Reengineering the Corporation; Schools for the Twenty-first Century; Reinventing Government... As evidenced by widespread restructuring in the public and private sectors, there is concern in the United States over our ability as a nation to deal with 21st century issues using resources designed for 20th century challenges. In higher education particularly, we are recognizing that the traditional beliefs underlying our handling of change will no longer apply. Maritime, and other, universities will need to replace what are fast becoming basic *mis*assumptions including:

Misassumption (*1*) We, the Academy, know what is “best” and should control the activities associated with our comprehensive mission of teaching, research and public service. According to the Public Agenda Forum[1], the reality is that higher education is becoming a consumer product. Outcomes and the increasingly popular “cost-to-benefit ratio” are key considerations in the student-as-consumer choice of institutions. Further, standard setting for higher education is no longer guaranteed to the Academy. Increasing pressures from government, business and industry have resulted in a number of well-meaning initiatives, such as Goals 2000, that, without the Academy’s responsible guidance, could find “higher education” becoming “higher training."

Misassumption (*2*) *If higher education is so critical to society, society will invest in its fruition*. In discussing the reality of public higher education’s complex relationship to government, Peter Ewell[2] surmises that while we insist: “You won’t give us the money we need (and we know you have)!” They insist: “There isn’t any money.”

Alas, *they* are correct. Government spending on education is seriously constrained by the growing pressure of entitlements. Breneman[3] suggests that the State of California’s only alternative to the status quo of ad hoc decision making or to privatization, is for the Governor to “declare higher education in a ‘state of emergency’.” As this is highly unlikely, the entire academic community must recognize that knowledge and skill in entrepreneurial resource acquisition and management can no longer be solely administrative concerns.

Misassumption (*3*) *The Academy owns knowledge* (and is its gatekeeper). By 2020, information will double every 70 days. Without telecommunications and computing literacy, faculty will lose, not only the monopoly of information but, more importantly, the ability to guide its exchange. Clearly, technological sophistication amongst the faculty ranks is imperative.

If we are to understand the 21st century challenges for a maritime campus, we must respect the gravity of our situation as succinctly stated by the Pew Higher Education Roundtable[4]:

The charges most important to higher education are those that are external to it. What is new is the use of societal demand -- in the American context, market forces -- to reshape the academy. The danger is that colleges and universities have become less relevant to society precisely because they have yet to understand the new demands being placed on them.

Given these exigencies, attempting only to adapt to 21st century change will not work.

2 The fundamental challenge

The *fundamental challenge* for maritime academies, colleges and universities in the 21st century is mastery (by ourselves and our students) of the process of guiding and managing, as well as adapting to, dynamic change; and doing so in light of a new, and very unfamiliar, set of basic assumptions that are, as we speak, reshaping both the Academy and the society we serve. In effect, the fundamental challenge will be to do *how we do* as well as we do *what we do*!

How should we approach the task? We can resist, react, or reconsider.

If we choose to *resist* this transformation of higher education, we will run headlong into the new wall of accountability. Moreover, grasping for the past will uselessly expend valuable energy. In California, for example, what purpose would it serve to wave I.O.U.'s for budget based "lost" faculty positions at whichever administrator had the bad sense to keep a copy of the, now defunct, guidelines to faculty allocation in the California State University "orange book."

If we choose to *react*, particularly in the ad hoc, "crisis" manner of the past few years, we will become caught in the "cut and combine" mode that now finds us adding more and more students to our traditional lecture/lab sections and nothing more. This does not work for maritime education. Ask our students. Ask our clients. Ask our accreditors.

If we choose to *reconsider*, we will, at least, be involved in the management of the changes we are undergoing. At best, we and our cohorts will master the process of guiding the changes that affect us.

Am I suggesting that we do more, with less, and do it better? No. I am suggesting that we choose the challenge of reconsidering our campuses, and focus our efforts on "working smarter" by playing a significant role in guiding our own destiny while not killing ourselves in the process.

3 The theoretical challenge

Almost twenty years ago, the Carnegie Foundation for the Advancement of Teaching recognized the need to reconsider the Academy. In *Scholarship Reconsidered: Priorities for the Professoriate*, Ernest L. Boyer[5] delivers a powerful challenge for the new century:

Is it possible to define the work of faculty in ways that reflect more realistically the full range of academic and civic mandates? ...the work of the scholar ...means stepping back from one's investigation, looking for connections, building bridges between theory and practice, and communicating one's knowledge effectively to students. ... the work of the professoriate (has) four separate, yet overlapping functions(:)... discovery; ...integration; application; and...teaching.

More than a decade ago, Boyer[6] and others refined the concept of *reconsidered scholarship* by stressing an integrated approach to its conduct. This has made **"and"** an equally important word in the phrase "teaching, research and public service." Walshok[7], as cited in Stukel[8], describes this as "knowledge linkage," the closer connection between knowledge-producers and knowledge-users. Walshok emphasizes that research, teaching, and service have more in common than divides them and that information can flow both ways.

Meeting the *theoretical challenge* of embracing *integrated scholarship* will allow colleges and universities, not only to work smarter and more productively in addressing our various missions, but also to master the process of guiding future change in public policy and practice, as well as professional education.

4 The operational & tactical challenges

Robbins[9] reminds us that while creativity is the ability to combine ideas in a new way, innovation transforms that creativity into something useful. So, the college also has an *operational challenge*, a test of *integrated scholarship,* that will turn theory into practice, creativity into innovation, and respect collective academic responsibility alongside individual academic freedom. Success in this challenge will result in a learning and working community that efficiently and effectively identifies, recruits, develops, empowers and utilizes the great reservoir of resources for change—the energy and creativity of faculty, staff, students, and community—as it strives to advance the commonwealth.

As attainment of theoretical goals requires implementation of practical objectives, so does that implementation require tactical accomplishments. Thus, in order to adequately address the more global challenges related to foundation, theory and operation, we must also confront a number of tactical challenges related to both the day-to-day and long range lives of the campus. These tactical challenges are the most sensitive of our charges because they touch the very heart of the Academy. Accepting the reality that external factors including technology, privatization, regulation and consumerism remove us, the professoriate, from our historic ownership of knowledge is a bitter pill. It is made worse by internal discontent including lack of resources, expectations that we perform other tasks (fundraising, student recruitment, etc.) lopsided professional preparation and mixed messages in our rewards structure. But these are the very real conditions for change—necessary change if we are to fulfill our comprehensive mission in the twenty-first century, a century that will demand understanding, promotion and celebration of diversity not only in race, ethnicity and culture, but also in learning styles, lifestyles and the tools and skills of information exchange.

The list of tactical challenges is exhaustive: administration *for* the campus, *students first*, “cultural competence,” etc.. Each of these topics is worthy of lengthy discussion, but time limits us to raising the issue and identifying the overarching tactical challenge, i.e., *changing the campus culture*.

5 Changing the campus culture

The culture of every college and university is unique. Yet, we all share certain values: Excellence in teaching and learning; service to students and our community or industry; commitment to diversity in a multicultural and pluralistic setting; collegiality and collaboration; collective responsibility and accountability; and academic freedom, creativity, and innovation. For the maritime college or university to meet the challenges of change, it must be a dynamic force that contributes significantly to each of these arenas. The challenge in changing the campus culture will be to provide the education, advocation and facilitation needed to secure the university's commitment to measures including

Removal of barriers to non-traditional learning experiences (e.g., "service learning") and expansion of interdisciplinary or community/industry collaboration, including obstructive budgeting and personnel practices.

Support of an *integrated* approach to *reconsidered scholarship* and related activities through workload management, technical assistance and modernization of recognition, incentive and reward structures.

Promotion of enrollment management strategies, such as alternative scheduling and cohorted programming, that would contribute to the establishment of *learning communities* and similar activities known to support increased retention and accelerated graduation while improving the overall quality of the educational experience.

6 The strategic challenge

And so, how should a college or university, maritime or otherwise, work to achieve appropriate change in the campus culture?

I am convinced that maritime colleges and universities are in a unique position within higher education to affect and be affected by the constantly changing nature of teaching and learning as well as the challenges surrounding the future of "faculty work." Further, I am joined by all of the other academic administrators on the maritime campuses in the United States[10] in looking to Ernest Boyer's aforementioned *Scholarship Reconsidered* as a contemporary environmental scan of higher education, including generational, technological, accountability, and other factors, and as the catalyst for a redefinition of *The Academy* (maritime or otherwise), with a focus on a seamless and interdependent relationship of learner centered activities. Again,

...the work of the scholar ...means stepping back from one's investigation, looking for connections, building bridges between theory and practice, and communicating one's knowledge effectively to students. ...discovery; ...integration; application; and...teaching.

During and beyond the 1990's, leading organizations in American higher education have fostered this transition from distinct arenas of teaching, research and service to a more unified approach to scholarship (AAHE's *Forum on Faculty Roles and Rewards*) while, at the same time, moving from teaching centered traditional instruction to the learning centered production of "intentional learners" who are informed, empowered, and responsibly engaged, as described in the Association of American Colleges and Universities' *Greater Expectations*[11].

Is this *reconsidered-scholarship-focused-on-intentional-learning* metamorphosis appropriate for maritime universities? Perhaps more importantly, can maritime education, with its assessment laden and effective degree productivity (e.g. >85% retention with an average 4 years to degree at Cal Maritime), serve as an exemplar for other professional preparation programs as well as for the traditional arts, sciences and humanities disciplines on comprehensive campuses? Yes, on both counts, that is, if our faculties possess the same "intentionality" we strive to imbue in our students. And, if our faculties are to be able to intentionally share best practices with their students and peers in a two-way efficacious manner, our maritime institutions need to support their professional development, particularly in terms of addressing any shortcomings associated with narrowly focused or otherwise limited preparation for an academic position.

Though not unlike other externally regulated professional colleges with cohorted student groups pursuing full time courses of study that include significant field components, which rely on instructors with significant practical experience (e.g., Nursing), North American maritime academies face additional challenges in maintaining contemporary faculties noted for their academic acumen. The scarcity of our institutions, including our geographical separation from each other (as well as from more comprehensive campuses), and a faculty profile heavily dependent upon instructors rich with industry experience, but sometimes limited in terms of their professional preparation for pedagogical and/or scholarly undertakings, often precludes us from following or leading academic change.

During the November 2005 meeting of the U.S. maritime academies' senior administrators, the provosts discussed this challenge of professional development for maritime educators, particularly as it involves teaching and learning in modern higher education. From that discussion, came an agreement to pursue enhancement of our pedagogical approaches to maritime education, including increased attention to "reconsidered scholarship" as a model for faculty work. Among the proposed undertakings will be a future conference devoted entirely to "teaching and learning in the maritime environment." That conference has now been scheduled for March 2007 and will be held at Cal Maritime with a call for papers already completed and a final program under development for dissemination in the not-too-distant future.

If we in maritime education agree to pursue a unifying strategy of intentionality (i.e., empowered, informed, and responsibly engaged) that is focused on an integrated approach to reconsidered scholarship, the upcoming "conference on teaching and learning in the maritime environment" may serve well as an anchor for a wider range of future activities designed to inform our faculty. Individual campuses can pursue similar "informed" professional development activities, many of which are addressed in the Reference cited with this paper. But, each campus will also require necessary unique modifications in order to assure that faculty are also "empowered" (e.g., via academic freedom with collective accountability) and "responsibly engaged" (e.g., via shared governance that addresses faculty responsibilities, roles, and results).

7 Conclusion

This presentation, "Reconsidered Scholarship: A Utilitarian Paradigm for Maritime Education," has intended to provide, for maritime educators, an introduction to this increasingly mainstream system of understanding and promoting a seamless relationship to teaching, research, and experiential learning in higher education. Beyond an introduction to the paradigm, this presentation was designed to provide Reference associated with "reconsidered scholarship," and provide an opportunity to interactively explore with maritime educators the added values it provides, particularly to our often non-traditional academic personnel.

Before I take your questions, let me share with you two comments. The first comes from a statement issued by the Pew Higher Education Roundtable in "To Dance With Change"[12]:

Our argument is simple and to the point: no institution will emerge unscathed from its confrontation with an external environment that is substantially altered and in many ways more hostile to colleges and universities.

The second is from *Florida Sunrise: Which Tomorrow?*[13] "Strangely enough, in the midst of change, the present course may often be the most risky one. It may only serve to perpetuate irrelevancy."

It is the nature of maritime education "to dance with change." However, if we want to "lead" in the 21st century we will need to inform, empower, and responsibly engage our faculty in focusing their future work on an integrated approach to reconsidered scholarship.

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Applying Unified Criteria in MET: The Way to Globalization

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Abstract Recent radical changes in political, economic, and educational concepts have impacted educational systems all over the world. Competition is no more limited to commodities and services but extends to other domains, such as the qualification and training of the human being. Graduates of maritime institutions will have to compete to secure jobs in the maritime industry. Maritime communities have either to participate in this wave of globalization or suffer exclusion from the map of maritime communities of excellence.

A comprehensive maritime strategy could be developed under the umbrella of IAMU. Such a strategy, which depends on cooperation between maritime institutes and academies all over the world, should aim at the development of an excellent culture of quality education and training. IAMU is now in a position to direct MET toward globalization, which is the core of this paper.

Considering that IAMU is in charge of developing maritime education and training, maritime safety and security, protection of the marine environment, and promotion of proficiency in English, which is the lingua franca of the sea, it should aim at developing effective mechanics to achieve total quality in MET through the establishment of global criteria governing maritime education and training. In other words, IAMU should lead the move toward globalization of maritime education and training, which is the main concern the present paper.

Keywords globalization; global MET criteria; quality assurance; education pivots; IAMU role

0 Introduction

The accelerating changes in all the walks of life are the typifying feature of the modern age; they have resulted in eliminating the borders of countries and in the globalization of organizations, the most important of which are educational organizations, together with globalization of educational systems. These accelerating changes have had a profound impact on competition within the field of quest for knowledge in this age of technology and communications. These changes have necessitated reviewing all educational systems. The maritime educational system is of course no exception. Educational systems of all types should be reviewed and modified to cope with the explosion of knowledge and the tremendous developments in technology. The old concepts of traditional educational systems are no longer capable of accommodating these new developments. Obviously, there is an urgent need to adopt new instruction and assessment techniques according to international standards with a view to achieving lifetime and self learning.

The world is characterized by continuous activity. It has been observed that in the past three decades international shipping sustained momentous changes. The global era started in the last decade. Commonly, it is expected that the winds of change toward globalization will change the existing systems of international shipping[1].

1 Globalization

The expression "Globalization" has acquired significant impressive meanings. Some regard it as a process that is valuable and self-imposing. Globalization includes prospects for actual worldwide progress, but this progress is not equal everywhere. The expression has become prevalent since 1980s, reflecting technological progress that has made it easier and faster to conclude international agreements in all fields. It refers to prolongation beyond national borders. The expression sometimes also refers to the evolution of people, such as labor, and technology across international borders. Hence, it is a term used to describe how human beings are becoming more interrelated around the world economically, politically, culturally, socially and psychologically. Although these links are not new, they are more penetrative than ever before. Finally, Globalization is a natural outcome of the development of the world[3].

2 Maritime education and training

Despite the multiplicity of MET definitions, all definitions comprise the following elements:

The procedure within which a candidate becomes conversant with the knowledge, attitudes and skills needed to execute the daily work and different duties of future deck or engineering officers onboard ships, and which empowers them to work in different fields of maritime transport. Such a procedure can provide the candidates with the ability to respond correctly and effectively to emergency situations[4].

A series of interdependent procedures such as teaching, learning, researching and utilizing resources embodying human material and information to carry out special educational and training goals to ensure marine safety, security and the protection environment[5].

Maritime education and training and globalization

The maritime field can be affected by several factors such as international conventions and regulations, flag state parties (the authority), shipping companies which should carry out the authority's regulations, and MET institutions which conform with international conventions and national regulations. Developed countries use advanced technology and ships, whereas the products from developing countries are seafarers. As a result, and because of the shift of seafarers from one continent to another, the problem of nonconformity worsens and ships are not safely operated. So, the solution to this problem is in globalizing MET[6].

Because of the numerous recent radical changes in political, economic and educational concepts, education today, particularly in the maritime field, is undergoing fast and profound changes. Globalization of the shipping industry has a direct impact on the competition for quality in maritime education and training.

Education is speedily becoming globalized; educational subjects are becoming more and more diversified and differentiated. So, the old educational model is no more of use; it has been substituted by a new model. The invasion of globalization has eliminated the borders between educational schools, hence, the educational services have become borderless. Globalization has changed the movements of overseas students seeking education[7].

3 Quality assurance

Quality has became a basic requirement which has global implications. It is a basic access to the criteria system which should be based on measuring and studying the ingredients of those criteria.

Quality is an integrated system which can be specified as a norm or mechanism which can be followed by any organization to enhance and improve its products/ services.

The three vital factors of quality are competitive strategy, the technology required for providing good products and/or services and the procedure to mange the organization[8].

Quality assurance is the procedure which controls the measures in order to minimize deviancy of products or outcomes; it is the process which controls the performance of the whole supply chain[8].

Quality assurance and quality audit provisions are employed in the educational process. Education and training institutes are accustomed to applying for recognition of their qualifications by outside bodies, often across national boundaries. Thus some assurance of standards is feasible, provided they can be usefully incorporated into a system of overall compliance at international level[9].

As regards quality assurance, it should be seen as the first step towards a permanent evolution organism[10].

In MET institutes, the quality assurance procedure defines the structure and regulatory approach to check all management and technical procedures, services and teaching activities. In a word, quality in MET is the path to excellence[11].

3.1 Achievement of quality assurance

To achieve quality assurance in MET in a comprehensive way, every MET institute should include an integrated system to outline the quality levels and their scopes, and provide convenience circumstances in order to achieve these outlines and their objectives. In MET institutes, the quality systems aim to:

Knowing the international standards of quality educational and research services, the provisions and specifications of quality as defined by accreditation bodies.

Continuous auditing and self reforming.

Allocating the procedures and techniques that should be used to reach the international standard of the activities, the educational and research process and interpolate the accredited provisions.

Spreading the concept of the quality assurance culture in MET institutes.

Enhancing activities when presenting educational and research services according to recognized international levels.

The implementation of appropriate techniques to achieve quality management requires the following ingredients:

Clear educational and researching strategy reflecting the universal educational criteria in all educational and research fields.

Correct and universal criteria in taking decisions.

Examining procedures and systems to increase and develop the educational resources and enhance the educational techniques, in addition to improving the courses by using systems of automatically updating information.

The ability to select students and instructors and all educational and research processes according to globalization criteria.

The long-run adherence to continuous improvement in all educational and research processes, activities, procedures and techniques as well as continuous updating the programmes, methods and knowledge resources.

Adopting the concept of "Error Free performance", i.e., correct performance without error.

Integration of training processes by applying quality management systems.

Adopting the concept of delegating authority with respect to whatever is related to developing educational services.

One of the ways to meet the increasing need for a global quality assurance is to design, implement and maintain quality system based on uniform international criteria. These generic criteria present guidelines for developing quality systems, as well as a set of requirements with which a MET institute should comply in order to register its quality system. The criteria provide a possibility for streamlining university operation, identifying, correcting and preventing quality problems, as well as quality improvement by means of internal quality auditing and various statistical techniques.

3.2 The objective of quality assurance and accreditation in met

Establishing globalized systems in MET institutes of IAMU in order to ensure quality and accreditation.

Spreading awareness of quality culture in these MET institutions.

Preparation of quality graduates who can meet the requirements of the modern era.

Developing international accreditation criteria and measurement mechanisms.

Developing the institutional capability to ensure continuous improvement of educational process.

4 STCW convention as an international standard

The international convention on standard of training, certification and watch keeping for seafarers (STCW), 1978 was adopted in July 1978 and entered into force in April 1984. Since then three amendments thereto were adopted in 1991, 1994, and 1995.

The STCW 95 can be viewed as a response to the lack of success of the STCW 78. It was a trial to define uniform standards of what seafarers should know and what they should be able to do. The convention does not address the issue of critical educational affairs. It sets a minimum global, professional standard for seafarers[10]. This professional standard includes skills, knowledge, understanding and the abilities needed to ensure that individuals are capable of fulfilling the role expected from them at sea[6].

It just began the process of harmonizing different national certification systems toward an international agreed system. Although the convention represents an important milestone in MET, because it codified global technical standard for seafarers for the first time and because it created perception of various approaches to MET worldwide[9], it did not define the process to be used for acquiring the competency. Briefly, the convention enumerated and defined certificates at various levels as the eventual product of the MET process without explaining the process it self.

Probably the Convention avoided the direct impact on the national MET system. It avoided determining the duration of education and training and MET entry requirements. Finally, it can be stated that the convention just began the process of harmonizing the certification system and at the same time harmonizing different national MET systems toward an internationally accepted MET system. The STCW convention presents an initiative towards internationally accepted standards[12].

5 Proposed unified criteria

There is an urgent need to radically change the concept of education in the present era of globalization and technological innovations. This could be achieved through developing international uniform criteria for maritime education and training and developing a mechanism for the implementation of quality standards to be applied in all maritime educational institutions. Such standards should be comprehensive, i.e., covering all the aspects of the educational process, and flexible, i.e., could be adapted to suit varying cultural contexts. The process of developing such standards should be based on concepts and principles which reflect the expected future developments in maritime education, e.g., utilizing whatever is technologically innovated, meeting the requirements of the increasing diversity of sources of knowledge and information, and the need to acquire new skills, in addition to the development of management techniques with a view to solving problems and taking the proper decision.

It should be noted that these criteria applied for certain periods and tested so that their outcome may be assessed.

5.1 The documents relating to global educational criteria

The criteria and indicators could be grouped under five major domains representing the aspects of the educational process. These criteria should function as reference to assess all the aspects of the educational process and self-assessment. These criteria are:

The criteria document of the maritime institute; it includes the vision and mission of the institute, the social environment prevailing in the institute, vocational development, quality assurance, and checking non-conformities.

The document of instructor criteria; it includes the following fields: planning, education and management strategies, the courses, assessment, and instructor's professionalism.

The document of excellent management criteria; it includes its cultural institutional domains, vocational participation, and change tool.

The document of the criteria of society's participation; it includes maritime community service and pooling its resources.

The document of curriculum criteria and learning outputs and the basic fields of skills: cognition skills and personal traits.

Each of these five domains has its own specifications, conditions, and fields, together with its development aspects and measurement units which are used to measure the quality of this domain.

Within the context of this paper, reference is made to the criteria of successful maritime institutes and the criteria of the productive teacher.

With respect to the successful maritime institute, five domains are identified:

The first domain: the vision and mission of the maritime institute.

The second domain: the social environment of the maritime institute.

The third domain: ongoing vocational development.

The fourth domain: the learning community.

The fifth domain: quality assurance and checking non-conformities.

Each of the above domains has its own criteria which are based on several quantitative and qualitative indicators.

With respect to the criteria of the instructor, who is considered the pivot of the learning process, today's instructors should have the following characteristics. He should be an educator, planner, contemplator, thinker, assessor, and definitely a leader. The nature of the modern era and the challenges of globalization require certain types of instructors who are highly efficient at the academic, professional, cultural and ethical levels. Only such instructors are capable of effecting change and inculcating in their students the skills of innovative thinking This also requires a type of management that is aware of the changing nature of the maritime community. In addition, the performance of the instructor should be improved, which could be realized by setting planning, educational and training criteria for his performance. His promotion should be determined on the basis of the level of performance, experience and training he has achieved and the researches he has conducted, together with his qualifications.

The domains and criteria of the instructor are:

The domain of planning, the most important criterion of which is determining the students' educational requirements.

The domain of education and class management criteria which pertains to facilitating the process of learning and increasing the students' participation in the learning process by engaging them in problem solving and creative thinking.

The domain of courses, the most important criterion of which is improving the capability to develop courses.

The domain of assessment, the most important criterion of which is self-assessment by the students.

The domain of the instructor's professionalism, the most important criteria of which are enhancing the ethics of the profession and professional development.

5.2 The pivots of the criteria are

The criteria of students' admission and assessment on the bases of skills, capabilities and excellence.

The criteria of new instructors selection.

The criteria of academic supervision.

The criteria of selecting leaders.

The criteria pertaining to quality organizations with respect to autonomy, objectivity, mechanics, financing and the bases of application.

With respect to criteria, consideration should be given to the following:

Defining and unifying the terms used in the project of global uniform criteria.

Revising the structure and classification of local criteria with a view to abiding by the global uniform criteria.

Reconsideration of local criteria to ensure their compliance with the concepts and principles embodied in the global uniform criteria.

Developing the mechanics of implementing the global uniform criteria by setting short and long-term plans which take into consideration the actual educational potentialities of each country with respect to material and financial resources. This is to be supplemented by spreading awareness of gradual application of the criteria.

Viewing the five domains of the global uniform criteria as an integrated system.

Reducing the number of the criteria to facilitate their application.

Setting the mechanics of developing the preparation of instructors who can appreciate and apply the criteria.

6 The role of IAMU

It is necessary to establish follow-up committees to monitor and assess the performance of the maritime institutes members of the Association. Care should be given to global communication between maritime institutes. Communication skills are based on developing dialogue skills which, in turn, depend on:

Exchange of information and knowledge.

Encouraging innovation.

Encouraging team thinking.

IAMU needs to be prepared to provide a vital link in developing a network of maritime institutes to ensure consistency in global standard. IAMU has a vital role to play in the endeavour to support globalization. This network of branches spanning every continent enhances international cooperation and collaboration effort[9].

IAMU should undertake the task of ensuring that the institutes members of MET have a responsibility to deliver quality courses that meet the required globalization of shipping industry[13].

IAMU has to set up the fundamental requirements of certification of graduates of maritime institutes[14].

We can observe from the progress of the compactation of mixed crewing environment on the majority of the world fleet today and from the international confederation of many shipping companies that the globalization of the shipping industry is more speedily developing than other industries. So, I believe that we are in era of globalization and rivalry of MET institutes. IAMU is invited to enhance, encourage and develop research within three working group:

Working Group 1: Maritime Education and Training.

Working Group 2: Safety Management System.

Working Group 3: Global Standardization[15].

IAMU members are invited to work in close cooperation with IMO and WMU in developing the worldwide database and databank as an important step towards the harmonization of MET system globally.[6]

7 Conclusion

In the past three decades international shipping under welled radical changes and the global era started in the last decade. Globalization is a natural outcome of process of development. Globalization of shipping industry has a direct impact on the competition for quality in MET. Quality assurance in MET is the path to excellence. The radical changes the concept of education in the present era of globalization could be achieved through developing international criteria for MET and developing mechanism for the implementation of quality standards. It is necessary to establish follow up committees to monitor and assess the performance of maritime institutes members of IAMU.

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Globalization, Cultural Intelligence and Maritime Education

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Abstract While many business leaders and political theorists wrestle with the significance of cultural difference and its impact on transnational relations in the current era of globalization, there is still much work to be done in this field. The concept of Cultural Intelligence (CQ) explores the relevance of cultural intelligence given the increasing globalization of business organizations, and seeks to determine why some individuals are more adept at dealing in situations of cultural diversity than others.

Maritime industries are among the most diverse and global in the world, and as such, elevating cultural intelligence should be a prime goal and objective of maritime academies. At California Maritime, this is accomplished not only through instruction in courses in history, comparative world religions, cultures of globalization, and foreign language study, but also through the experiential opportunity afforded by the Training Ship Golden Bear. This summer, everyone participating in the training cruises was asked to complete a survey designed by the original CQ developers. The compilation of this data will serve to quantify an area of inquiry that by its nature resists easy assessment; furthermore, this data could be used to identify and address shortcomings in maritime education as they pertain to interpersonal dynamics and transcultural knowledge exchanges. Such findings should prove immensely significant in preparing students to adapt to an increasingly globalized workplace.

Keywords cultural intelligence; CQ; cognition; Meta-cognition; maritime education

0 Introduction

Despite its ubiquity in academic and popular usage, the term “globalization” is notoriously elusive and difficult to define. There are as many conceptualizations of globalization as there are disciplines, and these varying conceptualizations are not only often contradictory, they are sometimes incommensurable with each other. Nonetheless, any project that invokes "globalization" as one of its key objects of inquiry must establish some theoretical framework, no matter how contingent that foundation may be. A formulation of globalization useful to this paper comes from the sociologist Jan Nederveen Pieterse: "globalization is an objective empirical process of increasing economic and political connectivity, a subjective process unfolding in consciousness as the collective awareness of growing interconnectedness, and a host of specific globalizing projects that seek to shape global conditions."[1] The operative idea in this explanation is that of "connectivity." Because one of the hallmarks of globalization is its complex connectivity across the planet, it must also be acknowledged that this connectivity extends not just from physical place to place, but, as noted by John Tomlinson, "the complexity of the linkages established by globalization extend to phenomena which have been separated out into the categories which we now break down into human life: the economic, the political, the social, the interpersonal, the technological, the environmental, the cultural. Globalization confounds such taxonomy."[2] In other words, the very "complex connectivity" that characterizes globalization (technological advances in transportation and communication, increased international trade, increased interdependence of countries) also corresponds to the connectivity between previously well-demarcated knowledge regimes and academic disciplines.

Even though the processes of globalization are often theorized and interrogated through their most visible manifestations in the political and economic arenas, we cannot easily separate, say, the political from the social or the cultural from the economic because of the tendrils that connect them all. Many attempt to theorize globalization are flawed, claims Nederveen Pieterse, because "economic, political, cultural, and social dynamics are not simply different facets of a single globalization; rather, they are each prisms through which globalization takes shape and is experienced and mapped differently, yet they all mingle and interpenetrate as well."[3] The recognition of the interpenetration of disciplinary fields provides the springboard for our analysis, for while the purpose of this essay is to examine globalization through the prism of culture (and, obviously, its significance for MET), one cannot easily separate issues of culture from those other structures with which it is indissolubly linked.

That said, the category of "the cultural" has, to some extent, been marginalized and subordinated in discussions of globalization, but it is rapidly emerging as an important field. Many business leaders and political theorists have turned their attention to the problem of cultural difference and its implications for transnational business relations. Several books and articles have been published, web-based programs initiated, and seminars created–all devoted to cross-cultural understanding. The bulk of these projects are directed toward international managers of corporate conglomerates, but the importance of understanding cultural difference has also been recognized as significant in maritime education and training. Maritime industries are among the most diverse and global in the world, and a nascent body of literature is emerging which points to the significance of culture, and cultural differences, in all aspects of maritime operations–from communication between multicultural crews to issues of port security(See especially, Benton, "Multicultural Crews and the Culture of Globalization;" Badawi and Halawa, "Maritime Communication: The Problem of Cross Cultural and Multilingual Crews;" Chaudry, "Cross Cultural Understanding is the Key to New Crewing Challenges;" Weihua, "Maritime English Education in the Context of Globalization;" Dzugan, "Cross Cultural Communication: Implications for Maritime Trainers;" and Erol and Sampson, "Transnational Seafarer

Communities."[4]). The arguments overwhelmingly call for an urgent need to study and assess cross-cultural relationships because (1) the forces of globalization will only move organizations toward greater cultural integration, and (2) confusion brought about through cross-cultural miscommunication has serious implications for ship and port safety.

This work on cultural difference and MET is earnest, well-intentioned, and as the first stage in an evolving field, certainly provides a necessary foundation. However, there is, to our minds, a problem with much of this early work on culture and MET, and this problem is two-fold. First, programs that *only* provide basic knowledge of cultural difference tend to reduce complex cultural negotiations into a laundry list of "do's and don'ts" (i.e., "Japanese behave this way and Americans behave that way"). This may be a useful primer, but such instruction is superficial and may even reproduce some antiquated cultural stereotypes. Also, such guides are usually only bilateral–situating one cultural group against another–and neglect to provide for circumstances when there may be several different cultural groups involved. Not only are 80% of the world's merchant ships multi-ethnic in crew composition,[5] but one in ten ships operates with crews composed of five or more nationalities.[6] Therefore a more multilateral, systematic approach is needed to accommodate this multiplicity.

Second, too often the pedagogical methodologies used to teach cross-cultural negotiations remain unrigorous, and often amount to no more than exposure to cultural differences coupled with simplistic entreaties to "tolerate difference." Such instruction is obviously well-intentioned and even necessary, but it doesn't provide meaningful, lasting skill sets, and in worst case scenarios such programs may promote an atmosphere of ethnocentric cultural superiority–certainly the very opposite effect of what is intended.

Into this arena, then, emerges a new theory within management and organizational psychology called Cultural Intelligence, or CQ. Various terms, including "intercultural competence," "global mindset," and "global competencies" had been in use for a number of years, but the definition of CQ as a special type of intelligence can be attributed to Christopher Early in his 2002 article in *Research in Organizational Behavior* and his Stanford University Press text of 2003.[7] Later developed and refined by a consortium of professors from the U.S., the U.K, and Asia, Cultural Intelligence seeks to systematically evaluate an individual's capability to deal with people of different cultures. While most people are familiar with IQ–the measure of the ability to reason–and perhaps also EQ–a measure of one's "emotional intelligence"–CQ is "a new idea that builds on these earlier concepts, while incorporating the capability to interact effectively across cultures."[8]

Because CQ researchers' key objective is to address the problem of why people fail to adjust to and understand new cultures, their work is rapidly gaining acceptance in the international business community. Obviously CQ projects are designed with transnational economic relationships in mind: academics across the globe work in conjunction with corporations to build and solidify trade relationships and to streamline the efficacy of capitalism in the globalized arena. However, the theory of CQ has been appropriated by other institutional apparatuses as well: most notably the United States Marine Corps' Small Wars Center for Excellence, which now administers CQ texts to prospective candidates.[9]

In 2004, Professor Soon Ang from the Nanyang Business School of Singapore presented a detailed paper on the measurement of cultural intelligence. CQ, in this context, is a multi-faceted construct with mental (both cognitive and meta-cognitive), motivational, and behavioral components. A brief description of each component follows.

1 The quotient of cultural intelligence

"Culture Intelligence," the authors note, differs from "existing formulas of intelligence such as emotional intelligence and social intelligence because it focuses specifically on capabilities that are relevant to settings and interactions characterized by cultural diversity."[10] The first of factors to measured, "meta-cognition," is an awareness of the process of learning which leads to information processing at a deeper level. Those with greater meta-cognitive capabilities "learn and perform more effectively because they monitor their progress, determine when they are having problems, and adjust their behavior accordingly."[11] Meta-cognitive CQ, therefore, refers to an individual's *cultural* consciousness and awareness during interactions with those who have different cultural backgrounds: "being high in meta-cognitive cultural intelligence should cause individuals to consciously question cultural assumptions, think about culture and cultural assumptions or norms before and during interactions with others, plus check and adjust their mental models based on interactions with those from other cultures."[12]

While meta-cognition focuses on higher-order cognitive processes, the second category in this assessment program–"cognition"–focuses on knowledge acquired from education and experience. To return to Ang, "when individuals are knowledgeable and skilled in a specific area, their knowledge structures are rich, complex, and well-organized. Cognitive CQ is an individual's knowledge of specific norms, practices, and conventions in different cultural settings. This includes knowledge of cultural universals as well as cultural differences. Cultural knowledge includes knowledge of the economic, legal, and social systems in other cultures. Cognitive CQ should allow individuals to assess similarities and differences across cultural situations in ways that enhance their performance in culturally relevant ways."[13]

In the third category, "motivational CQ," an individual's drive and interest in learning about and functioning in situations characterized by cultural differences are evaluated. Again, according to the Center for Cultural Intelligence, "those with high motivational CQ should be confident about their ability to engage in cross-cultural interactions and should experience intrinsic satisfaction from being in culturally diverse settings. When people are curious about other cultures, they are more attentive to similarities and differences. They are willing to ask questions, expose themselves to novel situations, and try new things even when signals are confusing and things don't quite make sense."[14]

The final component of CQ assesses individual behavior, particularly in regards to flexibility in one's ability to adjust verbal and non-verbal actions in response to specific characteristics of a given situation, and thus "behavioral CQ' measures an individual's capacity for adjusting to culturally diverse situations by picking up subtle cultural signals from others and making adjustments to talk with people from other cultures in an easy and relaxed manner.[15]

2 Application of cultural intelligence to MET

After extensive research and consultation with academics and international executives with cross-cultural expertise, Ang and her associates devised a twenty item, four factor cultural intelligence scale [See Appendix A]. Distilled from a much larger pool of questions, the twenty items of the scale comprehensively yet efficiently measure cultural intelligence via the aforementioned categories: meta-cognition, cognition, motivation, and behavior. In the summer of 2006, this Cultural Intelligence Scale was distributed to cadets from the California Maritime Academy who would be participating in exercises aboard the Training Ship Golden Bear. Cal Maritime conducts two cruises per summer, and the CQ Survey was distributed twice per cruise–one immediately after the ship departed, and once just prior to its return. During the cruise, four port stops totaling sixteen days were made, and shipboard classroom instruction in cultural awareness complemented these stops. Using the matrix provided by the Center for Cultural Intelligence, it was our desire to see if the experiential learning opportunities available on cruise had a positive impact on cultural intelligence. The following results–hampered somewhat by a smaller than expected sample–are taken from the first cruise only, because as of this time, data has not yet been received from the second cruise [See Appendix 2].

It was found that for Part One (the evaluation of meta-cognitive CQ), post-cruise cadets scored themselves significantly higher in assessing their consciousness of cultural knowledge in cross-cultural interactions. An aggregate score of 33.3% of cadets ranked themselves as "strongly agreeing" with the statements regarding their high level of meta-cognitive act before cruise, whereas post-cruise scores averaged 51.6%. In the section evaluating Behavioral CQ, initial pre-cruise aggregate scores for the highest level averaged 34.7% and post-cruise scores for the same category measured 43.4%. An even more dramatic increase was found for motivational CQ: pre-cruise numbers (using the same formula as above) measured 12.6% and post cruise numbers more than doubled to 26.6%.

In all these categories, a higher level of cultural intelligence was registered after participating in international exercises through ports of call. Interestingly, the one category that did not conform to expectations was cognitive CQ. Only 4.3 % of students before cruise felt strongly that, for example, they knew the legal and economic systems of other cultures, or that they knew the religious beliefs of other cultures. This number dropped precipitously to only 1.1% on the post-cruise aggregate high score. This decrease reverses predictions, and thus merits further attention.

To review, this category simply measures cognition–discrete, graspable knowledge units–that should be relatively easy to transmit in a traditional classroom environment, either on the ship or on campus prior to cruise. Those of us who teach in the humanities and social sciences–especially those whose courses cover political, economic, and cultural ramifications of globalization–should pay particular attention to these egregiously low scores.

However, on a more optimistic note, there may be a way to reconcile the increase in meta-cognitive CQ with this decrease in actual CQ cognition. There is an inverse relationship between the two categories: the more students are aware of their own capacity to think cross-culturally (meta-cognitive CQ), the more they may come to understand they know less about a foreign culture than they originally perceived. In sum, it is a classic example of discovering "the more you learn, the more you realize how little you know."

3 Future directions for CQ and MET

We believe the results of this first foray into measuring the cultural intelligence of maritime cadets is promising, and that future testing and assessment can only have positive outcomes in developing particular curricula devoted to cross-cultural problems. There are also, however, some adjustments to be made, and cautionary notes to strike.

First, much of the work at the Cultural Intelligence Center is designed to select, train, and develop a more culturally-intelligent workforce and therefore CQ has immediate practical application for "human resource professionals, assessment centers, international consulting firms [and] expatriate adjustment education centers."[16] Furthermore, the CIC proponents add: "The CQ scale could also be used to screen out those who are proficient in domestic settings but unlikely to succeed in cross-cultural settings or in jobs that require frequent interaction with those who have other cultural backgrounds."[17] Certainly this is not the intention of administering CQ tests at maritime universities: to "screen" potential mariners for industry positions based on their cultural intelligence. However–and this is a crucial point to make–if more and more industries choose to include a CQ test as part of the application process, we want to insure our graduates do as well as possible. This could be accomplished because CQ, unlike other IQ tests (and EQ tests that measure stable personality traits), is "a malleable state that may change based on cultural exposure, training, modeling, mentoring, socialization, and other experiences."[18] Cultural intelligence is not an innate sensibility, but rather a set of psycho-social and mental strategies. Because these are strategies, not instincts, they can be taught, and therefore learned.

Second, in regard to the data gleaned from the Cal Maritime survey, we are not so naïve as to assume just that a few weeks in foreign port cities spread out over one summer in and of itself elevate CQ. Rather, the cruise and port experiences should be viewed as part of a larger curriculum issue–one that sees the importance of culture as a significant challenge in the era of globalization and which can be met through the introduction and maintenance of instruction in world religions, globalization and culture, world history, and any other number of interdisciplinary perspectives on the issue.

Future work in this field could also be directed toward a more sophisticated collection and interpretation of data. A statistician trained in the behavioral sciences could run a much deeper analysis of the numbers than we have presented here. Also, the CQ test could be gauged by different factors: are third-year students more culturally intelligent that first year students? How might breakdowns by different majors look like? Do CQ results change depending on the cruise schedule and ports of call? Should the 20 point, four factor survey be altered? (There is an alternative, 54 point survey now available.) Is there a way to tailor the CQ test specifically for maritime purposes? These questions and many more will provide the basis for further research and advances.

4 Conclusion

Globalization is a multidimensional process, which, like all significant social processes, unfolds in multiple realms of existence simultaneously. Therefore globalization has created the conditions in which issues of cross-cultural communication impact many other aspects of trade and transportation. Tests, surveys, questionnaires, and other evaluative tools that purport to measure cultural intelligence are becoming more sophisticated, more elaborate, and are increasingly being used across a wider strata of public and private sectors. Those of us who work in maritime education and training need to monitor and adopt these tools to our own use without compromising the missions of our individual universities. Elevating cultural intelligence should prove immensely significant in preparing students to survive and thrive in an increasingly globalized workplace.

Appendix 1

The 20 Item Four Factor Cultural Intelligence Scale.

Read each statement and select the response that best describes your capabilities.

Select the answer that BEST describes you AS YOU REALLY ARE (1=strongly disagree;

5=strongly agree)

CQ Factor	Questionnaire Items
Meta-cognitive CQ:	
MC1	I am conscious of the cultural knowledge I use when interacting with people with different cultural backgrounds.
MC2	I am conscious of the cultural knowledge I apply to cross-cultural interactions.
MC3	I adjust my cultural knowledge as I interact with people from a culture that is unfamiliar to me.
MC4	I check the accuracy of my cultural knowledge as I interact with people from different cultures.
Cognitive CQ	
COG1	I know the legal and economic systems of other cultures.
COG2	I know the religious beliefs of other cultures.
COG3	I know the marriage systems of other cultures.
COG4	I know the arts and crafts of other cultures.
COG5	I know the rules (e.g., grammar) of other languages.
COG6	I know the rules for expressing non-verbal behaviors in other cultures.
Motivational CQ	
MOT1	I enjoy interacting with people from different cultures.
MOT2	I enjoy living in cultures that are unfamiliar to me.
MOT3	I am confident that I can socialize with locals in a culture that is unfamiliar to me.
MOT4	I am confident that I can get accustomed to the shopping conditions in a different culture.
MOT5	I am sure I can deal with the stresses of adjusting to a culture that is new to me.
Behavioral CQ	
BEH1	I change my verbal behavior (e.g., accent, tone) when a cross-cultural interaction requires it.
BEH2	I change my non-verbal behavior when a cross-cultural situation requires it.
BEH3	I use pause and silence differently to suit different cross-cultural situations.
BEH4	I vary the rate of my speaking when a cross-cultural situation requires it.
BEH5	I alter my facial expressions when a cross-cultural interaction requires it.

Resource from Cultural Intelligence Center, 2004.

California Maritime

CQ Survey

Golden Bear, First Cruise, 2006

Section One: Meta-Cognitive CQ

(MC1) I am conscious of the cultural knowledge I use when interacting with people with different cultural backgrounds

	1	2	3	4	5
Pre-Cruise %	3.7	3.7	40.7	22.2	29.6
Post-Cruise %	0.0	0.0	13.3	40.0	46.6
% Change	-3.7	-3.7	-27.4	17.8	17.0

(MC2) I am conscious of the cultural knowledge I apply to cross-cultural interactions.

	1	2	3	4	5
Pre-Cruise %	7.4	0.0	44.4	29.6	18.5
Post-Cruise %	0.0	6.6	13.3	26.6	53.3
% Change	-7.4	6.6	-31.1	-3.0	34.8

(MC3) I adjust my cultural knowledge as I interact with people from a culture that is unfamiliar to me

	1	2	3	4	5
Pre-Cruise %	3.7	3.7	18.5	33.3	40.7
Post-Cruise %	0.0	0.0	13.3	26.6	60.0
% Change	-3.7	-3.7	-5.2	-6.7	19.3

(MC4) I check the accuracy of my cultural knowledge as I interact with people from different cultures

	1	2	3	4	5
Pre-Cruise %	7.4	11.1	22.2	25.9	33.3
Post-Cruise %	0.0	6.6	13.3	33.3	46.6
% Change	-7.4	-4.5	-8.9	7.4	13.3

Section Two: Cognitive CQ

(COG1) I know the legal and economic systems of other cultures

	1	2	3	4	5
Pre-Cruise %	22.2	25.9	25.9	14.8	7.4
Post-Cruise %	0.0	46.6	40.0	13.3	0.0
% Change	-22.2	20.7	14.1	-1.5	-7.4

(COG2) I know the religious beliefs of other cultures

	1	2	3	4	5
Pre-Cruise %	7.4	37.0	29.6	18.5	11.1
Post-Cruise %	0.0	20.0	66.6	13.3	0.0
% Change	-7.4	-17.0	37.0	-5.2	-11.1

(COG3) I know the marriage systems of other cultures

	1	2	3	4	5
Pre-Cruise %	37.0	18.5	33.3	11.1	3.7
Post-Cruise %	6.6	40.0	40.0	13.3	0.0
% Change	-30.4	-21.5	6.7	2.2	-3.7

(COG4) I know the arts and crafts of other cultures

	1	2	3	4	5
Pre-Cruise %	14.8	29.6	44.8	14.8	0.0
Post-Cruise %	6.6	20.0	40.0	26.6	0.0
% Change	-8.29	-9.6	-4.8	11.8	0.0

(COG5) I know the rules (e.g., grammar) of other languages

	1	2	3	4	5
Pre-Cruise %	40.7	29.6	25.9	3.7	3.7
Post-Cruise %	6.6	46.6	40.0	6.6	0.0
% Change	-34.1	17.0	14.1	2.9	-3.7

(COG6) I know the rules for expressing non-verbal behaviors in other cultures

	1	2	3	4	5
Pre-Cruise %	29.6	37.0	22.2	14.8	0.0
Post-Cruise %	13.3	13.3	46.6	20.0	6.6
% Change	-16.3	-23.7	24.4	5.2	6.6

Section Three: Motivational CQ

(MOT1)I enjoy interacting with people from different cultures

	1	2	3	4	5
Pre-Cruise %	7.4	3.7	14.8	22.2	51.8
Post-Cruise %	0.0	0.0	13.3	20.0	66.6
% Change	-7.4	-3.7	-1.5	-2.2	14.8

(MOT2) I enjoy living in cultures that are unfamiliar to me

	1	2	3	4	5
Pre-Cruise %	11.1	11.1	18.5	33.3	25.9
Post-Cruise %	0.0	6.6	26.6	26.6	40.0

% Change	-11.1	-4.5	8.1	-6.7	14.1

(MOT3) I am confident that I can socialize with locals in a culture that is unfamiliar to me

	1	2	3	4	5
Pre-Cruise %	0.0	7.4	33.3	37.0	22.2
Post-Cruise %	0.0	6.6	20.0	33.3	4.0
% Change	0.0	-.8	-10.3	-3.7	-18.2

(MOT4) I am confident that I can get accustomed to the shopping conditions in a different culture

	1	2	3	4	5
Pre-Cruise %	0.0	11.1	11.1	44.4	33.3
Post-Cruise %	0.0	0.0	6.6	33.3	60.0
% Change	0.0	-11.1	-4.5	-11.1	26.7

(MOT5) I am sure I can deal with the stresses of adjusting to a culture that is new to me

	1	2	3	4	5
Pre-Cruise %	3.7	3.7	14.8	37.0	40.7
Post-Cruise %	0.0	0.0	0.0	53.3	46.6
% Change	-3.7	-3.7	-14.8	16.3	5.9

Section Four: Behavioral CQ

(BEH1) I change my verbal behavior (e.g., accent, tone) when a cross-cultural interaction requires it

	1	2	3	4	5
Pre-Cruise %	11.1	7.4	37.0	33.3	11.1
Post-Cruise %	6.6	6.6	6.6	33.3	40.0
% Change	-4.5	-.8	-30.4	0.0	-28.9

(BEH2) I change my non-verbal behavior when a cross-cultural situation requires it

	1	2	3	4	5
Pre-Cruise %	7.4	0.0	33.3	40.7	14.8
Post-Cruise %	6.6	6.6	13.3	33.3	33.3
% Change	-.8	6.6	-20.0	-7.4	18.5

(BEH3) I use pause and silence differently to suit different cross-cultural situations

	1	2	3	4	5

Pre-Cruise %	11.1	11.1	37.0	29.6	11.1
Post-Cruise %	0.0	13.3	33.3	33.3	20.0
% Change	-11.1	2.2	-3.7	3.7	8.9

(BEH4) I vary the rate of my speaking when a cross-cultural situation requires it

	1	2	3	4	5
Pre-Cruise %	3.7	14.8	37.0	25.9	18.5
Post-Cruise %	0.0	20.0	13.3	46.6	20.0
% Change	-3.7	5.2	-23.7	-20.7	1.5

(BEH5) I alter my facial expressions when a cross-cultural interaction requires it

	1	2	3	4	5
Pre-Cruise %	7.4	11.1	44.4	29.6	7.4
Post-Cruise %	13.3	6.6	20.0	40.0	20.0
% Change	5.9	-4.5	-24.4	10.4	12.6

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Maritime Business: An Analysis of Market Developments and Trends

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Abstract According to contemporary market analysts and experts, maritime business is dying and it lacks the luster of the high flying business sectors such as information technology or biotech. Shipowners based in most developed nations have been gradually reducing their shipping investment and pursuing other more lucrative ventures. However, market developments during the recent few years appear to have raised the profile of the shipping sector once again, and skeptics are left pondering whether or not there has been a paradigm shift in the industry's financial fortunes. The paper provides a summary of recent market developments globally as well as in the U.S., the world's largest single-nation consumer market. It also analyzes the current market conditions and provides an outlook for the future.

Keywords maritime business; market trends; market analysis; shipping markets; shipbuilding; global issues in shipping

0 Introduction

A year ago, the maritime sector was euphoric with spectacular market conditions prevailing in every related sector. It was the best year in many decades with all three major shipping markets, viz., the tanker market, the liner market, and the bulk market reaching concurrent highs and every major shipyard in the world being fully booked for the next three years. Many observers and analysts predicted that such conditions would not last and that the cyclical conditions would return with a vengeance. While the cyclical nature of shipping markets was never in question, what was uncertain was how precipitous would the market decline be after the 2004 historic highs. Despite some extraordinarily calamitous events, the year 2005 has proved to be yet another glorious year for the maritime industry. One could even surmise that had it not been for its immediate predecessor, 2005 would have been referred to as one of the finest years in recent memory for the industry. Although the market has peaked in most sectors, the relative declines could not have been more comforting.

There were a number of major maritime developments during the year. Internationally, these include the ongoing dominance of the Chinese economy living up to its sheet anchor role for the shipping industry and the evolving true globalization of the maritime sector. Asian companies once again led the charge in the ongoing international maritime rejuvenation. Interestingly, the rising tide lifted all boats in the harbor with the ensuing enthusiasm and optimism spreading to the usually nonchalant U.S. domestic market, and American maritime interests making some truly stellar moves. Although the 2004 Boxing Day tsunami was unmatched in 2005 in terms of sheer number of people killed, the death and destruction caused by the most active hurricane season in North America, in particular the devastation of the port city of New Orleans, provided absorbing human drama. A political storm over the proposed Dubai Ports World acquisition of P&O Ports' assets in the U.S. gave unparalleled attention for the sector in February 2006. These and other major developments are discussed next.

1 Market developments

It is estimated that Asia is responsible for 50 percent of world GDP growth currently. The liberalization of global trade and China's entry into the World Trade Organization have released a flurry of trade activities that have been responsible for the prolonged exceptionally good market conditions in the shipping industry. One could argue that innovations in the shipping industry have greatly lowered the landed cost of goods in target markets thereby directly facilitating globalization. The interdependency between global commerce and the merchant marine sector has never been so transparent as today.

The ongoing Chinese economic growth and its increasing trade surplus were the most important drivers of another solid year of excellent shipping market performance. China posted a global trade surplus of $102 billion in 2005, and has now become the world's third largest trading nation. The U.S. trade deficit with China has increased from $28 billion in 2001 to $114.7 billion in 2005 according to Chinese statistics which most analysts believe is severely underreported. Interestingly, if trade with the U.S. is excluded from these statistics, China has a trade deficit with the rest of the world.

1.1 Dry bulk market

The supply of dry bulk tonnage grew at a faster rate in 2005 compared to its demand, resulting in a decrease in capacity utilization. The Norwegian shipbroker R.S. Platou estimated a 3% reduction in capacity utilization from 97% in 2004 to a very respectable 94 percent in 2005. Accordingly, the 2005 average freight rates have dropped by as much as a third compared to the 2004 rates. It is however noteworthy that the 2005 rates were still far higher than those in 2003, once again highlighting the anomalous 2004 rates.

1.2 Liquid bulk market

The market for oil tankers is considered highly volatile and difficult to predict because of the highly complex variables involved. This was very evident in 2005, sending mixed messages to investors and analysts alike. The market for crude tankers did not match the record highs set in 2004 and the capacity utilization level dropped to 88.5% in 2005. Although world oil production and trade increased, the demand for tanker tonnage was tempered by unanticipated conditions such as a significant decline in demand for oil imports in China, stagnation at the non-OPEC oil production sources, hurricane-related delays in the U.S. Gulf, and strikes and delays at various ports. Despite all these, the average 2005 rates were significantly better than those in 2003, with a modern VLCC averaging $55,000 per day, more than doubling their $27,000 per day level established in the 1990s. In November 2005, VLCCs reported their highest earnings for the year on the route from Persian Gulf to South Korea, earning $100,880 per day on the 39-day round trip. It has been reported that Frontline, the world's largest VLCC owner, requires less than $28,000 per day to break-even. Royal Dutch Shell PLC was the leading charterer of oil tankers in 2005, hiring 762 crude oil tankers, constituting 7.5% of the world total. BP PLC was the second largest with 4.9 percent of the world total. The present cost of delivering a barrel of oil to the U.S. from the Persian Gulf is about $4. The LNG market which received considerable attention last year was relatively dull with low demand growth (6%) and high supply of new tonnage (14%). This resulted in lower tonnage utilization and also low spot market rates for LNG tankers in 2005.

1.3 Liner market

This was a comforting year for the liner sector for many reasons although their operating costs continued to increase. Port congestion that plagued container operations in many European and North American ports in 2004 was not an issue in 2005. The world container trade grew at a slightly faster rate than the rate of capacity growth in the sector. This led to increasing capacity utilization as well as rising overall charter hires for container ships. Accordingly, the freight rates went up in all arterial trade routes except the trans-Pacific trade where they went down marginally.

Liner operators are faced with increasing operating costs resulting from the high bunker prices as well as the increased costs of vessel chartering and cargo security. Voyage cost per TEU has reportedly gone up by as much as 25%. It costs $900 million a year to operate a fleet of five 8,200 TEU ships in a weekly trans-Pacific service today. A large number of new container ships are to be delivered in 2006 which will lower the tonnage utilization as well as the average freight rates. In general, with the anticipated drop in freight rates, carriers are positioning themselves to lower their costs and also aggressively pursue more remunerative cargoes.

1.4 Cruise shipping market

This is one market that continued its upward trend in 2005 unlike the others. Increased earnings through higher ticket prices, onboard activities and higher occupancy rates have more than exceeded the rise in cruise operating costs. 11.2 million North American passengers cruised in 2005, a 4.5% increase from the previous year. Carnival Cruise Lines (CCL), the market leader, increased its 2005 profits by 21% to $2.3 billion on revenues of $11.1 billion. This is despite the increase in fuel costs and a particularly bad North Atlantic hurricane season. Recent statistics from the International Council of Cruise Lines indicate that the cruise sector contributed more than $30 billion into the U.S. economy in 2004, supporting 316,000 jobs and $12.4 billion in wages and salaries.

Royal Caribbean International (RCI), the second largest cruise operator has placed an order for the world's biggest cruise ship with a Norwegian shipbuilder. The ship, capable of carrying 6,400 passengers, is expected to cost $1.24 billion and be ready by late 2009. Meanwhile, RCI will soon start operating *Freedom of the Seas* which will temporarily take over the title as the world's biggest passenger ship from Cunard Line's *Queen Mary 2. Freedom of the Seas* will accommodate 3,634 passengers and will have a crew of 1,400. As of now, there are 28 large cruise vessels under construction, averaging half a billion dollar in construction cost. At current exchange rates, the total cruise ship orders are valued at around $16 billion. Thus we are entering a new era in this segment, with increasing ship sizes and an unbelievable array of on board conveniences and spectacular attractions. What is not clear is whether the market is ready for such ships. There are not many ports which can accommodate such big ships and handle the large volume passenger logistics. Passengers may end up spending considerable vacation time to embark or disembark these huge ships, especially given the current security concerns.

One issue of great concern to the cruise operators was the proposed new U.S. requirement with effect from January 2006 that its citizens should possess a passport while returning back from the Caribbean, Bermuda, and Central/South America. Only one in five Americans has a valid passport. The government has revised its plans after serious lobbying by cruise interests and will introduce a new ID card for this purpose which will cost far less than getting a new passport. Another area of concern for the industry is the media attention paid to unsolved deaths aboard cruise ships. A recent study estimated that more than 50 people have gone overboard from cruise ships during the last decade.

There is a completely new offshoot of the cruise sector that is now mushrooming. Cala Corporation, a Houston-based company has begun marketing shipboard condominiums located above and below sea level. Ships with 320 condominiums priced between $2.5-8 million will be placed in key ports such as Miami-Dade and Cancun, Mexico. Each ship will have 250 residences above sea level, 20 at sea level and 50 undersea with aquarium views. At least three ships are being planned and additional sites in the U.S. and abroad are under consideration. Other players in this market include Four Seasons, the Residential Cruise Line, and the World of ResidenSea.

1.5 Shipbuilding market

The fast growing world economy and increasing trade volumes created unprecedented demand for new tonnage as discussed in the 2004 Annual Review. With all major yards being fully booked for the next three years, an escalation of costs was only to be expected. The price for new tonnage peaked in mid 2005 and is now on a gradual downward trend. Shipyards responded to the buoyant market conditions in different ways such as through reactivation of idle capacity and building new yards as well as through outsourcing part of the construction to lower cost building locations. The South Korean shipyards continue to be most aggressive, increasing their market share to 38% in 2005. China is making strong gains on the second placed Japan and is expected to surpass even the Korean builders within the next 10 years. The country has close to 600 shipyards most of which are state-owned. They typically price their new ships at about 10% less than their competitors' and are building a reputation for flexibility in accommodating customer needs. Japanese ship owners have more orders for new ships than any other nationality. Despite seemingly excellent market conditions, the shipyards' financial returns have not improved significantly from 2004. The ships being delivered now are those contracted in 2002 or 2003 whereas the current market price of steel and other inputs have escalated significantly in addition to adverse exchange rate fluctuations. The Korean and Japanese yards are becoming more selective with their new contracts.

1.6 Ship demolition market

Ship demolition prices are dictated by the market price for steel. The current high price of steel has increased the price for scrap iron globally. However, given the exceptionally good prevailing market conditions, there is very little tonnage being scraped today. Only one-half of the tonnage scrapped in 2004 was scrapped in 2005. Bangladesh was the most active market for ship demolition in 2005 followed by India. Clemenceau, a decommissioned French aircraft carrier, gained international attention in 2005 for all the wrong reasons. The ship was sold to a breaker in Alang, India without decontaminating its high asbestos content. This resulted in worldwide condemnation led by the Greenpeace. The ship which had been towed all the way to India through the Suez Canal was ultimately ordered to be brought back by President Chirac at a cost of Euro 3.5 million to the French taxpayers.

2 The U.S. Merchant marine

2005 will go down as a remarkably good year in the history of the U.S. Merchant Marine. Even though the year's major developments are unlikely to reverse the decline of the nation's merchant marine let alone restore the preeminence of a bygone era, they did bring an iota of optimism in American shipping and shipbuilding sectors that had been missing for a number of years. Nonetheless, Wall Street's new found enthusiasm for shipping IPOs waned significantly in 2005 that led to some companies cutting their price and scaling back their offer. There was also the usual mix of intrigue, controversies, and a few indictments to add flavor to the mix of events.

The contributions of the maritime sector to the local and national economy were strongly documented in an independent economic impact study of port operations in New York and New Jersey. The study found that the bi-port activities supported 232,910 full-time jobs in the region and $12.6 billion in salaries in 2004. The port activities generated $5.8 billion in local, state, and federal tax revenues of which $2 billion remained in the region. The most significant direct job growth occurred in container, cruise passenger, and auto handling operations.

3 The Jones Act scenario

The Jones Act requirements of U.S.-built, owned, and staffed ships for domestic cargo movements gained considerable attention in 2005. President Bush temporarily relaxed those restrictions in the wake of the devastation caused by hurricane Katrina, allowing foreign-flag tankers to distribute oil and gasoline where needed. This benefited European tanker owners primarily. However, their (and other trading partners') antagonism toward the Jones Act picked up further steam in 2005 with many of them referring the issue to the WTO for its scrutiny. There is also a demand in Guam political circles to end the Jones Act because of its impact on their freight costs.

The high cost of commercial shipbuilding in the U.S. has resulted in most Jones Act ship owners opting to prolong the life of their ships rather than replacing them with new ones. About a hundred of the Jones Act tankers will soon reach the end of their operating life because of the single hull phase out provisions of OPA 1990. Unlike the international tanker market which is highly volatile and difficult, the Jones Act tanker trade is relatively stable. The Jones Act product tanker market is estimated to be worth about $550 million and growing at 2% per annum. Overseas Shipholding

Group (OSG), a U.S. based tanker operator with significant international presence, has made this the cornerstone of their strategy in the U.S. tanker market. They placed orders with the Aker shipyard in Philadelphia, a decommissioned Navy shipyard transferred for commercial operations in 1997, to build ten 46,000dwt product tankers by 2010, with options for two more. The shipyard established a separate company, Aker American Shipping ASA that will own the yard as well as the ships. The parent company's equity issue of $120 million in Norway to secure the start up finance was oversubscribed four times. The rest of the financing will be provided by Norwegian banks. OSG will bareboat charter the ships from Aker American Shipping ASA. The overall project is priced at more than $1 billion, and each ship priced at the $80-85 million range. The yard will build roughly three ships a year, and also benefit from the learning curve thereby bringing down their cost and making a profit when the project is completed. OSG expects all 10 ships to be under charter agreement by end 2006 and are likely to order even more ships from Aker. With this masterful strategy, OSG will double its Jones Act fleet capacity which now includes two Panamax tankers, four handysize tankers, two dry bulk carriers and a car carrier. OSG was involved in about $3.5 billion worth major financial transactions in its worldwide operations in 2005.

Horizon Lines, the largest Jones Act carrier, successfully completed its IPO in September 2005. The company is planning to pay down its debts and grow through acquisitions in the near future. The carrier is planning to update its fleet and increase business in Alaska, Guam, Hawaii, and Puerto Rico. Horizon is also exploring short sea shipping options along the east coast. Matson, another traditional Jones Act carrier, has launched a China-U.S. service. Their proposed business model is to carry Chinese exports to the West coast, followed by westbound cargo to Hawaii and then empties from there to China. The likely success of this cross subsidization move is yet to be proven.

4 Title XI loan guarantee program

The Title XI Loan Guarantee program gives U.S. shipowners and builders longer term loans at interest rates lower than the commercial lending rate. The program was more than $300 million in default since 2000, bulk of that coming from the bankruptcy of cruise ship operator American Classic Voyages in 2001. This has led to the program being characterized as corporate welfare and subject to severe GAO scrutiny. In 2003, the GAO recommended that no new funds be allocated to the program until the U.S. Maritime Administration (Marad) had tightened its oversight of the loan portfolio. Thus a departmental credit committee was established in 2004 to review Title XI and other DoT lending programs. There is a perception in the industry that the committee is blatantly hostile to Title XI as evidenced by its proposed 2007 rule changes and that the proposed 2007 budget will effectively terminate the program.

5 The katrina controversy

FEMA's $236 million six month contract with Carnival Cruise Lines (CCL) to provide three of their ships (the Ecstasy, Sensation, and Holiday) in the Mississippi River and Mobile Bay elicited controversial comments from both sides of the political aisle. It was alleged that CCL was charging the government $1,275 per week assuming full occupation compared to $599 a passenger would pay in the commercial market. Antagonists view this as a grossly overpriced sweetheart deal whereas CCL argues that it would barely break even monetarily. The deal has come under special scrutiny, especially the company's tax status which is being investigated by congressional investigators. CCL, headquartered in Miami, is incorporated in Panama which gave them a tax liability of $3 million for the $1.9 billion in pre-tax income made in 2004 rather than the $475 million they would have had to pay had they been incorporated in the U.S..

6 Legal problems

The legal problems of ILA and its alleged mob connections worsened in 2005. A one time heir apparent to the ILA President and a long time president of ILA Local 1235 in Newark, NJ pleaded guilty to steering contracts of the ILA-Management benefit program to companies controlled by the Genovese crime family. As per the consent decree, he resigned from his union responsibilities. Others involved in the case include ILA's assistant general organizer and president of the union's NY-NJ maintenance local, international vice president for Miami, and an alleged Genovese crime family capo on bail. The latter three were acquitted of the alleged wire and mail fraud conspiracy. The crime family capo disappeared during the middle of the federal trial in early October and his dead body was later discovered in the trunk of a car parked behind a NJ diner in late November. Apart from these, in mid 2005, federal prosecutors filed a civil racketeering lawsuit accusing the ILA of being a mob-controlled organization under RICO (Racketeer Influenced and Corrupt Organizations) Act. The lawsuit would impose trusteeship on the ILA and its benefits programs, and require new elections under the supervision of a court appointed officer. All six top officials of ILA were named as defendants under the charge. The ILA denied all charges vehemently.

Another union leader that ran afoul of the law was the president of the American Maritime Officers (AMO) Union which represents merchant marine officers aboard U.S.-flag ships. The 13 count federal indictment against the AMO president, his brother, and two other union officials include charges of racketeering, embezzlement, fraud, and witness tampering. Two former executives of Stelmar, a tanker operator acquired by OSG in 2005 violated the Sarbanes Oxley Act provisions. They gave each other interest-free loan from Stelmar funds prior to its sale which they claimed were perfectly legal.

7 Pollution penalties

The crackdown on those violating the pollution rules in U.S. waters was particularly strong in 2005. Seven criminal cases were successfully prosecuted in 2005 compared to 23 of them between 1995 and 2004. It is reported that a new investigation is being launched every 2-3 weeks with more than a quarter of those being initiated by whistleblowers. In extreme cases such as repeat violation, the operator would be banned from U.S. waters. In an incident in Massachusetts, MSC Ship Management (Hong Kong) Limited pleaded guilty to charges that it engaged in conspiracy, obstruction of justice, destruction of evidence, false statements, and violated the Act to Prevent Pollution from Ships, and was fined $10.5 million. They will also be on probation for five years and must operate under the terms of a government approved Environmental Compliance Plan during this period. The ship's two senior engineers also pleaded guilty and will be sentenced in 2006. In an almost identical case in New Jersey, a chief engineer was sentenced to imprisonment for one year and one day, and three years of probation. The Operations Manager of the Fishers Island Ferry in Connecticut was sentenced to spend 30 days in jail and pay a fine of $10,000 for dumping untreated sludge into the Connecticut's Thames River and Long Island Sound. Meanwhile, 17 years after the Exxon Valdez incident, the $5 billion judgment against Exxon went to the federal court of appeals in early February 2006.

8 Port congestion problems

Port congestion, a major problem last year was not an issue at all in 2005. PierPASS, a non-profit company that began operations in 2005 summer, appears to have assisted in relieving Southern California's congestion problems. The program aims to reduce trucking movements during normal daylight hours by imposing a penalty of $40 per container, paid by the beneficial cargo owner. Off-peak container movements are thus encouraged from 6 p.m. to 3 a.m. on Mondays through Thursdays, and 8 a.m. to 6 p.m. on Saturdays. Its success is however dependent on truck drivers' willingness to work at night and has not been implemented in any other port region to date.

9 Global issues

9.1 Seafarers

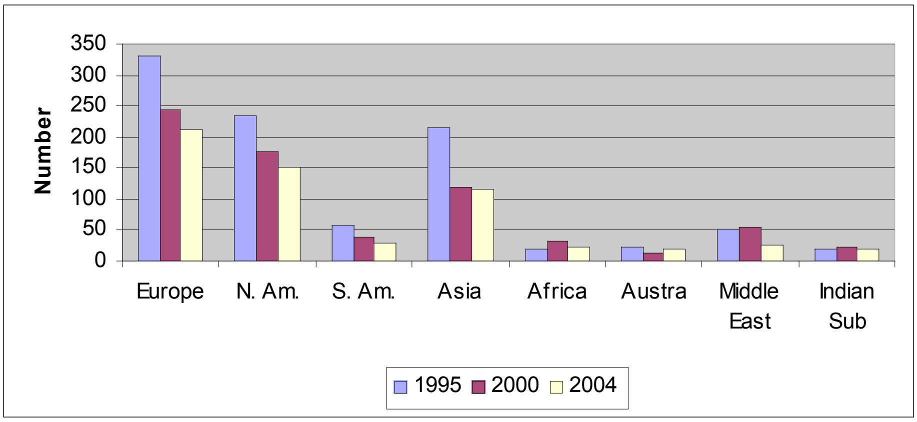
The 4th BIMCO/ISF manpower study found a shortage of 10,000 qualified merchant marine officers and a surplus of 135,000 ratings. Although the officer shortage is less than what it was in 2000, it is expected to worsen in coming years for a number of reasons. Some ship managers are already finding it difficult to comply with the provisions of the ISM Code because of the current shortage. There is also poaching of officers to the more lucrative sectors such as LNG and LPG operations.

One contributing factor for the increasing wastage of officers is the increasing security regulations at sea. A recent ITF survey of 17,000 seafarers found that 86 percent of them believe that the ISPS Code has resulted in extra work and adversely impacted their performance and well being. They perceive a lack of trust and discrimination against seafarers. 70% of the respondents pointed out that they had been denied shore leave in the U.S. They find the U.S visa process to be costly, inconvenient, and impractical. Seafarers from Vietnam, China, and the Middle East have the greatest difficult in getting U.S. entry visas. Australia is also following the U.S. model which is likely to lead toward more seafarer shore-leave denials.

The U.S. Coast Guard began issuing documents with new security provisions to prevent forgery and fraud. Most commercial vessels operating in U.S. waters are now required to carry alcohol testing kits on board so that ship's personnel can be tested within two hours of a serious marine incident. Trade associations and vessel operators are opposed to the new requirement because of the additional costs involved.

9.2 Shipping casualties

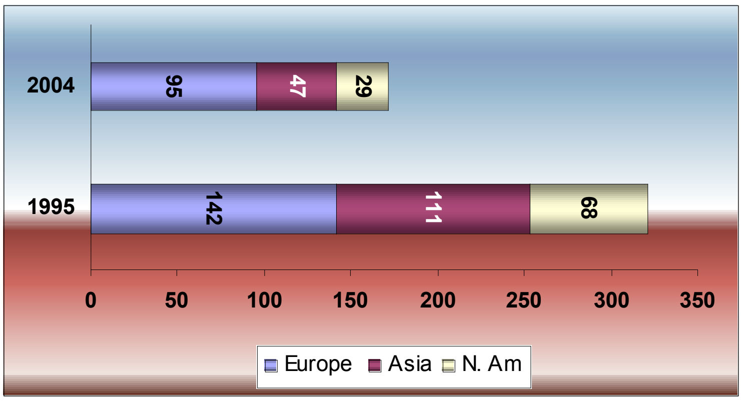
The various safety and pollution prevention rules and regulations implemented over the years are having a very tangible impact on the industry. Furthermore, ships today have better machinery and communication and navigational capabilities. Unfortunately, such improvements do not receive much attention from the public at large. Fig. 1 shows the decreasing number of casualties among bulk, roll-on roll-off, and tanker vessels in various parts of the world.



Source: Lloyd's MIU/LSE

Fig. 1 Bulk, Ro-Ro, and Tanker Casualties by Area

The oil tanker sector in particular, responsible for many massive operational and accidental pollution cases at sea in the past, has made dramatic progress and cut down such incidents drastically. In 1979, there were 34 oil tanker incidents that resulted in spilling 650,000 tonnes of oil whereas in 2004, there were only five incidents and over the last five years, less than 40,000 tonnes of oil have been spilled. In the last 10 years, tanker incidents have dropped by 47% (see Fig. 2). More than two out of every three VLCC in the world is now double hulled. Despite increasing number of tanker inspections, their detention ratio today is at an all time low of 3.6%. Panama and Liberia, the top two open registries, have an enviable safety record of 1.44% and 1.5% of their fleet respectively compared to the top ten flags' average safety record of 2.19% and the world average of 2.48%. With the safety regulations getting even tougher, maritime casualty statistics are expected to improve further.

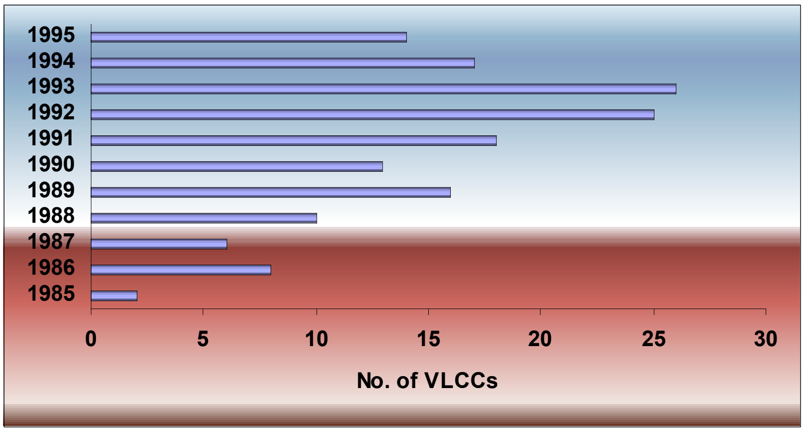


Source: Lloyd's Shipping Economist

Fig. 2 Oil Tanker Casualty Incidents, 1995 Vs. 2004

9.3 End of the single hull tanker era

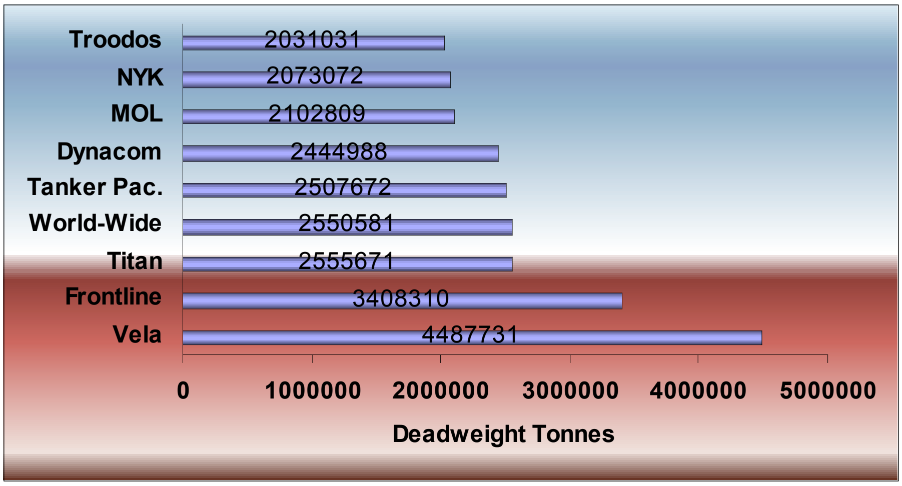
IMO Regulation 13G amended the MARPOL rules following the sinking of the single hull tanker Prestige off the Spanish coast in 2003. The new regulation mandates that all single hull tankers be phased out by 2010 or by their 25th anniversary if earlier and came into force in April 2005. An accompanying Regulation 13H prohibits the carriage of heavy crude oil and fuel oil cargoes from April 2005 in single hull tankers. With this, the EU has effectively shut out large single hull tankers from carrying crude and heavy grades in its waters from April 2005. In the U.S., the OPA 1990 mandates 2010 as the deadline for single hull tankers with the exception of the LOOP and other designated lightering areas.



Source: Lloyd's Shipping Economist

Fig. 3 Number of Single Hull VLCCs and Year Built

A large number of single hull vessels are expected to reach the end of their operational life from 2010 onwards (see Fig. 3). A strict application of the phase out rule will create significant shortfall in capacity, especially in the VLCC tonnage. There is however an opt-out provision in the law whereby flag states may allow vessels to sail beyond 2010 until a final 2015 deadline provided ships have not reached 25 years. They may be allowed to continue to be in operation even beyond 2015 by flag states if they have double bottoms or double sides but these exceptions can be overridden by foreign port states through entry denial. Big oil importing nations such as Japan and India have clarified that they will allow single hull tankers approved by the flag administration to trade into their ports. Major single hull tanker owners with one million or more deadweight tons in capacity are shown in Fig. 4. Each of these owners have at least eight such ships under their control.



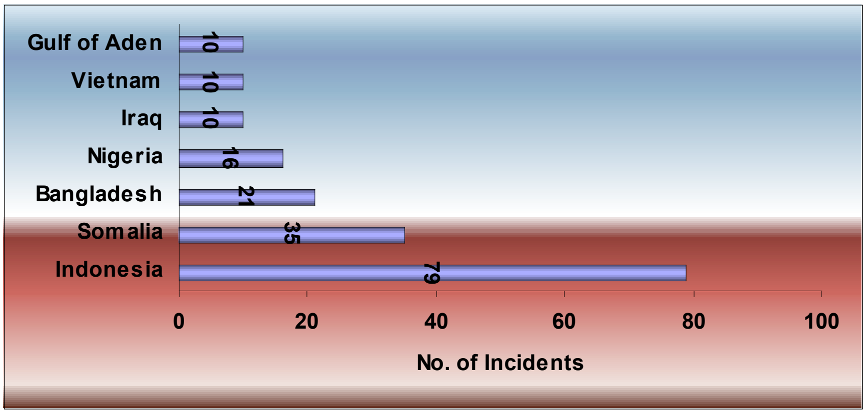
Source: Lloyd Shipping Economist

Fig. 4 Major Owners and Operators of Single Hull VLCCs

9.4 Piracy

Piracy at sea continues to haunt the merchant marine. There were marginal improvements in some traditional piracy-prone areas in 2005 only to be more than offset by new trouble-torn areas. 440 crew members were captured as hostages in 2005, the highest number ever in a year. Attacks in Indonesian waters dropped by 16% and those in the Malacca Strait dropped to 12 from 38 in 2004. This is believed to be an outcome of active joint air patrols in the region by Malaysian, Indonesian, Thai, and Singaporean authorities and also the peace agreement reached between the Aceh rebels and the Indonesian government. The U.S. Pacific fleet has also been playing a very visible background role in the area. An Indonesian soldier was arrested for kidnapping two ship's crewmen, proving the alleged complicity of military personnel in some of these activities. Piracy attacks using guns, knives, and hand-propelled grenade launchers have increased significantly in other regions such as off Somalia, the country with the longest coastline in Africa. Another surprisingly new troublesome area is off Basra in Iraq, in the close proximity of coalition forces.

Pirate attacks off Somalia received global attention when the cruise liner Seabourne Spirit was attacked by two 25 foot inflatable pirate boats 100 miles off the coast with RPGs and machine guns. The activation of LRAD (Long Range Acoustic Device) which releases earsplitting 150 decibel bangs combined with ship maneuvers is believed to have repelled the attackers. The device is used in some commercial and many naval vessels after the attack on USS Cole off Yemen in 2000.



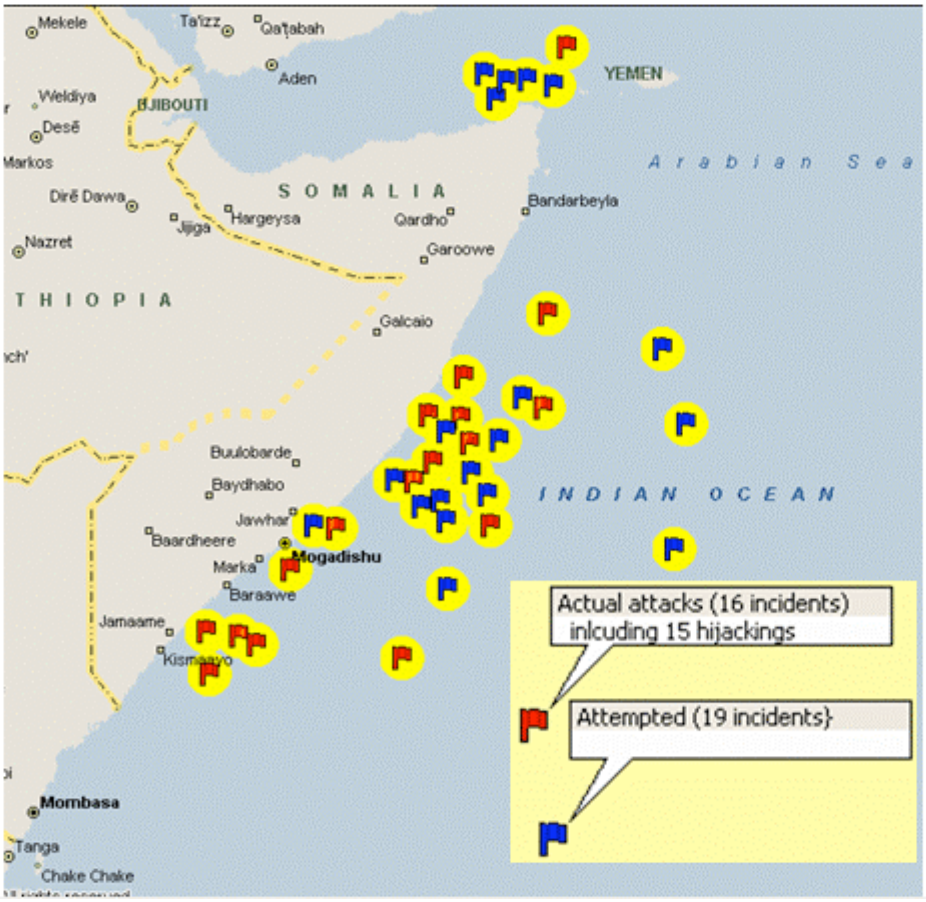
Source: IMB Statistics

Fig. 5 Major Areas of Maritime Piracy and Incidents in 2005

Pirates have become creative, luring vessels closer to the shore by firing distress signals. Somali pirates even hijacked three ships carrying U.S. humanitarian aid for that nation's starving citizens. Ships are now advised to stay 200 miles off the Somali coast. In early 2006, the USS Winston S. Churchill intercepted a pirate dhow upon notification from the International Maritime Bureau. The Churchill is part of a multinational taskforce patrolling the western Indian Ocean and Horn of Africa region. This particular action resulted in capturing 10 Somali pirates and rescuing 16 Indian hostages. The suspects were handed over to Kenyan authorities for hijacking a ship, threatening the lives of crew members, and demanding a $450,000 ransom. The pirates allegedly attempted to hijack three more ships while holding the 16 hostages on board.

The U.S. Navy and Coast Guard are determined to protect U.S. maritime interests in piracy prone areas. While the Coast Guard stands ready to protect the domestic waters, the Navy conducts maritime security operations in various parts of the world now. This is a new role for the U.S. Navy which has historically stayed away from law enforcement at littoral states. However, given the consequence of pirates collaborating with terrorists and causing a major disaster involving a loaded oil tanker or other hazardous cargo, this role is eminently justifiable. There was a grim reminder of this during the year when Indonesian pirates took control of a Malaysian registered oil tanker in June although no major damage resulted from this particular event.

The 24th Assembly of the International Maritime Organization passed a resolution to bring the issue of maritime piracy and robbery in waters off Somalia to the attention of the U.N. Security Council. Accordingly, the Security Council has urged Member States to use naval vessels and military aircraft in the fight against piracy and armed robbery off Somalia. Meanwhile, Somalia has outsourced its maritime security operations to TopCat, a private American security firm. The $55 million two-year contract calls for guarding the coastline from sea pirates. TopCat will conduct boat and air patrol to foil piracy attempts and capture the pirates, and supply equipment and training to help Somalian authorities.



Source: International Maritime Bureau

Fig. 6 ICC International Maritime Bureau(IMB)

Piracy Armed robbery-1 Jan. to 31 Dec. 2005 attachs off Somalia

9.5 Maritime security

An important trend in maritime security is the implementation of user fees. As an example, an association of 13 deepwater ports in the U.S. Pacific North West has implemented a fee of $250-600 per vessel per day to fund these expenses. Some perceive shipping containers as potential Trojan Horses. With about 14 containers coming to a U.S. port every minute of the day and increasing concerns about terrorism, the attention paid to maritime security went up a few notches again this year. The implementation of the MTSA and the ISPS Code in 2004 was discussed last year. The crux of the U.S. strategy is to stop potentially harmful containers from leaving its foreign port of origin for which multiple efforts are undertaken. These include the C-TPAT (Customs-Trade Partnership Against Terrorism), CSI (Container Security Initiative) as well as the 24 hour notification rule, and the use of technology. A C-TPAT company has an approved supply chain security program and their imports are inspected once every 306 times rather than once every 47 times, the usual standard. Although there was about 5,000 C-TPAT participants in early 2005, only about 10% of them had their compliance verified by the U.S. Customs and Border Protection (CBP). In April 2005, the privileges given to 4,000 of these companies were withdrawn until CBP could hire more auditors.

ll major ports that export containers to the U.S. are now part of the CSI network. The shipper or agent is required to provide extensive information about the cargo 24 hours before loading it on board a ship. CBP works in collaboration with the foreign Customs Service authorities at the CSI ports to screen containers; high risk containers are physically examined. Areas of concern here include whether or not all high risk containers are identified, the adequacy of training given to foreign customs officers, and the speed with which radiation detection equipments are placed in some of those ports.

The C-TPAT criteria for carriers introduced in 2002 are being upgraded presently. It will make the best practices in the industry a minimum standard. A carrier is expected to benefit if it exceeds those standards. Other nations are also following a similar trend. Canada introduced its mandatory 24 hour notification rule in 2004, Mexico will introduce the same in 2006 and the E.U. by 2008.

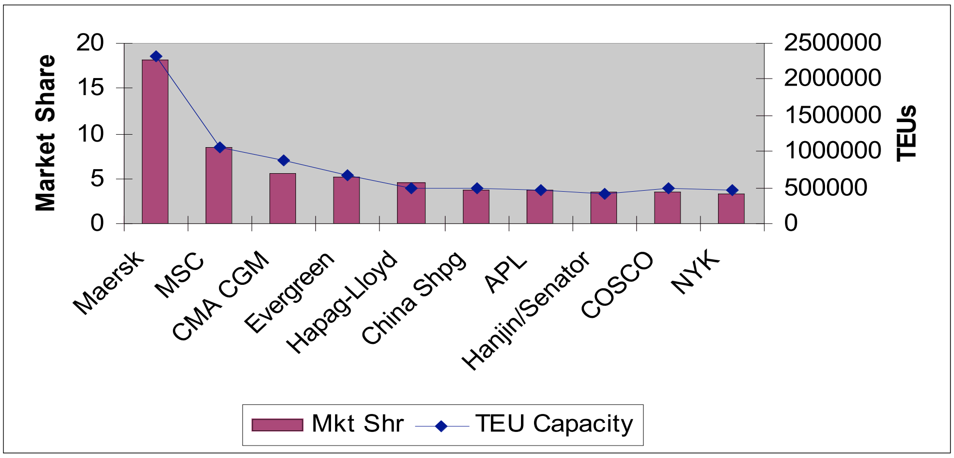
In addition to C-TPAT validated companies using C-TPAT validated carriers, exporting from CSI ports, and inspecting 100 percent of all suspect containers, a further expectation is to use smart containers. In this regard, e-seals and container security devices reached an important stage in 2005 with an ISO standard for e-seals expected by end 2006. DHS requires that channel members verify the integrity of container seals. The carriers and terminal operators are likely to opt for RFID technology which would go a step beyond and track the electronic seals. However, e-seals are only a tracking device and not a security device which would detect unauthorized entry. Containers with electronic sensors that detect entry are expected to receive a green lane treatment from CBP. GE Security, a subsidiary of GE, has begun marketing such a device which will be placed inside the container. There are less chances of it being damaged or broken accidentally unlike an e-seal. However, whereas as a disposable e-seal will cost only $10-20, the reusable GE security device will cost $1000-1,200 per piece restricting their use to certain niche markets, Starbucks being one of its early adopters.

9.6 Liner consolidation

While some carriers like the Chinese container operators grow organically through massive investment in new capacity, some are seeking growth through acquisition and some others through formation of strategic alliances. Consolidation in the liner shipping business reached a crescendo in 2005 driven by three big acquisitions. These include $2.9 billion acquisition of PONL by the AP Moller group, $2.3 billion purchase of CP Ships by the TUI Group (Hapag-Lloyd's parent company), and CMA CGM's acquisition of the shipping activities of the Bollore group for $600 million. The market share and the total container carrying capacity (owned and ordered) of the top 10 operators are shown in Fig. 6. Those who cannot afford the acquisition strategy are pursuing the alliance option. The top two alliances, the New World Alliance and the Grand World Alliance combined their operations in early 2006 and created a new alliance to respond to the Mearsk Line's ascent to supremacy. However, the consolidation trend is expected to continue in future years.

Shippers are justifiably concerned about increasing concentration of economic power among the top liner operators and are demanding changes in longstanding trade practices. In the U.S. liner trades alone, the top 50 carriers' market share during the 1st nine months of 2005 increased by 9.1% compared to the same period in 2004 as per PIERS/JoC statistics. The EU adopted a proposal to end the block exemption given to liner conferences under Regulation 4056/86.

Although it will be another couple of years before it becomes effective, the conference system has already lost its clout, particularly in the U.S. trades.



Source: BRS-Alphaliner/JoC PIERS

Fig. 7 Market Share and TEU Capacity of Top 10 Container Operators

9.7 The Dubai ports world controversy

The recent controversy about DP World's aborted acquisition of P&O Ports' U.S. assets should be evaluated in the context of the ongoing worldwide consolidation in liner shipping and container terminal operations. As the controversy gained extraordinary media attention and coverage, only a brief commentary is included here. The entire episode will be remembered in future years hopefully as a sad case of election year political spin and manipulation. The incredible success of the well-intentioned but misinformed politicians and the media in convincing the average American that an Arab controlled company was buying out six major American ports is troubling and even frightening. If a container terminal in an American port is run by a terminal operating company from any part of the world under U.S. rules and regulations, it does not alter our security standard even by an iota either way. What is most important is where those containers are being loaded and who has access to them before they reach here. The masterful way in which the spin doctors and the popular media converted this strategic business move by an efficient, fast growing global container terminal operator into a case of outsourcing and the epicenter of public anger defies rationale besides hurting America's standing as a champion of the free market. It was American consultants, engineers, and banks that went around the world advocating the efficiency of privatized ports and terminals. It is a fact that our supply chain security is lacking and needs careful scrutiny but should it be at the cost of rationality and commonsense to the point where even the nomination of a potential Maritime Administrator is being jeopardized solely because of his prior affiliation with a foreign employer?

10 Outlook

It has been a good year for the merchant marine by all accounts, operationally as well as financially. Major improvements were made in areas such as safety and security including maritime piracy and prevention of oil pollution. U.S.-based operators made incisive moves during the year, in particular OSG's impressive product tanker series building commitment, a rarity in the recent annals of merchant ship construction in this country. None of these negate the fact that the market cycles are definitely on a downward trend. However, other than the liner market where significant new tonnage is expected to enter during the next two years, any deterioration in market conditions will be far more tolerable than what the industry has typically witnessed in prior boom and bust cycles. There are however areas of major concern that one hopes policymakers will pay particular attention. Although the U.S. logistics infrastructure is envied by the rest of the world, its marine terminals and road and rail capability will be incapable of handling the nation's international trade volumes within the next 15 years. International container movements alone are expected to quadruple in the next 20 years, chocking gateway ports and hurting their efficiency. If no major improvements are made, congestion will become routine at the major ports within five years. There are of course other uncertainties in the marketplace such as a global outbreak of avian flu which could also cripple the merchant marine sector.

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PROPOSED INTERNATIONAL TRAINING PROJECT FOR ESTABLISHING COLLABORATION WITH SHIPPING COMPANIES

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Abstract Measurement of performance and deciding the actual needs of maritime industry generally require professional approach for the utilization of appropriate techniques to determine the satisfaction criteria of Maritime Safety Management System. The advanced measurement techniques will be used for specific activities of transportation process to obtain realistic outputs for the improvement of managerial based weaknesses. For this reason the criteria for success could be query of adequate qualified personnel availability. Consequently the measures of performances, corrective and preventive actions reliability and maintainability in the improvement cycle are the significant criteria to satisfy the expectations of ship management companies who are directly involved in transportation process. Besides, it can be a realistic approach to say that, ship management companies are confronting various challenges among flag State implementation, port State control and claim handling process with underwriters. This study proposes a post graduation corridor among IAMU member MET institutions to carry out an Executive Maritime Business Administration Program taking into account expectations of stakeholders who are involved in maritime industry.

Keywords MET; ship management; maritime business administration; post graduation corridor; expectation survey

0 Introduction

Human resources are generally considered to be most important asset of a Ship Management Company. Most of the ship operators seek high quality and well-trained staff to be employed both in the shore-based management side and onboard the ships as well. This is regarded as an investment in both safety, marine environmental protection caused by ships and the long-term economic operation of the competitive ship management process.

Previous researches are mainly based on the ship operating functions, which are technically described at SOLAS, MARPOL, COLREG, LOADLINE conventions Hunter[1]. Although relevant qualifications for crewmembers is established by STCW-95 as a minimum requirement on an international basis, there is no specific indication highlighted for shore-based management, which could directly enables the execution and administration of all technical ship management process.

This study defines the general principals of qualifications and required skills of shore-based management personnel in charge of departments and divisions who are responsible for implementing management activities related to safe and reliable operation of ships and environmental protection. Then a post graduation corridor is proposed among IAMU members taking into account the expectations of Ship Management companies from MET institutions.

1 Existing performance indicators of ship operators

The outputs of the survey study Er[2] for defining skills and qualifications of shore-based management staff, mainly indicates that some special conditions that are required prior to be employed as a shore-based staff at Ship Management Companies. The required skills and qualifications are summarised below in terms of priorities:

(1) Sea-going experience in the means of period of sea life for different qualifications including the type of ships, name of ship operators and the reputation of companies.

(2) Rank and work experience as a shore-based management personnel if available.

(3) English ability performing on professional tasks

(4) Unproductive periods in terms of months or years during the carrier of both sea life and, or other shore-based employment.

(5) Attended courses or special qualifications (auditor courses, ship management courses, chartering courses, insurance courses, classification societies technical courses, conferences etc.)

The above five general employment evaluation criteria are considered as common priorities at today's Ship Management Companies. Most of the Ship Management Companies who are operating more than four vessels are specially intended to employ their own Masters and Chief Engineers as a shore-based management staff after some period of time Jenssen[3]. The main reason of this intention directly comes from the experienced Masters and Chief Engineers become familiar with the company's policy and procedures, the ships historical defects or breakdowns and the shore-based management staff's execution techniques and human relations as well. Mostly well experienced Masters and Chief Engineers initiate to work at ship management companies as a Marine Superintendent or Technical Superintendent. When they firstly start to work as a shore-based management staff, some part of their carrier also takes practical training at company as well Obando[4]. Practical training does not only mean what is considered by familiarisation. When a Master is being employed as a Marine Superintendent, he starts to learn the details of post fixture process, international supply, budget estimation and configuration of ship's running cost etc. The similar conditions can also be applicable for Technical Superintendent as well. Technical Superintendents are also start to learn the survey types and execution of these surveys, statutory requirements of ships, inspections and audit techniques during their first year.

After being employed and get experienced as a Marine Superintendent or Technical Superintendent, they become the candidate of Operation Manager or Technical Manager or Crewing Manager. When they are promoting at ship management companies, Top Management or Fleet Manager(s) mainly defines the appointment status. In this respect it constitutes some risks whether they have the sufficient knowledge and background for carrying out their new duties or not. While executing the process with Masters and Chief Engineers, some oversighted mistakes become very important for safety and prevention of pollution. A simple example can be taken into account as, not suppling the appropriate spare part of oily-water separator on time to vessel, it probably can cause a detention by Port Sate Control or a penalty by discharging directly to sea. It means the oversighted process can directly cause pollution. The catastrophic examples could be exercised as well, when the major accidents and casualties' root causes are analysed in detail Equasis[5].

Mainly the ship management companies that are operating less than three or four vessels have mostly mixed organisations that their appointed Designated Person Ashore is the Technical, Operation and Crewing Manager simultaneously. Some of these companies are not employing Superintendents as well. This means all ship management process is expected to over come by one or two qualified or semi-qualified shore-based staff Traves[6]. In this consideration, the whole process becomes to solve managerial and operational problems, instead of preventing all deficiencies and implementing proactive management strategies. This result to increase the number of casualties, detentions and impairment of safety as well. The fraudulent certification of crewmembers and limited qualified personnel employment are directly caused by the above strategies.

In this respect the most important criteria is the appointment of Designated Person Ashore. Designated Person Ashore must have some special qualifications to coordinate and execute all the ship management process among the Top Management and shore-based personnel and crewmembers. This requires professional sea experience background prior to appointment. The second crucial criteria might be keeping abreast of all new or incoming rules and regulations and adapting to those directly to company structure and ships administration as well. In this consideration, Designated Person Ashore proficiency cannot be realized as the responsibilities of one of the Top Management personnel who are working as a President, General Manager or Managing Director etc. of the company or other shake-holders.

Most of the Ship Management Companies who have different types of fleets or their number of vessels are between five and twelve are intending to operate their managed vessels properly. Most of them are well organised at the transition period from three or four vessels to operate five or more vessels. After some period mostly two or three years, the weakness frequently causes by the inappropriate strategies especially for defining the human resources and managerial level decision-making depending on freights, loan payments of ships etc. Then the defects on ships become much more complicated to close out.

It is possible to recognise that the critical managerial step is mostly evokes after the transition period of operating five or six vessels. This directly depends on the nature of business, types of ships, and number of experienced shore-based personnel, coordination of activities. The management weakness becomes minimised when the ship management companies are started to operate vessels more than twelve. It is considered that they are well organised and their company structure expects good reputation among the charterers. Technical management performance of these companies is quite good. They already know how to plan and execute shore-based operations. Their employment criteria are well defined to prevent any type of casualties or non-conformances. They are employing their shore-based staff directly from their experienced Masters or Chief Engineers. Comparison of qualified shore-based management staff employment and the number of vessels operated by ship management companies are briefly illustrated in Fig. 1. Consequently there is no any indication or international competency standard as it is defined for seafarers in STCW Convention, which describes the expected needs or required qualifications for the shore-based management staff. It directly depends on the ship management company's own policy and procedures. These policies are considerably closed to the management philosophy of the Top Management, size and number of vessels operated by the company. Vessel type and trading area are also the essential factors, but the management principals are remain same for the employment of qualified shore-based staff who has a crucial effect on the proper implementation of Safety Management System to ensure safe shipboard operations and countermeasures that should be well organised to prevent pollution Traves[6].

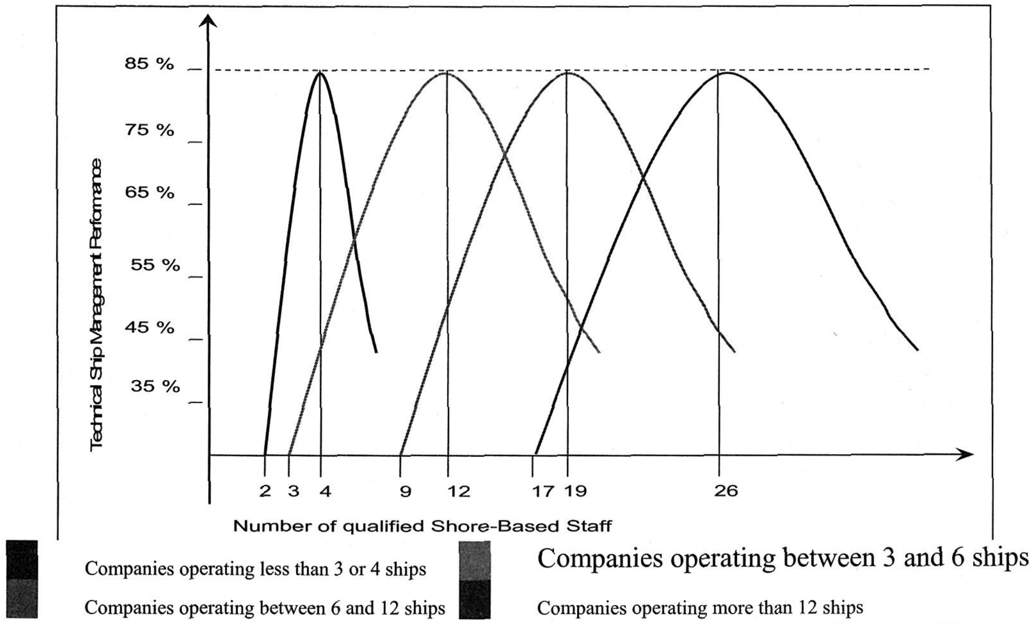

Fig. 1 Correlation Graph between, Number of Qualified Shore-Based Staff and the Technical Ship Management Performance

2 Analysis of stakeholders' expectations

Investigation of expected qualifications for shore-based staff was not only analysed with the ship management companies employers. The scope of this survey is enhanced with a wide range of maritime industry personnel who are directly affected with the results of their management. This investigation includes the ten following parties whose expectations may vary with different satisfaction perspective:

(1) Masters, Senior Officers;

(2) Classification Society Surveyors and Auditors;

(3) P&I and H&M Surveyors;

(4) Charterers;

(5) Port State Control Officers;

(6) Port Authorities, Harbour Masters;

(7) Agencies, Pilots;

(8) Independent Surveyors and Auditors;

(9) Existing Shore-based Management Staff;

(10) Top Management of Ship Management Companies.

The outputs of the investigation clearly mark the following aspects and intersect various impacts form the different expectations perspective. Relevant stakeholders expectations for the identification of shore-based management staff proficiency designation are illustrated in Fig. 2.

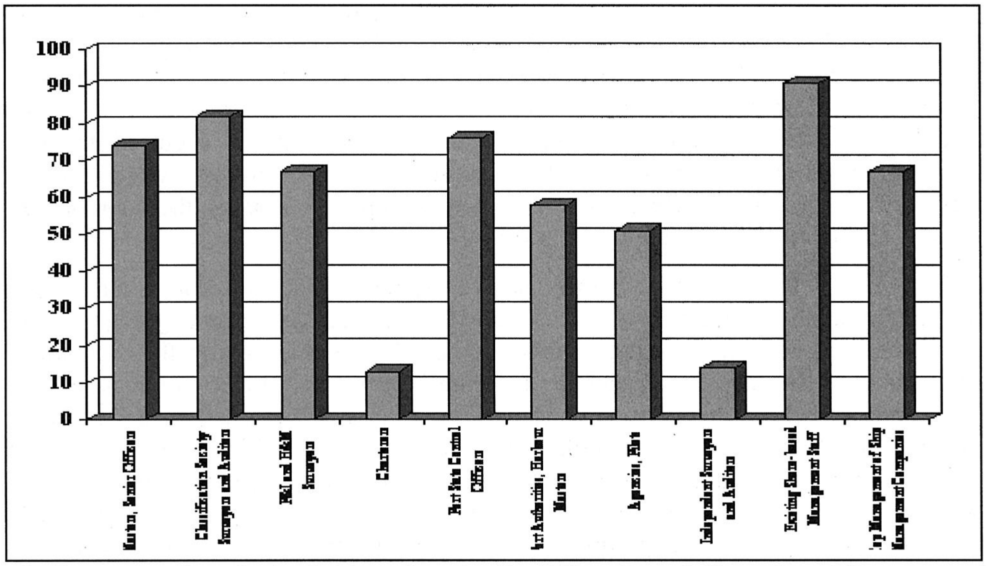

Fig. 2 Responses from Stake Holders for the Qualification of Shore-Based Management Staff

The evaluation of this investigation from the Masters & Senior Officers' point of view clearly indicates the importance of shore-based staff qualification due to the mandatory requirements that are established by IMO.

Some of Masters and senior officers complain the diminished allocation of resources to ships, and informatics transfer Redfern[7]. This complaint mainly comes from the Masters and senior officers who are employed at ship management companies that are operating vessels between one and four Er[8]. In their point of view, they are frequently acting as a supervisory role and preparing necessary data and solution profiles for the improvement of the facilities and ship operation process instead of requesting the useful outputs form shore-based management. Classification Society Surveyors and the auditors are especially concentrating on the inadequate management knowledge and administration abilities, inefficient use of human resources are the direct causes of additional surveys and audits that results additional expenses and off-hiring of ships. They are also suffering from the inadequate implementation of mandatory rules and regulations. Their observations are mainly concentrating on the sufficient technical knowledge, but insufficient execution and administration know-how to plan, to maintain and coordinate in an expected level of ship management process.

Protection and Indemnity Club and Insurance surveyors are indicating the difference between crew negligence and management negligence. In accordance with their point of view, there is only one way to reduce the management negligence is the re-training activities and properly defined qualifications of shore-based staff Er[9].

Charterers are not mainly dealing with the qualification of shore-based staff but they do not require any cargo claims and delay that are commonly occurred for the insufficient implementation of technical aspects and precautions during shipboard operations. The root cause of the above complaint is directly interested with the execution of shipboard activities that are commonly well known by the shore-based staff. Their main intention is the allocation of necessary resources for the maintenance of ship and equipment to minimise any type of cargo claims.

Port Sate Control Officers are the once who are defining the significance of qualification and training needs of shore-based staff in an explicit manner. They are expressing, the oversighted or inadequate managed ships mainly encounters plenty of deficiencies Their main point of view is the nature of the Port State Control that is actually known by all parties in terms of Ship's Master and senior officers, and the shore-based staff. The root cause of occurred deficiencies are the once, which the Company management does not take necessary corrective and preventive actions. Minimising the arrest and, or detention period of ships, the improvement of shore-based staff qualification in their first priority Er[10].

They believe that if the shore-based staffs are well qualified and collaborate with the Ship Master, then the number of unforseen expenses due to arrest and detention is going to decrease and the tendency of cooperative management structure becomes to reduce the casualties and accidents. Most of the troubles encountered during inspections can be summarized as the Master's improper actions between Port State Control and shore-based management staff. Consequently Port State Controls are looking for the rectification of deficiencies by suppling necessary resources to ships. They believe this strategy can completely close out deficiencies on time. Shore-based management staff mainly takes corrective actions for the major items at relevant port but not taking appropriate actions to prevent re-occurrence of the same non-conformances.

Agencies, pilots, independent surveyors and auditors are not very much dealing with the proficiency of shore-based staff. If the vessel has some problems or deficiencies, then they can able to participate in the corrective action process. Their main intension is positive for the identification and improvement of shore-based management staff skills and they are expecting some sort of training, which could be called as refreshment courses or carrier development courses etc.

The results of the investigation from the shore-based management personnel point of view could also be found interesting because most of them are positive and they rely on the identification of shore-based staff qualification, skills and additional training needs. Their main intention is only focusing on the uncompetitive conditions of seafarers training and the flue areas at STCW Convention. They are expressing that Masters and senior officers are certified by administrations after the completion of 7.01 and 7.02 IMO Model Course as a minimum requirement. Some of the Maritime Training and Education Institutions curriculum are at a university or higher education level in terms of graduation. Rest of them are only oriented based certification courses. The training and education period difference is almost two years between Maritime Training and Education Institutions that are serving as a higher education level and the institutions that are serving as certification courses Er[2]. Ultimately both of the certified officers are employed at ships with similar ranks. When these graduates are employed on board the ship and experienced, they are initiated to employ as a shore-based management staff at Ship Management Companies. The main difficulty and inefficient ship management process causes from the graduates who are graduated from the oriented-based certification courses, though they might be successful on shipboard operations. They are focusing the crucial importance of higher education and training, when acting as a shore-based management personnel as key personnel. They are also concentrating the importance of Maritime Business Administration when acting as shore-based management personnel in ship management companies. Existing shore-based staffs' expectations are illustrated in a logic sequence in Fig.3 in the next page. The Top Management of Ship Management Companies who are operating above ten or twelve vessels are directly focusing the importance of reliable ship operations and they are also intended for the identification of shore-based staff qualification in an international basis. They are indicating that if their shore-based key personnel are well trained and familiarised with the recent developments and commercial management of ships, it will have a positive effect on the improvement of actual cash flows.

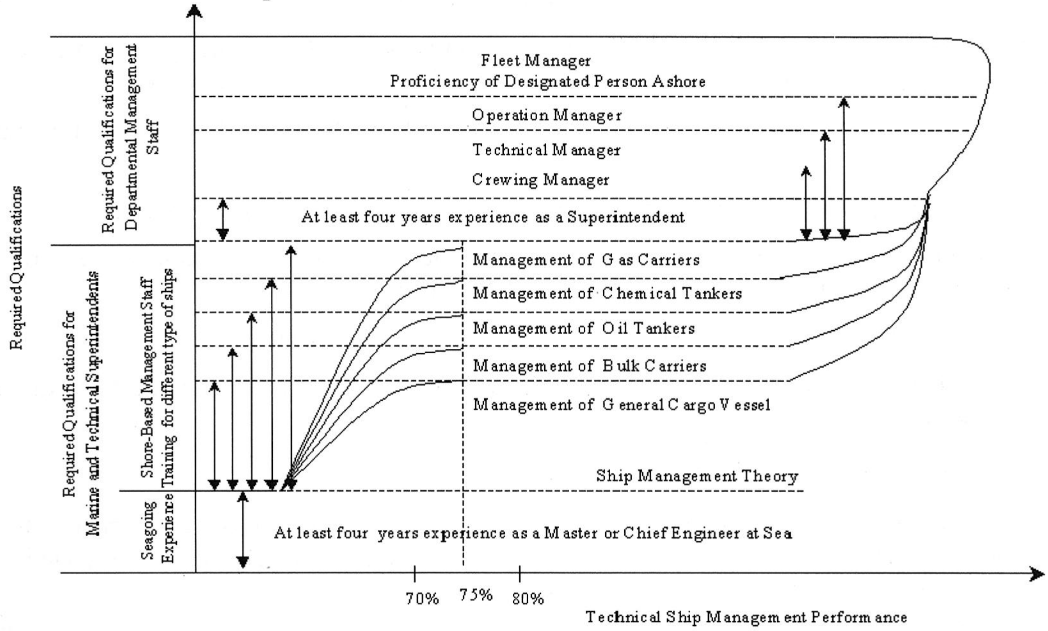

Fig. 3 Existing shore-based management staff expectation for ideal organization structure including hierarchy and promotion

Most of the Shipping Companies who are operating below three or four vessels are not mainly concentrating about the qualifications of shore-based staff. Their main intension is directly concentrating on the cash flows. If the required skills do not cost an increase on their budgets, then it could be acceptable for them to employ qualified shore-based staff.

3 Identification of proficiency and the expected duties and responsibilities for shore-based staff

In order to ensure a satisfactory level of safety and environmental management, a ship management company needs to have key people undertake the following activities Er[10]:

Coordination and Execution: The person carrying out these activities is the Fleet Manager or the General Manager of the Marine Division. These people are responsible for the technical and commercial management of ships as their first priority and provide all the necessary resources on behalf of the senior management.

Operational: The person carrying out these activities is usually the Operations Manager. This person is responsible for the pre-fixture and post-fixture of ships including the voyage and cargo plans, port operations, ship supplies, implementation of charter party requirements, the claims handling process, emergency preparedness both for the office and shipboard staff, and the work assignment of operations superintendents.

Technical: The person carrying out these activities is termed the Technical Manager. He/she is responsible for the maintenance of the ship and its equipment, supplying fuel and lubrication oil, any necessary ship docking and repair works, the traceability of a ship's statutory certificates, and the work assignment of technical superintendents.

Crewing: This person, called the Crewing Manager, is responsible for recruiting crew members, implementing pre-joining ship training procedures and the arrangement of crew.

The associated job descriptions for the people described above all have the following objectives:

- to pro-actively control and maintain the company's Safety Management System;
- to control non-conformance's and take corrective actions with the intention of preventing re-occurrences of quality and safety system deficiencies;
- to ensure that any implemented corrective actions are effective; and
- to undertake management reviews that identify system weaknesses and eliminate these weaknesses.

4 Proposed post graduation corridor

Defining the required skills and qualifications of each shore-based management personnel the following key ingredients are taken into account as prior to establish the post graduation corridor model as objectives, these are listed below:

Forming interrelationship with other departments and divisions that will improve quality in all aspects of service and technical ship management process.

Developing and maintaining a team approach that emphasis enhancing the competitiveness of the company through increased quality and productivity.

Providing an atmosphere that encourages every employee to achieve his or her full potential and pride in workmanship.

Developing a management system based on international rules and regulations to foster continuous process and environmental improvement and problem prevention instead of problem detection.

Defining and implementing integrated management system approach based upon employee involvement and commitment to excellence.

Giving all employees training and support needed to provide quality services to all customers including the philosophy of Total Quality Management in terms of quality circles, as well as meeting the environmental objectives.

The shore-based Staff Proficiency Designation during the ship management life cycle can be established by the initial certification of key management personnel taking into account the Administration of Safety and Environmental Management (AS&EM) needs that constitute all ship management activities both in the operation and management level. The details of the proposed Proficiency Designation process is illustrated in Fig. 4.

The first decision-making process in the loop decides whether the applicant has been employed as a shore-based staff in terms of key management personnel (SBS-KP) prior to applying the Proficiency Designation process. Defining the five different access levels of qualifications for each major activity, shore-based staff can be certified for five different proficiencies. For each proficiency level, the minimum requirements can be considered as the Initial Certification,

Proficiency Refreshment (PR) due to the effects of new regulations and technology change,

Upgrading Proficiency Level (UP) for promotion starting from Marine Superintendent or Technical Superintendent to the Designated Person Ashore (DPA)

The duration of indicated Proficiency Designation courses for each qualification and the refresher course periods are illustrated in Table 1. To update existing knowledge, refresher courses is proposed to be held at least every three years.

Table 1 Proposed course schedules for proficiency designation

Qualifications and Certification	DPA	Operation Manager	Technical Manager	Crewing Manager	Superintendents	
Initial Certification	422 h	297 h	297 h	297 h	165 h	Course Duration
Refreshment Cert.	80 h	66 h	66 h	66 h	33 h	

Finally the post graduation corridor in terms of executive MBA or similar training program model outline is proposed in conclusion as it is illustrated in Table 2.

Table 2 Proposed program outline

Term	Code	Course	Type
I.	MBA100	Introduction to Maritime Studies	Compulsory
	MBA101	Management and Organization in Shipping	Compulsory
	MBA102	Maritime Business Economics	Compulsory
	MBA103	Shipping Finance, Sale & Purchase	Compulsory
	MBA201	Technical Ship Management	Elective
	MBA202	Commercial Ship Management	Elective
	MBA203	Ship/Shore Communication & Information Management	Elective
II.	MBA104	Strategic Management in Shipping	Compulsory
	MBA105	Quality Management in Shipping	Compulsory
	MBA106	Human Resources Management	Compulsory
	MBA204	Ports and Terminal Management	Elective
	MBA205	Environmental Management	Elective

	MBA206	Maritime Law	Elective
III.	MBA107	International Maritime Regulations & Applications	Compulsory
	MBA108	Contingency Planning	Compulsory
	MBA109	International Business and Transport	Compulsory
	MBA207	Classification Society and Surveying	Elective
	MBA208	Shipping Accounting	Elective
	MBA209	Logistics	Elective
	MBA301	Integrating Strategy Project	Compulsory

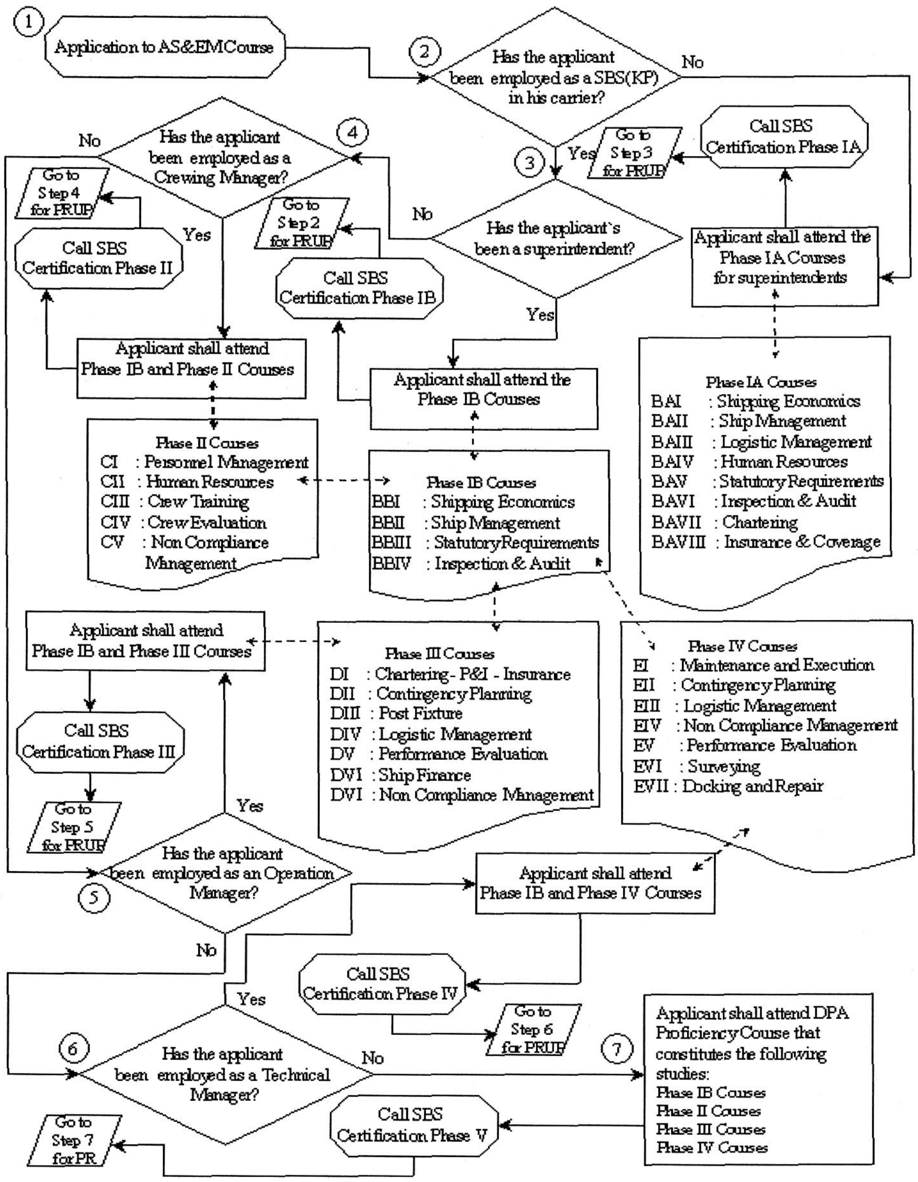

Fig. 4 Proposed Loop Cycle for Shore-based Staff Proficiency Designation

5 Conclusion

This study offers an approach for defining the key shore-based personnel proficiency requirements in order to minimise the deficiencies, hazardous occurrences and accidents. Although the STCW Convention clearly identifies proficiency standards and knowledge for shipboard personnel, it does not mean that all the critical factors, relating to the human element, are included in ship operations when the shore-based contribution is taken into account. This study proposes a post graduation corridor for IAMU member institutions for the superintendents, crew managers, technical managers, operation managers and DPAs, by defining their tasks and their expected knowledge. Proficiency level training needs are considered for each qualification. The duration of the proposed training program for each qualification and the associated refreshment courses are also indicated in an implicit manner to overcome the re-occurrences violances. Critical steps for the establishment of Executive Maritime Business Administration Program for the ship management companies shore based staff are determined. Ideal shore-based organization, key activities, job description of managers, and relationships with stakeholders are referenced to prepare the above program outline. Relationships between job responsibilities of shore-based organization members and training requirements established taking into account the expectations of stake holders in maritime industry. Establishing of performance evaluation methods for MBA programs with a cooperation between MET and ship management company can be a further research activity regarding with this study.

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International Cooperation of Shipping Companies and AMSMA for the Training of Seafarers

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1 Brief overview of the maritime labor-market in St. Petersburg and the north-west region of Russia

Nowadays situation at the labor market in St. Petersburg and North-West region of Russia is characterized by the following basic features:

- Extremely great demand for the qualified maritime labor force. Primarily comes the demand for the navigators beginning with the 2 mates and higher, and frequently this demand is higher than the proposal.
- Structural demand (rush for)–LNG and tanker specialists, officers experienced in operation under ice-conditions of the Far North (Slide N1).
- The navigators are in the highest professional demand, as long as marine engineers, electro-engineers, radio-engineers and other professionals are in less demand (Slide N1).

2 The policy of AMSMA in the sphere of international cooperation concerning the training of maritime specialists

AMSAM is structuring its policy on the assumption of the following:

- 130 year experience and traditions of our educational institution in the training of highly efficient professionals of the marine fleet.
- High marker demand for the graduates of AMSMA at the international market, availability for the direct cooperation with the Academy from the side of large-scale shipping companies of Russia and Europe.
- The necessity for the first of all assurance of the domestic Russian market with qualified

maritime professionals.

- The usage of all the opportunities and potential of loyal foreign companies at the organizing of cadets training.

Regional-country scheme of AMSMA cooperation with shipping companies for the training of specialists is exposed at slide 3.

About **60%-65%** of all the yang professionals, trained and targeted for work after the graduation is for Russian shipping companies.

- about **10%-15%** is for Northern countries–Norway, Sweden;
- about **7%** is for Baltic (Latvia, Estonia, Lithuania);
- about **5%** is for such countries of Commonwealth of Independent States as Byelorussia, the Ukraine;
- about **5%** is for Germany;
- 5% is for other countries.

3 Cooperation in the sphere of basic education–training of cadets

The Academy seeks to succeed the following basic principals at the cooperation with foreign countries.

The principle of work is a through-going "from entrance to the graduation" way of cooperation with a company on training of a cadet/ a group of cadets. In this situation the acquaintance of a cadet and his future employer happens at the early stages of training. All the ship-board practices are had by a cadet on board the ships of the Company. Thereby to the time of employment both the graduate and the company are well aware of each other abilities and requirements, the ship-owner can preliminary plan the availability of vacancies for cadets and officers.

The Principal of direct cooperation with a company avoiding any go-between organizations (such as crewing agencies, for instance), which enables for maximally precise consideration of the companies' requirements to the qualification and time-terms of specialists training, as well as maximally efficient usage of financial investments of the companies directly to the process of training and education.

The principles of the target training, the training maximally targeted to the requirements of the company, considering its specific features. The fulfillment of this principal enables to include additional blocks of lections/courses for separate groups of cadets (depending on the type of the ship on board of which the ship-owner is planning to employ them), to do the selection and testing of the cadets basing upon the ideology and requirements of the company.

The principal of flexibility of the training process–the opportunity of flexible time terms of ship-board practice by groups of cadets for optimal usage of the companies' abilities for the provision of vacancies on board the ships.

The principal of preliminary planning of the company demand for the graduates 3-5 years ahead through the query of the company's top people. Nowadays, in the connection with the step-by-step changeover from the education financed out of the state budget to the financing of the education by the companies, there is a changeover to the long-term planning for 5-7 years (for the planning of the entrants' acceptance at the entry to the Academy).

4 The forms of cooperation the Academy–companies

The mutual cooperation of companies and the Academy is embodied in a set of various forms.

The subjects of cooperation are, in different cases, separate companies, their manpower representative offices (joining, for instance, two independent shipping companies), as well as Associations of Shipping Companies, joining more than forty companies. Sometimes the relations outgrow the Academy–the Company level, practically getting to the intergovernmental level. It happened so in NSA Class Project, when the Ministries of Foreign Affairs, the Department of Commerce of Norway, the Ministry of Transport, the Ministry of Communication of Russian Federation took part in the discussing and signing of it. It was so at the development of the project with STENA Company, when in compliance with the national Swedish requirements the necessary to carry out the accreditation occurred and this accreditation of maritime education provided by the Academy was carried out by the Maritime Administration of Sweden. Later at this bases there was made a wide-ranging acceptance of Russian Maritime Graduation Diplomas by Sweden, providing the administrative bases for the cooperation between AMSA and STENA in the sphere of human resources.

The extent of involvement of the companies to the educational process can be quite various–from simple introduction of the standard syllabuses of the Academy and the graduation control/testing of graduates up to scrupulous mutual work at all the stages of education (so, for instance, the project of Norwegian Shipowners' Association executes 5 different forms of testing and interviewing just at the entrance of cadets to the project, more than 10 additional courses are included to the program of the cades' training within this project).

The companies are actively involved into the events for the attraction of entrants and cadets as their potential employees. Annually the Academy holds over 10 target presentations for the cadets (including those who just entered the Academy). During those presentations the companies provide detailed information about the fleet, strategy at the shipping market, about human resources and social policy, about professional requirements to the officers and about the terms of work in the company. The cadets even from the first year of studying start getting the opinion about the high requirements which must be complied with for the getting of attractive employment after the graduation. Lots of the cadets start consciously paying more attention to the studying of Maritime English, issues of shipping commercial management, subjects covering international and inter- ethnical issues.

Frequently the relations the Academy- the Company are not interrupted after the employment of the graduate, as the Academy arranges for the Company the post-graduate servicing: paper work for the embarkation of a young professional, contact with the graduate within minimum 3 years after the graduation.

5 The forms of support of the educational process in AMSMA by partner companies

At the expense of the companies the purchasing of the expensive maritime equipment used for the educational process is done.

A number of companies supports the publishing of educational literature, carrying out of scientific researches for the agreed area of issues, participation of the Academy specialists in scientific and professional educational conferences.

Some companies provide financial assistance to the Academy for the operation of the sailing training ship "MIR", owned by the Academy.

Some companies provide the vacancies for the ship-board practice of the Academy teachers on board their vessels, employing them to the positions of trainees, understudies, and established posts. This opportunity is, from one point of view, an important element of the Academy teachers upgrading, making them acquainted with the most update maritime technical means, and from the other point of view it is some additional financial stimulus for the teachers under the conditions of limited financial abilities of the Academy being a budget educational institution.

A number of companies provide regular support payments to those cadets, who are targeted to be employed by the companies after the graduation of the Academy (the companies of Norwegian project, Evergreen company). Definite financial means are spent for the development of social infrastructure of the Academy–gyms and recreation rooms).

Some companies are investing to the financing of important, for them, narrow directions of cadets' training and retraining of officers of their fleet (for instance, a welding class for NSA, courses of specialists training for the operation under the ice conditions).

An interesting project is presently being worked out by Kazmortransflot (Kazakhstan). At the financial support of the Academy by this company, it proposes to build up the system of local education in Kazakhstan with the usage of the Academy experience.

6 Main problems of cooperation between foreign shipping companies and the Academy

There is a sharp problem of correctly balanced internal Russian and external foreign interests in the training and employment of ship specialists. Among Russian companies there is a point of view formulated that the interior demand of the domestic market is not satisfied. It results in definite, not always positive reaction of the Ministry of Transport and the Ministry of Education at the signing of large-scale agreements with foreign companies. Our goal here is to correctly count the demand of the markets several years ahead, to competently balance the satisfaction of the domestic and foreign demand, to distinctly financially substantiate international agreements for the avoiding of the spending of Russian budget means for foreign interests.

It is an absolutely impartial necessity to solve the issue of the company interest defending at the spending by the companies of the means for the training of officers. The companies want to be sure that the training of a young specialist financially covered by them will be compensated by the guaranteed work of the young specialist for that company for several years–when there is no worked out legal basis for this issue it is difficult to provide the guaranties of this kind.

A lot of work for the cooperation with shipping companies is being done through the go-between–crewing companies, which represent a shipowner at the territory of Russia. It frequently makes the relations more complicated or next to impossible, as not all the crewing companies are loyal to the Academy. A number of them are focused at the instant financial interests, not inclined to “waste” the time, efforts and finances for assiduous growing of “their own” human resources. But the position of Russian crewing representative is greatly influencing the opinion of a principal-shipowner.

A number of education-pedagogical problems can also be mentioned, the problems which frequently come to the agenda at the cooperation with foreign companies. Lots of them are expressing their wish for the improving of English language training of cadets. As I have already mentioned at the beginning, we shall more actively develop the programs for LNG specialists training, to meet the increasing demand.

FIVE STEPS TO ASSURE NAVIGATIONAL SAFETY

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1 Formulation of the problem

The passage of objects through air or water is usually planned in advance. This is done graphically on a chart or analytically. The travel of the object is to be watched by the track. This is done at two Control Stations, one located on board the moving object, the other one located on Earth.

Air trips are monitored on Earth at Airport Control Stations, equipped with radars and communications suite.

In an airplane it is the cockpit with resources available to monitor the travel.

Sea trips are monitored on Earth at Traffic Control Stations, equipped with radars and communications suite.

In a ship it is the chart room with resources available to monitor the travel.

The principal difference of the navigating bridge from the cockpit is that when in congested waters bearings are taken mainly by sight. In a plane bearings are found by instruments.

A dispute arises between the two Control Stations due to different opinions as to the assessment of the situation, the priority of the teams and division of responsibility.

Analysis of the problem. Operators of moving objects, when at close quarters, have little time to assess the situation and make the decision. Having insufficient information they have to give orders, using personal experience and knowledge of laws which ‘close quarters’ comply with.

Airport Control Station operators have difficulties due to heavy air traffic, so they have to solve several problems simultaneously.

Shore Control Station operators have difficulties to evaluate close quarters approach, when immediate actions are required. This is due to employment of navigational instruments which are not precise enough, lack of techniques to assess the risk of collision as well as juridical responsibility for recommendations. The master makes decisions and bears sole responsibility, leaving the shore Control Station functions of coordinator and source of information.

Confirmation of the problem developed were two accidents: one occurred in the sky above Switzerland, the other one at the Black Sea near Novorossiysk. Both accidents were caused by the similar error-uncertain actions of crews at close quarters.

Notwithstanding that decades have passed since the collision of the motor vessels “Admiral Nakhimov” and “Pyotr Vasev” and several years have passed since the collision of the planes, the international community hasn’t taken proper measures for preventing such accidents. Responsibility is placed on aircraft pilots and sea craft captains.

Responsibility of airport control service hasn’t been defined to say nothing about responsibility of shore-based sea traffic control. It was established that just before the collision the Russian plane’s system had warned the commander of it, but the information was either ignored or too late.

2 Statement of research results

The following will concern sea-going vessels, though the results can be used for planes and submarines.

Satellite systems enable more precise position fixing, up to 3-5 meters on sea-going vessels. In consequence thereof, the navigator no more uses other techniques, having lost skills of determining position by (DR) Dead-reckoning, celestial position fixing and radar lines of position using an overlay of fixes plotted for solving the problem to pass well clear, and a number of other knowledge.

Lack of skills prevents the navigator from perceiving physical processes when moving and passing clear, and from monitoring the ship’s position when failure of satellite systems occurs.

The process of approaching and passing clear takes short. Due to this, there is practically no time to analyze the situation, to estimate and to make the decision. In this situation it is required to estimate maneuvering in advance and give the operator recommendations in such form which would enable to perceive the situation and in ample time give orders to the helmsman to prevent close quarters situation.

If parameters of the ship’s movement are described without regard to the forces causing its movement, such equations are called kinematical. If the movement is described with regard to the forces, causing it, such equations are called dynamic (See Fig. 1).

The above equations are of three types:

- dynamic equations of a ship’s movement, derived from laws of motion;
- dynamic equations of a ship’s movement to the pole of the turn, derived from laws of motion:
- kinematics equations of connection of ship’s angular and line speed with space coordinates, derived from kinematical relation between various systems of axes.

The structure and form of equations of ship’s movement depend essentially on the system of axes adopted [2-5]. Three systems of axes are used:

(1) immobile geocentric, connected with the Earth, rectangular $O\xi\eta\zeta$, the ship's movement being considered as regards flat and immobile Earth;

(2) mobile, connected with a ship, originating in its CG, with which it travels in space $GXYZ$, and axis GX points towards the bow, axis GY points towards the starboard side, axis GZ points upwards.

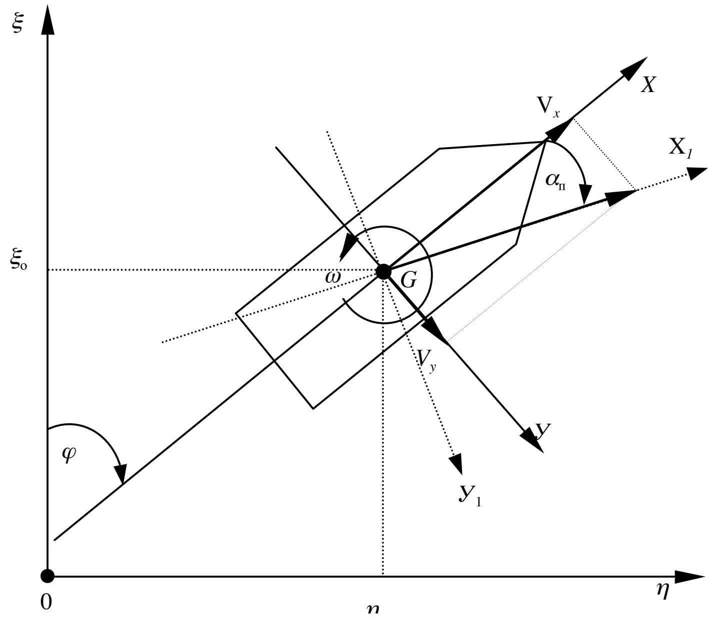


Fig. 1 System of axes and position fixes of a ship

(3) semi connected, mobile $GX_1Y_1Z_1$ (wind axis), originating in GZ, connected with line speed vector.

Axes GX_1 go along speed vector V, and axis GY_1 points towards the starboard side.

Kinematical equations of connection of rotation in matrix can be written in the form[1].

$$\begin{bmatrix}\omega_x \\ \omega_y \\ \omega_z\end{bmatrix} = \begin{bmatrix}1 & \sin\Psi & 0 \\ 0 & -\cos\varphi\cdot\sin\Theta & \cos\Psi \\ 0 & \cos\varphi\cdot\cos\Theta & \sin\Psi\end{bmatrix}\begin{bmatrix}\Theta \\ \Psi \\ \varphi\end{bmatrix} \quad (1)$$

Where φ is angle of yaw; ψ is angle of trim; θ s angle of list; ω_x ω_y ω_z are projections of angular speed of rotation on the axes.

At Ailer minor angles and similar level of derivatives, kinematical matrices become single, and the projections of angular speed on connected axes coincide with the derivatives of corresponding Ailer angles.

$$\omega_x = \dot{\Theta}; \quad \omega_y = \dot{\Psi}; \quad \omega_z = \dot{\varphi}.$$

Planes $O\xi\eta$ and GXY coincide with water plane, kinematical parameters of movement being line speed V, angular speed of rotation $\grave{u}$ and drift angle αt due to turn.

To describe movement of objects we'll use kinematical differential equations, as parameters of ships' travel are described without regard to the forces causing the movement.

Let own vessel *A* be at the origin of geocentric system of axes, and vessel *B* is at a distance of D_{bg} and bearing B_{bg}, as shown in Fig. 2.

Analytical method to estimate the parameters of close approach is based on the fact that the vector of speed of relative travel $\overrightarrow{V_{\tilde{n}}}$ equals vector difference in speed of vessels *A* and *B*:

$$\overrightarrow{V_{\tilde{n}}} = \overrightarrow{V_{\text{B}}} - \overrightarrow{V_{\text{A}}} \qquad (2)$$

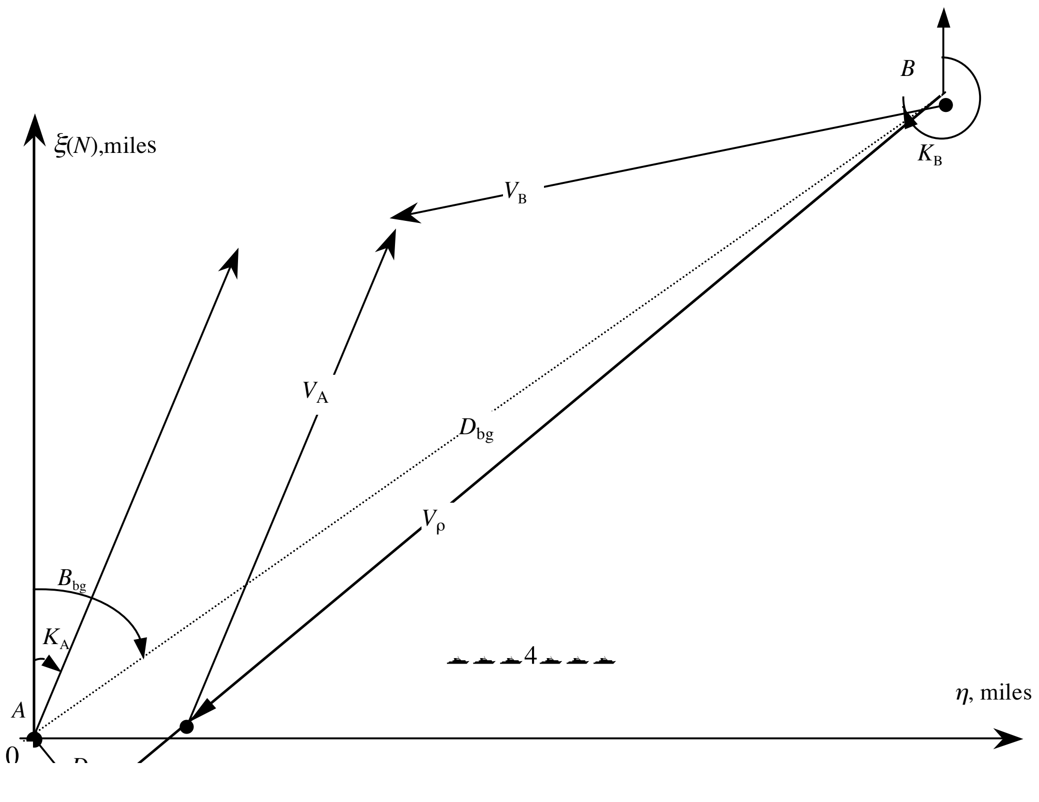
Let/s determine the projections of relative speed on axes ζ and η:

$$V_{\text{oç}} = V_{\text{Bç}} - V_{\text{Aç}} = V_{\text{B}} \cdot \sin K_{\text{B}} - V_{\text{A}} \cdot \sin K_{\text{A}} \qquad (3)$$

$$V_{\text{oî}} = V_{\text{Bî}} - V_{\text{Aî}} = V_{\text{B}} \cdot \cos K_{\text{B}} - V_{\text{A}} \cdot \cos K_{\text{A}} \qquad (4)$$

The module of relative speed $V_{\tilde{n}}$ is:

$$V_\rho = \sqrt{V_{\rho\eta}^2 + V_{\rho\xi}^2} \qquad (5)$$



With invariable courses and speeds of the objects' movement the track of the objects' movement the track of movement of vessel *B* relative to *A* is a straight line, the equation of which can be written in the form

$$\xi - \xi_B = \lambda \cdot (\eta - \eta_B) \tag{6}$$

Where $\lambda = \tan\alpha = V_{\tilde{n}\hat{i}} / V_{\tilde{n}\c{c}}$ is the tangent of angle to the axes η, and η_B and ζB are the ship's fixes. They can be estimated through polar coordinates:

$$\eta_B = D_{bg} \sin B_{bg}, \ \xi_B = D_{bg} \cos B_{bg} \tag{7}$$

The distance of the closest approach D_{cpa} is determined by a perpendicular drawn from the origin of the axes on RML_B and it can be estimated from:

$$D_{CPA} = \frac{|\xi_B - \lambda \cdot \eta_B \ |}{\sqrt{1 + \lambda^2}} \tag{8}$$

The distance to the point of the closest approach can be determined from (Fig. 2):

$$\hat{A}\tilde{N} = \sqrt{D_{bg}^2 - D_{cpa}^2} \tag{9}$$

To draw diagrams of dependence of the distance between the vessels on time it is necessary to estimate regular ships' movements on the axes η and ξ :

$$\eta_A = V_A \cdot \sin K_A \cdot t\,;\;\; \xi_A = V_A \cdot \cos K_A \cdot t \tag{10}$$

$$\eta_B = D_{bg} \cdot \sin B_{bg} + V_B \cdot \sin K_B \cdot t$$

$$\xi_B = D_{bg} \cdot \cos B_{bg} + V_B \cdot \cos K_B \cdot t \tag{11}$$

With regard to dependence (10) and (11) the distance between the ship will be determined from:

$$D(t) = \sqrt{(\eta_B - \eta_A)^2 + (\xi_B - \xi_A)^2} \tag{12}$$

The dependence shown enables to draw a diagram of relative distance variation and to determine the risk of 'close quarters'.

At close quarters it is practically impossible to solve the problem of safe passage. Such a situation occurs when the target is detected visually or spotted on the radar screen suddenly at close quarters, due to unforeseen maneuver, low reflectance or lack of proper lookout. It is impossible to do any estimates under such situation, and delay of maneuver can result in an accident. Such a maneuver, which should be carried out immediately to prevent collision, in theory and practice of ship/s control is called "maneuver of the last moment" [6-8].

Its peculiarity is in the requirement for strong, maximum operating effects. Moreover, in compliance with Rule 2 of Colregs-72 it is not required to observe any rules, which are in force under ordinary conditions, but one: to choose such a maneuver which would enable to avoid a collision, and if it is impossible, to minimize possible damages.

Variety of situations and a great number of alternatives at the first sight do not make it possible to solve the problem.

In the meanwhile thorough analysis of the close quarters situation with regard to all factors enable both to propose the algorithm of the problem solution and derive analytical formulas to choose the single maneuver possible. To solve the problem it is necessary to introduce two axioms, which are obvious and do not require to be proved.

Axiom 1. If risk of collision exists, these targets are dangerous and the condition $(\mathrm{d}Br/\mathrm{d}t) = 0;\, (\mathrm{d}D/\mathrm{d}t) < 0$ is fulfilled (See Fig. 3).

Axiom 2. The optimum altering course for preventing collision is parallel or counter course of the hazardous vessel. If our vessel thus alters her course, it will minimize the dependence of hazardous approach on probable maneuver of the vessel on reciprocal course. Increasing or decreasing her speed and altering her course off our vessel improve the close quarters situation and altering course towards our vessel is hardly possible, but it can be foreseen and given regard to by introducing safe distance, of which it will be said more detailed below. By introducing Axiom 2 we bring in certainty into the problem solution and we can estimate the last moment maneuver for the hazardous vessel beforehand. It is convenient to estimate the time for maneuver commencement by the parameter observed, i.e. the distance between the vessels.

To obtain analytical dependencies we'll consider the triangle AMB from which we'll derive correlations provided that the target's bearing doesn't change:

$$\sin q = \frac{k \sin P}{\sqrt{1 - 2k\cos P + k^2}} \qquad D_{\text{ÒÀÊ}} = V_{\text{A}} \cdot t_{\text{crs}} \sqrt{1 - 2k\cos P + k^2} \qquad (13)$$

where P–is relative course, changing from 0 to 180º; t_{crs} – is period of time from the commencement of observations until arrival at the position of crossing courses; k– is relation of speeds $V_{\text{A}} / V_{\text{B}}$; q– is course angle.

The dependences derived (13) show that the situation of hazardous approach is determined by correlation of speeds of movement of our vessel and targets, by value of relative course and, what is particularly important, by our vessel's speed, and the less the speed is the more preferable the situation of close quarters is.

To derive analytical dependences for the calculation of the vessel's maneuvering characteristics while the last moment maneuver with reference to dependences (13), from Fig. 3 we derive [6-8]:

$$D_{\text{br}} = \acute{I}_{\text{br}} \grave{I} \sqrt{1 - 2k\cos P + k^2} \qquad (14)$$

$$D_{\text{stb}} = \acute{I}_{\text{stb}} \grave{I} \sqrt{1 - 2k\cos P + k^2} \qquad (15)$$

$$D_{\text{port}} = \acute{I}_{\text{port}} \grave{I} \sqrt{1 - 2k\cos P + k^2} \qquad (16)$$

The expression under the radical will be $R = \sqrt{1 - 2k\cos P + k^2}$.

With reference to error of *dimensions*, size of ships and probable unfavorable maneuver by the

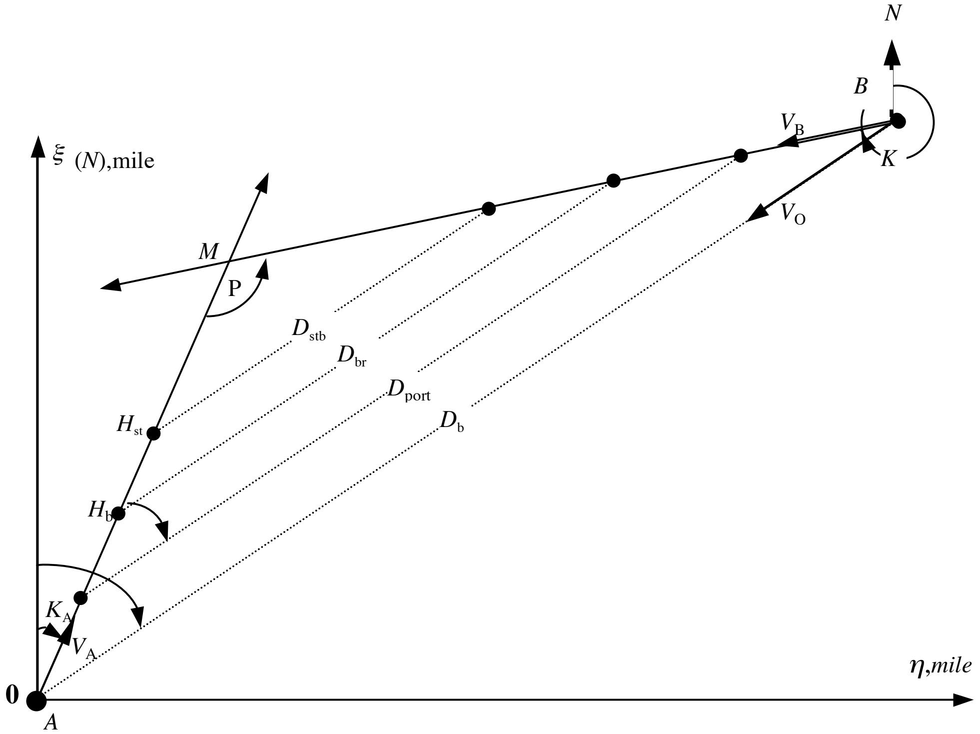


Fig. 3. Diagram of close quarters situation when ships pass clear

on-coming vessel towards ours, it is necessary to introduce safe navigation distance $S_{res} = f(L, M_D, t)$. With reference to dependences (13) the expressions (14)~(16) will look like:

$$D_{br} = (S_{br} + S_{res})R; \tag{17}$$

$$D_{port} = \left[\left(\grave{a}_{port} + b_{port} \cdot tg\frac{\Delta k_{port}}{2}\right) + S_{res}\right] \cdot R; \tag{18}$$

$$D_{stb} = \left[\left(\grave{a}_{stb} + b_{stb} \cdot tg\frac{\Delta k_{stb}}{2}\right) + S_{res}\right] \cdot R \cdot \tag{19}$$

where $a_{port}, b_{port}, a_{stb}, b_{stb}$ - coefficient of turn ability, $S_{br.}$ – is headway for mode astern fool; ΔK - is turn angle, determined by the expressions:

$\Delta k_{port} = D$ while

$$q_{stb};\ \Delta k_{stb} = 180 - D \text{ while } q_{stb}; \tag{20}$$

$$\Delta k_{port} = 180 - D \text{ while } q_{ports};\ \Delta k_{stb} = D \text{ while } q_{ports}. \tag{21}$$

Safe navigation distance is determined by the expression:

$$S_{\mathrm{res}} = L_{\mathrm{rs}} + M_{\mathrm{D}} \frac{\sin P}{\sin(P+q)} + \ell_2 \cdot \cot\frac{P}{2}, \tag{22}$$

where L_{rs} is the distance from the position of Radar antenna to the vessel's forepeak; M_{D} is mean square error of distance determination; ℓ_2 is direct target-shifting when putting the rudder hard over; D_{cur} current distance.

With reference to dependences (17)~(22), the period of time required to make the last moment maneuver by braking will be determined from the expression:

$$\grave{O}_{\mathrm{br}} = \left(D_{\mathrm{CUR}} - D_{\mathrm{br}}\right)/V_{\tilde{n}}R \tag{23}$$

The time of approach of the last moment maneuver by turning to port is:

$$\grave{O}_{\mathrm{port}} = \left(D_{\mathrm{CUR}} - D_{\mathrm{port}}\right)/V_{\tilde{n}}R \tag{24}$$

The time of approach of the last moment maneuver by turning to starboard is:

$$\grave{O}_{\mathrm{stb}} = \left(D_{\mathrm{CUR}} - D_{\mathrm{stb}}\right)/V_{\tilde{n}} \cdot R \tag{25}$$

The dependences derived (17)-(25) allow to elaborate recommendations necessary for the last moment maneuver, and to automate selection of the maneuver type with reference to the parameters of target movement, to the close quarters situation and to the vessel's maneuvering characteristics.

The dependences derived are true for an ideal model of danger pass-by, when the vessel's bearing doesn't change. If the vessel's bearing changes within dangerous limits (which are set by a navigator through bringing in value $\pm \mathrm{d}q_{\mathrm{set}}$), the problem should be solved in compliance with the axiom taken regarding the position of crossing courses.

Solution technique will be the former one, but the dependences will vary.

The algorythm of selection of the maneuver type is in determining the distance between the vessels and the time of approach of the last moment with regard to the close-quarters situation, the parameters of movement of the targets and the vessel, maneuvering characteristics of own ship and targets to carry out for all possible alternatives, including the last one. If the time of the last moment maneuver is lost, it is necessary to maneuver by stopping FAS and make the last turning maneuver.

Conclusion. The subjects in question relate to the preliminary preparation of the vessel for navigation in special conditions. This enables to develop the manoeuvring algorythm and automate certain navigation processes.

One of the ways to improve is to reduce the navigator's workload on the bridge through the use of automatic tools, and to establish expert systems.

Navigational control procedure of the vessel's position involves the information of two types - procedural and declarative.

Procedural information is in the algorythms of actions involved with maintaining navigational control and giving orders. Declarative information is in the data involved with the navigator's work.

The combination of these two types comprises the information base. This information may be described through vectors, matrices or hierarchic structures.

There is a lot of information about vessels and effects on them in the same base, and it's required to establish a special system to control the information base. It enables to exploit the information and, if necessary, to extract it from the base, modify and enter again in the form required.

With improvement of the information base of maneuvering process information is presented in the form of knowledge, this form having combined the features of procedural and declarative types.

With lack of knowledge maneuvering process is controlled through test and error which results in increasing probability of error and navigational incident.

The dependencies derived have enabled to establish regularities of the navigator's actions in close quarters, called “the law of the last maneuver moment”.

It is true for all types of moving objects–above water, marine and submarine.

However, it is necessary to make calculations in horizontal plane for above water and submarine objects. If there is no close quarters situation in horizontal plane, collision will not occur in vertical plane either.

The main point of the law is that the operator's actions depend on ‘close quarters’ geometry, defined by relative course p and course angle q.

If the starboard side course angle and $p > 90^\circ$ first comes the moment of turn to port and then turn to starboard.

The moment of commencement of full astern depends on the present speed of the vessel and either comes first or follows turn to port or turn to starboard.

If the starboard side course angle and $p < 90^\circ$ first comes the moment of turn to starboard and then turn to port.

The moment of commencement of full astern depends on the present speed of the vessel and either comes first or follows turn to port or turn to starboard.

In case of aircraft it is necessary to consider brake action handsomely.

To calculate the moment of commencement of ‘close quarters’ it is required to know manoeuverability of the object to select the type of maneuver.

The ‘close quarters’ situation may be controlled by sole parameter–relative distance.

3 Suggestions

With lack of knowledge maneuvering process is controlled through test and error which results in increasing probability of error and navigational incident.

Due to the lack of systematized concept when providing maneuver characteristics, only 20% of data about providing certain reserve of speed control to prevent ship control loss, providing maneuvering characteristics, rules of the road, predicting collision danger, proper quantity of is available.

In order to solve the problem, we offer 5 basic steps.

(1) To develop positioning system and systematize data presentation as to ship's maneuvering characteristics.

(2) Develop ships navigation guide, that will contain all necessary information on maneuvering in congested waters, in poor weather conditions, in shallow waters, choosing optimal speed and how to control it.

(3) Systematize collision avoidance systems, including relative motion patterns.

(4) Develop and implement "segregation of duties" schemes for masters and pilots, including legal models of sharing liabilities and duties.

(5) Develop computer-based Safety Assurance System.

All these will help to find proper solution in providing navigational safety onboard and will help to minimize accidents risk.

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The Maritime Educational Training (MET) and the Maritime Safety

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0 Introduction

This article analyses the well known relationship between the Maritime Educational Training (MET) and the serious deficiencies of the ships which can lead to maritime accidents.

We have focussed this question considering the importance that mainly has the educational training at the operational and management level on board the ships and its influence on the maritime safety and the pollution prevention.

The main problems of the present crews in most of the companies around the world have also been assessed; it is known that there are multinational crews and it can usually cause problems with the working language, other questions as the poor educational training in some countries, the actual problem of the certificates falsification, the crews ignorance of the international regulations related with maritime safety and the pollution prevention...

It is also included an exam of the serious deficiencies detected in the Port State Control Inspections related with the educational training of the crews and the establishment of the relationship with possible maritime accidents.

.1 Objectives

This article analyses the relationship between the Maritime Educational Training (MET), the Maritime Safety on board the ships and the serious deficiencies detected in relation with this subject by using data from the inspections made by the Paris Memorandum of Understanding on Port State Control.

.2 Used data

In this article have been used the SIRENAC database (this is the informatics application used by Memorandum of Understanding (MOU) on Port State Control (PSC) for consulting and reporting the data related with ships inspected under their provisions), the 2004 Blue Book and the results of the Concentrated Inspection Campaign (CIC) made on 2002 to verify the compliance of the STCW -78/95. The CIC's have as main objective the reinforcement of the inspections related with decided specific requirements, these campaigns are applied for a limited period of time, after which the results are analysed to achieve Conclusion.

.3 Methodology

Different ships registered in black, grey and white list flags have been selected, the inspections made on them during the year 2004 and the results of the Concentrated Inspection Campaign on STCW-78/95 made on the same ships during 2002 analysed. The followed criteria for selecting the ships has been that ships in which the CIC on STCW-78/95 had been applied in 2002, were also inspected in 2004, because the last blue book is referenced to the results obtained in 2004

With reference to the inspections made on 2004, only SOLAS related operational deficiencies have been selected in our analysis, and the study of the STCW Campaign has been centred in the questionnaire to be completed during the inspections.

All the ships have been selected by chance whenever they fulfilling the requirements above indicated.

1 SOLAS related operational deficiencies

- Muster list
- Communication
- Fire drills
- Abandon ship drills
- Damage control plan
- Fire control plan
- Bridge operational
- Operation of GMDSS equipment
- HSC operation
- Monitoring of voyage or passage plan
- Cargo operation
- Operation of machinery
- Manuals, instructions, etc.
- Establishment of working language on board
- Dangerous goods or harmful substances in packaged form
- Operation of fire protection systems
- Maintenance of fire protection systems
- Operation of live saving appliances
- Maintenance of live saving appliances
- Evaluation of crew performance
- Other (SOLAS operational)

2 Concentrated inspection campaign—STCW-78/95 questionnaire

Is the Flag State on the White List(IMO List)?

Safe manning document on board (SOLAS V/13)?

Is the ship manned according to the manning document?

Watch duty schedule posted(Ch VIII/1.5)?

Deck and Engineer officers hold appropriate certificates(Ch II & III)?

Are the certificates issued under the STCW95 amendments?

Is the correct number of personnel certified for operating the GMDSS in the sea area the ship is certified for (A-IV/2)?

Are the required documentation(s) for personnel with designated duties in order (Re: Muster list)?

If dispensation is issued to any of the required certified seafarers is it valid (not exceeding 6 months, Article VIII)?

Has the Flag State been consulted on any discrepancy?

3 Results

Three flags included in the very high risk category of the Black List Flags, three Grey List Flags and three White List Flags have been selected. Two ships per flag have been analysed for studying the SOLAS related operational deficiencies and the compliance of the STCW-78/95. The results are as follows:

Table 1 SOLAS related operational deficiencies (2004)

IMO	Flag list	Flag in 002	Current flag	Inspections in 2004	Number of def. in 2004	Number of detent. in 2004	Deficiencies
5070945	Black	Albania	Albania	3	26	3	Mainten. of communications systems deficient (2 inspections)-Mainten. of fire protection systems deficient- Mainten. of life saving appliances deficient (2 inspections)-Nautical public., navig. charts not up to date (3 inspections)-Nautical public. missing−Muster list not up to date
7392244	Black	Albania	Albania	9	74	5	Mainten. of fire protect. systems deficient (6 inspections)- Mainten. of life saving appliances deficient (3 inspections)-Navig. charts, nautic. publications not up to date (5 inspections)-Muster list not posted−Ship Security Plan not in working language−ISM

							manual not in working language–Security operational deficiencies–ISM records delayed–Echo sounder missing (3 inspections)-SART & EEBD procedures missing–Mooring arrangements, one roller broken (2 inspections)-High pressure F.O. system not according with SOLAS–General mainten. of ship and equipment deficient

7111860	Black	Tonga	Albania	1	4	1	Mainten. of fire protection systems deficient-Mainten. of life saving appliances deficient-Navig. charts not up to date
8230998	Black	Tonga	Korea Democr. Peop. Rep.	2	13	1	Mainten. of life saving appliances deficient -Nautical public., navig. charts not up to date–Muster list not up to date–Satellite EPIRB wrong location–Table of working hours not posted
7614965	Black	Cambodia	Cambodia	1	5	0	Annual survey not carried out–Cleanliness of ER–Crew certificates not original
6801212	Black	Cambodia	Cambodia	1	8	0	Mainten. of life saving appliances deficient -Compass correction log missing
8000123	Grey	Morocco	Morocco	2	7	0	Mainten. of life saving appliances deficient (embarkation ladder)
9143843	Grey	Morocco	Morocco	4	14	0	Mainten. of life saving appliances deficient -Mainten. of fire protection systems deficient-Nautical public. not up to date–Cleanliness of ER–Safety of navigation (arc of stern light not as required)-Operation of fire protection systems (fire doors key closed)
8301620	Grey	Cyprus	Cyprus	3	17	0	Mainten. of fire protection systems deficient-Nautical public. missing (3 inspections)-Navig. charts not up to date–Operation of GMDSS equipment–Mooring arrangements, four rollers sized
9064891	Grey	Cyprus	Cyprus	2	0	0	
8125844	Grey	Vanuatu	Vanuatu	1	3	0	Mainten. of fire protection systems deficient (emerg. fire pump)-Mainten. of life saving appliances deficient
7928794	Grey	Vanuatu	Vanuatu	1	0	0	
8420098	White	Germany	Germany	1	0	0	
9189574	White	Germany	Germany	2	0	0	
8801917	White	Isle of Man	France	2	1	0	Cleanliness of ER

9179751	White	Isle of Man	Isle of Man	1	0	0	
6704426	White	UK	UK	1	0	0	
8519954	White	UK	UK	3	2	0	Table of working hours not posted-Not manned according to the min. safe manning document

The ship Normand Pioneer–IMO 9179751 was inspected in 2005 and was found 11 deficiencies.

Table 2: Categories of deficiencies

Category of deficiencies	Number of inspections in which the categorie is repeated	Total number of insp. Analysed	Category found in black list flag	Category found in grey list flag	Category found in white list flag
Muster List	3		×		
Operation of GMDSS equipment	4		×	×	
Bridge operational	18		×	×	
Operation of machinery	3		×	×	×
Manuals, instructions, …	12		×	×	
Establishment of working language on board	2		×		
Operation of fire protection systems	2	40	×	×	
Maintenance of fire protection systems	11		×	×	
Maintenance of live saving appliances	11		×	×	
STCW	2		×		×
Other (SOLAS operational): ISM /ISPS operational, general maint. of ship and equipment	7		×	×	

Table3: STCW deficiencies (CIC 2002)

IMO	Flag list	Flag in 2002	Current flag	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Def	Det	LW
5070945	Black	Albania	Albania	N	Y	Y	Y	Y	N	Y	Y	NA	NA	N	N	N
7392244	Black	Albania	Albania	N	Y	Y	Y	Y	Y	Y	Y	NA	NA	N	N	N
7111860	Black	Tonga	Albania	N	Y	Y	N	N	N	Y	Y	N	Y	Y	N	Y
8230998	Black	Tonga	Korea Democr. Peop. Rep.	N	Y	Y	Y	Y	N	Y	Y	NA	N	Y	N	Y
7614965	Black	Cambodia	Cambodia	N	Y	Y	Y	Y	N	Y	Y	NA	NA	Y	N	N
6801212	Black	Cambodia	Cambodia	N	Y	Y	N	Y	N	Y	Y	NA	N	Y	N	Y
8000123	Grey	Morocco	Morocco	Y	Y	Y	Y	Y	N	Y	Y	NA	NA	Y	N	Y
9143843	Grey	Morocco	Morocco	Y	Y	Y	N	Y	Y	Y	Y	NA	NA	N	N	N
8301620	Grey	Cyprus	Cyprus	Y	Y	Y	Y	Y	N	Y	Y	NA	NA	Y	N	Y
9064891	Grey	Cyprus	Cyprus	Y	Y	Y		Y	Y	Y	Y	NA	NA	Y	N	Y
8125844	Grey	Vanuatu	Vanuatu	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	N	N	N
7928794	Grey	Vanuatu	Vanuatu	Y	Y	Y	N	N	N	Y	Y	N	Y	Y	N	Y
8420098	White	Germany	Germany	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	N	N	N
9189574	White	Germany	Germany	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	N	N	N
8801917	White	Isle of	France	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N

		Man														
9179751	White	Isle of Man	Isle of Man	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	N	N	N
6704426	White	UK	UK	Y	Y	Y	N	N	N	Y	Y	N	N	Y	N	Y
8519954	White	UK	UK	Y	Y	N	N	Y	Y	Y	Y	NA	Y	Y	N	N

Y—Yes；N—No；NA—Not applicable；Def—Deficiencies；Det—Detention；LW—Letter of Warning.

Comments of the deficiencies detected per category:

Muster List: This category of deficiency on board the ships implies that the crew does not know their obligations in emergency cases, increasing the reaction time and generating confusion. This can lead to an aggravation of the emergency situation.

Operation of GMDSS equipment: The complete control of this system is always required; much more if an emergency takes place to receive the external assistance necessary to guarantee the maritime safety and the pollution prevention in such a case.

Bridge operational: Basic for the safety of navigation.

Operation of machinery: Cleanliness in engine room has been indicated in some of the reports by the inspectors; this deficiency is subjective and ambiguous because it does not specify if the risks related to this deficiency can take place according to the level of cleanliness found. These risks, known by everybody could be person falls, possible fires…

Establishment of working language: Obviously this is a necessity to understand and to be understood on board. The safety management/ship security plan has to be in the working language to achieve the control of the content and procedures.

Maintenance of fire protections systems: If the maintenance of fire protections systems is deficient, a controllable fire with the available means on board could move on to an uncontrollable emergency and lead to personal and material losses.

Maintenance of live saving appliances: Abandon ship cases and other cases in which human life can be threatened require the immediate availability of all the live saving appliances.

STCW: Photocopies of certificates of compliance can indicate that these certificates have been forged. It can also indicate that the crew training does not agree with the requirements of the STCW-78/95 Convention.

ISPS operational: Complete vulnerability faced with threats to the ship's security.
Comments of CIC on STCW-78/95

- had been found that Deck and Engineer officers did not hold appropriate certificates in Black, Grey and White List Flag ships
- had also been found certificates not issued under the STCW95 amendments in Black, Grey and White List Flag ships

There are several questions of the inspection reports do not understandable:

- Ships belonging to non White List Flag indicated in the reports that the Flag State was on the White List (IMO List)

- Ships in which different STCW deficiencies were found, it is indicated not deficiencies found in the inspection reports

4 Conclusion

Has been observed that the same ships have been inspected in several times and there are some deficiencies remaining on board in all the inspections without any kind of corrective action by any competent authority.

Ship owners whose Flag State is on the Black List inspected by MOU-PSC with a big number of deficiencies try to avoid future inspections by changing the ship's name and Flag, maintaining deficient safety standards.

Has also been verified that the crews do not know as well as required the different procedures related with the maritime safety and the pollution prevention, even being established in the safety management system, even though it is a common practice to maintain the files which indicate that periodical practices have been carried out.

In the different reports have been observed that the maintenance of fire protection systems and the maintenance of live saving appliances were deficient in a high number of inspections, even though neither the owners nor Administrations applied the required measures to avoid substandard ships.

In this article have also been analysed different cases of forged certificates, a common practice in Black List Flags.

According to the CIC on STCW results, sometimes the management and operation of the ships, whatever was the Flag State List of the ship, are under the responsibility of officers without appropriate certificates. In the same way, there are certificates not issued under the STCW95 amendments, this deficiency has also been found in ships whose Flag State were in any of the three Flag Lists.

To conclude, can be indicated that the inspection reports are ambiguous and they do not specify accurately the deficiencies, the consequences and the required action to be taken in order to rectify those deficiencies. Likewise that fact does not allow an adequate treatment in the future inspections made by other Administrations in the ambit of MOU-PSC.

In general, it is observed that the crew training and education do not agree with the requirements of the STCW-78/95 Convention.

Acknowledgements

Our acknowledgements to Mr Laureano Fernádez of the “Dirección General de la Marina Mercante” and to the Secretariat Memorandum of Understanding of París.

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Poor Monitoring of the Navigation and Steering Equipment Increases the Reaction Time in Fault Situations

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Abstract Behaviour of the officer of the watch (OOW) in managing a failure in the automatic navigation and steering system has been studied by analysing five real accident cases. This paper describes the main results of the analysis. In all analysed cases the accident was partially caused by delayed operator action after a critical failure in the system. The situation is extremely difficult for the operator, when the system fails to give a direct alarm of the failure. The analysis revealed that the operator does not continuously monitor the performance of the equipment. The OOW concentrates on monitoring the overall situation and the movements of the ship rather than on finding out how the navigation and steering equipment is working. These two levels of monitoring are called 'the process level' and 'the equipment level'. Only if an abnormality is noticed on the process level the OOW pays attention to the equipment level. This can not be considered as a user error or an indication of fatigue, but a quite logical behaviour of the OOW. In all the five analysed accident cases the process level monitoring failed to give the OOW a reason to check the performance of the equipment until it was too late to avoid the grounding. This problem of delayed operator action is particularly dangerous in confined waters. It can not be solved by providing more visual information about the performance of the equipment, due to the behaviour of the operator. It can neither be solved by increasing the training of the users because the delayed operator action is not caused by lack of skills, knowledge or motivation. Some potential ways to solve the problem are discussed in the end of the paper.

Keywords bridge systems; navigation; automatic steering; safety; human factor

0 Introduction

The integrated navigation and control (INC) system of the ship is a technical entity able to automatically measure the position, heading and speed of the ship and to automatically steer the ship after a heading setpoint, a course-over-ground setpoint or a track setpoint.

The basic components of the INC system contain a GPS receiver for defining the position of the ship, the gyro compass for measurement of the heading and the rate of turn, the autopilot for controlling the movements of the ship using the rudders or the azimuthing propulsion units of the ship. Often the system is equipped also with an acoustic log for measurement of the speed of the ship. The system contains also means for editing the track or the route plan and monitoring the system and the movements of the ship relative to the track.

Behaviour of the officer of the watch in managing a failure in the INC system has been studied by analysing five real accident cases. This paper describes the main results of the analysis. In all analysed cases the accident was caused by delayed operator action after a critical failure in the system. Also in all cases the self diagnostics and alarm functions of the system failed to make the operator fully aware about the dangerous failure. Obviously managing the situation becomes extremely difficult for the operator, if the system fails to give a direct alarm of the failure. The analysis also revealed that the operator does not continuously monitor the performance of the equipment. Actually this finding is not surprising. Naturally, it is much more important for the OOW to monitor the overall situation and the movements of the ship rather than to find out how the navigation and steering equipment is working. And most of the time there is nothing abnormal in the behaviour of the equipment anyway. It would be waste of resources to pay much attention to the technical system in stead of following the traffic situation.

These two levels of monitoring are called 'the process level' and 'the equipment level'. The officer of the watch should concentrate on the process level monitoring. This is actually one of the main reasons for the increased use of automation, i.e. to provide the operator with better possibilities to transfer his/her attention from the equipment level to the process level. Consequently, the automatic systems must be designed and built assuming that the operator does not pay attention to the operation of the equipment. And, on the other hand, the operator must be able to assume that there will be a clear indication about any dangerous abnormality in the operation of the equipment. In other words, the system should be able to detect and give a clear alarm about all dangerous failures in the system.

Unfortunately this is not the case in the real life. The self diagnostics of the navigation and steering system did notice or was not able to inform the user about the dangerous situation. The user of the automatic system is seen as the last back-up of the automatic system in failure situations. The designer of the system assumes that the operator can manage the situation if the automation fails. This is a clear conflict of targets: By introducing more automation, the operator's attention is transferred from the equipment level to the higher process level. But, on the other hand, in order to be able to act as the back-up in failure situations, the operator should quickly notice any abnormalities in the operation of the equipment.

The analysed cases clearly show that the operator of an automatic system is not good in detecting equipment failures. The reaction time can be too long for successful handling of the situation, especially in confined waters. This is a consequence of the transfer of the operator's attention to the process level. Only after an abnormality is noticed on the process level the OOW pays attention to the equipment level. This must not be considered as a user error or an indication of fatigue, but an essential feature of the behaviour of the operator of an automatic system. In all the five analysed accident cases the process level monitoring failed to give the OOW a reason to check the performance of the equipment until it was too late to avoid the grounding. This problem of delayed operator action is particularly dangerous in confined waters. It can not be solved by providing more visual information about the performance of the equipment, since the operator does not pay attention to such information. It can neither be solved by increasing the training of the users since the delayed operator action is not caused by lack of skills, knowledge or motivation.

1 Analysis of the five accident cases

Navigating a ship is a safety critical function and the automatic technical system taking care of this task should be extremely safe and reliable. The INC system of a ship is backed-up by several manual control modes and extra navigation and steering equipment. But still accidents take place due to failures in the technical system. The back-up mechanisms do not always work properly. Is there a common reason why a single failure in the integrated navigation and control system leads to an accident? Is there a weak point in the system? An answer to these questions was searched by analysing the following five real accident cases:

- The grounding of m/s Royal Majesty close to the east coast of the USA in June 1995[1]
- The grounding of the passenger ferry m/s Silja Europa in the Swedish archipelago close to Stockholm in January 1995[2]
- The grounding of the tanker ship m/t Natura in front of Sköldvik, Finland in October 1998[3]
- The grounding of the ro-ro passenger ferry m/t Finnfellow in Åland, Finland in April 2000[4]
- The grounding of the passenger ferry m/s Isabella in Åland, Finland in December 2001[5]

The chain of events of each of these cases contains a failure, a disturbance, a malfunction or wrong use of the INC system, or a combination of these. The cases were analysed by looking at the failed protections and by investigating the timeline of the chain of events. The aim was to find out if the five cases have common factors explaining why the fault situation developed into an accident. Localising such factors could help in development of the safety of INC systems.

The protection methods were studied by asking the following two questions: “Which methods were used to prevent the development of the fault situation into an accident?” and “Why these protection methods failed?” The first question identifies the protection methods and the second one identifies the causes of breaking of the protections.

The analysis was simplified by dividing the protection methods into four categories:

- automatic recovery mechanisms
- operator action based on alarms from the equipment level self diagnostics
- operator action based on alarms from the system level self diagnostics
- operator action based on his/her own observations about the performance of the equipment

The timeline analysis of the chain of events focused in studying the failure tolerance time, the detection delay and the reaction delay. The timeline of a fault situation is shown in Fig. 1. The picture is based on the 'Fault timeline' by Powel-Douglass[6].

The most interesting moments in the timeline analysis are the time of the failure, the time of detection of the abnormality, the time of starting the corrective action, the last possible moment to take the corrective action to avoid the accident (i.e. the point-of-no-return) and the time of the accident. The time of the dangerous failure is T_0. After this moment the ship is in the dangerous state. An accident takes place if no effective corrective action is taken before the point-of-no-return. The time when the user detects the abnormality is T_h. After this moment the user has to decide what to do in the situation and to take the corrective measure. The time of starting the corrective action is T_k. There is a maximum time for starting the corrective action after the failure. This time margin varies case-by-case. This is called the *failure tolerance time* and it ends at the moment T_1, which is the *point-of-no-return* of the particular fault situation. After this moment the user does not have enough time for any corrective action to prevent the accident.

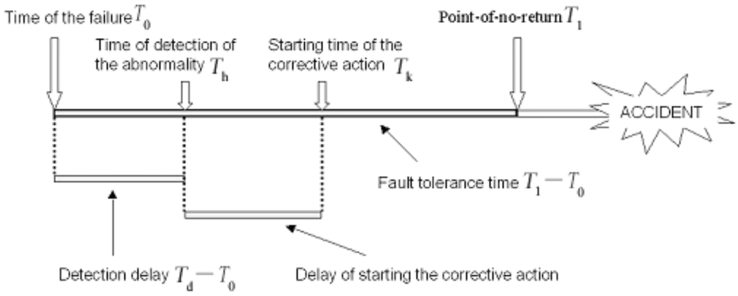

Fig. 1 The timeline of a fault situation

2 The main findings of the analysis

As the result of the analysis, some interesting factors common to the accident cases were found:

Firstly, the standard protection mathod against failures in the automatic system is based on manually activated back-up functions and devices. It is up to the user to activate the necessary back-up function or device after a dangerous failure. In other words, everything depends on the user after a dangerous failure.

Secondly, the self diagnostics of the automatic system seems to have serious shortcomings. Disability of the system to provide the user with appropriate information about the failure and its severe consequences was common to all analysed cases. Consequently the user lost the situation awareness and did not realise the necessity of a particular corrective action to avoid the accident until it was too late.

The third feature common to the analysed accident cases is the inactivity of the user to monitor the equipment. In all cases the user had several indications about the abnormal behaviour of the system on the bridge. However, the user of the INC system did not notice these indications because he/she did not actively check the operation of the equipment. Not even the most critical ones, such as the rudders and the main propellers.

Fourthly, as a result of the factors mentioned above, the activation of the manual back-up device or function failed. In all five cases the user had a possibility to take a corrective action and to avoid the accident. But this action was either delayed or did not happen at all.

These factors together form a dangerous combination. It seems that groundings and incidents due to a technical failure in the automatic navigation and control system are typically developed according to the chain of events shown in Fig. 2.

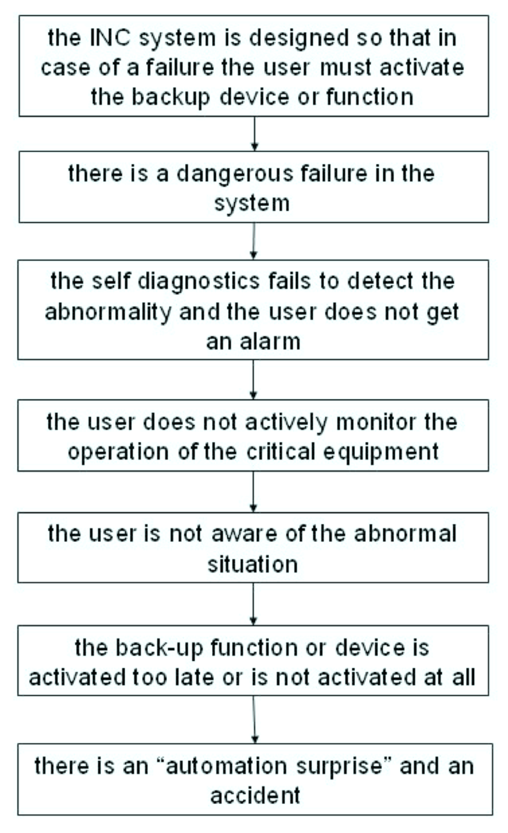

Fig. 2 The chain of events of a typical accident due to a fault of the INC system

3 The monitoring strategy of the OOW and its consequences

It might seem strange that the user of the INC system does not pay too much attention to the operation of the equipment. In the accident investigation reports this behaviour is often interpreted as an operator error. Is it a sign of fatigue or over-reliance on the technical system or is there something wrong with the design of displays or with the placing of critical indicators? Is there lack of information on the bridge about the performance and condition of the equipment or is this a result of insufficient training of the deck officers to use the INC system in the right way?

The monitoring strategy of the operator of an INC system is, however, very logical. There are two entities to be monitored: the process and the technical system controlling the process. The process in this case means the movements of the ship relative to the planned route and possible obstacles, the weather conditions, the traffic situation and also the communication with the outside world. The technical system consists of the navigation sensors, the communication links between the units of the system, the power supplies, the processing units, the automatic pilot, the propulsion units and the steering equipment. It is quite natural and also correct that the monitoring of the process is on the highest priority. An experienced deck officer does not pay too much attention to the instruments, but focuses his/her attention to the traffic situation and to the movements of the ship. After using the automatic system for a longer time the operator has learned that the system operates properly as far as there are no alarms about failures in the system and no indications about abnormalities of the behaviour of the ship on the process level. The equipment level gains attention only if there is an indication about an abnormality on the process level or if there is an alarm. This kind of operator behaviour was quite clearly seen in all analysed cases.

What are the consequences of this kind of operator behaviour? Clearly it has implications on the safety of the INC system in fault situations. The strongest concerns are related with maintaining the situation awareness in abnormal events. If the operator des not actively follow the indications about the behaviour of the equipment, the self diagnostics and the ability of the system to detect and indicate faults and other abnormalities becomes extremely critical. This was confirmed by the analysed cases. If the system can not make the operator aware of the dangerous failure by giving a clear alarm, an accident can be close. A failure without an alarm leads always to delayed operator action. The operator does not initiate a corrective action before some abnormality has been registered on the process level. In the Royal Majesty case the officer of the watch did not notice anything abnormal on the process level and the corrective action was delayed for over 30 hours! In confined waters even some tens of seconds might be too long delay to avoid grounding.

Unfortunately many INC systems seem to contain such failure modes which are not covered by the self diagnostics. The manufacturers of INC systems and navigation equipment have a temptation to put too little effort in development of comprehensive self diagnostics to a new product. The reason is apparent: the customers normally do not pay much attention to such additional features as self diagnostics and alarms. Factors like performance, user friendliness, ergonomics, outlook, compatibility, brand, price etc. are much more important when a comparison between different alternatives and a purchase decision is being made. Good self diagnostics is one of the last things to be developed to a new product. The weaknesses of the self diagnostics may become apparent to the user-and sometimes also to the manufacturer-years after the purchase. Nancy Leveson states: "the carefulness in designing and testing is too often directed to the normal operation of the system, while the unexpected and erroneous states get much less attention"[8].

4 Some proposals

Firstly one has to remember, that it is not necessarily an operator error if the operator does not behave as the designer has planned or assumed. The mismatch of the design of the system and the behaviour of the user could also be seen as a design error. Design errors tend to appear as operator errors during the use of the system. James Reason has addressed this problem by saying: "*the active errors of stressed controllers are, in large part, the delayed effects of system design failures*"[9]. The poor monitoring of the operation of the equipment is not a result of missing knowledge or skills or correct attitudes. It can be seen as a natural and even intentional result of the use of automation. An essential goal of the introduction of navigation automation has been to allow the OOW to transfer his/her attention from the equipment to the traffic situation. So the correct method to solve this problem is not training of the users. Training of the designers might perhaps offer better results.

It is quite obvious that the INC system should not be designed assuming that the user is aware of the operation of different pieces of the equipment. The performance of individual devices is checked only after an alarm or if an abnormal event on the process level gives the operator a reason to do so. This must be the basic assumption in the design of the safety of INC systems in fault situations.

What should be done? Either the self diagnostics of the INC system has to be designed and tested to cover all possible failure modes of all individual devices as well of the whole system in order to make the user aware of all abnormalities in the operation of the equipment. Unfortunately this is hardly possible in the reality. The other alternative is to set the requirements for fault-tolerance of the INC systems higher, i.e. the redundancy has to be based on automatic activation of back-up functions or components after any single failure. These solutions are common in dynamic positioning systems of offshore vessels and in the automatic flight control systems of modern passenger aircrafts[10].

5 Conclusion

Behaviour of the officer of the watch in fault situations of the INC system has been studied by analysing five real accident cases. In the analysed cases the operator action after a critical failure in the system was too much delayed to avoid grounding. The situation seems to be extremely difficult for the operator, if the system fails to give a clear alarm of the failure. The user of the INC system does not continuously monitor the performance of the equipment. In stead of checking the indicators of individual devices the OOW concentrates on monitoring the overall traffic situation and the movements of the ship. These two levels of monitoring are called ‘the process level’ and ‘the equipment level’. Only if there is an alarm or if an abnormality is noticed on the process level the OOW pays attention to the equipment level. This should not be interpreted as a user error or an indication of fatigue, but a part of very logical behaviour of the OOW. In all analysed accident cases the process level monitoring did not give the OOW a reason to check the equipment until it was too late to avoid the grounding. This delayed operator action is extremely dangerous in confined waters due to short time margins, but the case of M/S Royal Majesty shows that sometimes the corrective action of the user may lead to a grounding tens of hours after the failure.

The problem can not be solved by providing more visual information about the performance of the equipment on the bridge. It can neither be solved by increasing the training of the users because the delayed operator action is not caused by lack of skills, knowledge or motivation. Some potential ways to solve the problem were mentioned in the end of the paper, perhaps the most promising one being the introduction of full automatic redundancy to INC systems.

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BETTER WAYS TO DEVELOP STANDARDIZED MARITIME ENGLISH SYLLABUS

(Some recipes from Russian cuisine)

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Abstract Being deeply involved in the professional education of a future "officer-in-charge-of-a-navigational-watch" the English Language Department of the Far Eastern State Technical Fisheries University has developed a new approach to maritime language teaching. Given below are some recipes, which can help to properly implement the standardized IMO recommendations regarding the Maritime English course with account of the increased requirements to the professional training of seafarers.

The basic task of the whole course of the Maritime English (ME) language developed by the department-to teach students to use every bit of their knowledge of language for their own survival (both at sea and ashore).

The most difficult and crucial task was to choose the ingredients, i.e. the topics most important for the daily routine of a navigator of many possible ones because of the time frames for the whole course of English for the students of navigation department. On the one hand the language competence of a seafarer should meet very strict international standards specified by the International Maritime Organization, which recommends the "Model Course 3.17: Maritime English"[1]. On the other hand the situation with the EFL teaching in Russia differs from the global one: on the quantity of hours allotted for ME; on the students' motivation for language learning; on the basic language proficiency of the students and their entry level (not all of our students studied English at school); on the students' professional knowledge (to teach ME to the first year student is rather ungrateful task), etc. So we needed to bring about changes taking into consideration the mentioned differences.

Then we needed the specialist advice concerning the basic themes to be included into the course within the framework of the allotted time. The next step was to think over the very recipe that is the logical sequence of the themes input. But this task was not the difficult one, bearing in mind the starting point: the ship's calling at foreign port. The daily routine of a navigator is governed by numerous regulatory documents; so the best way to arrange the themes within the Maritime English course was to apply for the recommendations and requirements of the said documents.

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1 Model Course 3.17: Maritime English. IMO Publication, 2000

After all ingredients have been double checked, analyzed and prepared 'the chef' got a good recipe of a Russian cuisine which required special tools and techniques (methodology), as well as additional spices (jokes, songs, proverbs and sayings, puzzles) to get a tasty final product.

Keywords IMO requirements; standardized syllabus; maritime English

1 Background

Today educationalists are no longer concerned with the search for a single method, which provides a formula for language teaching. Modern instructors recognize that there are no hard and fast rules dictating how to teach but that they can select from the best of many methods. Instructors need to be clear about the aims of their particular courses and the needs of their particular group of learners so that they can make informed choices about which techniques best suite their circumstances[1].

To keep in line with the current tendencies in society and maritime community; to comply with the requirements for graduates of technical universities, colleges, etc. training professionals for the shipping industry the government supported educational institutions of Russia, have to find some ways to optimize language training.

The existing system of teaching foreign languages for specific purposes at the Technical Universities of Russia has some specific features, which make the whole process of language teaching and learning rather complicated and difficult.

Traditionally every technical student in Russia has to learn at least one foreign language; which is included into the curriculum from his first year of studies at the University. Depending on the student's specialization, the whole period and the intensity of the foreign language learning may vary from one to five years. The curriculum of maritime colleges and universities (tertiary education) of Russia presupposes Maritime English learning by the students of all (i.e. five) years of studies.

An active search for the most efficient ways of the foreign language for specific purposes teaching characterizes the period of the specialists' foreign language teaching as a whole. The prevailing tendencies are the use of the intensive methods of the foreign language teaching and the implementation of the innovative technologies into the educational process.

Russian linguists understand intensification as a rational course outline, improvement of the classes system, usage of technical aids, and development of a new system of academic materials.

Currently the intensive methods of foreign language teaching are used either instead of the traditional ones, or by means of implementing some changes and innovations, which may help to achieve better results within the same period of time. To intensify the process of teaching the most improved achievements of the pedagogical thought and various innovative technologies are being used.

The very process of teaching English for specific purposes at the stage of the tertiary education is aimed at teaching real communication using foreign language.

Mastering the complex of skills and abilities required in the professional activity, mastering language material, which helps to form, develop and utilize the said skills and abilities make the content of the foreign language for professional (specific) purposes. The characteristic feature of ESP is the existence of an actual need.

Another important features of the foreign language for specific purposes teaching are well-defined organization of material and students' academic activity; correct distribution of classes, provision with the appropriate friendly atmosphere, creation of the actual communication situations when the level of the knowledge acquisition is determined by meeting the requirements of the professional communication.

An academic material acquisition takes place rather fast if an academic activity transforms into an academic-creative one. In this case great volumes of academic materials may be acquired in a maximum qualitative way, at the same time the personal reserves of a student; which is possible in the event of the friendly conditions of learning.

The maximum productivity of the professional foreign language learning is achieved in case of its rational organization and productive use of academic time; utilization of intensive technologies; motivated students' activity in the appropriate emotional surroundings; maximum variety of methods, types and forms of academic activity; wide usage of technical aids.

Some scholars consider among the most important characteristics of the professional foreign language the following ones: good results achieved by every student; productive acquisition of great volumes of information within the unit of time; creation of friendly atmosphere, positive emotional microclimate; lack of strength, stress, overstrain; optimal combination of the types of academic activity; high motivation.

2 New Approach To Maritime Language Teaching

Being deeply involved in the professional education of a future "officer-in-charge-of-a-navigational-watch" the English Language Department of the Far Eastern State Technical Fisheries University (dalrybvtuz) has developed a new approach to maritime language teaching.

One of the most important steps on the way to improve the existing system of the foreign language teaching was to re-arrange the curriculum hours allocated for the English language studies. Traditionally the maritime students of the higher educational establishments in Russia study Maritime English during the whole period of the studies at the University. It means a great quantity of academic hours dragged out for a five-year period of studies. In practice the distribution of hours within a semester could bring up to two, four or sometimes even six academic hours per week. The first and the second year students had weekly two or three pairs of English, but the fifth-year students had a chance to study English once a week. It was rather difficult to explain the specific features of the ships' daily routine for a first year student and absolutely impossible to input the required minimum into the two-hours class of English for the fifth-year students. That system proved to be ineffective.

Another problem for the department is the necessity to simultaneously work with the students of different basic knowledge of English (the same group): some of them are the graduates of high schools specializing in languages, but the others-are from some distant villages where they didn't study language at all. The STCW[2] convention specifies the minimum standards of competence for deck/ engine officers regardless of the above fact. The instructors have to be very inventive trying to make odds even.

Low motivation in learning foreign language is also the issue of concern of the language teachers, especially in case with the training specialists for fishery fleet. The fact that their relatives, crewmembers of some coastal ships, have never been abroad can dominate in their mind. Their shortsightedness could hardly be overcome.

New approach to the teaching language for specific (professional) purposes has been developed using both traditional and intensive methods of language teaching. The first step on the way to optimize the foreign language studies was to re-distribute the subjects studied at the early stages of the professional education, as well as hours allocated for language studies. The summarized quantity of the academic hours allotted for the foreign language studies has been divided into three cycles; the term 'cycle" is used by the instructors of the English Languages Department to denote the complete periodic course of language teaching. Since then only a third year student-navigator begins to study English. By that time every student has already had a sailing practice. Every third-year student has to be certified as an able seaman; has already got some basic knowledge of the profession; has studied some disciplines of the professional block, i.e. "Ship's architecture", "Pilot books and sailing instructions", etc. Practically all of them have been abroad-the fact, which helps to keep the motivation in learning language rather high. A prepared and well-motivated person begins to study English language for specific purposes i.e. Maritime English.

The updated curriculum includes three cycles of English both for the content-based and general communication. The duration of a cycle differs depending on the year of studies, namely: four weeks for the third and fourth year students and five weeks for the fifth year students.

The whole approach to foreign language teaching has changed, the main aim of the course could be formulated as follows: to teach every student to freely communicate in any situations of everyday and professional activity irrespective of their complexity and/ or unpredictability. Verbal communication is the issue of the most importance; it is supplemented by other language skills (reading, writing and listening) when necessary.

Intensifying the process of teaching is impossible without setting up special conditions under which the reserves of a human body could be effectively revealed and used. We believe the most efficient method to intensify the teaching process is one which not only gives good final results but is also economic concerning the time consumed and the efforts of the instructor and learner. A method, which activates intellectual work makes for the removal of natural tiredness, i.e. provides for a psychophysical effect.

The methodology of the new approach is based on the principles of the communicative approach to language teaching. This approach meets the International Maritime Organization conventional requirements in that it promotes practical, communicative competence in English.

The success of an educational activity is directly dependent on the planning and organization of the process of learning itself. Students' potential abilities are used in a methodically organized, specially planned progression of studies, and this process contains the actual reserves for the intensification of the teaching process. When solving the problem of optimal teaching conditions, it is extremely important to consider the external factors affecting a learner, the individual response to such influences, plus the adequacy of a student's internal psychophysical state to the given external condition.

The language competence of a seafarer includes the whole complex of his knowledge, lingual skills and abilities acquired in the course of education and training and aimed at the solution of various professional tasks. Successful teaching is based on the instructor understanding and responding to trainees' needs which means he or she must take an interest in the group as individuals. Ongoing needs' analysis can help the instructor decide the focus of the teaching, for the purpose of identifying: what professional tasks the learners are required to carry out in English; how much language the learners can actively use already; the extent of learners' passive knowledge of the language systems of English; the strengths and weaknesses of individual learners[1].

The outline of the whole EL course includes all language skills; use of the intensive methods of teaching helps to better arrange them within the whole period of teaching.

For example, the first step when new officer in charge of a navigation watch arrives, according to the instructions his duty is to get familiarized with the ship's equipment, aids to navigation, navigating bridge, hydrographic publications, etc. A set of check-lists determines this requirements, an officer needs to read the check-lists, company standing orders, pilot books, sailing directions, etc. When calling at port an officer needs to inform the port authorities, ship's agent, as well as other bodies of the fact, to write a telex (ETA telex)–is another important skill. When sailing in congested waters, narrow channels and canals to ensure the safety of navigation, an officer in charge of a navigation watch listens to radiobroadcast, to get the required information. A daily routine of a navigator includes an ability to get such information, to properly report to the authorities of some obstacles, dangers and sightings. To read, write and listen are important for a navigator, no doubt. But an ability to speak and communicate cannot be compared to any other skill. The aim of our work is to teach the students to speak the foreign language and "to survive" under any circumstances of communication. Well-known fact when people having very good vocabulary fail to communicate by the reason of some fears or complexes.

It is important to note that the mentioned approach has been developed about 15 years ago, at the time when it was really difficult to get IMO publications especially in the far East of Russia. Nevertheless many of the ideas developed and implemented by the instructors of the English Language Department of Dalrybvtuz happened to be in conformity with the IMO Model Course 3.17 recommendations.

When developing the syllabus it was absolutely clear that it should include both general and maritime English; every seaman has an opportunity to communicate both at sea in the professional situations and in the port when landing, for example. Furthermore, there exist many situations both at sea and ashore which are very close to each other. One needs to meet not only a pilot, but another seaman when landing. Health problems might arise both at sea and ashore. Such situations are around us; they do not overlap each other but are very similar. The latter fact was successfully (in our opinion) used in syllabus development.

Having analyzed the existing practices of an ocean going vessel and some hypothetic officer in charge of a navigation watch the conclusion has been made: to properly set-up the syllabus it's important to take the daily routine of an officer-navigator as a starting point. Based on this issue three cycles of Maritime English have been divided into the following parts: piloted movement; clearing the ship in/ out; accidents at sea. Three major parts include additional information: an ability to read hydrographic publications, to use aids to navigation, to know the ship's particulars and the arrangement of the ship's crew, etc. to take a pilot on board, it is necessary to inform the port authorities with the ETA telex, then to report the ship's position and arrange the procedure of taking a pilot on board.

Finally, the themes of the first cycle has been arranged in the following sequence: types of ships, ship's architecture and particulars, aids to navigation, ships' crew organogram, duties and responsibilities of a crew, ETA telex-writing, navigation warnings, safety messages, COLREGs, pilot-book, sailing directions, check-lists, commands, taking a pilot on board, piloted movement, passing through narrow channels and canals, anchoring operations, (un)mooring operations, towing. The first stage of the foreign language learning is the most difficult one for the students. Therefore the course of the general English has been simplified a little to achieve a kind of a balance between two aspects. The main point in the general English teaching was to revise the material learned at school and to get the information required at this stage of work. The instructors of general language have better opportunities to revise material learned before and to pay special attention to the difficult and problem-causing material. The general English course supports the maritime topics. The first cycle of the general English (each cycle comprises two aspects every day) includes such themes as greetings, introduction, description of an appearance, place where I live, hotel reservation. All language systems (grammar, vocabulary and phonology) are covered in the syllabus. There exist some distribution of "responsibilities" between the instructors of the general and maritime language. The instructors of the Maritime English, for example, work basically with the grammar phenomena characterizing the maritime language, while the general English instructor covers the other themes.

The second cycle gives better options for the themes of the general and maritime language combination. The second stage is in the foreign port, so the topics to be covered are ship's port clearance in/out by the customs and immigration authorities; port health authorities; sanitary condition of a ship, first aid; agents and shipchandler's services; cargo works. The choice of themes dictates the language skills required: reading ship's papers, instructions, cargo papers, etc; writing telexes, letters, filling in various blank forms, cargo documents; listening to radio messages, urgency messages, radiotelephone communication when rendering first aid, etc; verbal communication with the port authorities, representatives of various companies, etc. The second cycle gives wide opportunities to enrich the general English vocabulary. The themes of the general English overlap the themes of the maritime one, help students to better memorize material: at the doctor; meals; shopping. The topics are similar but the accent differs: in case of learning the principles of rendering first aid at sea the main points of discussion are injuries and wounds, also danger of contagious diseases spread on board. While ashore, during the classes of the general language the material covered–colds, toothaches and other ailments typical ashore.

3 Student Centered Approach

The language classroom presents many opportunities for interacting in English: greetings, social conversations, assisting with problem-solving, asking for help, presenting information, giving instructions and tasks, project works, peer correction, reacting to someone's opinion, etc. Student to student communication in English is an important part of classroom activity. The use of tasks that require the learners to use English to achieve a result is an important part of communicative learning. The key feature of this type of task-based learning is that students need to use language in realistic ways (asking, negotiating, discussing, etc) for realistic purposes (finding out information, exchanging opinions, problems solving, etc.)

E.g.: Ask your cadets to find out the procedure of taking a pilot on board communicating with the oncoming vessel. Firstly: they have to simulate the utilization of the VHF radiotelephone and follow the recommendations for seafarers on this type of communication. Secondly: they need to revise the specific information concerning the pilot-transfer procedure. Thirdly: they might use some authentic materials to solve the problem, namely: pilot book recommendations or other instructions.

They may have to complete some table by finding information from their partners, they may be asked to find a solution to a problem by working together in groups. For example: captain asks a watch-officer to prepare a passage plan filling in the appropriate check-list. Or the students need to complete some shipboard papers to be ready for the ship's clearance inward, like the Crew' Effects Declaration or Ship's Stores Declaration, etc. Information gap tasks replicate "real life communication" which is usually based on the need to exchange information of any kind. It takes place when the captain of the vessel may ask the pilot to explain the procedure of mooring; when the chief-officer gives instructions to the boatswain, etc. This type of activity gives a variety of options to the instructor: either to involve pairs or small groups or the whole class working simultaneously. Sometimes we even practice inter-groups activity: when one group fulfills the duties of the Traffic Center and the other group acts as the shipboard personnel, the bridge team, to be exact. In this case we use some minor technical aids like intercom system. Then it is possible to achieve the specific content environment. At the same time the distance between two groups (both groups accommodate their own class rooms) reveals the problems of the real-life situation: poor connection and misunderstanding/ lack of the professional knowledge and sailing experiences of the student/ the necessity and fear to make a decision, etc.

In a student-centered approach to teaching, the instructor stimulates frequent learner participation to assess how much students already know; stimulate interest in a topic; increase opportunities to interact in English; recycle language previously taught; give both strong and weak students the chance to speak in class; encourage independent thinking by helping students to works out some "rules" for themselves. The last point can help students to identify patterns in language by analyzing examples of the target structure. The learner should be pushed to formulate their own theories and guided to the right answer by the instructor, as far as they are able. The techniques of guiding students towards answers can be used at any stage of the lesson, for any aspect of language learning or practice. The process of drawing on the students' existing knowledge as a basis for language work is an essential means of involving the group in learner-centered approach. In every group some students are more inclined to speak than others, but it does not always mean that the quiet students do not have ideas or knowledge. The instructor should direct the questions or whatever the response at the students who do not volunteer information and encourage them to contribute. The teacher is the person to judge when it is appropriate to spend time eliciting information: sometimes it's easier and quicker to clarify the point and move on. The teacher needs to increase the amount of student participation so that everyone has a chance to speak. Student to student interaction should be a part of every lesson through the use of pair and group work.

For pair and group work to be successful, learners need to understand the value of cooperative learning. Students often prefer their first language in front of their peers for various reasons: shyness, embarrassment, fear of making mistakes or personality differences may cause group work to fail. With repeated encouragement, learners can come to accept that speaking English to their peers is a normal and necessary part of active learning.

Managing group work can be tricky and teachers may feel threatened by the prospect of "losing control" of their class. However, students won't learn to develop their social-linguistic competence if they are not permitted a degree of freedom in the classroom. While students are working it is important to monitor their work discreetly, without interfering. Though the development of the target-situation sometimes can bring the learners to some unexpected or unpredicted results. At this point the teacher should be very creative and try to show all possible ways out of the situation. It is what we call the "survival technique". As the students will be well prepared to respond under any circumstances.

Giving content-based real-life instructions/ tasks is one of the ways to achieve the learning environment required. We try to re-construct the daily routine of an officer-in-charge-of-a-navigational-watch where all the duties, activities, commands, responses, etc. are caused and justified by the surrounding setting.

Content-based jokes, puzzles, crosswords and word grids, funny and curious stories, poems and rhymes are the everyday practice of the instructors. Drawing pictures and schemes can assist in memorization of the mooring ropes, parts and types of ships, etc. especially for those learners who have good motor memory.

Using songs in the classroom we may solve such goals as: listening comprehension, writing, spelling, learners' interaction and team-work, enhancing motivation, using musical intelligence to language acquisition. Special course "Tune into Maritime English" has been developed, singing songs "Taking a pilot on board" or "Clearing the Ship Inward", etc. the cadets can practice and learn how to properly pronounce the words and improve their knowledge of the standards phrases for communication at sea.

Sometimes instructors practice not the "real-life" situations, they use some fantastic, hard-to-believe models and situations. Most of our learners are young 18-20 year people rather inexperienced, some of them tend to say "I don't know what to do under the circumstances" or "I don't have the slightest idea…" But if they are motivated (by the instructors formulating the tasks during the classes or some other way) to react, to communicate even in these situations they are no doubt will be able to find their way in any even the most difficult circumstances.

A set of computer tests based on the studied materials, home-reading of the IMO Resolutions, other conventional documents, pilot book, COLREGS, etc. help to keep the desired level of the cadets' motivation and verify their knowledge and understanding of the various aspects of maritime English. We also believe that the competence of the instructors in the issues dealing with the shipboard routine of the watch officers, their desire for self-education and utilization of the latest technologies in teaching, as well as well-prepared and timely updated materials will keep in line with the required level of the graduates proficiency. It is the issue of the utmost importance that a seafarer has an ability to create safe and efficient voyages especially in multilingual crew. The step on the way to success in it is the language competence of a seafarer. Not a single deck officer can pretend to be called a professional without this basic knowledge. No matter the approach, method or whatever practices in learning English used; one can select from the best of many methods. The aforementioned approach is the combined effort of the DALRYBVTUZ English Language Department instructors to reach the most important goal–to teach student the way he is able to comply with the STCW requirements to ensure accident-free ship's operation.

Reference

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Tough Challenges and Real Answers for Maritime English in the 21st Century for Deck & Engine Room Cadets

–Hope for none-native speakers, worldwide

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Abstract "Vision 21" concerned a plan and looking into the future. For this we look back a little and to the president at the time, Dr. Kiyoshi Hara. He laid out a few points in his paper Perspective of Maritime Universities-Challenge of Kobe University of Mercantile Marine. Among the aspects include the target to make to "make a social contribution" and basic education that includes "cross-cultural communication." An aim is also expressed "to play a key role in maritime universities over the world." There is a deep desire "for developing international maritime education network (for example IAMU). As stated "Individual capability with global perspective for instructors, staffs and students … with an international mind and social contribution … We will make every effort so that the new Faculty of Maritime Science will play an important role."[IAMU News' Issue 8, January 2003, pp 84-86] It is the goal of this paper to further the noble aims expressed.

The International Maritime Organization (IMO) is increasingly asking for Basic International English to be the foundation of Maritime English. It has been my responsibility to find an answer to a problem which has not been successfully dealt with clean across some one hundred years, or so. Indeed, since the founding of our institution. I understand that this may be the case in other non-English speaking, maritime institutions around the world. The question is how to get from here to there? This paper will attempt to give a lead, here.

The maritime world has always led in the globalization of our world. Incidentally, it still does. So, the world maritime establishment is looking to us to find answers. This paper will suggest a radical, new approach which can answer this, the greatest challenge we face in our field: for our students' to gain the competency in the Language of the Sea.

Keywords maritime English; basic English; peerless maritime education; appeth of tar; Oxford English Dictionary

0 Introduction

.1 Current Situation

It has been my honour to have been the native "English speaker" at what was the former Japan National Maritime University-Kobe (KUMM). Last year this distinguished institution was merged with Kobe University, where we now form the Department of Maritime Sciences.

What with the demographic turning-point having been reached in Japan, and other issues, the student population has been diminishing for some time now. So, in recent days our Fukae campus feels sadly empty. The students that we do have are increasingly spread between the faculties of *Maritime Technology Management, Maritime Transportation Systems and Marine Engineering*. There are a surprising number of international students with us; friends from Uruguay, Panama, Rumania, Vietnam, Indonesia, Taiwan and China, to name but a few. We also run master level courses, and some are going for doctorates. Indeed, one of my students, the very second PhD graduate from this Japanese university was from Dalian, China!

.2 The Most Special Opportunity for students

An important part is the Sea Training Institute, which includes six of the finest specially designed training ships in the world; among them being the *Nippon Maru* and *Kayo Maru*. Perhaps we can agree, two of the most beautiful ships-sailing barques-in the world. Indeed, non other than Archbishop Desmond Tutu of South Africa, wrote to us here to say exactly that![In 2005 *Kayo Maru* was heavily damaged in a storm. This included a helicopter lift off -- lucky students!]

Our part of the training process includes physical fitness, and the students are a pretty fit bunch. For example: the current champion cutter crew-ladies-that is of All Japan, happens to be one of ours! Every summer the boys' cutter club makes a voyage in an open boat. This can be for up to 2 weeks. Peerless maritime education, challenge and adventure. We also have a few sleek rowing 8's. Some of the heartiest of students (girls as well as boys) make up about 10% of the student body. Some manage the huge challenge of swimming two hours in the *Akashi Kaikyo*. They are under the charge of our champion swimmer, Prof. Homma. We also have specialized clubs such as yachting, this under the one time *Fastnet* Atlantic racer, Prof. Yamashita. Some years back one of our number dingy achieved the national dingy sailing championship finals.[This was in the early 60s. Matsuo Kimura went on to reach captain's rank and from time to time he talks to the young students of "the Shosen Spirit!" By that he means the Spirit of the Sea. It is, as it always has been courage, adventure and dreams.

1 The problem

The maritime aspect of Maritime English alone, in isolation, consists of perhaps a few hundred terms and formed expressions. No problem here; they have that down pretty well. So it is a handsome picture; indeed so. The Japanese maritime training establishment is second to none, and in almost every part save one; that is English.

Our English level here in Japan is very low. At any rate few of our students come to us with much spoken English, and maritime English is almost only a spoken one. It is not unfair to say-and I have heard this-that our students, bright and energetic as they are, are the "worst" in the maritime world![It could be true. Current proficiency, I estimate at 5%, if that.] This is the only major flaw in the otherwise exemplary maritime programme for Japanese marine officers. This is what we can call the "spoiling of the ship for an 'appeth of tar."

"Don't spoil the ship for an 'appeth of tar"

{Expression: old English origin. Derived from the early maritime English of Great Britain, and has entered the full English language as a widely understood truism. Meaning-total system failure for the smallest of reasons.}

2 Causes for failure

Why does it continue to be unaddressed in any real way? I will now address this problem**.**

2.1 Why is this so

There is a medley of reasons, including that it is not really necessary in Japan. After all the complex Japanese language is-in size-to the order of number 6, internationally. My students do have quite a bit of writing, although little hearing and few proper sentences. Whatever the hopes (and the advertising!) our English classes are based on the premise that our lessons, per say, amount to little more than 18 hours per year. These are thinly spread across 14 weeks, or so. What can be expected then, for the student, marooned as he/she is, often in vast high school style classes? And for such time as equals the flight between New Kansai and JFK, New York! Can this possibly make any genuine difference? Is there in fact a better way? The answer is "yes."

2.2 Cause for hope

The world of English often seems to focus on the higher mountains. For example: we can say CNN, TV News (that anyway is high speed and with an odd, 'new word' vocabulary). Newspapers, some running to a 25,000 word vocabulary, and yes, TOIEC! None of this need concerns us. The illustrious OED, the Oxford English Dictionary estimates, and tells us, that Basic English is a plateau of some 5,000 words. That can be our lodestar**.**

2.3 Hope envisaged

Most all of my Japanese students do have 2,500 words, or so. That is half of the 5,000 word definition for Basic International English, the good old OED! Good. We can utilize this. A new approach can move confidently "Full Steam Ahead" They are, most all, already halfway there!

3 Examples and solutions

3.1 (Practical) Example I

Student A (one of my first year students) could not respond to a standard:

"Good morning."

“*Wakaranai?”* (I don’t know?)

However, as they so often were at KUMM the boy had spirit. And so he joined my group in America. This would include time at the California Maritime Academy. Here, my students were lucky enough to be allowed to berth aboard *Golden Bear.* Now this same boy, along with some others, was rather good at soccer. {You may recall, that Japan reached the last 8 in the Korea/Japan World Cup 2002} So he joined the CMA soccer club and were some involved in a practise game. After the game, went and swam to the buoy, perhaps 3 cables off shore. (I thought to try myself. However, I felt better on it. Sure I could reach the buoy, but I very much doubted I could get back again!) At any rate, the last time I saw this student, in California, he was on the phone. Talking to a local girl, he was, and in perfect English sentences!!

“*Wakarimas!”* (I understand!)

3.2 Example II

Student B was one of my third year students. He could not be understood, that is whatever he said. In this case we were together in Labrador, Canada. This young man, who was also a Boy Scout leader, was having a tough time. Amongst other things there was seldom opportunity to smoke, and had no more cigarettes during his flights halfway across the world! However, this sort of thing, led to constant interaction between him and the English speakers everywhere now about him. From this, and constant repetition-and desperation(!) began to give him the cadences of English. He began to hear. He naturally slowed down, and by end he was translating Japanese into English, for me!

3.3 (From China) Example III

Student C was from China, name Tei Ho. He started out with some English, but by end of his formal education he would be fluent. In Year 200 he joined the Japanese cadets in Alaska, and along with them earned the title ‘Companion of Peace.’ (For peace he brought along with him the red flag of the People’s Republic of China, and this remained with us for all future activities. Tei Ho went on to get a masters degree in the UK. Currently he is working within British Government Marine institutions.

3.4 “Breaking Through” into Basic International English

Over the years there has been towards one hundred students to have joined me in various adventures, or “gone foreign” as they might say. Adventure in fact forms quite a bit of the activities undergone in connection with my other research. I advocate we harness that great power of youth, and building it into the (reformed) marine officer language course. But not like any other course that can be found anywhere else.

As regard specialized (and expensive) courses in English-I say “who needs ‘em?” You see the central answer to our problem is not classes, it is fostering young human friendship via a changed, international environment. That means above all else living together in standard student accommodation; nothing special. I do however expect all students to join a club of the institution where they will be lodged; probably sports, or some other, based perhaps on a hobby. It might be noted that in such as in UK, the biggest membership grouping of all, with 2 millions members, and it is in, can you believe bird watching: If we are flexible enough, our wonderful students can become among the best in the maritime world. And theirs will be a dream of a lifetime.

Both Student A and B spent a total of 3 weeks, only, outside of Japan. Bearing in mind that each student has to the order of a 2,500 word English vocabulary; then I estimate that an unbroken 20 weeks is the optimum in breaking through into Basic International English. That being so, then across the 20 weeks, would mean 12 words a day, memorized to bring up to the requisite 5,000 word English vocabulary. This would give our students the vocabulary that we can really, and dynamically, build our Maritime English upon.

Also, a diary will be written everyday (in English) and read out loud to the new friends. They, usually happily and willingly, will correct the small basic sentences of our student. Who will then, each day rewrite the diary entries and re-read them correctly out loud again. Given the full 20 weeks, I estimate that the majority will breakthrough into Basic English. Never again will they hesitate, nor will they need look back. Theirs will be an adventure and envied by ALL the other students in their home country!

3.5 The Weakness of Testing

It is notoriously difficult to get meaningful *results* with spontaneous communication, where a word-or even a gesture-can hold more true meaning than a full lecture. How to quantify magic? Testing comes first to mind. However, even here they have problems. For example I recently heard that TOIEC are considering changes in the light that a German test-taker with excellent English received a result in the 400s; whilst a successful test-taker getting in the 800s could not communicate much at all. He was Japanese. For professionals, my peers, to best consider, I would suggest pre and post comparative results in camera. This will allow us the best objective measuring, and for all to see.

4 Consideration

Wherever our students were to go, it must be out of their home country. In the case of my students, of course Japan. It is by no means necessary that it need be an English speaking country. Ideally, it would be where youth culture is strongest; that points to UK. The great museums are there, there. And in Britain they are without equal, and for the most part, I believe, still free. However, pretty much anywhere will do. For even in countries without an English language tradition, communicating will all be done in Basic.

4.1 Call to Action

My estimate on individual student success in “breaking through” into what is the basis within which Maritime English lie (Basic International English) is half, or better than. With this reform programme then yes, the majority will succeed. By that I mean a minimum of 51%. (I would hope for even better than that.) And remember, this is up from the current derisory 5% level. In this happy crew I also include the seeming least able of students.[I note: that of our current student body, some of the best do better than those with higher scores on the Common Entrance Examination (CEE)] Never mind the so-called ‘best’ -- I am also looking at the so-called ‘worst.’ Give them an environment where they can see daylight, then they will amaze you.

4.2 To the Secure the Future

We first need adequate empirical data; that means establishing a working example, and somewhere in the maritime world. A full report with empirical detail could then follow. We would also need assistance, funding for airfares and the costs associated with dormitory living. This, in whichever international environment that we would eventually commence this experimental programme.

4.3 Timing

There is active planning toward the Fukae campus becoming a Graduate school for the maritime sciences; this starting as soon as April 2008. This might be the time to kick this programme off. A graduate school cannot go on giving high school type lessons. Reform here, at any rate, is a must.

5 Conclusion

Basic International English is the bedrock of Maritime English and some solid, real use of it would form a powerful, world-class tugboat, which indeed could pull their ship of life into confident and competent Maritime English. I conclude, and based on my large past experience with taking Japanese cadets (and one Chinese) abroad, that we can fix the 'English problem' once and for all. Without this kind of commitment from us, including sufficient time to create a critical mass in language exposure, then we will not succeed.

Join us then, sister maritime universities and institutions in countries without a tradition in English; join the splendid Japanese students at Kobe University-Maritime, and together we can resolve this problem once and for all. Give our young students, bright with dreams the chance to become fully competent and confident international Seafarers. We can do nothing less.

Appreciations

I wish to express my great appreciation to Professor M. Sales, Dean-University of Guam, and the brave students of Kobe who agreed to join our international experiments, who said "Yes" to adventure-*the Shosen spirit!*

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Maritime English Classroom Instruction in Global Maritime Context

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Abstract With more and more multi-lingual and multicultural crews joining the transnational seafarers' maritime community, their competence in maritime English becomes a public concern. There is a need for maritime English lecturers to use some effective pedagogies. During the process of maritime English teaching in DMU, teachers found some teaching and learning problems relating to four macro skills in the English language communications. Regarding proper teaching techniques, suggestions are made to teach maritime English.

Keywords globalization; maritime English; maritime English teaching approach

0 Introduction

In the context of global maritime industry, the shortage of seafarers in the world makes it necessary to muster different nationalities on board. The cross-cultural labor mobility makes many maritime English instructors aware that getting proper teaching pedagogy will ensure the quality of the cadets in the global seafarers' community.

Maritime English, the language of the sea, is needed in today's shipping industry. The demands for competent seafarers require their proficiency in understanding and using maritime English. The mixture of seafarers' different cultures makes maritime English a compulsory linguistic medium in aspect of the safety of life at sea, ship property, pollution preventions, etc. People commonly admit knowledge and skills of maritime English can ensure the effectiveness of communication between English speaking seafarers and non-English speaking seafarers; and between seafarers and offshore personnel. To some extent, guarantee of safety at sea relies on seafarers' communication in maritime English. Proper command of maritime English is not only for the essentials of seafarers but also for the appropriate operation of ship.

Although IMO has officially adopted maritime English as the language of maritime industry, there is a clear necessity for ensuring seafarers to gain maritime English communication skills in the current globalizing world shipping market. Most of maritime institutes are aware that mastering communication skills is one of the important components which ensures the safety at sea. In order to cultivate the high-quality seafarers, maritime English instructors should focus on teaching the particular terminology and communication skills that include listening, speaking, reading, writing as required by IMO conventions in the international shipping industry. MET institutions should perfect the syllabus of teaching maritime English; and maritime English instructors should find effective ways to teach the language. All these will benefit maritime English education in the globalization of maritime industry.

Through analysis of the situation of maritime English teaching in China, the paper is aimed at enriching the teaching approaches in MET institutions. It reveals difficulties in maritime English teaching, with focus on how to improve four communicative skills in maritime English teaching. Maritime English lecturers play an essential part in realizing the goal of maritime English teaching. The quality of ME teaching decides whether the cadets will become competent seafarers to meet requirements of IMO Conventions, and whether they will be communicating freely in the global maritime community.

1 Globalization and Maritime English Teaching

Globalization is a multilevel phenomenon. It is a process of globalizing all aspects of social life in the world. As Stromquist (2000: 3) explains, "a contemporary term that entered the consciousness of most people by now, is a phenomenon that comprises multiple and drastic changes in all areas of social life, particularly economics and culture." The globalization in maritime industry is broadening. In the last decades, with the development of economics and ever-changing world seafarer labor markets, world seafarers are in serious shortage, multi-lingual and multi-cultural crews have become main composition of world merchant ships. About two thirds of the world merchant fleet are composed of several nationalities. The fast-growing global shipping community requires multi-lingual and cross-cultural cooperation(Horck, 2005). Removing language barriers has become more and more significant in assisting communication in global community. Maritime English, the language at sea, as well as the guarantee of the safety of life, property and ship operation, becomes the need of competent seafarers. The importance of maritime English teaching has become a growing concern. Therefore, MET institutions should give high priority of maritime English teaching, and have enough preparation of competent seafarers among internationalisation of working groups in global maritime field.

2 Difficulties in Learning and Teaching Maritime English

The intensifying need of good knowledge and skills of maritime English is one of characteristics in global maritime field. Studies have shown that Maritime English instructors and students in DMU (Dalian Maritime University) have difficulties in the process of teaching and learning maritime English. The major problem for cadets is that their learning motivation is low. One of the reasons is that some of them are not aware of the importance of the future use of maritime English which relates with their opportunities of getting better life and job performance. On the other hand, some of the students lack in enough courage to speak English publicly, especially when they conduct communication with foreigners. They always worry about the mistakes they will make during the communication conversations. As a result, they become silent ones during the learning process; and have barriers in speaking English psychologically. Hence, these block their way to be a competent seafarer.

The result of MSA (Maritime Safety Administration) evaluation examination every year also reveals some unsatisfactory results. Some students cannot express clearly, whether in maritime English or everyday English. Some of them convey the information in long and perplexing Chinglish sentences. For example, in role-playing the conversation about ***Making an Appointment,*** a student spoke: "I will go to the school gate to meet you at seven o'clock" instead of speaking: "I will be there at seven o'clock" in a concise and idiomatic way. Another difficulty students met in learning is that they cannot memorize the maritime vocabularies due to their lack of basic knowledge of vocabularies. For example, in memorizing the technical terms relating to cargo handling gear, the phrase "***standing guy***", if students do not have enough knowledge of vessel structure and equipment, the confusing homonyms will make them understand it in a mistaken way.

To make it worse, very few students learn how to listen actively. When some students listened to materials, they regard the vocabularies in the sentence as separate ones, ignoring stress, rhythm, and intonation. For example, in listening the following conversation about the PSC inspection, if they ignore the stressed content words: ***take, oil sample, oil tank, send, crew, accompany, sure, possible, fetch samples,*** they will not understand what they are required to do.

A: I will take an oil sample from your oil tank. Could you send a crew to accompany me?

B: Sure, I will accompany you. If possible, I will fetch samples for you.

In this way, they cannot take in a language, but only memorize the fixed pattern and could not use it to communicate freely if they were put in a different environment.

As to the productive skill—writing which requires comprehensive knowledge of English to produce, the students have some problems in writing due to lack of some knowledge of English.

At the same time, there are pedagogical issues that concern us. The proper selection of text books and maritime English teching materials is one of the primaries in commanding maritime English. If the students learn the outdated textbook, they would not keep up with new development in shipping indurstry, not mention some new technical terms. What is more, the quantity of academic hours provided by the curriculum for maritime English teaching is not sufficient though we have almost two year maritme English teaching and learning. Therefore the students do not have enough practise on board. Consequently, they lost the opportunity to practise what they have learned at school. Another issue that exists in MET in China is that experienced instructors are in demand due to the increased recruiments of cadets. Based on these problems, suggestions are made in the following section.

3 Suggestions for Classroom Instruction

Maritime English instructors do find it indispensable to rely on the communicative resources of maritime English for effectively teaching the knowledge and skills required by IMO. In Dalian Maritime University, the communicative approach should be employed to teach maritime English. To get competent seafarers, our programs for cadets should be aimed at helping them to communicate in English confidently and fluently, develop their language skills including listening, speaking, reading and writing. The whole teaching process should be thoroughly considered, including the selection of textbooks and teaching materials, classroom management, and assignments after school and evaluation examination. All these should meet the requirements of IMO Conventions.

In order to arouse the students' interests in classroom learning, the instructors should not always emphasize the difficulties. As for some students, to understand the different conceptual ideas in another language already makes their memory load very high. Although the teacher's job is to remind the students of them being realistic about difficulties in studying, the side-effect undermines their confidence (Michael and Jimmie, 1999).

To improve cadets' communicative skills, the instructors should put listening first, for the input of good listening materials will contribute to the language acquisition. The instructors should use global listening and sub-skills of listening in the teaching process to improve the students' ability to communicate. Tape listening and multi-media are useful in assisting their practice in learning. The lecturers should do some related computer software uploading the DMU Website to facilitate the cadets' studying. Thus, the students will be getting their input to their intake. As for the selections of listening materials, it is wise for the maritime English lecturer to choose different English varieties which closely relate to their future job. Thus they will arouse the students' interests. Therefore the cadets will have good preparation for their future exposure among the multi-lingual set ups.

Speaking a foreign language is a very complex skill. To improve the students' ability to speak, the concise, and understandable SMCP should be the first selection in training the students to operate the ship and handle other problems that occur in shipping. For non-native speakers, SMCP is a short-cut to communication with other language speakers on board. As in Dalian Maritime University, the maritime English lecturers should use the resources of maritime English materials, such as parts of *Sailing Directions*, the textbooks by MSA and textbooks edited by the experienced lecturers themselves. In practicing these teaching materials, the lecturers should give the students some authentic situation first, and then require the students to do role playing. All the conversations in role-playing must be natural. While the students are doing role-playing, the lecturers should not pay too much attention to their pronunciation and structures, because frequent corrections by the lecturers undermine students' confidence. In order to make the student become confident in speaking, the lecturers should not correct mistakes until the students finish the complete task. In this way, the students can use the language to communicate freely in the global community.

As for the students' poor command of maritime English vocabularies, the lecturers should assign some students home reading tasks. Besides reading some textbooks, we should also employ some maritime English-based realia, such as original ship documents, charts, notices to mariners, and parts of sailing directions, especially the sailing directions of South China Sea, UK, Holland and America which can exemplify some sailing routes. Through these reading context, it will be easy for students to memorize some vocabularies. Tests should be designed to check the results of home-readings, so the lecturers will know whether the students read these materials or not, and to what extent they have read. Then, the lecturers will be getting to know how to guide the students to read and how to improve teaching techniques. Maritime lecturers should also employ part of maritime English -based realia in classroom, such as telexes, original ship documents or charts, etc to arouse the students' interest of reading. Gradually, comprehensive reading will broaden the students' horizon, and enlarge the students' vocabularies. In this way, the students can gain the knowledge of documents which can contributes to the required English level of competent seafarers internationally.

Although it is not easy for cadets to master writing skills, The writing model of business letters, notices and marine note of sea protest should be given to the students. The lecturers should give the students some writing assignments in order to improve their writing ability. On the other hand, lecturers should collect realia of business letters, notices and marine note of sea protest, etc. from shipping companies and ask the students to point out some advantages and disadvantages of the writings. Gradually, the cadets will know how to write the correct ones. Writing skills are necessary for cadets to become competent seafarers.

Generally speaking, the syllabus of maritime English teaching in MET institutions in China should provide enough academic hours to teach maritime English. Enough time will ensure reinforcement of training the students maritime English. Consequently, the students will obtain more competence in maritime English in the long term.

Measures should also be taken to update the experience of the Maritime English lecturers. On board training is essential for those from non-native backgrounds. As STCW requires the quality of maritime English instructors: "...all instructors, supervisors and assessors are appropriately qualified for particular types and levels of training or assessment of competence of seafarers either on board or ashore..." In Dalian Maritime University, the team of maritime English instructors is composed of some sepcialists, former seafarers, and literature and linguistics graduates. DMU should provide some maritime English lectuerers or would-be maritime English lecturers good research environments through inter-college and transnational academic communication. In this way, more and more literature and linguistics graduates will gain more knowledge of maritime English teaching, and will join the group of maritme English teaching. Therefore, MET institions will have competent maritime English lecturers to facilitate Maritime English education.

4 Conclusion

Problems in listening and speaking, vocabulary memorizing and the lack of knowledge of writing block the cadets from becoming competent seafarers. The lack of updated maritime English instructors hinders the cadets from becoming competent seafarers in the globalized maritime community. Suggestions were put forward with a view facilitating maritime English teaching.

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Approval of Romanian MET System by EMSA

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Abstract In 2003, the European Maritime Safety Agency (EMSA) started an ambitious campaign for evaluation and assessment of the maritime education and training system in non EU countries that are supplying officers for the European Union (EU) merchant fleet. In other words, EMSA has started his own investigation in order to build an EU White list.

Theoretically, in accordance with the EMSA policy, the evaluation and assessment process of the national MET system should only be focused on the STCW 95 provisions and requirements. Practically it implied more than that, not in terms of curricula but regarding the quality management of the MET process. The STCW Convention or the IMO MSC Committee had no provisions regarding the implementation of a quality management system (QMS) for the MET system. In Romania, universities will have to implement a special QMS model by the end of 2006.

After the EMSA inspection, we congratulated ourselves that The Constantza Maritime University (CMU) had voluntarily adopted the ISO 9000 QMS under BV certification 3 years ago. We think that in the absence of an already functioning QMS, it would had been very difficult to meet the EMSA standards.

Keywords maritime; education; assessment; EMSA; QMS

0 Introduction—the European Commission directives

After the oil tanker “Erika” disaster (1999) the European Commission (EC) made the legal framework (Regulation (EC) N° 1406/2002) for the creation of the European Maritime Safety Agency (EMSA). The main role of EMSA is to provide technical and scientific advice to the Commission in the field of maritime safety and prevention of pollution by ships in the continuous process of updating and developing new legislation, monitoring its implementation and evaluating the effectiveness of the measures in place.

Year after year, the control of EMSA over EU member state maritime authorities was increased and the Agency involved in strengthening of the Port State Control regime, auditing of the Community-recognized classification societies, development of a common methodology for the investigation of maritime accidents and the establishment of a Community vessel traffic monitoring and information system.

In 2001, the European Parliament and the European Council adopted the directive 2001/25/EC regarding the minimum level of training for seafarers. The directive 2001/25/EC represents recognition of the IMO STCW 95 Convention and all member states had to comply with these convention requirements, in terms of seafarers training and certification[1]. Furthermore, EC expand EU maritime legislation and accordance with the provisions of regulation (EC) N° 1406/2002 of 27 June 2002, article 2(b), EMSA was tasked to assist the European Commission in any task assigned to it by existing and future Community legislation[2] in the "training, certification and watchkeeping of ships crews" in member states. In 2003, a new adopted directive (2003/103/EC) introduced a centralized and harmonized procedure for community-wide recognition of certificates issued by third countries which comply with the STCW Convention. Based on this directive, the European Commission, assisted by EMSA, will carry an assessment of the 3rd countries' or the 3rd areas' maritime education, training and certification systems. The term "3rd country" refers at non EU member states which provide seafarers for the EU member states fleets.

If the EMSA assessment of the 3rd country MET and certification systems is positive, then the EC recommends to EU member states recognition of a third country system. Member states can recognize it for 5 years without further submission to the Commission. The assessment process will be resumed at least every 5 years[3].

Because EMSA has limited human resources, they could not undertake more than 10 assessments per year, but the process could be very slow for countries that have many maritime training institutions. EMSA officials have to assess all the maritime education and training institutions from one country, including the national maritime authority system for certification of seafarers.

1 EMSA evaluation methodology for MET

In order to achieve the target of 10 assessments/year, EMSA had established a scoring system for the 3rd countries or the 3rd areas, in order to establish a priority list[3]. The scoring system is based on the following criteria:

- how important the third country is in terms of officers working in EU registered ships?
- how important it is regarding officers certified in that third country and employed in the world fleet?
- have cases of fraudulent certification been identified?
- how many Port State Control (PSC) deficiencies concerning STCW have been detected in ships registered in that third country?
- are there complaints on the level of training and/or on certification procedures?

- how extensive has the previous assessment been?
- how complex to carry out is an on-site visit?

In accordance with the above criteria, the first half of the hierarchy for the 3rd countries or the 3rd areas scrutinized by EMSA is shown in Table 1.

Table 1 Hierarchy for the 3rd countries or the 3rd areas scrutinized by EMSA

1. Philippines	10. Croatia	19. Iran
2. Turkey	11. Pakistan	20. Singapore
3. Ukraine	12. Bulgaria	21. Brazil
4. Indonesia	13. Romania	22. Vietnam
5. Russia	14. Malaysia	23. Australia
6. P.R. China	15. Myanmar	24. Hong Kong, P.R. China
7. India	16. South Korea	25. USA
8. Georgia	17. Senegal	26. Cuba
9. Egypt	18. Jamaica	27. Serbia & Montenegro

We have to remember that EMSA is interested only by the countries that are non EU members and that are delivering seafarers on EU states flag ships.

The methodology used by EMSA for assessing the national MET systems has the following stages:

- definition of the reference system
- the assessment process
- in-office study of documentation
- on-site visit
- elaboration and publication of the assessment report and final Conclusion.

The external pressure applied to the National MET system and the output controlled and assessed by the National Maritime Authority is summarized in Fig. 1.

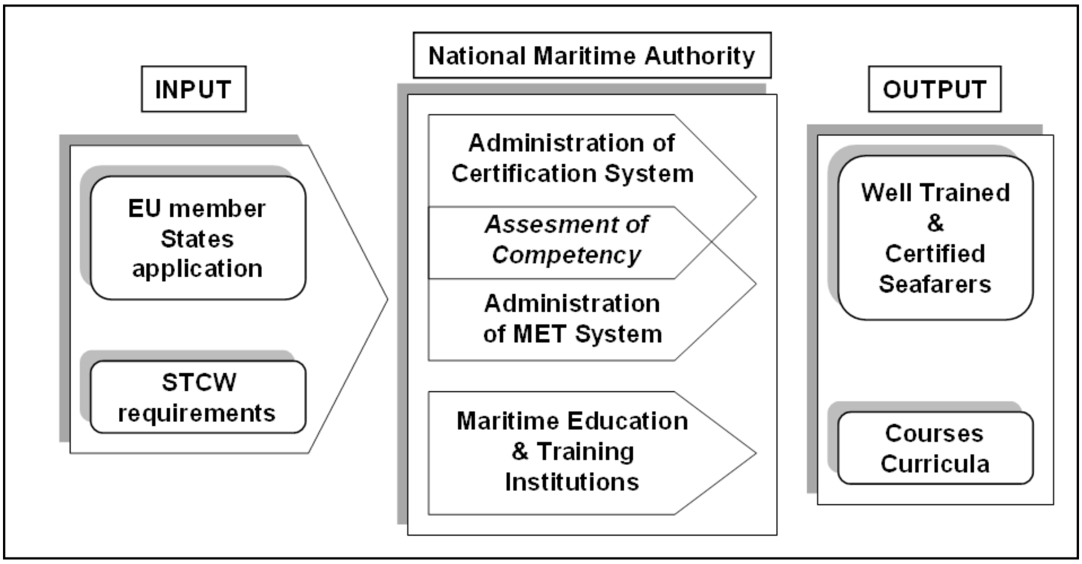

Fig. 1 National MET and Certification system

1.1 The reference system

The reference system used by EMSA for comparing the achievements of the national MET system is the STCW 95 Convention, including up-to-date amendments. The main provisions of the Convention, verified by EMSA are contained in Regulations and Code A and chapters 1 to 8. Starting from these requirements, a step by step analysis is undertaken for the following items (in brackets are the Reference at STCW articles and regulations):

(1) Quality Processes–*Plan, Do, Check, Act*-(R I/8)

(2) Qualification and Training of instructors, supervisors and assessors

(R I/6, R I/8 & R I/12)

(3) Issuance & Endorsement (Art. VI & R I/9)

(4) Format (R I/2)

(5) Medical standards (R I/9)

(6) Registration (R I/9)

(7) Consultation by others States (R I/9)

(8) Prevention of Fraud (R I/5)

(9) On-board Training Validation (R II/1 to 4 and R III/1 to 4)

(10) Assessment of competence (R I/6)

(11) Recognition (R I/10)

(12) Revalidation (R I/11)

(13) Equivalents (Art. IX)

(14) Dispensation (Art. VIII)

(15) Courses and Programs Approval (R I/6 & R I/8)

(16) Monitoring of Maritime Training Institutions (R I/6 & R I/8)

(17) Quality Processes–Plan, Do, Check, Act-(R I/8)

(18) Staff Qualifications and Training (R I/6, R I/8 & R I/12)

(19) Trainees' Recruitment (R I/8)

(20) Training Monitoring and Supervising (R I/6 & R I/8)

(21) Training Facilities (R I/6 & R I/8)

(22) Use of Simulators (R I/6 & R I/12)

(23) Examination Process (R I/6 & R I/8)

(24) Issuance of document of evidence (R I/6 & R I/8)

(25) Course Review and Approval Process (R I/8)

(26) Governmental Monitoring (R I/6 & R/8)

The national Maritime Authority of the 3rd party states must submit to EMSA all explanatory documentation for the above mentioned items, in order to assess the implementation of the STCW provisions in the maritime national legislation. For the beginning, maritime universities will have to prepare and provide English documentation for items 9, 10, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26. For nations that do not have English as native language, translation in English of all that papers represents a very difficult and time consuming task. Some of these documents (9, 15, 18, 19, 21, 23) must be prepared in the first place, because they will be submitted in an electronic format to the EMSA headquarters. The practical importance of this type of evaluation is underlined in Fig. 2.

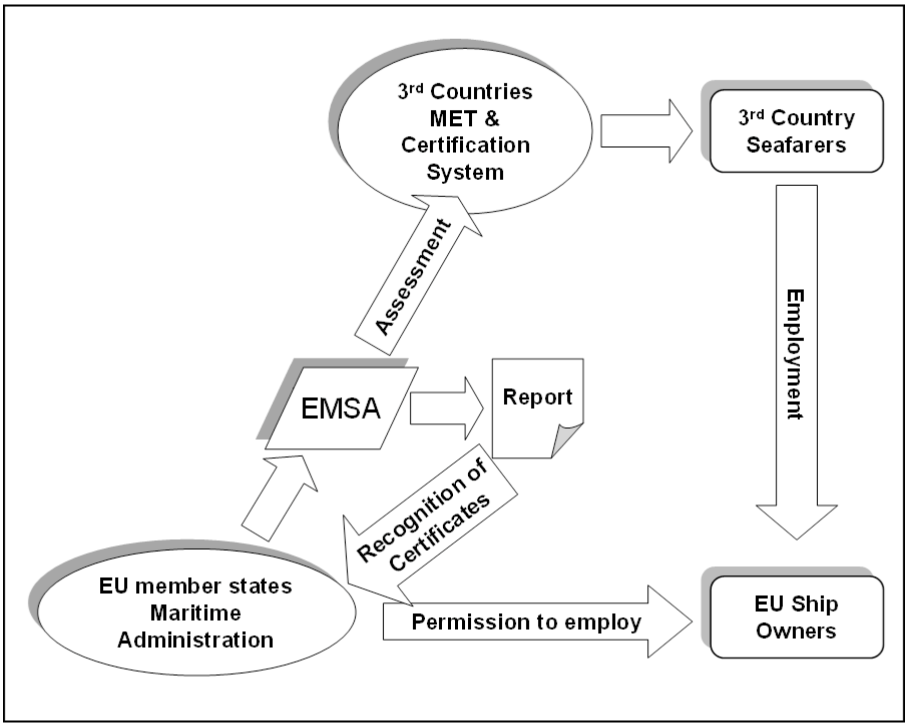

Fig. 2 Implications of the EMSA assesment

EMSA is interested in the training and certification system for all categories of seafarers, and each type of MET institution has to provide documentations for the specific level (ranks) of seafarers trained in the institution[4]. For maritime universities, the correlation between STCW and education curricula refers mainly to the operational level for 3rd officers' deck and engineers.

1.2 In-office Study of Documents

A schematic representation of the assessment steps undertaken by EMSA are shown in Fig. 3. After the National Maritime Administration (NMA) was notified about the starting of the assessment for the respective country, the NMA must prepare and transmit to EMSA all the required and available documents and documentation. NMA will contact all maritime education institutions in order to collect essential documents, as curricula and courses syllabus. For this stage, documentation will be in electronic format.

Communication between the NMA and EMSA must be very efficient, in order to supply all the documents asked by EMSA and to provide answers and clarifications regarding possible misunderstandings in the interpretation of documents.

The in-office study of received documents is a very important stage in the evaluation process, because it represents the first contact made by the EMSA officials with the 3rd country national MET and certification system[5]. In these circumstances, a well organized folder and easy to read documents (including a very good English translation) are essential for a smooth beginning of the assessment process.

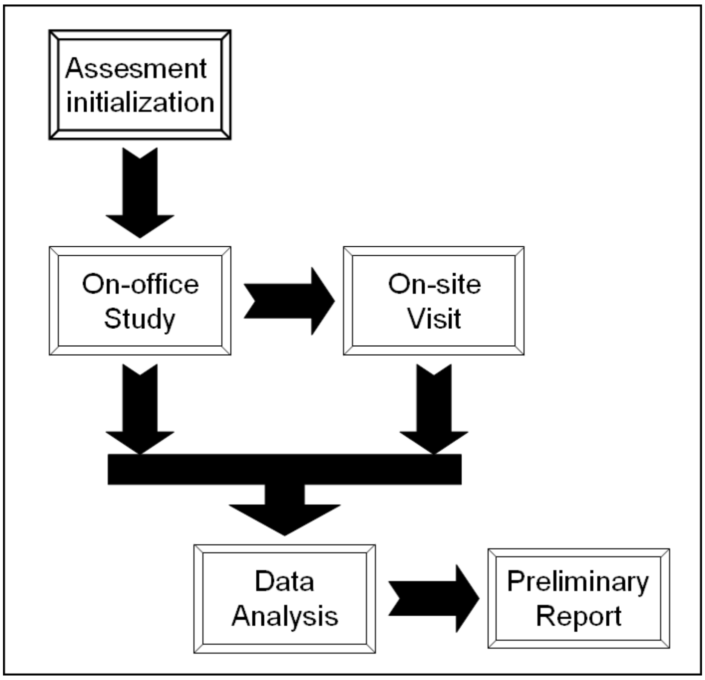

Fig. 3 EMSA assessment process

From the point of view of the maritime universities, all internal regulations and quality manuals must be translated in English in order mo be made available for EMSA consultation. It is a huge amount of work that must be done in a very short time (usually 2 weeks). Universities that already have these documents translated in English are fortunate, but they must take care to update the information contained in these pages if necessary.

Supplementary documents or explanations for the already transmitted documents are asked by EMSA through the NMA[6]. You have to remember that the NMA will collect information regarding: trainees' recruitment, training facilities, examination process, education curricula, courses and programs approval, teaching staff qualifications and training, on-board training from all over the country's maritime education and training institutions. It will be better if most of these documents will have a uniform format and will contain as many standardized procedures as possible. From this point of view, the most sensitive aspects are related to: duration of studies, contains of the curricula, duration of sea training period, standards for qualification of the teaching staff.

Regarding this last aspect, we have to underline that EMSA is interested only in the courses that are strictly related with the set of knowledge and competencies required by the STCW[7]. In accordance with these objectives, there will be a distinction between the teaching staff that teaches general knowledge courses (e.g. mathematics, physics, chemistry, computers) and the teachers involved in dedicated maritime knowledge courses (navigation, cargo work, maritime safety, communications, ISM, etc.). For example, the graduates of our university are awarded with an engineering diploma in maritime transport at the end of the faculty. In order to obtain a technical engineering diploma, in accordance with the Romanian higher education curricula, in the first year of study, all technical universities must have a package of similar courses, including: mathematical analysis, algebra, differentials & analytic geometry, physics, mechanics, chemistry, study & technology of materials, machine design, electrotechnology, electrical measurements, electronical devices & circuits. These type of disciplines, including courses syllabus, acreditation and teachers qualification and professional experience are ignored during the EMSA assesment.

2 On-site assessment procedures

It is obvious that for the national Maritime Authority personal and for the universities' staff, the most stressing part of the EMSA evaluation process is the on-site inspection. The duration of the EMSA visit is in accordance with the number of institutions that will be evaluated in that round. If the on-office study of documents was considered successful, than it is possible that the on-site time for assessment of one training institution to be maintained to 1 day. Otherwise, it is possible that for some of the education institutions, the time allotted for inspection to be extended to 2 or 3 days.

The EMSA team will have 3 members, each of them with different backgrounds, in order to cover all the STCW and quality management system (QMS) aspects. At least one of them will be very familiar with the deck department problems and another EMSA team member will be special trained for QMS certification. Usually, the third team member will be focused on the engineering department problems.

Before arrival of the team, a detailed schedule of the visit will be arranged with the NMA, and the maritime education institution will be notified about this schedule. Objectives of the visit will be also mentioned and they will cover the following topics:

Implementation and application of STCW Convention:

- Organization and methods
- Certification and courses
- Qualifications
- Equipment and facilities
- QMS procedures:
- Manual, documents and records
- Monitoring of processes
- Internal audit
- Corrective actions
- Management review

As we observe, the first part of the inspection will be dedicated to the study of the QMS documents, included Quality Manual, management of activities and resources, process monitoring and methods used for improving activities. The QMS procedures are also compared with the national education legislation and other internal rules and regulations of the university. On this stage, the representatives of the university (Rector, Vice-rector, Deans, Head of departments, QMS Director) are interviewed in order to assess their role and how the QMS provisions are put at work in the day by day education process[8].

During these interviews it is very important that the managers of the university speak good English, in order to present their opinions as convincing as possible and to clearly understand the questions raised be EMSA representatives, in order to give pertinent and at the point answers. We will also recommend having available one or two English translators or teachers from the English language department. If you already know that some of the managers of your university are not good enough English speakers, presence of a translator is compulsory in order to ensure the communication flow between the EMSA officials and the university staff.

For this stage, one of the most important roles is played by the Director of the QMS department. If he is capable to answer the specific questions posed by EMSA, and to explain contains of the non translated documents, the impact over EMSA officials will be a positive one. The rules and procedures implied by a QMS are international, so you have to be prepared to meet the standards required by EMSA, from the moment you affirm that you have implemented such a system in the university.

The problem with the QMS assessment relies in the national education legislation. For example, in Romania, the implementation of a QMS in higher education institutions became compulsory only from 1st of January 2006. The QMS implemented in 2002 by our university is certified by Bureau Veritas and is an ISO 9001. This standard was voluntarily implemented by our university, as a consequence of the Senate decision to increase the quality standards for the education process[9]. We think that without this initiative and without 3 years of experience regarding handling the activities in accordance with the rules and procedures imposed by the quality management system, it would have been very difficult to meet the expectation of EMSA.

EMSA was also interested in the independent evaluations of the MET undertaken at national level. We had to explain how the universities are periodically evaluated at every 5 years by an external body (National Commission for Evaluation and Accreditation) and this evaluation is done in accordance with the national education law.

The Romanian Naval Authority (RNA) was very afraid about the EMSA inspection and it tried to be involved as low as possible in the monitoring and supervision of the MET in the Romanian maritime universities. RNA officials declared to EMSA representatives that in Romania there are no legal provisions giving such responsibilities to RNA and their involvement in the education process is limited to the final certification exams for the 3rd maritime deck and engineers officers. In other words, RNA acted cowardly, and let the maritime universities to handle the EMSA inspection by themselves.

In reality, RNA is approving year after year the MET curricula and the syllabus of the courses that create competencies required by STCW. More than that, all major decisions regarding changes and updates of the curricula, approval of sea training programs, etc. are made after consultations with RNA officials and in accordance with their requirements.

The lack of RNA support was obvious in the second part of the inspection, when EMSA moved to assess the education and training process related to STCW competencies. The education curricula and STCW related courses syllabus were already familiar to EMSA officials, so the second part of the inspection was focused mainly on the adequate qualification of teachers, use of simulators, methods of evaluation of students' competencies required by STCW Convention.

For the second part of the inspection, the EMSA team had split in two, each inspector being focused on his main field of expertise: deck or engineering department. At this stage, the training facilities were visited, with much time being spent at the simulators, including detailed discussions with the simulator instructors.

Our simulator instructors were questioned about the methods used for the design of scenarios and validation of scenarios in accordance with the STCW competencies that must be created to the students[10]. The documentation recording a detailed scenario description was also revised by the inspectors and for each scenario they asked about the evaluation or scoring system used to asses the performance of the students during the exercise. EMSA officials insisted very much on the aspect regarding a standard and uniform procedure that must be kept for al scenarios[7], in order to monitor and asses the gradual achievement of knowledge by the students. EMSA had also quantified the number of hours spent by students on simulated exercises, and the courses that included in their curricula such type of modern training.

Practically, from the entire teaching staff, the simulator instructors were only once interviewed by EMSA and their positive answers and demonstration of best practice applied for the practical training of students using simulators was a very important aspect. The main simulators that had to be in the maritime universities portfolio are the ship handling simulator, the GMDSS simulator and the engine room simulator. From the EMSA point a view it is very important how a maritime training institution managed to integrate the simulators in the education process, because the STCW 95 emphasizes the use of simulators, and it is certain that in a near future, an update of the STCW Convention will make such type of training as compulsory.

Another stage of the second part of the inspection was focused on the compulsory IMO model courses. For these courses, identified in the education curricula, the EMSA officials verified courses syllabus, qualification of teachers and specific training facilities. Here, the inspectors observed that there were some differences between the syllabuses of the same IMO courses taught in different maritime training institutions. The recommendation was that for these standard courses, the teaching syllabus must be some no matter which training institution is delivering the IMO model course.

At the end of the day, a round table was organized with the participation of the EMSA team and all the top level personnel of the university. The EMSA representatives made a general overview of the inspections, underlining the good points and also commenting on the less good findings, but without pronouncing any final Conclusion. It is less important how good an individual institution has performed, because EMSA will make an assessment for the entire national maritime education system. That’s why all the training institutions had to be as good as possible, in order to give a positive image of the entire MET in that country.

3 Conclusion

The EMSA evaluation of the 3rd country MET system could not be considered finished until the final report will be published. This report has the following main chapters:

- Overview of the MET and Certification systems
- General conclusion about compliance

- Description of the non compliances
- Improvement opportunities

This report will be sent by EMSA to the European Commission (EC) and the EC will notify the inspected country about the conclusion of the assessment. In accordance with the report conclusion, seafarers from the inspected country will be allowed for employment on the EU flag ships[11].

Until now, the most part of the former inspections (for the 3rd countries or the 3rd areas located among the first 10 in the EC list–see Table 1) were done by teams sent by the Directorate General for Energy and Transport (DG TREN). In 2004 this task was commisioned to EMSA, so the 5 year renewal assessment will be undertaken by EMSA, following the procedures described in the previous chapters of this paper.

In accordance with our experience, the key points that must be taken into account in order to have a successful inspection are:

- a maritime education curricula of at least 3 years of study;
- fully coverage during training of the competencies required by the STCW 95 (including after 1995 updates and supplementary requirements);
- an QMS (for example ISO 9000) for the educational process, implemented in the university;
- a QMS specialist that also has to be a very good English speaker, in order to explain the content of the documents that are not translated in English and some of the procedures;
- modern training facilities that have to include at least a Radar Simulator (preferable a Ship handling Simulator) and a GMDSS Simulator;
- qualified instructors for simulator training (in accordance with IMO recommendations for simulator instructors);
- a good evidence (records) of the training undertaken with the use of simulators (objectives, scenarios, number of hours/student, etc.);
- above average English speakers among the teaching staff, in order to give documented answers during the interview with the EMSA inspectors;
- a clearly and well organized folder with the electronic documents that must be submitted beforehand to the EMSA office;
- a support staff able to translate in short time in English all the required documents (including internal regulations and national education general provisions);
- capacity of high level managers (rector, vice-rector, deans, head of departments) to assume possible mistakes or nonconformities.

The cooperation with the national Maritime Authority (NMA) and the implication of this institution in the organization of this visit are also very important. The NMA could also assume some of the lapses and declare that it will monitor the accomplishment of these unfinished tasks. A statement like that will be considered by EMSA and thus some of the report remarks could be avoided in this manner. The NMA implication will also certify that there is a constant supervision of the maritime training process from the most authorized national institution[12]. Such an attitude will be positively appreciated by EMSA.

We hope that our paper has offered some useful hints to the maritime universities that will be inspected in the near future by EMSA and our practically advises will help other IAMU member institution to successfully pass the EMSA assessment.

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Roles That Chinese Maritime Institutions Should Play in the Research of International Maritime Conventions

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Abstract Based on the current development of the Chinese shipping industry and our activities in the IMO, this paper analyzes our gap with other advanced shipping countries in the international maritime affairs and points out the roles that Chinese maritime institutions should play. Taking Dalian Maritime University as an example, this paper introduces the current practice of DMU in the research of international maritime conventions and the goals that we should try to reach, that is, through cooperation with IMO and other maritime educational and research institutions, to build a base of international maritime conventions researchers and relevant talents. This paper thinks that Chinese maritime institutions should not only cultivate sufficient talents in navigation and maritime management for the sustainable development of the shipping industry, but also provide strong decision-making support for governments, shipping enterprises in the research of international maritime conventions.

Keywords international maritime conventions; maritime institutions; IMO; research

0 Introduction

With the rapid development of world economy and the sped-up economic globalization, the international trade has been continuously enlarged and the shipping industry experiences a great prosperity. However, when the international technical and legal relations need to be further adjusted, in order to ensure the safe, secure and environment-friendly development of the shipping industry, and in order to give a strong support to the world economy, governments should sit down to discuss together the future development of the world shipping industry. IMO has provided a good platform for the joint discussion. On this platform, all the member states could discuss together, working out standards that are acceptable to the whole industry, setting up an adjustment system and representing these standards in the form of conventions, protocols, resolutions, regulations, etc.. As a developing shipping country, China was fortunately elected one of the I Category Council States. Therefore, it should shoulder more responsibilities in the constitution and implementation of the international maritime conventions. However, due to some historical reasons, weakness exists in the quantity and quality of our IMO proposals. Therefore, in order to better shoulder our international responsibilities, we should strengthen our research on the international maritime conventions and their implementation. The research of international maritime conventions covers wide areas, like maritime safety, environmental protection, security and so on, which needs the efforts of a variety of researchers. Besides the personnel from the maritime administrations and other relevant authorities, the technical and legal support from the research institutes, especially the maritime institutions is also a must. Maritime institutions are endowed with rich human resources. They possess the qualifications of doing research on international maritime conventions. Meanwhile, they are shouldering of maritime personnel cultivation and discipline construction. There is no shirking the responsibility of exerting more efforts in the research of international maritime conventions.

1 The current development of the Chinese shipping industry and its responsibilities in the international maritime affairs

China is a big shipping country. It possesses vast oceans, more than 18,000km mainland coastlines and more than 14,000km island coastlines. Recent years, the Chinese shipping industry is experiencing a prosperous development. In 2004, the international fleet owned or operated by China has reached more than 4.4 mission deadweight ton, topping the fifth in the world. The number of international ports has reached more than 130, with a total international output of 115 million tons.

The development of the Chinese shipping industry has won recognition worldwide. Ever since 1973 when the Chinese government resumed its member status in the IMO, China has been elected the B Category Council State in the 9th -15th IMO General Assembly. Since the 16th IMO General Assembly in 1989, China has been successively elected the A Category Council State for 9 times, being recognized as a key country to provide international shipping service.

According to the international practice, as the IMO member state, especially the A Category Council State, China should shoulder its responsibilities and fulfill its obligations in the constitution, amendment and implementation of international maritime conventions, including participating in the IMO meetings, submitting proposals; proposing amendments to the IMO Conferences, committees and sub-committees for the improvement of IMO Conventions; fulfilling obligations of convention implementation, and carrying out the second round legislation.

1.1 In the constitution of maritime conventions: participate in the IMO meetings, and submit proposals on relevant topics.

As a member state of IMO, China should actively participate in the constitution of international maritime conventions. According to the International Maritime Organization Convention1948, our rights and obligations as a member state are as follows:

- Participate in the IMO meetings;
- Submit proposals on the topics of maritime safety, sea environmental protection and security

that draws much attention among the member states;

- Show opinions in the discussions of IMO committees and subcommittees, and vote for the passing and coming into force of international maritime conventions;
- Encourage the popularization of the highest applicable standards in maritime safety, navigational efficiency, prevention and control of marine pollutions from ships.

1.2 In the amendment of maritime conventions: submit proposals for further amendments.

With the development of social economy and the advancement of maritime science and technology, some clauses in the maritime conventions may become out of date. As an unseparated part of the constitution of maritime conventions, some clauses need to be amended along with the time. As a member state, in order to further improve and gradually perfect the conventions, we are responsible to report to IMO about the implementation and the problems that we encounter.

1.3 In the implementation of maritime conventions: shoulder responsibilities in the implementation and the second-round legislation of conventions.

According to the International Law, member states must abide by the conventions that they have accepted. Article 26 of the Vienna Convention, the Law of Treaties 1969 states that "Every treaty in force is binding upon the parties to it and must be performed by them in good faith."

Our Constitution does not specify the application of international conventions in China. Since some important technical conventions, like SOLAS, MARPOL and STCW all adopt the methods of "consultation" and "package deal", trying to avoid destroying the uniformity of the conventions and the disagreement in the rights and obligations among member states, these international conventions are totally applicable in China.

2 China's status in IMO

As a nation which has great benefits in the shipping affairs, China's important position has been recognized by the international shipping industry. Our country has been successively elected IMO Category A Council Member for nine times and positively participate in the IMO's activities together with the other member states to support IMO's developments and operation.

Our country has done considerable work in the conventions' constitution and modification and made our contributions to the various maritime conventions' modifications and perfection. In addition to positively take part in the discussion of maritime conventions and regulations' constitution and modifications, we put forward large number of proposals of high qualities. For example, the recently hold MSC81 has finished the discussion of "performance standard for protective coatings for dedicated seawater ballast tanks" which has drawn world wide attention of international ship-building and shipping industry. China, Japan, Korea, Denmark, Greece and other international shipping and ship-building organizations have put forward 14 proposals on the important subject of performance standard for protective coatings for ballast tanks to the conference, three of which were made by China. In the meeting, China's delegation introduced the proposal on date of the standards' enter into force and the maintenance and repair of coating, in addition, explain our country's standpoint and principals in the standard's establishment. In the IMO's SLF 45 hold on July, 2002, China Classification Society (CCS) provided four proposals to the conference, three of which were adopted to be the general used standards in international shipping industry. The main topic of discussion in the conference was focus on the safety of large bulk carriers. Since the 1980's, large bulk carriers have suffered large sum of maritime accidents and caused great loss of lives and properties at sea. This is concerned with the deficiency of bow height and reserve buoyancy. The proposals on "bow height and reserve buoyancy" put forward by China contains much true and reliable data and abundant materials. It fetched up the actual design deficiency of large bulk carrier and greatly enhanced the safety of navigation. The conference finally decided to bring the proposal into the amendment to the International Convention on Load Lines, 1966 (1966 LL) and accordingly revised the title of article 39 to be "the minimum bow height and reserve buoyant". The amendment to the 1966LL which reflect the new revision has come into force in 1 January, 2005.

3 The gap between China and other countries

China's activities in IMO have become more and more active, but we have to admit that when compared with developed shipping countries, we still have much to do.

Table 1 statistics of the proposals provided to MSC and MEPC by main shipping countries

Conference	America	UK	China	Greece	Norway	Korea	Japan
MSC81	2	10	3	4	4	6	11
MSC80	3	4	0	4	5	3	7
MSC79	3	7	0	1	4	5	6
MSC78	4	7	1	2	7	3	7
MEPC54	0	4	1(HK)	0	3	4	2
MEPC53	6	4	1	0	3	2	4
MEPC52	10	3	0	0	4	1	4
MEPC51	1	1	0	0	2	0	6

Note: The numbers in the table represent the numbers of proposals

Table 1 reveals the statistics of the proposals provided to MSC and MEPC by main shipping countries. Obviously, the proposals provided by China are limited, while the other Asian countries and IMO Category A Council Member like Japan and Korea all provided large sum of proposals for each conference.

From the outside, the gap between our country and developed shipping countries looks like the limited quantity of proposals provided for the conference, in fact the deep reason is our research on the international maritime conventions is inefficient. We ought to say our research on the international maritime conventions has been constantly strengthened these years, also does the research depth and effects of conventions' implementation. But the research force hasn't been fully bring into play because of the lack of efficient organizing and administration.

In China, the Maritime Safety Administration (MSA) is in charge of the affairs relating to IMO.

MSA is engaged in the research and enact work of laws and regulations' which are in line with the international conventions and treaties; in addition, follow up and research the recent developments of international maritime conventions. In order to better follow up and research the status and development of IMO's conventions related to safety at sea and prevention of pollutions from the ships, enhance our country's ability of legislation, engage in the international maritime affairs and level of conventions' implementation, the MSA established an ad hoc international maritime affairs research committee. The committee is composed of the leaders of China MSA and local MSAs, they are coordinators, while the sub-committees under the committees which are directly attached to the local MSAs are engaged in the conventions' research and follow up. For example, STW sub-committee is attached to Guangdong MSA, NAV sub-committee is attached to Shenzhen MSA, PSC sub-committee is attached to Tianjin MSA, maritime investigation sub-committee is attached to Shanghai MSA, and etc.

The advantage of such kind of research and follow up of conventions is sufficiently use of the exist source of MSA, while the disadvantage is the lack of communications between them while each MSA is an isolated system. But the research of international conventions are focused on the systematization and continuance, the IMO's committees will hold meetings to discuss some issues which draw jointly concern,. However, the seperated research methods in China is not good for the exchange of information.

But we still haven't make use of an important source. In foreign countries especially developed shipping countries, maritime academic institutions and research centers are main force in the conventions' research and implementation, for example, Japan has set up some specialized research institutions which are related with the IMO affairs, including Electronic Navigation Research Institute, Japan Marine Science and Technology Centre, and etc. Currently in China, there are more than 34 maritime higher educational institutions which possess an abundance of human resources. However, these resources have not been, or have hardly been fully utilized. Besides the government, maritime institutions have not fully realized their own roles. They lack the passions and wishes to actively serve for the big shipping country.

4 Maritime universities should play an active role in the government's involvement in IMO affairs

Our government has realized that if China intends to get involved more actively in IMO affairs, maritime universities' support will prove very useful. Last year at a forum about "How To Increase Involvement In IMO Affairs" people present reached an agreement that the government should make good use of resources of universities and colleges in doing follow-up research in maritime conventions. As the only key maritime university in China, Dalian Maritime University (DMU) has put in efforts and will put in more efforts in China's active involvement in international maritime activities.

DMU has long been supporting the government in its involvement in international maritime affairs. In 1983, the United Nation's Development Plan (UNDP) and IMO set up the Asia-Pacific International Maritime Training Center in DMU. In 1985, World Maritime University set up its Dalian Branch in DMU. DMU has always been on good terms with IMO in cooperation, and

DMU has the human resources necessary for studying maritime conventions. As a university with special maritime characteristics, DMU has many shipping and navigation related specialties such as Marine Traffic Engineering, Navigation Information Engineering, Ship Intelligence, Marine Equipment Repair and Construction, Communications and Information System, Marine Environment Protection, International Law. At the same time, DMU has many experts who are well grounded in maritime research theories and who are well experienced in doing research in their own fields, and DMU also has many young teachers who are active in scientific thinking and very creative in spirit. Without a doubt, DMU has the potential to assist the government in participating in IMO affairs.

In order to give the government more support and better advice in IMO affairs, DMU set up International Maritime Convention Research Center in 2004. This center mustered the elites of research people in the university as well as those in the maritime community, with nine full-time researchers, thirty-five part-time researchers in other departments of the university, and forty-two researchers in the maritime community or in other countries. Our main tasks at the present are as follows:

4.1 Collect and exchange IMO information

The large number of documents at IMO conferences is the first-hand information for studying IMO development goals and maritime policies, and collecting and sorting out data according to the different aspects the five IMO Committees are in charge of—maritime safety, maritime environment protection and law—is the first step for setting up a library of international maritime reference books. Our library not only provides reference for government agencies and shipping companies, it is also open to teachers and students who are doing research in international maritime conventions. Besides, we compile and publish a periodical named Research And Recent Developments Of International Maritime Convention every two months, and we have also set up a website so that we can offer research information for the whole industry.

4.2 Carry out research projects

As a research center devoted to maritime convention research, we have invited experts in DMU and other universities to be our visiting professors. They give lectures to the staff and the students, at the same time, they hold panel discussions on hot issues in international maritime research, which can lay a good foundation for future research.

4.3 Cooperate in research and training of maritime personnel with other maritime institutions in China and abroad

A good case to prove the success of our cooperation with other maritime institutions is the running of the Maritime Safety and Environment Management Class between World Maritime University (WMU) and DMU. Some of the lecturers for the class are from DMU, some are from WMU. The involvement of international teachers in teaching brings new information in recent developments in research, it also brings valuable research data to DMU, thus enhancing our research capability.

4.4 Prepare proposals for IMO Conferences, providing reference for the government

In the past few years, this center has sent teachers as representatives of DMU to join the Chinese delegation at the IMO Conferences and meetings. Before every meeting, this center musters experts and professors to prepare and study proposals submitted to the meeting following IMO annual agendas. We not only follow up the development of the conventions, we also aim at submitting forceful proposals and make our voices heard at international conferences. After every conference, DMU organizes a special department to do follow-up work, on the one hand, to inform people concerned of the discussions at the conference and the reactions of different countries to the proposals as well as the position of our country, on the other hand, to carry out future research on important issues in order to bring forward our countermeasures and suggestions for implementing the conventions.

Our experience proves that maritime universities should and can play an active part in maritime convention research, in supporting the government in international affairs and in offering reference for shipping companies in decision-making. Meanwhile maritime universities can become the main force in training maritime talents and researchers. At the present, many other universities are beginning to take actions in this respect.

5 Conclusion

Most maritime universities in China are comprehensive universities with many specialties overlapping with other specialties, and various talents are available for studying maritime conventions. Some developed countries that involve in the shipping industry have taken advantage of the teaching and research personnel in maritime universities and have achieved good results. As a developing country, China is beginning to get benefits in the government's cooperation with maritime universities. As a key maritime university we should take the initiative in the drafting and implementation of maritime conventions to prove our worth, to make greater contribution to the country as well as the world shipping industry. DMU is confident that with support from people in all walks, we will not only become the base for training scientific talents, we will also become a base for doing research in maritime conventions and for training advanced maritime talents.

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Modeling Reforms in Maritime Education at the Operational Level—The Complete Revision of the Deck Training Program for Summer Cruise at the California Maritime Academy

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Abstract Practical training for deck cadets in the merchant marine is an essential segment of the complete training regimen. The skills and knowledge-based competencies learned and demonstrated during this training are equally as important as the academic foundations ascribed to the accomplishment of procuring a license upon matriculation from a maritime academy. In the Fall of 2001, the Department of Marine Transportation came to the consensus that the at-sea Deck Training Program for the seniors and sophomores needed a complete revision. A strategic plan was developed and members of the Marine Transportation Department, Maritime Operations, and the Student Health Center formulated a new practical training regimen. This program encompasses fully one-third of the cadets' cruise experience. The program revision required new curriculum development and current curriculum review, program resource origination, and the creation of assessment and measurement attributes.

Keywords curriculum development; program design; assessment; leadership training; resource origination

0 Introduction

Since 1931, the California Maritime Academy (CMA) has been actively training young men and women to become officers in the United States merchant fleet and leaders in the maritime community ashore. CMA joined the California State University system in 1995 and is nationally unique as the only maritime academy on the West Coast of the United States. The University currently educates over six hundred and fifty cadets in six undergraduate majors.

Cadets desiring the U.S. Third Mate's license pursue a degree in Marine Transportation. The Department of Marine Transportation (MT department) retains a licensed faculty component of about ten tenure-track professors with several lecturers, as needed. The Department of Maritime Operations (MO department) maintains the U.S. Training Ship Golden Bear (TSGB) and teaches many courses also required in the deck curriculum. Graduation occurs through the successful completion of both the U.S. Coast Guard administered Third Mates license exam, the STCW Officer-in-Charge-of-a-Navigational-Watch, and academic completion of the Marine Transportation degree requirements.

Two critical components of the licensing program are the senior level summer training cruise, CRU 300, and the sophomore level cruise, CRU 100. These two training periods represent sixteen of the one hundred and fifty-nine academic units required for graduation in this discipline. Cadets complete an additional eight unit, junior level cruise aboard U.S. commercial, public, or military vessels.

1 Background

In Fall 2001, the Marine Transportation department came to the consensus that the at-sea Deck Training Program, scheduled for the summer semester, for seniors and sophomores needed a complete revision. This training comprises fully one third of all deck cadets' cruise experience, aside from their mid-program commercial ship internship.The IMO's STCW 1995 convention had previously mandated changes to administrative record-keeping of individually demonstrated cadet competencies in license training (an assessor has to evaluate the cadet's performance on a one-on-one basis as competent/incompetent); in response, the summer deck training had been modified from 1998 to 2000 to meet those changes. The consequence of this modification was that a great deal of the practical, hands-on training aspects of cruise were reduced in order to accommodate the time needed for the assessments as mandated by the STCW convention.

The MT department, supported by frequent discussions with the TSGB captains and MO department faculty, reviewed the then existing program. Two Conclusion were unanimously reached by the reviewing panel: 1) the STCW competencies could best be assessed in existing Fall and Spring courses ashore, specifically, components of the Navigational Watch competency could better be assessed in the Full Mission Bridge Simulator assuring consistency and repeatability. These components were removed from the cruise curriculum. 2) the deck training portion of cruise should be revised as the existing program did not meet the MT department objectives for practical training. This revision should also include a significant component of leadership development.

Several STCW assessments remain as part of the cruise curriculum, specifically, celestial navigation, elements of practical navigation, third class helmsman, fast rescue boat, and aspects of GMDSS. With the exception of fast rescue boat, these components are integral to the watchstanding portion of cruise and required very little modification with the restructuring of the deck training program.

2 Strategic development

The MT department formed a subcommittee (Committee) to develop a strategic plan focusing the summer cruise deck training on practical merchant marine exercises. These exercises were centered specifically on the practical skill sets expected of junior deck officers. The Committee determined that half-day modular training best suited the program's design: the 5-day watch/work/training rotations of the summer cruise. Additionally, modular training has a great degree of scheduling flexibility that allowed the coordinators to work around conflicting necessary ship operations, unexpected schedule-changing events, and inclement weather conditions.

A detailed review of the cruise calendars revealed that between twelve and fourteen training days were available for each of the three deck divisions. It should be noted that the only time not associated with training days on cruise are in-port days (watch and work remain in effect). By dividing the available days in half, a total of approximately twenty-four modules were available for training purposes-keeping the training equal for all divisions. (Please see the attached list of topics and the number of modules assigned to each.)

Additionally, the Committee recognized that senior and sophomore training had to be conducted primarily as separate entities; sophomore training to focus on basic skills and senior training to focus on advanced skills, leadership, and the re-enforcement of basic skills. Two personnel, Deck Training Officers (DTOs), would conduct the training, one for each 1/C and 3/C group (group sizes average 15 students). An added advantage of modular training was the flexibility for the integration of first-class and third-class cadets for certain training segments.

The Committee requested training topic input from all deck faculty, the TSGB captains, and students. Again, the topic focus was centered on the practical deck skills deemed essential for junior officers. Additional input from industry was derived from Commercial Cruise evaluations and comments. As a result, the topics represented the aggregated efforts of most of the personnel directly involved with and affected by the training; thus, the broadest and most collaborative efforts were expended by all parties involved.

3 Curriculum development

The Committee solicited members of the MT department, MO department, and the Student Health Center as experts in topic fields in formulating and developing the new practical training curriculum. Additionally, by working closely on cruise with the faculty, ship's department heads, and ship staff, many of these courses were taught by the experts themselves.

Course syllabi and curriculum binders were developed to ensure consistency between cruises and personnel. The purpose was not to stifle academic freedom of the faculty but, rather, to ensure preset objectives were achieved. Indeed, the result was the ability of the DTOs to teach those modules with which they had the most experience and to expose the students to a broad range of industry operational experiences.

During development, certain course curriculum required multiple modules to encompass the material and training. Specific personnel, primarily ship staff (the Bosun to teach "Splicing" and "Knot Tying", the ship's medical staff to assist in "First Aid"), are needed to teach particular topics. Combined with the desire to integrate the first-class and third-class cadets for leadership and teamwork training, the DTOs had to carefully schedule the training before cruise began, keep all personnel involved aware of the schedule, and follow-up throughout the cruise to keep the schedule on track. Leadership training was a particular concern as first-class cadets are assessed on their ability to properly manage peers and subordinates throughout their final matriculation period.

4 Resource origination and allocation

CMA's Academic Administration financially supported the revision efforts. The Committee developed funding needs and a preliminary budget for the first training cycle. Training equipment storage and office space needs were discussed and the TSGB captains allocated a large storage space for the Deck Training Gear aboard the ship as well as secure office for the curriculum texts and high-dollar, fragile equipment.

Under the California Lottery statutes, portions of the lottery monies are allocated to public education. Some of this money, around $10,000, funded initial equipment needs above then existing equipment aboard the TSGB. Funding beyond first year needs was categorized as newly capitalized gear and sustainable (consumable) equipment. As lottery monies could only be utilized for newly capitalized items, the academic budget was earmarked for annual consumables.

After the first year, it became clear that training equipment utilized in this program must be separate from the operational equipment of the vessel even if this meant duplication. The areas most effected were fire fighting equipment (including SCBA's, turn out gear, cylinder refilling compressors, hoses, nozzles, and foam), and mooring equipment (including mooring hawsers, heaving lines, and stoppers).

This past year, with budget shortages threatening all, a second MT department sub-committee created a cruise fee proposal (later approved) to replace the academic budgetary support and as well as funding for needed repairs for other deck training (i.e. the 60 sextants used by the students each summer). The financial future of the program is thus ensured regardless of University budgetary fluxes.

Early in the resource origination process, the Committee recognized that industry support would be needed to fund some high-dollar capital and consumable equipment. Donations have been solicited every year. To date: Vallejo Air discounted an air compressor to support the SCBA training; the TSGB Engineering department donated a $1,000 transformer, built a mount and installed the compressor; the Oakland Fire Department has donated dozens of SCBA bottles and packs with masks on two separate occasions; MMC has discounted meters used in the Atmospheric Testing/Enclosed Space Entry training; the U.S. Maritime Administration donated, and continues to donate, many consumables including firefighting turn-out gear.

5 Evaluations

Student Assessments have been a constant source of discussion and argument among the cruise faculty. All recognize the need for formative and summative measures; few can agree on the overall purposes of the evaluations and the form of the instrument. Initially, the DTOs utilized a broad, interpretive and largely comment-type format to be used formatively in improving the program. The main problems were the difference in interpretation among the students untrained in evaluation and the difficulty in statistical analysis of comments rather than a graduated, quantitative scale. While the comments were overwhelmingly positive towards the program, no statistical analysis could be performed due to the open-ended comment nature of the forms.

In the summer 2005 training sequence, a newer instrument was selected that focused on student outcomes using a graduated scale. The student outcomes-based format coincided with the overall strategic focus of the program revision. Additionally, this survey encompasses the entire summer at-sea training regimen: Watchstanding, Daywork, and Deck Training. In future years, the MT department plans to formalize the evaluations and analysis to support the program's budgetary increases as well as assess the strengths and weaknesses of the program. Additionally, ship staff and other involved personnel will be encouraged to assess pertinent portions of the program.

6 Conclusion

6.1 What the future holds in store

A key strength of this program is its flexibility. As enrollment has increased, the program has been adapted to encompass numbers beyond its original design. Current solutions include increasing the number of faculty, proportionate to the increases in students and subsequent teaching of multiple sections of the training program.

In the near future, the MT department plans to expand the focus of the training program to include a new "training bridge" to be built aft of the current operational Bridge aboard the TSGB. This training bridge will allow remedial training as well as additional exposure for all deck students in piloting, radar, ARPA, celestial navigation, and watchstanding in a real "at sea" environment. This addition would allow the creation of a new Navigation Training Program to handle increased numbers of cadets.

The MT Department considers the Deck Training Program to be a work-in-process responsive to changes in industry and education and exploiting the expertise available at CMA. Additionally, the annual student program evaluations ensure the students have a solid voice in determining the quality and applicability of the program. This evaluation process has already lead to several modifications to individual module content and to module sequencing.

Whatever changes or adaptations these programs endure, the Marine Transportation Department of the California Maritime Academy maintains a commitment to practical deck training ensuring competent, confident graduates capable of assuming appropriate responsibilities upon joining their first vessel.

6.2 First Class Training Modules

Deck Training Modules	Number of Modules
Safety Inspection	2
Mooring	4
Firefighting	6
Atmospheric Testing	1
Fast Rescue Boat	1
Survival Craft	4
General Seamanship Exam	1
Emergency Equipment	2
SCBA	1
Block and Tackle	2

6.3 Third Class Training Modules

Deck Training Modules	Number of Modules
Trick Wheel (After Steering)	1
Splicing	3
Medical (First Aid)	3
Mooring	4
Knots	1
Ground Tackle	1
Canvas (Constructing a Sea Bag)	1
Firefighting	6
Blocks & Tackle	2
Emergency Equipment	1
SCBA	1

Developing the TOMEC—Test of Maritime English Competence—Toward Global Standardization of Maritime English Assessment

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Abstract This paper is the first report of a joint project between the Tokyo University of Marine Science and Technology (TUMSAT) and the California Maritime Academy, a California State University (CMA) to develop a test of maritime English competence (TOMEC) under a grant given to the TUMSAT by the Japanese Ministry of Education, Culture, Sports, Science and Technology to enhance the quality of Maritime English Education at the TUMSAT.

In order to properly assess each learner's competence in Maritime English as required by the STCW 95, the authors developed a multiple choice test that consists of five parts. The first three parts are for testing listening comprehension. Here test takers are required to choose one statement that best describes a picture, to find an appropriate answer to a question, and to answer a written question after listening to a conversation or an announcement. The last two parts are designed to assess learners' basic vocabulary and grammar, and reading comprehension. The principles in designing these items and what aspect of Maritime English is assessed by each part are discussed in detail.

We have prepared 2 versions for deck and 2 versions for engine cadets, each version or test consisting of 100 questions in total, the first three listening parts with 50, and

the remaining two parts with another 50 questions. Recordings were made in Japan by two professional narrators of British English.

What makes the present project so unique is the close collaboration between non-native, non-sea-going English teachers who are familiar with language testing on one hand and English speaking captain and chief engineer who are “living” Maritime English on the other. Only after such complimentary contribution can one expect a good test of Maritime English that is both reliable and valid.

Although the test was originally made to assess the effectiveness of the newly introduced maritime English courses at the TUMSAT, it certainly can be used to assess any person’s command of maritime English. The authors wish to further increase the number of exam items and to standardize different versions by giving the TOMEC to students studying at different IAMU member institutions.

0 Introduction

The TOMEC (Test of Maritime English Competence) reported here was developed to assess the effectiveness of newly introduced maritime English courses (Deck and Engine) at the Tokyo University of Marine Science and Technology (TUMSAT) under a grant from the Japanese Ministry of Education, Culture, Sports, Science and Technology.

Although there are standardized tests of business or academic English such as TOEIC, TOEFL, and IELTS, they are not designed to specifically assess maritime English competence. The ISF Marlins English Test, which measures English proficiency in maritime context, is commercially available, but it is computer based and thus not suitable for testing 35-40 students simultaneously in a classroom.

Our original goal is straightforward: to develop at least two sets of maritime English exam questions of approximately equal difficulty, so that we can give one set prior to, and the other set after, two semesters of maritime English courses in order to assess learners’ improvement. We opted for an audio tape/CD-based, paper and pencil, multiple-choice test for convenient administration and scoring. The test measures listening comprehension (Parts 1, 2, and 3) and basic grammar and vocabulary (Part 4), and reading comprehension (Part 5).

The TOMEC was designed to assess maritime English competence required by the STCW 95. Thus the deck department questions cover onboard, ship-to-ship, and ship-to-shore communications using the Standard Maritime Communication Phrases (but not exclusively so since the SMCP is a minimum requirement and real mariners, especially native speakers, do not necessarily communicate using them) and nautical publications such as sailing directions. The test for the engine department concentrates on ability to perform engineering duties and understand engineering publications such as manuals.

In preparing the test items, the third and fourth authors, who are English speaking captain and chief engineer, were responsible for the authenticity of maritime English and technical integrity for the listening comprehension questions. The first and second authors, who are non-native English teachers familiar with language testing, were responsible for the remaining grammar/vocabulary and reading questions.

Ideally, recordings for listening questions should be made with various dialects of English, including non-native speakers with moderate accents because this is what mariners actually hear at sea. This option, however, was not possible, and the recordings were made in Japan by two professional narrators, who were both native speakers of British English.

In what follows, we will discuss each of the five parts of the test in detail using sample questions and conclude the paper with possible future directions toward global standardization of maritime English assessment.

1 Listening comprehension

The listening comprehension section of the test consists of three parts. The formats used here are similar to those found in the TOEIC test. In Part I, a statement that best describes a picture must be chosen among four statements. In Part II, a question or statement is played and test takers are to choose one of the four possible answers/responses to the question that are also aurally presented. In Part III, examinees listen to a conversation or announcement, and they are to answer a question written on the booklet.

1.1 Part I

Two sample questions (one for deck and the other for engine cadets) are presented below. For each question, the picture is printed in the test booklet in black and white, and four statements are aurally presented. The correct answer is printed in bold italics.

Fig. 1 Sample question 1

Fig. 2 Sample question 2

Sample question 1

(A) The starboard anchor is currently deployed by the vessel.

(B) The containership is fitted with a bulbous bow.

(C) The gantry cranes are in operation.

(D) The vessel is moored starboard side to the pier.

Sample question 2

(A) The men are working on a part fixed with a vice.

(B) The men are working on a lathe.

(C) The men are fixing a vice onto the work bench.

(D) The men are lapping in a valve.

The two examples above clearly show that this picture description format is suitable for testing listening comprehension of basic deck and engine related vocabulary items. These include nouns describing ship's nomenclature and engine room equipment and tool names (bulbous bow, starboard anchor, vice, lathe, etc.), verbs describing actions and conditions (to be deployed, to fix something with a vice, to lap in a valve, etc.). Although not presented in the above examples, Part I questions also test important adjectives (a taut/broken line, a frozen valve, etc.), and prepositions/prepositional phrases (X is behind/next to Y, moving forward/aft, etc.).

1.2 Part II

In Part II, examinees listen to a question or statement followed by four possible answers/responses. They are to choose the best answer or response to the initial question or statement. Unlike in Part III, where questions and response alternatives are printed in the booklet, in Part II, both a question/statement and possible reponses are presented aurally. Two sample questions will follow:

Sample question 3

Who is responsible for securing the after hatch?

(A) I will make a security call.

(B) The hatch is secure.

(C) The Bosun is responsible for the after hatch.

(D) All the lines aft are secured.

Sample question 4

At what time is finished with engines estimated?

(A) We will start the engines at 0800.

(B) Scheduled departure is in one hour.

(C) By 1300 at the latest.

(D) The engine maintenance will be finished at 1400.

As can be seen from the examples above, this part evaluates ability to understand a spoken message likely to be encountered onboard ship or in professional situations and to respond to it appropriately.

1.3 Part III

In Part III, test takers listen to a conversation between two people or a statement by a single speaker, and answer a question written in the test booklet. Two sample questions will follow. The recording scripts that are presented aurally appear in italics, followed by the questions and response alternatives printed in the test booklet.

Sample question 5

Securite, Securite, Securite.

All ships in the Prince Rupert traffic lanes, the HMS Queen Victoria, call sign FTAK is proceeding southbound in Grenville channel with dangerous cargo. All vessels are instructed to keep a 500 meter precautionary zone around the vessel.

> What is the nature of this communication?
>
> (A) There is an aid to navigation malfunctioning.
>
> (B) A man has fallen overboard

The next example is a conversation between a chief engineer and a third officer.

Sample question 6

A: Bridge, this is the Chief Engineer.

B: Hi, Chief. This is the third officer.

A: Hi, John. Can we come to all stop to inspect a main bearing high temperature alarm?

B: Eh, it's really foggy and there are several danger targets. Can we just reduce speed for now?

A: OK. We will start reducing speed now.

B: Thanks, and I'll check with the Captain and get back to you.

> What can be inferred from this conversation?
>
> (A) The captain is likely to make a final decision as to when to stop the engine.
>
> (B) They must stop the engine immediately or else the main bearing will seize.

Part III is suitable for testing ability to understand radio messages (e.g. Mayday, Securite, Pan Pan), ship-to-ship (e.g. making a passing arrangement), ship-to-shore (e.g. making a tug arrangement), and internal (e.g. bridge-engine room) communications.

2 Grammar/vocabulary (Part IV)

Part IV evaluates basic grammar and vocabulary. Since both "general" English and "maritime" English share a common grammar, successful communication depends on its sufficient knowledge. Any mariner should be able to understand the difference between "Starting air has run out." and "Starting air is running out." In order to express time sequence of events, one should be able to use conjunctions such as "before" and "after" properly. A coast guard vessel may "chase a pirate boat," but it is a completely different story if it "is being chased by a pirate boat." Thus, our grammar questions include tense, voice, proper use of different parts of speech, and function words such as conjunctions, prepositions, and auxiliary verbs.

Adequate knowledge of technical terms is also essential. Obviously, nouns form a central part of maritime vocabulary: pilot ladder, thruster, bearing, piston ring, main bearing, exhaust valve, etc. The list is almost endless. However, nouns alone do not make sentences. One must learn their collocations with other parts of speech such as verbs and adjectives: one "rigs" a pilot ladder, piston rings must be replaced when "worn", and main bearings can "seize" if lube oil film is broken. Our test questions include those vocabulary items as well.

Two grammar-oriented sample questions are presented below. Examinees must choose one multiple choice item that best completes the sentence.

Sample question 7

Lube oil cannot be _______ its temperature is too low.

(A) efficient filter if

(B) efficiently filtered unless

(C) efficiently filtered if

(D) efficient filter unless

Sample question 8

The most critical time for preventing an accidental oil spill during bunkering is when the tanks ________.

(A) are topping off

(B) topped off

(C) being topped off

(D) are being topped off

The first question involves appropriate use of parts of speech and conjunctions, and the second one deals with tense and voice. Note here that grammar is tested in maritime contexts in the TOMEC. We now present two vocabulary-oriented sample questions:

Sample question 9

A vessel's position should be plotted using bearings of ______ known objects on shore.

(A) fixed

(B) repaired

(C) replaced

(D) stored

Sample question 10

A properly adjusted ________ for an auxiliary boiler opens at its set pressure.

(A) safety valve

(B) maneuvering valve

(C) butterfly valve

(D) needle valve

The word "fixed" is not strictly maritime, but it is so in this particular context. The response alternatives for the last question consist of different valves, and to answer this question, one must know what these valves are. In this sense, this question presupposes a certain amount of technical knowledge, but we believe any chief engineer would expect his/her third engineer to know what a safety valve is.

3 Reading comprehension (Part V)

The last part of the test is designed to evaluate reading comprehension of practical materials that deck or engine cadets must read and understand such as sailing directions, international regulations and conventions, operation manuals, etc. After reading a passage, examinees are required to answer questions about its content. To save space, only one sample question for engine cadets is presented below:

Sample question 11

Read the following passages and answer the questions.

Misfiring may be rhythmical or erratic. The former indicates that the same cylinder(s) are misfiring all the time; the latter means that cylinders misfire randomly. Rhythmical misfiring is caused by a specific problem with one or more cylinders, such as low compression or faulty fuel injection. If it occurs on start-up then clears up once the engine warms, it is almost certainly due to low compression. The air in the cylinder is not initially reaching ignition temperature, but as the engine warms the air gets hotter until the cylinder fires.

The guilty cylinder(s) of a rhythmical misfire can be tracked down by loosening the injector nut on each injector in turn (with the engine running) until fuel spurts out. If the engine changes its note or slows down, the cylinder was firing as it should, and you can retighten

Q1

When an engine was lit off, misfiring at a regular interval was observed but it disappeared later. What is the most likely cause of this problem according to the passages above?

(A) Faulty fuel injection.

(B) Insufficient compression

(C) Excessive fuel injection

(D) Erratic ignition temperature

Q2

How can one identify a misfiring cylinder according to the passages above?

(A) By turning the injector while the engine is in operation.

(B) By making sure that no fuel spurts out.

(C) By shutting fuel supply to the cylinders one at a time.

(D) By listening to the sound coming from each cylinder in turn.

Although choosing authentic reading materials seems reasonable, this indeed poses a challenge. If a test taker already knows what is being described in the reading material, he or she may be able to answer the questions without actually reading the passage. For example, presenting a passage referring to the maximum oil content allowed in bilge discharge and asking the maximum concentration would not work. To avoid this, we decided not to choose a reading material that may lead to questions that are too obvious.

4 Future goals

We believe that the sample questions presented here are enough to demonstrate the validity of the TOMEC test. It measures maritime English competence necessary for deck and engine cadets to perform their duties. Its reliability, however, must be tested empirically, and for that, we must give this test to as many students as possible, not only in Japan, but also in other countries.

For each department (i.e. Deck and Engine), we originally made two different versions of the TOMEC test, each consisting of 100 questions in total, with Part I through Part V consisting of 20, 20, 10, 30, and 20 questions respectively. We administered one version to junior-year deck students studying at the TUMSAT and found that these questions were too many for our 90-minute class. To make the test easier to administer in terms of its duration, we have decided to split each version into two equal halves, creating four versions that consist of 50 questions (25 listening, 15 grammar/vocabulary, 10 reading questions).

Our next step is to obtain sufficient data for equalizing the difficulty level among those versions. This process is also essential to obtain item discriminability and “weed out” inappropriate test items. To achieve this end, we would like to ask for IAMU members’ cooperation. Even though the test is not fully standardized yet, it can still be used for useful purposes. For example, it can be used as a screening tool. The test, if given to cadets newly admitted to an MET institution, will certainly teach them importance of learning maritime English. One can track their improvement by giving the same test just before graduation, proving the effectiveness of the Maritime English curriculum. So if any member institution is interested, please let us know. We would be happy to provide the test booklets, answer sheets, and scoring service. Confidentiality is guaranteed. The more data we have, the better the TOMEC becomes, and the member institutions can benefit from the test. We need your cooperation.

Using the test results, we will exclude test items with low discriminability, and create, hopefully, 3 versions that are approximately comparable. By giving these versions to English speaking cadets (seniors), we can estimate native speakers’ performance in terms of mean and standard deviation.

These parameters could be used to classify test takers level of Maritime English. For example, if a non-native examinee's score is above the mean, this would be classified as level A, within one standard deviation below the mean, level B, between one and two standard deviations below the mean, level C, and otherwise level D. A classification scheme like this would show each student how good their maritime English is compared to native speakers who are of equal academic standing (i.e. senior cadets).

The authors believe that the TOMEC test, when successfully completed, will provide MET institutions of the world with a convenient tool of evaluating maritime English competence as required by the STCW 95, and certainly work toward global standardization of maritime English assessment.

Rough Waters

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Abstract "Piracy" is defined under the 1982 United Nations Convention on the law of the Sea to include illegal acts of violence, detention, or depredation for private ends committed by the crew or passengers of one ship against another ship, or person or property on board that ship. Piracy per se occurs in international waters, outside the jurisdiction of any state, and usually outside security patrolled or monitored areas.

The number of pirate attacks worldwide has tripled in the past decade, and new evidence suggests that piracy is becoming a key tactic of terrorist groups. Unlike the pirates of old, whose sole objective was quick commercial gain, many of today's pirates are maritime terrorists with an ideological bent and a broad political agenda.

There would seem to be important lessons to be learned from maritime piracy that could be relevant when considering the potential threat of seaborne terrorism. Pirates and terrorists use similar tactics and operate with impunity across broad geographic regions. There is also increasing evidence of interaction between pirates and terrorists.

With nearly 90 percent of international trade moving by water, the immediate and inevitable actions countries would take in response to a major maritime terror attack would most likely disrupt critical trade flows, industrial supply chains and, ultimately, the global economy.

The response of ship operators to piracy has been limited and inconsistent. Typically, standing orders prevent active resistance; the most often recommended course of action, should a vessel be boarded, is for crew members to lock themselves in a "safe room" until the danger has passed. But for a vessel underway, such a strategy fails to consider the potentially disastrous consequences that could result

from a loss of shipboard navigational control, including collision, grounding, or a major oil or toxic chemical spill.

Given the scope and dimensions of the maritime security problem, collective action, at the regional or international level, will most likely be required, and there has been some movement in this direction.

Several important maritime security initiatives also have been recently put into effect, as "The International Ship and Port Facility Security Code", takes some crucial first steps in addressing maritime security needs both afloat and ashore.

In the longer-term, implementing a system of positive vessel identification and control may hold the best hope for reducing incidents of piracy and enhancing overall maritime security.

0 Introduction

In the first years of the nineteenth century, Mediterranean pirates, with the support of the nomad states of northern Africa, would capture merchant ships and hold their crews for ransom.

From that moment till today the piracy acts has growing up, in the past decade the number of pirate attacks on ships has also tripled, putting piracy at its highest level in the modern history.

Most disturbingly, the scourges of piracy and terrorism are increasingly intertwined: piracy on the high seas is becoming a key tactic of terrorist groups. Unlike the pirates of old, whose sole objective was quick commercial gain, many of today's pirates are maritime terrorists with an ideological bent and a broad political agenda.

1 Maritime transport and piracy

Waters covers almost three-quarters of the globe and is home to roughly 50,000 large ships, which carry 80 percents of the world's traded cargo. The sea has always been an anarchic domain. Unlike land and air, it is barely policed, even today.

Based on International Maritime Board statistics, piracy worldwide appears to be on the rise, with an average of 405 incidents per year during 2000–2003, compared to an average of just 233 during 1995–1999. Between 1995 and 2003, it is estimated that more than 2,500 vessel crew members were held hostage, while nearly 1,000 have been reported injured, killed, or missing due to piracy incidents.

The full dimensions of the problem may be much broader, however, as many industry experts have suggested that acts of piracy are highly underreported.

Piracy attacks appear to be most prevalent in countries with emerging economies, numerous estuaries and offshore islands, large stretches of remote coastal areas, and ongoing political insurgencies. More than 60 percent of piracy incidents reported in 2003 occurred in just five areas: Indonesia, Bangladesh, Nigeria, the Malacca Straits, and India–with Indonesia accounting for more than a quarter of all incidents. At a more aggregate level, vessels appear to be more vulnerable to piracy in Africa and Asia than in other regions of the world.

To date, little has been done to effectively address the increasing frequency of pirate attacks. In part, this may stem from a lack of counter piracy resources in those countries where piracy is most prevalent. And without bilateral agreements to the contrary, international law and issues of sovereignty preclude intervention by outside naval powers.

The highly "international" nature of ocean shipping also may have an impact. A single ship, for example, might be built in Korea, owned by a Swiss corporation, flagged in Singapore, chartered by a German company, manned by Ukrainian officers, crewed by Filipinos, and carry the cargoes of shippers and consignees from around the world. These conditions may serve to dilute the outrage and calls for action that might otherwise result if an act of piracy were perpetrated against the interests of a single country.

The response of ship operators to piracy has been limited and inconsistent. Typically, standing orders prevent active resistance; the most often recommended course of action, should a vessel be boarded, is for crew members to lock themselves in a "safe room" until the danger has passed. But for a vessel underway, such a strategy fails to consider the potentially disastrous consequences that could result from a loss of shipboard navigational control, including collision, grounding or a major oil or toxic chemical spill.

Could the current lack of an aggressive response to maritime piracy be setting the stage for a more significant security threat? An analogy to the present situation may be seen in the build-up in air piracy incidents. In the hindsight, these incidents highlighted a number of major security gaps that should have been addressed: failing to confirm passenger identities and screen passengers for any potential weapons, failing to adequately search all baggage and match it with ticketed passengers, failing to reinforce cockpit doors, and failing to adopt policies and tactics for resisting skyjackers.

Equally, there would seem to be important lessons to be learned from maritime piracy that could be relevant when considering the potential threat of seaborne terrorism. Pirates and terrorists use similar tactics and operate with impunity across broad geographic regions. There is also increasing evidence of interaction between pirates and terrorists. Most importantly, the frequency and success of maritime piracy attacks provides strong empirical evidence about the at-risk nature of coastal assets and underscores the vulnerability of all nations to attacks launched from marine environment.

Below is presented the Annual Report of ICC International Maritime Bureau regarding the pirate attacks during the year of 2004, categorized by regions and ship class.

Location number of actual and attempted attacks 2004:
Indonesia: 93 attacks
China/Hong Kong/Macau/Taiwan: None
South China Sea: 8 attacks
Philippines: 4 attacks
India: 15 attacks
Malaysia/Thailand: 13 attacks
Vietnam: 4 attacks
Cambodia: None
Sri Lanka: None
Straits of Malacca: 37 attacks
Singapore Straits: 8 attacks
Bangladesh: 17 attacks
Brazil: 7 attacks
Total number of attacks in 2004: 325 attacks
Recorded attacks by ship class:
Bulk carrier: 72 ships
General cargo: 38 ships
Tanker Crude Oil: 17 ships
Container: 48 ships
Tug: 24 ships
LPG: 13 ships
LNG: None
RO-RO: 2 ships
Chemical Tankers: 55 ships
Trawler/fishing: 18 ships
Passenger: None
Livestock Carrier: 2 ships
Ferry: None
Woodchips/log carrier: None
Yacht: 10 ships
Research ship: None
Vehicle carrier: 1 ship
Storage ship: None
Multipurpose: None
Warship: None
Barge carrier: 1 ship
Supply ship: 8 ships
Heavy lift: None

Refrigerated: 10 ships
Combination carrier: None
Unknown: 1 ship
Total for the year 2004: 325 ships

According to the same report, violence to crew carried out during attack has classified as follow:
Taken hostage: 148 persons
Kidnap/ransom: 86 persons
Crew threatened: 34 persons
Crew assaulted: 12 persons
Injured: 59 persons
Killed: 30 persons
Missing: 30 persons
Total: 399 persons

Maritime attacks by type has been classified as:
Attempted Boarding: 76 ships
Vessel Boarded: 226 ships
Hijack: 11 ships
Missing: None
Vessel fired upon: 12 ships
Detained: None
Total: 325 ships

For illustration of increasing rate of piracy attacks will present the following statistics realised by the same institution, ICC International Maritime Bureau, based on dates recorded in 1994 and 2004:

attacks recorded by ship class: 1994–90 ships; 2004–325 ships

violence to crew carried out during attack: 1994–29 persons; 2004–399 persons

This statistics show how high is today the piracy around the world.

2 Securing the seas

Given the scope and dimensions of the maritime security problem, collective action, at the regional or international level, will most likely be required, and there has been some movements in this direction. For example, the Association of South East Asian Countries has made addressing piracy and other transborder crimes as a priority and is working with key trading partners to find solutions.

Several important maritime security initiatives also have been recently put into effect. The "International Ship and Port Facility Security Code", for example, takes some crucial first steps in addressing maritime security needs both afloat and ashore. Other new programs include "Container Security Initiative", "Customs-Trade Partnership Against Terrorism", and more thorough methods for screening ships and cargoes perceived to present risks.

In the long-term, implementing a system of positive vessel identification and control, much like the one now take for granted to manage air transportation, may hold the best hope for reducing incidents of piracy and enhancing overall maritime security. Transporters installed on ships could be interrogated for vital information on vessel identities, registries, ownership, voyage histories, cargo carried, crew, etc. primary targets lacking transponders would be imaged using sophisticated radar or photographic techniques to achieve positive identification, and any vessel perceived to be a threat would be tracked and intercepted long before reaching a port. Such a system would take time to evolve, and required substantial resources to develop. A starting point would be using shore-based radar to identify vessels in ports and territorial waters; ultimately thought, the system could cover the high seas, using satellites in low earth and geosynchronous orbits.

Such sophisticated responses, however, are still in the future. In the near-term, participants in the maritime industry must consider what they can do to minimize piracy related risks. On the high seas, ship crews, owners and operators are largely on their own. A common sense approach for a carrier would be to develop a comprehensive, coordinated security plan and standing orders across its fleet. Such planning needs to take into account origins/destinations, routes and cargoes, with sensitivity to areas of the world where security threats are greatest. Equally, ports and key facilities at tidewater locations need to develop their own action plans to deal with risks from maritime threats.

[2] Charles J. Reinhardt-Maritime Piracy, 2003.

[3] ICC International Maritime Bureau, Annual Report, 2004.

Decision Support for Avoiding Roll Resonance and Wave Impact for Ship Operation in Heavy Seas

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Abstract There have been several instances of ships being badly damaged due to heavy rolling motion in sea state, which clearly shows the need for a method to estimate the potential danger in order to support the work of the ships' officers. In the paper a simplified but robust method is shown for the on-board calculation, based on the comparison of the ships natural rolling period and the period of wave encounter to prepare a polar diagram for synchronous and parametric resonance and other wave effects from basic data of the ship and the sea state, even by manual calculation. It is also possible to include the potential danger of high wave group encounter or Surf-riding and broaching respectively.

A computer program ARROW–Avoidance of Roll Resonance and Wave impact was developed to display the potential dangerous conditions of rolling resonances or other high wave impacts on ships due to specific wave encounter situations. The tool allows

for quick variation of the relevant parameters and was implemented as a module into a ship weather routing program.

Keywords resonance; parametric rolling; weather routing; surf-riding and broaching

0 Introduction

Over the last few years several vessels have experienced the dangerous effects of rolling resonance. Investigations have shown that these effects are based on phenomena known as synchronous and parametric roll resonance[1, 2]. Moreover, there can be additional dangers by reduction of intact stability caused by riding on the wave crest on successive high wave attacks or dangers of surf-riding and broaching in following seas. The phenomena described in Table 1 can occur when a ship is affected by high sea state, either separately or combined.

Table 1 Overview on dangerous phenomena in high sea state, occurrence and effects

Phenomena	Occurrence		Effect
	Direction	Periods/Encounter	
1. Synchronous rolling motion	All directions possible	Natural rolling period of a ship coincides with the encounter wave period.	Heavy oscillations with high amplitude
2. Parametric rolling motion	Specifically for head and stern wave conditions	Wave encounter period is approximately equal to half of the natural roll period of the ship	Heavy oscillations with high amplitude
3. Reduction of stability riding on the wave crests of high wave groups	Following and quartering seas	Wave length larger than 0.8 x ship length and significant wave height is larger than 0.04 x ship length	Large roll angle and capsizing
4. Surf-riding and broaching-to	Following and quartering seas	The critical wave speed is considered to be about $1.8\sqrt{L}$~$3.0\sqrt{L}$ with respect to ships' length	Course deviation and capsizing

Over the last decade there have been many investigations and recommendations into this phenomena and publications can be found on how to calculate some of these effects but either they do not cover all the effects which are mentioned above or they were not designed to support the ship's crew in order to give effective guidance for the operation of ships. The IMO 1995 has published guidelines to the master for avoiding dangerous situations in following and quartering seas to be aware of several effects due to sea state [3, 4]. In 2003 a draft of a new German guideline for stability on board ships was published[7] and some of its aspects were given to the IMO where a review of the IMO guideline is currently taking place [5, 8]. Summarizing all these methods, the current methods are lacking a simplified, user friendly approach for the calculation of the effects, necessary for education and training, for use on board and an overall approach for presentation of all effects in one diagram related to the actual ship and wave conditions.

This paper describes briefly how to effectively find out the potentially dangerous situations. Simplified calculation methods are given which were developed to manually calculate a polar diagram presentation e.g. on RADAR Plotting Sheets. The software program ARROW will be described as a tool to estimate and display the potential dangerous conditions of rolling resonances or high wave impacts on ships due to complex wave encounter situations e.g. for long range voyage planning in co-operation with a weather routing program.

1 Description of effects and methods

1.1 Ships' motion and ship natural rolling periods

The ships' motion can be generally subdivided into 6 degrees of freedom. For the problems handled within this paper we will mainly focus on rolling motion and the surge/sway and yawing motion for the surf riding and broaching. To calculate the rolling period Tr of a ship one can apply the so called WEISS–Formula. For small roll angles up to $\Phi\approx5$ or even to $\Phi\approx10°$ it reveals:

$$Tr(10°) = \frac{Cr \cdot B}{\sqrt{GM}}$$

where:

GM–Initial stability, metacentric height (m), *B*–ship's beam (m); Lpp–length (m)

Cr–the inertia coefficient for rolling motion, e.g. according to IMO–Guidelines as to $Cr = 2*c$ with

$c = 0.373 + 0.023(B/d)–0.043(Lpp/100)$ with *d*–draft(m).

For large roll angle amplitudes up to $\Phi\approx40°$ or more the roll period can change, compared to the period $Tr(10°)$ for small angles. The magnitude of the difference is according to the type of the stability curve. There are three types of curves:

Strong over-proportional increase of the up-righting lever, compared to the tangent according to *GM* indicated by the dotted line in Fig. 4, i.e. $Tr(10°) > Tr(40°)$, as it can be seen from the values for Tr(10°) and $Tr(40°)$ in that Fig. (left part),

Nearly linear gradient up to the maximum, proportional to the tangent according to *GM* (i.e. $Tr(10°) = Tr(40°)$),

Strong under-proportional decreased curve, i.e. $Tr(10°) < Tr(40°)$.

To calculate the rolling period $Tr(40°)$ for rolling angles Φ up to 40° a formula can be used (according [6, 9]).

1.2 Sea state and encounter period to waves

The sea state is approximated by a regular wave system with one characteristic direction, average wave height, described by average wave period *Tw*, wave length Lw and wave speed *Cw*. The wave period *Tw* is the period a fixed observer would time between the passing of two consecutive wave crests or two consecutive wave troughs. The wave period directly corresponds to the wavelength *Lw*. The following relation holds between the wave length and wave speed for harmonic waves:

$$Lw = k \cdot Tw? \quad and \quad Cw = k \cdot Tw$$

where:

k denotes the coefficient for the wave system (wave number), which is according to the types of wave systems (*k* = 1.56 for full developed swell, long crested; *k* = 1.3 for heavy seas not fully developed in intermediate conditions; *k* = 1.04 for wind sea, short crested with new developing sea waves).

Lw: wavelength (m); *Tw*: wave period (s); *Cw*: Wave speed / celerity (m/s)

The encounter situation between ship and waves is very important for the wave impact: The ship will be forced into oscillation exited by the encounter period *TE* between ship and sea. For general encounter situation the encounter period *TE* can be calculated as to:

$$TE = \frac{k \cdot Tw?}{k \cdot Tw + 0{,}514 \cdot V \cdot \cos\gamma}$$

With:

V–ship's speed vector[kn] and component *V* * cos (γ)–For conditions where the ship is overtaking the waves the wave speed has to be considered as negative

γ– encounter angle (γ=0° for head sea; γ=180° for following sea)

Generally for a given encounter period TE and wave period the speed can be calculated to:

$$V_{TE} = \frac{k \cdot T_w}{0{,}514 \cdot \cos\gamma} \cdot \left(\frac{T_w}{T_E} - 1 \right)$$

1.3 Conditions for synchronous and parametric rolling resonance

Resonance develops when the ship's natural rolling period coincides with the excitation period of the waves (the encounter period). The rolling amplitudes of the ship may be stimulated depending on the ratio between the ships' natural rolling period *Tr* and encounter period *TE*. There are two significant types of resonance:

Synchronous resonance occurs when the ships' natural period Tr and the encounter period TE have nearly the same value. There is Direct Resonance at *Tr* = *TE* or *Tr* / *TE* = 1.0 where the maximum amplitudes are to be expected and in the range 0.8 ≤ *Tr* / *TE* ≤ 1.1 where still up to about 50% higher amplitudes occur. In the resulting polar diagram (Fig. 1) synchronous resonance conditions are to be seen as red stripes whereas specifically the Direct Resonance condition is represented as a line (also seen in Fig. 3) nearly in the middle of the stripes and the conditions for 50% lower amplitudes are at the outer border lines.

Parametric Resonance occurs specifically in head or stern seas when the ships natural period T and the encounter period TE have nearly double or half values. There is Direct Parametric Rolling Resonance: for $Tr = 2 * TE$ or $Tr / TE = 2.0$; and range $1.8 \leq Tr / TE \leq 2.1$with still up to 50% higher amplitudes. In the resulting polar diagram (Fig. 1) they are to be seen as red sector segments in head or stern seas where the Direct Resonance conditions are represented as a line (seen also in Fig. 3) nearly in the middle of the segment and the conditions for 50% lower amplitudes are at the outer border lines. These conditions are represented in the polar diagram as sector segments +/– 30° off the wave direction. This type of rolling can occur in head and bow seas where the wave encounter period is exiting the ship preferably by the effects due to the stability change when on wave crest or in wave trough. Therefore the excitation is high specifically for those types of vessels with large stability differences at the respective wave positions as for instance modern container vessels with a "pontoon" stern shape and tremendous bow flare.

Fig. 1 Resulting Polar diagram with dangerous course and speed vectors based on the example ship and calculated with the respective formulas from Table 2 indicated by coloured circles. (Example-Ship: L_{pp}=113m, B = 17.6m; rolling coefficient Cr = 0.74; i.e. $Tr=Tr(10°)$= 10 s; Sea from 23° with Tw= 8 s in Wind sea (k=1.04)

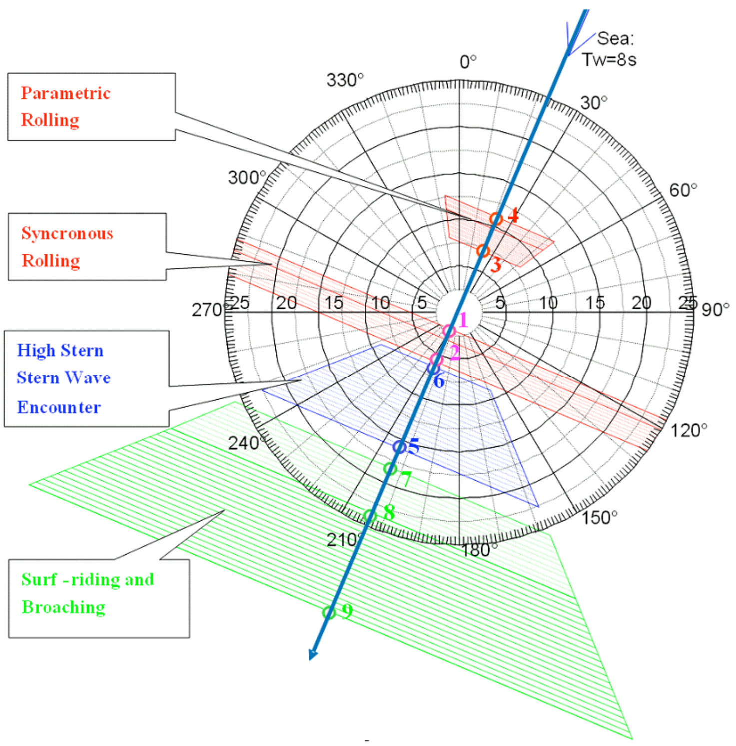

Fig. 2 Resulting Polar diagram

1.4 Dangerous stern wave encouter

During high wave groups' encounter and when a ship is riding on the wave crest, the intact stability will be decreased substantially according to the ship shape. The amount of stability reduction is nearly proportional to the wave height and the ship may lose the stability when the wave length is one to two times of ship length and wave height is large. This situation is especially dangerous in following and quartering seas, because the duration of riding on wave crest, i.e. the time of inferior stability, becomes longer. Besides the danger of reduction of stability when the ship is riding on the wave crest for a long time there is also an exciting effect of waves in Head /Stern Sea when the waves are travelling along the ships hull periodically–this will yield potential for parametric rolling. This leads to extreme dangerous situation when several high waves will trigger the ship coming as a group.

The IMO 1995 has given in the guidelines a diagram highlighting the potential occurrence of high wave group encounters; however, the information is given in a dimensionless format only by a ratio of ships speed V and wave period Tw. Here the new polar presentation can have its benefit by relating the data to the current values of ships speed and wave period / direction with the potential of High wave group encounter as for example is given in Fig. 1: The segment for direct following and quartering seas+/-45° is shown as blue dot and dash area.

1.5 Surf-riding and broaching-to

Surf-riding and broaching occurs if the ship speed is so high that its component in the wave direction approaches to the phase velocity of waves. Then the ship will be accelerated to reach surf-riding and broaching condition. That means the ships will be lifted by a following wave at the stern and accelerated; if then the ship is affected by small course change a yawing/ swaying motion can occur followed by large heel angels up to capsizing. The critical speed for the occurrence of surf-riding considered to be $1.8\sqrt{L}$ (kn), where L is ship length. It should be noted that there is a marginal zone ($1.4\sqrt{L}$~$1.8\sqrt{L}$) below the critical speed. Here a new polar diagram can have its benefit by relating the data to the current values of ships speed and length as well as wave direction. For the example in Fig. 1 the potential of surf riding / broaching-to for direct following and quartering seas is given for the green segment in the lower part of the Fig..

1.6 Summary of effects and formulas

The method presented here briefly (a complete description is published in[9]) allows for calculating and plotting a polar diagram for ship operation in a very simplified way as indicated in Fig. 1 and with formulas given in Table 2. Using a Radar Plotting sheet (with speed values at the axis instead of distances) the only task is to draw a line in the direction of the wave propagation and to calculate the encounter speed values *V* (indicated by small circles and numbered according to the numbers of the formulas in Table 2) on courses with direct head sea (*V* positive) or following sea (*V* negative). The Table 2 summarizes the effects and formulas for calculating the circles with the respective numbers of the formula in the table.

Table 2 Summary of effects and formulas for calculation of basic polar diagram values

Phenomena	Direction / Sector/Area	Equations to Calculate the speed values as basis for the Diagram Elements (numbers acc. to circles in Fig. 1)	
1. Synchronous rolling motion	Stripe segments over diagram; All directions	1. for TE=Tr/0.8:	2. for TE=Tr/1.1:

	possible	$V_{0.8} = \frac{k \cdot Tw}{0.514} \cdot \left(\frac{Tw}{Tr/0.8} - 1 \right)$	$V_{1.1} = \frac{k \cdot Tw}{0.514} \cdot \left(\frac{Tw}{Tr/1.1} - 1 \right)$
2. Parametric rolling motion	Segment for direct head and stern wave conditions +/-30°	3. for TE=Tr/1.8: $V_{1.8} = \frac{k \cdot Tw}{0.514} \cdot \left(\frac{Tw}{Tr/1.8} - 1 \right)$	4. for TE=Tr/2.1: $V_{2.1} = \frac{k \cdot Tw}{0.514} \cdot \left(\frac{Tw}{Tr/2.1} - 1 \right)$
3. Reduction of stability riding on the crest in wave groups	Segment for direct Following and quartering seas +/-45°	5. $V\_DWaveGr_{0.8} = -0.8 * T_w$ 6. $V\_DWaveGr_{2.0} = -2.0 * T_w$	
4. Surf-riding and broaching-to	Segment for direct Following and quartering seas +/-45°	7. $Vsurf1.4 = -1.4 * \sqrt{L_{pp}}$ (marginale Zone) 8. $Vsurf1.8 = -1.8 * \sqrt{L_{pp}}$ 9. $Vsurf3.0 = -3.0 * \sqrt{L_{pp}}$	

The results will be used to draw specific shapes of areas with potential danger in a Polar Diagram taking the speed values (in the circles) as a basis for the diagram elements:

A synchronous resonance area will be drawn as a red stripe over the whole angle area of the polar diagram, orthogonal to the sea direction. The parametric excitation will be drawn in the same way but only for a red sector segment of ±30° around the direction of stern sea or against the sea respectively. Additionally the areas for surf-riding (green) and encounter of wave groups (blue) in zones of ±45° around stern sea directions will be drawn.

By means of the polar diagram an assessment of situation or estimation of countermeasures can easily be done to find out suitable values of the ships' speed and course or measures to change stability and likewise the ships roll time period T avoid resonance–either by means of that diagram manually created as in Fig. 1 or more convenient by using the computer software ARROW described in the following chapter.

2 Arrow–Software Program

2.1 Overview

The ARROW program is a software tool to estimate and display the potential conditions and countermeasures to Avoid Rolling Resonances Or Wave impacts on ships due to specific wave encounter situations. By means of the Main user interfaces (Fig. 3) the a small amount of data is needed to be entered into the areas of the Ship Parameter Input (top left side) and Wave Parameter Input (lower left side) to provide the qualitative results in the Result Display Area (right hand side):

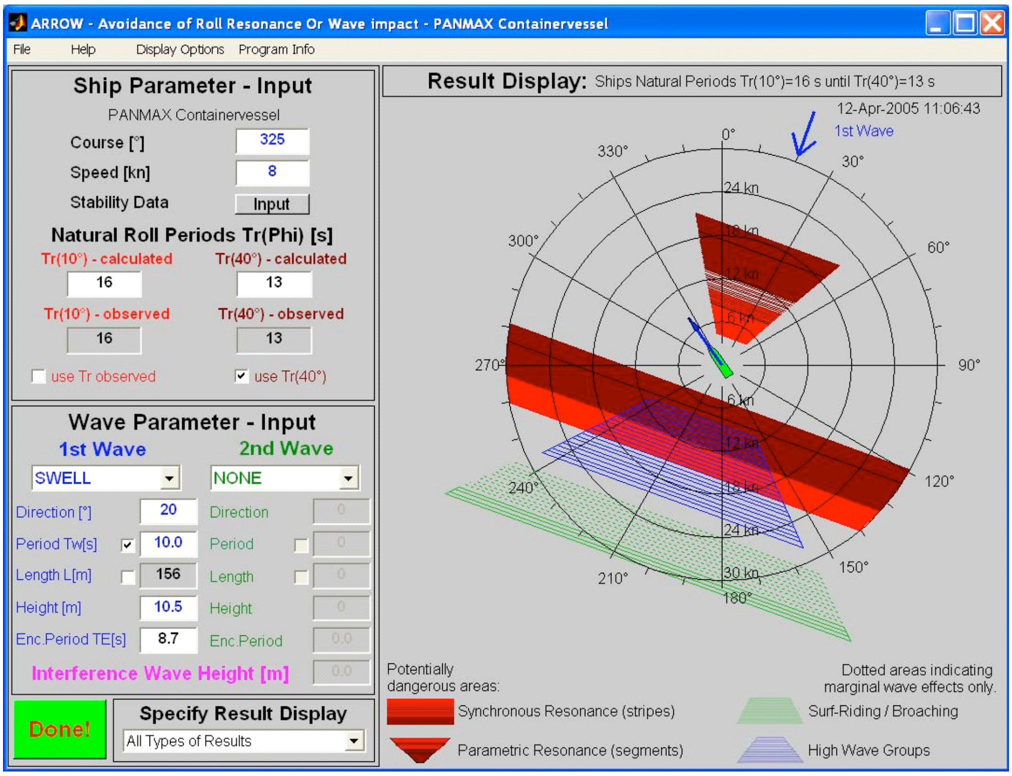

Fig. 3 ARROW program window–overview on main user interface elements

2.2 Parameter input

Ships course and speed can be entered in the respective data fields. The heading direction of the ships contour and speed vector in the Result Display will immediately change according to changes in the data fields. Alternatively these values can be set by mouse click (right button) into the ARROW—Result Display Area.

Natural Roll periods of the ship can be either calculated (a) by using stability data or alternatively (b) by entering observed roll periods directly:

(a) Using Stability Data Input the data can be entered into the respective input fields of ARROW—Stability Data Window. The input of these Stability Data can be checked in the plot of the *GM* and *GZ_* values versus roll angle (Fig. 4 left). To compare the *GZ_*-values with the initial stability *GM* a tangent is drawn (dotted line) from 0 to the *GM* value at roll angle *Phi* = 57.3°. The ships' natural roll periods *Tr* will be immediately calculated and shown in the left side of the ship parameter input area (s.Fig. 3) parallel to the stability data input. The *Tr* values are displayed both for small (up to 10°) and large (up to 40°) roll angles. Corresponding to the draft input the inertia coefficient *Cr* for rolling motion is shown (s. Fig. 4 right) in the field below the draft input field from the ships hydrostatic tables.

(b) Using Alternatively the Direct Input of Natural roll period from Observations it is possible to use ob-served ships roll periods instead-for this purpose a checkbox is available to change between "calculated" and "observed" roll periods. In this case the respective *Cr* value is highlighted according to the *GM* value.

Fig. 4 Stability Data Window–Graph of up righting lever versus roll angle *Phi* and *GM* tangent (left) and Graph of Inertia coefficient *Cr* and respective *Cr* value due to draft input (right).

For Wave Parameter Input the ARROW program accepts the input of two different wave systems. The 1st Wave area (left side) is designated for the input of the dominant wave system interacting with the ship. Only a few wave input parameters, taken either from observations on the ship or from weather reports and forecasts, have to be entered in the respective fields. The input for the 2nd Wave system is identical to the 1st Wave. The direction of the first wave system is drawn as a blue arrow outside of the polar diagram in the ARROW—Display Area (s. Fig. 3), the second system as green arrow. Another arrow shows the direction of the interference wave.

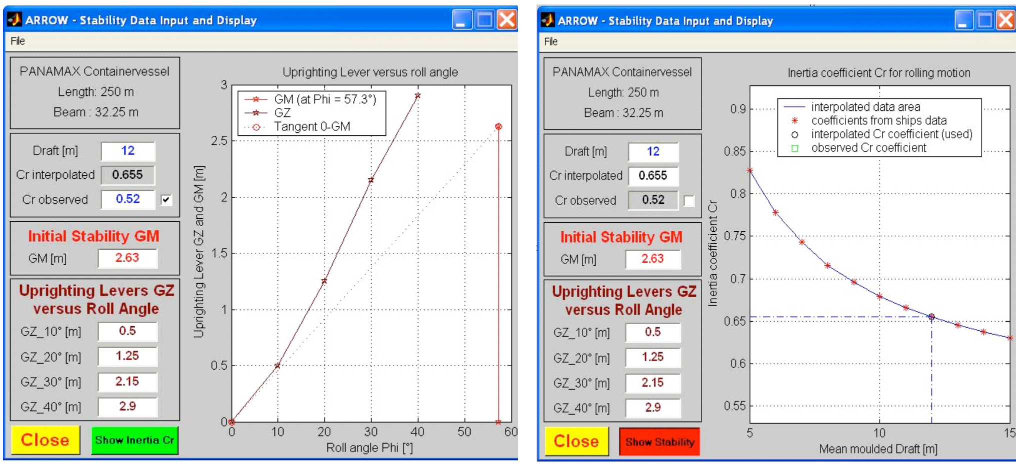

Fig. 4 Stability Data Window

2.3 Result display area and measures to avoid problems due to wave effects

The polar diagram provides the critical course and speed ranges resulting in resonance areas by stripes and sectors of high wave impact according to IMO guidelines. All types of resonance and wave impacts are drawn with different colours and shapes to distinguish between them. Even for large amplitude rolling periods the potential resonance conditions can be shown in brown colour next to the red areas for small rolling amplitudes displayed in parallel. Beneath the polar diagram a legend is drawn to clarify the relation of the different colours and shapes with respect to the different types of resonance and wave impacts. If the point of the ships' arrow (ships speed vector) is within one (or even more) of the dangerous areas the ships conditions are potentially unsafe. In this case the ships speed and course have to be changed to bring the arrow top out of those areas. Alternatively the ships rolling period could be varied by changing the stability parameters (*GM* or *GZ*_values) in order to avoid resonances as shown in Fig. 5. All of these countermeasures can be checked by trial variations using the ARROW program modules.

Fig. 5 Shifted resonance areas after changes of rolling period due to change of *GM*: Results for *Tr*(10°)=11.3 s *GM*= 1.32 m (left) and for *Tr*(10°)=8.24 s *GM*= 2.50 m (right)

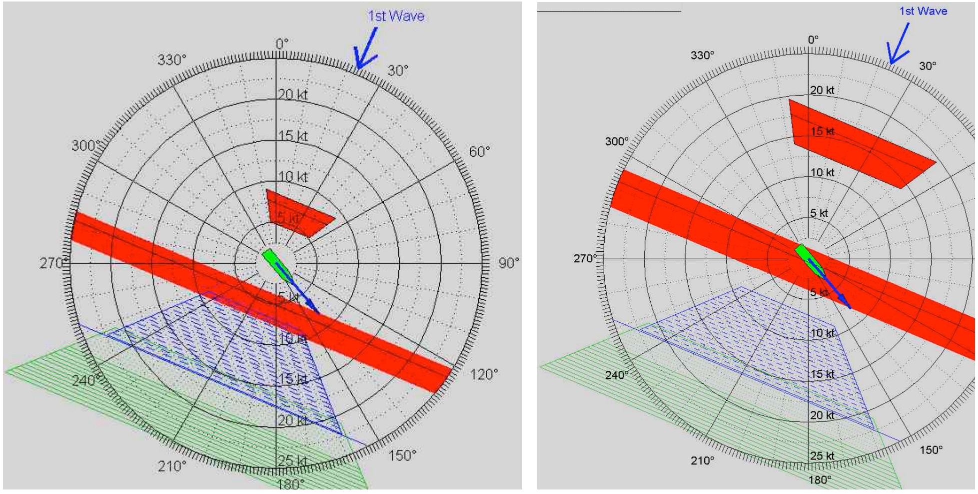

Fig. 5 Shifted resonance areas after changes of rolling period due to change of GM

3 ARROW: Versions and USE

3.1 Training institute version

There are two version of the ARROW software in existence. One is for Education and lecturing of Wave Effects at Seafaring Training Institutions. For this reason several different vessels and encounter situations can be prepared and loaded for demonstrations according to the specific training needs. An encounter situation consist of ship information on speed, course and own rolling period and of wave information (direction, period, height) of two wave systems. Fig. 6 show the procedure of loading an encounter situation from a list of several different situations.

After selecting a situation the data will be loaded and a previously stored comment will be shown explaining the encounter situation.

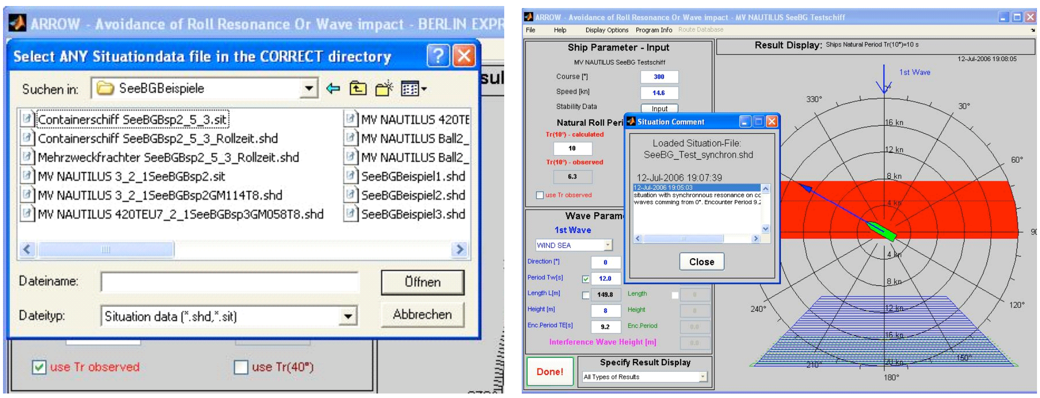

Fig. 6 Procedure to selection of different stored encounter situations for education

3.2 Use of arrow software together with ships routing program “bon voyage”

The second version of the ARROW software is the onboard version. The basic version is specifically designed and database adjusted to quickly calculate and display all wave effects for one specific vessel. A permanent storage of a special wave encounter situation is possible. The enhanced version of the ARROW software establishes a link to an onboard weather routing system (see Fig. 7).

When using the onboard routing system Bon Voyage from Applied Weather Technology AWT the most recently edited route can be imported (top menu: "Route Database/Load Route Database") and viewed in the ARROW route list table. ARROW will instantly analyse the route points of this route in terms of the formerly described risks.

The status of a route point can be viewed (see Fig. 7) in both, the ARROW route list table and the Result Display / Wave Parameter-Input section:

If any line in the ARROW route list table has been highlighted red then there is a potential risk, if orange then a marginal risk may have been left.

By clicking on the corresponding line in the ARROW route list table (e.g. middle row of table left below) the ARROW main interfaces pops up to display the respective situation highlighting potential dangerous conditions and allows the check whether the ships' speed vector is within or out of these conditions (top left of Fig. 7).

Fig. 7 Use of ARROW program together with onboard routing system "Bon Voyage" (AWT): Sea chart with weather information along the planned route on rhumb line (right) and ship with rolling period *Tr*=18.2 s at a specific position (Triangle), ARROW main interface (top left) with information for that respective position/situation, ARROW route list table (left below) with information overview for all waypoints.

In order to avoid potential resonance conditions, either the ships natural rolling period could

be adjusted by *GM* corrections in the ARROW interface(see Fig.8). Or the route can be changed

in the Bon Voyage system (course or speed respectively, see Fig.8 *GM* corrections in the

ARROW interface

Fig.).

Both options can be used to find suitable conditions by simple trail and error methods.

Fig. 8 Use of ARROW program together with onboard routing system "Bon Voyage" (AWT): Avoiding Resonance by Changing Stability from rolling period *Tr*=18.2 s to *Tr*=22.2 s.

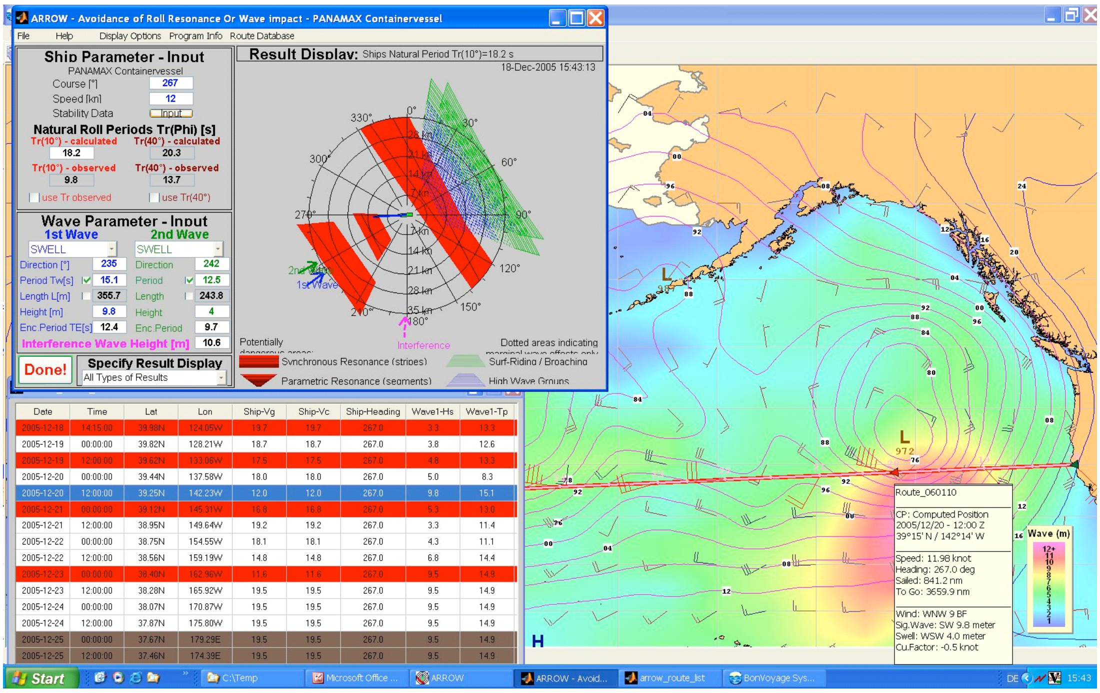

Fig. 7 ARROW software establishes a link to an onboard weather routing system

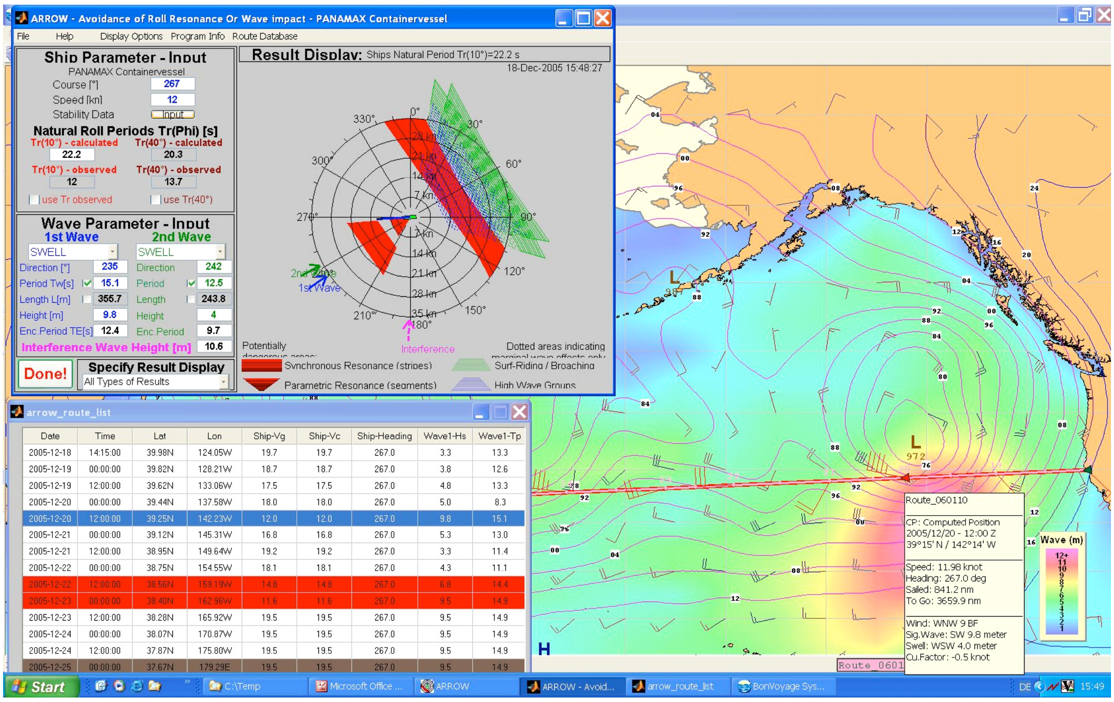

Fig.8 *GM* corrections in the ARROW interface

Fig. 9 Use of ARROW program together with onboard routing system “Bon Voyage” (AWT): Avoiding Resonance due to change of the ships route by shifting of one waypoint on Rhumb line.

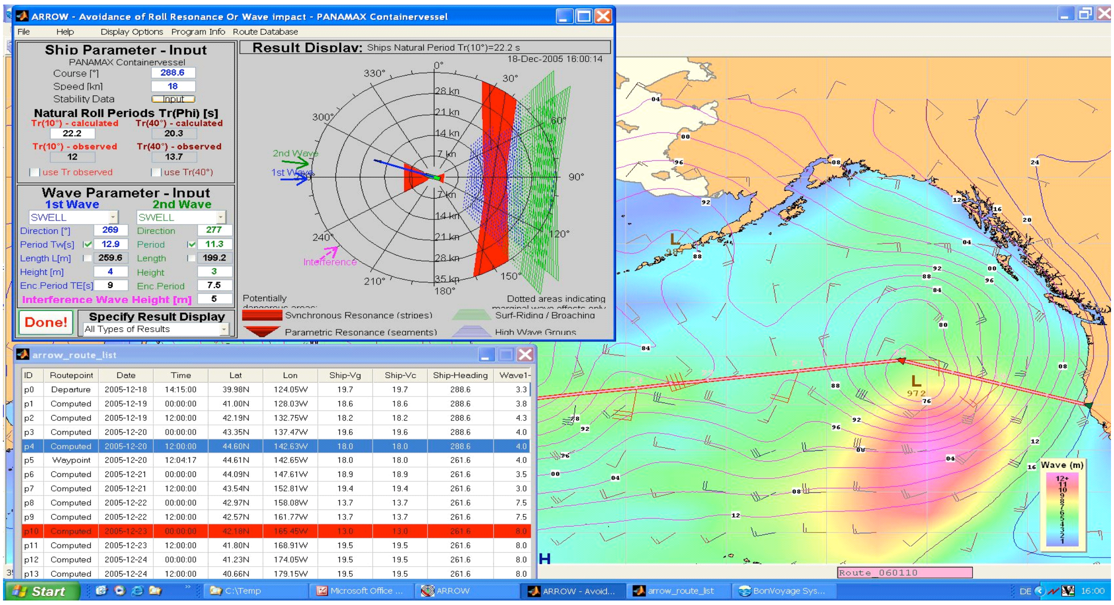

Fig.9 The route can be changed in the Bon Voyage system

4 Conclusion

In the paper a simplified but robust method is shown to estimate the potential danger of wave impact in order to support the work of the ships' officers. It is based on the comparison of the ships natural rolling period and the period of wave encounter and allows preparing a polar diagram for synchronous and parametric resonance and other wave effects from basic data of the ship and the sea state, even by manual calculation. It is also possible to include the potential danger of high wave group encounter or Surf-riding and broaching respectively.

A computer program ARROW–Avoidance of Roll Resonance and Wave impact was developed to display the potential dangerous conditions of rolling resonances or other high wave impacts on ships due to specific wave encounter situations. The tool allows for quick variation of the relevant parameters to find out safe conditions by trail and error methods and to see the tendency of changes in the parameters. The ARROW Program was implemented as a module into a ship weather routing program in order to analyse all the route points and segments in terms of the described risks and to give and overview in the ARROW route list table.

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THE CHANGING BUSINESS ACTIVITY OF UK MARITIME INSTITUTIONS

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Abstract UK Maritime Institutions have had to adapt their business to fit the educational demands of the UK education system as well as meeting the demands of the shipping industry. UK examination targets at high school level are the General Certificates of Education (GCSEs) at 16 and a higher advanced level examination (A Levels) taken at 18 years of age. Traditionally the UK Merchant Navy recruited from a pool of GCSE students at age 16, however this diminishing pool has required that 18 year olds with A levels be targeted. The reduction of the UK fleet has meant that the flow of UK seagoing students to UK nautical colleges and universities has declined and UK maritime institutions have therefore had to adopt new strategies in order to remain viable. These strategies have taken a variety of forms. Non UK students have been attracted to MET programmes; new programmes have been devised taking in the wider maritime industry and various entry routes have been developed leading to careers in the Merchant Navy. This paper explores the effects on the business activity of UK MET institutions created by the changing educational requirements within the UK and the needs of UK shipping companies and the wider maritime industry.

Keywords maritime institutions; Cadets; business activity; MET; educational requirements

0 Introduction

Maritime and marine education and training can be traced back in the UK for over 250 years (Higginbotham)[1]. In Liverpool 150 years ago many seagoing officers and ratings started their seagoing careers on the training ships moored in the river Mersey (MMM)[2]. In 1892 the Liverpool Nautical College started to educate Master Mariners and this is the foundation of the maritime and marine section at Liverpool John Moores University. Other maritime colleges and universities in the UK have similar beginnings having developed from training establishments of the 19th and 20th centuries. Maritime education and training clearly developed as demanded by the evolving industry at the time. However the nature of the education and training today is different from that of past decades and centuries partly because the maritime industry has changed but also the pool of those wishing to enter the industry has altered. To some extent the concept of a career has blossomed taking over from the “running away to sea” idea that existed many years ago. Whilst some people will enter the industry for a short period many people do see the maritime industry as a way of life that they wish to follow for the whole of their career, even if not always afloat.

The idea of “running away to sea” perhaps leads to the understanding that in the UK it has always been possible and still is today to reach the highest ranks from very lowly beginnings. The preferred route by employers and academics has been that prospective seafarers should attend college/university and then sign articles or a contact to a voyage or term at sea. Some people however still do develop their careers from lowly beginnings, although such routes take far longer, and naturally they have to pass the STCW examinations.

1 Requirements of the UK seagoing and shore based maritime industry

There have been many studies into the manpower needs of the UK maritime industry (Gardener et al.)[3], (DFT)[4], (Glen et al.)[5], (Glen et al.)[6], (McConville)[7] (Moreby et al.)[8] to mention just a few and these have found that there is a continuing demand for UK seafarers in the shore based jobs and careers as well as at sea. The level of demand for UK seafarers in these positions has tended to fall (Gardener et al)[9] with employers finding that they can use other people than seafarers for some jobs. Jobs have been "downgraded from the essential to advantage category"(IBID). For many years there has been maritime education for shorebased jobs for those not wishing to go to sea (Dinwoodie)[10] but still wishing to find a career in the maritime industry.

1.1 Careers

The UK economy is the fifth largest in the world since China became the fourth largest in April 2006 (Hoon)[11] and has unemployment at about 980,000 people (Treasury)[12] or around 2% of the working population. This means that young people leaving school and those in the early years of working life have many more opportunities other than those offered by the Maritime Industry. Entry to the UK Merchant Navy from UK school leavers has been falling for many years and the UK Chamber of Shipping has acted to reverse this decline through the lobbying of the UK Government. This lobbying has focused on support for cadet training through the Tonnage Tax measures and the setting up of the Sea Vision campaign with its regional voluntary bodies as a way of raising the profile of the maritime industry with the general public and schools.

The maritime industry is much wider than just seagoing although traditionally this has been the high profile occupation and the one considered by many as the most significant. It is also the one where the training and education has been the most specific. This is because of the IMO and national certification systems where competence through certification is legally required. Elsewhere formal training can be taken in areas such as in ship broking but this is not absolutely necessary to be able to work in ship broking or legally required.

Some of the careers available in the Maritime Industry are listed in Table 1.

Table 1 Careers available in the maritime industry

Career	Dinwoodie[10]	Gardener et al[3]
Seagoing	×	
Ship broker, Charterers & Agents	×	×
Port Management	×	×
Transport Management	×	
Import/ Export	×	
Marine Insurance	×	×
Ship & Crew Management	×	×
Maritime Law	×	×
Freight Forwarding	×	
Marine leisure	×	
Classification Societies		×
Consultants/Surveyors		×
Towage/ Salvage/ Dredging		×
Ship Finance		×
Marine Equipment & Information Technology		×
Marine Engineering		×
Ship Owners and Operators		×

Maritime Schools		×
Miscellaneous		×

Table 1 takes its data from one report and one journal paper. The report (Gardener et al)[3] inquired into the shore-based careers available to seagoing officers hence the reason it didn't identify seagoing as a career. On the other hand the journal article (Dinwoodie)[10] considered perceived careers available to maritime business students, hence the reason engineering and technical careers were not cited.

Table 2 lists the areas covered by member firms of the UK Society of Maritime Industries. There are too many individual products and services to list here but the range of areas and consequent careers available can be contrasted with those identified in Table 1. These two tables show the vast scope of job opportunity in the maritime field.

Table 2 Maritime industry product and service categories (SOMI 13)

	Product or Service Category	Number of products/ services listed
1	Marine Science and Technology	2
2	Equipment and Services	18
3	Offshore Equipment and Services	6
4	Ports, Related Services and Equipment	11
5	Professional Services and Consultancy	20
6	Maritime Services	17
7	Shipbuilders and Ship Repairers	3
8	Pollution Control Equipment Services	8
	Total number of products and services	85

There are 122 individual members of the UK Society of Maritime Industries indicating the scope available for those wanting to work in the industry.

1.2 Educational requirements (age profile)

Education in the UK is legally required up to the age of 16 when most students take General Certificates of Secondary Education (GCSEs). Most disciplines have a GCSE standard and all students must take English, Mathematics and a Science. Along side these core subjects other subjects of the students own choice are taken. It is general for students to take 8 or 9 GCSEs with many taking 11. These GCSEs are graded between A* and G with grade C being a watershed above which students are considered to have a reasonable pass. The UK Government and individual schools provide statistics on the number of students achieving 5 or more GCSE passes at grade C and above. UK Merchant Navy Officer entry can still be gained with a minimum of 4 good GCSEs in at least English, Mathematics, Physics or Combined Science (MNTB)[14]. Clearly entry is then available to 16-year old school leavers via this traditional HND route.

From September 2006 entry is also available via a Foundation Degree (FD). This new qualification was introduced by the UK Government in 2001 (DES)[15] and was the first new higher education qualification for 25 years. It is designed to be a work-related degree and time in the workplace is a major part of the syllabus and operation of each individual FD. Foundation degrees have been taken up by many disciplines and are widely available in all areas of the UK.

The UK Chamber of Shipping has championed a FD in Nautical Science and Marine Engineering and the four main nautical colleges have developed FDs as part of this initiative with four universities in their geographical area providing the underpinning validation requirements. Entry qualifications to these FDs are for the nautical colleges and universities to decide, however the Merchant Navy Training Board (MNTB) recommendations are for a minimum entry of 120 UCAS (University and College Admissions Service) points in unspecified A-Levels plus good grades in GCSE English, Mathematics and Physics or Combined Science (MNTB)[14].

A-Levels are the next tier of examinations in the UK after the GCSEs. They are taken at secondary school or further education (FE) college with most students taking 3 but many taking 4 or 5 at age 18. Students have a free choice in subjects and the combination of A-Levels obtained by students can be random and individual to each student. The A-level course is 2 years.

For many years there have been undergraduate (Bachelor) degrees in Nautical Science or similar names. These degrees have combined both academic study and the necessary underpinning knowledge to obtain the STCW OOW certificate of competency (CoC). The short course requirement for the CoC is obtained through a NC which of recent years has often meant that the early years of the BSc (Hons) seagoing degrees have been spent at a nautical college rather than at a university. Entry requirements to these degrees are via A-levels with a tariff point total of around 200 points or close to twice that of the FD.

There are FDs and Bachelor degrees for marine engineers although these are not so widely available and the Bachelor degree is usually a BEng rather than a BSc. There is always an entry requirement for A level Mathematics to these BEng. programmes.

1.3 Tonnage tax

The UK government introduced to the world wide maritime community the concept of a UK Tonnage Tax as part of its Finance Act 2000. The Tonnage Tax regime is an offer to shipping companies that any vessels registered under the UK flag can be considered for a reduction in corporation tax that would have been necessary, calculated on the "daily profit of each qualifying ship−and the net tonnage of the ship" (Finance Act)[16]. There is also a link to training in that a condition of gaining tonnage tax is a commitment to training. This commitment can be seen as:

(1) The training of one trainee per year for each 15 officers employed, or

(2) Payment in lieu to the Maritime Training Trust,

(3) The trainees must be British or EEA nationals and ordinarily resident in the EU (MCA)[17].

This commitment has thus seen the UK cadet numbers rise from around 400 per year in 1998 (DFT)[4] to around 620 in 2003-4 (Orrell)[18]. The Maritime Training Trust is a limited company administered by the Chamber of Shipping to provide funding for cadet training and the development of cadet training in the UK. Shipping companies may only pay into this Trust if there is no other way of them fulfilling the training requirement. They cannot opt for this payment as a way of avoiding cadet training.

2 Structure of UK maritime & marine education and training

Maritime and marine education and training in the UK is divided amongst several further education (FE) and higher education (HE) establishments. These establishments almost exclusively have a long history and have developed their portfolio of courses from the changing nature of maritime education over the last century or more. In the 1960's (Bonsall)[19] the major maritime colleges developed degree programmes to conform to the UK educational policies and direction at the time. This meant that in the 1970's and 80's two types of maritime education establishments emerged: maritime universities and nautical colleges.

2.1 Nautical colleges and maritime centres

Nautical colleges are where Merchant Navy Officers and Ratings are taught from Cadet and EDH to Class 1 Master Mariner or Chief Engineer. They are all FE colleges and sit within that sector in the UK educational system. The UK MCA controls the course syllabus and updates it as necessary by reports from committees of IAMI (International Association of Maritime Institutes). This latter body is essentially a UK organisation although Cork College from Eire is a full member. The underpinning knowledge of the UK (CoCs) is studied within the framework of an HND (Higher National Diploma). Specific knowledge such as Lifeboat Skills, First Aid and Ratings' training is provided outside of this framework in the form of short courses. The colleges that are involved in seagoing training are listed in Table 3.

Table 3 shows that there is maritime seagoing training in all parts of the UK except Wales and Northern Ireland. The scope and level of training varies between the colleges with some such as Warsash and South Tyneside providing a full gamut of programmes including marine engineering. Others such as Fleetwood Nautical College (FNC) only provide deck training but at all levels. Lowestoft provides OOW and Chief Mate plus offshore and dynamic positioning whilst NW Kent College provides EDH plus some statutory STCW deck and engine room officer courses plus short courses and open learning.

Table 3 UK colleges covering seagoing training

No	College[20] Jackson	Training Areas Covered	Part of UK
1	Banff and Buchan College of Further Education	Pre Sea & STCW Officer Deck & Engine. EDH. RYA. STCW Short Courses	NE Scotland
2	Blackpool and the Flyde College. Fleetwood Nautical Campus	Pre Sea & STCW Officer Deck & Engine. EDH. Fishing. RYA. STCW Short Courses	NW England
3	Plymouth Maritime Training Centre	STCW Officer Deck EDH. Deck & Engine L2 support. STCW Short Courses	SW England
4	Lowestoft College of Further Education	Offshore; Dynamic Positioning	England. East Anglia
5	NW Kent College of Further Education (National Sea Training College)	EDH. STCW Short Courses	London & SE England
6	South Tyneside College	Pre Sea & STCW Officer Deck & Engine. EDH. Fishing. RYA. STCW Short Courses. BSc BEng	NE England

7	Warsash Maritime Centre. Southampton	Pre Sea & STCW Officer Deck & Engine. EDH. Fishing. RYA. STCW Short Courses. BSc. BEng	South England
8	Glasgow College of Nautical Studies	Pre Sea & STCW Officer Deck & Engine. EDH. Fishing. RYA. STCW Short Courses. BSc. Eng Degree.	Glasgow. Central Scotland
9	Lairdside Maritime Centre	Advanced Short Courses some bespoke and not necessarily statutory.	NW England
10	North Atlantic Fisheries College.	STCW Short Courses. Deck & Engine.	Shetland

2.2 Maritme universities

Separate to the nautical colleges there are several universities that have maritime sections or provide at least one maritime or marine degree and these, are listed in Table 4. The table shows that only 3 universities offer seagoing degrees and the same 3 offer maritime management degrees.

Many more universities offer marine engineering and/or naval architecture degrees. Those marked with a star (*) would not consider themselves "Maritime Universities" as the maritime programmes have not developed from a historic link with seagoing training. Those without the star have maritime programmes that have developed from previous seagoing training and Southampton Solent is closely linked with Warsash Maritime Centre, which is listed in Table 3. Greenwich University is a comparatively new University but is housed in the old Greenwich Palace that was formerly a Royal Navy Officer training centre. The maritime section is linked to the NW Kent College listed in Table 3. Many of these universities offer other maritime or logistics or leisure degrees at both the undergraduate and postgraduate level. They also offer PhD study.

Table 4 shows that there are many UK universities offering postgraduate maritime management, business or law programmes and few of these would consider themselves "maritime universities". Still more offer postgraduate marine engineering programmes but again the majority of these would not consider themselves maritime universities.

Table 4 Universities offering maritime or marine undergraduate degrees (UCAS)[20]

No	University	Seagoing	Maritime Management and/or Law	Marine Engineering and/or Naval Architecture
1	Glasgow*		× PG	× UG/ PG
2	Greenwich 1		× PG	× UG
3	Plymouth	×	× UG/PG	
4	Southampton (Solent)	×	× UG/PG	× UG
5	Liverpool John Moores	×	× UG/PG	× UG/ PG
6	Bournmouth*			× UG
7	Newcastle Upon Tyne*		× PG	× UG/ PG
8	Strathclyde*		× PG	× UG/ PG
9	University College London*		× PG	× UG/ PG
10	Southampton *		× PG	× PG
11	City University (London)*		× PG	
12	London Metropolitan		× PG	

13	Cardiff		× PG	
14	Hertfordshire*		× PG	
15	Nottingham*		× PG	
16	Wales (Swansea)*		× PG	
17	Bristol*		× PG	
18	Portsmouth*		× PG	

Table 5 Maritime research groups and their activities

No	Research Group/ Centre	Associated University	Research Activity
1	Centre for International Transport	London Metropolitan	International Transport Manage-ment
2	Maritime Research Group	Southampton (Solent)	
3	Institute for Employment Research	Warwick	Employment
4	Marine Institute	Plymouth	Biochemistry, Bioscience, Marine Policy, Marine affairs, Marine Science
5	Marine, Transport and Offshore Research Group	Liverpool John Moores	Risk assessment. Operations of Ships, Offshore Installations and Ports. Logistics
6	Seafarers International Research Centre	Cardiff. School of Social Sciences	Seafarers, Their lives and employ-ment.
7	Transport & Shipping Research Group	Cardiff Business School	Short Sea Shipping. Maritime Economics/ Simulation
8	Maritime Research Group	Napier University (Edinburgh)	Maritime Economics
9	Legal Studies Research Group	Wolverhampton	Maritime Law
10	Maritime Ergonomics	The Ergonomics Society	Erganomics
11	Fishermans' Safety at Sea Working Group	Banff and Buchan College	Fishermens' Safety

2.3 Research centres

There are several maritime research groups and centres in the UK. Often but not always these are within the university sector and are associated with teaching groups. Tables 4 and 5 list maritime universities and many of these were former nautical colleges, which now find themselves as part of a university and as such have stopped seagoing teaching and are becoming more involved with research. Research is considered a main-stream activity alongside the delivery of academic degrees and this research this tends to underpin the teaching activity. Table 5 lists a number of the maritime research centres, groups and institutes: Some of these have long histories.

The Centre for International Transport and London Metropolitan University was opened by the Secretary of State for Transport in 1992, however the Cardiff Business School Transport and Shipping Research Group is possibly the oldest tracing its roots back to research carried out in the old Department of Maritime Studies that was closed in the late 1990s. The Marine Centre at Plymouth University was opened in the spring of 2006 and has 80+ academics and researchers. It is a virtual umbrella body with links to many schools in Plymouth University. This follows, although does not directly replace the Institute of Marine Studies (IMS) closed a couple of years ago when its elements were dispersed to individual schools in the University.

3 Developments and future needs of MET in the UK

MET in the UK is very varied in its delivery and venue. It is found in colleges of further education and universities with some places delivering only short courses and others providing three or four year degrees. This is a dynamic area partly because qualifications in the high school sector and tertiary colleges are undergoing change and also because entry into the shipping and maritime industry in the UK is under constant change. There are new qualifications developing in secondary schools under the "diploma" heading. These will affect all students and the maritime, shipping and transport industry is finding it hard to keep abreast of these changes. By 2013 all students in high schools will be able to study a general diploma or a specialised employer led diploma (Hertfordshire CSF)[22]. The former diploma will be awarded to those gaining 5 A*-C grade GCSEs including English, Maths and ICT and the latter will be in the form of one of 14 specialised areas considered of importance to the UK. These specialised diplomas are not intended to relate to any particular industry but to emphasis basic core skills that can be used anywhere. It is unfortunate for the UK Maritime industry that there is not a Transport and Logistics specialised diploma. However there is not one in either Law or Science hence Transport and Logistics has not necessarily been forgotten.

The Foundation Degree (FD) will also become established from September 2006 and it remains to be seen if employers feel that this qualification meets their expectations of new entrants. The colleges and universities have embraced the concept and positioned themselves to allow prospective students the opportunity to enter the industry via this route. The HND route will continue for some years and a final date for the finish of this qualification has not been set. One problem with the FD is that it requires entry at 18 with A-levels. There still remains a strong feeling in some parts of the industry that entry at 16 is desirable and complete closure of this route is not desired by some employers. This means that entry to the industry will be complicated for some time to come.

There is also a Maritime Studies qualification currently under development (Jackson)[23]. This qualification raised by NW Kent College in 2004 provides the knowledge related to seafaring skills required by all industries and focuses on pathways into industries particularly the maritime industry. At a foundation level in the UK two bodies, the Learning Skills Council (LSC) and the Sector Skills Councils (SSC) oversee skills and qualifications. The LSC has government funding and paid employees whilst the SSCs are employer led bodies concerned with the skills and business needs of a particular sector. These two bodies have supported the Foundation Degree developments, which include FDs in ports and logistics, maritime studies, nautical science and marine engineering.

In Liverpool the sector champion Mersey Maritime has started a Ship broking apprenticeship. This is recruiting on an annual basis a small number of 16 year old school leavers into the Liverpool shipping companies to develop their understanding of the office practice of shipping and transport. This apprenticeship can lead to the Institute of Chartered Shipbrokers (ICS) qualifying examinations. These examinations are longstanding and international and are usually studied by distance learning under the ICS Tutorship scheme. The three main maritime universities usually offer the opportunity for their maritime business students to also sit these exams. Holders of the maritime degrees can usually obtain some exemption from these exams.

4 The business of UK maritime universities

The previous discussions have covered nearly the full gamut of education and training available in the UK. The business of UK maritime universities can be seen to be consolidating on the undergraduate, post graduate, PhD and research elements. Seagoing is included in the undergraduate area and many seafarers, both deck and engine room, study for the postgraduate MSc qualifications in either maritime business or its clones (with engineers also being able to take the engineering MScs). These universities, which are really only the maritime sections of the Universities of Plymouth, Southampton (Solent) and Liverpool John Moores, are closely linked to a maritime training provider and this link seems to be important to them as it allows for the continuing seagoing connection.

These three universities also have links with universities and/or colleges in other countries nearby i.e France, Holland and Scandinavia. Lecturers from Liverpool John Moores and the other maritime universities also teach overseas in such places as Greece and Iran. This widening of the remit of lecturers seems to be a developing requirement for staff working in these areas. The programmes offered by these universities cover the areas of maritime business, maritime technical and increasingly the courses for the growing maritime leisure industry. Liverpool John Moores has also developed a series of Certificates of Professional Development (CPDs) allowing students to study full time for a semester or less. These are taken by students studying on maritime or transport programmes in their own universities but needing to study for some of their time overseas in the UK.

Table 4 also showed that there are several other universities that do not necessarily consider themselves as maritime universities (in the full sense of the term) but have specific maritime programmes usually at the Postgraduate level. The number of these programmes is increasing slowly and thus in future the indication is that more UK universities will be considered under the heading of a “Maritime University”.

5 Conclusion

The paper set out to investigate the changing nature of the business of “Maritime Universities” in the UK. Initially it was necessary to distinguish universities delivering higher education from nautical colleges delivering further education, within which is the bulk of seagoing training and education. It is found that the delivery of MET in the UK is quite complicated with academic degrees and postgraduate education in many cases being separated from seagoing training. The delivery of MET in the UK is longstanding having a history dating back over 150 years however the delivery of that training has changed during that period with some quite dynamic alterations occurring at the present time. For the first time in the UK maritime training, and thus the Certificates of Competency (CoCs), will in future be mainly acquired via a degree education rather than diploma education. This starts in September 2006 hence it will be some time before the effect of this change is known. During that time a small number of students will continue to study under the BSc (Hons) Nautical Science degrees whilst many more will continue with the HND route.

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The Baltic Sea PSSA and Navigational Associated Protected Measures

—New Challenge for Navigation Education

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Abstract The Baltic Sea has officially been classified (2005) by the International Maritime Organization (IMO) as a new item on the short list of Particularly Sensitive Sea Areas (PSSA). A PSSA designation–which requires ships to take special care when navigating through areas of ecological, economic, cultural or scientific significance–can be used to protect a variety of marine and coastal habitats.

The Baltic Sea has some of the busiest maritime traffic in the world. Large number of islands, narrow straits and routes which are difficult to navigate, and long annual periods of ice cover greatly increase the risk of a devastating oil accident in the Baltic Sea.

A PSSA can be protected by Associated Protected Measures (APM) which are huge challenge for navigation education not only in Gdynia Maritime University but also in the rest of maritime universities around the world. It is something new that corrections in navigation course outline should be done.

In the paper the Author would like to present all aspects of that problem, including proposal of model course in operational use of APM in PSSA.

The paper discusses Baltic Sea PSSA, navigational associated protected measures (APM) and their impact on Maritime Education and Training (MET) especially teaching of Navigation.

Keywords navigation; safety at sea; PSSA (particularly sensitive sea area); APM (associated protected measures); MET (maritime education and training); Baltic Sea

1 Introduction

The Baltic Sea, as well as the Torres Straits, the Galapagos Islands and the Canary Islands, have officially been classified (2005) by the International Maritime Organization (IMO) as a new item on the short list of Particularly Sensitive Sea Areas (PSSA).

A PSSA designation - which requires ships to take special care when navigating through areas of ecological, sociological, economic, cultural, educational or scientific significance - can be used to protect a variety of marine and coastal habitats.

The Baltic Sea has some of the busiest maritime traffic in the world. Large number of islands, shallow waters bays, gulfs, banks, rocks, wrecks, obstructions, narrow straits and routes that are difficult to navigate, and long annual periods of ice cover greatly increase the risk of a devastating oil accident and pollution in the Baltic Sea.

Several protected areas, such as Baltic Sea Protected Areas (BSPA [1], Natura 2000 [2] and Ramsar sites[3, 4]), exist adjacent to oil transportation routes. The Baltic Sea is also an important migratory route for black guillemot, waterfowl, geese and waders, and provides valuable habitat for marine mammals such as grey seals, Baltic ringed seals and harbour porpoises.

New protected measures, which were adopted by the IMO, include new traffic separation schemes and a recommended deep-water route, both aimed at decreasing the risk of shipping and oil accidents.

WWF (World Wildlife Fund) is also urging ships to follow the IMO's recommendation to use pilotage when navigating from the North Sea into the entrances to the Baltic Sea for every ship with a draught of 11m or more, or by ships carrying hazardous cargo.

The paper discusses Baltic Sea PSSA, navigational associated protected measures (APM) and their impact on Maritime Education and Training (MET).

2 Particularly sensitive sea areas (PSSAs)

2.1 What is a PSSA?

A PSSA is defined as "an area that needs special protection through action by IMO because of its significance for recognized ecological, socio-economic or scientific reasons and because it may be vulnerable to damage by international shipping" (Annex 2, Paragraph 1.2 of the IMO Assembly Resolution A.927(22)[5]). A designation of an area as a PSSA can help coastal States to prevent accidents, avoid habitat damage and stop pollution by regulating the passage of ships through or away from sensitive areas.

Thus, the identification of a PSSA is linked to the special character of the sea area and the need to protect the sea area against damage arising from international shipping activities.

2.2 What are the criteria for an area to be designated as a PSSA?

Paragraph 5 of Annex 2 of the IMO Assembly Resolution A.927(22)[5] lists the factors to be taken into account when considering whether an area is at risk from international shipping activities.

The factors are divided into two categories; vessel traffic characteristics and natural factors. In addition to being at risk from international shipping activities, the area should fulfil at least one of the criteria listed in Paragraph 4.4 of Annex 2 of the IMO Assembly Resolution A.927(22) [5]. The criteria listed are divided into the following categories: ecology; sociology, culture and economy; as well as science and education.

2.3 Which associated protective measures can be adopted in a PSSA?

The associated protective measures to be adopted within a PSSA include the following options (Paragraphs 6.1.1-6.1.3 of Annex 2 of the IMO Assembly Resolution A.927(22)[5]):

- to designate an area as a Special Area in accordance with Annexes I, II or V of MARPOL 73/78 and/or as a SOx Emission Control Area under Annex VI of MARPOL 73/78; or application of special discharge restriction to ships operating in a PSSA;
- to adopt ships' routeing and reporting systems near or in the area, under the SOLAS Convention and in accordance with the General Provisions on Ships' Routeing and the Guidelines for Ship Reporting Systems; and
- to develop other measures, such as compulsory pilotage schemes or vessel traffic management systems, aiming at protecting specific sea areas against environmental damage from ships.

The proposed associated protective measures may thus include measures within IMO's competence and falling within one of the below mentioned categories:

- already available in an existing instrument;
- any measure not yet existing, but falling within the competence of IMO;
- any measure proposed for adoption in the territorial sea or pursuant to Article 211(6) of the UNCLOS (United Nations Convention on the Law of the Sea)[6].

An application for a PSSA designation must include either a proposal for one or more associated protective measures or a description of how the area is already being protected (Paragraphs 7.1-7.2 of Annex 2 of the IMO Resolution A.927(22) [5]).

2.4 How can national or regional associated protective measures be adopted?

An IMO Member State or a group of IMO Member States, with joint interest in the protection of a sea area, can submit national/regional proposals for associated protective measures to be adopted within a PSSA.

Among the countries to support the Baltic PSSA were (all the Baltic countries except Russian Federation): Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden.

The proposed associated measures should not derogate from the rights and duties of the coastal States as provided for in the United Nations Convention on the Law of the Sea [6]. Likewise the proposed associated measures should take into account other rules of international law.

2.5 Who can designate a sea area as a PSSA?

Designation of PSSAs within internal waters and the territorial sea can be done by States, nationally as well as regionally, whereas IMO is the competent international organization for the designation of PSSAs outside the territorial sea.

All applications for PSSA designation should be submitted to the IMO Marine Environment Protection Committee (MEPC), which will make an initial review of the application. The application will then be referred to the appropriate IMO sub-committees (e.g. NAV Sub-Committee) for further consideration of the proposed associated protective measures. Only after consideration by the pertinent IMO sub-committee may MEPC make a final decision on whether or not to designate a sea area as a PSSA.

2.6 Which PSSAs already exist?

Only IMO Member States can propose PSSA designations. Currently there are eleven PSSAs (Table 1 - dates of designations are in brackets):

Table 1 The areas adopted as PSSA by IMO

1	the Great Barrier Reef, Australia (1991)
2	the Sabana-Camagüey Archipelago in Cuba (1997)
3	Malpelo Island, Colombia (2002)
4	the sea around the Florida Keys, United States (2002)
5	the Wadden Sea, Denmark, Germany, Netherlands (2002)
6	Paracas National Reserve, Peru (2003)
7	Western European Waters (2004)
8	Extension of the existing Great Barrier Reef PSSA to include the Torres Strait (proposed by Australia and Papua New Guinea) (2005)
9	Canary Islands, Spain (2005)
10	the Galapagos Archipelago, Ecuador (2005)
11	the Baltic Sea Area, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden (2005)

2.7 Ships routeing measures to protect PSSAs

A PSSA can be protected by ships routing measures–such as an area to be avoided: an area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships, or by certain classes of ships.

The IMO Publication Ships' Routeing includes general provisions on ships' routeing, first adopted by IMO in 1973, and subsequently amended over the years, which are aimed at standardizing the design, development, charted presentation and use of routeing measures adopted by IMO.

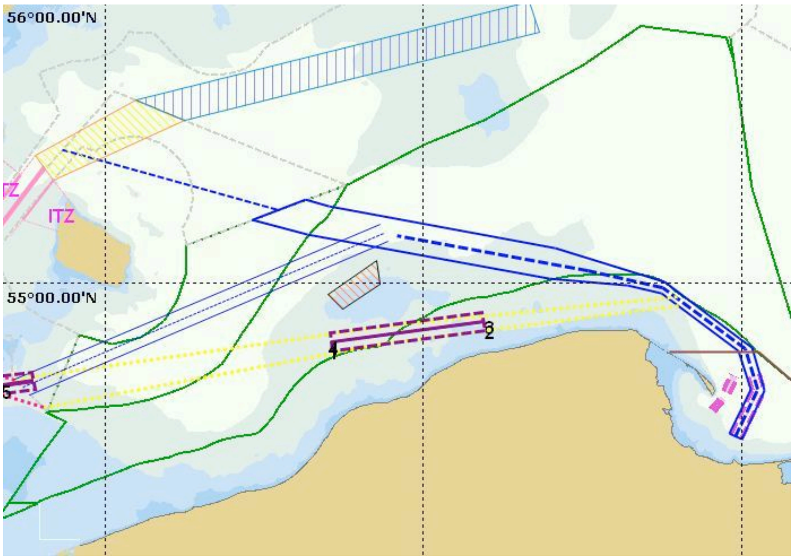

Fig.1 Ships routeing measures to protect PSSAs in Polish Coast of Baltic Sea

Development of other measures, such as compulsory pilotage schemes or vessel traffic management systems, aims at protecting specific sea areas against environmental damage.

The above mentioned Associated Protected Measures (APM) are huge challenge for navigation education not only in Gdynia Maritime University but also in the rest of maritime universities and training centres around the world. It is something new–corrections in navigation course outline should be done.

- Associated Protective Measures (APMs) are binding measures regulating shipping in an area that the IMO has designated as a PSSA. The APMs are decided upon by the member states of the IMO, but a proposal is submitted by the coastal countries concerned. The APMs can be international or territorial. APMs regulate shipping, not ship structure, and hence requirement for double-hull cannot be an APM.
- Traffic separation schemes can be compared with lane divisions in motorways. Ships are referred to use a different route when travelling from north to south and vice versa.

Table 2 Existing IMO Protection Measures

Category	**Measures Used**
Ships Routing Systems	Traffic Separation Schemes
	Areas to be Avoided
	No Anchoring Areas
	Inshore traffic zones
	Deep water routes
	Precautionary areas
	Recommended routes
Ships Reporting Systems	IMO guidelines and criteria for Ship Reporting Systems–resolution 43(46)
	Voluntary / Mandatory
Vessel Traffic Service Systems	IMO Guidelines for Vessel Traffic Services A.857(20)

Discharge and Emission Restrictions	MARPOL Special Areas
	MARPOL Annex VI Sox Emission Control Area
	Special Discharge Restrictions for PSSA's

3 MARPOL special areas

It is not the first time where Baltic Sea is established as a special area. The first was MARPOL Convention [7]. Special areas under MARPOL 73/78 are as follows:

- Annex I: Regulations for the prevention of pollution by oil.

Regulation 10 identifies the following special areas with strict controls on discharge of oily wastes:

- Mediterranean Sea area;
- Baltic Sea area;
- Black Sea Area;
- Red Sea area;
- "Gulfs" area;
- Gulf of Aden area;
- Antarctic area;
- North West European Waters;
- Oman Sea area of the Arabian Seas (from 1 January 2007);
- **Annex II: Regulations for the prevention of pollution by Noxious** Liquid **substances.**

Regulation 1 identifies the following special areas with strict controls on tank washing and residue discharge procedures:

- **Baltic Sea area;**
- Black Sea Area;
- Antarctic area;
- **Annex V: Regulations for the prevention of pollution by Garbage.**

Regulation 5 identifies the following special areas, in which there are strict controls on disposal of garbage:

- Mediterranean Sea area;
- **Baltic Sea area;**
- Black Sea Area;
- Red Sea area;

- “Gulfs” area;
- North Sea;
- Antarctic area (south of latitude 60 degrees south);
- Wider Caribbean region including the Gulf of Mexico and the Caribbean Sea;
- **Annex VI: Prevention of air pollution by ships.**

This annex entered into force on 19 May 2005 and established the **Baltic Sea area** as a "SOx Emission Control Areas" (SECA) with more stringent controls on sulphur emissions from ships. The North Sea was adopted as a SECA in July 2005, under amendments to Annex VI adopted by the MEPC in July 2005, with expected entry into force in Nov. 2006.

4 Particularly sensitive sea areas(PSSAs) and marine environmentally high risk areas(MEHRAs)

4.1 Introduction

In 2002, the World Summit on Sustainable Development(WSSD) adopted the Plan of Implementation, which strongly reaffirmed its commitment to the Rio principles and the full implementation of Agenda 21. In this context, international shipping is under significant pressure to minimise the impact of accidents and operations on the marine environment. These pressures arise from global agreements, port initiatives and raised public awareness. Oil spills, collisions and groundings as well as waste discharges, anti-fouling systems, anchor damage, wake impacts and ship-generated noise have become increasingly important and high profile issues[8].

4.2 Management Options

Ship owners and operators can take action through ensuring the integrity, maintenance and effective environmental management of their vessels and, secondly, through due consideration of the environmental requirements of any regions in which their ships will operate. In order to achieve the latter, it is important for nations individually and collectively to identify sensitive locations where a combination of high environmental and socio-economic values, and high vulnerability to shipping impacts, requires special care to be taken. Such areas are likely to benefit from further review and appraisal of the measures available to help reduce accidents and prevent pollution by controlling where ships go and what they do. As a consequence Particularly Sensitive Sea Areas (PSSAs) and Marine Environmental High Risk Areas (MEHRAs) have been proposed.

4.3 PSSA’s

The International Maritime Organization’s (IMO) Resolution A.927(22): Guidelines for the Designation of Special Areas under MARPOL73/78 and Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas defines a Particularly Sensitive Sea Area (PSSA) as [5]: “An area which needs special protection through action by IMO because of its significance for recognised ecological or socio-economic or scientific reasons and which may be vulnerable to damage by maritime activities.”

This resolution updates and replaces, in an abbreviated form, resolutions A.885(21)–Procedures for Designation of Particularly Sensitive Sea Areas and the adoption of associated protective measures; and A.720(17)–Guidelines for the Designation of Special Areas.

The guidelines set out by IMO for an area to gain PSSA status are separated into three categories, which are then subdivided into further criteria. For a PSSA to be designated it must meet any one of the following criteria (see: Tab.3 and Tab.4):

Table 3 PSSA categories and criteria [8]

PSSA Categories	Criteria to be met
Ecological	Uniqueness, dependency, representativeness, diversity, productivity, naturalness, integrity and vulnerability
Social, cultural and economic	Economic benefit, recreation and human dependency
Scientific and educational	Research, baselines and monitoring studies, education and historical values

Having established exceptional value(s) the purpose of a PSSA is to identify areas where these values or environmental assets are vulnerable to damage by international shipping. Associated Protective Measures (APMs), within the purview of IMO can be proposed to determine the most appropriate way to address any vulnerability. This should also take into account oceanographic, ecological, local vessel traffic and other conditions that make the area sensitive to shipping impacts, together with the impact of any proposed APM on the safety and efficiency of navigation. The need for critical evaluation of this information and consensus building is important as achieved by the Wadden Sea feasibility study [9].

4.4 MEHRA's

Marine Environmental High Risk Areas (MEHRAs) are a UK national initiative to improve the safety of shipping and increase protection of the environment [8]. MEHRAs can be defined as: "Comparatively limited areas of high sensitivity which are also at risk from shipping. There must be a realistic risk of pollution from merchant shipping."

Routeing measures aim to encourage ships to follow routes where vessels are less likely to collide with each other, run ashore or get into difficulties. They also aim to reduce the scope for a disaster if a ship does get into difficulty and direct ships away from areas where pollution would be highly damaging. Given the right of vessels to use such areas, the purpose of MEHRAs is to draw attention to where extra protection from shipping is desirable. To give MEHRA's maximum effect the intention of the UK government is to restrict any 'designations' to relatively small areas of coastline. Publicised information in the form of charts and electronic navigational aids will be made available to ship masters, which should be taken into account when planning passages. The master is then expected to observe the highest standards of care, exercising extreme caution when transiting through these areas.

Table 4 PSSA criteria for an area to be identified as a PSSA it must meet at least one of the following criteria[8]

PSSA Criteria	Description of Criteria

Ecological criteria	
Uniqueness	An ecosystem can be unique or rare. An area is unique if it is “the only one of its kind”. Habitats of endangered species that occur in one area are an example.
Dependency	Ecological processes of such areas area highly dependent on biologically structured systems. Such biotically structured ecosystems often have high biodiversity, which is dependant on the structuring organisms. Dependency also embraces area representing the migratory routes of marine fish, reptiles, birds and mammals.
Representativeness	These areas have highly representative ecological processes, or community or habitat types or other natural characteristics.
Diversity	These areas have a high variety of species or include highly varied ecosystems, habitats, communities, and species.
Productivity	The area has high natural productivity.
Naturalness	The area has high naturalness, as a result of the lack of human-induced disturbance or degradation
Integrity	The area is a biologically functional unit, an effective, self-sustaining ecological entity. The more ecologically self-contained the area is, the more likely it is that its values can be more effectively protected
Vulnerability	The area is susceptible to degradation by natural events or the activities of people. Communities associated with the coast may have a low tolerance to changes in environmental conditions, or they may exist close to the limits of their tolerance.
Social, cultural and economic criteria	
Economic Benefit	The area is of particular importance to utilisation of living marine resources
Recreation	The area has special significance for recreation and tourism
Human Dependency	The area is of particular importance for the support of traditional subsistence and/or cultural needs of the local human population
Scientific and educational criteria	
Research	The area has high scientific interest
Baseline and monitoring studies	The area provides suitable baseline conditions with regard to biota or environmental characteristics
Education	The area offers opportunity to demonstrate particular phenomena
Historical Value	The area has historical and/or archaeological significance

The following combination of maritime and environmental considerations is highlighted by the Table 5:

Table 5 Considerations for MEHRA status

Maritime Considerations	**Environmental and Socio-economic Considerations**
The number, type and size of vessels passing and the nature of their cargoes	Existence of wildlife feeding or breeding sites of international significance or the presence of biological communities of flora or fauna of particular interest or rarity; nature conservation designations such as Special Protection Areas under the EC Birds Directive (1979) or Special Areas of Conservation under the Habitats Directive (1992)
The distance of the usual shipping lanes from the shore	

Any circumstances giving rise to an increased risk of collision such as a significant amount of traffic going across the normal flow	will normally be regarded as evidence of this
Hydrological conditions relevant to safe navigation, such as lack of safe anchorages	The existence of commercially exploitable biological resources and mariculture sites
Prevailing meteorological and tidal characteristics	The extent to which the area provides a public recreational amenity

4.5 Complementary designations

The Wildlife Trusts and WWF recognise the importance of using both PSSAs and MEHRAs together in order to help deliver an ecosystem-based approach that incorporates environmental considerations within the management of shipping activities. Both protection measures are important tools in the prevention of potentially devastating shipping impacts [8].

Table 6 A comparison of PSSAs and MEHRAs

PSSAs	MEHRAs
International concept (larger size)	National concept (smaller size)
Applied anywhere throughout the world as long as the country of jurisdiction is a member of the IMO	Only applicable in territorial waters (12 nautical miles from coastal baseline)
More likely to be recognised by ship masters	Masters likely to be unfamiliar with MEHRA concept
Can employ a range of associated protective measures such as routeing, Areas To Be Avoided, pilotage, Vessel Traffic Services, reporting and information monitoring	Primarily aimed at raising awareness. Measures include routeing provisions (e.g. Traffic Separation Schemes) and response measures (e.g. availability of oil spill response equipment)
Requires IMO approval for designation	Does not need IMO approval for designation, but can receive greater recognition if the designation and associated protective measures are brought to the attention of IMO.

5 Guidelines for management of Baltic Sea protected areas

5.1 HELCOM and the Baltic marine environment

The Helsinki Commission has been assessing the effects of nutrients and hazardous substances on ecosystems in the Baltic Sea for the past 25 years. The resulting assessment reports contain unique compilations of data and detailed analysis based on the scientific research carried out around the Baltic Sea, including the special monitoring programmes co-ordinated by HELCOM[1].

HELCOM measures and monitors airborne and waterborne inputs of nutrients and hazardous substances (including radioactive substances), as well as the state of all the various compartments of the marine environment (water, sediments and biota). HELCOM's monitoring work provides valuable data to help experts understand and assess the interactions between the physical environment and all forms of marine life, with particular attention paid to the many and varied impacts of human activities. HELCOM's assessments help to improve our understanding of marine ecological processes and allow experts to evaluate the impacts of our activities on the marine environment. This work also helps in the setting of objectives for environmental quality, the formulation of policies, and the setting of priorities for actions designed to protect the marine environment, and ensure it is used sustainably.

HELCOM coordinates several monitoring programmes covering the whole Baltic Sea and its catchment. The resultant data is used in:

- annually updated indicator fact sheets;
- thematic reports on various topical issues;
- holistic assessments of the state of the Baltic marine environment.

Recalling HELCOM Recommendation 15/5, the Commission recommended to the Governments of the Contracting Parties to the Helsinki Convention [1, 10]:

"that management plans be established for each BSPA (Baltic Sea Protected Area) to ensure nature protection and sustainable use of natural resources. These management plans shall consider all possible negatively effecting activities, such as: extraction of sand, stones and gravel; oil and gas exploration and exploitation; dumping of solid waste and dredge spoils; constructions; waste water from industry, municipalities and households; intensive agriculture and intensive forestry; aquaculture; harmful fishing practices; tourism; transport of hazardous substances by ship through these areas; military activities..."

5.2 The need for management

The need for management arises from conflicts of interest and from specific nature conservation goals. But also the aim to keep an area as it is and to focus on an undisturbed natural succession needs to be described within a management plan. Conflicts between conservation interests and anthropogenic exploitation or side effects from such and other human activities detrimental to nature must be avoided in a BSPA. On the other hand, an activity by man, such as environment friendly farming practices may be essential for the upholding of conditions needed for certain species or habitats.

5.3 Required background information

Available information concerning the state of the environment and the flora and fauna and their interactions with outside areas have to be compiled. Additional information should be gathered through literature studies including ecological changes, or base-line studies must be undertaken to gather new information.

Existing legal and administrative structures pertaining to the area and constraints already put on the area must be clarified, e.g., existing frameworks for coastal fisheries, marine transportation and other relevant controls on present use of the area. In both instances, and most likely in the latter, it may be necessary to follow up by monitoring at appropriate intervals depending on regeneration potential and the impact and frequency of detrimental activities, in order to assess the need for management. Actual and potential ecological stress factors, conflicts and threats have to be scrutinized in order to assess their effects on the environment and on the flora and fauna. Maps and charts with all relevant data including conflicts should be produced.

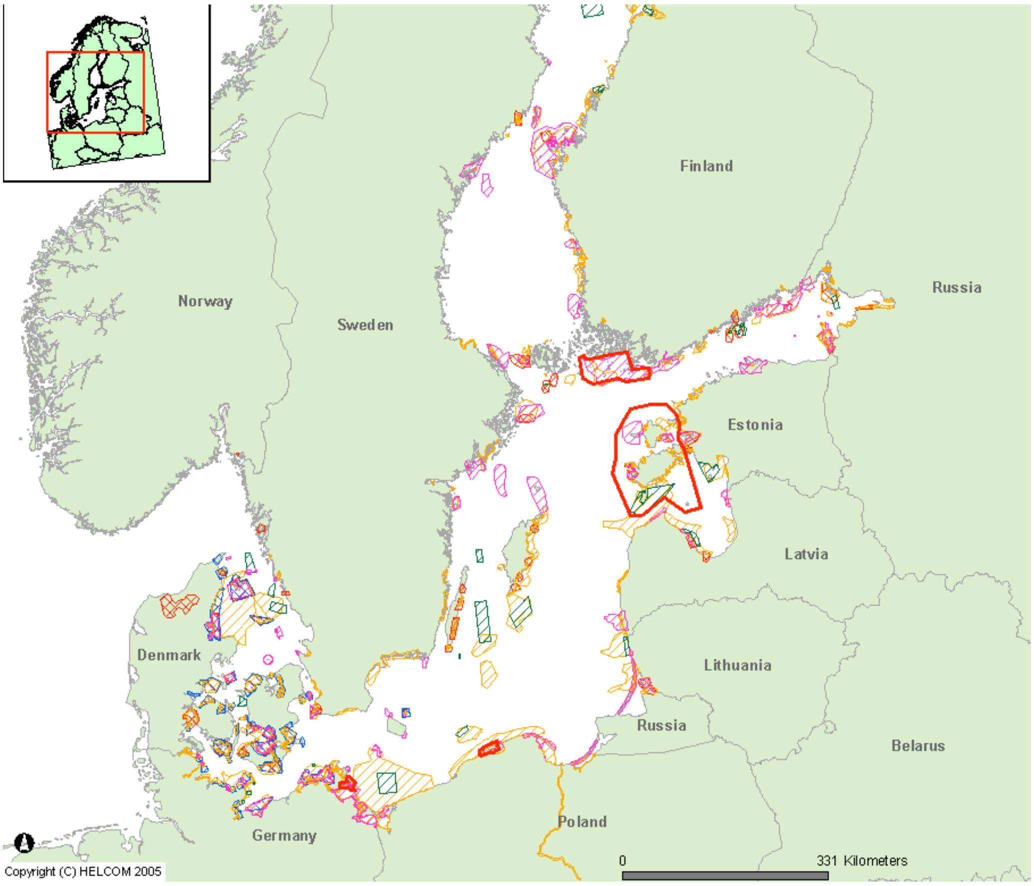

Fig.2 Baltic Sea Protected Areas[10]

5.4 General and specific aims of management

Baltic Sea Protected Areas have been chosen as examples of typical biotopes of ecological significance occurring in each of the Baltic Sea sub-regions. The general aim of management of these areas is to ensure the conservation and/or restoration of a representative set of biotopes and habitats in order to preserve biodiversity and sustainable use of natural resources where appropriate.

To reach the general aim in an area, it is necessary to focus on a number of specific aims, depending on the conservation needs of the area. Zoning could be a useful tool to reach the specific aims. Elements in need of specific protection within a BSPA must be described comprehensively.

5.5 Required administrative elements

An assessment of the arrangements including financial, human and physical resources required to establish the BSPA and to manage it effectively could cover the following items, including budget and timetables[1]:

- staffing;
- equipment and facilities;
- training;
- interpretation and education;

- monitoring and research;
- maintenance and/or restoration;
- surveillance;
- enforcement;
- evaluation and review of effectiveness.

One nature conservation authority should be responsible for the management of each BSPA or for BSPAs.

5.6 Management options in BSPAs

In compliance with the guidelines for designating BSPAs, the aim of protection should be described and, when appropriate, assigned to IUCN categories for protected areas[11]. When a zoning system with different protection categories is appropriate, separate regulations should apply for each zone.

Specific forms of sustainable land use should be regulated when appropriate. Scientific research should be controlled by the management authority that should be responsible for education and public awareness too.

The following options exist to regulate or compensate harmful human activities[1]:

a. restriction of activities in extent;
b. restriction of activities in space (including zoning);
c. restriction of activities in time (ban of certain activities for a specific period, e.g., during breeding seasons or spawning periods);
d. maintenance of sustainable and traditional use when appropriate;
e. alteration of procedures (e.g., reintroduction of traditional land and sea use practices);
f. substitution of materials or substances (e.g., to avoid contamination);
g. total ban of activities or demolition of construction (e.g., demolition of dykes);
h. restoration, reintroduction.

The following activities and threats should be regulated[10]:

(1) extraction of sand, stone and gravel;
(2) oil and gas exploration and exploitation (incl. accidental spillage of oil) and of other natural resources like amber;
(3) dumping of solid waste and dredged spoils;
(4) constructions (including coastal defence measures and infrastructure);
(5) waste water (from industry, municipalities and households) and other harmful emissions;
a. emission of nutrients and biodegradable organic substances,
b. emission of heavy metals and other hazardous substances such as pesticides, antifouling agents, chemicals and radioactive substances;
(6) aquaculture;
(7) transport of hazardous substances by ship through these areas;
(8) military activities;
(9) installation of wind-farms (including offshore wind-farms);
(10) submarine cables.

The following activities and threats should be regulated, where appropriate:

(1) agriculture and forestry incl. water regulation;
(2) fishing and hunting;
(3) tourism and recreational activities;
(4) ship's routeing.

5.7 Ramsar

The Ramsar Convention is an international treaty for the conservation and sustainable utilization of wetlands, i.e. to stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.

The official title is The Convention on Wetlands of International Importance, especially as Waterfowl Habitat. The convention was developed and adopted by participating nations at a meeting in Ramsar, Iran in 1971 and came into force in 1975 [4]. The Ramsar List of Wetlands of International Importance now includes over 1,550 sites (known as Ramsar sites [3]) covering around 1,339,000 km², up from 1,021 sites in 2000. The nation with the highest number of sites is the United Kingdom at 163; the nation with the greatest area of listed wetlands is Canada with over 130,000 km², including the Queen Maud Gulf site at 62,800 km².

Presently there are 150 contracting parties, up from 119 in 2000 and from 18 initial signatory nations in 1971. Signatories meet every three years as the Conference of the Contracting Parties (COP), the first held in Cagliari, Italy in 1980. Amendments to the original convention have been agreed to in Paris (in 1982) and Regina (in 1987). There is a standing committee, a review panel and a secretariat. The headquarters is located in Gland, Switzerland shared with the IUCN[3].

Table 7 WWF's proposal: List of additional protective measures needed (marked with x) in different parts of the Baltic Sea[11]. The numbered areas are illustrated in Fig.3.

AREA MEASURE	1 Kattegat/ Beltsea	2 Polish coast	3 Lithuanian/ Kaliningrad	4 Latvian Waters	5 Gotland	6 Swe Coast	7 GoF	8 Arch Sea	9 Quark	10 Kemi Area
Compulsory pilotage	X	X	X	X	X	X	X	X	X	X
Escort towing	X						X	X		
Traffic separation scheme	X				X		X	X	X	
Compulsory Routing	X				X		X	X		
Areas to be avoided	X	X	X		X	X	X	X	X	X
Ice classification				X		X	X	X	X	X
Speed reduction						X	X	X	X	X
Additional protective measures for the whole Baltic Sea										
VTMIS	X	X	X	X	X	X	X	X	X	X
Common coast guard	X	X	X	X	X	X	X	X	X	X
Ports of distresss	X	X	X	X	X	X	X	X	X	X

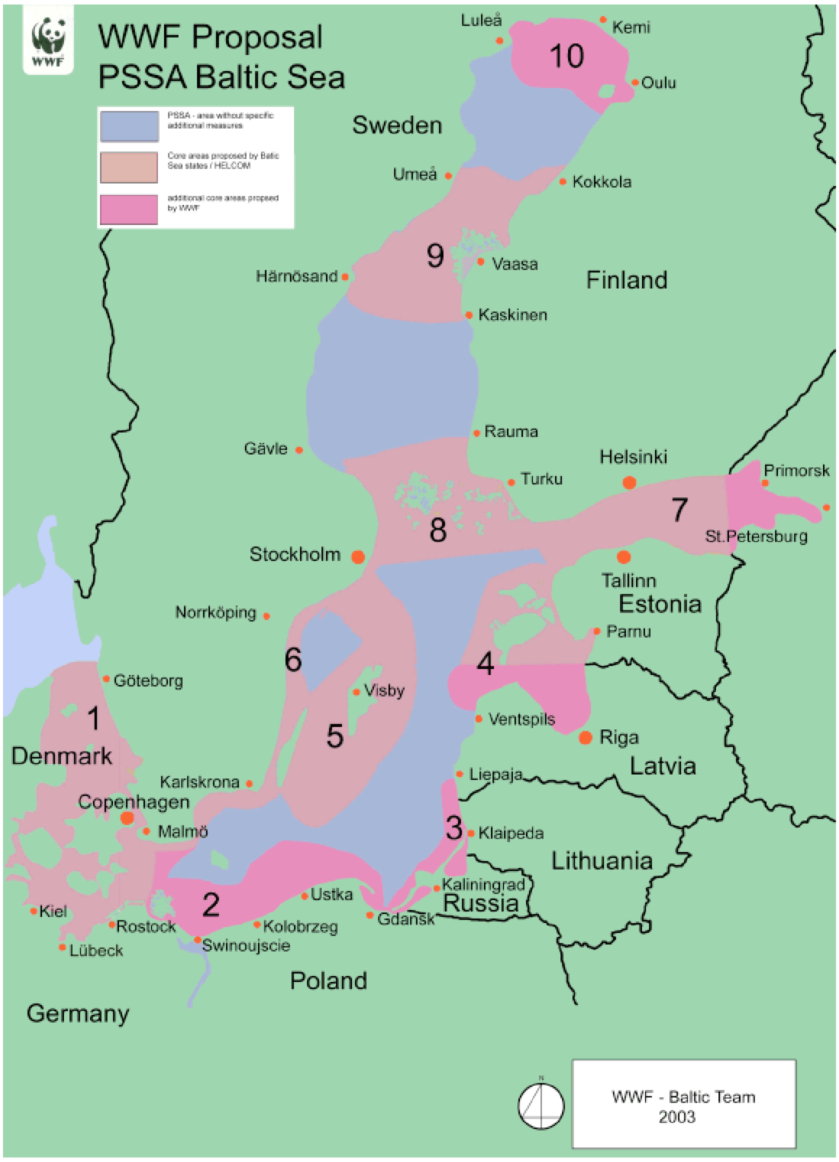

Fig.3 WWF's proposal conserning the core areas which need additional safety measures in the Baltic Sea PSSA[12]

5.8 Natura 2000

In May 1992 European Union governments adopted legislation designed to protect the most seriously threatened habitats and species across Europe. This legislation is called the Habitats Directive and complements the Birds Directive adopted in 1979. At the heart of both these Directives is the creation of a network of sites called Natura 2000. The Birds Directive requires the establishment of Special Protection Areas (SPAs) for birds. The Habitats Directive similarly requires Special Areas of Conservation (SACs) to be designated for other species, and for habitats. Together, SPAs and SACs make up the Natura 2000 series. All EU Member States contribute to the network of sites in a Europe-wide partnership from the Canaries to Crete and from Sicily to Finnish Lapland.

Natura 2000 sites can be designated on both land and water. Marine Special Areas of

Conservation might include reefs or lagoons, intertidal areas, areas which are always covered by the sea or perhaps land near the sea which is used by marine wildlife. Marine Natura 2000 areas are protected by innovative conservation measures to ensure they are not over-fished, or affected by pollutants from sewage or shipping traffic [2].

6 Baltic master Project

Baltic Master is an international project which aims to improve maritime safety by integrating local and regional perspectives. The focus is on the Baltic Sea Region and issues concerning preparedness, prevention and marine spatial planning.

Fig. 4 and Fig. 5 corresponds directly to the general scheme of the first phase of BalticMaster Project (WP2), PSSA mechanism in accordance with the IMO rules and procedures, Associated Preventive Measure assessment process scheme, and Maritime Safety concept in the Baltic according to Copenhagen Agreement.

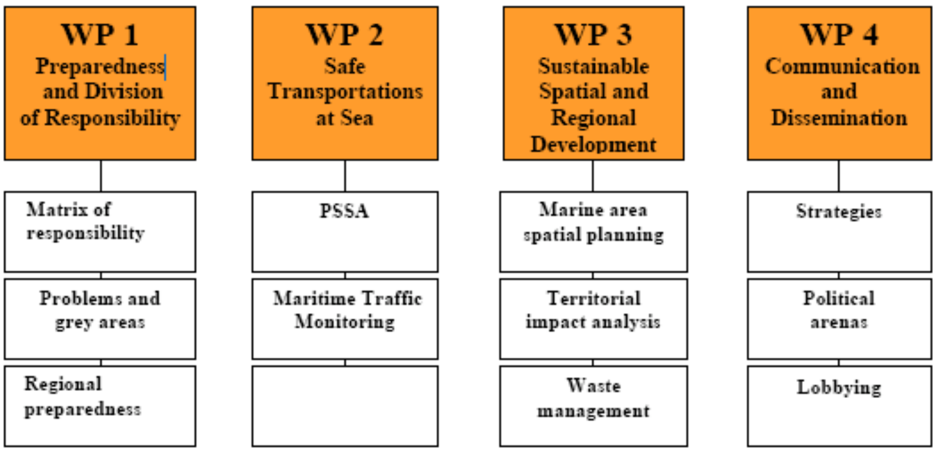

Fig. 4 General scheme of the first phase of the Baltic Master Project

Baltic Master Project aims to improve maritime safety by integrating and bringing forward local and regional perspectives. This includes measures to improve the prevention and the preparedness for ship accidents.

Maritime safety in a wider perspective, including regional development and spatial planning, will also be investigated further. For example there will be focus on conflict risks due to increased use of the sea and the coastal areas (Fig. 5).

The project consists of four work packages. Each work package entails several activities and outcomes, for example scenarios, think tanks, conferences, studies and reports. The titles of the four work packages are:

- Preparedness and Division of Responsibility;
- Safe Transportation at Sea,
- Sustainable Spatial and Regional Development;
- Communication and Dissemination.

The partnership is cross-sectorial, including national authorities, regions, municipalities and international organizations. This will guarantee that local and regional priorities are promoted and considered in the spirit of dialogue and cooperation.

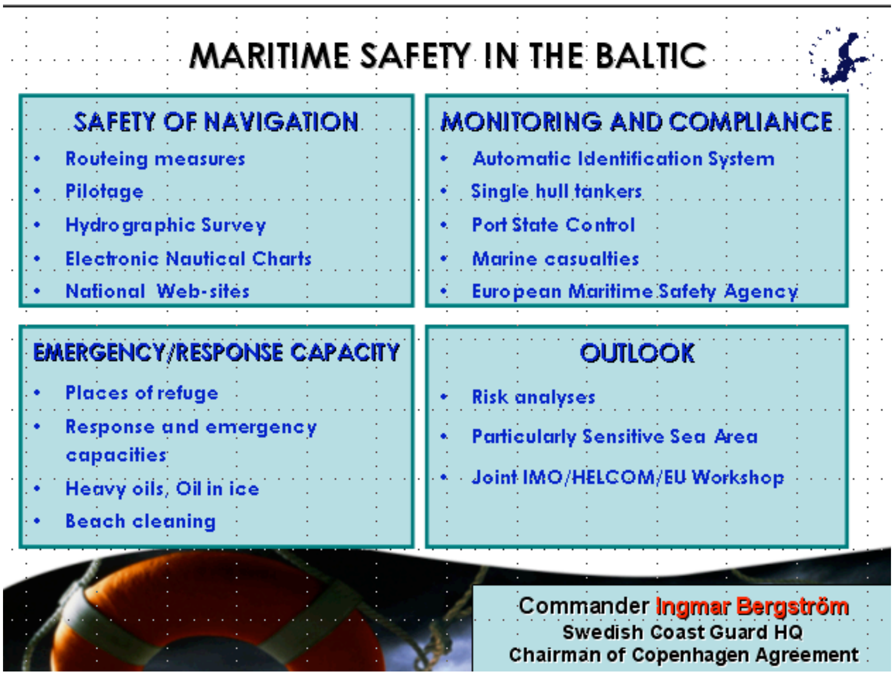

Fig. 5 Maritime safety in the Baltic Sea scheme

7 Model course in operational use of APM in PSSA

The model course in operational use of APM in PSSA should cover the following training areas[13, 14]:

Task 1

Measures to provide protection to the Baltic Sea PSSA (and other PSSAs) from specifically identified maritime activities in accordance with the IMO rules and procedures:

- studying of measures to provide protection to PSSA;
- identification of navigational dangers on the Baltic Area;
- analysis of routes and fairways to main ports of the Baltic Coast;
- analysis of routes and fairways to secondary ports of the Baltic Coast;
- accident and pollution risk assessment using ENC and ECS at the Baltic Sea;
- accident and pollution risk assessment using AIS monitoring system at the Baltic;
- FSA of data presented on paper and electronic navigational charts covering Baltic Sea;
- analysis of the existing and planned PSSA measures at the Baltic Sea taking into account transport forecast at that region;
- results dissemination and implementation;

- variant assessment and evaluation;
- providing of supporting information for a the Baltic Safety Management System.

Training Area 1.1

Traffic separation schemes at Baltic Sea PSSA:

- analysis of Traffic Separation Schemes (TSS) at Baltic Sea adopted by IMO;
- analysis of Traffic Separation Schemes (TSS) at Baltic Sea adopted by local Maritime Administrations;
- identification of present maritime traffic patterns at Baltic Sea Traffic Separation Schemes (Baltic TSS);
- analysis of compatibility of existing TSS and maritime traffic patterns at Baltic Sea;
- identification of future trends in maritime traffic patterns at Baltic Sea Traffic Separation Schemes (Baltic TSS);
- analysis of compatibility of existing TSS and future trends in maritime traffic patterns at Baltic Sea;
- analysis of possible changes to existing Baltic Sea TSS based on future trends in maritime traffic patterns at Baltic Sea;
- analysis of implementing new TSS at Baltic Sea based on present maritime traffic patterns and future trends;
- results dissemination and implementation.

Training Area 1.2

Routing and maritime traffic patterns at the Baltic Sea PSSA:

- identification of navigational dangers at the Baltic Area;
- identification of areas to be avoided at the Baltic Sea PSSA;
- identification of no anchoring areas at the Baltic Sea PSSA;
- analysis of routing measures at the Baltic Sea;
- identification of maritime traffic patterns at the Baltic Sea;
- analysis of compatibility of routing measures and maritime traffic patterns at the Baltic Sea;
- analysis of routes and fairways to main ports of the Baltic Sea;
- analysis of routes and fairways to secondary ports of the Baltic Sea;
- analysis of pilotage measures at the Baltic Sea PSSA;
- analysis of possible additional measures in pilotage and routing at the Baltic Sea;
- results dissemination and implementation.

Training Area 1.3

Collision regulations and collision avoidance at Baltic Sea PSSA:

- analysis of international and local regulations concerning movement of vessels and collision avoidance at the Baltic Sea;

- analysis of contravening international and local regulations at VTS and TSS areas at the Baltic Sea;
- analysis of contravening international regulations at open sea at the Baltic Sea;
- identification of areas of high risk of collision at the Baltic Sea;
- analysis of preventive measures at areas of high risk of collision at the Baltic Sea;
- analysis of recommended measures at areas of high risk of collision at the Baltic Sea;
- analysis of existing tools of collision avoidance at the Baltic Sea;
- analysis of implementation of new ways of collision avoidance at the Baltic Sea;
- results dissemination and implementation.

Training Area 1.4

The Passage Planning of Vessels Transiting the Baltic Sea:

- design of the Passage Plan based on information available on board;
- gathering and analyze of additional information related to safety of the passage;
- developing of the recommendations for application of additional safety margins and measures, based on additional factors impeding the safety of the passage;
- design of the Contingency Plans;
- simulation tests for some of the Contingency Plans and for an alternative routes for the various vessel types;
- developing of the additional Recommendations on Passage Planning;
- results dissemination in form of practical guide for masters and navigating officers on the passage planning of vessels transiting the Baltic Sea.

Training Area 1.5

Hydrographic Survey - Coverage of Electronic Navigational Charts at the Baltic Sea:

- collecting of required BA Nautical Charts & Publications for the Baltic Sea;
- definitions and present status of electronic navigational charts and electronic charts systems;
- analysis of electronic navigational charts coverage at the Baltic Sea;
- identification of co-operation between hydrographic offices at the Baltic Region;
- collecting of required Electronic Navigational Chart cells of Primar Stavanger and IC-ENC RENCs covering the Baltic Sea;
- hydrographic survey analysis at the Baltic Sea;
- accident risk assessment using ENC and electronic chart systems;
- pollution risk assessment using ENC and electronic chart systems;
- FSA of data presented on paper and electronic navigational charts covering the Baltic Sea;
- analysis of electronic charts as measures to provide protection to the Baltic Sea PSSA;
- results dissemination and implementation;
- variant assessment and evaluation.

Training Area 1.6

Vessel reporting and traffic surveillance based on VTS and AIS monitoring measures at the Baltic Sea:

- analysis of VTS centres operating at the Baltic Sea;
- analysis of information gathered at VTS centres at the Baltic Sea;
- analysis of information broadcasted at VTS centres at the Baltic Sea;
- analysis of AIS Monitoring System at the Baltic Sea;
- analysis of vessel monitoring within VTS areas at the Baltic Sea;
- analysis of vessel monitoring outside VTS areas at the Baltic Sea;
- analysis of existing and planned hydro-meteorological monitoring system;
- analysis of ship's reporting systems at the Baltic Sea;
- analysis of monitoring system of vessels transporting dangerous goods at the Baltic Sea;
- identification of weak points in monitoring vessels and ways to improve;
- identification of ways to improve vessel monitoring at the Baltic Sea;
- analysis of places of refuge at the Baltic Sea;
- accident risk assessment using AIS Monitoring System at the Baltic Sea;
- pollution risk assessment using AIS Monitoring System at the Baltic;
- results dissemination and implementation.

Task 2

Associated Preventive Measures assessment process to provide protection to the Baltic Sea PSSA from specifically identified maritime activities in accordance with the IMO rules and procedures:

Training Area 2.1

- Present status of PSSA measures at the Baltic Sea:
- definition and present status of routeing system at the Baltic Sea;
- definition and present status of area to be avoided at the Baltic Sea;
- definition and present status of no anchoring area at the Baltic Sea;
- definition and present status of ship's reporting systems at the Baltic Sea;
- definition and present status of vessel traffic services (VTS) at the Baltic Sea;
- definition and present status of AIS monitoring systems at the Baltic Sea;
- present status of hydrographic survey at the Baltic Sea;
- present status and coverage of electronic navigational charts at the Baltic Sea;
- definition and present status of discharge restrictions at the Baltic Sea;
- definition and present status of places of refuges at the Baltic Sea.

8 Conclusion

PSSA designation brings with it international recognition. It is also consistent with adopted guidelines that advocate a precautionary approach and the polluter pays principle. Whilst APMs to control shipping impacts are integral to the PSSA concept, it is not a requirement of PSSA designation to introduce any APMs and provision is also made for the introduction of APMs at a later date. Notwithstanding the importance of raised awareness and global publicity, the real and immediate effectiveness of any PSSA will relate to the introduction of appropriate APMs firmly linked to risk assessment studies.

At a national level MEHRAs are proposed to identify areas where pollution would be particularly damaging to critical natural and socio-economic assets.

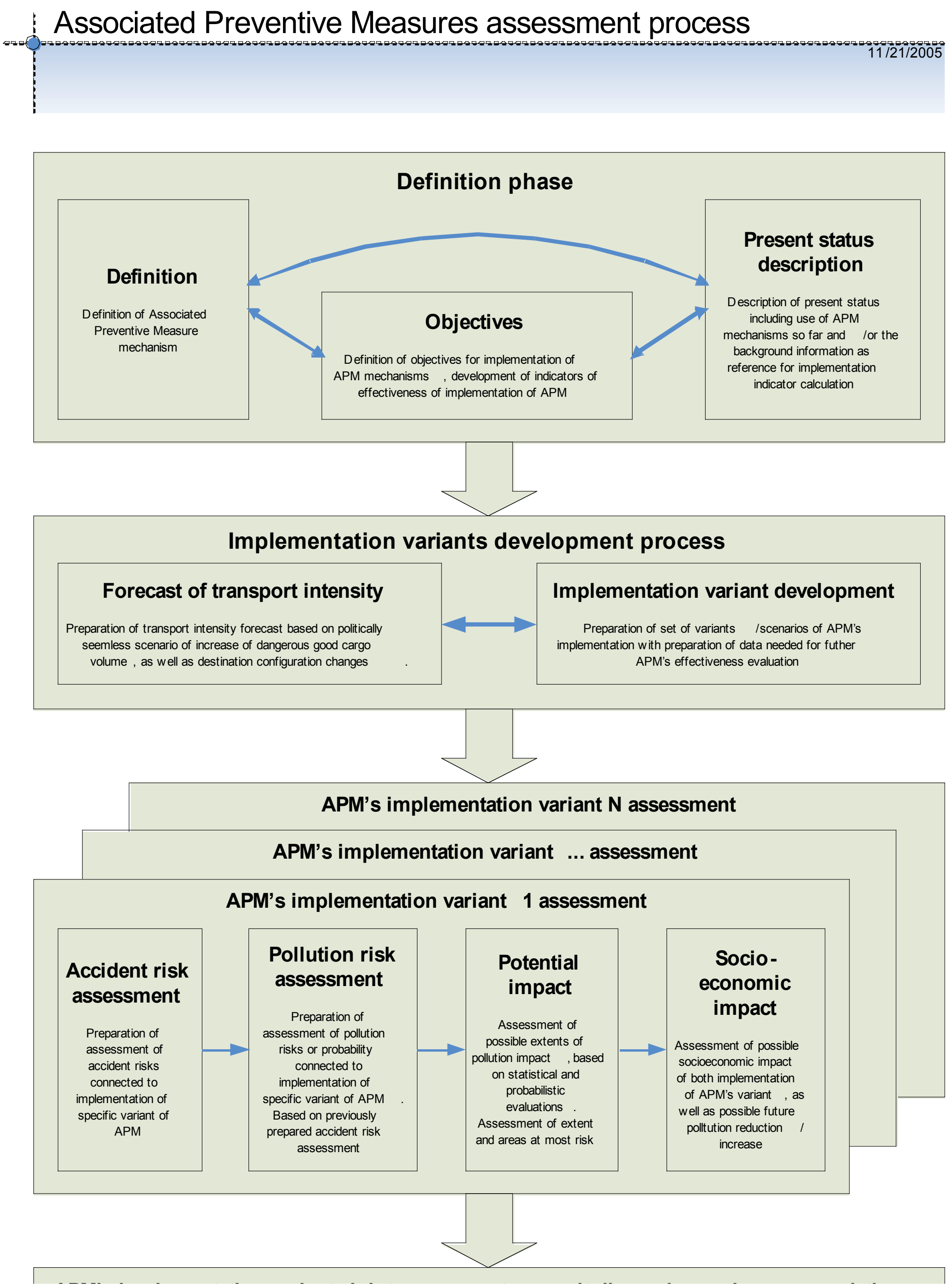

Fig. 6　APM (Associated Preventive Measures) assessment process

PSSAs, BSPAs and MEHRAs, particularly when developed as a tiered approach, can significantly contribute to a sustainable shipping policy and management regime. As demonstrated at the Baltic Sea, the two concepts complement each other to create a strong integrated marine spatial planning and management tool for reducing potential shipping impacts. In many ways this approach can be likened to the establishment of core zones within terrestrial protected areas, where the level of protection (on land this generally means restricted access) from, for example, trampling, is highest. The challenge is to gain the balance between the respective size of PSSA's and local special areas. It would not be desirable for special areas to be too small, as they might become a lost mark on a navigational chart.

Whilst the PSSA concept represents an element of marine spatial planning, encouraging international co-operation and ensuring that shipping and shipping route decisions will be compatible with other activities, it retains a strong sectoral focus and further work is needed to achieve the necessary co-ordinated overall framework for marine areas.

Table 8 Possible Protection Measures for PSSA's

Area Categories	Potential Measures
Territorial Sea	Special passage planning requirements
	Special anchoring requirements
	Special activity restrictions
	Discharge restrictions
	Air pollution limitations
Measures Pursuant to UNCLOS Article 211.6	Description of oceanographic and ecological conditions that make the area vulnerable to shipping
	Highlight inadequacies in existing international rules and standards
	Suggestion of measures to be used in the Exclusive Economic Zone similar to those for the territorial sea
Additional Measures	Measure to reduce the potential for damage to the marine environment by ships on an area specific basis
	Example: no anchoring area in Florida Keys PSSA
	Separate proposals for amendments to an existing instrument or a new instrument would be required in accordance with IMO procedures

8.1 Recommendations

- Future PSSA proposals would benefit from the scrutiny of a properly constituted formal technical evaluation group. Such an expert group of MEPC could consider in detail any proposals and supporting evaluations produced by or on behalf of applicant nations. This would provide a far more objective process than the current, sometimes political, checklist vetting within a time constrained MEPC session and would provide IMO with a more secure and scientific decision base.
- WWF have taken a lead with the formulation of a draft guidance document to assist IMO Member Governments in identifying appropriate APMs for PSSA's. Greater use can also be made of the implicit authority available under UNCLOS for port states and coastal states to adopt measures to protect their marine environment and resources. The process for this, however, could be made clearer.
- In order to achieve ecosystem-based planning and management there is considerable merit in a tiered approach whereby a PSSA identifies a wider area of vulnerability and MEHRAs target the most vulnerable areas, whether these are inside or outside the PSSA. In effect this achieves the original core and buffer area concept envisaged for PSSA's and perhaps, in view of custom and practice, such a system should also be recognised by IMO.
- Overall objectives should be developed for PSSA's and local special areas (BSPAs, MEHRAs) based on a forward looking agenda, considering multiple uses and taking into account transboundary and cumulative effects.
- Integration of the PSSA/BSPA concept in developing the policy and legal framework for

marine spatial planning, and ensuring compatibility with other marine activities including the development of offshore renewable energy will need further consideration.

- PSSA and Associated Protected Measures should be the part of educational system of IAMU members - corrections in navigation course outline should be done.

8.2 Final Conclusion

The Baltic Sea Area comprehensively meets the criteria established by IMO for PSSA designation, albeit that the ecological criteria of naturalness and integrity must be substantiated. The Guidelines (MEPC 46/6 Annex 2 paragraph 4.5) state that:

"The criteria relate to PSSAs within and beyond the limits of the territorial sea. They can be used by IMO to designate PSSAs beyond the territorial sea with a view to the adoption of international protective measures regarding pollution and other damage caused by ships. They may also be used by national administrations to identify Particularly Sensitive Sea Areas within their territorial seas." In the opinion of the author benefits of Baltic Sea PSSA designation outweigh burdens on the basis that:

- The PSSA concept recognises the competence of existing as well as any proposed additional risk management and reduction measures;
- The costs to international shipping associated with PSSA designation are relatively modest, largely linked to any proposed additional measures and consistent with the polluter pays principle;
- The PSSA criteria reflect the importance of the full range of economic activities associated with the Baltic Sea Area, many of which depend upon a clean and well functioning environment;
- A PSSA designation would reinforce the supra-regional environmental importance of the Baltic Sea, particularly in terms of vulnerability to risks associated with international maritime activity, consistent with the precautionary principle;
- The direct and indirect costs of dealing with a major pollution incident on a soft sediment shoreline are significantly more than for a rocky shoreline;
- The threat to the Baltic Sea environment from the impact of international shipping is largely derived from maritime activity in the adjacent water; and
- The students of maritime universities, especially navigational faculties, should understand and fill very well above mentioned problems; PSSA and APM (Associated Preventive Measures) assessment process should be included into education programme.

An over riding benefit is considered to be the message that PSSA designation sends out internationally as to the value of the Baltic Sea.

A significant risk to the Baltic Sea environment from international maritime activities exists. The exceptional density of commercial shipping, together with the presence of fishing vessels and recreational craft in the Baltic Sea and adjacent waters make the region vulnerable to accidental and operational pollution. The combination of meteorological, hydrological, oceanographic and additional complicating factors (e.g. marine exploitation activity) make the region navigationally complex. Other considerations, such as past incidents, also highlight the advantages of a more co-ordinated trilateral approach.

In response to the combination of vessel traffic characteristics and natural hazards in the Baltic Sea, significant measures are in place to help ensure the safety of shipping and to integrate shipping and other activities in the Baltic Sea and adjacent waters (Great Belt, Little Belt, The Sound, Skagerrak and Kattegat). The study has confirmed that:

- Navigational hazards are offset by means of a comprehensive navigational warning system and DGPS for position fixing;
- Collision avoidance is enhanced by IMO routeing systems;
- Pilotage is targeted at ship types posing the highest risk but weather, fatigue of ship's officers and cost of deep sea pilots (voluntary) are all considered relevant;
- Evidence to support the effectiveness of current measures to reduce operational impacts is variable and enforcement of these measures is a problem internationally.

Significant attention internationally has been given to the identification of maritime risks and their reduction. Prospective future international measures, regional agreements and local initiatives (harmonisation) will help protect the Baltic Sea.

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On Notion of Foundations of Navigation in Maritime Education

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Abstract The problem of travelling, ordered motion and related transportation goes back to long-ago times. It has been appearing in changing forms since then. Its aspects were called in different ways during the centuries in the past. Together with the following progress the nature of navigation was also becoming more Abstract. How is it nowadays? Looking at the navigation problem submitted by Ernst Zermelo (1871 - 1953) we propose to generalize it. Analysis of the evaluation of the long standing problem goes through historical and present concepts based on the practical applications as well as the modern theories. Conclusions concern the view at the present trends and obtained results forming the ideas of nearest future with reference to maritime education.

Keywords navigation; maritime education; Zermelo; geometry;

0 Introduction

It is hard to state exactly when people started to travel and how they guided themselves to reach chosen destination. Let us say that as far as remembered the human being had been travelling. Of course the meaning of “travelling” can be different. It depends on the point of view at the problem. When we focus on the different scientific disciplines we find out that the problem of travelling is present and evergreen there. One of its aspects is navigation. There are several kinds of navigation which are studied nowadays considering the applications. The progress made in transportation caused the different types of navigation appeared. We try to focus on maritime part however it is worth of remembering it is a part of navigation in general. Thus, can we say if there is one navigation as research discipline nowadays?

It is necessary to point out that the time of writing this article influenced considerably on its contents. Analyzing the same subject for instance in the 19^{th} century it would not have included other types of navigation which appeared since then. Then the maritime part was the most significant and the created models treated on its applications. However we try to look at the concerned subject in general way. So first things first.

1 Programme of navigational lectures at maritime university

The studies at maritime university take usually four or five years including approximately twelve months of sea practice. The programme of lectures of navigation which is obviously the most important at faculties of navigation includes e.g.

- terrestrial navigation with the analytical and geometrical aspects;
- great circle and rhumb line navigation;
- accuracy in navigation;
- astronomical navigation;
- tides and tidal streams calculations;
- Electronic Chart Systems, Electronic Chart Display and Information System and other electronic aids to navigation (including e.g. satellite systems);
- voyage planning (including navigation in constrained waters or ice) and optimization;
- automation of calculus (different coordinate systems) and computer systems in navigation.

All the lectures follow the standards according to respective conventions as STCW or SOLAS. Additionally there is also a background of the compulsory lectures on mathematics, physics, cartography, geodesy, electronics, computer sciences, meteorology or oceanography. The programme has to be flexible. That means ready to implement the new solutions prepared by international bodies. From time to time the programme needs changes and all the time should be evaluated.

There are of course other groups of lectures obligatory for students to know the job on board the ship properly. However it is not our goal to list all other important disciplines which are necessary for maritime purposes but to focus on navigation itself. The contents of the programmes all over the world are very similar according to international criteria with accepted differences in their time organization. And this is all referring to applications basing on newer and newer solutions implemented in the maritime industry. The students need the part of knowledge compulsory to follow the above mentioned lectures. We propose another one which should not be avoided. This can be found in such research disciplines as mathematics and physics. However is there a space in education programmes for the general view at navigation we are looking for below?

2 Historical background of navigational problems

Research on 5th Euclid's postulate (parallel postulate) caused discovery of non-Euclidean geometries. Given any straight line and a point not on it, there exists one and only one straight line which passes through that point and never intersects the first line, no matter how far they are extended. This statement is equivalent to the fifth of Euclid's postulates, which Euclid himself avoided using until proposition 29 in his *Elements*. For centuries, many researchers believed that this statement was not a true postulate, but rather a theorem which could be derived from the first four of Euclid's postulates. That part of geometry which could be derived using only postulates 1-4 came to be known as absolute geometry. Over the years, many purported proofs of the parallel postulate were published. However, none were correct, including the 28 "proofs" G. S. Klügel analyzed in his dissertation of 1763. The main motivation for all of this effort was that Euclid's parallel postulate did not seem as intuitive as the other axioms, but it was needed to prove important results. John Wallis proposed a new axiom that implied the parallel postulate and was also intuitively appealing. His axiom states that any triangle can be made bigger or smaller without distorting its proportions or angles. Wallis's axiom never caught on. In 1823, Bolyai and Lobachevsky independently realized that entirely self-consistent non-Euclidean geometries could be created in which the parallel postulate did not hold. Gauss had also discovered but suppressed the existence of non-Euclidean geometries. As stated above, the parallel postulate describes the type of geometry now known as parabolic geometry. If, however, the phrase "exists one and only one straight line which passes" is replaced by "exists no line which passes," or "exist at least two lines which pass," the postulate describes equally valid (though less intuitive) types of geometries known as elliptic and hyperbolic geometries, respectively. The parallel postulate is equivalent to the equidistance postulate, Playfair's axiom, Proclus' axiom, the triangle postulate, and the Pythagorean theorem. There is also a single parallel axiom in Hilbert's axioms which is equivalent to Euclid's parallel postulate. S. Brodie has shown that the parallel postulate is equivalent to the Pythagorean theorem.

Problem of finding the shortest route has already been considered by the ancients for practical reasons. Looking back in the past it can be said that the idea came back many times but in different forms accordingly to appearance of new problems or new circumstances. The roots of calculus of variations go back to Fermat's principle of least time (1662). However, the problem which gave the development of the field its first momentum was the celebrated brachystochrone problem stated by Galileo (1638) and solved by John Bernoulli. Bernoulli's paper on the problem was published in the Acta Eroditorum Lipsae (1696)[10]. The brachystochrone problem can be stated as follows:

Consider a curve in a vertical plane, starting at a given point A and ending at another given point B, located at a lower ordinate. Point mass slides along such a curve, under the effect of gravity, so moving from A to B in some interval of time (*transfer time*). *Which is the curve connecting A to B resulting in the shortest transfer time?*

Following the successful solution of the brachystochrone problem, many other variational problems were studied in the subsequent centuries, from the search of geodesic lines to isoperimetric problems, from nautical paths in stationary sea currents to the Zermelo navigation problem[6].

On a cold New Year Eve of 1720, Count Jacopo Francesco Riccati, a nobleman living in the Republic of Venice, wrote a letter to his friend Giovanni Rizzetti, where he proposed two new differential equations. In modern symbols, these equations can be written as follows:

$$\dot{x} = \alpha x^2 + \beta t^m \tag{1}$$

$$\dot{x} = \alpha x^2 + \beta t + \gamma t^2 \quad (2)$$

where *m* is a constant and *t* is the independent variable. This is probably the first document witnessing the early days of the Riccati equation which was to become of paramount importance in our days. Riccati's main interest in the area of differential equations focused on the methods of separation of variables. Such an interest originated in the reading of Gabriele Manfredi's book *De constructione aequationum differentialium primi gradus* printed in Bologna in 1707. Originally, Riccati attention focused on the following problem of geometric type: *suppose that a point of coordinates* (α ,β) *describes a trajectory in the plane according to a linear differential equation of the first order*. Once Riccati days had passed, his equation has been studied by many, in particular Euler (ca. 1760) and Jacques Liouville (ca.1840). However, it is in the 20th century that the equation reaches a paramount importance, especially for the developments of calculus of variations and optimal filtering and control. While the literature on the second variation methods in calculus of variations mainly developed in the first half of the 20th century, optimal filtering and control entered the scientific stage with Kalman's contribution mainly during the decade 1960-1970, and stimulated the research activity for the remaining portion of the century. The problem dealt with in this new field is also a functional optimization problem, but, a new challenging issue is there; the presence of exogenous variables, affecting the dynamics of a phenomenon described in state-space form.

Under the impetus of Kalman work, such a modelization of the real world had to become of paramount importance for diverse fields of investigation and engineering application for the years to come. Thanks to such a unifying model, phenomena, plants, devices, processes did not need any more a conceptual diversification. Another characteristic of Kalman modelization is the possibility of easily incorporating the effect of disturbances, a major ingredient for the formidable communication and information problems of the 20th century. Finally, we should note that, while the independent variable in calculus of variations is typically thought of as a space coordinate, the typical independent variable of optimal filtering and control is time. Under state-space representations, the optimality conditions are naturally posed in terms of Riccati equations[6].

Hilbert's list of problems, read at the International Congress of Mathematicians in 1900, is perhaps one of the most influential documents in the history of mathematics. The twenty-three problems in this list have been the subject of numerous investigations for the last hundred years and continue to yield much beautiful mathematics. Even when one of Hilbert's problems has been solved in its original formulation, its variations and the developments arising from its solution continue to pique the curiosity of mathematicians. One example is Hilbert's third problem on the decomposition of polyhedra. This problem was solved by M.Dehn just two years after Hilbert's address, but the concepts he introduced have evolved in different directions. For instance, the theory of valuations, a central part of modern convex geometry, is a direct descendent of Dehn's solution. In posing his problems, Hilbert did not shy away from vague statements which would be subject to interpretation. Problem six on the mathematical treatment of the axioms of physics is perhaps the prime example of this. Hilbert's fourth problem is another. In its original formulation, Hilbert's fourth problem asks *to construct and study the geometries in which the straight line segment is the shortest connection between two points*. The original wording makes one think the problem is part of Hilbert's project to study the foundations of geometry. However, the different modern approaches make it clear that the problem is at the basis of integral geometry, inverse problems in the calculus of variations, and Finsler geometry[14].

Probably we could add more significant examples of the past problems concerning field of navigation however they cannot be reported here due to lack of space. It is worth of reminding that one of the first Leonhard Euler's papers was focused on marine navigation. We can see the foundations of navigation refer to geometries which differ. The fact has been well known since 19th century. We conclude mentioning that the scientific research changes the researched object.

3 Mathematical models in navigation and its applications

Besides their pedagogical value, many map projections are invaluable for specialized professionals. A common problem is finding the shortest route across the Earth surface between two points. Such path is always part of a geodesic or *great circle* on the globe surface. The geodesic is used by ship and aircraft navigators attempting to minimize distances, while radio operators with directional antennae used to look for a bearing yielding the strongest signal. For many purposes, it is entirely adequate to model the earth as a sphere. Actually, it is more nearly an oblate ellipsoid of revolution, also called an oblate spheroid. This is an ellipse rotated about its shorter axis. Compared to a sphere, an oblate spheroid is flattened at the poles. The earth's flattening is quite small, about 1 part in 300, and navigation errors induced by assuming the earth is spherical, for the most part, do not exceed this, and so for many purposes a spherical approximation may be entirely adequate. On a sphere, the commonly used coordinates are latitude and longitude, likewise on a spheroid, however on a spheroid one has to be more careful about what exactly one means by latitude[1].

The great Flemish cartographer Gerhard Kremer became famous with the Latinized name Gerardus Mercator. A revolutionary invention, the cylindrical projection bearing his name has a remarkable property: any straight line between two points is a loxodrome, or line of constant course on the sphere. In the common equatorial aspect, the Mercator loxodrome bears the same angle from all meridians. In other words, if one draws a straight line connecting a journey's starting and ending points on a Mercator map, that line's slope yields the journey direction, and keeping a constant bearing is enough to get to one's destination. The only conformal cylindrical projection, Mercator's device was a boon to navigators from the 16th-century until the present, despite suffering from extreme distortion near the poles: Antarctica is enormously stretched, and Greenland is rendered about nine times larger than actual size. Indeed, stretching grows steadily towards the top and bottom of the map (in the equatorial form, in higher latitudes; the poles would be actually placed infinitely far away). Although important, a Mercator map is not the only one used by navigators, as the loxodrome (rhumb line) does not usually coincides with the geodesic. This projection was possibly first used by Etzlaub (ca. 1511). However, it was for sure only widely known after Mercator's atlas of 1569. Mercator probably defined the graticule by geometric construction. E.Wright formally presented equations in 1599. More commonly applied to large-scale maps, the transverse aspect preserves every property of Mercator's projection, but since meridians are not straight lines, it is better suited for topography than navigation. Equatorial, transverse and oblique maps offer the same distortion pattern. The transverse aspect, with equations for the spherical case, was presented by Lambert in his seminal paper (1772). The ellipsoidal case was developed, among others, by the great mathematician Carl Gauss (ca. 1822) and Louis Krüger ca. 1912. It is frequently called the Gauss conformal or Gauss-Krüger projection[16].

The vessel or aircraft can reach its destination following the fixed bearing along the whole trip disregarding some obvious factors like for instance weather, fuel range, geographical obstructions. However, that easy route would not be the most economical choice in terms of distance. The two paths almost coincide only in brief routes. Although the rhumb line is much shorter on the Mercator map, an azimuthal equidistant map tells a different story, even though the geodesic does not map to a straight line since it does not intercept the projection centre. Since there is a trade-off: following the geodesic would imply constant changes of direction (those are changes from the current compass bearing and are only apparent, of course: on the sphere, the trajectory is as straight as it can be). Following the rhumb line would waste time and fuel. So a navigator could follow a hybrid procedure[15]:

- trace the geodesic on an azimuthal equidistant or gnomonic map;
- break the geodesic in segments;
- plot each segment onto a Mercator map;
- use a protractor and read the bearings for each segment;
- navigate each segment separately following its corresponding constant bearing.

The shortest path between two points on a smooth surface is called a geodesic curve on the surface. On a flat surface the geodesics are the straight lines, on a sphere they are the great circles. Remarkably the path taken by a particle sliding without friction on a surface will always be a geodesic. This is because a defining characteristic of a geodesic is that at each point on its path, the local center of curvature always lies in the direction of the surface normal, i.e. in the direction of any constrained force required to keep the particle on the surface. There are thus no forces in the local tangent plane of the surface to deflect the particle from its geodesic path. There is a general procedure, using the calculus of variations, to find the equation for geodesics given the metric of the surface[1].

The Earth is not an exact ellipsoid, and deviations from this shape are continually evaluated. The geoid is the name given to the shape that the Earth would assume if it were all measured at mean sea level. This is an undulating surface that varies not more than about a hundred meters above or below a well-fitting ellipsoid, a variation far less than the ellipsoid varies from the sphere. The choice of the reference ellipsoid used for various regions of the Earth has been influenced by the local geoid, but large-scale map projections are designed to fit the reference ellipsoid, not the geoid. The selection of constants defining the shape of the reference ellipsoid has been a major concern of geodesists since the early 18th century. Two geometric constants are sufficient to define the ellipsoid itself e.g. the semimajor axis and the eccentricity. In addition, recent satellite-measured reference ellipsoids are defined by the semimajor axis, geocentric gravitational constant, and dynamical form factor, which may be converted to flattening with formulas from physics.

In the early 18th century, Isaac Newton and others concluded that the Earth should be slightly flattened at the poles, but the French believed the Earth to be egg-shaped as the result of meridian measurements within France. To settle the matter, the French Academy of Sciences, beginning in 1735, sent expeditions to Peru and Lapland to measure meridians at widely separated latitudes. This established the validity of Newton's conclusions and led to numerous meridian measurements in various locations, especially during the 19th and 20th centuries. Between 1799 and 1951 there were 26 determinations of dimensions of the Earth.

There are over a dozen other principal ellipsoids, however, which are still used by one or more countries. The different dimensions do not only result from varying accuracy in the geodetic measurements (the measurements of locations on the Earth), but the curvature of the Earth's surface (geoid) is not uniform due to irregularities in the gravity field.

Until recently, ellipsoids were only fitted to the Earth's shape over a particular country or continent. The polar axis of the reference ellipsoid for such a region, therefore, normally does not coincide with the axis of the actual Earth, although it is assumed to be parallel. The same applies to the two equatorial planes. The discrepancy between centers is usually a few hundred meters at most. Satellite-determined coordinate systems are considered geocentric. Ellipsoids for the latter systems represent the entire Earth more accurately than ellipsoids determined from ground measurements, but they do not generally give the best fit for a particular region. The reference ellipsoids used prior to those determined by satellite are related to an initial point of reference on the surface to produce a datum, the name given to a smooth mathematical surface that closely fits the mean sea-level surface throughout the area of interest. The initial point is assigned a latitude, longitude, elevation above the ellipsoid, and azimuth to some point. Satellite data have provided geodesists with new measurements to define the best Earth-fitting ellipsoid and for relating existing coordinate systems to the Earth's center of mass. For the mapping of other planets and natural satellites, Mars is treated as an ellipsoid. Other bodies are taken as spheres, although some irregular satellites have been treated as triaxial ellipsoids and are mapped orthographically[15].

The metric has already been mentioned without its definition. It is important to remember that obtained shortest distance (geodesics) also depends on the type of metric we use on the considered surface in navigation. A function $g: X \times X \rightarrow R_{+} = \{x \in R \mid x \geq 0\}$ is called a metric (or distance) in X, if (Viro, Ivanov, Netsvetaev, Kharlamaov[17])

(1) $g(x,y)=0$, if and only if $x = y$ (positivity);

(2) $g(x,y) = g(y,x)$ for every $x, y \in X$ (symmetry);

(3) $g(x,y) \leq g(x,z) + g(z,y)$ for every $x, y, z \in X$ (triangle inequality).

Metric is a nonnegative function describing the "distance" between neighboring points for a given set. The pair (X, g), where g is a metric in set X, is called a metric space. The geodesics can look different even on the plane if different metrics are taken into consideration what is presented in Fig.1. It is easy to see that mentioned brachystochrone problem belongs to the group of problems characteristic for the field of navigation.

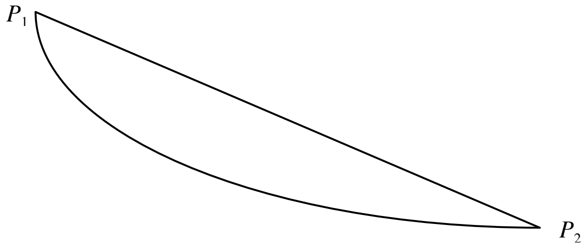

Fig. 1 Geodesics on the plane in different metrics

If we consider the Euclidean metric on the plane, the shortest distance is presented as a segment of a straight line P_1P_2 in the Fig.1. However the arc P_1P_2 can be geodesic when considering a different metric. In the pure geometrical research we don't consider time. To consider time means to consider the speed (velocity) vector. Actually the brachystochrone problem the criterion was time. The curve of the shortest time occurred to be the part of cycloid. Roughly speaking a geodesic is a curve whose length is the shortest distance between two points as already mentioned. This notion makes sense not only for surfaces in R^3 but also for Abstract surfaces and more generally (Riemannian) manifolds. The distance between two points is the length of the path connecting them. In general, the distance between points x and y in a Euclidean space R^n is given by

$$d = |x - y| = \sqrt{\sum_{i-1}^{n} |x_i - y_i|^2} \qquad (3)$$

For curved or more complicated surfaces, the metric can be used to compute the distance between two points by integration. The distance generally means the shortest distance between two points. For example, there are an infinite number of paths between two points on a sphere but, in general, only a single shortest path. The spherical distance between two points A and B of a sphere is the distance of the shortest path along the surface of the sphere (paths that cut through the interior of the sphere are not allowed) from A to B, which always lies along a great circle. Most often the research and calculus in navigational literature are considered on the spherical or spheroidal models of Earth because of practical reasons. The flow of geodesics on the ellipsoid (spheroid) differs from the geodesics on the sphere. There are known different geodesics on the same surface, with the same metric considered. However geodesic refers to the metric what is usually not taken into consideration in the navigational lectures. And there are different flows of geodesics on the same surface when different metrics are considered. That means we can obtain very interesting results in navigational aspect if we change the researched object with its geometrical and physical features.

The mathematical formulas used in navigation and studied at the maritime universities are known well. However if we considered different shape of the planet (surface) the formulas could be quiet different. Let us imagine that the vessels do not sail on spherical (or spheroidal) earth but torus – shaped planet. In this case the flow of geodesics and mentioned rhumb line or used charts are based on other mathematical expressions (different geometrical object). The torus is topologically more simple than the sphere, yet geometrically it is a very complicated manifold indeed. The round torus metric is most easily constructed via its embedding in a Euclidean space of one higher dimension.

4 Zermelo's problem of navigation

Ernst Zermelo was a legend already during his lifetime. Today and also at that time his name was connected to the big debate on the axiom of choice used by him in 1904 for the proof of the well-ordering theorem. He was responsible for the axiomatization of set theory presented in 1908, which helped to establish set theory as a widely accepted mathematical theory. Today Zermelo's name is omnipresent in set theory in acronyms like "ZF" (Zermelo – Fraenkel system) or "ZFC" (Zermelo – Fraenkel [axiom of] Choice). But Zermelo was more than the founder of axiomatized set theory. With his application of set theory to the theory of chess, he became one of the founders of game theory, and with his application of the calculus of variations to the problem of the navigation of aircrafts he pioneered navigation theory. With his recurrence objection in kinetic gas theory he annoyed Ludwig Boltzmann, and with a translation of Homer's Odyssee he pleased even philology experts. In short: Zermelo was famous in his time [18].

Navigation problem was posed by Zermelo in 1931. Let a vessel travelling at constant speed navigate on a body of water having surface velocity. The navigation problem asks for the course which travels between two points in minimal time. Zermelo assumed that the open sea was R^2 with the Euclidean metric. This problem is thought to be a time optimal control problem which consists of finding the quickest nautical path of a ship in the presence of stationary sea currents or wind. The sea surface can be modeled by a two-dimensional Riemannian surface M and the currents by an autonomous vector field $X \in Vec\ M$. Dynamics of optimal trajectories for Zermelo problem are given by

$$\dot{q} = X(q) + \cos u e_1 + \sin u e_2, \quad q \in M, \ u \in S^1 \tag{4}$$

where (e_1, e_2) forms an orthonormal frame of the Riemannian surface M. In Riemannian geometry the Gaussian curvature reflects intrinsic properties of the geodesic flow. That means properties that do not depend on the choice of local coordinates. For example the geodesics of the surface have no conjugate points if the curvature is non-positive. These geodesics are extremals of a particular time optimal control problem. Recently, Shen generalized the problem to the setting where the sea is an arbitrary Riemannian manifold $(M; h)$. When the wind is time-independent, the paths of shortest time are the geodesics of a Randers metric[9, 12]. Zermelo's navigation problem has served as a rich example of various problems in the calculus of variations for many years. It is possible to discuss a modern version of the basic problem of minimal transit time and suggest a new class of related problems[19].

Analyzing Zermelo's navigation problem and some historical problems mentioned before we can see they belong to one group of problems. Although their background is completely different. If we disregard the field of interest (discipline) they are immersed in we observe that their basic structure seems to be very similar or just the same. So the foundations of navigation can also be researched in the group of pure problems of the same origin. In this way it is possible to notice where the same root of quiet different areas began. So the evolution of one problem can be observed by analyzing the questions used to be asked in the past and their solutions or propositions. In case of navigation the process is still realized what is proved by the modern theories (including new notions and theorems). As we wrote in first sentences of the paper travelling, ordered motion started long time ago. It is difficult to state exactly when. However the point is it is continued and navigation follows the process. Its ideas and questions have changed the form many times and can be found in other disciplines as the key problems. Though it may be not easy to state they had the same origin. Of course the reader can wonder if the limits of navigation are so far. It depends on the point of view. Following above mentioned way we treat the maritime navigation as one part of the field. The historical problems (e.g. of brachystochrone) presented in the paper can be the particular cases of generalized Zermelo navigation problem where the different variables are considered, time in particular (classical case of the problem). So the new class of problems of the same origin can be researched then and analyzed for instance on different topological objects.

5 Abstraction and reference to present theories

We aim to discuss roughly a current and uniform treatment of flag and Ricci curvatures in Finsler geometry, highlighting recent developments. The flag curvature is a natural extension of the Riemannian sectional curvature to Finsler manifolds. Of particular interest are the Einstein metrics, constant Ricci curvature metrics and, as a special case, constant flag curvature metrics. Our understanding of Einstein spaces is inchoate. Much insight may be gained by considering the examples that have recently proliferated in the literature. Happily, the theory is developing as well. The Einstein and constant flag curvature metrics of spaces of Randers type, a fecund class of Finsler spaces, are now properly understood. Enlightenment comes from being able to identify the class as solutions to Zermelo's problem of navigation, a perspective that allows a very apt characterization of the Einstein spaces. When specialized to flag curvature, the navigation description yields a complete classification of the constant flag curvature Randers metrics. The sine qua non here is Shen's observation that Randers metrics may be identified with solutions to Zermelo's problem of navigation on Riemannian manifolds. This navigation structure establishes a bijection between Randers spaces (M,F) and pairs $(h;W)$ of Riemannian metrics h and vector fields W on the manifold M. The Randers metric F with navigation data $(h;W)$ is Einstein if and only if h is Einstein and W is an infinitesimal homothety of h. The transparent nature of the navigation description immediately yields a Schur lemma for the Ricci scalar, together with a certain rigidity in three dimensions. Manifold is an Abstract mathematical space which, in a close-up view, resembles the spaces described by Euclidean geometry, but which may have a more complicated structure when viewed as a whole. The surface of Earth is an example of a manifold. Locally it seems to be flat, but viewed as a whole it is round. A manifold can be constructed by gluing separate Euclidean spaces together. For example, a world map can be made by gluing many maps of local regions together, and accounting for the resulting distortions. Every space can be described by its own coordinate system, but different pieces need different ones. However, different choices of coordinate systems can be equally valid.

A sphere surface and a torus surface are examples of two-dimensional manifolds. Manifolds are important objects in mathematics and physics because they allow more complicated structures to be expressed and understood in terms of the relatively well-understood properties of simpler spaces. Additional structures are often defined on manifolds. Examples of manifolds with additional structure include:

- differentiable manifolds on which one can do calculus;
- Riemannian manifolds on which distances and angles can be defined;
- symplectic manifolds which serve as the phase space in classical mechanics;
- the four-dimensional pseudo-Riemannian manifolds which model space-time in general relativity.

The study of manifolds combines many important areas of mathematics: it generalizes concepts such as curves and surfaces as well as ideas from linear algebra and topology. Certain special classes of manifolds also have additional algebraic structure. They may behave like groups, for instance. Before the modern concept of a manifold there were several important results. Carl Friedrich Gauss may have been the first to consider Abstract spaces as mathematical objects in their own right. His theorema egregium gives a method for computing the curvature of a surface without considering the ambient space in which the surface lies. Such a surface would, in modern terminology, be called a manifold and in modern terms, the theorem proved that the curvature of the surface is an intrinsic property. Manifold theory has come to focus exclusively on these intrinsic properties (or invariants), while largely ignoring the extrinsic properties of the ambient space.

Non-Euclidean geometry considers spaces where Euclid's parallel postulate fails. Saccheri first studied them in 1733. Lobachevsky, Bolyai, and Riemann developed them 100 years later. Their research uncovered two types of spaces whose geometric structures differ from that of classical Euclidean space. These gave rise to hyperbolic geometry and elliptic geometry. In the modern theory of manifolds, these notions correspond to manifolds with constant negative and positive curvature, respectively. The spherical Earth is navigated using flat maps or charts, collected in an atlas. Similarly, a differentiable manifold can be described using mathematical maps, called coordinate charts, collected in a mathematical atlas. It is not generally possible to describe a manifold with just one chart, because the global structure of the manifold is different from the simple structure of the charts. For example, no single flat map can properly represent the entire Earth. When a manifold is constructed from multiple overlapping charts, the regions where they overlap carry information essential to understanding the global structure. In the case of a differentiable manifold, an atlas allows to do calculus on manifolds. The atlas containing all possible charts consistent with a given atlas is called the maximal atlas. Unlike an ordinary atlas, the maximal atlas of a given atlas is unique. Though it is useful for definitions, it is a very Abstract object and not used directly for example in calculations. Charts in an atlas may overlap and a single point of a manifold may be represented in several charts. If two charts overlap, parts of them represent the same region of the manifold. Given two overlapping charts, a transition function can be defined which goes from an open ball in Rn to the manifold and then back to another (or perhaps the same) open ball in Rn. The resultant map is called a change of coordinates, a coordinate transformation, a transition function, or a transition map.

If we read above mentioned notions we can see there are many ones well known in the field of navigation studied at maritime university. However it is not realized that, roughly speaking, if the programme of lectures was generalized it could treat on modern theories and important open problems in some branches of mathematics or physics. In other words the programme of navigation touches very important aspects of Abstract research. Unlike curves and surfaces, higher dimensional manifolds cannot be understood by means of visual intuition. Indeed, it is difficult or even impossible to decide whether two different descriptions of a higher-dimensional manifold refer to the same object. For this reason it is useful to develop concepts and criteria that describe intrinsic geometric and topological aspects of these mathematical objects. Such criteria are commonly referred to as being invariant, because they are the same relative to all possible descriptions of a particular manifold.

If we tried to describe the generalization of surface on which its navigational aspects are considered we ask if it is possible to generalize the manifold. It can be found out that such notions like orbifolds, algebraic varieties and schemes or CW- complexes have already been researched. An orbifold for instance is a generalization of manifold allowing for certain kinds of singularities in the topology. Roughly speaking, it is a space which locally looks like the quotients of some simple space (e.g. Euclidean space) by the actions of various finite groups. A CW complex is a topological space formed by gluing objects of different dimensionality together. For this reason they generally are not manifolds.

To measure distances and angles on manifolds, the manifold must be Riemannian. A Riemannian manifold is an analytic manifold in which each tangent space is equipped with an inner product in a manner which varies smoothly from point to point. This allows one to define various notions such as length, angles, areas (or volumes), curvature, gradients of functions and divergence of vector fields. A Finsler manifold allows the definition of distance, but not of angle. It is an analytic manifold in which each tangent space is equipped with a norm, in a manner which varies smoothly from point to point. This norm can be extended to a metric, defining the length of a curve; but it cannot in general be used to define an inner product. Any Riemannian manifold is a Finsler manifold. The Randers metrics which are considered in Finsler geometry form an important and rich class of Finsler metrics. They were first studied by physicist, G. Randers, in 1941 from the standard point of general relativity. Since then, many Finslerian geometers have made efforts in investigation on the geometric properties of Randers metrics. An important approach in discussing Randers metrics is navigation representation, that is, express Randers metric in terms of a Riemannian metric and a vector field[3]. Interestingly, the two navigation descriptions also tell us that any Einstein Randers metric that arises as a solution to Zermelo's problem of navigation on a Riemannian space form must be of constant flag curvature[9].

Zermelo's navigation problem was to find the shortest travel time in a Riemannian manifold under the influence of a current (or wind). The solutions are the geodesics of a Randers space (a special Finsler space), and conversely, every Randers metric arises from such a problem. For example in the paper[2] the main goal is to set up a complete list up to local isometry of strongly convex Randers metrics of constant flag curvature via Zermelo navigation. We aim to present the problem here from the general point of view. That is why we try to avoid, if possible, defining strictly all used notions. Many recent developments have advanced our understanding of the flag and Ricci curvatures of Finsler metrics. Einstein metrics of Randers type are studied via their representation as solutions to Zermelo navigation on Riemannian manifolds. This viewpoint leads to the classification of all constant flag curvature Randers metrics. It also yields a Schur lemma, and settles a question of rigidity in three dimensions, for Einstein–Randers metrics. Via mentioned examples we aim to show how the problems coming from navigation are researched in the advanced and Abstract theories. There is more to be said on navigation than it is usually included in educational programmes at faculties of navigation at maritime universities. Obviously because of practical reasons there is no need to teach such advanced problems as mentioned. However it is important to know that navigation of the same origin is continuously researched although its forms can be Abstract, complicated and with surprising solutions or still open essential questions.

6 The limits of navigation conclusions

If we look back at the evolution of navigation asking the same questions but in different areas of human research we can find out that the limits have been shifted. We can consider only its maritime aspect however it is worth of remembering there are the same roots for different kinds of nowadays navigation. Because of obvious reasons we can present high technology solutions and be proud of progress made in maritime or land sectors. There are more accurate systems of better functionality. Thus, is the navigation limited by range of applications? Another question which arises here is: should we increase the area of interest in navigation at the universities? And is there any space in the programmes for navigational problems in general? Analyzing the research articles we notice that apart from very practical aspects present in the education programmes the navigational problems can be the base for modern theories with Abstract background. Are we ready to accept the conclusions implicated by them if they are even opposite to the practical solutions well known from maritime applications? After the readers' attempts to answer above mentioned questions we can ask again if there is one navigation only. And what are its limits? Do all briefly discussed Abstract problems belong to a field of navigation or they are completely isolated and became part of today mathematics and physics only? Parametric programming is one of the broadest areas of applied mathematics. Practical problems, that can be described by parametric programming, were recorded in the rock art about thirty millennia ago. As a scientific discipline, parametric programming began emerging only in the 1950's. This is done using a limited theory (mainly for linear and convex models) and by means of examples, figures, and solved real-life case studies. If we compare the evolution of parametric programming and navigation we can see that their foundations have the origin in long-ago times. However the problems of navigational aspects appeared many times through the centuries. As already said they could have different background. Interestingly, among the topics discussed in parametric programming such as games of market economy, a projectile motion model, decision making models there can also be found Zermelo's navigation problem under the water[20].

Problem of finding the shortest route has already been considered by the ancients for practical reasons. Looking back in the past it can be said that the idea came back many times but in different forms according to appearance of the new problems or circumstances. Presently the advanced studies are being carried in modern mathematical theories. Thus, the scientific research changes the researched object. In the article we tried to think of navigation in general aspect attempting to clarify the foundational aspects of the subject and thus intuitions dating back to the past centuries became precise and developed through different theories and applications. We were looking at its historical roots, the problems taken into consideration in the past which referred to navigation, however not only in its maritime sector. We compared the present education programmes at university to the most important navigational questions asked in different fields. It is worth of seeing that beside the maritime knowledge there are many areas of research interest e.g. in mathematics or physics considering exactly the same problems but with different backgrounds.

The famous mathematician Ernst Zermelo submitted in 1931 the navigational problem (Zermelo's Problem of Navigation) which is useful in modern theories for example in Finsler geometry. It was used on Riemannian manifolds to solve a long standing problem, namely the complete classification of strongly convex Randers metrics of constant flag curvature. In our opinion the navigational problems, travelling, ordered motion and related transportation go back to long-ago times. They were present with different names in the centuries following the civilization progress made in the passing time. The nature of navigation also became more Abstract. We asked if there was one navigation. Can we call the navigation the same name in practical aspects referring to practical applications and Abstract theories? Both have got the same origin. Is it still one research field or completely different disciplines? Let us think of the above mentioned problems considering their evolution through the centuries. We look at the problem of travelling with its different aspects referring to navigation. Above mentioned notions and discussed problems relating to navigation can be researched in the future applications of micro and macro scale. Such names as for instance Euler, Einstein, Riemann are not far away from the area of interest described here. The reader may well ask about the relationship between the practical and Abstract approach of navigation. The answer may be that they are the two sides of the same coin. It would be a pity if the reader of the article would conclude that there is nothing to contribute to the subject. It still has much to yield. We end this conversation by mentioning that navigation covers a wider field than usually it is thought.

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The Utility of Risk Assessment Tools in Maritime Security Analysis

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Abstract The international maritime community has embraced the need to introduce and adopt security measures to protect vital shipping, facility and port assets from terrorist attacks. This said, the maritime security environment is dynamic and changing, and the specific nature of the threat can vary across time, from country to country, and – within an individual country – from port to port. Threat and risk assessments, and training scenarios, need to become more dynamic, and tailored to specific needs of individual ports, facilities and even vessels. To this end, we introduce a simple set of tools that may allow port and facility managers, and vessel security officers to perform their own individualized risk assessments; specifically the use of *risk matrices* to help identify their most likely risks, and develop security and training plans accordingly. Very simply, a risk matrix allows the user to identify how serious a risk is, based on the expected destructiveness (cost) of an event, and the probability of that event occurring.

Keywords Maritime security; ritime terrorism; isk assessment; isk matrix; isk analysis

0 Introduction the complexity of the global maritime domain

Terrorist risks to merchant shipping are a growing part of the overall spectrum of terrorist threats and present significant challenges to control and prevention due to the nature of the global maritime trade environment. Between 80% and 95% (depending on measure) of global trade is carried by ship[1], with more than 1.2 million seafarers[2] on 120,000 vessels in the global maritime fleet,[3] making calls at over 2,800 ports in the world[4] The maritime environment is so extensive and so complex, that securing the maritime environment a) from attack, b) from being used in an attack, or c) in support of an attack, is a global challenge.

The international maritime community recognizes the vulnerability of the global maritime domain to terrorist attack, and since September 11, 2001, has embraced the need to introduce and adopt security measures to protect vital shipping, facility and port assets. The International Ship and Port Facility Security Code (ISPS), initiated by the International Maritime Organization in 2002 as an amendment to the Safety of Life at Sea Convention (SOLAS, 1974), describes minimum requirements for ship security, with Part A providing mandatory requirements, and Part B providing non-mandatory guidance for the implementation of Part A. The main objectives of ISPS are:

- To detect security threats and implement security measures;
- To establish roles and responsibilities concerning maritime security for governments, local administrations, ship and port industries at the national and international levels;
- To collate and disseminate security-related information;
- To provide a methodology for security assessments so as to have in place plans and procedures to react to changing security levels.[5]

The latter requirement – providing an assessment methodology to allow for changing security levels – presents a complex and challenging task: The maritime security environment is shifting and dynamic, and the specific nature of a given threat can vary across time, from country to country, and – within an individual country – from port to port. There is a need for threat and risk assessments, and training scenarios, to become more responsive to the specific needs of individual ports, facilities and even vessels. However, coming up with individualized risk and threat assessments, and appropriate training exercises, can be a daunting task, involving significant amounts of time and money (both of which are always in short supply).

To this end, the introduction of a simple set of tools, drawn from risk assessment techniques used in the social sciences and computer science, may allow port and facility managers, and vessel security officers to perform their own *individualized* security assessments; specifically the use of *risk matrices* to help identify the most likely risks to their shipping and port facilities, and develop security and training plans accordingly. Very simply, a risk matrix allows the user to identify how serious a risk is, based on the expected negative impact (destructiveness, cost) of an event, the vulnerability of a ship, port or facility to attack, and the associated probability of that event occurring.

1 Defining threat and risk

It is important to define the terms "threat" and "risk". The two terms are often used interchangeably, but there are subtle differences between the concepts that are worth emphasizing.

1.1 Threat: A function of will and capacity

Threat refers to both the *will* and the *capacity* to inflict damage or harm:

- *Will* consists of the desire not only to *acquire* the means to inflict harm, but actually to *use* these means. If, for example an individual/group/country has acquired WMD, but has no desire to use them against its adversaries, there is no immediate threat;

- *Capacity* consists of the means to inflict harm on a desired target; specifically any necessary *knowledge* and/or *materials*. Capacity is a considerably higher obstacle than will – it is easy to desire to do harm but much harder to operationalize the desire into a credible threat.

To use the standard "bomb-in-a-box" "nightmare" scenario as an example: For there to be threat from a dirty bomb hidden in a shipping container, *each* of the following must occur:

- There must be someone who both desires this to occur, and is willing actually to undertake the logistics, organization and planning necessary to set such an event in motion (*will*), and

- They must have the ability actually to undertake the logistics, organization and planning necessary to set such an event in motion; they must also have the knowledge necessary to build an effective radiological device, *and* they must have access to radioactive material, and the materials needed to build an effective device (capacity).

It is important to remember that threat is a multiplicative function: If there is will, but no capacity, there is no threat. Similarly, if the capacity to do harm exists, but there is no will, then there is no threat.

1.2 Risk: threat, vulnerability and impact

Risk, on the other hand, can be seen as a partial function of threat:

$$\text{Risk} = f(\text{Threat } x \text{ Vulnerability } x \text{ Impact})$$

Where:

- *Threat* (as above) consists of both will and capacity to do harm. Again, it is important to think of this as multiplicative (will *x* capacity) because if either will or capacity is equal to zero, there is no threat;

- *Vulnerability* refers to the opportunity given (usually inadvertently) to others to do harm. It is a reflection of how well protected (or not) the target (ship, port, etc) is against an attack or harmful event – either through fortunate circumstance or through sound security policies. ("Fortunate circumstance" occurs when a category of threats does not obtain due to geography, nature of the cargo handled, etc. For example, an offshore oil platform is not vulnerable to a truck bomb; a port which does not handle LNG is unlikely to be vulnerable to an LNG attack).

Vulnerability is, therefore, related to *probability*. The more vulnerable a facility is (for whatever reason) the more probable the event, *ceteris paribus*. (It is important to note that the ship, port facility, etc. has a considerable degree of control over its own vulnerability).

- *Impact* refers to the destructiveness, cost, etc., of the event, should it occur. In addition to loss of life, destruction of infrastructure, and financial losses due to stopped or delayed business, impact can also include time lost due to employees refusing to come to work, having difficulty working once they have returned, or time diversion due to the need to respond to the press, local and national politicians, community concerns, etc.

This is to say, someone may wish to do me great harm and have the ability to do me great harm – may, in fact, be a threat to me – but I run no risk from this threat if my vulnerability to it is zero ***or*** if the impact of the threat is zero. Similarly, I may be extremely vulnerable, and the impact of any act of harm may be significant, but if no one wishes to do me harm or has the capacity to do me harm (ie, there is no threat) my risk exposure is zero.

To use the "bomb in a box" scenario again:

- Someone may have both the desire and capability to plant a radioactive device in a shipping container and place it on a vessel scheduled to call at one of my nation's ports (Threat > 0);
- The global supply chain from the point where the container is loaded, placed on a ship, and delivered to my port (with possible numerous other transfers in between) is not one hundred percent secure – that is, possible weaknesses can be identified in the supply chain, either in one's own port, during points of transit, or in the ports of one's trading partners which makes the probability of the event occurring greater than zero (Vulnerability > 0);

While other definitions exist, these will obtain for the purpose of this analysis. "Threat" will refer to specific scenarios that can cause harm; "risk" will refer to a multiplicative function of an existing terrorist threat, a ship or port's vulnerability to that threat, and the impact of the terrorist event, should it occur.

Once again, the analysis of threat and the analysis of risk – while intrinsically intertwined – must be kept conceptually and operationally separate. For any given threat, the risks associated with that threat will differ, because vulnerabilities differ. The distinction between the two concepts is very important when conducting a risk assessment – not all identifiable threats will be risks for a given ship or port facility.

1.3 Implications

Once threats and risks have been identified, the fact that even in an identifiable risk environment (assuming a constancy of this environment), vulnerabilities and impacts can vary enormously, creating three problems:

(1) The magnitude of conducting risk analyses for all the ports. (While it is tempting to focus on only the "major" ports, this may well at best create only a "diversion" effect – and a terrorist attack on a smaller port could well have a major economic impact due to the psychological impact an attack would create).

(2) Second (and related) – there is no uniform risk analysis for all ports – not globally, not within a single country. There might be a "grouping" of "like ports" that can be determined – i.e., ports with similar enough profiles that the risks are considered similar enough for them to be determined and analyzed as a single category. This said, this cannot be known until an assessment has been done, compiled, and analyzed for a significant number of a nation's ports. Those who are in the best position to do this are the port managers and security personnel on the ground -- perhaps in conjunction with external security analysts/experts -- but not with complete reliance on them.

(3) Third – even if a thorough risk analysis (and corresponding solutions) were performed, it would be static – as the times change, so do the threats, vulnerabilities and impacts; and, consequently the associated level of risk.

What is perhaps most useful at this stage is a *risk framework for analysis* that can be used by port managers and security specialists to self-analyze their individual threats and risks. If a uniform framework for analysis can be adopted, it could provide numerous benefits, including ease of comparability not only between ports, but also within individual ports over time.

Therefore, using the simple terms defined above, any risk analysis will consist at a minimum of two general parts:

- Identification of threat – (will x capacity x opportunity)
- Identification of risk – (threat x vulnerability x impact)

The specific details of these two components are presented in the following section.

2 A risk framework for analysis (RFA)

The basic risk model outlined above forms the foundation of a *risk framework for analysis*, when added to specific techniques for identifying and assessing threat, vulnerability and impact. Risk analysis techniques are commonly used in many businesses – computer technology comes to mind – where security is a daily concern. These techniques are used whenever an event could cause unacceptable losses – in human life, financial losses, infrastructure, business delays, etc. Proper risk and threat analysis techniques – at the level of scenario formation – are the foundation of successful plans, strategies, and training.

Risk analysis has two key components: 1) risk assessment, and 2) risk management. In 1981, Kaplan and Garrick[6] posed three fundamental questions that constitute the risk assessment process:

- What can go wrong? (What are the threats?)
- What is the likelihood? (What is the probability of the event occurring; or how vulnerable is the ship/port?)
- What are the consequences? (What are the possible impacts should the event occur?)

Risk management (beyond the scope of this study), on the other hand, addresses the following:

- What can be done and what are the options available?
- What are their associated tradeoffs in terms of cost, benefit and risk?
- What are the impacts of current management decisions on future options?[7]

2.1 The risk filtering, ranking and management (RFRM) method

To address these questions, we have partially adopted the *Risk Filtering, Ranking, and Management* method (RFRM) developed by Haimes, Kaplan, and Lambert[8]. Divided into seven phases, the RFRM introduces a process to filter, prioritize, and manage a large number of risk scenarios:

- Phase I: Scenario Identification. A hierarchical holographic model (HHM) is developed to identify all risks applicable to a system; in our case, a port facility. Holographic refers to "holistic" and "multi-dimensional" in system-component identification (ie, in the maritime domain, being aware that threats can be subsurface and airborne, and not just attacks from land or sea-surface).

  Taken to greater complexity, the HHM can be viewed as a "master chart" with different perspectives on the system, sub-systems within the system, etc (ie, subsurface is a system component – human attacks could be viewed as a subsystem, as could technological attacks, animal attacks, etc). The utility of this approach is that it encourages those performing the threat assessment to think through all possible arenas of threat and attack.

- Phase II: Scenario Filtering, the set of risk scenarios identified in Phase I is filtered according to the needs, preferences, and interests of the system user.

- Phase III: Bi-Criteria Filtering and Ranking: The scenarios are filtered further, using qualitative assessments to arrive at a matrix of "likelihood and consequence", probability and impact, yielding a severity – or risk – *value*.

- Phase IV: Multi-Criteria Evaluation: Scenarios that remain after Phase III are examined in the context of the facility, to see if the identified scenarios can "defeat the resiliency, robustness, and redundancy of the underlying system".

- Phase V: Quantitative Ranking; Based on the results of Phase IV, a quantitative matrix scale of likelihood and consequence is developed and applied to represent both the relative and absolute importance of the remaining scenarios (and thus the importance of addressing them). The scale is based on which scenarios are more of a threat to the facility, given the security systems already in place. For example, scenarios that may be less severe (low risk value) may actually rank high on the Quantitative Ranking if the facility does not yet have the means adequately to address the threat.

- Phase VI: Risk Management is performed, involving the identification of management options for dealing with the most urgent remaining scenarios, and estimating the cost, performance benefits, and risk reduction of each.

- Phase VII: Safeguarding Against Missing Critical Items, the performance of the options selected in Phase VI is examined against the scenarios that have been filtered out during Phases II to V.

- Phase VIII: Operations Feedback, the experience and information gained in system operation is used to refine and update the scenario filtering and decision processes in Phases II –VII.

2.2 Risk analysis: performing a layered approach using the RFRM method

Returning to the questions posed by Kaplan and Garrick, a layered process can be performed to begin to assess the level of risk associated with a given port facility:

- *What can go wrong?* To answer this question, Phase I of the RFRM is performed – The "holographic" components of the maritime domain are identified, and using the HHM, maritime terrorist threat scenarios are determined.

- *What is the likelihood? What are the consequences (impact)?* The RFRM, Phases II and III, are then applied; the terrorist threat scenarios are filtered and ranked, and, based on qualitative assessment, the probability and impact of each scenario is determined.

(Phases IV through VII of the RFRM are applicable to Risk Management, and are beyond the scope of this immediate study).

2.3.1 RFRM (Phase I): threat event/scenario identification

Identifying terrorist threat scenarios specific to the maritime domain is a two step process:

(1) First, all key elements of the maritime domain must be identified (the "holographic" approach);

(2) Threats for each domain component are identified, using evidence from the literature, and creative speculation about what could happen. Threat identification is, at its essence, a fundamentally creative concept – the more scenarios identified, the greater the likelihood that plans will be in place to protect against the widest range of potential threats.

2.3.2 RFRM (Phases II and III) likelihood and consequences: using a probability- impact matrix

Once a set of threats is identified (and this may run into the hundreds), the must be organized in a manner that allows for their practical assessment. A simple matrix, based on the probability of an event occurring and the impact of an event, should it occur, can be a very useful means of presenting (and comparing) a wide range of threats in a simple schematic form.

Table I is an example of a 5×5 table (risk matrices/tables can be expanded to any number of rows and columns – greater or fewer – depending on the needs of the user):

Table 1

	Probability				
Impact	1	2	3	4	5
1	(1)	(2)	(3)	(4)	(5)
2	(2)	(4)	(6)	(8)	(10)
3	(3)	(6)	(9)	(12)	(15)
4	(4)	(8)	(12)	(16)	(20)
5	(5)	(10)	(15)	(20)	(25)

The numbers 1 though 5 associated with *Probability* run from lower to higher:

(1) Lowest probability of occurring (0% to 20% probability)

(2) Low probability (21% to 40% probability of occurring)

(3) Medium probability (41% to 60% probability of occurring)

(4) High probability (61% to 80% probability of occurring)

(5) Highest probability (81% to 100% probability of occurring)

Because probability is, by definition, a number from zero (the event will not occur) to one hundred (the event will certainly occur), the probability values in a 5x5 table can be associated with their respective quintiles.

The numbers 1 though 5 associated with *Impact* also run from low to high:

(1) Lowest level of negative impact

(2) Low level of negative impact

(3) Medium level of negative impact

(4) High level of negative impact

(5) Highest level of negative impact

The number in parentheses in the middle of each cell is the ***risk value***:

$$\text{Risk Value} = \text{Probability } x \text{ Impact}$$

Items with higher risk values are considered the primary threats. Note that it is possible to have an extremely destructive event (Impact = 5) but not a high risk value if the probability of this event occurring is very low (Probability = 1). So events with high impact or high probability can be less of a risk that events with a lower impact and lower probability.

In our color coded table, the green cells represent events with the lowest risk value (RV), the blue cells have low risk values, the yellow cells have moderate risk values; the orange cells have higher risk values and the red cell has the highest risk value. The orange and red cells, therefore, represent events of the most serious concern.

3 Example: Applying the Risk Framework to an Hypothetical Port

Risk analysis requires performing phases 1-3. *Phase I* involves threat scenario identification – scenarios are identified from open sources, using previously published studies, reports and information, and interviews with experts. In a project at the California Maritime Academy, a research team under the supervision of the author identified forty-five maritime threat scenarios [9]. These scenarios are listed in Appendix A.

In *Phase II*, we filtered the scenarios, in essence performing a "reality check". We decided that the scenarios were best grouped and presented according to source, or point of origin, of the attack:

- Direct attacks on vessels;
- Surface attacks;
- Subsurface attacks;
- Airborne attacks;

- Landside attacks; and
- Water/Land interface attacks.

In *Phase III*, we prepared the scenarios for use in the Probability-Impact matrix, assigning each scenario both a probability value (1-5) and an impact value (1-5). The assignment of both the probability value and the impact value was based on an assessment of similar events that had occurred in the past, as well on educated hypotheses of what might happen in the future. Obviously, the initially assigned probabilities are *subjective* probabilities and should be updated and refined by Bayesian techniques as additional information becomes available.

Our results are as follows in Table II (the numbers in each cell refer to the number of the threat scenario in Appendix A).

Table 2

	Probability				
Impact	1	2	3	4	5
1	(1) 1, 36	(2)	(3)	(4)	(5) 19
2	(2) 14, 15	(4) 2	(6)	(8) 25, 27, 33, 26	(10)
3	(3) 24	(6) 21, 22, 16	(9) 34	(12) 12, 35	(15)
4	(4) 6, 7	(8) 17, 18, 8, 38	(12) 11, 4	(16) 30, 45	(20) 31
5	(5) 20, 37	(10) 3, 9, 10, 23, 39, 40	(15) 13, 28, 29, 41, 42, 43, 44	(20)	(25) 32, 5

For ease of use, the table is color-coded to highlight events of similar risk levels:

- Green (Risk Values 1-5): Events of lowest risk (11 events)
- Blue (Risk Values 6-10): Events of low risk (18 events)
- Yellow (Risk Values 11-15): Events of moderate risk (11 events)
- Orange (Risk Values 16-20): Events of high risk (3 events)
- Red (Risk Value 25): Events of highest risk (2 events)

3.1 The importance of individual port and security assessments

The assignment of the probability and impact values is largely subjective, with the numbers assigned better thought of as relative rankings, rather than absolute values. An event with a probability value of "four" for example, means only that the event is considered more likely to occur than an event with a probability value of "three" and less likely to occur than an event with a probability value of "five".

Along similar lines, it is important to remember that the probability and impact values (and therefore, the risk values) will vary from port to port within and between nations. For example, an event that is assigned a probability value of "three" and an impact value of "four" for a San Francisco port, may have a probability value of "two" and an impact value of "five" for a port in Singapore.

3.2 Interpreting the results

While all the events in the table should be taken seriously, and plans developed to guard against them, a clear hierarchy of events emerges: Those events with both the highest probability *and* the highest impact should be given priority in planning, training and testing. This does not mean that events with lower risk values should be ignored; this framework merely establishes a means of establishing priorities, and allows ports to test more realistic scenarios, rather than the generic "bomb-in-a-box" which may or may not be a risk specific to their particular facility.

Therefore, when the RFA is taken to the next level, to incorporate both Risk Management as well as Risk Assessment, the threat scenarios in the Orange and Yellow cells of the Risk Matrix should form the foundation of future training operations and scenario formation.

4 Conclusion

This article has been an effort to present a basic introduction to the use of risk matrices in risk analysis and risk management. The utility of risk matrices stems from the ease with which they can be learned and used, their flexibility, and their adaptability to dynamic and rapidly-changing security climates. Their success, however, depends on the following:

- Correct and complete identification of threat scenarios. The forty-five scenarios presented here are a partial list of threats to a hypothetical port facility. The development of an accurate threat list requires that vessel and facility security professionals have a solid understanding of the range of possible events that can occur. This is based both on historical analysis of terrorist events that have occurred, and on a creative assessment of what, hypothetically, could occur. This knowledge is a combination of experience, research, and study.

- Correct and accurate assignment of probability and impact values. Again, determining which threat scenarios are more likely to occur than others (and which are less likely to occur) depends on a solid understanding both of the historical record, and on knowledge of known terrorist capabilities. A truck bomb (a terrorist device used with some frequency) is more probably than a radiological device hidden in a shipping container – precisely because the former has happened, while the latter – while it clearly could happen – has not occurred and is beyond the capabilities of most terrorist groups operating today.

- The same requirement for accuracy holds for the assignment of impact values as well – for example, a conventional truck bomb is likely to cause a smaller impact than a successfully-detonated radiological device (although there are conditions under which this might not be true – a correct assessment of the impact value here could depend on knowing how a radiological device disperses compared to, for example, ammonium nitrate – or how destructive radiation is compared, for example, to sarin gas.

- Appropriate training in, and practice of, these techniques. This will involve not only dedicated ship, port and facility security professionals, but members of the international maritime academic community as well. The latter, in particular, are well-placed to undertake the historical analysis of past maritime terrorist events (the range of what has happened), as well as studies of the impact (economic, structural, psychological) they had when they occurred. At the same time, it is the professionals currently working in the ports and on vessels who are perhaps best placed to understand the range of the possible hypothetical events that could occur on their ships or in their facilities.

Given the above considerations, recommendations for the future might involve workshops for academics and professionals to learn and practice these techniques in "table top" and "gaming" environments, as well as in-depth group or research projects for students at the world's maritime universities. The benefits in increased accuracy of risk assessments, more focused security drills and training, and financial gains (either from not trying to protect against all threats, or from failing to protect against a more likely threat in favor of a more destructive – but less likely – threat) make a better understanding of risk assessment tools well worth exploring.

Acknowledgements

The authors wish to thank Kate Barrett and Joe Mahach (Cadets, California Maritime Academy, Program in Global Studies and Maritime Affairs) for their research assistance, and the US Maritime Administration for funding a previous version of this project.

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Appendix A

Threat Event List: Sorted by Point of Origin

The list is separated in to several distinct categories, based on the point of origin of the attack:

- Direct attacks on vessels;
- Surface attacks;
- Subsurface attacks;
- Airborne attacks;
- Landside attacks; and
- Water/Land interface attacks.

While some attacks may fit into two or more categories, we have placed them in the one category that best suits the scenario. Also included is a rating of the probability of the event occurring (P) and its impact (I), should the event occur. Both are coded on a scale of 1 to 5, five being more probable/higher impact. The scenarios are then ranked, in their respective categories, according to their risk value (RV), or the probability of the scenario multiplied by its impact.

#	Event	P	I	RV
	Vessel (Direct Attack)			
1	*Attack ship's navigation systems, possibly cause crash in port:* This is a convoluted scenario involving tampering with the ship's radar and compass to make the ship think it is in a position according to latitude and longitude that is false. It could cause a collision, but that is not highly probable.	1	1	1
2	*Target barge with DMC for explosion:* This scenario would not be very destructive unless the barge was attached to a terminal facility.	2	2	4
3	*WMD/DMC explodes, sinks ship at entrance to port:* Not all harbors are like the San Francisco Bay, with a small mouth leading into a large bay. Thus, the destructiveness of this scenario varies from port to port.	2	5	10
4	*Missile fired from one ship to another in port.* This involves the commandeering of a vessel from which it is possible to fire missiles to another vessel.	4	3	12
5	*Truck bomb on ferry explodes.* This scenario would cause a lot of media attention, and could also cause the sinking of a ship and the loss of many lives.	5	5	15
	Surface (Attack from surface)			
6	*Hijack ship mid-voyage and use to ram an oil tanker, cause oil spill.* Hijacking is difficult. But the spill caused by ramming an oil tanker could be disastrous, taking many days to clean up and closing down a harbor.	1	4	4

#	Event	P	I	RV
7	*Concerted attack of more than one ship on another ship(s).* Due to the logistics of it, this type of attack is very unlikely. However, it could cause a larger amount of destruction than other scenarios that include vessels ramming into other vessels, because there is at least one more vessel involved. This could cause a large enough obstruction in the middle of the harbor to stop traffic.	1	4	4
8	*Hijack ship mid-voyage to use to ram another ship in port, cause traffic jam.* Again, hijacking a vessel is difficult. The destruction caused by ramming into the right type of vessel, one carrying DMC, could cause a serious explosion.	2	4	8
9	*WMD on suicide boat explodes as rammed into another ship in port.* This scenario's objective is to cause a traffic jam in port by rendering a ship dead in the water through an attack from a suicide boat. Depending on the size of the suicide boat and the amount of WMD it has, the damage could be significant.	2	5	10
10	*WMD in tug/pilot boat explodes next to ship in port.* This scenario is the same as that of a suicide boat, just the disguise of the suicide vessel is different.	2	5	10
11	*Hijack Coast Guard boats to use as suicide boats, provide cover.* The use of USCG boats allows the terrorists to get as close to the terminal as possible without being noticed, as a Coast Guard boat can go anywhere it wants unquestioned. However, original boats are hard to commandeer, but they are extremely easy and cheap to duplicate. They can cause a lot of destruction, too.	3	4	12
12	*Zodiac suicide boat.* This scenario can be easily achieved because Zodiac boats are easy to get hold of and the explosives are also easy to get hold of. It has been used by terrorists in the past, with success, so it should be assumed that it is still a tactic that will be used.	4	3	12
13	*WMD in suicide boat explodes next to ship.* This scenario is similar to that of ramming a vessel in port, the difference being that this time, the suicide boat does not ram the vessel, only sidles up alongside the vessel.	3	5	15
	Sub-surface Attacks			
14	*Dolphins trained to deliver explosives to ship in port.* This scenario involves a lot of training and resources, and so it is not very probable. Also, the target will not create a lot of destruction.	1	2	2
15	*Dolphins trained to deliver explosives to terminals.* This is similar to the scenario above. Again, this involves a large amount of training and resources. However, it could create more destruction than just targeting a vessel.	1	2	2
16	*Mines placed strategically in port.* This scenario has a very ambiguous target. It is hard to place mines in a harbor to specifically target a certain vessel. Also, there is a lot of manpower necessary.	2	3	6
17	*Divers attaching explosives to underside of ships.* This requires a large amount of resources and training, and it only has the potential to sink a vessel.	2	4	8
18	*Divers attaching explosives to terminals.* This is similar to the scenario above involving dolphins, but with more accuracy in placing explosives, more damage can be done.	2	4	8
	Airborne Attacks			
19	*WMD in aircraft crashes into ship in port.* The combination of the explosion of the aircraft's fuel along with the bomb onboard can be very destructive to the vessel and surrounding environment.	5	1	5
20	*WMD in aircraft crashes into terminal.* This scenario can be very destructive to the terminal, shutting it down so it cannot process vessels, thus affecting many vessels. Also, the explosion can be cause a lot of damage.	1	5	5

#	Event	P	I	RV
21	*Using manned/unmanned aircraft (including helicopter) to drop bomb on terminal*. This scenario is similar to the scenario above, however attacking a terminal can be more destructive than attacking a vessel.	2	3	6
22	*Using manned or unmanned aircraft (including helicopter) to drop bomb on ship*. This scenario involves using aircraft, which could be used to attack or to scope out facilities in port.	2	3	6
23	*Attack refineries, chemical factories, power plants in port by explosives-laden plane*. This could shut down the port facilities accepting the cargo that vessels bring in, causing a back up in port, and could take a long time to rebuild. It is not hard to get the materials for this scenario.	2	5	10
	Facility (attack from or on facility) (Note: Facility has been deemed to signify only facilities that directly service and interact with ships)			
24	*Terrorists blockade port*. This scenario involves a terrorist fleet, like that of the Tamil Tigers in Sri Lanka. It involves a large number of vessels that can securely blockade a port, necessitating a lot of man power and supplies to feed, refuel, etc.	1	3	3
25	*Cyber attack to disrupt vessel traffic service, possibly stop port traffic*. This scenario could be easily executed, but the damage may not be that great.	4	2	8
26	*Cyber attack to disrupt terminal operating system*. This scenario involves hacking into the terminal operating system to cause disruption.	4	2	8
27	*Terrorists disguised as casual longshoremen*. It is not hard for terrorists to become casual longshoremen, who are hired on short notice. They also might be able to smuggle in an explosive device.	4	2	8
28	*WMD delivered to terminal in container by train. T*his scenario also has the objective of destroying terminal facilities.	3	5	15
29	*WMD delivered to terminal in container by truck*. This scenario is almost exactly the same as the scenario with the train, and thus is it rated the same.	3	5	15
30	*Missile fired from one ship to port facility* (factory, refinery). This requires a vessel from which a missile can be fired, a missile, etc. But this threat seems much more destructive because it targets certain facilities that could have a larger impact on port operations. For example, if the missile hit a refinery, then it could cause the refinery to shut down for repairs and thus the tankers waiting to offload their cargo would back up as well as tankers waiting to take the refined products elsewhere.	4	4	16
31	*Cutting cables on cranes/destroying cranes*. This could be very destructive because of the fact that to repair the cables could take a very long time. It would also cause a lot of backup at the terminal, and although the ships would be running, they would not be able to unload their cargo. They would have to wait in port or find another terminal, putting pressure all through the port.	5	4	20
32	*Attack refineries, chemical factories, power plants in port by explosives-laden truck*. This is similar to the scenario with an explosive laden plane, but I see it causing more damage as a truck can carry more explosives than a small plane.	5	5	25
	Landside (attack from land) (Landside signifies attacks on parts of ports that would not directly and/or immediately affect ships)			
33	*Terrorists disguised as legitimate facilities maintenance personnel in port*. This scenario would permit terrorists unlimited access to the terminal facilities, allowing them to find out everything their superiors want to know about the different security weaknesses of the terminal. They could also smuggle in an explosive device.	4	2	8

#	Event	P	I	RV
34	*Explosives in a communication tower.* This scenario could be easily executed, and it could interrupt radio communications. Therefore, it could cause a lot of damage, even a collision.	3	3	9
35	*Blow up food truck laden with explosives near terminal entrance.* This could be a serious security risk for terminals because it could blow up the entrance to the terminal, thereby eliminating the gate that controls access to the terminal, and shutting down the terminal for the amount of time it would take to get gate rebuilt.	4	3	12
	Water/Land Interface (attack from water/land interface)			
36	*Ballast water attack, inserting disease into ballast water.* This scenario includes inserting a disease into the ballast tanks of a vessel. However, this would require access to the vessel as well as access to a large amount of the disease in order to carry out the attack. The target is ambiguous, as once ballast water is dumped out, there is no control over the disease's movements, and thus it is very imprecise.	1	1	1
37	*Concerted attack of more than one ship on terminal.* This scenario would be very unlikely because of the fact that there is more equipment needed (more than one vessel needs to be commandeered). But it could cause serious damage.	1	5	5
38	*Hijack ship mid-voyage to use to ram terminal.* The hijacking of a large vessel is difficult, but the destruction caused when the vessel rams into a terminal could be serious.	2	4	8
39	*WMD in tug/pilot boat explodes next to terminal.* This scenario is the same as if any small vessel with a WMD exploded near a terminal.	2	5	10
40	*Smuggle weapons and terrorists in cargo hold/containers to attack from within terminal.* This would not cause a lot of destructiveness because of the small amount of weapons that could pass inspection.	5	2	10
41	*WMD in container explodes on ship in port.* In this scenario, the objective of the terrorists would be to destroy the terminal facility.	5	3	15
42	*WMD in suicide boat explodes as rammed into terminal.* This scenario is similar other WMD scenarios, but the target is different. The effects of the suicide boat ramming into the terminal is a bit more destructive as it actually can affect more than just one or two vessels, since the terminal would take a while to get back up and running.	3	5	15
43	*WMD in tug/pilot boat explodes as rammed into terminal.* This is the same scenario as with any small vessel, just a different type of suicide boat.	3	5	15
44	*WMD in suicide boat explodes next to terminal.* This scenario is similar to that of a suicide vessel ramming the terminal. The damage could close down the terminal for a while for repairs, affecting other vessels indirectly.	3	5	15
45	*Terrorists disguised as port security inspection team.* This would allow the terrorists unlimited access to anywhere on the terminal and surrounding vessels. It would not be hard to buy the necessary uniforms of a port security inspection team on the black market. They might also be able to smuggle in an explosive device.	4	4	16

Maritime Security—Assessment and Management

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Abstract After the tragedy of September 11, 2001, there is widespread concern in the international society that a terrorism organisation capable of the suicide hijackings of airliners could readily adapt these capabilities to major shipping targets. Techniques require to be developed to bridge maritime security gaps, which are defined as the potential areas associated with how to assess the security levels of a vulnerable maritime target and how to use the assessment to make appropriate decisions and controls. Some safety experts have focused their mind and attempted to use traditional risk assessment and decision making approaches to deal with possible terrorism threats in a maritime security area, investigate the key vulnerabilities and provide effective security control and management options. Two of the major challenges are to analyse security in situations of a high level uncertainty and to construct all information available with difference in nature in a utility form suitable as input to a risk inference mechanism. To solve such difficulties, this paper proposes a subjective security-based assessment and management framework using the combination of two fuzzy evidential reasoning (ER) approaches.

Keywords maritime security; security assessment; fuzzy logic; evidential reasoning

0 Introduction

The recently implemented International Shipboard and Port Facility Security (ISPS) Code [1] requires security assessment for various ship and port facility security plans. However, apart from its Section 8 in parts A and B, the Code does not prescribe a generally accepted methodology to carry out such assessment. Although Section 8 in Part B provides a number of issues to be considered when a security assessment is carried out, an obvious problem involved is that Part B is not mandatory and this may leave maritime stakeholders to choose and define their "suitable" methodologies and guidelines for individual maritime security assessments. For example, the American Bureau of Shipping (ABS) or Lloyd's Register favours the risk assessment guidelines provided by the United States Coast Guard (USCG), while Det Norske Veritas (DNV) and Germanischer Lloyd (GL) have developed guidelines based on checklists which have a close relationship to the ISPS Code. The USCG guidelines do not include any statements about likelihood of security threats, whereas the DNV-GL approach allows for a consideration of likely threats only[2]. The USCG approach requires the development of mitigation strategies and clear identification of the best option(s) from costly risk control measures and on the other hand, the users of the DNV-GL approach have to update their security assessments frequently depending on the latest security information available. As far as the threat of terrorism is concerned, the lack of critical mass in statistical data and the complexity of selecting the best SCO (optimisation) based on multiple security control attributes will prove the tasks of adapting traditional approaches to be challenging and generating novel and uniformed methodologies to be urgent.

One realistic way to analyse security with unavailable or incomplete objective data is to employ subjective assessment based on fuzzy *IF-THEN* rules in fuzzy set theory (FST). The approach based on the fuzzy rules, where conditional parts and/or conclusions contain linguistic variables [3] can model the qualitative aspects of human knowledge and reasoning process without employing precise quantitative analysis. It does not require an expert to provide a precise point at which a risk factor exists. This actually provides a tool for working directly with the linguistic information, which is commonly used in representing risk factors and carrying out safety assessment [4-7]. The purpose of analysing security is to identify the high-level risks in a prioritised list so as to ensure the correct decisions to be made and appropriate SCO(s) to be selected. However, realising such an objective requires other factors from economical, technical and environmental considerations to be satisfied. The factors can be defined as multiple decision attributes in analysing a complex maritime security management problem and normally investigated by the rules of a knowledge base in a hierarchical structure, in which the sub-criteria of the attributes can be further developed. In general, a bottom-up approach can be used to solve such a problem. Pieces of evidence from the lowest-level criteria are aggregated as evidence for the second lowest-level criteria/ attributes, which is in turn aggregated to produce evidence for higher-level attributes. The ER approach has presented the superiority in dealing with the synthesis of various pieces of evidence obtained/evaluated. Therefore, this study proposes a subjective security-based assessment and management framework using the combination of two fuzzy ER approaches. In the following, Section 2 outlines the security analysis and synthesis framework using a FRB-ER approach. The framework of synthesising security estimation and other multiple decision attributes is provided in Section 3 where the synthesis result can be used to produce the preference estimates associated with SCOs for ranking purposes. An illustrative example is used to demonstrate the application of the proposed framework in Section 4. Section 5 concludes this paper.

1 Fuzzy rule-based security analysis framework

The proposed framework for modelling security assessment consists of five major components, which outline all the necessary steps required for maritime security analysis.

1.1 Identify risk parameters and define fuzzy input and output variables

The threat-based risk parameters used to define subjective security estimates include those at both the senior and junior levels. The senior parameter is "***Security estimate*** (***SE***)", the single fuzzy output variable, which can be defuzzified to prioritise the risks. The variable is described linguistically and is determined by some junior parameters. In risk assessment, it is common to express a security level by degrees to which it belongs to such linguistic variables as "Poor", "Fair", "Average" and "Good" that are referred to as security expressions. To analyse the junior parameters, four fundamental risk parameters can be identified and defined as "*Will*" (***W***), "*Damage capability*" (***D***), "*Recall difficulty*" (***R***) and "*Damage probability*" (***P***). ***W*** decides the failure likelihood of a threat-based risk, which directly represents the lengths one goes to in taking a certain action. To estimate ***W***, one may choose to use such linguistic terms as "Very weak", "Weak", "Average", "Strong" and "Very strong". The combination of ***D*** and ***R*** responds to the consequence severity of the threat-based risk. Specifically speaking, ***D*** indicates the destructive force/execution of a certain action and ***R*** hints the resilience of the system after a failure or disaster. The following linguistic terms can be considered as a reference to be used in subjectively describing the two sister parameters: "Negligible", "Moderate", "Critical" and "Catastrophic" for ***D*** and "Easy", "Average", "Difficult" and "Extremely Difficult" for ***R***. ***P*** means failure consequence probability and can be defined as the probability that damage consequences happen given the occurrence of the event. One may choose to use such linguistic terms as "Unlikely", "Average", "Likely" and "Definite" to describe it.

Fuzzy logic, based on FST, accommodates such linguistic terms through the concept of partial membership. In FST, everything is a matter of degree. Therefore, any existing element or situation in security assessment could be analysed and assigned a value (a degree) indicating how much it belongs to a member of the five sets of the risk parameters. Furthermore, five membership functions can be defined as five curves to describe how each point in the input and output space is mapped to a membership value (or degree of membership) between 0 and 1. Due to the advantage of simplicity, straight-line membership functions, especially triangular and trapezoidal membership functions have been commonly used to describe risks in safety assessment[8]. Consequently, the fuzzy membership functions in security assessment, consisting of five overlapping triangular or trapezoidal curves, are generated using the linguistic categories identified in knowledge acquisition and the fuzzy Delphi method[9]. They are provided in the work by Yang [10].

1.2 Construct a fuzzy rule base with a belief structure

Fuzzy logic systems are knowledge-based or rule-based systems constructed from human knowledge in the form of fuzzy *IF-THEN* rules [11]. An important contribution of the fuzzy system theory is that it provides a systematic procedure for transforming a knowledge base into a non-linear mapping [12]. A fuzzy *IF-THEN* rule is an *IF-THEN* statement in which some words are characterised by continuous membership functions. For example, the following is a fuzzy *IF-THEN* rule: *IF* ***W*** of a threat is "Very strong" AND ***D*** is "Catastrophic" AND ***R*** is "Extremely difficult" AND ***P*** is "Definite", *THEN* ***SE*** is "Poor". The descriptions of ***W***, ***D***, ***R***, ***P*** and ***SE*** are characterised by the membership functions. A fuzzy system is constructed from a collection of fuzzy *IF-THEN* rules from human experts or based on the domain knowledge and is then completed by combining these rules into a single system.

Obviously, the *IF-THEN* rules in this study can have two parts: an antecedent that responds to the fuzzy input and a consequence, which is the result/fuzzy output. In classical fuzzy rule-based systems, such input and output are usually expressed by single linguistic variables with 100% certainty and the rules constructed are also always considered as single output cases. However, when observing realistic maritime security situations, the knowledge representation power of the fuzzy rule systems will be severely limited if only single linguistic variables are used to represent uncertain knowledge. Four fuzzy input parameters include 17 (=5+4+4+4) linguistic variables, which can be assembled to produce 320 (=5×4×4×4) antecedents. Given a combination of input variables, *SE* may belong to more than one security expression with appropriate belief degrees. For example, a fuzzy rule with certain degrees of belief can be described as: *IF* ***W*** of a threat is "Very strong" AND ***D*** is "Catastrophic" AND ***R*** is "Extremely difficult" AND ***P*** is "Likely", *THEN* ***SE*** is "Poor" **with a belief degree of 0.9**, "Fair" **with a belief degree of 0.1,** "Average" **with a belief degree of 0,** "Good" **with a belief degree of 0** and "Excellent" **with a belief degree**

of 0.

In order to model general and complex uncertain problems in security assessment, the classical fuzzy rule-based systems are extended to assign each rule a degree of belief. Assume that the four antecedent parameters, U_1=***W***, U_2=***D***, U_3=***R*** and U_4=***P*** can be described by linguistic variable A_{iJ_i}, where i=1, 2, 3, or 4 respectively and J_1 = 1, …, or 5, J_2, J_3 and J_4 = 1, …, or 4. One consequent variable ***SE*** can be described by 5 linguistic terms, D_1, D_2, D_3, D_4 and D_5. Let $A_{iJ_i}^k$ be a linguistic term corresponding to the i^{th} parameter in the k^{th} rule, with i=1, 2, 3 and 4. Thus, the generic k^{th} rule in the rule base can be defined as follows:

R$_{\mathbf{k}}$: IF ***W*** is $A_{1J_1}^k$ and ***D*** is $A_{2J_2}^k$ and ***R*** is $A_{3J_3}^k$ and ***P*** is $A_{4J_4}^k$, then ***SE*** is D_1 with a belief degree of β_{1k}, D_2 with a belief degree of β_{2k}, D_3 with a belief degree of β_{3k}, D_4 with a belief degree of β_{4k} and D_5 with a belief degree of β_{5k} .

where $\sum_{i=1}^{5}\beta_{ik} = 1$, $k\in\{1, \ldots, 320\}$. It is noted that all the parameters and the belief degrees of the rules are usually assigned at the knowledge acquisition phrase by multiple experts on the basis of subjective judgements. An entire rule base including 320 rules with a belief degree structure is provided in [10].

1.3 Application of a frb-er approach

Once a rule-based system is established, it can be used to perform inference for given fuzzy or incomplete observations to obtain the corresponding fuzzy output, which can be used to assess the security level of a vulnerable maritime target. The inference procedure is basically composed of three steps, summarized as follows.

1.3.1 Observation transformation

Before starting the inference process, observations available should be analysed to determine their relationship with each junior risk parameter in the antecedent in a numerical form. Four kinds of possible observations may be represented using membership functions to suit conditions under this study. They are either a single deterministic value with 100% certainty, a closed interval, a triangular distribution or a trapezoidal distribution [11]. Having defined the four junior risk parameters above, a matching function method [7] can be employed to perform the observation transformation and determine the belief degrees to which actual observations, which have been numerically described, match to each linguistic variable in the antecedent.

The matching function method chooses the *Max-Min* operation to show the similarity between the real input fuzzy set A^r and the corresponding fuzzy linguistic variables A_{iJ_i}, because it is a classical tool to set the matching degree between fuzzy sets [3]. Therefore, the matching degree between A^r and A_{iJ_i} can be defined as follows:

$$a_{iJ_i} = M(A^r, A_{iJ_i}) = \max[\min(\mu_{A^r}(x), \mu_{A_{iJ_i}}(x))] \quad (1)$$

where x covers the domain of the input A^r. Each a_{iJ_i} represents the extent to which A^r belongs to the defined linguistic variables in the i^{th} risk parameter in the antecedents. It is noteworthy that the fuzzy input may also be directly judged and expressed by experts using linguistic variables without the requirements of observation transformation.

1.3.2 Activation of rule weights

The aim of the observation transformation to the risk parameters is to obtain the corresponding security levels for further evaluating the priority of risks. Thus, the introduction of the risk parameters with some similarity degrees transformed from the realistic observations into the rule-based inference system constructed above is necessary. An activating rule weight method is used to implement such an introduction. In other words, the distributions of different weights to all rules can be used to describe the relationship between the risk input transformed from observations and the rules in the system. In order to obtain an appropriate weight for the k^{th} rule, the similarity degrees related to the k^{th} rule are required to be synthesised in a logical way that can reflect the *AND* connective between their representing risk parameters. Liu *et al.* [7] have recommended using the *Product* operator as the logical tool to synthesise the degrees and deal with the dependencies of the parameters ***W***, ***D***, ***R*** and ***P***. Consequently, since the four junior risk parameters have the same importance, the weight of the k^{th} rule can be calculated as follows:

$$\theta_k = \frac{\prod_{i=1}^{4} \alpha_{iJ_i}^{k}}{\sum_{m=1}^{320} \left(\prod_{i=1}^{4} \alpha_{iJ_i}^{m}\right)} \quad (i = 1, 2, 3 \text{ or } 4;\ J_1 = 1, \ldots, \text{or } 5;\ J_2, J_3 \text{ and } J_4 = 1, \ldots, \text{or } 4) \quad (2)$$

Note that the situations where some of $\alpha_{iJ_i}^{m}$ are equal to zero will geminately simplify the calculation through the ignorance of the rules including those linguistic variables with a zero similarity degree.

1.3.3 Rule inference for the calculation of security levels using the er approach

Use of the rule weight method can successfully distribute different weights to all related rules and thus, enables the establishment of a new rule-based system, which can be summarized using the following rule expression matrix shown in Table 1.

Table 1 A new rule expression matrix for the introduction of observations

Antecedent \ Belief \ Consequence					Poor	Fair	Average	Good
$A^1_{1J_1}$	$A^1_{2J_2}$	$A^1_{3J_3}$	$A^1_{4J_4}$	θ_1	β_{11}	β_{21}	β_{31}	β_{41}
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
$A^k_{1J_1}$	$A^k_{2J_2}$	$A^k_{3J_3}$	$A^k_{4J_4}$	θ_k	β_{1k}	β_{2k}	β_{3k}	β_{4k}
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

$A^{n}_{1J_1}$	$A^{n}_{2J_2}$	$A^{n}_{3J_3}$	$A^{n}_{4J_4}$	θ_n	β_{1n}	β_{2n}	β_{3n}	β_{4n}

In the matrix, n represents the number of all rules whose weights are not zero.

Having represented each rule using the rule expression matrix, the ER approach [13-14] can be used to combine the rules and generate a final conclusion, which is a belief distribution on the security expressions as well as giving a panoramic view about the security level for a given observation.

1.4 Security synthesis in a hierarchy

The discussion above focuses on the security assessment of basic events at the bottom level of a hierarchical structure done by an expert. The security levels of a system on a higher level are often determined by all the associated vulnerable events of their individual components, which make up the structure. Therefore, this part is concerned with the security synthesis of a system at various levels such as:

- The synthesis of security estimates of a specific vulnerable event for a component done by a panel of experts; or
- The synthesis of security estimates of various vulnerable events to a component, furthermore, to the security associated with each sub-system, and finally the security associated with the system being investigated.

Consequently, the multi-expert and multi-level security synthesis can be carried out to obtain the security evaluation of the system using the ER approach introduced previously.

1.5 Ranking security estimates

In order to rank the security estimates expressed by fuzzy sets, the fuzzy linguistic variables require to be defuzzified by giving each of them an “appropriate” utility value (U_v). Many defuzzification algorithms have been developed, of which Chen and Klien [15] may be well suited to modelling the fuzzy security expressions.

Consequently, the four security linguistic expressions of the senior risk parameter can be deffuzzified as the set of [0, 0.3125, 0.5926, 1]. The index value (N_v) for ranking the security estimates can be calculated as follows:

$$N_v = \beta^1 \times 0 + \beta^2 \times 0.3125 + \beta^3 \times 0.5926 + \beta^4 \times 1 \qquad (3)$$

where β^i (i = 1, 2, 3, 4) is a belief degree measuring the subjective uncertainty that “ SE belongs to each of the four security expressions”.

2 Fuzzy link-based security management framework

The study of this section is to synthesise the security estimates acquired above with other associated decision attributes (i.e. cost and time) and obtain the overall performance scores for each SCO. The analysis of a complex security-based decision making problem can be carried out using a hierarchical structure, where the top decision making issue is often determined by multiple attributes. Each attribute usually has several parameters and the parameters may be further decomposed into more detailed sub-parameters. Such a top-down hierarchy can be kept under analysis until the lowest level factors can be effectively assessed by domain experts using their subjective knowledge based on objective information. The generic model of the hierarchy is shown in Fig. 1.

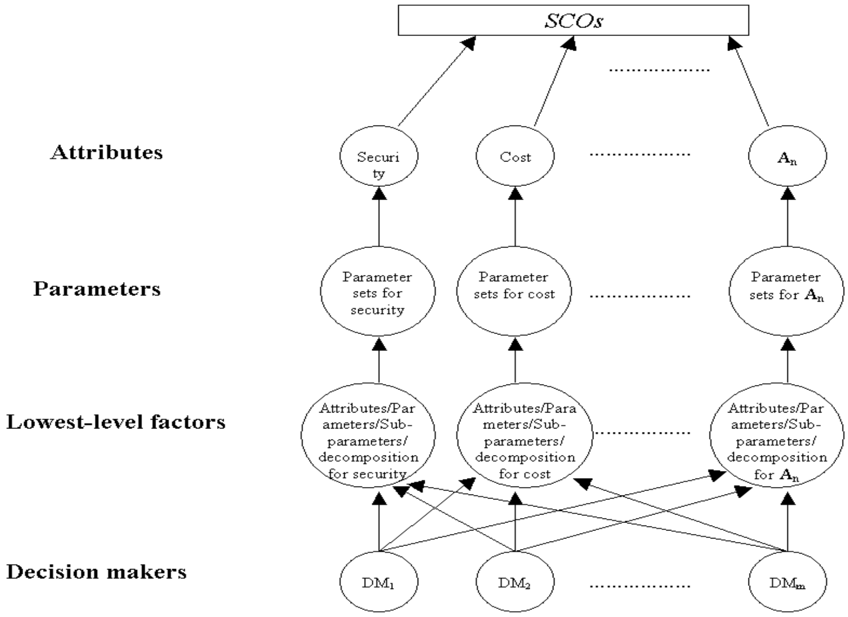

Fig. 1 A generic model of security-based decision making hierarchy

Once the hierarchy is constructed, the next step is to synthesise all evaluations from the experts to obtain the overall performance score of the top level event based on a bottom-up analysis. Let the estimation of the lowest-level factors based on all expert judgements to be fuzzy input and the overall performance scores to be fuzzy output. Then, the calculation of the fuzzy input can be obtained by combining the expert judgements using the ER approach. The transformation from fuzzy input to fuzzy output is usually complex and requires careful analysis of appropriate synthesising approaches.

In the work by Wang *et al.* [5], a traditional safety-cost based decision making method has been developed using the ER approach to provide a possible basis for the synthesis. However the applications of such a conventional method requires many assumptions such as the same amount of decision attribute linguistic variables and the unilateral-order relationship between the linguistic variables.

Having given the security analysis framework above, the FRB-ER method can be repeatedly used for the transformation from fuzzy input to fuzzy output in decision making. It requires establishing multiple fuzzy rule bases by following the top-down hierarchy, which can be produced by investigating individual family branches including a parent variable and its attached children. In the fuzzy rule bases, the linguistic variables used to express children constitute the antecedent part and the ones used to describe parent make up the consequence. An obvious weakness of this method is that both construction and calculation associated with multiple fuzzy rule bases are cost-ineffective and time consuming.

A fuzzy link-based method is developed for security-based multiple attribute decision-making analysis. The ER approach has proven to be an effective tool to deal with multidisciplinary information and data. However, the application of the approach requires the assumption that all information and data is assessed or obtained on the basis of the same universe (one common utility space), which is often not the case in security management. Therefore, the information and data need to be transformed before being aggregated using either the rules based on fuzzy logic theory (which is related to the FRB-ER method) or the belief distributions based on the utility theory (which is associated with the FLB-ER) by decision makers. By taking the attribute “cost” in one multiple attribute decision making (MADM) analysis as an example, the FLB-ER approach can be introduced in the following context.

Assume the attribute “Cost” has its parent event “*SCO*” and children parameters “Investment” and “Maintenance” in a decision-making hierarchy. The top level event “*SCO*” can be expressed using such linguistic variables as “Slightly preferred”, “Moderately preferred”, “Average”, “Preferred” and “Greatly preferred”. The attribute “Cost” is described linguistically as “Very High”, “High”, “Average”, “Low” and “Very Low”. The linguistic variables used to assess the parameters “Investment” and “Maintenance” are individually the sets of (“Substantive”, “Large”, “Moderate”, “Little”) and (“Excessive”, “Reasonable”, “Marginal”, “Negligible”). Then, a belief structure linked between the linguistic variables expressing different three-level attributes can be generated for the transformation from fuzzy input to output and shown in Fig. 2.

In Fig. 2, *w* represents the relative (normalised) weights of each attribute/parameters (same-level factors) under the same parent. The values attached to the arrows are the belief degrees β distributed by experts for indicating the relationships between linguistic variables of different-level decision factors. Note that the sum of the belief values from one linguistic variable is equal to one. For example, the parameter “Investment” with “Large” expression indicates that the level of the attribute “Cost” can be believed as 0.8 ($\beta_{i=2}^{c=2}$) “High” and 0.2 ($\beta_{i=2}^{c=3}$) “Average” without the presence of other evidence. As far as selecting the best “*SCO*” is concerned, the “High” cost evaluation can support “*SCO*” to 1 ($\beta_{c=2}^{r=2}$) “Moderately preferred” and the “Average” cost evaluation can be transformed into 1 ($\beta_{c=3}^{r=3}$) “Average” on the universe expressing “*SCO*”. Such a linked belief structure can be used as a channel to transform the fuzzy input to fuzzy output by aggregating all values of fuzzy input, factor weights and belief degrees. The detailed transform process and aggregating calculations can be described in [10].

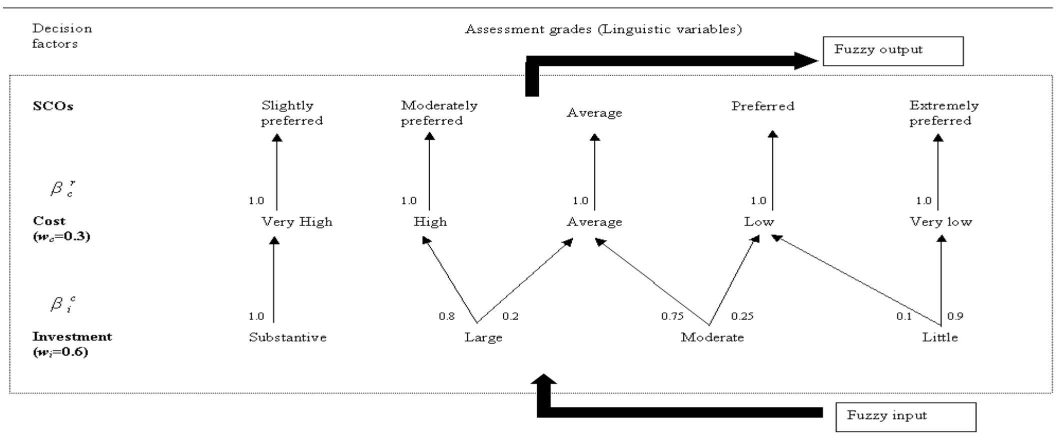

Fig. 2 An example of transforming fuzzy input to output

Suppose there are p SCOs, which are studied using s lowest-level factors and assessed by t experts. For the j^{th} SCO (j = 1, 2, …, p), the fuzzy input of the l^{th} factor (l = 1, 2,…, s) can be obtained by combining its t assessments from all experts on the basis of the ER approach. Using an Analytic Hierarchy Process (AHP) method [16], the weight of the l^{th} factor can also be calculated. Furthermore, using the fuzzy link-based approach, all fuzzy input can be transformed into their corresponding fuzzy output $O^{S_{jl}}$ with the individual weights $w^{S_{jl}}$ based on the same space, the utility expressions of SCOs. Then, all $O^{S_{jl}}$ can be further synthesised using the ER approach to obtain a preference estimate associated with the j^{th} SCO in terms of the utility expressions. The synthesised preference estimate U_j for the j^{th} SCO can be expressed as follows:

U_j = {u_j^1, *"Slightly preferred"*, u_j^2, *"Moderately preferred"*, u_j^3, *"Average"*, u_j^4, *"Preferred"*, u_j^5, *"Greatly preferred"*}

Preference degree P_j associated with the j^{th} SCO can be obtained by:

$$P_j = \sum_{t=1}^{5} u_j^t K_t \tag{4}$$

where the numerical values of K_t (t = 1, 2, …, 5) are assigned to describe the five utility expressions. The membership functions of the preference estimate can be decided by experts using the fuzzy Delphi method. Using the deffuzzification method in [15], the crispy values of the linguistic variables used to express the parameter preference can be obtained as follows:

$$K_1 = 0, K_2 = 0.3, K_3 = 0.5, K_4 = 0.7, K_5 = 1$$

SCO selection can therefore be carried out on the basis of the preference degrees associated with the p SCOs with regard to the particular considerations of security and other decision attributes. It is obvious that a larger P_j means that the j^{th} SCO is more desirable. The best SCO with the largest preference degree may be selected on the magnitudes of P_j.

3 An Illustrative example

The case introduced in the work by Yang *et al.* [17] is used and extended to illustrate the proposed framework in SCO selection and the inference reliability of the fuzzy rule-based approach in security assessment by comparing the results obtained from such two different studies.

A port is highly likely to be attacked by terrorists using two ways, attacking the channel/ waterway or bombing the quayside infrastructures/facilities of the terminals. Either of them can be associated with several attacking modes (See the analysis associated with Fig. 1 and Table 3 in [17]). Suppose there are four security analysts. There are four SCOs, which are described as follows:

*SCO#*1: *AIS* and Ship Identification Number.

*SCO#*2: Security awareness education as well as security and rescue training and drills.

SCO#3: Adequate perimeter fencing, lighting and locking, defending and cargo scanning devices and security equipments as well as supervision of transferring container cargo.

SCO#4: A security officer designated in the selection of staff (including the consideration of the background of employees or the reputation of the labour agency) as well as the positive identification of all visitors and vendors.

3.1 Ranking basic security events and calculating prior security estimate of top level events

Suppose four security analysts make the judgements on each attacking mode for the calculation of the prior security level of a target port. The judgements are assessed on the basis of the four defined junior risk parameters. For example, the mode of "using a missile or bomb to attack the channel" (EXT-CHA) can be analysed in Table 2. Using Equation (1), the input (observations) in Table 2 can be transformed and the judgements can be uniquely expressed by linguistic variables in Table 3. Then the fuzzy input based on all expert judgements can be obtained using the ER approach.

Table 2 An example of the subjective assessment of the junior risk parameters

Expert	***W***	***D***	***R***	***P***
E # 1	1, "Weak(W)"	(0.3, 0.5, 0.7)	{0.3, 0.4, 0.6, 0.7}	1, "Likely(L)"
E # 2	(0.1, 0.3, 0.5)	0.5, "Moderate(M)", 0.5, "Critical(Cr)"	(0.3, 0.5, 0.7)	{0.5, 0.6, 0.8, 0.9}
E # 3	[0.2, 0.4]	[0.4, 0.6]	[0.4, 0.6]	[0.6, 0.8]
E # 4	0.3	{0.3, 0.4, 0.6, 0.7}	1, "Average(A)"	(0.7, .08, 0.9)

Table 3 The unique linguistic variable expressions of the junior risk parameters

Expert	***W***	***D***	***R***	***P***
E # 1	1, "W"	0.5, "M", 0.5, "Cr"	0.17, "E", 0.5 "A", 0.33, "D"	1, "L"
E # 2	0.21, "VW", 0.53, "W", 0.26, "A"	0.5, "M", 0.5, "Cr"	0.14, "E", 0.57 "A", 0.29, "D"	0.43, "A", 0.57, "L"
E # 3	1, "W"	0.5, "M", 0.5, "Cr"	1, "A"	1, "L"
E # 4	1, "W"	0.5, "M", 0.5, "Cr"	1, "A"	1, "L"
Fuzzy input	0.04, "VW", 0.92, "W", 0.04, "A"	0.5, "M", 0.5, "Cr"	0.06, "E", 0.82 "A", 0.12, "D"	0.07, "A", 0.93, "L"

Having known the fuzzy input, the evaluation of the senior risk parameter, *SE* can be performed using the proposed FRB-ER method. In the rule base, 320 rules have been established, of which only 36 rules are fired in this particular case, i.e. Rules #18, #19, #22, #23, #26, #27, #34, #35, #38, #39, #42, #43, #82, #83, #86, #87, #90, #91, #98, #99, #102, #103, #106, #107, #146, #147, #150, #43, #82, #83, #86, #87, #90, #91, #98, #99, #102, #103, #106, #107, #146, #147, #150, #151, #154, #155, #162, #163, #166, #167, #170 and #171. Based on the individual matching belief degrees, the activation weight θ_k (k = 1,…, 36) of each rule in the fired sub-rule base is calculated using Equation (2). Consequently, the fuzzy rule expression matrix for the sub-rule base with the employed 36 rules is shown in Table 4.

Table 4 The fuzzy rule expression matrix of the EXT-CHA risk analysis

Rule	**Antecedent attribute (input)**					**Security estimate (output)**			
No	*W*	*D*	*R*	*D*	θ	Poor	Fair	Average	Good
18	Very weak	Moderate	Easy	Average	0.000084			0.5	0.5
19	Very weak	Moderate	Easy	Likely	0.001116			0.55	0.45
22	Very weak	Moderate	Average	Average	0.001148			0.7	0.3
23	Very weak	Moderate	Average	Likely	0.015252			0.75	0.25
26	Very weak	Moderate	Difficult	Average	0.000168			0.75	0.25
27	Very weak	Moderate	Difficult	Likely	0.002232			0.8	0.2
34	Very weak	Critical	Easy	Average	0.000084		0.2	0.7	0.1

35	Very weak	Critical	Easy	Likely	0.001116		0.35	0.65	
38	Very weak	Critical	Average	Average	0.001148		0.3	0.7	
39	Very weak	Critical	Average	Likely	0.015252		0.5	0.5	
42	Very weak	Critical	Difficult	Average	0.000168		0.5	0.5	
43	Very weak	Critical	Difficult	Likely	0.002232		0.6	0.4	
82	Weak	Moderate	Easy	Average	0.002016			0.6	0.4
83	Weak	Moderate	Easy	Likely	0.026784			0.75	0.25
86	Weak	Moderate	Average	Average	0.027552			0.8	0.2
87	Weak	Moderate	Average	Likely	0.366048			0.9	0.1
90	Weak	Moderate	Difficult	Average	0.004032			0.9	0.1
91	Weak	Moderate	Difficult	Likely	0.053568			1	
98	Weak	Critical	Easy	Average	0.002016		0.2	0.8	
99	Weak	Critical	Easy	Likely	0.026784		0.4	0.6	
102	Weak	Critical	Average	Average	0.027552		0.25	0.75	
103	Weak	Critical	Average	Likely	0.366048		0.45	0.55	
106	Weak	Critical	Difficult	Average	0.004032		0.5	0.5	
107	Weak	Critical	Difficult	Likely	0.053568		0.6	0.4	
146	Average	Moderate	Easy	Average	0.000084			0.9	0.1
147	Average	Moderate	Easy	Likely	0.001116		0.05	0.95	
150	Average	Moderate	Average	Average	0.001148			1	
151	Average	Moderate	Average	Likely	0.015252		0.1	0.9	
154	Average	Moderate	Difficult	Average	0.000168		0.1	0.9	
155	Average	Moderate	Difficult	Likely	0.002232		0.25	0.75	
162	Average	Critical	Easy	Average	0.000084		0.35	0.55	0.1
163	Average	Critical	Easy	Likely	0.001116		0.55	0.35	0.1
166	Average	Critical	Average	Average	0.001148		0.3	0.7	
167	Average	Critical	Average	Likely	0.015252		0.5	0.5	
170	Average	Critical	Difficult	Average	0.000168		0.5	0.5	
171	Average	Critical	Difficult	Likely	0.002232		0.7	0.3	

In Table 4, the ER approach is used to implement the combination of the 36 rules and generate the security estimate of the EXT-CHA threat. The final assessment result can be computed as follows and is shown in Fig. 3.

The prior SE of the EXT-CHA threat: {0, “Poor”, 0.188, “Fair”, 0.771, “Average”, 0.041, “Good”}

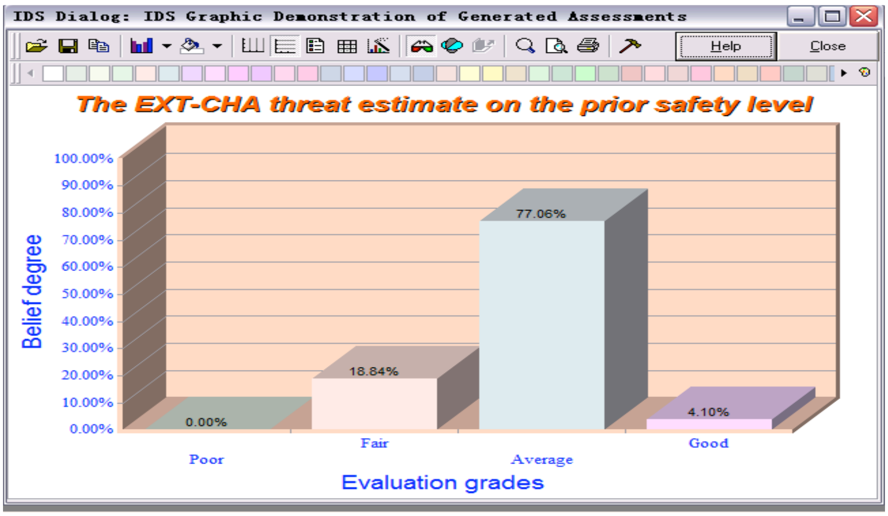

Fig. 3 The security estimate of the *EXT-CHA* threat

This result can be interpreted in such a way that the security estimate of the EXT-CHA threat is “Fair” with a belief degree of 0.188, “Average” with a belief degree of 0.771, and “Good” with a belief degree of 0.041.

Next, Equation (3) can be used to calculate the index value of the security estimate obtained for a ranking purpose as follows:

$$N_v = 0 \times 0 + 0.188 \times 0.3125 + 0.771 \times 0.5926 + 0.041 \times 1 = 0.557$$

Similar computations are performed for the other five basic events in the case. The security estimates generated for the VES-CHA, CARGO, EMPLOYEE, EXT-TER and VES-TER threats are summarised in Table 5. Since the FRB-ER and discrete fuzzy set approaches [17] have the same fuzzy input (subjective judgements), the fuzzy output should be kept in harmony to a significant extent in order to validate the reliability of the two different inference engines. The results have shown that the six basic events have been assessed with defuzzified values and ranked in an order to a quite similar extent with the results obtained from the work by Yang *et al.*[17]. The slight output difference in terms of deffuzzified values and ranking order is partly because of the application of different defuzzification methods and partly due to the accuracy of entirely subjective belief degree distributions in the rule base.

The ER approach can be used not only to aggregate fuzzy rules for the security analysis of the basic events in the FRB-ER framework but also to assess the security of the whole system (top level event) as well. According to the study in the work[17], the weights of the basic events can be appropriately distributed and obtained. Consequently the prior security estimate of the top event can be calculated by synthesising all fuzzy input of the basic events in Table 5 with their individual weights as follows:

The prior SE of the threat of terrorist attacking the port: {0.12, "Poor", 0.371, "Fair", 0.501, "Average", 0.008, "Good"}.

Table 5 Security analysis and ranking of the basic events

Events	Junior security para-meters	E # 1	E # 2	E # 3	E # 4	Synthesised fuzzy input	Senior security estimates	Ranking (defuzz-ified values)
EXT-CHA	***W***	1, "W"	(0.1, 0.3, 0.5)	[0.2, 0.4]	0.3	0.04, "VW", 0.92, "W", 0.04, "A"	0, "P", 0.188, "F", 0.771, "A", 0.041, "G"	0.5576
	D	(0.3, 0.5, 0.7)	0.5, "M", 0.5, "Cr"	[0.4, 0.6]	{0.3, 0.4, 0.6, 0.7}	0.5, "M", 0.5, "Cr"		
	R	{0.3, 0.4, 0.6, 0.7}	(0.3, 0.5, 0.7)	[0.4, 0.6]	1, "A"	0.06, "E", 0.82, "A", 0.12, "D"		
	P	1, "L"	{0.5, 0.6, 0.8, 0.9}	[0.6, 0.8]	(0.7, 0.8, 0.9)	0.07, "A", 0.93, "L"		
VES-CHA	***W***	1, "S"	(0.5, 0.7, 0.9)	{0.5, 0.7, 0.8, 0.9}	0.7	0.1, "A", 0.81, "S", 0.09, "VS"	0.42, "P", 0.48, "F", 0.1, "A",	0.211

	D	(0.7, 0.9, 1)	1, “Ca”	[0.8, 1]	{0.8, 0.9, 1, 1}	0.09, “Cr”, 0.91, “Ca”	0, “G”	
	R	{0.7. 0.8, 0.9, 1}	(0.7, 0.8, 1)	[0.7, 0.9]	0.5, “D”, 0.5, “ED”	0.48, “D”, 0.52, “ED”		
	P	1, “L”	{0.6, 0.7, 0.8, 0.9}	[0.75, 0.85]	(0.7, 0.8, 0.9)	0.03, “A”, 0.97, “L”		
CAR GO	***W***	1, “VS”	(0.8, 1, 1)	{0.8, 0.9, 1, 1}	1	0.08, “S”, 0.92, “VS”	0.195, “P”, 0.463, “F”, 0.342, “A”, 0, “G”	0.3473
	D	(0.3, 0.5, 0.7)	0.5, “M”, 0.5, “Cr”	[0.4, 0.6]	{0.3, 0.4, 0.6, 0.7}	0.5, “M”, 0.5, “Cr”		
	R	{0.4, 0.5, 0.6, 0.7}	(0.4, 0.5, 0.6)	[0.4, 0.6]	0.8, “A”, 0.2 “D”	0.83, “A”, 0.17 “D”		
	P	0.7, “A”, 0.3 “L”	{0.3, 0.4, 0.5, 0.6}	0.55	(0.4, 0.5, 0.6)	0.78, “A”, 0.22 “L”		
EMPLOYEE	***W***	1, “A”	[0.45, 0.55]	0.5	1, “A”	1, “A”	0.03, ”P”, 0.1, “F”, 0.87, “A”, 0, “G”	0.4924
	D	(0.3, 0.35, 0.4)	1, “M”	[0.3, 0.4]	{0.2, 0.3, 0.4, 0.5}	0.03, “N”, 0.94, “M”, 0.03, “Cr”		
	R	{0.3, 0.4, 0.5, 0.6}	(0.4, 0.5, 0.6)	[0.4, 0.6]	1, “A”	0.03, “E”, 0.89, “A”, 0.08, “D”		
	P	0.5, “L”, 0.5 “D”	{0.7, 0.8, 0.9, 1}	[0.8, 1]	(0.8, 0.9, 1)	0.56, “L”, 0.44 “D”		
EXT-TER	***W***	0.5, “A”, 0.5, “S”	(0.5, 0.6, 0.7)	[0.5, 0.7]	0.6	0.5, “A”, 0.5, “S”	0, “P” 0.241, “F”, 0.755, “A”, 0.004, ”G”,	0.5275
	D	(0.3, 0.35, 0.4)	1, “M”	[0.3, 0.4]	{0.2, 0.3, 0.4, 0.5}	0.03, “N”, 0.94, “M”, 0.03, “Cr”		
	R	{0.4, 0.5, 0.6, 0.7}	(0.4, 0.5, 0.6)	[0.4, 0.6]	0.8, “A”, 0.2 “D”	0.83, “A”, 0.17 “D”		
	P	1, “L”	{0.6, 0.7, 0.8, 0.9}	[0.75, 0.85]	(0.7, 0.8, 0.9)	0.03, “A”, 0.97, “L”		
VES-TER	***W***	1, “S”	(0.5, 0.7, 0.9)	{0.5, 0.7, 0.8, 0.9}	0.7	0.1, “A”, 0.81, “S”, 0.09, “VS”	0.151, ”P”, 0.665, “F”, 0.184, “A”, 0, “G”	0.317**2**
	D	(0.6, 0.7, 0.8)	0.7, “Cr”, 0.3 “Ca”	0.75	{0.6, 0.7, 0.8, 0.9}	0.74, “Cr”, 0.26, “Ca”		
	R	{0.4, 0.5, 0.6, 0.7}	(0.4, 0.5, 0.6)	[0.4, 0.6]	0.8, “A”, 0.2 “D”	0.83, “A”, 0.17 “D”		
	P	0.5, “L”, 0.5 “D”	{0.7, 0.8, 0.9, 1}	[0.8, 1]	(0.8, 0.9, 1)	0.56, “L”, 0.44 “D”		

3.2 Making security-based decision making and selecting the best SCO

The FRB-ER approach contributes itself to the subjective security assessment and also exposes its weaknesses such as the complexity of inference. Therefore, when more elements require to be considered in a wider context, the FLB-ER approach proposed in Section 3 can be used. In this example, suppose there are four criteria chosen to decide the preference of the four SCOs. They are separately Security (S), Cost (C), Technique Requirement (TR) and Implement Time (IT). Some criteria have their sub-criteria. For example, the prior and posterior security estimations are developed as the two sub-criteria of S, to demonstrate the security level changes after the implement of the SCOs. Such a hierarchy can be constructed in Fig. 4.

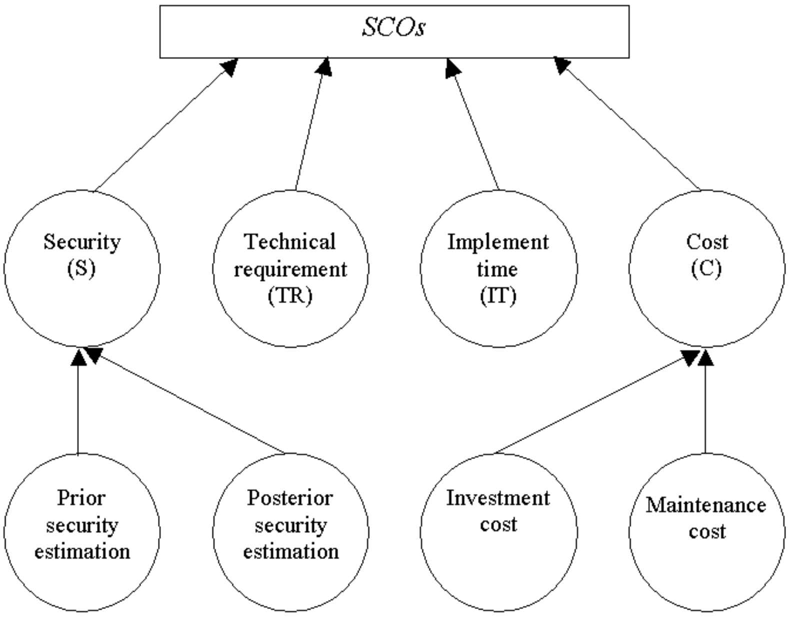

Fig. 4 The hierarchy of security based decision making

Suppose the four security analysts make their judgments on the lowest level criteria, which have been synthesised using the ER approach and shown in Table 6. Note that the judgements associated with the posterior security estimates are obtained using the FRB-ER approach in a similar way in which the prior security estimates are calculated. The linguistic terms used to express TR and IT are separately the sets of ("Very high(VH)", "High(H)", "Average(A)", "Low(L)", "Very low(VL)") and ("Very long(VL)", "Long(L)", "Average(A)", "Short(S)").

Table 6 The decision making attribute assessments

Lowest level criteria	*RCO#*1	*RCO#*2	*RCO#*3	*RCO#*4
Prior security estimate	0.12, "P", 0.371, "F", 0.501, "A", 0.008, "G"	0.12, "P", 0.371, "F", 0.501, "A", 0.008, "G"	0.12, "P", 0.371, "F", 0.501, "A", 0.008, "G"	0.12, "P", 0.371, "F", 0.501, "A", 0.008, "G"
Posterior security estimate	0, "P", 0.221, "F", 0.236, "A", 0.543, "G"	0, "P", 0.033, "F", 0.247, "A", 0.72, "G"	0.04, "P", 0.288, "F", 0.433, "A", 0.239, "G"	0.012, "P", 0.35, "F", 0.534, "A", 0.104, "G"
Technical requirement	0, "VH", 02, "H", 0.5, "A", 0.3, "L", 0, "VL"	0, "VH", 0.7, "H", 0.3, "A", 0, "L", 0, "VL"	0, "VH", 0, "H", 0, "A", 0, "L", 1, "VL"	0, "VH", 0, "H", 0, "A", 0.2, "L", 0.8, "VL"
Implement time	0.9 "VL", 0.1, "L", 0, "A", 0, "S"	0, "VL", 0.4, "L", 0.6, "A", 0, "S"	0, "VL", 0, "L", 0.2, "A", 0.8, "S"	0, "VL", 0, "L", 0, "A", 1, "S"
Investment cost	0, "S", 0.75, "La", 0.25, "M", 0, "Li"	0.4, "S", 0.6, "La", 0, "M", 0, "Li"	0, "S", 0.2, "La", 0.7, "M", 0.1, "Li"	0, "S", 0, "La", 0, "M", 1, "Li"
Maintenance cost	0, "E", 0, "R", 0.9, "M", 0.1, "N"	0.2, "E", 0.8, "R", 0, "M", 0, "N"	0, "E", 0.45, "R", 0.55, "M", 0, "N"	0, "E", 0, "R", 0.25, "M", 0.75, "N"

In order to obtain the best SCO, the judgements and estimates associated with each SCO require to be considered, combined and then defuzzified. However, as the fuzzy sets used to describe the judgements are defined on the basis of different universes, it may not be convenient to directly implement such a synthesis using the ER approach. It will be desirable that the FLB-ER approach can be used to carry out a unification of the different decision making attribute estimates in order to avoid loss of useful information. Next, using the transforming graphic technique introduced in Fig. 2, the judgements listed in Table 6 can be transformed and expressed on a unified space, the preference of decision makers, as shown in Table 7.

Table 7 The unified decision making attribute assessments

Lowest level criteria	*RCO*#1	*RCO*#2	*RCO*#3	*RCO*#4
Prior security estimate	0.008, “SP”, 0.375, “MP”, 0.311, “A”, 0.21, “P”, 0.096, “GP”	0.008, “SP”, 0.375, “MP”, 0.311, “A”, 0.21, “P”, 0.096, “GP”	0.008, “SP”, 0.375, “MP”, 0.311, “A”, 0.21, “P”, 0.096, “GP”	0.008, “SP”, 0.375, “MP”, 0.311, “A”, 0.21, “P”, 0.096, “GP”
Posterior security estimate	0, “SP”, 0.177, “MP”, 0.257, “A”, 0.159, “P”, 0.407, “GP”	0, “SP”, 0.026, “MP”, 0.229, “A”, 0.205, “P”, 0.54, “GP”	0.04, “SP”, 0.23, “MP”, 0.447, “A”, 0.103, “P”, 0.18, “GP”	0.012, “SP”, 0.28, “MP”, 0.551, “A”, 0.079, “P”, 0.078, “GP”
Technical requirement	0, “SP”, 02, “MP”, 0.5, “A”, 0.3, “P”, 0, “GP”	0, “SP”, 0.7, “MP”, 0.3, “A”, 0, “P”, 0, “GP”	0, “SP”, 0, “MP”, 0, “A”, 0, “P”, 1, “GP”	0, “SP”, 0, “MP”, 0, “A”, 0.2, “P”, 0.8, “GP”
Implement time	0.9, “SP”, 0.08, “MP”, 0.02, “A”, 0, “P”, 0, “GP”	0, “SP”, 0.32, “MP”, 0.38, “A”, 0.3, “P”, 0, “GP”	0, “SP”, 0, “MP”, 0.1, “A”, 0.18, “P”, 0.72, “GP”	0, “SP”, 0, “MP”, 0, “A”, 0.1, “P”, 0.9, “GP”
Investment cost	0, “SP”, 0.6, “MP”, 0.338, “A”, 0.062, “P”, 0, “GP”	0.4, “SP”, 0.48, “MP”, 0.12, “A”, 0, “P”, 0, “GP”	0, “SP”, 0.16, “MP”, 0.565, “A”, 0.185, “P”, 0.09, “GP”	0, “SP”, 0, “MP”, 0, “A”, 0.1, “P”, 0.9, “GP”
Maintenance cost	0, “SP”, 0, “MP”, 0.09, “A”, 0.81, “P”, 0.1, “GP”	0.2, “SP”, 0.16, “MP”, 0.64, “A”, 0, “P”, 0, “GP”	0, “SP”, 0.09, “MP”, 0.415, “A”, 0.495, “P”, 0, “GP”	0, “SP”, 0, “MP”, 0.025, “A”, 0.225, “P”, 0.75, “GP”

Suppose the weights of decision making attributes and sub-criteria have been distributed in Table 8 by the four experts using an AHP method. Then, the judgements produced in Table 7 can be synthesised to obtain the utility description on the four SCOs using the ER approach, which can be further defuzzified as a crispy value for ranking the SCOs using Equation (4) as follows:

The preference assessment of the *RCO*#1: P_1 = {0.21, “SP”, 0.222, “MP”, 0.273, “A”, 0.194, “P”, 0.101, “GP”} = 0.44

The preference assessment of the *RCO*#2: P_2 = {0.076, “SP”, 0.373, “MP”, 0.313, “A”, 0.119, “P”, 0.119, “GP”} = 0.471

The preference assessment of the *RCO*#3: P_3 = {0.009, “SP”, 0.081, “MP”, 0.265, “A”, 0.131, “P”, 0.514, “GP”} = 0.836

The preference assessment of the *RCO*#4: P_4 = {0.002, “SP”, 0.058, “MP”, 0.113, “A”, 0.106, “P”, 0.721, “GP”} = 0.969

It can be noted that in this case, SCO#4 is ranked first, SCO#3 second, SCO#2 third and SCO#1 last. This implies that security and other decision making attributes are considered equally important while carrying out the security control evaluation, the best selection is SCO#4. When the relative importance of security against other attributeschanges, there may be different ranking orders of the SCOs. Suppose the relative weights of all the attributes and sub-attributes except security remain unchanged shown in Table 8. Fig. 5 shows the preference degrees associated with the four SCOs at different values of relative importance of security and the other attributes (TR, IT, C). For example, when the relative importance of security against the other attributes increases by 400%, the ranking of the four SCOs is SCO#2>SCO#4>SCO#3>SCO#1.

Table 8 The weights of decision making attributes

	Prior security estimate	Posterior security estimate	Technical requirement	Implement time	Investment cost	Maintenance cost
Weight ratio	0.1	0.9	1	1	0.6	0.4
Normalised weights	0.025	0.225	0.25	0.25	0.15	0.1

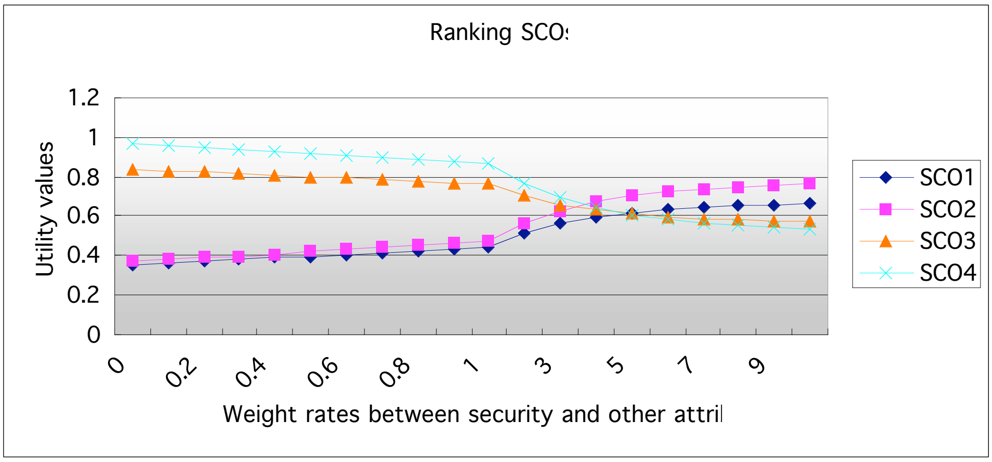

Fig. 5 Ranking of the SCOs

4 Conclusion

This paper outlines and explains a philosophy of subjective security based decision making modelling for maritime security assessment and management using fuzzy logic and ER approaches. For each SCO, the prior and posterior security estimates of each basic event are first carried out using the security analysis model based on the application of the FRB-ER approach. Then the ER approach is used to synthesise the prior/posterior security estimates to obtain the security estimates of the top event as the security attributes of the SCOs. Finally, the synthesis of security and other decision making attributes are performed using the MADM modelling based on a FLB-ER approach and mapped onto a common utility space before proceeding to the preference estimation and ranking SCOs.

Different from most conventional risk based decision making methodologies, the framework introduced is characterised with a unique feature associated with unification of input and output data. In the security analysis modelling, each input can be represented as a probability distribution on linguistic values for the antecedent using a belief structure. The main advantage of doing so is that precise data, random numbers and subjective judgements with uncertainty can be consistently modelled under a unified form. In the decision making modelling, the input data transformed by the linked belief structures can be unified and take into account subjective experts judgements with uncertainties having both probabilistic and possibilistic nature. Moreover, the ER approach provides a novel procedure for aggregating calculation, which can preserve the original features of multiple attributes with various types of information. This provides a solution for solving the difficulty of subjective risk assessment results involving academic bias resulting from various options from different individuals. Therefore, two kinds of combination of the fuzzy logic and ER approaches can offer great potential in maritime security assessment and management.

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The Implementation of the Safety and Security Courses into the MET System of Odessa National Maritime Academy

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Abstract Shipping has always been a risky industry. The safety of navigation is one of the key issues of modern shipping. The detailed analysis of ship accidents has shown that the majority of accidents with far-reaching consequences can be traced to human (or organizational) errors. Only about 20% of catastrophic accidents are caused by structural or mechanical failure of the vessel under extreme environmental conditions.

Accidents resulting from operations have several origins. Various factors may influence the occurrence of human errors. Economical difficulties of the ship owner may lead to dangerous compromises and reduced safety standards, errors in management decisions i.e. organizational errors may also be closely associated with the reliability of ship operations. The designing engineer as well as the ergonomist may also be addressed in this respect as they influence the human behavior and may cause an individual error and human errors can be minimised by creating the right working environment. To cope with the intolerable degree of maritime casualties IMO issued some documents, the most important of which are STCW 1978 Convention as amended in 1995, STCW Code and ISM Code.

Another problem the world shipping is nowadays facing is security. In general security is not a new issue. The vulnerability of ships on the open ocean, without any protection has long been recognized. Piracy and terrorist attacks are common threats in this respect.

Formal security measures have been introduced only very recently, being formulated in the International Ship and Port Facility Security Code (ISPS), agreed by 108

nations at the December 2002 IMO Diplomatic Conference on Maritime Security which took full effect on 1 July 2004.

Safety and Security have the same aim, namely the protection of people, property and the environment. Both are connected with risks and in both the so-called "Human factor" is a central element.

Although security concerns the risks connected with protection against willful i.e. intentional acts of disturbance, damage or destruction while the safety on the other hand concerns the minimization of the risk of something accidentally going wrong, safety and security go hand in hand.

There is no better example to prove it than the close relationship that exists in both cases with the human factor. Security threats, latent or acute, will influence the behavior of the crew on board and thus have an impact also on safety.

Taking into consideration the importance of the "Human factor" IMO has put forward the objective today to provide the assurance that the people manning the ships of the world today are motivated, educated, qualified in accordance with adequate standards and practically have all the necessary skills for proper fulfilling their duties under any circumstances.

This preconditions a high level of safety and security culture, the development of these qualities being the task of the educational institutions. Odessa National Maritime Academy is implementing the development of the above culture as a mandatory part of the modern MET model.

0 Introduction

High consequence accidents resulting from human error can be caused by drawbacks in design and construction or by mistakes in the operation of a vessel.

Accidents resulting from operations have several origins. Traditional values may influence the occurrence of human or organizational errors. Errors of individuals finally are also responsible for some of the accidents.

The human factor in the maritime industry is a complex diverse problem. We are going to discuss here only those aspects which affect safety and security.

Ship-builders usually concentrate their attention on the structural design of the ship, the machinery and the equipment. Only recently it has become evident that for a significant improvement in the safety operations is also a human element, the organization and the total system has to be regarded.

1 Terms & definitions

Let us give definitions to "HAZARD" and "RISK", both terms are widely used in discussing issues of safety and security. HAZARD is a "potential, undesirable outcome in the process of achieving a certain purpose, solving a problem or performing some actions" or "a physical state which can be harmful under certain circumstances"[7].

There are many definitions of the term "RISK". Ch. Kuo gives the following definition: "Risk is a measure of danger including its consequences and probability of its occurrence. The simplest mathematical expression of risk is the equation: $R=PC$, where R- Risk, P- probability and C- consequence"[6].

Steven Jones, the author of "Maritime Security. A Practical Guide."[1] gives the following definition: "Risk is the likelihood a specific threat or hazard will exploit a certain vulnerability, and the resulting impact of that event: Likelihood x Impact = Risk or Vulnerability x Hazard = Risk.

Risk analysis is the starting point in an overall risk management process; it is a systematic approach that identifies and assesses risks and provides recommendations to reduce risk to a reasonable and appropriate level. Risk can be categorized, say, very low, low, medium or high and an appropriate and proper response than put in place. If only a low risk is posed by certain threats it may be simply accepted"[6].

The experts in maritime safety are also trying to categorize risks. Existing risks are divided into static and dynamic… Shipping companies are mostly interested in static risks, as they are deeply concerned in preventing or limiting losses. "Management of risks" is defined as an instrument of protection company's resources and incomes from losses[6]. That is we can conclude that both ISM and ISPS Codes impose a risk management approach.

2 Human-related hazards to safety

Human error occurs on board ship when a crewmember's ability falls below what is needed to successfully complete the task. Whilst this may be due to a lack of ability, more commonly it is because the existing ability is hampered by adverse conditions. Below are some examples (not complete) of personal factors and unfavorable conditions which constitute hazards to optimum performance. A comprehensive examination of all human-related hazards should be performed. During "the design stage" it is typical to focus mainly on task features and on board working conditions as potential human-related hazards.

- Personal factors;
- Reduced ability, e.g. reduced vision or hearing;
- Lack of motivation, e.g. because of a lack of insensitives to perform well;
- Lack of ability, e.g. lack of seamanship, unfamiliarity with vessel, lack of fluency of the language used on board;
- Fatigue, e.g. because of lack of sleep or rest, irregular meals;
- Stress;
- Organizational and leadership factors;

- Inadequate vessel management, e.g. inadequate supervision of work, lack of coordination of work, lack of leadership;
- Inadequate ship owner management by, e.g. inadequate routines and procedures, lack of resources for maintenance, lack of resources for safe operation, inadequate follow-up of vessel organization;
- Inadequate manning, e.g. too few crew, untrained crew.

Inadequate routines, e.g. for navigation, engine room operations, cargo handling, maintenance, emergency preparedness[3].

3 Human-related hazards to security

Steven Jones in the following way identifies the "**HAZARDS"** to security of the ship in the form barriers to vigilance:

Fatigue. Tiredness, overwork and fatigue are all major barriers to vigilance while all onboard work is under the auspices of the STCW Convention, Hours of Rest Rules, there are many who believe that the minimum manning standards applicable on vessels do not take into account the extra work generated by the requirement of ISPS Code.

Lack of time. As with the concerns over fatigue it is recognized that ships are busy and that personal may not feel they have time to apply security or to remain vigilant.

Familiarity. Security is still not a natural function of many seafarers' day-to-day operations and many lack the confidence and experience that they constantly apply to safety. It is this lack of knowledge that can lead to wrong responses or even no responses. Until all crew and officers are fully conversant with all provisions within the SSP there can be no true security culture in evidence.

Lack of training. It is clear that unless personnel fully appreciate the threat facing them there is little chance of their willing or able to adopt security as an important part of shipboard life and operations. A lack of training, knowledge and skills is a serious barrier to progress and it is the job of master, CSO and SSO to identify those who lack them. It will be then necessary that the crew understand what is expected of them and also the reasons for this[1].

All the sources claim that the level of safety culture and training of seafarers are not adequate. As to the security culture it hardly exists:

- "lack of seamanship…", "unfamiliarity with vessel"[3];
- "a vessel may have the best equipment, and work under the most effective security management systems, but all this counts for nothing without the involvement of adequately trained and motivated"[2];
- Security of maritime transport can only be as good as the people working within the industry;
- "The awareness necessary to maintain a secure and vigilant vessel takes a number of different forms but at all levels it requires the master, SSO, officers and crew to have certain levels of

knowledge and training…"[2].

4 Safety & security courses at ONMA

Odessa National Maritime Academy maintains constant contacts with the different organizations responsible for shipping safety in Ukraine:

- Ministry of Transport of Ukraine;
- State Department of Sea and River Transport of Ukraine;
- State Inspectorate for Training and Certification of Seafarers;
- State Inspection for Safety of Shipping of Ukraine;
- State Maritime Inspection of Ukraine;
- Russian Maritime Register of Shipping;
- Ukrainian Maritime Register of Shipping.

For further development of safety culture required by ISM Code and in connection with the coming into force in 2004 ISPS Code it was decided to establish the Department of Safety and Security at Sea in Odessa National Maritime Academy which was effected in 2003.

The department started the new disciplines:

- Ship Safety Management;
- Organization and Standards of Ship Security Provision;
- A new optional special course "Administration of Safety at Sea" was opened at the department in 2005;

The following disciplines are covered at the course:

- Responsibilities and functions of Flag State;
- Responsibilities and functions of Port State;
- Coastal State and its function;
- System of training and employment of seafarers;
- Methodology of marine accident incident investigation;
- Instruction of Shipboard and shore personnel in emergency situation.

A special certificate of the approved form is issued to every graduate of the course[7].

5 Conclusion

So we can conclude that the implementation of the safety and security courses in the MET system of maritime higher educational establishments is an urgent problem.

Safety and security go hand in hand. There are examples where the new security efforts will possibly enhance safety.

When speaking about the aspects of education and training process we may easily come to conclusion that the investigation in these two spheres and consequently the educational disciplines have so much in common that it is desirable to unite them into one educational and research complex.

Although we are learning a lot from safety as we start to be involved with security, there are many examples where safety requirements may actually be damaging in respect to security. Many of the safety requirements as well as operational procedures prescribed for instance for equipment may actually clash with security.

But it still more proves that these disciplines should be investigated and trained by one maritime educational and research centre. Especially if formalization is sought to be undertaken the theoretical process is to be very similar if not the same.

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The Influence of Seafarers' Malnutrition upon Maritime Safety

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Abstract The results of seafarers' nutrition surveys from some countries reflect that seafarers' malnutrition is still a problem in the world maritime community. After synthesizing the published data of the Chinese oceangoing seafarers' nutrition surveys in the last ten years, the Chinese seafarers' nutrition status is discussed. Vitamin C, vitamin B_2, vitamin A and calcium are determined as the susceptible nutrients in shortage for Chinese oceangoing seafarers during navigation. Seafarers' malnutrition is thought to be a contributing factor to human error which is reported to be the dominant factor in maritime accidents, contributing to 80% to 85% of incidents. The influence of seafarers' malnutrition upon maritime safety is discussed through the analysis of the relationship of malnutrition, the third status, disease, fatigue, human error and maritime safety. The influence of improper diet, improper response to stress, sleep deprivation and lack of exercise on seafarers' malnutrition is also analyzed. Suggestions for improving the situation are raised which touch seafarers' nutrition training and education, improvement of food storage technology aboard ship, nutritional supplements and fortified products, Dietary Reference Intakes, further improvement of living and working conditions aboard, and establishing a ship's living and working condition management system.

Keywords seafarer; diet; nutrition; human error; maritime safety

0 Introduction

Human error continues to be the dominant factor in maritime accidents, contributing to 80% to 85% of incidents. USCG[1] data analyzed for all accidents over the reporting period of 1999 to 2001 confirm the approximate 80% to 85% human error involvement. About 50% of maritime accidents were initiated by human error, and another 30% were associated with it. In MARS reports, mariners note human error in the majority of reports and chiefly attribute accidents and near misses to lack of competence, lack of knowledge and ability, human fatigue, workload, manning, complacency and risk tolerance. Although the maritime community has done much work to try to eliminate human errors, the above statistics still show a high percentage of human error as a contributing cause to maritime accidents. So we still need to seek approaches to reduce accidents caused by human error. In the last ten years, medical researchers in the United States[2], Australia[3], Poland[4, 5], Finland[6], Russia[7], China [9-12], Japan and other countries have carried out nutrition surveys and investigations on board vessels and have drawn the conclusion that many seafarers are malnourished. But the important role of seafarers' malnutrition in maritime accidents has not been set forth clearly. On one side, the medical researchers are discussing their seafarers' nutrition survey results; on the other side, the maritime community is seeking the ways to decrease the maritime accident rate and paying attention to a number of influencing factors in maritime accidents. In the author's view, seafarers' malnutrition is a major problem aboard ships throughout the world. It is the dominant contributing factor to human error and the maritime accidents herein produced. It is important to identify the dominant influencing factor and clarify the relationship of it with the others. Since the nutrition statuses of seafarers are different in different countries, the author illustrated his view with the Chinese oceangoing seafarers' nutrition survey results and offers some strategic suggestions for improving the situation.

1 The Nutrition Status of Chinese Oceangoing Seafarers

So far no Dietary Reference Intakes (DRI) exists for merchant marine seafarers in China[8]. Researchers making assessments of seafarers' nutritional status have to use the DRI usually employed for ordinary residents of the country. Even with this standard and without consideration for the particularity of seafarers' living and working conditions, the malnutrition status of Chinese seafarers has been revealed by researchers in China through nutrition surveys. In the last ten years, Ji Hongguang[9], Zhong Jinyi[10], Zhang Yanbin[11], Yao Yuxiang[12] and others have conducted diet and nutrition surveys on board Chinese oceangoing vessels and published their results jointly or respectively. The author of this paper synthesized the data of the surveys on board 15 vessels and presented the situation of the nutritional status of Chinese seafarers (Table 1). Although the surveys were carried out on a limited number of ships, the identity of their results reflected the possibility that seafarers' malnutrition is a prevalent problem among Chinese seafarers and needs further study.

In Table 1, the data of nutrients in the diet are calculated using the weighing method, and the data of metabolic index of serums and urine are obtained from laboratory tests. The values of the nutrients in daily diet are given with average values except for vitamin C. The value of vitamin C is given with a range of value since the lack of vitamin C typically happens in the late period of a long voyage. RDA1 and RDA2 refer to the recommended daily allowance for Chinese ordinary adults with light work and moderate work respectively. The recommended values are given by nutrition scientists. The evaluation results are based on the comparison of the nutrient average values with their relevant RDA1, RDA2 or the recommended values as well as the judgment of nutrition professionals. The percentages of daily intakes of protein, fat and carbohydrate are 13%, 36% and 51% respectively. The average daily intake of protein is 106.9g which exceeds the value of RDA2 by 18.7%. The average intake of fat is 131.6g which exceeds the value of RDA2 by 64.5%. The recommended percentages for the intake of the three energy nutrients are protein: 10%~12%, fat: 20%~25% and carbohydrate: 55%~65% respectively. So the intake of fat is unsuitable in both its amount and its percentage. The mean daily energy intake is 13.9JM exceeding RDA2 by 11.2%. It is a contributing factor for seafarers to get fat. The intakes of calcium, vitamin A, vitamin B_2 are insufficient. The intake of vitamin C is severely insufficient during the late period of a long voyage. In addition, the ratios of PUFA: SFA and Ca: P are also unsuitable. The shortage of sodium was reported to be probably caused by seafarers' working under high temperature.

Table 1 Chinese Seafarer's Individual Daily Nutrients Intakes and Evaluation

	Methods of survey	Sample	Average	RDA1	RDA2	Recommended value	Evaluation
Protein	Estimated intake(g)	508	106.9	80.0	90.0		Suitable
Fat	Estimated intake(g)	508	131.6		80.0		Unsuitable
Chlesterol	Estimated intake Lab test (mmol/L)	36 249	384 4.4			300 2.3-5.6	
Triglyceride	Lab test (mmol/L)	249	1.3			0.3-1.9	
PUFA:SFA	Estimated intake	36	2.2:1			1.25-1.5:1	Unsuitable
Carbohydrate	Estimated intake(g)	508	431.7		480.0		
Protein:Fat: Carbohydrate	Estimated intake	508	13%:36%:51%			Protein: 10%-12%, Fat: 20%-25%, Carbohydrate: 60%-65%	Unsuitable
Diet fibre	Estimated intake(g)	370	7.1		6.0-8.0		Suitable
Daily energy	Estimated intake(JM)	406	13.9	10.9	12.5		Unsuitable
Na	Estimated intake(mg) Content in serum(C/ μm□L^{-1})	36 81	5881.4 125.8			 131.8-147.8	 Unsuitable
K	Content in serum(C/ μm□L^{-1})	81	4.1			3.3-5.0	Suitable
Ca	Estimated intake(mg) Content in serum(C/ μm□L^{-1})	473 81	603 3.0	800.0	800.0	 2.2-3.3	Unsuitable
P	Estimated intake(mg)	36	1246.6				
Ca:P	Estimated intake	218	1:2.21			1:1-1:1.5	Unsuitable
Mg	Content in serum(C/ μm□L^{-1})	81	1.1			0.7-1.2	Suitable
Fe	Estimated intake(mg) Content in serum(C/ μm□L^{-1})	473 81	27.7 20.3	12.0	12.0	 10.9-26.7	Suitable Suitable
Zn	Estimated intake(mg) Content in serum(C/ μm□L^{-1})	473 81	12.6 17.9	15.0	15.0	 13.8-20.0	Suitable Suitable
Cu	Estimated intake(mg) Content in serum(C/ μm□L^{-1})	370 81	2.4 14.6		2.0-3.0	 14.1-18.5	Suitable Suitable
Se	Estimated intake(μm)	36	64.4	50.0	50.0		Suitable
Vit A Retinal equivalent Vit A	Estimated intake(μm) Serous content(C/ μm□L^{-1})	320 148	617.7 385.9	800.0	800.0	 300-900	Unsuitable Unsuitable
Vit E	Estimated intake(mg)	36	68.1	10.0	10.0		Suitable

Vit B_1	Estimated intake(mg)	473	1.8	1.3	1.5		Suitable
	Urine load test(m/μm)		204.3			≥200.0	Suitable
	TPP effect (%)		14.8			≤16.0	Suitable
Vit B_2	Estimated intake(mg)	473	0.96	1.3	1.5		Unsuitable
	Urine load test(m/ μm)	157	337.8			≥350.0	Unsuitable
	Content in RBC (C/ μm□L^{-1})	145	139.1			≥200.0	Unsuitable
Niacin	Estimated intake(mg)	473	17.3	13.0	15.0		Suitable
	Urine load test N'-Me(m/ μm)	157	4.3			≥3.0	Suitable
Vit C	Estimated intake(mg)	473	47.6-130.1	60.0	60.0		Unsuitable
	Urine load test(m/ μm)		1.9			≥3.0	Unsuitable
	Content in WBC (ω/mol·g^{-1})		75.1			≥106.4	Unsuitable
	Content in WBC (mg/kg)		14.1			≥20	Unsuitable
Vit B_6	Serous GOT(ξ/mol□s^{-1}□L^{-1})	81	16.8			--	
	RBC-GOT (ξ/mol□s^{-1}□L^{-1})	81	3072.0			--	

RDA1: Recommended daily allowance for Chinese adults with light work

RDA2: Recommended daily allowance for Chinese adults with moderate work

[Information synthesized from surveys done by Ji Hongguang, Zhong Jinyi, Zhang Yanbin, Yao Yuxiang, et al.]

The symptoms found during the survey periods were reported to be gum swelling and pain (24.1%~67.7%), oral mucosa ulcer (17.2%~51.6%), scrotum eczema (13.2%), constipation (31.4%), insomnia (48.8%), the time for dark adaptation prolonged, overweight and obesity, which were said to be in close relation with the malnutrition status.

2 Malnutrition

2.1 The possible impairment of malnutrition

Both insufficient of nutrition and excessive of nutrition are malnutrition.[8] Malnutrition may produce "the third status", weak immune system and diseases. The basic function of the nutrients which are deficient in Chinese seafarers and the possible impairment due to their deficiency can be described as follows:

Vitamin A assists in the formation and maintenance of healthy skin, hair and mucous membranes; aids in the ability to see in dim light (night vision); assists in proper bone growth, teeth development, and healthy reproduction. Deficiency of vitamin A may produce night blindness; rough skin and mucous membranes; infection of mucous membranes; drying of the eyes; impaired bone growth and poor tooth enamel. Vitamin B_2 mainly helps release energy from carbohydrates, proteins, and fats; and aids in the maintenance of mucous membranes. Deficiency of vitamin B_2 may produce skin disorders, especially around the nose and lips; cracks at corners of the mouth;

and sensitivity of eyes to light. Vitamin C is mainly to aid in the formation of collagen; help maintain capillaries, bones, and teeth; help protect other vitamins from oxidation; may block formation of cancer-causing nitrosamines. [13]

Since the function of vitamins involves assisting enzymes to function, any shortfall of vitamins may terminate or change the biochemical reactions in the human body and impair the process of normal metabolism. A long period of abnormal metabolism may produce "the third status", a degraded immunity system and chronic diseases. For the Chinese seafarers in short of several kinds of vitamins and minerals, they were in "the third status" or in a development of chronic disease or even already suffering disease.

2.2 The main factors causing malnutrition

2.2.1 Improper diet

The cause of malnutrition in respect to diet is the unbalanced intake of nutrients and bad diet habits. Table 2 shows the daily diet structure of seafarers on board 14 Chinese oceangoing vessels during navigation. The values in the table are averages calculated using the data of the diet surveys on board the vessels. To synthesize the results of the surveys and the studies in other countries the causes of improper diet can be listed.

Table 2 Diet structure of Chinese oceangoing seafarers during navigation

Type of food	In the early days		In the later days		Reference structure
	Quantity(m/g)	%	Quantity(m/g)	%	%
Grain	456.3	35.8	490.0	43.1	32.5
Yam	25.4	2.0	58.5	5.1	6.3
Bean	27.9	2.2	34.0	3.0	4.2
Sugar	20.4	1.6	19.6	1.7	1.4
Plant oil	76.8	6.0	75.6	6.6	1.4
Meat	111.8	8.8	118.1	10.4	5.6
Fish	67.4	5.3	46.4	4.1	1.4
Dairy	1.5	0.1	1.0	0.1	4.6
Egg	47.0	3.7	38.0	3.3	3.8
Fruits & vegetable	440.3	34.5	256.3	22.5	38.8

[Information synthesized from surveys done by Ji Hongguang, Zhong Jinyi, Zhang Yanbin, Yao Yuxiang, et al.]

(1) Limited quantity of fresh fruits and vegetables on board and stored in refrigerator. The water soluble vitamins in fruits and vegetables decrease with the lapse of time.

(2) Some crew members have to work in a dark environment. The consumption of vitamin A should increase. The lack of vitamin A has a negative effect on seafarers who work in the dark.

(3) Stress, anxiety, depression etc. make seafarers consume more micro-nutrients.

(4) Lack of exercise puts seafarers in a state of positive energy metabolism balance.

(5) The diet with more frying food, refined sugar, refined starch and less whole grain, beans, dairy, fresh vegetables and fruits makes seafarers consume more energy nutrients, less vitamin and mineral.

(6) Consuming more beverages containing alcohol, refined sugar and caffeine.

(7) Irregular work shifts, night work and other temporary work cause poor or hasty eating habits and this, in turn, can impair the seafarers' digestive systems.

(8) Smoking consumes more micro-nutrients.

(9) Seasickness causes seafarers to take less food and nutrients.

2.2.2 Stress

"Stress" refers to the stimulus causing the stress reaction. These stimuli are now referred to as stressors. Nearly anything can be a stressor.[14] Stress occurs when a person is confronted with an environment that poses a threat or demand, and the individual becomes aware of his/her inability or difficulty in coping with the environment. Stress is the body's knee-jerk reaction to a threat. It is one of those survival-of-the-species basic instincts dating back to the beginning of life.[15] Some things are stressful in a positive way or even fun. Others are stressful in a negative way. It is not the stress itself but the reaction of people to the stress in the environment that depletes their immune systems and leads to illness.[16]

Stress and nutrition are closely intertwined. A person is more vulnerable to nutritional deficiencies when stressed than during almost any other time in life, and these nutrient deficiencies amplify the stress. Any type of stress upsets nutritional balance, which in turn makes the stress just that much worse. If the stress is short lived and the person is already well-nourished, he/she will handle the situation with less anxiety and the stress is not likely to significantly affect nutritional status. However, if a person is marginally nourished prior to a stressful situation and/or the situation lasts for some time, he/she overuses body's ability to handle this high-stress period and therefore impairs his/her health unless immediate action is taken to improve diet and coping skills.

For seafarers, stress is induced by sleep deprivation, work load, intense time schedules, improper relationship with other crew members, work in dark, dangerous situation, engine or equipment failure, bad weather, unwell body, etc. Since working on board ship is a relatively dangerous job and seafarers are always reminded to be alert to the dangers around them, they are actually in a state of stress all the time on board ship. This is one of the most important influencing factors in the deterioration of the marginal or malnutrition status of seafarers.

Physiologic responses to stressors include the central nervous system (CNS), hypothalamic-pituitary-adrenal (HPA) axis, and the autonomic nervous system (ANS). Hormones play a particularly key role in the adaptive coping response by the organism to the stressor stimulus. The secretion of glucocorticoids by the HPA axis, and the release of catecholamines by the ANS are among the most fundamental responses to stressors[13]. Liu Kaiji, et al. [17] measured the 24-hour urinary excretion values of 17-hydroxycorticosteroids (17-OHCS), 17-ketosteroid (17KS), catecholamine (CA), epinephrine (E) and norepinephrine (NE) of 344 ocean-going seamen as well as the self-rating anxiety scale (SAS) scores of 34 of them during different periods of a 61-day voyage and 60 days later after the voyage, to investigate seafarers' psychosomatic disorder morbidity and its possible relationship with their psychological stress. Liu Kaiji's team concluded that the seafarers' psychosomatic disorder morbidity was intensive and they were under psychological stress during the voyage. The stress tended to become more intense as the voyage proceeded and was relieved only after a period of off-ship vacation. The stress was more intensive in the morbidity group than that in the non-morbidity group, which suggested that the seamen's psychosomatic disorder was related to psychological stress.

2.2.3 Sleep deprivation

Sleep deprivation is also one of the important factors, which leads to the shortfall of nutrients in seafarers' bodies and to a negative balance of energy metabolism. Sleep appears to have a basic role in the physiologic recovery of waking metabolic functions, especially in relation to the brain. Based upon an evaluation of the physiologic correlates of sleep deprivation, there is evidence that sleep serves a fundamental role in the maintenance of balanced energy expenditure for the whole organism. Rechtschaffen et al.[18] showed in a large number of elegant experiments that sleep-deprived rats developed a negative energy balance through a doubling of energy expenditure (mean = 210%~270% of baseline), based upon increased food intake (hyperphagia) accompanied by weight loss. It appears the sleep-deprived animals underwent an increase in basal energy expenditure not evident in work, waste, or weight.

Shift work and night operations on board ships are common. The traditional 8~9 hours per day of sleep for people living on land cannot be guaranteed on board oceangoing vessels. Psychological studies reveal that sleep duration less than 7 hours a day results in cumulative sleep debt, waking neurobehavioral impairments and metabolic deficiencies, both of which are associated with potentially lethal outcomes such as traffic accidents.

2.2.4 Exercise

Although there is still much work for scientists to do in respect to the relationship between exercise and nutrition, it is clear that exercise is an important factor in regulating the energy metabolic balance. Since the Chinese seafarers are in the state of positive energy balance and have the risk of overweight and obesity, increasing exercise during navigation is one of the strategies to maintain a balanced energy metabolism.

3 The influence of Malnutrition upon Maritime Safety

3.1 The third status

Seafarers who have been diagnosed with certain kinds of disease and deemed to be not competent for their position on board ships are not permitted to work on board ship and will be sent to receive proper treatment in hospital ashore. As patients staying ashore for treatment, their health status does not create any threat to maritime safety. However before they are diagnosed as suffering from diseases and therefore not suitable for work on board ships, if they are malnourished, their bodies' organ functions and tissue structures have already begun declining. They might have some recognitions of this state, but believe it is not so serious as to affect their holding certificates of competence. They are in a state between total health and disease. This state is called "the third status" or "sub-health" in medicine. Although there isn't a worldwide accepted definition for it, descriptions about it do exist. It is described as a state where the structure of the human body is declining; physiological function is becoming weak; and mental function is unbalanced. It usually has no clinical manifestation and physical symptoms.[19] The third status includes:

(1) Uneasy feeling physically or mentally, but difficult to be diagnosed as a certain disease;

(2) In the period before some clinically diagnosed diseases;

(3) Syndrome with unknown cause, such as climacteric syndrome, neurasthenia, fatigue syndrome;

(4) The state carrying pathogens, such as hepatitis B virus carriers, tubercle bacillus carriers;

(5) At the state of highest or lowest limit values by clinical tests, such as hypertension, hyperglycemia, hyperlipemia, hypocalcemia and hypopotassemia, etc.;

(6) High pathogenic risk factors, such as overweight, smoking and over stress.

It is reported that 45% to 70% of people are in the third status. According to this reported percentage and considering that seafarer's fatigue belongs to the third status and half or even more seafarers on board are in a malnourished state, especially during the late period of voyage, in the author's view, at least half of the active seafarers aboard are in the third status.

3.2 Continuing work on board with disease

Some seafarers are still permitted to stick on their positions on board ships even though they have been diagnosed to be suffering certain kinds of chronic diseases if only mild diseases so far. It is obvious that they are susceptible to fatigue. According to the health examination analyzing results of 101 entry-exit Chinese seafarers at Huidong Port published by Xiaomeng Zhu and Xiaozhong Wu[20], 131 person-times were abnormal among the seafarers under surveillance. A high percentage of seafarers were suffering from positive HBsAg, ALT, hypertension and hyperlipemia, TG, CHOL, UA and peptic ulcers which are connected with malnutrition (Table 3). Hypertension examinations were done on 500 seamen of a coastal ship shipping company and 18.06% of them were found suffering from hypertension.[21] At the same time, the national adult hypertension rate was 3%~9% and the worldwide hypertension rate was 8%~18% according to the WHO. Although these data are not based on a widely systematic survey, they reflect to some extent that approximately 20% Chinese seafarers are active on board ships with chronic diseases.

Table 3 Health examination results of entry-exit Chinese seafarers at Huidong Port, 2003

Diseases	Cases found	Rate found
HBsAg	18	17.82
ALT	14	13.86
hydrotension	18	17.82
TG	22	21.78
CHOL	25	24.9
UA	10	9.9
Peptic ulcer	10	9.9
Siphilis	1	0.99

3.3 Fatigue

Fatigue has been discussed in the maritime community in recent years which is thought to be a contributing factor to human error. Alertness is the optimum state of the brain that enables seafarers to make conscious decisions. Fatigue has a proven detrimental effect on alertness. When a person's alertness is affected by fatigue, his/her performance on the job can be significantly impaired physically and mentally, such as in decision-making, response time, judgment, hand-eye coordination and countless other skills. Fatigue can affect an individual's ability to respond to stimuli, perceive stimuli, interpret or understand stimuli. It also takes longer for seafarers to react to stimuli once they have been identified. Fatigue is known to affect a person's performance detrimentally and may reduce individual and crew effectiveness and efficiency; decrease productivity; lower standards of work, and may lead to errors.

So far the role of nutrition in central fatigue is still an ongoing subject for scientists to study.[22] The focus is on the neurotransmitter serotonin because of its role in depression, sensory perception, sleepiness and mood. No matter what the mechanism is, any shortage of vitamins and calcium may impair the mechanism since it needs energy and the energy is produced through body metabolism from energy nutrients and uses vitamins as coenzymes. The neurotransmitter and neuron need calcium. The lack of vitamins and calcium impairs the body energy metabolism and the activity of the nerve system. As a result vitamin and mineral deficiency degrades the performance of seafarers.

3.4 Human error and maritime safety

Human error is an unavoidable incident for human beings. It is impossible to eliminate it. But in some circumstances influenced by some factors, the frequency of human error may increase. In these circumstances with effective measures, human error can be diminished. Malnutrition is an abnormal metabolic state. If it lasts for some time, the third status develops. Fatigue is one of its manifestations. Seafarers in this situation show degraded performance. The frequency of human error increases. The risk of maritime accident increases and maritime safety is threatened.

3.5 Summary

Nutrients supply energy and material for the metabolism of seafarers' body to keep it running and recovering from any tissue damage. The shortfall of nutrients, such as vitamin A, vitamin B_2, vitamin C and calcium impairs the metabolic process. A long-period of this status makes a weak immune system, the third status and even disease. The usual circumstance for seafarers on board vessels is fatigue which is one of the manifestations of the third status or disease. Since more than 50% of the crew members aboard are in the third status or 20% of the crew members work on board despite disease, this situation impairs the effectiveness and efficiency of the seafarers' performance, increases the frequency of human error and the risk of maritime accidents. As a result, maritime safety is threatened.

4 Suggestions for Improving the Situation

Since seafarers' malnutrition is an actual problem and has a close relation with maritime safety, it is important to reach a common approach or strategy of coping with it for maritime community which includes shipping companies, insurance companies and regulators as well as the seafarers. In the author's view, the following points should be considered.

(1) Training and education There are three points to consider in regard to seafarers' nutrition training and education. The first is the seafarers' awareness of their marginal nutritional status. If seafarers are not aware that their nutritional status is in a marginal state and any carelessness or indulgence in unsuitable foods and beverages, any further sleep deprivation or stress may induce further malnutrition, any efforts to improve the situation will not be rewarded as expected. The second is that seafarers should have basic nutrition knowledge. The third is the food management aboard, the ordering and storage of food and the cooking skills of the ship's cook. Nutrition is a new science compared with medicine. It is reported that clinical nutrition had not emerged as an important discipline in modern medicine until recent years.23 In the USA, Australia, China and some other countries nutrition training is given to solders. So offering a nutrition course in the merchant marine seafarers' training class is a new idea. If we decide to improve maritime safety further through a seafarers' diet and nutrition approach, training and education of nutrition is absolutely necessary. An elective course about seafarers' nutrition has been offered by the author to the undergraduate students in Dalian Maritime University since February 2005. Nearly half the of the 100 students who elected the course were in the nautical science and engineering.

(2) New storage technology So far cold storage is the typical method for food storage aboard. Meat, fish, poultry, etc. are stored under 18□C; vegetables and fruits stored from 0□C to 4□C; rice, flour, oil, dried vegetables and caned food, etc. stored from 1□C to 10□C.[9] Water soluble vitamins, especially vitamin C, in the food decrease with the lapse of time under these conditions. Seafarers usually show malnutrition symptoms in the late period of a long voyage. One of the reasons is that the foods they take contain less quantity of vitamin. Complete natural food is the best source of nutrients. There is a need to have better techniques for keeping food fresh and maintaining their nutrients for a longer time.

(3) Nutritional supplements and fortified products Since the living and working conditions on board ships cannot be thoroughly changed and time is needed to develop new food storing techniques, it is necessary and practicable for seafarers to use suitable supplements and fortified products. Chinese researchers studied and tested supplements on board vessels.[24, 25, 26] In recent years, the health care product industry has developed very quickly in China. A variety of supplements has been promoted in the markets of China and some other countries. Which products are suitable for seafarers? It is not easy for seafarers to make an informed decision. One man's meat is another man's poison. Actually one kind of supplement effective for some people, may not be effective for others. Here it comes back to the education issue. People without enough nutritional knowledge may be manipulated by the product manufacturers or misuse supplements which could impair their health. How seafarers can take advantage of supplements and fortified products is a new question for the maritime community. For the shortfall of vitamin C, vitamin B2, vitamin A and calcium, for instance, seafarers can deal with them with different ways according to their personal situations. However it is better to take vitamin A through the foods which are rich of vitamin A or carotinoid because it is harmful to take too much vitamin A. They also can take proper doses of carotinoid supplements. The other kind of nutrients can be supplemented through fortified food or suitable supplement products.

(4) DRI for seafarers The Nutrition Association of China has developed Dietary Reference Intakes (DRI) for ordinary residents of China. It can be used as reference standard for evaluating the nutrition status of them. Although the researchers have applied it to the evaluation of Chinese seafarers' nutrition state in their surveys, actually it is not suitable. However, currently they have to do so because there isn't any DRI especially for seafarers. So it is necessary to develop a DRI for Chinese seafarers. In order to develop the DRI for Chinese seafarers, it is necessary to organize a comprehensive and systematic seafarers' nutrition survey.

(5) Further improvement of living and working conditions Although there have already been some standards and regulations for ships' construction, such as the standards for the structure of ships' accommodation and bridge, noise in engine room, etc. in the conventions and standards concerned, they are the basic requirements. In the long run, the seafarers' living and working conditions on board ships should be improved in line with the upgrade of the living and working conditions on land, since all the people in a society have the need to enhance their spiritual and material living standards. We shall be aware that maritime safety is maintained mainly by the physically and mentally healthy seafarers. How can we look to the seafarers in malnutrition status and fatigue to enhance the safety standard of the ship management system? It is the time to consider further improvement of the seafarers' living and working conditions aboard, the problem of manning, sleep deprivation, malnutrition, stress, noise, etc.

(6) Ship's living and working conditions management system In order to deal with the influencing factors as well as the seafarers' malnutrition status, it is necessary to establish a ship's living and working conditions management system. The objective of the system is to make the seafarers aboard healthy, safe and efficient. It can be either an independent system or a subsystem of the ship safety management system which has already been running. The system may have a structure similar to the ship safety management system and in addition includes doctors and persons well trained in seafarers' nutrition and mental issues. The ship's captain is no doubt the first responsible person aboard. The competent authority of the government is responsible for supervising the system's running in light of the standards and regulations concerned. A professional hospital or medical institute is the designated supporter which supplies necessary biochemical tests and health examinations. Based on such a management system, nutrition education and training, taking supplements, improving the living and working conditions and other necessary measures can be implemented effectively. Crew Endurance Management System proposed by USCG[27] is a system aimed at improving seafarers' living and working conditions on board ships. The structure of the system and the rationale for sleep management can be used for reference.

Acknowledgement

I am very grateful to President Leonard Tyler, Dean John Barlow, the faculty and staff of Maine Maritime Academy, the USA, for their kind and positive support and help while I was doing this study there. I also want to thank Professor Laurie Stone of Maine Maritime Academy and Professor Anne S. Bosch of Canada for their reviewing the paper and checking some of the words and expressions in it.

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VAULT LABORATORY DESIGN FOR NAVIGATION SIMULATOR

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Abstract The paper introduces the vault laboratory designed for shipping navigator simulator. The vault laboratory, based on multimedia technology and computer network system technology, is composed by two parts; navigator simulator and planetarium simulator, that connected between each other by network. The shipping navigator simulator will show corresponding seascape or port that the operator required, at the same time, the planetarium simulator will also show the astronomical phenomena of the period of the day according to the parameters that the operator entered. In the laboratory, student could not only study both the navigation technology by shipping simulator and astronomical phenomena knowledge by planetarium simulator, but also syncretize navigation technology with astronomical phenomena knowledge much better. Students could master much more competence abilities, such as chronometer orientation, navigate equipment calibration and adjustment etc. By using this laboratory, students will study more technology and improve their practice abilities as if they were onboard ships at sea.

Keywords vault laboratory; simulator; design

0 Introduction

The vault laboratory, based on multimedia technology and computer network system technology, is composed by navigator simulator and planetarium simulator. By this means our training and education effects could reach the ideal results.

So far, navigator simulators and planetarium simulators are manufactured by many companies. These are ripe technologies. Many universities in our country have built navigator simulator and planetarium simulator laboratories. But these two laboratories are generally built up in two laboratory buildings or rooms. Although these laboratories have played a very important role in our navigation high education, we find that many integration studies and experiments could not be completed in the laboratories. For example, navigation equipments adjust according to astronomical phenomena and ship orientation and so on. In order to solve these questions, the vault laboratory has been designed for shipping navigation simulator specially. The vault laboratory, based on multimedia technology and computer network system technology, is composed by navigator simulator and planetarium simulator. By using this laboratory, students could study more technology and improve their practice abilities as if they were onboard ships at sea.

1 Simulators and requirement

The inner of vault laboratory is built by two parts. One is a cylinder, which high is 4 meter and diameter is 18 meter. On the cylinder, it is a half ball, which radius is 9 meter.

We are going to choose a single ball planetarium simulator, which made by a Chinese company. This simulator could show 88 constellations, about 5100 stars, Canicula, nebulas and the Milky Way, both in the south and north sky. The planetarium simulator has four different coordinates system. One is equator coordinate system, the second one is ecliptic coordinate system, the third one is horizon coordinate, and the last one is meridian coordinate.

Single ball planetarium simulator is showed in Fig 1.

The movement of simulator could be controlled not only by the calendar, sky-high height and horizon but also by the center computer that connects with the navigator simulator.

The navigation simulator is a panorama simulator, which could display a wide visual field reaches to 270 degree that will show the students with different tides, wave or weather such as fine, cloudy, raining or snow in different time.

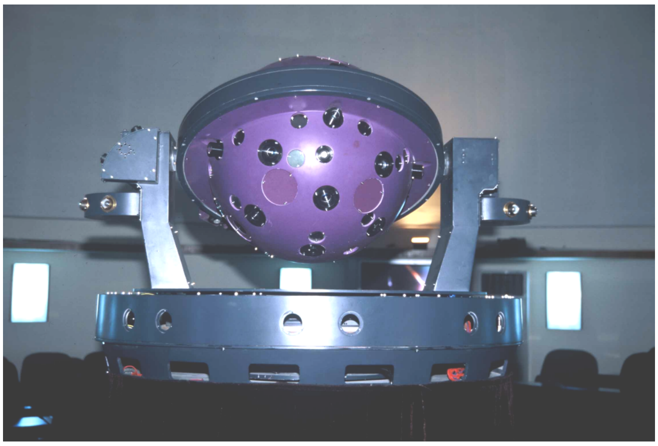


Fig. 1 Single ball planetarium simulato

2 Coordinate and movements

In order to make navigator simulator and single ball planetarium simulator synchronization, we have to do some special designs for driving system of the single ball planetarium simulator. First, we have to set up the coordinate that shows as Fig 2. Then we define some special movements and angles as follows.

2.1 Course angle driving system (ϕ)

Navigator simulator could show course angle very easily, when the operator turns around the steering wheel. The vision, which is shown on the circle screen, will give your sense organ some information that the ship is swerving. But the single ball planetarium simulator, solar simulator and moon simulator could not do this so easily, since these simulators only could show that the sun or the moon rises from east. Traditional planetarium simulator could turn only in one direction that is clockwise to show the sun rise and sun down. We have to design a driving system, a servo motor system, on the single ball planetarium simulator to complete horizon movement, which is synchronization with the navigator simulator. By this mean, the operator could feel the ship is swerving through both seascape on the circle screen and astronomical phenomena on the vault.

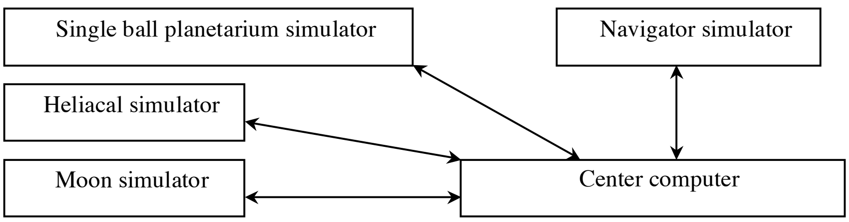
Fig 2. The coordinate of the ship

2.2 Pose swing angles (β, γ)

Pose angles could be divided into pitching angle β and rolling angle γ. Pitching angle β is a shake angle that wiggles from the fore to the poop system. Rolling angle γ is a shake angle that wiggles from the starboard to larboard. We have design two servo motors on the chassis of the single ball planetarium simulator to complete sky-high movement, which changes the movement of the Polaris altitude angle. The movement of the Polaris is synchronization with the navigator simulator. But the traditional planetarium simulator could not implement this movement.

2.3 Network and functions

In order to implement these two different kinds of equipment synchronization motions, we have to do some special design and reform. First we have designed a computer network system which is a center computer connected with these equipments, shown as fig3.



When the students utilize the simulator, we will input not only some parameters such as the kind of ship you have choses, the weather condition (wind power, wind direction, clear or cloudy, and so on), stream, parameters of the ship (sea gauge, speed and power of main engine, draft and so on), position (Longitude, latitude and course) as generally, but also time and date into the center computer. This computer will calculate your ship course angle and pose angle according to the parameters of weather, waves and steering wheel. And the computer will control single ball planetarium simulator synchronization with the navigator simulator. Navigator simulator will show corresponding seascape or port in accordance with the position the vessel situated, at the same time, the planetarium simulator will show the astronomical phenomena of the period of the day entered by the operator.

3 Effect drawing

We have designed a new laboratory building in our campus, which is shown in Fig 4.

Fig. 4 New laboratory building

Day and night scene of the vault laboratory inside is shown in the Fig 5 and Fig 6.

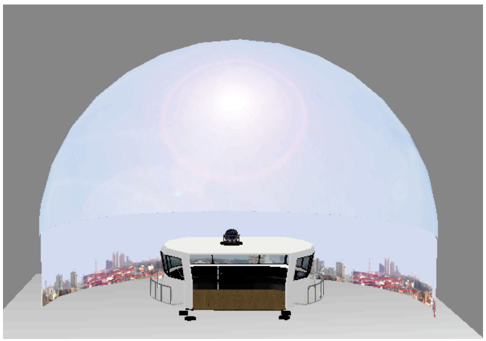


Fig. 5 Day scene of the vault laboratory inside

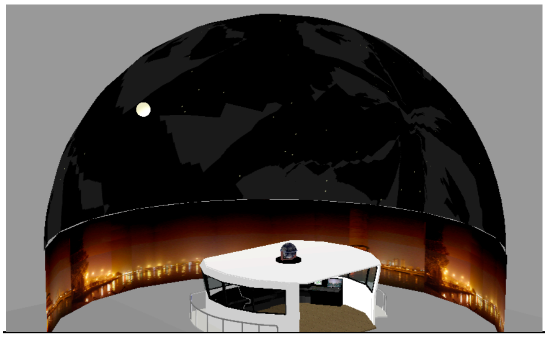


Fig. 6 Night scene of the vault laboratory inside

4 Result

In the vault laboratory, students could not only study both the navigation technology by the navigator simulator and astronomical phenomena knowledge by the planetarium simulator, but also could syncretize navigation technology with astronomical phenomena knowledge much better. Students could master much more abilities, such as chronometer orientation, navigate equipment calibration and adjustment etc. By this way, students' abilities will be improved.

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The New Mimic Panel and Its Effects on Simulator Education of Marine Engineers at ITU Maritime Faculty

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Abstract Simulator-based training is well recognized by the international convention of STCW'95. Engine room simulator consists of the simulation of various systems and machinery in the engine room of a ship.

ITU Maritime Faculty got a set of Konsberg full-mission simulator and workstation simulators in 2001 by support of JICA. However, it was realized that it was not possible to create the real engine room conditions with this simulator due to lack of some operations on the mimic panel. And mimic panel was renewed in 2006.

The new mimic panel was specially designed by ITU Maritime Faculty and JICA personnel. All training courses especially Engine Room Team Management courses are effectively given with the new mimic panel.

In this study the properties of new mimic panel and its additional effects on education of students and engine room team management applications are explained.

Keywords ERS; ERTM; maritime education; STCW

0 Introduction

Simulators can be used as sophisticated, flexible and realistic training tools which are 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.

In developing STCW requirements for the use of simulators, the focus centered around defining standards of performance for simulators used in training and assessment, the thinking being much influenced by the requirement for mariners to clearly show that they were competent to do the job for the certificate or license being issued.

The purpose of the Standard is to ensure that the simulations provided by any maritime simulator include an appropriate level of physical and behavioral realism in accordance with recognized training/assessment objectives. The purpose is derived from the STCW Code Section A-I/12 where it is stated that each Party (i.e. the administration in the State where the training/assessment program shall be approved) shall ensure that simulator used under certain conditions shall fulfill six general performance requirements[1]. The full text can be read in the Convention and the following is our interpretation of the essentials:

- suitable for training/assessment objectives
- physical realism appropriate to training/assessment objectives
- sufficient behavioral realism
- capable of producing a variety of conditions (operating environment)
- the learner can interact
- the instructor/assessor can control/monitor/record exercises

The increased use of marine simulators for training means that instructors must ensure that simulator training is not only effective but is also valid. 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. The transfer of simulator acquired skills to the real world is only a valid assumption provided that the training outcomes are satisfactory.

In this study, the deficiencies of the former mimic panel (Fig 1.) to form a realistic engine room environment, the properties of the new mimic panel (Fig 2.) which are created by eliminating the mentioned deficiencies and the educational gains of the new mimic panel is explained.

1 The ERS training in ITUMF

Maritime training institutions all over the world started to recognize the value of simulation systems as a training tool.

Engine Room Simulator is designed to simulate various types of machinery and equipment as used in the engine room of an actual ship. The main objective of ERS training is that the training is carried out efficiently, reliable with cost-effective configuration by simulating realistic environment.

The biggest advantage of using ERS as a training tool is the possibility of creating malfunctions repeatedly to train trainees for increasing their troubleshooting skills.

With the cooperation of Japanese International Cooperation Agency (JICA) and Istanbul Technical University Maritime Faculty (ITUMF), ERS of ITUMF was installed in June 2001.

ITUMF ERS consists of two types of ERS. One is CBT type ERS; the other one is full mission type ERS. The ERS has six units of CBT type ERS and one full mission type ERS. CBT type ERS is called WS. The trainee is able to practice the operation of the engine plant in individual or a small number of trainees on the Work Station (WS).

The full missions type ERS consists of the large-sized mimic panel which imitates an engine room, a control console which imitates a control room, an instructor console which imitates a bridge of an actual ship and a main switchboard which has same function as monitoring system and remote control system. By full mission type ERS; the trainee is able to practice more realistic operation than WS in suitable size of group.

Before the ERS training started the efficient methods for simulator training is considered and a training plan which is necessary for an efficient training is formed. The ERS training plan was created at ITUMF[2]. The training plan indicates training subject, objectives, training method and evaluation type. The training plan contains simulator I and simulator II as training subject. Simulator I is realized as capability of the operational level depending on the competence of STCW convention. Simulator II is realized as capability of the management level depending on the competence of STCW convention. The aim of Simulator Ⅰ training is that the trainees learns basic plant operation procedures such as normal start and stop each plant composition machinery, correct order of starting up the engine plant, the duty of the watchkeeping and recovery emergency situation. For this purpose we have prepared four objectives shown in Table 1.

Table 1 The ERS training plan

Subject	Objective	Method	Evaluation
Simulator I	Fundamental plant operation	WS checklists	Training report I
	Machinery operation	ERS scenario I	Evaluation sheet I
	Watchkeeping	Log book & Oil record book	Log book, Oil record book, Training report II
	Emergency operation	ERS scenario II	Evaluation sheet II
Simulator II	Plant operation management	ERS checklists	Training report III
	Team management	ERS scenario III	Evaluation sheet III
	Risk management	ERS scenario IV	Evaluation sheet IV
	Maritime communication Internal & external communication	Communication phrases	Evaluation sheet V

The aim of Simulator II training is that the trainee learns higher skills concerning plant operation such as plant management and team management. It has been prepared four objectives for Simulator II training.

When the training courses were conducted according to this plan, although we created the training plan depending on the function of the ERS, we realized that there were some deficiencies in the mimic panel which should be improved to carry out “The ERS training plan” more effectively and more realistic as we proceeded with the training. In short, it might be said that the training by using the existing mimic panel would not bring accomplishment we expected when we created the plan. And also we though that we were not able to expect any advancement in the educational quality in the future. Then, we began to ponder the necessity of renewing the mimic panel.

2 The new mimic panel

ERS comprises mimic panel, control console, main switch board and instructor console. The mimic panel represents an actual engine room and it is the most significant component among the system components to carry out an effective ERS training. Regarding the former mimic panel, there were lack of functions and all the necessary procedures from starting up the propulsion plant to the state of navigation cannot be done on the panel. Under processing the operation of the former mimic panel, we needed to press the key board to continue the procedures. The Fig. of the former mimic panel is seen at Fig. 1. It causes the trainees confuse and interrupts their comprehension. Therefore, renewing the mimic panel was necessary to implement an effective ERS training. Renew of the mimic panel was officially requested in February 2004. The sequence of the request to installation of the new mimic panel took place as follows:

- Drawing the design of the new mimic panel was begun by ITUMF team and JICA personnel in November 2003.
- Discussion on necessity of the new mimic panel was started in November 2003.
- The first version of the drawing of the new mimic panel was completed ‘n February 2004.
- One engineer from Kongsberg came to the faculty to have a technical discussion in February 2004.
- One engineer from Kongsberg came to the faculty to have technical discussion.
- Official letter requesting the new mimic panel was submitted in February 2004.
- The final evaluation of the project was implemented and the necessity of the new mimic panel was approved in November 2004.
- Installation of the new mimic panel was completed in January 2006.

Fig.1 The former mimic panel

2.1 Design concept of the new mimic panel

Before design period of the new mimic panel, the following points are considered for the new mimic panel concept which is for modifying the mimic panel to a superior level with which the standard is reached and the all level courses and ER Team Management Course can be executed:

(1) The existing soft ware should not be changed.

(2) All necessary procedures related to starting up the propulsion plant can be done on the panel.

(3) For the trainee's monitoring, as many analogue meters as possible should be mounted on the panel.

(4) GSP (Group Starter Panel) should be adopted and placed on the lower part of the panel.

(5) Main engine ignition indicator lamps should be adopted to realize the difference between engine running and inertial rotation.

(6) A propeller model should be mounted to make a realistic environment and makes it rotate by the revolution signal.

(7) The size of the panel should be 2,500mmH×10,600mmW×400mmD approximately in consideration of the room size.

(8) AVR (Auto Voltage Regulator) and dedicated UPS for the panel should be adopted to avoid interruption caused by power supply.

The new mimic panel and the differences can be seen at Fig. 2.

Fig. 2　The new mimic panel

2.2　Designing the new mimic panel and specification

During the design period according to the determined concept above, the structure and the characteristics for a realistic mimic panel were considered and summarized below:

(1) All necessary systems for propulsion plant were described and their layout was newly arranged.

(2) Each system was described in consideration to reality as much as possible and easy to understand what configuration it has.

(3) GSP was placed on the lower part of the panel as a part of the panel construction. Switches and indication lamps were mounted in consideration to reality as much as possible and they have same function as an actual GSP.

(4) Instruments such as switches, lamps and analogue meters, on the mimic panel were chosen in consideration to its mounting area and its height from the panel surface. Particularly, the boiler frame indication lamp was made with special specification.

(5) Color arrangement was chosen in consideration to no outstanding line and illustration but easy to identify them.

(6) At the beginning, it was planed that the structure of the mimic panel was made of steal plate and acrylic plate in consideration to strength, finish and protecting surface and illustration should be described on the rear side of the acrylic panel by digging. However, it was decided through the discussion that the structure of the panel was made of aluminum plate and acrylic plate and illustrated mimic sheet should be pasted on the aluminum plate. Regarding the surface of GSP, it should be covered with poly-carbonate film coating to protect the surface from injury.

The differences between the new mimic panel and the former mimic panel are listed in the Table 2.

Table 2 The differences between the new mimic panel and the former mimic panel

Items		The new mimic panel	The former mimic panel
Structure		2 mm acrylic plate and 3 mm aluminum plate covered with illustrated mimic sheet	3 mm acrylic plate illustrated on the rear side by digging
Dimension (m)	Total width	10.8	7.2
	Height	2.3	2.3
	Depth	0.5	0.5
Layout		Main engine was placed on the center and whole layout was completely rearranged.	Bunker system and bilge system were placed on the center.
Additional systems		All cylinders were illustrated.	5 cylinders were illustrated
		All cylinder heads and all attached valves were illustrated.	Only 5 cylinder heads with no attached valve were illustrated.
		ME ignition indicator lamps were added.	Non
		Steering system was additionally illustrated and instruments concerned were added.	Non
		Refrigerant system was additionally illustrated and instruments concerned were added.	Non
		Emergency generator system was additionally illustrated and instruments concerned were added.	Non
		Engine room fans were additionally illustrated and instruments concerned added.	Non

		GSP was additionally placed and instruments concerned were added.	Non
		Bow thruster was added.	Non
Number of instruments	Switches	724	493
	Indication lamps	285	56
	Analogue meters	174	7
	Model Propeller	1	Non
	Process Cont.	44	44

3 The educational gains of the new mimic panel

The deficiencies we realized have been recovered and the function by using the mimic panel has been improved in terms of the following respects:

- It became easy to understand the system configuration of the propulsion plant due to the rearrangement of the layout,
- It came to be able to perform all the procedures to start up the plant on the panel, (The key board of PC to carry out the operation of the plant became unnecessary any longer)
- Monitoring by the trainee standing in front of the panel became possible due to the analog meters which increased sharply in number,
- The mechanism of starting and stopping pumps had been completely changed and the same operation as an actual operation to start and stop pumps became possible and also the trainee can realize whether stand-by pump is actually in stand-by condition in dual pump system due to the additional stand-by indication lamps,
- Rearranged layout of the plant, more realistic illustrations, the model propeller, main engine ignition indicator lamps and special designed boiler flame lamp were very effective to create more realistic environment for the training and successful to improve trainee's motivation.

Table 3 The differences between the new mimic panel and the former mimic panel in mechanism of starting and stopping pumps

	The new mimic panel	The former mimic panel (MP)
Single pump system	Press "START" on GSP to start Press "STOP" on GSP to stop	Press 'START' on the MP to start Press again "START" on the MP to stop
Dual pump system	Press No1"START" on GSP to start Set No1 & No2 "COS" on GSP to "AUTO" to make them S/B. (No2 S/B lamp will be lit)	Press No1 "START" on the MP to start Press again No1 "START" on the MP to stop Press No2 "START" on the MP to

		start Press again No2"START" on the MP to stop. (There were no S/B indication lamps)

The new mimic panel yields the advantage of conducting all level courses and ER Team Management Course. Therefore by these courses the students and the applicants from companies would develop higher level skills than before such as:

- risk management;
- team working understanding in the engine room and leadership practices;
- "Internal" and "external" communication skills development in the engine room.

Scenarios for simulating situation where management of panic condition is needed at most emergency procedures.

Case studies to reflect the real situation where team management is evaluated.

Utilize resources and personnel effectively.

The new and the former form of pump start stop mechanism is depicted at Fig. 3 and the details are listed at Table 3.

3.1 Simulator I training with the new mimic panel

The Simulator I Course training items are machinery operation, watch keeping, and emergency operation. The trainee can learn unusual operation methods such as manual operation and emergency operation etc. about the selected machineries through this training. The aim of the machinery operation is familiarization of the operation for selected machineries by utilizing full mission ERS.

The aim of the watchkeeping is that trainee learns how to take over the duty of the watch by using full mission ERS. The training which duty of watch keeping is taken over to the other trainees is performed.

The objective of the emergency operation is that trainee learns how to recover emergency situations such as black out, ME shut down, ME auto slow down, Oil fired boiler burner trip, etc. Mainly, under the state of navigation, making an emergency malfunction intentionally, a trainee performs operation for recovering it to a normal state.

Because the new mimic panel can provide more realistic environment and operation conditions, it is possible to reach the aims and objectives mentioned above with the new mimic panel.

3.2 Simulator II training with the new mimic panel

The Simulator II Course training items are team management, risk management, maritime communication

3.2.1 Team management

In a crisis, a leaderless group will achieve nothing. A simulator is a valuable tool for demonstrating how good leadership is vital for establishing and motivating team effort. The highest priority of a team is to accomplish team goals. If those qualifications are lacking or missing them effective machinery space management will break down and the ship will be thrown into a risk. Achieving those qualifications is very important, that's why this objective is set up.

For this purpose, trainee learns team play under proceeding plant operation such as start up the engine plant, stand by station for entering/leaving port and emergency operation.

The former mimic panel was not sufficient for team organizations to study more efficiently due to absence of some systems and lack of instruments. The new mimic panel increased team training performance.

3.2.2 Risk management

To reduce the human errors, training for troubleshooting repeatedly with a good communication and team working is needed and therefore, utilization of ERS for this purpose is proposed. For this purpose, this part of the course is about to increase the ability of trainee over the control of risk.

The objective of the risk management is that trainee learns how to take counter measures by predicting an emergency state from the running date which is in the out of the normal range. Mainly, under the state of navigation, for example, it is performed by taking necessary counter measures after detecting high temperature of scavenging air caused by fouled surface of the air side of air cooler.

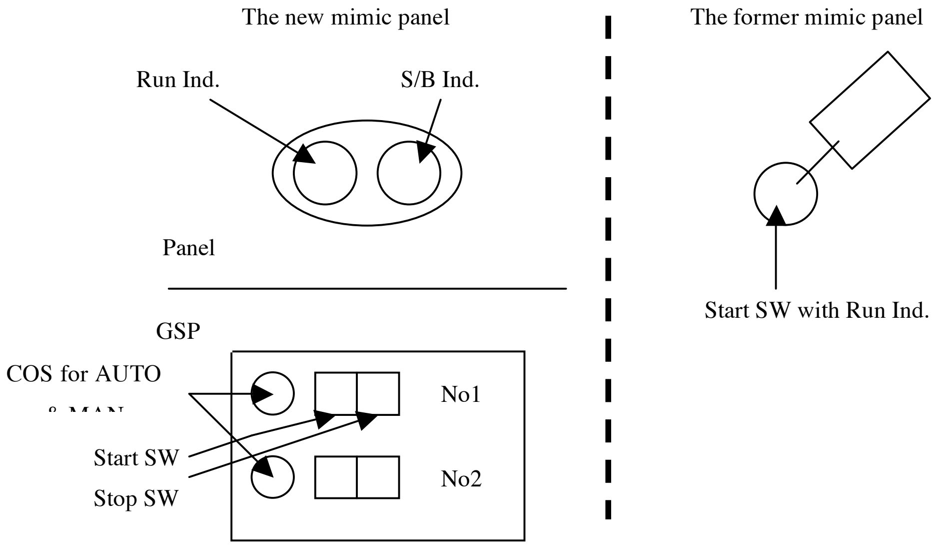

Fig. 3 The mechanism of starting and stopping pumps

The lack of instruments is delaying the beginning of perception of undesirable process. Even more it is causing more complex procedures than normal procedures for intervention. On the other hand, risk management is aiming to teach to implement the true procedure at true time in the fastest way. Because all systems and necessary measurement instruments can be seen on the new mimic panel, risk management training can be executed properly.

3.2.3 Maritime communication

Communication in the engine room is so important in terms of eradicating of marine accidents which are considered to be based on communication failures.

The maritime communication is to learn how to communicate with other staff members in the engine room and how to communicate with the bridge, further more to learn technical terms. It goes without saying that communication both in an upward and downward direction is vital for good management, both in day to day routines and in crisis. ERS can be utilized to demonstrate that, without good communication, tasks are made much harder due to lack of direction and misunderstanding.

With the new mimic panel it is possible to operate the whole system on the mimic panel. Therefore, the internal communication can be done more clearly and realistic.

3.3 Ertm training with the new mimic panel

ERTM training is different from Simulator I and Simulator II Courses. This Course is specially designed for marine engineers who have see going experience as engineer officer. This course is for team working understanding in the engine room and practices. The main principle of team management related to the non-technical skills associated with the social interaction between team members, situation awareness and the decision-making. This is a high fidelity, complex, simulated working environment. The course covers:

- Organization and Procedures
- Team Building and Development
- Situational Awareness and Error Trapping
- Internal and external Communications
- Management of Stress and Distractions
- Fatigue and Circadian Rhythm
- Leadership and Group Decision Making
- Multicultural Diversity

This course duration is four days. Teaching methods cover lectures, simulator exercises, pre reviews, debrief sessions and case studies.

Fig. 4 A Photo of ERTM Course with Engineers

The course works best with a team of varied ranks and we recommend a complete engine room team of Chief Engineer, First/Second Engineer, Second/Third Engineer and Third/Fourth Engineer. The course can accommodate a maximum of four officers and a minimum of three officers. A photo of a training team is shown at Fig. 3.

This course is started after the new mimic panel is installed. By this course, the trainees not only refreshing their knowledge but also increasing their team management knowledge, skill and ability.

4 Conclusion

For the effective training with simulators the simulator environment should be as real as the engine room. By the changes of former mimic panel ERS is now more appropriate to real engine room environment.

With the new mimic panel it is possible to give marine engineering candidates higher level qualifications. For example, the use of ERS for team-management and for communication skills could very efficiently be arranged because of the opportunity of preparing the scenarios based on the type of the training and education. Through this type of training, marine engineer candidates can easily learn the safety culture, how to manage the risk and the aspect of the human error.

After the new mimic panel installed and the courses carried out, the importance of ERTM courses is understood. And many shipping companies have applied for the ERTM course and many courses have carried out in a more realistic machinery space simulator.

Acknowledgements

We would like to thank JICA and JICA personnel for their support and help.

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Advanced Education and Research on Marine Propulsion

–Experimental Study on Propeller Air-Drawings and Bearing Forces

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Abstract Marine screw propeller is one of the fluid-dynamic propulsor, so the generated thrust is determined by the product of the mass of fluid and the acceleration. When a certain thrust is generated, it is well known on the momentum theory that the greater mass and the lower acceleration of concerned fluid, the better propeller efficiency. Therefore, a larger diameter and a lower rotational speed have been pursued for marine screw propellers; accordingly the propeller immersion depth has been relatively smaller. Even if a propeller blade dose not appears above water surface, an amount of air is drawn from free water surface to the low pressure region on the blade surface and the propeller shaft exciting forces, namely the bearing forces are induced under a certain condition.

In order to investigate the relation between the air-drawing phenomena and the induced bearing forces, the experiments of model propeller in open condition are carried out at the circulating water channel of Kobe University, Faculty of Maritime Sciences (KUMS). The air-drawing phenomena are observed dynamically by using of a high speed video recorder system. The shaft forces (the thrust, the torque and the bearing forces) are detected by the 4 components load cell and analyzed.

Keywords screw propeller; air-drawing; bearing force; shaft force; immersion depth

0 Introduction

A marine screw propeller working near free water surface draws air onto the blade surface under a certain operational condition and a certain volume of cavity is formed on the blade surface. The occurrence of the air-drawing induces the deterioration of the propeller performance and the increase of the fluctuation loads and forces on the propeller shaft. Siba[1] reveled the fundamentals of the air-drawing phenomena as a pioneering investigation. Nisikawa, et al[2-4] carried out experimental study and reveled the air-drawing can be classified into the partial air-drawing which is defined unstable and/or partial cavity formed on the blade surface, and the full-drawing which is defined as stable sheet cavity formed over the whole blade surface. And it was also pointed out that the bearing force which is the perpendicular force to the shaft axis increases remarkably when the partial air-drawing occurs. However, the both of cavity variations in time and in space were not been discussed individually, and also the unstable bearing force was considered only from the viewpoint of time averaged analysis in the former investigations[3, 4].

The dynamic observations of the cavity formation on the propeller blades by using of a high speed video camera and the shaft force measurements are carried out in order to analyze dynamically the partial air-drawing phenomena in this paper.

1 Experimental apparatus and procedure

The experiments were carried out using the circulating water channel in KUMS with 1.2m depth, 1.5m width and 5.5m length of the working section. The open propeller dynamometer which can detect 4 components of the propeller forces and moments was installed on the elevator so as to vary the propeller location to any desired immersion depth. The 4 components, which are the thrust “F_X”, the torque “M_X”, the horizontal bearing force “F_Y” and the vertical bearing force “F_Z” under the still space coordinates, and the rotational phase angle were recorded on the data recorder with 2,000Hz sampling frequency. The visual observations were carried out and recorded by the high speed video camera with 250 frames an second. The measurements and the observations were done under steady flow velocity, steady rotational speed and steady immersion depth. The schematic diagram of experimental apparatus is shown in Fig.1. The principal particulars of examined propeller and the experimental conditions are shown in Table 1 and 2 respectively.

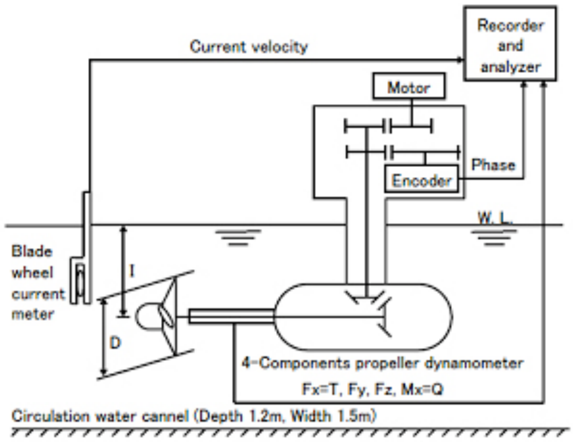

Fig. 1 The schematic diagram of experimental apparatus

The operational conditions are represented as the "*ps*" which is product of the pitch ratio "*p*" and the slip ratio "*s*". It is in direct proportion apparently to the attack angle of the propeller blade, consequently it means the propeller load amplitude. The propeller immersion depth "*I*" is been dimensionless "*I/D*" by the propeller diameter "*D*". "*I/D*=0.5" means that the propeller tip at the upper position coincides with the still water surface. The bearing force is valued as the difference between maximum and minimum during one propeller rotational period. The propeller bearing forces are also been dimensionless by an ordinary manner.

$$K_{\mathrm{Fy}} = \frac{F_{\mathrm{Y}}}{\rho\, n^2 D^4},\quad K_{\mathrm{Fz}} = \frac{F_{\mathrm{Z}}}{\rho\, n^2 D^4} \tag{1}$$

2 Experimental results

2.1 Bearing force measurment

The time averaged bearing force is obtained as a mean value of bearing force over the measured period of about 30 seconds. The fluctuating one is defined as the difference between maximum and minimum values over the same measured period. The bearing force coefficients arranged with *I/D* are shown by each "ps" in Fig.2. The polygonal line shows the time averaged bearing force and the vertical line segments represent the fluctuating amplitude of the bearing force.

The results in terms of the time averaged bearing force agree properly with the former investigations[3, 4]. An unique change of the time averaged bearing force by the *I/D* can be seen between *ps*=0.7 and 0.5. The time averaged bearing force is pretty large in the restricted range of *I/D* despite the fluctuating one is extremely small.

The all results of bearing force measurements are re-arranged to a contour chart shown in Fig.3 and Fig.4. It can be cleared from Fig. 4 that an unstable air-drawing phenomena is occurred in the narrow region of 1.0>*ps*>0.7 and 0.75>*I/D*>0.6.

2.2 Air-drawing observation

The cavity formed on the propeller blades, caused by the air-drawings, is classified into 4 modes as shown in Fig.5. The first is non-cavity on the any blade, the second is unstable cavity formed and the third is uniformed cavity on the all blades without regard to allover the blades' surface. The fourth indicates there is remarkable difference of cavity formation on the several blades even if it is stable in time. The non-uniformed air-drawing, the fourth mode, can be in addition classified into 4 patterns of which the large cavities are formed on the only one blade, the continuous two blades, the alternate two blades or the continuous three blades compared with the other blades in the case of 4 blades propeller.

The high speed recorded video is played back with slow motion and the cavity formations are evaluated as shown in Fig.6 according to the above definitions.

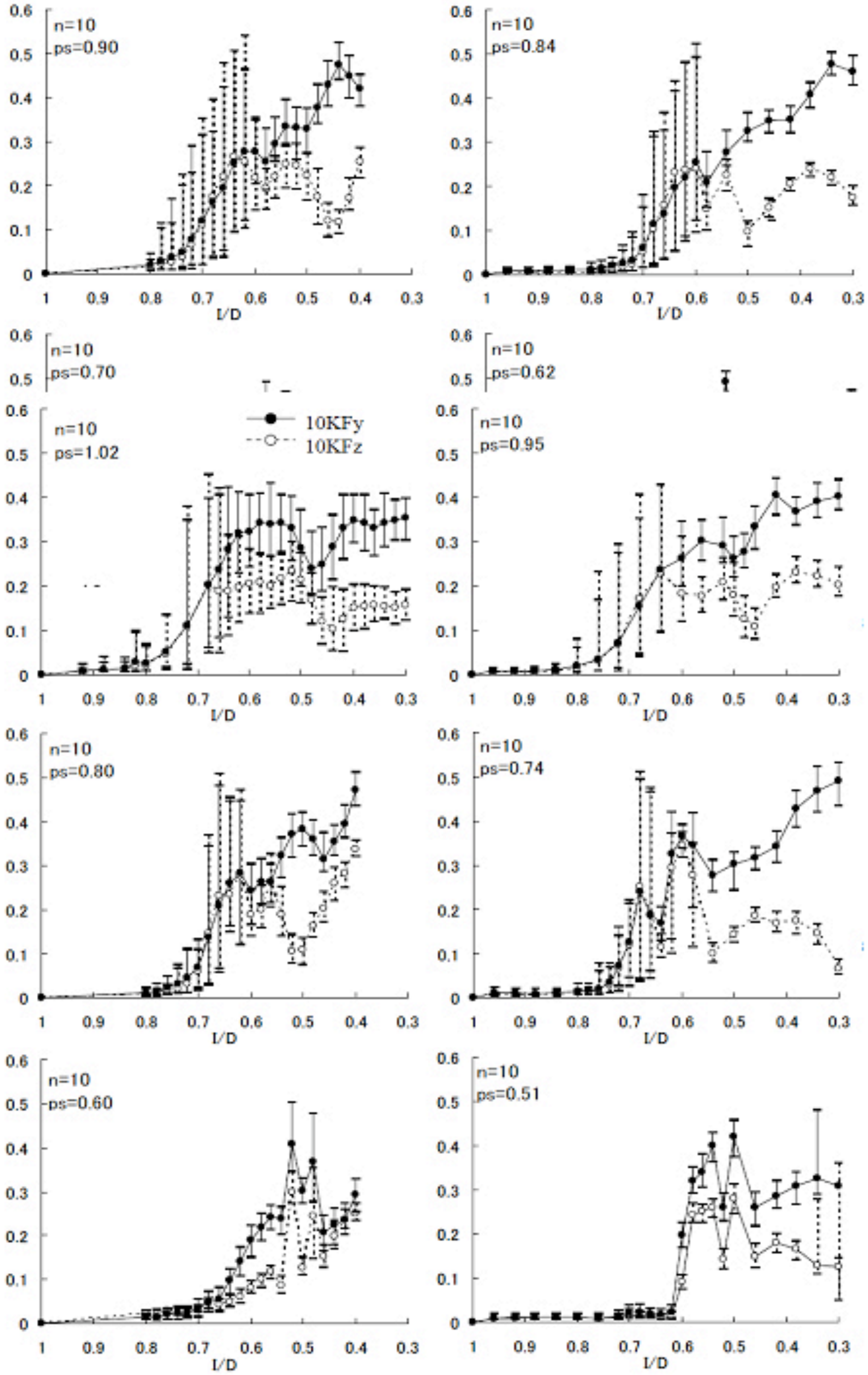

Fig. 2 Bearing force coefficients, K_{Fy} and K_{FZ}, by immersion depth I/D

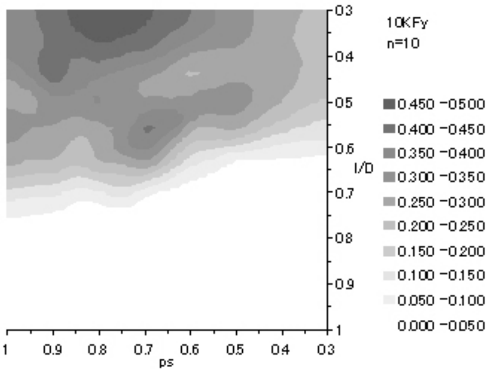

Fig. 3 Contour of the averaged bearing force

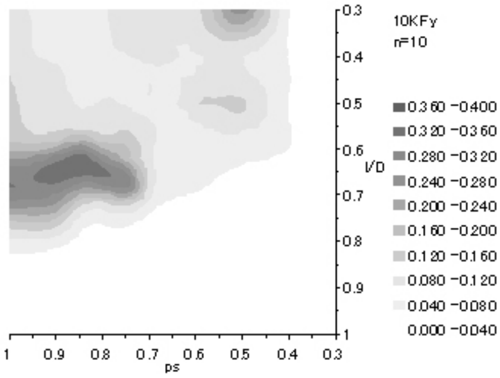

Fig. 4 Contour of the fluctuating bearing force

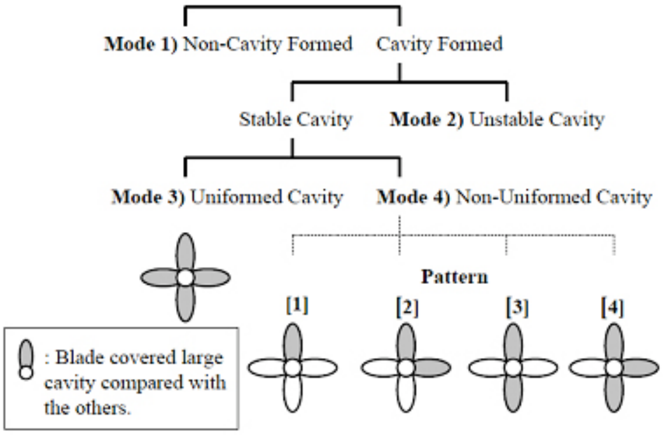

Fig. 5 Classification of cavity formation mode

3 Considerations

3.1 Relation between air-drawing and bearing force

From the results of the averaged bearing force and the cavity formation, i.e. Fig.3 and Fig.7, it can be seen that the steep rise in the averaged bearing force occurs in the region of the non-uniformed air-drawing. The region is insular shape within $0.75 > ps > 0.45$ and $0.7 > I/D > 0.45$.

From the results of the fluctuating bearing force and the cavity formation, i.e. Fig.4 and Fig.7, it can be said the large fluctuation of the bearing force occurs in the region of the unstable air-drawing and the undefined mode. Though the cavity formations in the undefined mode were not able to be confirmed by VTR due to the turbulent bubble around the blade, most undefined mode can be judged as the unstable air-drawing.

3.2 Evaluation chart for air-drawing

The evaluation chart for the air-drawing mode is introduced as shown in Fig.8 by putting together the whole of the results mentioned above. The uniformed air-drawing is divided by the cavity size on the blade into the uniformed full and partial air-drawing. The full is 76%-100% cavity area on the blade, and the partial is under them.

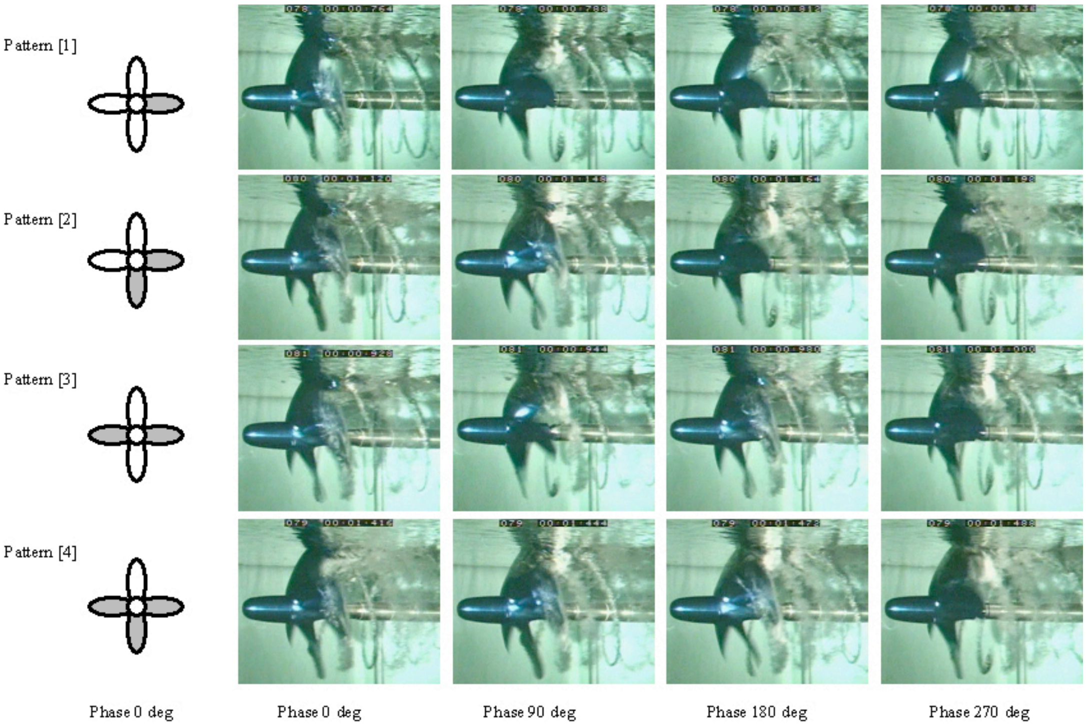

Fig. 6 Typical example of non-uniformed air-drawing

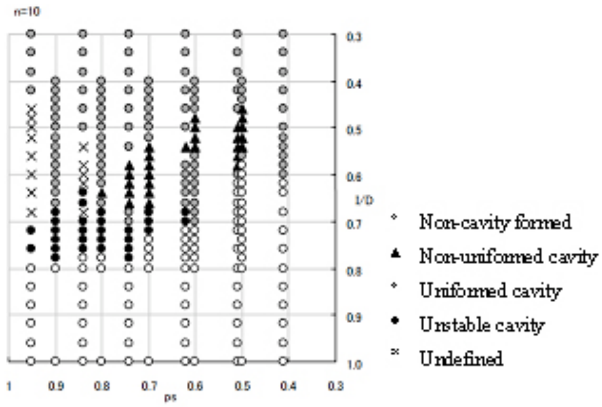

Fig. 7 Results of cavity formation

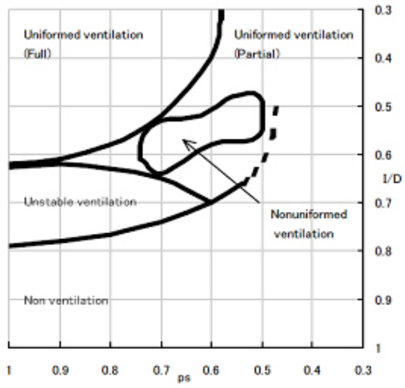

Fig. 8 Evaluation chart for air-drawing mode

The "partial air-drawing" called so far is consist of 3 different modes. They are the uniformed but partial, the non-uniformed and the unstable air-drawing.

3.3 Magnitude of bearing force and pattern of non-uniformed cavity

When the non-uniformed cavities are developed on the blades, the induced bearing forces are increased. Each magnitude of averaged bearing forces on the non-uniformed air-drawing is shown in Fig.9 being assorted into the four cavity formation patterns. The magnitude of bearing force has a strong correlation with the asymmetrical cavity formation. Since the pattern 2 has a largest asymmetry and the pattern 3 has contrastively symmetry, the pattern 2 is highest and the pattern 3 is lowest as respects the magnitude of bearing force.

$$\text{Pattern (2)} > \text{Pattern (4)} > \text{Pattern (1)} \gg \text{Pattern (3)} \quad (2)$$

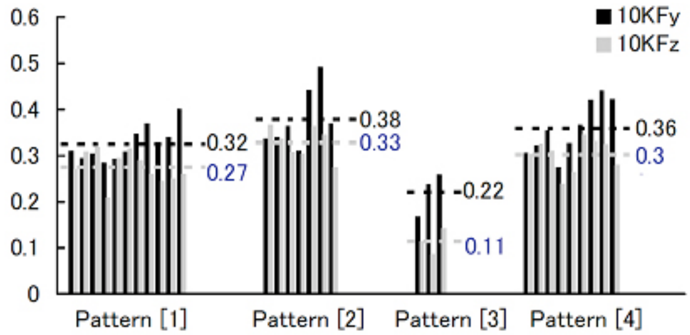

Fig. 9 Averaged bearing forces on non-uniformed air-drawing

Table 1 The principal particulars of examined propeller

Type		MAU 4-55
Blade number	Z	4
Diameter (m)	D	0.25
Pitch ratio	p	1.1
D.A.R.		0.55
Boss ratio		0.18
Thickness ratio		0.05
Mean width ratio	M.W.R.	0.263
Raked angle (deg)		10

Table 2 The experimental conditions

Blade number	Z	4	
Diameter (m)	D	0.25	
Propeller revolution (rps)	n	9	10
Froude number	Fn	1.44	1.60
Reynolds number ($\times 10^{-5}$)	Re	4.94	5.49
Reynolds number × M.W.R. ($\times 10^{-5}$)		1.30	1.45
Weber number	We	131	146
Advance velocity (m/s)	V_a	0.25 – 1.75	
Advance ratio	J	0.11 – 0.78	0.10 – 0.70
Slip ratio	s	0.90 – 0.29	0.91 – 0.36
Pitch ratio × Slip ratio	ps	0.99 – 0.32	1.00 – 0.40
Depth (m)	I	0.25 – 0.075	
Immersion depth ratio	I/D	1.00 – 0.30	

4 Conclusion

In order to investigate the relation between the air-drawing phenomena and the induced bearing forces, the experiments of model propeller are carried out. The experimental results obtained in this paper are summarized as follows.

(1) The cavity formation on the a propeller blades caused by air-drawing is classified into stable or unstable mode, and uniformed or non-uniformed mode. The uniformed air-drawing is also classified by cavity dimension on the blade. The non-uniformed air-drawing is also classified into 4 patterns in the case of 4 blades propeller. It is revealed that the partial air-drawing called so far can be sub-divided into more than one condition.

(2) The air-drawing can be pigeonholed by immersion depth *I/D* and *ps* witch means propeller load. The evaluation chart for air-drawing mode is obtained. The non-uniformed air-drawing can be seen in the confined region on the evaluation chart.

(3) When the non-uniformed air-drawing occurs, the magnitude of the time averaged bearing force is extremely large, on the other hand the fluctuating bearing force is just little. This means the non-uniformed air-drawing phenomenon is highly stable.

(4) The magnitude of bearing force at the non-uniformed air-drawing has a strong correlation with

the asymmetrical cavity formation.

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Maritime Security Regulations —Who Really Pays?

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Abstract The terrorist attacks of the past decade have resulted in significant changes within the maritime industry. The International Ship and Port Facility Security (ISPS) Code, the basis for national maritime security legislation, states that preventative measures will be instituted to prevent security incidents from affecting ships or port facilities. These security measures have placed a disproportionate burden on the vessel and the seafarer. Attacks on vessels continue to account for significant injuries, and numerous kidnappings. Mandated security duties have increased workloads, but not manning levels. The implementation of security measures has the potential to increase crew fatigue and thus negatively influence the safe and effective operation of the vessel. Security-oriented skills versus marine-related skills are now de rigueur and security considerations require front line personnel to deal with the resultant enforcement issues. Inconsistent port state control and port facility access control measures result in lengthy confinement to the vessel for the ship's crew, particularly for those from select countries. The imposed security regulations have increased the burden for ships' officers having a potential impact on ship operations. The financial, social, physical, and mental impact on the seafarer may be a cost that many are not prepared to pay.

Keywords Piracy; maritime security; safe manning; crew fatigue; security training; port state control measures; shore leave

0 Introduction

The events of September 11th, 2001(9/11) and the attacks on marine assets, such as the USS Cole and the VLCC Limburg, compelled the International Maritime Organization (IMO), through its Maritime Safety Committee (MSC) and Maritime Security Working Group (MSWG) to develop procedures for the protection of ships and port facilities. These procedures are outlined in the International Ship and Port Facility Security (ISPS) Code, which came in to effect on July 1st, 2004.

The objective, as stated by the ISPS Code[1] is the establishment of a cooperative framework whereby governments, administrations, agencies, and the shipping and the port industries work together to initiate procedures that protect ships and port facilities. It requires the establishment of roles and responsibilities for these stakeholders, and the provision of security assessments and security plans. Further, it insists that security measures be adequate and proportionate.

An analysis of these objectives suggests a cooperative approach by all stakeholders to mitigate security threats, with ships and port facilities being the primary beneficiaries. It infers a partnership of equals in which security measures will be shared on a proportionate basis. In reality the implementation of the ISPS Code and associated national maritime security legislation has resulted in the vessel absorbing a disproportional share of the security burden.

This paper will examine the effectiveness of these security regulations and the impact that they have had on seafarers.

1 Piracy and security incidents

SOLAS[2] defines a security incident as any suspicious act threatening the security of a ship. The International Maritime Bureau (IMB)[3] defines piracy as “An act of boarding or attempting to board any ship with the apparent intent to commit theft or any other crime and with the apparent intent or capability to use force in the furtherance of that act”. Although piracy constitutes only one form of security incident, statistics as gathered by IMB[4], provide a yardstick to measure the effectiveness of the mandated security measures. A comparison of the yearly totals suggests a correlation between the introduction of ISPS and the decrease in piracy attacks. At the end of 2001 the number of such incidents stood at 335, and increased through 2002 (370), and 2003 (445). The numbers fell in 2004 (329), the first year of ISPS implementation, and continued to decrease in 2005 (276). These statistics suggest that ISPS implementation has had a significant and positive impact in reducing incidents of piracy.

However further analysis of the IMB 2005 Annual Report does reveals some disturbing trends. In 2005, twenty-three vessels were hijacked, the second highest number recorded, and the number of hostages taken (440) was the highest ever documented by IMB. At the end of 2005 more than 50 seafarers were still held captive, often with high ransom amounts demanded for their release. During the first quarter of 2006[5] sixty-three crewmembers have been taken hostage. This is more than double the number for the same period in 2005, suggesting that incidents of hostage taking continue to rise.

The statistics indicate a decrease of attacks in areas such as the Straits of Malacca, and is attributed to increased law enforcement patrols, while a sharp increase in piracy attacks in other areas, such as the coast of Somalia, is attributed to the lack of law enforcement. The primary objective of ISPS is the protection of ships and port facilities. All stakeholders, including government agencies, must undertake cooperative security measures to ensure this protection. When such protection has not been provided, it is primarily the mariner who has endured the consequences.

Despite the fact that the definition of port facility[6] is inclusive of anchorages, waiting berths and approaches from seaward, the 2005 statistics reveal that 77.5% of the successful pirate attacks occurred while the vessel was berthed or at anchor, while only 22.9% occurred while the vessel was steaming. In some cases such facilities, due to the type of vessel serviced, may not be required to implement security arrangements as outlined in the ISPS guidelines. However these statistics indicate that these areas pose the greatest risk of attack and that the victims of the attack are vessels and their crew.

The IMB[7] also notes incidents of attempted but unsuccessful attacks. Interestingly, 80.3% of these unsuccessful attacks occurred against vessels that were steaming. In fact, in 2005, there were only 45 reported cases of successful attacks where the vessel was steaming, with 57 cases of unsuccessful attacks. Conversely, there were 159 successful attacks on the vessel while at anchor or berthed, with only 14 unsuccessful attempts. This suggests that vessels underway have been far more successful in preventing such attacks, but while at anchor or berthed are far more susceptible to them. The IMB attributes the reduction in the number of piracy attacks to an increased security awareness supplemented with anti-piracy watches, both of which are requirements of the ship security plan. Crediting only the vessel for these successes may be simplistic as there are many factors involved. However, while underway the vessel is normally left to its own devices and evidence suggests that many of the security arrangements within the ship security plan are having some effect. Conversely, vessels at anchor or berthed, where security responsibilities are shared, have been more vulnerable.

A number of Conclusion are formulated from these statistics. While there may be some threats and even actual attacks on port facilities, statistically the main target is the vessel, cargo and crew. The vessel while underway has been reasonably successful in mitigating such attacks. While evidence shows that geographic area is a main predicator of piracy attacks, within those geographic areas the greatest risk occurs while the vessel is berthed or at anchor. The ISPS Code dictates that Governments, agencies, local administrations, and the industry at large ensure adequate and proportionate measures are in place to protect the ship and the facility. The other stakeholders need to shoulder more ‘adequate and proportionate’ responsibility in order to decrease the numbers of such security incidents in these areas. It appears that we are not yet meeting this goal and it is the vessel and crew who ultimately pay the price.

2 Safe manning

In 1999, the IMO, recognizing the principles of safe manning, adopted guidance to enable contracting governments establish minimum safe manning levels. In 2003, with the extra demands of the ISPS Code, an IMO resolution amended the guidance on safe manning. Resolution A.955 (23)[8] defines safe manning as a function in numbers and experience of qualified seafarers for the safety and security of the vessel, crew, passengers, cargo and the marine environment. The amendments instruct vessels, companies, and contracting governments to consider additional tasks as dictated by ISPS when determining appropriate manning levels. It identifies administrative tasks, the coordination of security activities, and the assessment of security tasks, duties and responsibilities as additional criteria to be considered. Further, it instructs government administrations to approve the manning level of a vessel only if, in addition to the other responsibilities, it adequately meets the requirements of the security regulations.

The ISPS Code[9] lists a broad range of duties expected of crewmembers. It requires the vessel to implement security measures for access control, the control of movement of persons and their effects, identification and monitoring of restricted areas, monitoring of the deck and areas surrounding the vessel, and controlling the movement of ship stores and cargo. Additionally, the ship security officer (SSO) is required to undertake a number of specified duties. Crewmembers are tasked with numerous security duties including 24-hour gangway watches, roving patrols, and physical searches of persons, baggage, stores and cargo.

Most would argue that such measures are normally dictated through the routine practice of good seamanship, however prior to the introduction of the ISPS Code, vessels implemented security measures on an ad hoc basis. Crewmembers engaged in traditional duties such as cargo operations, ship maintenance, and deck watches, while concurrently performing security duties.

The security plan is now required to contain detailed security procedures. To ensure compliance, the plan is reviewed, approved, verified and certified by the appropriate government administration. Additionally, it is not uncommon for Port State Control (PSC) Officers, Company Security Officers (CSO), or even ship charterers to perform ‘penetration tests’ to ensure security personnel are conforming to the ship security plan.

The security regulations also require preparation for three different security levels that correspond to the identified levels of risk. An increase in the security level will require an increase in security duties, including the provision of additional personnel for access control, for roving patrols, and for other security monitoring duties, but without necessarily indicating where the additional human resource is to be obtained.

The maritime industry is competitive, with tremendous pressure to control cost but remain efficient. The guidance issued by the safe manning resolution has been used by contracting governments to draft the minimum manning levels as determined by and for that flag state. In 2004 the Chairman of the IMO Maritime Safety Committee[10] suggested that some flag states may use reduced manning requirements in order to attract shipping companies to their registry. These reduced levels in conjunction with mandated security duties may make it impossible for the ship to conform to the intent of the safe manning resolution.

Competitive pressure has affected manning levels, as evidenced through statistics gathered by a number of agencies. The Paris MOU[11], through a port state control inspection campaign in the fall of 2004, discovered that almost 50% of total deficiencies (2392) related to the Seafarer’s Hours of Work and Manning of Ships Convention. While there is no evidence to show cause and effect with the new security regulations, these statistics do indicate a problem with conformance to safe manning guidance and it is logical to assume that the additional duties imposed by ISPS related regulations have only exacerbated the problem. The chairman of the IMO Maritime Safety Committee[12], in a presentation to the National Shipping Industry 2004 Conference, suggests that it would make an interesting study to see whether manning levels have increased to reflect these additional responsibilities of the security regulations. The tone of his presentation suggests that they have not.

3 Fatigue

Fatigue, defined by the IMO[13] as tiredness or sleepiness as a result of prolonged physical or mental work, extended periods of anxiety, exposure to harsh environments, or a lack of sleep, has also been a byproduct of ISPS implementation and contravention of the principle of safe manning. Without sufficient manning levels, it is common for crewmembers to work long hours and juggle multiple tasks with resultant physical and mental stresses.

The IMO Guideline on Fatigue[14] affirms that the effect of fatigue (impaired performance and diminished alertness) influences everyone regardless of skill, knowledge or training. The resultant diminished capacity not only affects the ability to perform security duties, but also normal shipboard duties and consequently may affect the safety of crew and ship. The IMO[15] indicates, “human error resulting from fatigue is now widely perceived as the cause of numerous marine casualties”. It also states “because shipping is a very technical and specialized industry, these negative effects are exponentially increased”. Unlike most port facilities that hire security personnel, the majority of vessels use the existing crew complement to perform security duties. The extra time allocation and responsibilities associated with these duties may cause fatigue, which may not only defeat the intent of security regulations through inadequate vigilance, but also have severe consequences affecting the safe navigation of the vessel.

4 Security skills and training

Security has always been a function of the maritime industry, however security regulations now demand that mariners, in addition to traditional seafaring skills, have specialized security training. The ISPS Code[16] outlines 25 areas of training for the Ship Security Officer (SSO), including methodology of security assessments, instructional techniques, knowledge of security threats and patterns, recognition and detection of dangerous weapons, methods of physical searches, and crowd management. The SSO, normally a senior officer and burdened with a myriad of duties, is now responsible for security and training.

The ISPS Code[17] also identifies 11 areas of specialized training for crewmembers having security duties plus other training requirements for crewmembers having no assigned security duties. Training will include recognition of dangerous weapons and of characteristics and behavioural patterns of persons likely to threaten ship security. The list of topics may suggest that mariners, to some degree, are now expected to take on the additional roles of security officer, enforcement officer, educator and psychologist, usually without commensurable compensation or training.

5 Port state control measures

Port State Control (PSC) measures ensure that vessels are in compliance with various regulations, codes and conventions, and strive to eliminate sub-standard shipping. The Tokyo MOU[18], one of a number of port state control regimes, reveals that in 2005 it carried out 21,058 ship inspections, and discovered 14,421 deficiencies, resulting in 1,097 vessel detentions.

The North of England P&I Club[19] notes that vessel detentions can have serious consequences, including breach of charter parties and of carriage of goods contracts, and may affect a ship's ability to trade. It further notes that the number of ship detentions will likely increase as additional regulations come into effect.

As of July 1st, 2004, there has been increased emphasis to ensure that vessels conform to the new security regulations. Port facilities are also feeling the effects of these inspections. However, because the port facility and the PSC inspector are governed by the same national regulations and because there is frequent interaction between these parties, it is expected that facilities will be given more time and latitude to deal with deficiencies. Ships, however, may not be given the same leeway. Although the ISPS Code espouses safety and security for ship and crew, it appears that some administrations view the vessel as a threat rather than a target. Anecdotal evidence suggests that vessels are too frequently treated with suspicion, particularly when flying a foreign flag or employing a foreign crew. Some of the penalties for suspect vessels may include denial of port entry, detention, delay of departure or entry, and/or significant fines.

Different jurisdictions may have variation in the requirement, application, or administration of security regulations. It is a challenge for the SSO to remain current with the countless national security rules and regulations, particularly if visiting numerous countries and ports. Port facilities will normally deal with only one such jurisdiction.

Vessels, even when compliant with security regulations may be deemed a risk to port state security due to extenuating factors. The United States[20], for example, uses a targeting matrix, which reviews five broad areas of risk. Only one deals directly with the vessel's implementation of the security plan. The history of the ship's management is also subject to review. A poor security record of any vessel operated by a company may elevate the risk associated with other vessels within that company, and subject them to more stringent PSC measures.

The matrix also reviews the security records of the flag state and the security record of the Recognized Security Organizations (RSO's). Therefore, a flag state or RSO having a number of security infractions above a certain threshold, will negatively impact vessels using that flag or RSO.

Under the matrix, the vessel's last five ports of call also impact perceived risk. If either of those ports is on a targeted list, then the vessel is deemed to be of higher risk. A United States Coast Guard (USCG) Port State Advisory[21] identifies several states to be non-compliant. It informs vessels that have visited these countries that they will be subjected to a number of possible PSC measures, including boarding by USCG at sea, operational restrictions, or denial of entry to any US port. While vessels visit the ports of non-compliant countries, the advisory mandates actions including implementation of MARSEC Level 2 measures, and the execution of a Declaration of Security, or the vessel will be refused entry in the US. In addition, if permitted entry into the US, the vessel will be required to have all access points guarded by private, armed security personnel. This notwithstanding, vessels will be allowed entry only at the pleasure of the US government.

Although PSC measures are meant to deter or prevent security incidents within the port state, it is clear that any security weaknesses exhibited by other vessels within the company; the flag state of the vessel; the RSO's used; or the port state visited, may all impact how the vessel is treated. Unfortunately most of these factors are outside of the vessel's direct control, but the consequences are negative and the ramifications severe.

6 Shore leave

The Seamen's Church Institute[22] has described shore leave as, "an ancient and cherished seafarers' right that should not be denied except for compelling reasons". According to the International Transport Workers' Federation[23] there are 1.25 million seafarers on vessels engaged on the international trade. With foreign seafarers working at sea on voyages that are frequently of several weeks duration and often working on ten to twelve month contracts[24], the IMO, recognizing in part the need for freer movement of crewmembers and port services, ratified the Convention on Facilitation of International Maritime Traffic. This convention[25] states that, unless there is a reason to refuse permission, foreign crewmembers shall be allowed ashore. The ISPS Code, recognizing the provisions of the Convention on Facilitation of International Traffic, urges contracting governments to take it into account when implementing security regulations. The IMO, through MSC/Circ. 1112, has also reminded administrations of the need to maintain the proper balance between the requirement for security and the protection of human rights. This Circular[26] states, "a singular focus on the security of the port facility is contrary to the letter and spirit of the ISPS Code and will have serious consequences for the international maritime transportation system."

Of course it is the facility that is responsible for developing the port facility security plan. The ISPS Code[27] outlines the procedure, content and format for such a plan. It directs port facilities to develop a plan that addresses, *inter alia*, procedures for shore leave, and access of visitors to the vessel, in addition to procedures for access control. Many facilities place a disproportionate weight on access control procedures and, having identified the vessel as a point of access to the facility, use severe measures that curtail the movement of crewmembers. At some facilities[28] mariners are kept on the vessel under armed guard while at others they are refused access to the facility even for the purposes of making a phone call or reading the ship's draft. Anecdotal evidence[29] also suggests that at some facilities, crewmembers are granted shore leave but are required to use facility approved 'ISPS transportation' to get from gangway to gate, often for exorbitant sums of money.

A port facility conducts a security assessment, and uses the information gathered to formulate the security plan. However it is the contracting government that is ultimately responsible for reviewing and approving this plan and as IMO[30] directs, it is also their responsibility to ensure that facilities meet the requirements of the ISPS Code. Refusal of shore leave or unreasonable access control measures should not be allowed to become the norm. Administrations, through the verification process, can and must, determine if proposed measures meet the required standard.

Most international conventions recognize that ship's crews should not be required to obtain a visa for temporary shore leave. However some jurisdictions, most notably the United States, require mariners to have an individual visa in order to avail of shore leave or to join or depart the vessel in any of that country's ports. The Seamen's Church Institute[31] identifies numerous logistical problems that make it difficult for seafarers to obtain such a visa. The cost of a visa, while low by western standards is also a prohibitive expense for many low wage earners.

The problem with shore leave, as espoused by PSC or the facility security officer, is the reliable verification of a seafarer's identification. The International Labour Organization (ILO)[32] though ILO-185 has set standards for a seafarer identification document (SID) to ensure that such information is reliable, verifiable, and internationally acceptable. It is expected that widespread ratification and acceptance of such standards and the related documentation will at least partially alleviate this problem. However, such widespread ratification and acceptance is not yet the case.

7 Cost assessment

The Department of Homeland Security of the United States[33], estimated the initial average cost of ISPS implementation for its 10,300 affected vessels to exceed $21,000, and the average cost in subsequent years to exceed $17,000, with the vessel operator normally expected to bear these costs.

Other stakeholders, notably governments, administrations, and agencies, have also experienced increases in security costs. In many cases security is, at least partially, their *raison d'etre* and the additional costs are frequently covered through applicable government agencies or borne by the taxpayer.

Port facilities have also experienced an escalation in security costs. For public or quasi-public facilities, such costs are covered in a similar manner as previously noted for agencies. Other port facilities will pass security costs on to vessels using that facility. In some jurisdictions, such as Canada[34], the government has provided significant funds to enhance the security of port facilities.

Vessels, because of implementation and operational demands and expenses that have been passed on by port facilities or government agencies, have had significant cost increases. In most jurisdictions there has been no funding mechanism to provide financial relief for the ship operator. Due to the competitive nature of the shipping industry, it is often difficult to pass on the security costs to the customer and consequently this affects the owners' bottom line.

8 Conclusion

The ISPS Code and resultant national security regulations have impacted the shipping industry. No doubt there have been positive results stemming from such regulations, however there is a need for stakeholders to institute further improvements.

Governments and associated agencies need to expend more effort in deploying resources to security 'hotspots'. Security regulations should be expanded so that they apply to more vessels and port facilities not currently covered by the ISPS Code.

The IMO must ensure that safe manning guidelines are not used by flag states in a negative manner, to attract shipping companies to their registry. Contracting governments should ensure that safe manning regulations properly reflect the requirements of the IMO guidance, while port state control officers must ensure adherence to the safe manning regulations. Such measures will also have a positive impact in terms of crew fatigue, and consequently result in the safer operation of vessels. Vessel operators, recognizing the requirements of the security regulations, must provide specialized security training, and additional physical and human resources as required.

Where possible port states should strive to implement security procedures that are uniform and consistent worldwide. Similarly, PSC procedures and expectations need to be applied in a more consistent manner. Vessels and crews need to be treated as part of the security solution instead of as the security problem.

Standards for a seafarer identification document (SID) need worldwide acceptance. Flag states must ensure that the port facility security plan includes procedures for shore leave, as required by the ISPS Code. With the implementation of a standardized SID, onerous visa requirements must be eliminated.

While implementation of the security regulations has created a significant financial cost for all stakeholders, it is the social, physical, and mental costs that are less easy to measure, and for which greater numbers of seafarers may be unwilling to pay.

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Analysing of Maritime Accidents by Approaching Method for Minimizing Human Error

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Abstract This study clarifies the current traffic situation in the Istanbul Strait, TURKEY based on statistical information; 928 data from across 75 years. The main objective is to investigate the risk profile of maritime accidents in the Istanbul Strait, and then to build up a methodology for minimizing human error. Maritime accidents have occurred in spite of existing safeguards. The main reason is that these safeguards do not concern enough the minimizing of human error. Evaluation methods of human behaviour are restricted, and it is very difficult to model it among all parameters of the components in a safety system.

The geographical and physical specifications of the Istanbul Strait are investigated and the potential threats defined as the risk profile. Then, proper analysis will be implemented on the resulting statistical information and the factors discussed are called 4M (Man, Machine, Media and Management) both individually and from an aspect of their mutual related effects. The existing safeguards are so evaluated, and their effectiveness is judged through carrying out experimental studies. For this purpose, the Ship Handling Simulator and actual onboard experiences have been utilized. These studies can provide the necessary data for understanding the human factors involved during navigation.

Keywords Maritime Safety; Istanbul Strait; risk assessment; human error; 4M

0 Introduction

The Istanbul Strait (Turkey) is a very strategic point that has been explained in many publications in details. It is better here to explain its importance in brief, this way;

Geopolitical; this is the only existing area from the Black Sea to the world. It is of number one importance, for passing through the Istanbul Strait the majority of oil reserves from Russia and the Caspian Sea Region. The Istanbul Strait also has one of the rarest marine biological corridors for important ecological functions.

Historical; several important conventions have been signed during historical times reflecting the political powers of the day. And, Istanbul has vast value historical places not only for Turks but also for the other cultures.

Geographical; Istanbul Strait, has a narrow and curved structure, and has two coasts; the Anatolian (35 km in length) and the European (55 km in length). The entire length of the Strait is 31 km. It is known as the narrowest strait in the world, and at with average width of 1.5 km. Its narrowest part is at Kandilli with a width of just 700 meters. Strong currents are also here at 4-8 knots sets. Two layers of current (surface and undercurrent) prevail over the Strait. Surface current (main current) flows from the Black Sea to the Agean Sea. Undercurrent flows below the surface current in reverse direction. Average depth in the Strait is about 37 meters. There are several sharp bends in this strait; four of them require manoeuvres of up to 80 degrees and up to 12 alternating in course. The following photos in Fig.1 show one of the difficult points (Kandilli and Yenikoy) in this strait and illustrate how difficult ship handling can be in these areas.

Fig. 1 Passing at Kandilli and Yenikoy in the Istanbul Strait (Photos: C. Istikbal)

The average numbers of ships' passing through the Istanbul Strait are 48,456 yearly, 4,038 for monthly and 133 for daily. The Istanbul Strait is the second strait in having the densest traffic (after the Malacca Strait) and according to passing ratios, the volume of traffic in the Strait is 3 times greater than in Suez Canal, 4 times greater than in the Panama Canal and 2 times greater than in the Kiel Canal[1].

Istanbul Strait mainly has three periods for safe navigation, that in term of routing systems:

The first period (1965 to 1982), when the routing system of passing on the starboard side of the other ships was adopted, known as "Left-Side Navigation".

The second period (1982 to 1994), when the routing system was changed to passing on the port side of other ships, known as "Right-Side Navigation".

The third period (since 1994) was when the routing system with Traffic Separation Schemes (TSS) was established, this on Right-Side Navigation. And, at the end of 2003 the Vessel Traffic Services (VTS) was established in covering area of the Istanbul Strait, the Marmara Sea and the Canakkale Strait called the Turkish Strait.

1 objectives

In this study, we mainly aim to illustrate the current traffic situation in the Istanbul Strait for a fundamental study, to understand the role of the human factors in accidents then we carry out some research for minimizing the effect of navigator's insufficient behaviour. For this purpose, some past studies are explained as literature review in following parts. It helps to compare with current situations and give a guideline for research. The risk of maritime accidents in the Istanbul Strait is investigated by using updated data for understanding the characteristics of accidents in the Strait. Then present and future research is determined to improve a methodology for preventing human error.

Evaluation methods of human behaviour are restricted, that's why Ship Handling Simulator and some convenient tools such as; the Heart Rate Monitor and the Eye Mark Recorder for observing human characteristics in physical and psychological conditions, these are determined as suitable tools not only in authors' research field but also in supported researches.

2 Literature Review

Tan and Otay (1998, 1999) defined a stochastic model to estimate the maritime accidents concerning of tanker traffic for narrow waterways. The drift probabilities and random arrival of ships in the model achieved by the Markov chain model, and from which they developed a state-space representation, location of ships at a given time. The model clarified that the expected number of accidents is proportional to the square of the tanker arrival rate. The most important characteristic of this model is not depending on time[2-3].

Brito (2000) investigated the traffic condition in the Istanbul Strait by using the Markov chain model in two cases. If the present condition of the traffic is not congested and is congested for the future condition to find the costs for any delays in these traffic conditions. According to Brito, the estimated cost of moving oil from Baku to Ceyhan is $1.00 to $2.00 per barrel, when the cost comes in at less than 20 cents per barrel if it has moved by tanker. According to his research; one of the ways to increase traffic flow in the Strait is to reduce the separation between ships, unfortunately this lead to an increased probability of accidents and coincides with Tan and Otay (1999) as the probability of an accident in the Strait rises with the square of the volume of traffic[4].

Otay and Ozkan (2003) developed a mathematical model to simulate the passage through the Istanbul Strait and focused on ship manoeuvring. The model estimated the probability of casualties by using the geographical characteristics. The model verified that ships proceeding southbound are more disadvantageous of ship handling, because of the surface current. That's why the larger southbound ships are found to be the main cause of collisions and also the model gives the risk of collision as higher than grounding and stranding in the Strait. Their paper shows that the effect of ship manoeuvring on accidents depends on ship size and their position in the Strait. The risk maps for collision, grounding and stranding are presented in their paper. It shows that during the passage of 100,000 ships; 46 of them collided and 23 of them were stranded or grounded[5].

Yurtoren (2004) explained that the volume of traffic, both southbound and northbound and for different traffic regimes is increased from 3.2 ships/hour to 5.6 ships/hour. The latent environmental stress due to the geographical restrictions and ship handling difficulties, and the latent environmental stress due to traffic congestion increased slightly through the periods, in both routes. He defined the stress is rarely imposed by geographical restrictions in the south entrance of the Strait, but the stress due to traffic congestion is enormous. That's why the south area of the Strait is the most difficult area to operate a ship. On the other hand, the middle and north area of the Strait has a comparatively high stress due to the geographical restrictions; but the stress due to traffic is not so great. Finally, he described the encounter criteria for large size ships passing through the Strait by using marine simulation[6].

Yazici and Otay (2006) developed a real time traffic control tool for safety routes; it can be applied not only in the Istanbul Strait but also in other waterways. The model consists of two algorithms for the main casualties as grounding and collision; the "Grounding Only" algorithm is for any grounding and/or stranding condition and the "Collision Combined" algorithm is employed when the time is less than 3 minutes before collision, includes the other algorithm. These two algorithms determine the total casualty probability for every route and the model gives a suggested course for the minimum probability[7].

Ece (2006) defined the navigational constraints of the Istanbul Strait, in a wide field as; geographical, meteorological, hydrographical, oceanographical, economic, strategic, legal issues, maritime traffic, the casualties and casualty statistics, current safety measures and innocent passage. The casualties and near miss are investigated by using the statistical methods for the different navigation regimes. In the part of statistical analysis, the collisions and contacts are evaluated as individual events based on the number of interfered ships in the event. And, a regression model predicts the probability of maritime accidents in the Istanbul Strait, as defined in the paper[1].

3 The Risk Profile of the Istanbul Strait

The data of maritime accidents in the Istanbul Strait collected from various sources such as; T.C. Ministry of Transport Undersecretariat for Maritime Affairs, Turkish Maritime Pilots' Association, Turkish Marine Research Foundation (TUDAV) and related publications, internet pages for the 75 years between 1930 and 2005[8-11]. Then, the accident database constituted into ten parameters and the variables are categorized as shown in Table 1. In the analysing part, the data of accidents between 1982 and 2005 are investigated for understanding of the general perspective, and the near miss is separated from accident database and not investigated in this study. Then, the time interval is divided into three periods as shown in Table 2. Also, collision and contact in the accident database are taken as one event. Some researchers utilize the accident data of collisions separately for each ship in collision. But this makes double counted data, and affects the results in reality. In any case of collision and contact, maybe only one side of the shipping is faulty or with two parts, the event and the result should be evaluated in one case as collision and/or contact.

The number of the data in maritime accidents is 541 and is used for analysing as shown in Table 2. The number of near miss between 1994 and 2005 is 175. To consider the maritime accident database, the authors wish to inform that there is much missing data, which is not recorded, or unknown data, due to insufficient recording of maritime casualties in the Istanbul Strait. That's why this missing data is illustrated by "Unfounded: Unf." in the database and it is shown in all Fig.s.

Table 1 Components of the accident database

Parameters	Categories
Ship's Name	×××
Flag	×××
Ship's Type	General Cargo Bulk Carrier Tankers (Product, Chemical, LNG and LPG) Passenger (Passenger, Ferryboat and Sea Bus) Others
Gross Tonnage-GRT	0–500;–3,000;–10,000;–25,000; Over 25,000
Accident Date	Date, Month, Year
Accident Time	Daytime (D), Twilight (T), Nighttime (N)
Position of accident	Area-A, Area-B, Area-C, Area-D
Type of accident	Grounding Contact

	Stranding	Fire
	Collision	Sinking
Cause of accident	Human Error	Restricted visibility
	Dense Traffic	Failure
	Weather	Security threats
	Current	Others
Remarks	Death, injured or missed person, pilot onboard or not, etc.	

Table 2 The number of accidents in the Istanbul Strait

Time Intervals are investigated in this study		The Number of Accidents
Right-Side Navigation to TSS	(1982-1993)	277
TSS to 2004	(1994-2003)	235
VTS to 2005	(2004-2005)	29
Total (Right-Side Navigation to 2005)	(1982-2005)	541

4 Passing through the Istanbul Strait

The average numbers passing through the Istanbul Strait is 48,456 yearly, 4,038 for monthly and 133 for daily depend on last 10 years. The Fig. 2 shows the number of passing through the Istanbul Strait and is not enough to understand the existing (real) marine traffic in the Strait. This data just belongs to ships that have passed directly and entered/leaved any port in the Strait. They do not include the local traffic. The local traffic in the Strait is daily as 1,410 voyages of ferryboats, 76 voyages of small ferry, 125 voyages of sea bus and 645 voyages of pleasure boats and plus sailing boats, motor yacht and fishing boats[6].

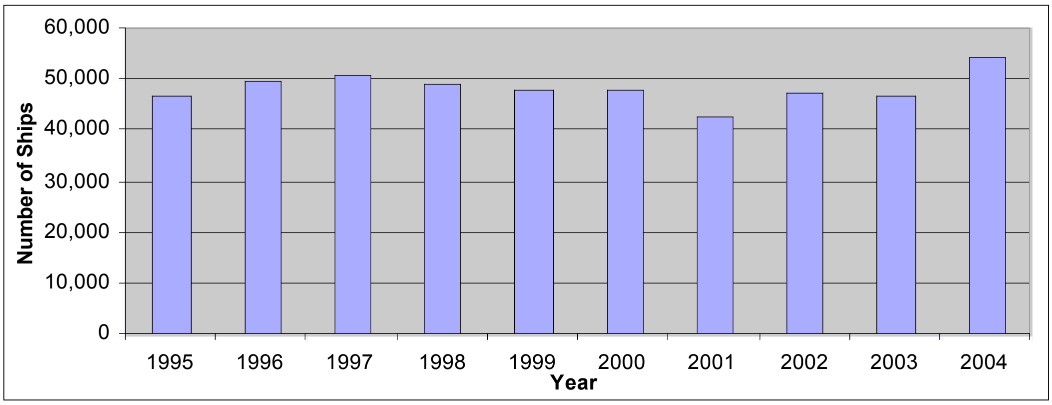

Fig. 2 The number of passing through the Istanbul Strait for 10 years

In Fig. 2, 54,564 ships passed through the Istanbul Strait in 2004 and 9,399 (17.2%) of them were tankers (product tanker, chemical tanker, LPG and LNG). The number of tankers increased year by year, from 9% to 17% as shown in Fig. 3.

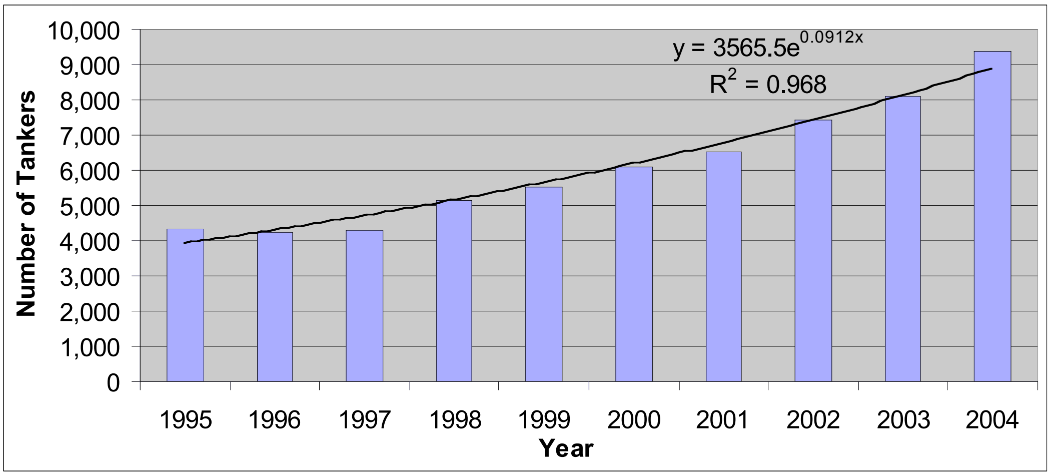

Fig. 3 Passing of tankers through the Istanbul Strait for 10 years

In 2004, the monthly number of passages average was 4,547 and the daily average was 149. In 2003 the monthly average was 3,911, 129 daily. It shows that VTS which started to actual operate at the end of 2003, had an effective role for increasing the number of passage without making any concession to safety (the traffic increasing rate in the Strait is 16.2%, and it shows that the Strait is becoming full capacity under these maritime regulations and theme). Also, the ratio of ships' length (less than 200 m) passing through the Strait is 94.4% and tonnage less than 500 GRT is 3.9% in 2004 as shown in Fig. 4. According to the "Maritime Traffic Regulations for the Turkish Straits" that known as 1998 Guidelines, large vessels have a length overall of 200 m. or more, and these vessels can not keep their course in the Traffic Separation Schemes[12]. The first maritime traffic regulations adopted by IMO Maritime Safety Committee (MSC) for the Turkish Straits came into force on 1st of July, 1994. It included some important precautions for safety passage in the Turkish Strait region, such as; establishment of TSS, ships longer than 200 m. can pass only in daytime, etc. In 1998, these regulations were revised after 4 years of practice and experience. IMO adopted 1998 Guidelines in MSC 71 and circulated IMO Rules and Recommendations as "Rules and Regulations on Navigation through the Strait of Istanbul, the Strait of Canakkale and the Marmara Sea" (IMO Resolution A.857 (20) and A.827 (19))[13].

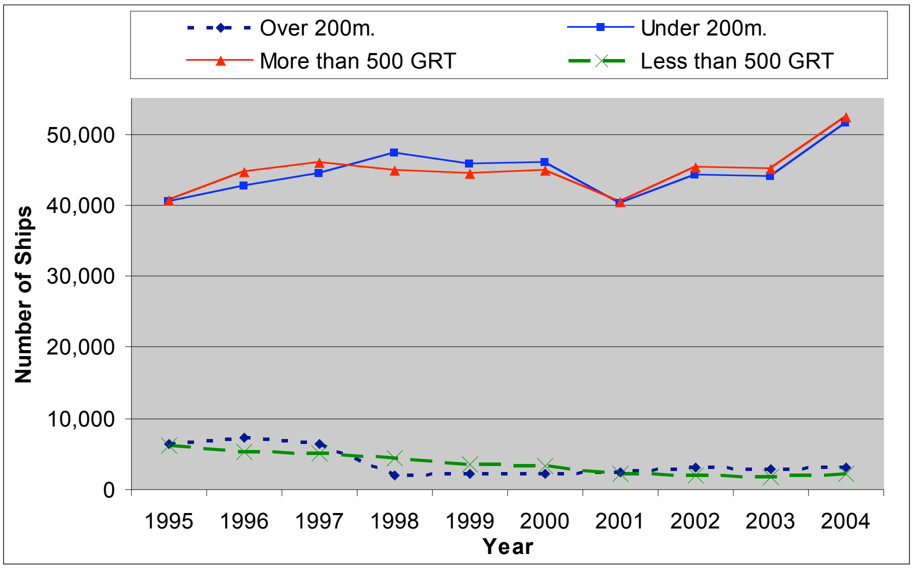

Fig. 4 The number of passing based on ships' length and gross tonnage

The number of passing based on Turkish flag and foreign flag shows that there is a decreasing ratio of Turkish flag from 39.1% in 1997 to 22.5% in 2004 as shown in Fig. 5.

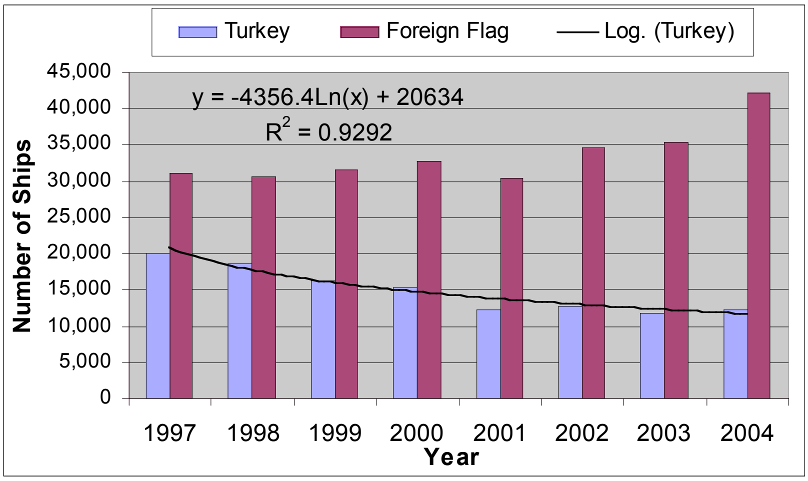

Fig. 5 Ships' passing ratio under Turkish flag

According to the waiting hours for passing through the Istanbul Strait between 2000 and 2004, the longest duration for suspending traffic in the Strait is in 2004 (mainly for tankers passing). In 2004, the opening ratio of the Strait is 80%; it can also be interpreted as available capacity. On the other hand, the maximum passing was done in 2004; it also shows the effectiveness of VTS in the Turkish Strait. The waiting duration of maritime traffic in the Istanbul Strait is 8.8 days per year, due to sea and weather conditions such as fog, current, etc., less than half a day per year due to accidents and emergency situations and 3 days per year due to the other reasons, except tanker passage.

5 The maritime accidents in the Istanbul Strait

When the accident database is investigated, the causes of maritime accidents in the Istanbul Strait are identified as; Human error, Dense traffic, Weather conditions, Surface current, the Natural structure of the Istanbul Strait, Restricted visibility, Failure, Security Threats (Sabotage, etc.), and Others (high energy lines, insufficient navigational aids on shore side, insufficient communication, bad affect of the shore lights, etc.). Surface current is one of the most important factors in those accidents North to South, and it much affects southbound ships. This verifies the number of accidents is higher than which ships proceeding northbound[1]. However, when the ship proceeding the same direction with current, her speed increases and that affects to ships grounding and getting out of the own traffic line, so the potential of collision increases[14].

The Fig. 6 shows the frequency of accidents between 1982 and 2005. The decreasing ratio of accident is 20% in 2004 by comparing with the previous year and the least accidents were in 2005. There is a rapid decrease in the accidents.

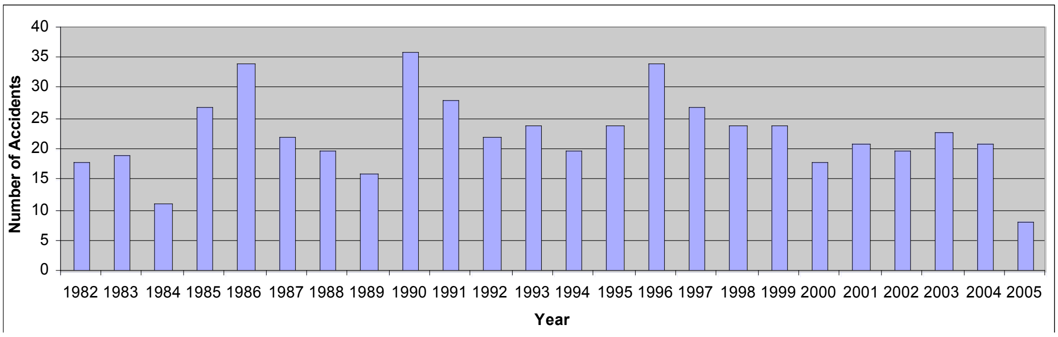

Fig. 6 The frequency of accidents between 1982 and 2005

The most accidents occurred in the winter season, February and March (12.7%), January (12.2%) then in December (10.2%), the minimum accidents occurred in spring season in April (5.0%) and June (5.9%) between 1982 and 2005, as shown in Fig. 7. On the other hand, after VTS has been provided the number of accidents in winter season decreased and there wasn't any accident in April and October. It is supposed that there was no accident in April and October due to VTS.

The affect of light on the visual view is considered as three levels; day time (the clear view based on the sun light is luminous), twilight (the time duration between darkness and luminous) and night (there isn't any sun light, completely darkness). The Fig. 8 shows the ratios of accidents occurred at day, twilight and night. Ece (2006) clarified the time of accidents based on watchkeeping times and explained that the highest accidents occurred between 04:00 and 08:00 (the ratio is 12.5%). She focused the main reason of that is human error, such as sleeplessness, fatigue and occupational boredom, etc.[1].

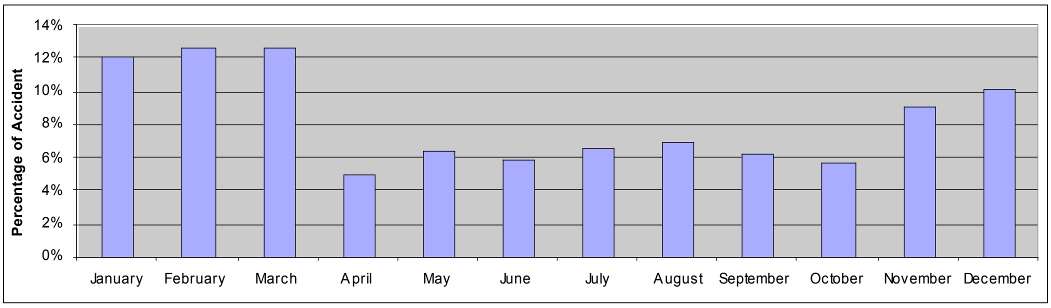

Fig. 7 The percentage of accidents via to months between 1982 and 2005

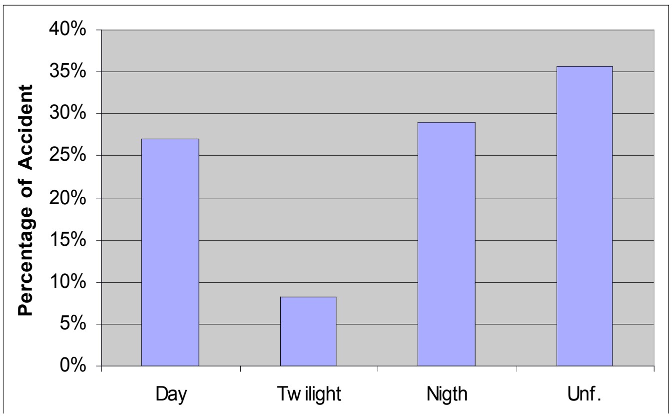

Fig. 8 The accident percentage based on luminous situation

When the causes of accidents are investigated, human error has the highest affect to cause an accident. And secondly, the accidents occur due to rudder and engine failure. The environmental conditions (bad weather, foggy visibility and strong surface current) also have strong affect to cause an accident. On the other hand, the percentage of missing data is so high due to not recording the main reason of accidents properly. It is estimated that 17.5% of the missing data for the main reason of accidents is dense traffic, 9.3% of that belongs to the natural structure of the Strait and 5% of that belongs to human error[1].

The type of accident is defined into 6 categories as shown in Fig. 9. Collision (39.6%) and grounding (38.3%) are the highest accidents in the Strait and sinking (2.8%) is the minimum.

The area of the Istanbul Strait is divided into 4 areas according to the environmental traffic condition, such as; local traffic situation, strong surface current, sharp turnings and so on. The area between South Entrance and the line of Çengelköy-Ortaköy is defined as Area-A; it includes the mainly local traffic (especially crossing the TSS). The Area-B is between the line of Çengelköy-Ortaköy, and the line of Çubuklu-İstinye included the critical changing of route, due to strong surface current. The Area-C is between the line of Çubuklu-İstinye and Sariyer including the sharpest altering of course up to 80 degrees difference. The Area-D is between Sarıyer and North Entrance of the Strait including the final course altering, and then direct proceeding. The Area-A has the highest accidents (41.8%) among the other areas and the minimum accidents in Area-D (7.9%).

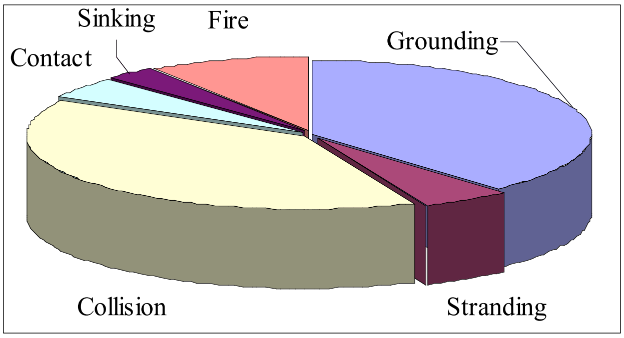

Fig. 9 The ratio of accidents based on the type of accident

Fig. 10 shows the type of accident occurred in position among the areas. In Area-A, it is so clear that the main accident is collision. There is 62% of collisions occurred in this area. And, fire is the highest in Area-A. It can be explained as; the cause of the fire is mainly sabotage to passenger ships and almost all passenger terminals are in Area-A.

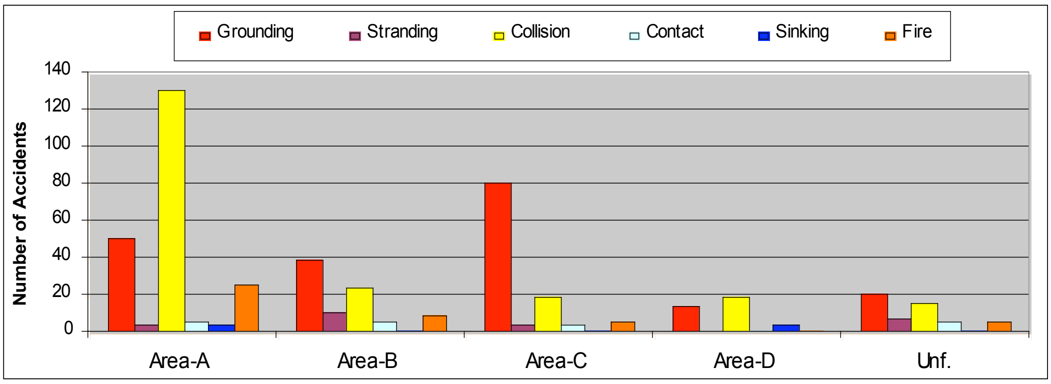

Fig. 10 The frequency of accident based on the type of accident among the areas

In Area-B, stranding is the highest among the areas and also there is influential grounding. The effective surface current and counter currents are in Area-B and affect the ships to get out of their routes; then it is easier to lose control of the ship's manoeuvrability for captains unfamiliar to the Strait. Grounding is the highest in Area-C compared with the other areas. There are many wrecks, shallow waters and sharper altering course in Area-C. The widest area of the Strait is Area-D. The highest accident in this area is collision due mainly to human error. On the other hand, the highest ratio for sinking belongs to Area-D among the other areas. This area is open for the bad weather and sea condition that comes from Black Sea and is dangerous for keeping ship's stability, if there is not sufficient seaworthiness or cargo lashing. Because the main cause of many accidents in this area occurred due to the poor condition of ships. And, Area-D has higher fatality due to foundering and/or sinking. It is difficult to carry out search and rescue operations in such bad weather/rough sea condition.

According to ships' type, general cargo ships have the highest accidents as shown in Fig. 11. And also, the percentage of accidents interfered by tankers shows Istanbul is face to face with the potential disaster. On the other hand the accidents of tankers between 2004 and 2005 (after VTS) the accident ratio was dramatically decreased by a ratio of 1/8.

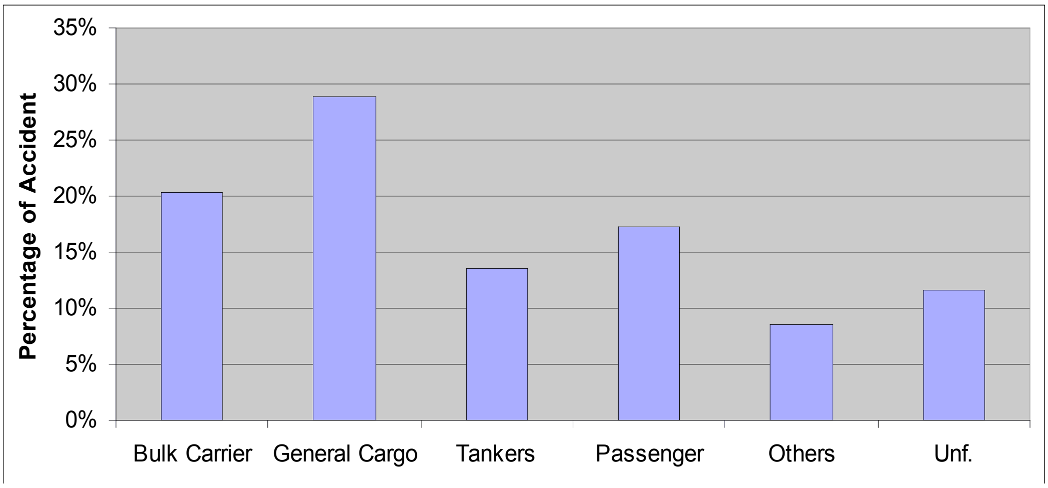

Fig. 11 The percentage of accidents based on the ships' type

The highest ratio of accidents belongs to the ships are 500−3,000 GRT between 1982 and 2005 as shown in Fig. 12. The accident ratio of less than 500 GRT is 16.1 and for the ships over 25,000 GRT is 7.2%. The total accident ratio for the ships under 10,000 GRT is 3 times higher compared with over 10,000 GRT. But after 2004, the number of accident interfered under 10,000 GRT decreases dramatically by 50%.

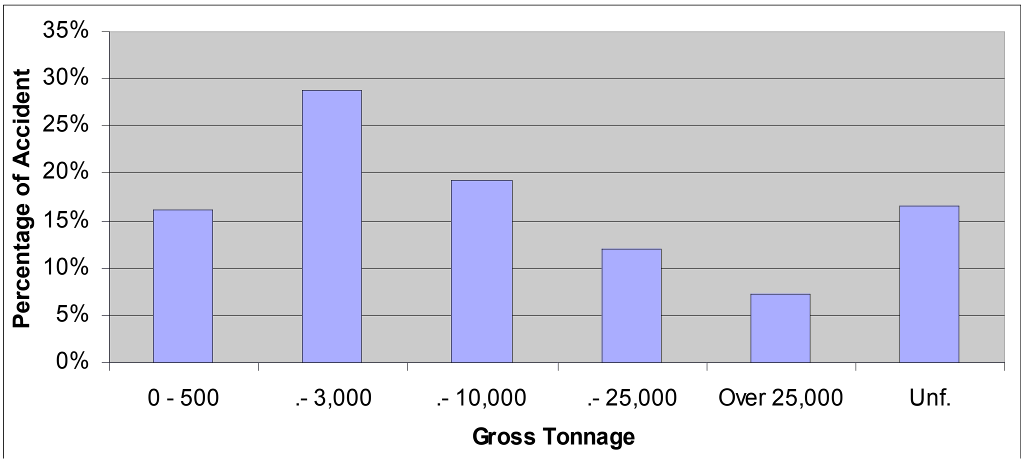

Fig. 12 The percentage of accidents based on the ships' tonnage

The statistical analysis is carried out by using Microsoft Excel. The parameters are defined based on the accident database. Firstly, either there is any statistical relation among the parameters or not is investigated by using χ^2 Test (Chi-Square Test) to define the differences or not[15]. The Chi-Square Test for accident year is carried out not only for the coming years in 1982-2005 but also for the time intervals (periods) as mentioned before into three periods. Then, the correlations (Pearson's product moment correlation) among the parameters are investigated and tested if they are significant or not. Finally, the power and tendency among the parameters are interpreted. The statistical analysis can be summarized as below;

6 The Chi-Square Test

Table 3 shows that there are statistical relations among the parameters as a result of χ^2 test. It means that probability of the χ^2 distribution is founded less than 0.05 and values are significant at the Asymptotic Significance.

When the accidents was investigated based on months, the general cargo ships had accidents mostly in January and the expected accidents numbers in April was higher for them. And, tanker ships had accidents in March higher than the other months. According to distribution of the group of gross tonnage that interfered accidents based on months, there was not found any difference, relation between the gross tonnage and months. On the other hand, ships under 10,000 GRT had accidents mostly in winter season (January, February and March). According to type of accidents, the most decreasing of accidents in December is fire and also the contacts much decreased in February.

Table 3 The results of χ^2 test

	Ships' Type	Gross Tonnage	Year	Month	D-T-N	Position of Accident	Type of Accident	Cause of Accident
Ships' Type	-							
Gross Tonnage	O	-						
Year (Periods)	O	O	-					
Month	X	X	X	-				
D-T-N	O	O	O	X	-			
Position of Accident	O	O	O	X	O	-		
Type of Accident	O	O	O	X	X	O	-	
Cause of Accident	O	O	O	X	O	O	O	-
Remarks	**X:** P > 0.05 (Not significant), **O:** P < 0.05 (Significant)							

When the accidents investigated based on the luminous condition as daytime, twilight and nighttime, the most accidents in March occurred in the daytime and the most accidents in February occurred at night. According to ships' type which interfered accidents based on the luminous condition, the general cargo ships and bulk carriers mainly had accidents at night, and the number of accidents was higher than expected. On the other hand, there was a high decrease in accidents occurred at nights for the passenger ships. The number of missing data related with time of accidents was high. That's why there was not found any relation between gross tonnage and time of the accidents, and it was not so clear that when the ships between 10,000 and 25,000 GRT interfered the accidents. The ships over 25,000 GRT had accidents at night. Any difference of type of accident based on the luminous condition was determined. But, the collision in the daytime was higher than expected, and grounding mainly occurred at night. According to the cause of accident and time of the accidents, the main reason of the accidents occurred at night was due to human error as shown Fig. 13. Restricted visibility has strong effect to increase accidents during the daytime, and the accidents in twilight increased due to current effect. The accidents caused by security threats were higher than expected in day time and twilight. There was an excessive decreasing for nighttime accidents caused by other reasons. The relationship between accident position and time of accident shows that there was a similarity in Area-A and Area-B based on the accidents occurring time. But, the difference among areas based on the accident time was determined, due to the missing data was high in Area-C for the accident time and expected numbers of accidents in the daytime. The highest accidents in daytime were occurred in Area-A, and the highest accidents at night were occurred in Area-C.

When the accidents investigated based on the ships' type; there was a difference among the periods of navigation regime. Bulk carriers had more accidents in the year 1994-2003 and after 2004 there was an excessive decreasing for them. But, comparing with the other ships' type had accidents after 2004, bulk carriers has more accidents than expected. Passenger ships have no interference in any accidents after 2004. Bulk carriers were the group which has highest accidents for over 10,000 GRT, and the general cargo ships were for less than 10,000 GRT. It shows that the number of bulk carries under 10,000 GRT decreased to have accident and also there was an excessive decreasing for the general cargo ships over 25,000 GRT. General cargo ships had the highest accidents due to human error. Failure mostly caused bulk carriers and general cargo ships for having accidents. The main reason to have accident for passengers was security threats. Bad weather conditions strongly affected to bulk carriers and tended to increase the number of accidents. Current had the most effect for general cargo ships, to cause an accident. Restricted visibility mainly affected to tankers and to be the reason for increasing tanker accidents. The passenger ships had more accidents in Area-A than in other areas and general cargo ships had more accidents in the other areas than Area-A, and also they had more accidents than expected in Area-B.

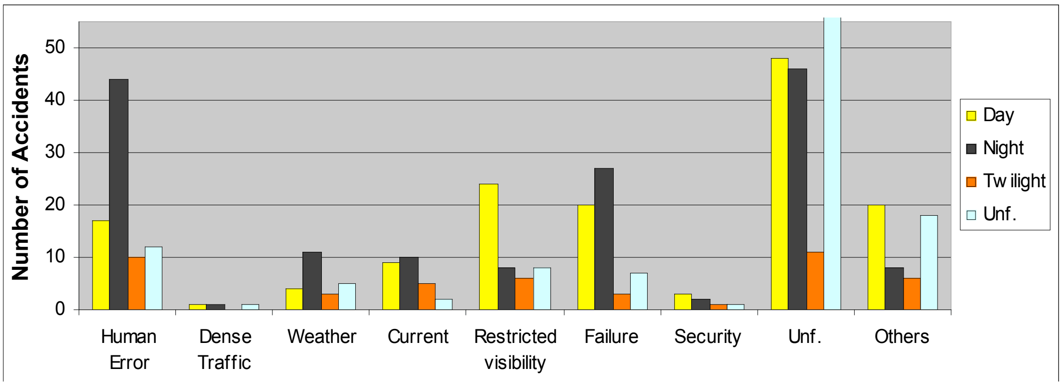

Fig. 13 The accident frequency based on luminous condition via to cause of accident

After 1994, there was a strong decrease of accidents for the ships over 10,000 GRT. On the other hand, less than 10,000 GRT had more accidents than expected and over 25,000 GRT had fewer accidents than assumed in the period of TSS. According to cause of accidents based on gross tonnage groups, human error strongly effected to the ships over 10,000 GRT. Failure and security mainly affected to ships under 10,000 GRT. The bad weather condition also affected to the ships between 10,000 GRT and 25,000 GRT and tended to increase accidents for this group. In Area-A the highest accident ratio belonged to under 10,000 GRT and in Area-B the ships over 25,000 GRT had more accidents than expected. There was a decreasing in Area-D for the ships 10-25,000 GRT. On the other hand, the missing date of tonnage in Area-C was high level.

When the type of accidents is considered, there was a decrease of groundings, stranding and fire after 1994. Especially collision and grounding had dramatically decreased after VTS operation. Collision and fire were mainly occurred in Area-A, stranding was mainly occurred in Area-B, grounding was mainly occurred in Area-C and for Area-D sinking had the highest ratio. In Area-A, grounding and stranding were less than expected, but collision and fire increased. Stranding ratio increased in Area-B. Grounding in Area-C was higher than expected, but collision was less, and sinking increased in Area-D. The passenger and general cargo ships mostly interfered to collision, and for grounding general cargo ships and bulk carriers had more accidents. There was an increasing into groundings for bulk carrier and also there was a decreasing for them to have collision.

The most effective parameters to cause accident were human error and restricted visibility. After 1994, human error and failure increased and the affect of weather and visibility decreased in the accidents. And also, accidents due to security had dropped to zero level after 1994. The highest human error mainly occurred in collisions in restricted visibility. Groundings were mainly caused by human error and failure. The current tended to increase grounding. The main reason for sinking was bad weather. Fire mainly caused by security threats.

The accidents in Area-A and C increased after TSS, but for the other areas it decreased. After VTS, the accidents into all areas decreased, especially in Area-B and C. Human error and failure were the highest in Area-A, and also failure was higher in Area-C. The accidents due to restricted visibility decreased in Area-A, the accidents due to current and restricted visibility increased in Area-B, the accidents due to failure and bad weather increased in Area-C and the accidents due to restricted visibility increased in Area-D.

7 The correlation (Pearson's product moment correlation)

Table 4 shows the coefficients of correlation among the parameters. The results were not determined as so powerful and significant. The coefficient of correlation was small but it can give some idea about the tendency among the parameters. E.g. there is a negative relation between ships' type and accident year; ships' type has positive relation with the other parameters. Year has a negative correlation with time of accident based on the luminous condition and cause of the accident, and correlation with the other parameters is positive.

Table 4 The results of correlation analysis

	Ships' Type	Gross Tonnage	Year	Month	D-T-N	Position of Accident	Type of Accident	Cause of Accident
Ships' Type	1.000							
Gross Tonnage	0.144*	1.000						
Year	-0.045*	0.042	1.000					
Month	0.310	0.021	0.032	1.000				
D-T-N	0.286*	0.113*	-0.061*	0.301	1.000			
Position of Accident	0.224*	0.095*	0.021*	0.145	0.125*	1.000		
Type of Accident	0.097*	0.036	0.022	0.009	0.014	0.187*	1.000	
Cause of Accident	0.166*	0.108*	-0.074	0.001	0.351*	0.084*	0.043	1.000

Remark	* is significant according to t-test (P<0.05) of coefficients.

8 Research field

Until this part the potential risks for maritime accidents is explained by using accidents statistics and also some models are introduced as past work on the safety navigation through the Istanbul Strait. All these item mainly affect theoretical issues, unfortunately in practice all models and the estimations about the safety concept become insufficient, because of an including human factors. Human should be considered in the central of all systems. That's why the models and analysis for the suggesting better countermeasures to improve safety should care about the human mechanism. Past works and also the statistical analysis such as explained in this paper are just enough to understand the condition and may recommend some safety measures on the environment, on management, on the traffic rules and so on. They can be called as "Simple Accident Model"[16].

When we defined the safety navigation system for the Istanbul Strait and/or the similar waterways based on the concept of Man, Machine, Media and Management (4M), the existing international rules and safety measures in the local region can cover the high ratio of Machine, Media and Management as follows:

To care about Media, there are excessive improvements in the Istanbul Strait, for example; Vessel Traffic Services and the components (facilities and technical equipments) of this system. And also the services of escort/tug, research and salvage, pilotage and the aids to navigation are improved. The environmental conditions are almost revised and many types of equipment are fitted for assisting of passage, but it doesn't mean that is all. Navigators sometimes continue to have wrong interpretation or not to recognize some buoys, lights, etc. Or, they become confused by visual mixed and congested shore lights.

The rules related with safety navigation are improving under the international maritime conventions and the equipments on navigation support system are examined simultaneously improving of technology. The latest of them is Automatic Information System-AIS. At the 77th Session of Maritime Safety Committee (28 May-6 June 2003), the new technology on board merchant ships was issued for the efficiency and effectiveness of watchkeeping to use the systems to make better decisions, and to improve the safety of operations. The report said that; "*Training for the use of such systems should take into account the special human element issues associated with the human machine interface, the recognition that automation changes a task it was meant to support and that operators will monitor less effectively when automation is installed.*"

It is easy to say that the most important item based on the Machine concept is the human machine interface called as ergonomics (or human engineering). The interface should be as easy as serviceable. On the other hand, there are lots of information and many source of information on the bridge, and that makes the navigator become overload. And also, when there is a contradiction between these information sources (such as the difference of target tracking between ARPA and AIS), this situation tending to the navigator become more complex.

Kobayashi (2006) defined the behaviour of navigator as the function of navigator's competency and navigational condition. When the difference between required competency by navigational environment and attainable competency by navigator exists, it tends navigator to make insufficient behaviour. In other words, when a quantity of the task exceeds human competency, human behaviour would be insufficient[17]. And, this insufficient behaviour is a potential cause for maritime accident. Not for every time, but it is the risk of maritime accident. There are some researches on this issue by using the Ship Handling Simulator (SHS) for understanding of the navigator's behaviour under his responsibility[18-20]. It shows that SHS is very effective tool. In this sense, the authors had parallel researches to investigated human factors on maritime field such as follows (they can be called as "Intermediate Accident Model"[16] and they are the fundamental researches)：

- Investigating of characteristics of the mental workload on actual ship with using Heart Rate Monitor-HRM in the Istanbul Strait in some cases such as berthing, unberthing, anchoring and passing through the Strait. In the paper, the navigators' interactions among the bridge team were also founded[21].

- Defining the view points of navigator as the results of eye movements by utilizing SHS. The navigator's view points, fixation durations and changes in the view points were evaluated. The tendency was defined as the navigator firstly caring to the inside field (bridge) and then perceives outside field for understanding the situation. The equal balance between images of inside and outside of the bridge is the best way to realize the situational awareness in navigation[22]. In case of many collision accidents in the past, most of the causes in the accidents were judged as improper lookout as human error. On the other hand look out, the visual images in the environmental is an important source to take information about the own situation for any decision to consider about existing situation.

- The characteristics of navigator and human reliability were investigated and some information was given for analyzing of human reliability. The Technique for Human Error Rate Prediction-THERP is one of the useful techniques for human reliability analysis. The main problem of that is how to design human behaviour and include some shortcomings. That's why it is better to carry specific research to understand the characteristics of human as a navigator[23].

After that time, the main research will be a continuous study on the fundamental researches and it will be based on the main aim of this paper for developing a "Contemporary Accident Model" via to human error[16]. The following items are prepared for this aim：

- The updated situation for the maritime safety and maritime accidents are considered (in this paper the knowledge about the maritime accident in the Istanbul Strait is updated and the risks are identified).

- Simulator scenarios are developed for Istanbul Strait. And, two specific equipments (Heart Rate Monitor and Eye Mark Recorder) are involved for understanding of navigator behaviour. These equipments are considered as objective tool and a questionnaire is prepared for the subjective consideration. This questionnaire mainly consists of four parts. There are some questions for clarify the profile of participants at the first section. The first part will be answered before carrying out the scenario, the other questions related with the situation during the scenario and after completing the scenario, and the final part is for emergency cases.

- After executing simulator scenarios, they are compared with another waterway as similar with Istanbul Strait. Seto Inland Sea (JAPAN) is the most available area for this purpose. Especially, for the fitting the same scale and for caring the most sharing patterns, the comparison will be as; Area-A in Istanbul Strait with Akashi Strait, Area-B with Kurishima Strait, Area-C with Kanmon Strait and Area-D with Bisan Seto. There will be some actual onboard experience for the Seto Inland Sea like as carried before in the Istanbul Strait.

- Finally, we can get enough knowledge for understanding navigator's behaviours. When the comparison is made for different waterways, the sharing human errors will be identified, and then appropriate measures can be defined on the contemporary model.

9 Conclusion

To investigate the maritime accidents, it is so important to keep information for reference and consideration of casual factors. According to IMO Resolution A.849 (20) "*Code for the Investigation of Marine Casualties and Incidents"* (*1997*), each Flag State has a duty to conduct an investigation into any accident (casualty) occurring to its ships. There is an obligation arising from Regulation I/21 of SOLAS for flag states to report casualties to the IMO. And also, the Code recommends Flag States to send a copy of the final report to the interested States, for invitation their significant and substantiated comments. There is an insufficient recording of maritime accidents in the Istanbul Strait, that's why the missing data is so high. Especially, with two different kinds of missing data based on the categorization by researchers overlap strongly affect to results and tend to the consideration in wrong interpretations. After that it might be better to develop an accident database based on the Code, and then the analysis can be more qualified.

To evaluate the human behaviour, EMR, HRM and SHS are the useful tools. To minimise the human error, to develop the quality of rules better than its quantity. The aim should be more user-friendly for handling of the equipments by caring ergonomics. On the other hand the environmental condition is improving for navigator as having better working condition comparing with the past condition. In 2006, the working conditions were reviewed at the 94th Maritime Session of the International Labour Conference. Now is a good time for increasing the motivation on board for getting good performance and then the aimed for quality becomes closer. But, human factors of qualified personnel can not be omitted; getting the required competency with the difference of attainable competency becomes minimal for protecting any on board risk situation.

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Risk Analysis Methods in Oil Spill Contingency Plans

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Abstract Risk analysis of oil spills is an essential step of developing contingency plans. It is not only the basis of oil spill risk assessment, but also the basis of decision making about treating risks. Risk analysis involves consideration of the sources of risk, their consequences and likelihood that those consequences may occur. The consequences and likelihood of each risk source determines the level of risk. It is inappropriate to assume that the quantitative is always better than qualitative analysis. Risk analysis may be undertaken to varying degrees of detail depending upon the risk, the purpose of the analysis, and the information, data and resources available. Risk analysis in contingency plans does not attempt to quantify absolute risk levels, but compares the relative risk between different geographical regions and allocates reasonably limited resources. Therefore, qualitative risk analysis is sufficient for the purpose of the developing a contingency plan. This paper describes the risk analysis methods that can be used in oil spill contingency plan, based on introducing methods of risk analysis.

Keywords ship; oil spill contingency plan; risk analysis; risk matrix

0 Introduction

China requires a large quantity of oil to develop economically. China is the third largest oil consumer country in the world now. In 2003 and 2004, the amount of imported oil had reached 100,000,000 tones each year. 90% of imported oil is transported by sea. In addition, there are approximately 200 ships along the coast of China every day, adding more and more large-size ships. These make the navigational environment more complicated. Therefore, the oil spill risk will increase.

Oil spills are directly linked to the events of ship's accidents. Oil spill risk can be reduced primarily through preventative measures. International conventions and national legislation has provided important preventative measures. These are necessary to prevent oil spills from occurring. Although these measures have been implemented, the accidents are still occurring. Therefore, we should have contingency plan in place so that we can respond to spills promptly, in order to reduce the damage from oil spills. Contingency plans continue to be established by the various organizations. These initial achievements have been an important start.

Preventing oil spills is the best strategy for avoiding potential damage to the environment. However, once a spill occurs, the best approach for containing and controlling the spill is to respond quickly and in a well-organized and effective manner. A response will be quick and organized if response measures have been planned ahead of time.

International conventions and national legislation demand that contingency plans are developed. They are also encouraged by governments，organizations and the stakeholders that may be impacted by oil spills.

Risk analysis of oil spills is an essential step to developing a contingency plan. Risk analysis involves consideration of the sources of risk, their consequences and the likelihood that those consequences may occur. The consequences and likelihood of each risk source determines the level of risk.

For developing contingency plans, the objectives of oil spill risk analysis are as follows,

Measuring the risk, understanding the nature of risk and to calculating the risk level;

Assigning priorities to risks; as it will not be possible to give equal protection to all sensitive resources, priorities need to be determined;

Providing the basis for further risk assessment and making decision of risk-reduction measures.

1 Research Methods

Literature review about the standard's documents, papers and materials of oil spill risk analysis and assessment;

Literature review about examples about ship's oil spill contingency plans;

Risk analysis methods are selected for use in developing oil spill contingency plans.

2 The steps and methods of risk analysis

2.1 Identify the risks

It is the precondition of risk analysis to identify risks. Comprehensive identification using a well-structured systematic process is critical, because a risk not identified at this step may be excluded from further analysis and assessment. Furthermore, it is not impossible to prevent and control risk. Identification of risks means knowing what might happen, where and when, why and how it can happen. It is necessary to consider possible causes and scenarios. The aim is to generate a comprehensive list of sources of risks.

Approaches used to identify risks include checklists, judgments based on experience and records, flow charts, brainstorming, systems analysis, scenario analysis and systems engineering techniques.

2.2 The risk analysis methods

Risk was defined as a measure of the probability and severity of consequences of undesirable events (Lowrance，1976). Risk analysis is about developing an understanding of the risk. Risk analysis involves consideration of the sources of risk, their consequences and likelihood that those consequences may occur. That is, the risk is analyzed by combining consequences and their likelihood. The consequences and likelihood of each risk source determines the level of risk.

There are three methods; qualitative, semi-quantitative and quantitative that can be used in risk analysis. These methods can be used separately or jointly.

2.2.1 Qualitative analysis

Qualitative analysis uses words (i.e. High medium, low) to describe the magnitude of potential consequences and likelihood that those consequences will occur. Those scales can be adapted or adjusted to suit the circumstances, and different descriptions may be used for different risks.

Qualitative analysis may be used:

□as an initial screening activity to identify risks that require more detailed analysis;

□where this kind of analysis is appropriate for decisions; or

□where the numerical data or resources are inadequate for a quantitative analysis.

2.2.2 Semi-quantitative analysis

In semi-quantitative analysis, qualitative scales are given values. The objective is to produce a more expanded ranking scale than is usually achieved in qualitative analysis, but not to suggest realistic values for risk such as is attempted in quantitative analysis. However, since the value allocated to each description may not bear an accurate relationship to the actual magnitude of consequences or likelihood, the numbers should only be combined using a formula that recognizes the limitations of the kinds of scales used.

Care must be taken with the use of semi-quantitative analysis because the numbers chosen may not properly reflect relativities and this can lead to inconsistent, anomalous or inappropriate outcomes. Semi-quantitative analysis may not differentiate properly between risks, particularly when either consequences or likelihood are extreme.

2.2.3 Quantitative analysis

Quantitative analysis uses numerical values for both consequences and likelihood. These may be estimated by modeling the possible outcomes of an event or set of events, or by extrapolation from experimental studies or past data. Because of the estimates, assumptions and extrapolations made in quantitative analysis, the outcomes are often imprecise. The quality of and validity of the risk analysis is dependent on the availability of data, and on the accuracy and completeness of the numerical values and the methods used.

In most cases, quantitative risk analysis will involve the use of computers and the need to obtain or develop appropriate software.

3 Risk analysis using in oil spill contingency plan

The contingency plan is a strategic document. Risk analysis in this document does not attempt to quantify absolute risk levels, but compares the relative risk between different geographical regions and allocates reasonably finite resources. In addition, not all the used data in the risk analysis are quantitative. Some of the data is estimation and judgment. Response to oil spill is not a discipline and it is often based on practice. Oil spill risk analyses are often qualitative or combining qualitative and quantitative values in contingency plan.

3.1 Identify oil spill risks

There is a link between oil spills and ship's accidents, such as collisions, groundings, fire and explosion and structural failure. It is relevant to refer to ship's accidents data if there is not enough spills data. The most common causes of spills are due to ship's collisions and groundings, but there are some exceptions. The spill hazards should be identified thoroughly and systematically.

Spill risk identifications are very important not only to spill risk analysis, but also to recommend risk-reduction decisions. For example, providing escort procedures after the grounding of the Exxon Valdez was successful in reducing the average oil spills from groundings, but it increased the average oil spills from collisions as the escort vessels returning from an escort assignment interacted with the tankers in the Prince William Sound. A further analysis showed that escort tugs are the highest cause of oil spills from collisions (Merrick et al., 2000).

3.2 Likelihood analysis of oil spill

The likelihood analysis of oil spills is used to determine the frequency， amount, type and the location of accidental spills from vessels in the specific geographic region. It should consider oil transport volume and type; historical spill records, which are needed over longer time spans in order to average results, traffic patterns and frequency, accident history reports and statistics, expert experiences and judgments. The frequency， amount and type of accidental spills from vessels varies widely between different locations, depending both on the amount of oil transported and combined effect of local factors which are chiefly related to navigational hazards. These local factors include traffic density, weather and sea conditions, visibility, water depth and the nature of the seabed. There are also considerations about open fishing times, locations, and duration (Stewart et al., 1986; Moller et al., 2003). The preferred method for estimating the likelihood is through the statistical analysis of data. Local past spills records are the best basis for the risk analysis. If local data are insufficient, analysis has to rely, at least in part, on other resources, like expert judgment and databases. Elicitating expert judgment is often crucial in performing risk analysis (Cooke, 1991; Moalesh et al, 1988). The data, which was used in analysis, has a significant impact on the results (Stewart et al, 1986). They will affect the reliability of outcomes and may increase the uncertainty of outcomes. The data may come from international and national databases. For example, historical spill records may come form ITOPF's spill databases. Over 30 years ITOPF have gathered some 470 pollution spill incidents of over 100 tonnes in 85 countries. Data on oil tanker shipments on specific routes may come from Lloyods Marine Intelligence Unit (Moller et al., 2003) and coastal ship reporting systems. Oil spill assessment in Australian Waters that was done by DNV calculated risks based on historical accident rates from around the world. Australian historical spill frequencies were then used to check if the results of the predictive model were similar to Australian historical experience. The results showed that the risk model is reasonably close to Australian historical data overall.

The likelihood is assigned a rating of three levels (see Table 1) ：

Table1 Likelihood ranking (three levels)

Level	Descriptor	Definition
3	High	One time per year
2	Medium	One time per ten years
1	Low	One time per 50 years

Or five levels (see Table 2):

Table 2 Likelihood ranking (five levels)

Level	Descriptor	Definition
5	Almost certain	One time per year
4	Likely	One time per 5 years
3	Possible	One time per 10 years
2	Unlikely	One time per 30 years
1	Rare	One time per 50 years

3.3 Consequence analysis

Key criteria for consequence are environmental and socio-economic vulnerability of the specific geographic region. The vulnerability analysis section of a contingency plan provides information about resources and economy that could be harmed in the event of a spill.

Amenity areas, ecologically sensitive areas, sea water intakes, fisheries, mariculture, seabirds and marine mammals and other resources likely to be threatened by oil spills should be identified. Since it will not be possible to give equal protection to all sensitive resources, priorities need to be determined. Account should be taken of the practical problems as well as the relative economic and environmental values of each resource and their sensitivity to oil pollution. Seasonal variations e.g. of beaches and breeding areas should be noted. Information on the location and sensitivity of resources and priorities for protection is frequently provided in the form of maps annexed to the contingency plan.

The chief impact of oil spills is of an economic nature, in the form of property damage, business interruption and consequential losses. Therefore, the losses can be described in monetary terms.

The consequence is assigned a rating of three levels (see Table 3)：

Table 3 Consequence ranking (3 levels)

Level	Descriptor	Losses（￥）
3	High	10 M above
2	Medium	1-10M
1	Low	0.1-1M

Or five levels (see Table 4):

Table 4 Consequence ranking (5 levels)

Level	Descriptor	Losses （￥）

5	Severe	100M above
4	Major	10-100M
3	Moderate	1-10M
2	Minor	0.1-1M
1	Negligible	0.1 M below

3.4 Risk measure (calculation)

The calculation of the level of risk can be seen utilizing the two-dimensional risk matrix combining likelihood and consequence.

$$\text{Risk}=\text{likelihood}\times\text{Consequence}$$

The final outcomes are in relative risk level values, rather than actual risks (Moller et al., 2003). Having established the comparative risk level applicable to individual impacts, it is possible to rank those risks. Three risk categories have been used: High (9), Medium (4-6), and Low (1-3) (see Table 5)or four risk categories have been used: Extreme（15-25）, High（8-12）, Moderate（4-6）, and Low（1-3）(see Table 6).

Table 5 Risk matrix (both 3 levels)

Likelihood	Consequence		
	Low	Medium	High
High	3	6	9
Medium	2	4	6
Low	1	2	3

Table 6 Risk matrix (both 5 levels)

Likelihood	Consequence				
	Negligible	Minor	Moderate	Major	Severe
Rare	1	2	3	4	5
Unlikely	2	4	6	8	10
Possible	3	6	9	12	15
Likely	4	8	12	16	20
Almost certain	5	10	15	20	25

The Risk Matrix is a qualitative tool for ranking the likelihood and consequence for oil spills accident that may occur and assigning the risk level. It is a simple and straightforward method. The value of the Risk Matrix lays not so much in establishing a specific risk level but in help to evaluate relative risks and decide risk-reduction measures as a result of subsequent prevention and /or mitigation step in developing contingency plans.

3.5 Combine existing controls

Evaluating the effectiveness, strengths and weaknesses of existing controls is part of the analysis process. It is also for improved allocation of response resources and to avoid implementing risk-reduction measures that would adversely affect system risk (Harrald et al., 1990 and Merrick et al., 2002). The risk-reduction measures include two aspects: the one is the preventative and the other is preparedness. The preventative measures can cause a decline in the accidents occurring; the preparedness measures can decrease damage from accidents. The preventative measures include the regulations of ship's navigation safety, facilities and management aimed at ship's navigation safety, such as double hulls of tanker, Vessel Traffic Systems, traffic separation scheme and area of evasion etc. Preparedness measures include the designation of a competent national authority to deal with marine emergencies, the preparation and adoption of national contingency plan, participation in regional or multilateral spill response arrangements, the provision of oil spill response equipment and materials, and the ratification of certain relevant international conventions. The level of preventative/preparedness may be ranked high (3), medium (2) and low (1). Effective preventative measures can decrease the levels of the likelihood (original level of likelihood - level of preventative); effective preparedness measures can decrease the levels of consequence (original level of consequence – level of preparedness).

3.6 Uncertainty of risk analysis

No matter which method is used, the uncertainty and variability of both consequences and likelihood should be considered in the analysis. In particular, the analysis of environmental risk, due to oil spills often produces results with a high degree of uncertainty. Reasons for this include:

□ the environment has a large number of components that interact in complex ways, and may not be fully understood;

□ the likelihood and consequence analysis of accident occurring may be based on improper data;

□ there are many factors affecting risk levels. The risk analysis consider the primary factors affecting risk levels, (e.g. the number and type of vessels, sensitive resources and the nature of oil, etc); there are other factors not considered in the risk analysis which may affect risk levels, (e.g. berth layouts, management level of company and complexity of ship routes, etc.);

□ the time scale relevant to environmental risk analysis may be long; it increases uncertainty of risk analysis.

4 Recommendations

Further research should be undertaken as follows:

(1) Establishing relevant standards for developing contingency plan, including oil spill risk analysis in order to assist organizations and related parties in planning;

(2) Researching the methods to minimize uncertainty of risk analysis;

(3) Providing special preventative and / or preparedness measures to identified areas of high risk, based on analysis results;

(4) Using geographic information system (GIS), combining computer software, construct a dynamic risk analysis model in developing contingency plans if there is appropriate numerical data.

Acknowledgements

The author is a visiting scholar in OH&S division of RIMT University, Melbourne from Nov. 2004 to Oct. 2005. The author wishes to thank all staff for helpful comments and courses on study of risk management. Especially, the author is especially indebted to Gloria Kyriacou and David Mclerne who assisted to revise this paper.

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7th Annual General Assembly
and Conference
AGA-7
October 16-18, 2006
The International Association of Maritime Universities
IAMU

ISBN 7-5632-2002-X
9 787563 220021 >

ISBN 7-5632-2002-X
定价：150.00元