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DEVELOPMENT OF AN INLAND WATERWAY TRANSPORT EDUCATION AND TRAINING PROGRAM IN CHINA
- Application of new technologies and quality standards system to improve river ship officers' education and training

By

LI YONG
The People’s Republic of China

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

MASTER OF SCIENCE

in

MARITIME EDUCATION AND TRAINING
(Nautical)

1999

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DECLARATION

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

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

...............................
Li, Yong

16 August 1999

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ACKNOWLEDGMENTS

No achievement would be possible without the generous assistance, instruction and supervision of the Professors and other staffs such as librarians at WMU. I would especially like to acknowledge the support and generous assistance of my supervisor, Professor Peter Muirhead. I would like to express my appreciation to my assessor Professor Günther Zade, and Professor Dieter Lemburg for their assessing this dissertation.

No acknowledgment could be complete without expressing my gratitude to the Ministry of Communications of the P. R. China, Wuhan Transportation University, and to those who gave me direct assistance from China, particularly to Professor Qi Chuanxing, and associate Professor Chen Wei.

I would like to express sincere appreciation to my sponsor, Global Foundation for Research and Scholarship (GFRS), for providing me with financial aid to successfully complete my study at WMU.

I would like to express my thanks to those who provided me with valuable information and advice I am indebted for their contribution.

I would also like to express my gratitude to all the people who have given me support and help.

My final gratitude goes to my parents and my wife, Xu Yunhua, and son, Li Geng for their on-going encouragement and full support during study in Sweden, without whom nothing is possible. In addition, I should also thank my sisters-in-law for their assistance to my family.
ABSTRACT

Title of Dissertation: Development of an Inland Waterway Transport Education and Training Program in China

Degree: MSc

This dissertation is an initial and full research of the Chinese inland waterway transport education and training (IWTET) system. Through the investigation, comparison and analysis of the external and internal environment for the Chinese IWTET, and consideration of the features of IWTET, a new IWTET program for improvement of the Chinese IWTET is proposed.

The inland waterway transport in China and in the selected countries is introduced and compared. An introduction to the Chinese IWTET and the historical development behind it is made. In order to define the features of IWTET, the similarities and differences between inland waterway transport and sea transport as well as IWTET and MET are identified by making a comparison. In order to identify the existing problems in and the opportunities for the Chinese IWTET, an analysis is made. Application of new technology to waterborne transport and IWTET is described. A framework of a quality standards system for IWTET is designed to ensure the quality of the Chinese IWTET. A framework for a new higher level IWTET program and curriculum for ship navigation course is established to improve and update the existing program and curriculum.

Recommendations are finally made for improvement of the Chinese IWTET through the actions of legislation, establishment of an IWTET committee, redistribution of IWTET centres, trial implementation of the new higher level IWTET program, improvement of internal conditions and promotion of international exchange.

Key words: China, Inland waterway transport, Education and training, River ship officer, New technology, Quality standards system
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LIST OF ABBREVIATIONS

AAP  Adaptive Auto Pilot
ABS  American Bureau of Shipping
AIS  Automatic Identification System
ARPA Automatic Radar Plotting Aid
BRM  Bridge Resources Management
BSI  British Standard Institute
CAC  Concerted Action Committee
CAI  Computer Assisted Instruction
CAL  Computer Assisted Learning
CBI  Computer Based Instruction
CBT  Computer Based Training
CD-ROM  Compact Disk - Read Only Memory
CFR  Code of Federal Regulations
CIT  Communication and Information Technology
CIWTETI  Chongqing Inland Waterway Transport Education and Training Institute
COC  Certificate of Competence
COLREGs  International Regulations for Preventing Collisions at Sea
DGPS  Differential Global Positioning System
DHSD  Digital High Speed Data
DNV  Det Norske Veritas
ECDIS  Electronic Chart Display and Information System
ECS  Electronic Chart System
ENC  Electronic Navigation Chart
EPIRB  Emergency Position Indicating Radio Beacon
FDI  Foreign Direct Investment
FIS  Fairway Information System
GDP  Gross Domestic Product
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<td>GLMA</td>
<td>Great Lakes Maritime Academy</td>
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<td>GLONASS</td>
<td>Global Navigation Satellite System</td>
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<td>GMDSS</td>
<td>Global Maritime Distress and Safety System</td>
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<td>GNP</td>
<td>Gross National Product</td>
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<td>GNSS</td>
<td>Global Navigation Satellite System</td>
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<td>GPS</td>
<td>Global Positioning System</td>
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<td>HSA</td>
<td>Harbour Superintendency Administration</td>
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<td>HEQC</td>
<td>High Education Quality Committee</td>
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<td>HIWTETI</td>
<td>Heilongjiang Inland Waterway Transport Education and Training Institute</td>
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<td>HSD</td>
<td>High Speed Data</td>
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<td>IALA</td>
<td>International Association of Lighthouse Authorities</td>
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<td>IBS</td>
<td>Integrated Bridge Systems</td>
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<td>ICHCA</td>
<td>International Cargo Handling Co-ordination Association</td>
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<td>ICS</td>
<td>Integrated Control System</td>
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<td>IHO</td>
<td>International Hydrographic Organisation</td>
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<td>IMLA</td>
<td>International Maritime Lecturers' Association</td>
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<td>IMO</td>
<td>International Maritime Organization</td>
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<td>INDRIS</td>
<td>Inland Navigation Demonstrator for River Information Services</td>
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<td>INS</td>
<td>Integrated Navigation System</td>
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<td>IRM</td>
<td>Information Resources Management</td>
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<td>LES</td>
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<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
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<td>MET</td>
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<td>MOC</td>
<td>Ministry of Communications</td>
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<td>MRCC</td>
<td>Maritime Rescue Co-ordination Centre</td>
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<td>RCDS</td>
<td>Raster Chart Display System</td>
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<tr>
<td>RENC</td>
<td>Regional Electronic Navigational chart co-ordination Centre</td>
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<tr>
<td>RINAC</td>
<td>River based Information, Navigation and Communication</td>
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<tr>
<td>RIS</td>
<td>River Information System</td>
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<tr>
<td>SAR</td>
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<td>System Electronic Navigational Chart</td>
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<td>TTI</td>
<td>Tactical Traffic Information</td>
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<tr>
<td>USCG</td>
<td>United States Coast Guard</td>
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<tr>
<td>USMMA</td>
<td>U. S. Merchant Marine Academy</td>
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<tr>
<td>USSR</td>
<td>Union of Soviet Socialist Republics</td>
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<tr>
<td>VHF</td>
<td>Very High Frequency</td>
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<td>WWRNS</td>
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Chapter One

INTRODUCTION

Inland waterway transport is an important mode of transport in the countries which possess rich inland waterways, such as China, the European countries, Russia and the United States of America. Inland waterway transport education and training is one of the fundamentals of development of inland waterway transport and ensuring inland shipping safety.

1.1 Background

The Chinese economy is growing continuously and economic reform is deeply embedded with the centre of development of the national economy moving to the areas along rivers, particularly along the Changjiang (Yangtze) River. The proportion of growth in the economy of these areas will become greater and greater (see 4.2.1). In the twenty-first century, the economic corridor of the Changjiang River will become a backbone of economic expansion in China.

The inland waterway is being turned into one of the least polluting and most economical modes of moving goods and produces in the world. In the developed countries, particularly in the European countries more and more attention has been paid to research into and development of inland waterway transport. In the past decade, there has been several research projects concerning inland waterway transportation. For example, the International Cargo Handling Co-ordination Association (ICHCA) had a research project about 'inland waterways - the maritime links', which stated the importance of inland waterway transport in the European countries in 1988. Between 1993 and 1996, the European Commission had a research project about inland waterway transport system in Europe, the aim of
which was to provide an analysis of the possibilities and conditions for an efficient integration of inland waterway transport into the logistics and multi-model transport chain. In recent years, the European Commission has selected inland navigation as one of the areas in which progress should be developed by technological improvements and political measures. In order to achieve this goal a Concerted Action Committee (CAC) including seven countries' representatives has been established. A number of large research projects and programs concerning inland navigation, such as RINAC (River based Information, Navigation and Communication) and INDRIS (Inland Navigation Demonstrator for River Information Services) have been established. The project of RINAC includes the research of standards of training, certification and watchkeeping for river ship mariners in the future. The inland waterway shipping service is also an important mode of transport in China. The government of China has begun to pay more attention to the development of the inland waterway shipping industry (see 4.2.2).

It is known commonly that the waterborne transport industry has undergone accelerated advancements in modern technology. The level of today’s ship technology can be considered adequate to deal with various complicated situations. The different systems for shipping safety have been applied widely (see 5.1.1). In the field of education and training new technology has been utilised to improve teaching and training methodologies in order to meet the needs of rapid development of a new technology age (see 5.1.2).

The STCW 95 convention has been implemented since 1997. The purpose of the convention is to provide the minimum standards for the training of seafarers because the way to eliminate or reduce the risk of human error in shipping casualties is to develop the skills and competence of seafarers through effective education and training. The requirements of the convention have a great impact upon the maritime and training (MET) institutions. In response to the STCW 95 convention, one of the major tasks facing the MET institutions is to establish a quality standards system in order to ensure a high quality of maritime education and training. Certainly, the convention has impacted on inland waterway transport education and training indirectly.
The reform of the high education including maritime education and training in China is now in the ascendant in order to meet the challenges of new technology in the next century.

Because inland waterway transport is not an international industry, inland waterway transport education and training (IWTET) is not the concern of international communities. There are few national IWTET systems or training programs for river ship mariners in the world. There are no articles and books regarding the IWTET systems and the river ship mariners' training programs in the library at World Maritime University (WMU). According to the survey of dissertations, no dissertation topic about IWTET or river ship mariners' training has been written about by students of maritime and training course (nautical) from 1985 to 1998 (see table 1-1).

<table>
<thead>
<tr>
<th>Topics</th>
<th>MET (system, program and training course)</th>
<th>Simulation and CAL</th>
<th>Technology (satellite, GMDSS, ENC)</th>
<th>Maritime safety (SAR and VTS)</th>
<th>Marine casualties (collisions)</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers</td>
<td>58</td>
<td>18</td>
<td>13</td>
<td>13</td>
<td>6</td>
<td>11</td>
<td>119</td>
</tr>
<tr>
<td>Percentage</td>
<td>49%</td>
<td>15%</td>
<td>11%</td>
<td>11%</td>
<td>5%</td>
<td>9%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: WMU library, 1999

Table 1-1 Statistics of dissertations written by students of MET (N) 1985 - 1998

1.2 Objectives

The application of new technology to the development of IWT and use of modern equipment for safer inland shipping is important but human beings are the decisive factor. Through education and training the risk of human error may be reduced, if not totally eliminated, because training is a planned and systematic effort to modify or develop knowledge, skills and attitude by experience to achieve effective performance in an activity. The purpose of IWTET is to enable a river mariner to acquire skill and competence in order to perform efficiently a given task or duty.

The current existing problems and developing opportunities for the Chinese IWTET have been sought out through analysis of the present states of IWT and
IWTET in comparison with the Chinese MET system. Therefore, the methods including application of new technology and establishment of quality standards system are introduced. A new approach including redistribution of IWTET centres and redesign of the IWTET program and curriculum for river ship navigation course is proposed in order to improve the Chinese IWTET and to meet the needs of the development of inland waterway transport in the twenty-first century.

The objectives of the dissertation are:

- to review the current situations of inland waterway transport;
- to review the current state of IWTET;
- to examine and compare the IWTET with the MET system in China;
- to analyse the existing problems in and the opportunities for IWTET;
- to introduce new technology and quality standards system to IWTET;
- to draw conclusions as to the need to modify and update existing programs;
- to make recommendations on the introduction of new practices.

1.3 Methodologies

In order to achieve the objectives of research, before and during writing the dissertation, the author made contact with and investigated the relevant institutions and companies in China and other countries through fax, e-mail, and letter communication. The author also searched and studied the relevant materials in the library at WMU and from the Internet. Meanwhile, the author interviewed with the experts in the field of IWT and IWTET.

All the information and data collected have been studied, analysed and conclusions drawn in addressing the imperative needs for improving the Chinese IWTET system.

This dissertation is divided into six chapters:

Chapter one gives a short introduction to the background, objectives, methodologies, limitations and omissions of research.

Chapter two makes a general overview of inland waterway transport and inland waterway transport education and training in China and in the selected countries.
Chapter three makes a comparison between the IWTET and MET systems in China. The comparison covers the similarities and differences between inland waterway transport and sea transport and between the IWTET and MET system. The features of IWTET are pointed out.

Chapter four analyses the present existing problems in IWTET and opportunities for IWTET in the future.

Chapter five gives a proposal for improvement of the IWTET program in China. The proposal includes application of new technology and quality standards system, establishment of a framework of new higher level IWTET program and a new curriculum for river ship navigation course, requirements of teachers/instructors, outfit of facilities and the methods of teaching/training.

Chapter six concludes the research by summarising the key points. The recommendations on the introduction of new practices are proposed.

1.4 Limitations and omissions

This dissertation is not intended to describe the IWT and IWTET system to a full extent, but only for the purpose of this dissertation. The dissertation is limited by the lack of materials regarding IWTET directly.
Chapter Two

OVERVIEW OF INLAND WATERWAY TRANSPORT EDUCATION AND TRAINING

2.1 An overview of inland waterway transport

Globally, inland waterways are the oldest mode of transport, for a long time being the main source of creation and development of civilisation, its urbanisation and industrialisation. This development enabled external trade over a longer distance and gave rise to trade centres that have turned into great cities where all kinds of economic activity are concentrated (Egbuna, 1990). Inland waterway transport is one of the five main transportation modes. World history provides evidence of many cases of inland shipping, starting with Egyptians, Chinese, Dutch and Britons. The use of rivers and the building of canals to avoid hindrance to navigation came naturally. The initial uses were for passenger traffic and later for goods transport (Sava, 1997). In this chapter, the aim is to overview inland waterway transport in the world and to review the development of the Chinese IWTET, so that a profile of IWT and IWTET will be formed.

2.1.1 The situation of inland waterway transport in China

China was one of the first countries to use inland waterway transport. According to recorded history, in 219 BC, during the Qin Dynasty, the Ling Canal was dug and connected to the Changjiang River system and the Zhujiang River system. The resulting growth in inland waterway shipping obtained great effectiveness from it. In 486 BC, the Jinghang Canal (the Great Canal) was dug, which is about 1700 Km length from northern to southern China, and connected the
five river systems, namely Haihe, Huanghe, Huaihe, Changjiang and Qiantanjiang. It is the longest man-made canal in the world.

There are more than 900 lakes and 50,000 large or small rivers with a total length of 430,000Kms. Among these rivers, there are 5,600 rivers having navigable inland waterways with a total length of 109,000Kms. They form a large inland waterway network in China.

2.1.1.1 The Main River Systems
2.1.1.1.1 The Changjiang River system

The Changjiang River, of a total length of 6,300Kms is the longest river in China, and the third longest in the world (see figure 2-1). The Changjiang River system has more than 3,600 tributaries, which connects with the Huaihe River and the Jinghang Canal, a total navigable waterway length of 57,447Kms and occupying 52.7% of the total navigable inland waterways in China. The main course flows through nine provinces and two municipality cities, and directly to the East China Sea.

The Changjiang River is the main transportation line across east and west China, and links the three large regions of Southwest, Mid and East China. The River has long been called the "Golden Waterway". The provinces and cities along the river have considered navigation on the Changjiang River as the backbone of economic expansion.

At present 3,000dwt pushed-barge convoys can navigate on the upper reach below Chongqing; 6,000-8,000dwt pushed-barge convoys can navigate from Lingxian to Yichang on the middle reach; 10,000dwt pushed-barge convoys can navigate from Wuhan to Lingxian and 36,000dwt pushed-barge convoys can navigate from Shanghai to Wuhan. A tonnage of ten thousand seagoing or river-sea cargo vessels can navigate from Shanghai to Nanjing, five thousand river-sea cargo vessels can sail to Wuhan and three thousand river-sea cargo vessels can sail to Chenglingji. After the completion of the Three Gorges Dam Project in 2009, 10,000dwt pushed-barge convoys will be able to directly navigate on the upper reach, Chongqing.
2.1.1.2 The Zhujiang River system

The Zhujiang (Pearl) River system is a main inland waterway transport line in the Southwest and the South of China. It is the second most important inland waterway in China. There are 300 large or small tributaries, of a total length of 30,000Kms, among which there are 12,000Kms waterway navigating in all time and occupying 11% of the total navigable inland waterways in China.

2.1.1.3 The Heilongjiang River system

The Heilongjiang River is the largest river system in the Northeast of China, which is a boundary river with Russia. The main course has a length of 3,420Kms. The drainage basin covers 1,620,000 sq.kms. It is a seasonable navigation river because of freezing over in winter.

2.1.2 Types of ship in inland waterway transport

In China, the inland waterway transport ships can be classified into four types according to propulsion modes.

- **Tug pushed-barge convoy**
  Tug pushed-barge convoys are a main mode of inland waterway transport in China. Tug pushed-barge convoys have been used in the Changjiang River since 1956. Currently, there are several types of Tug pushed-barge convoy utilised widely. The largest Tug pushed-barge convoy has propulsive power up to 4,412Kw, which can carry cargo of 36,000 tons.

- **Tug towing-barge convoy**
  Tug towing-barge convoys are mainly used in the lower reaches of rivers and tributaries or narrow canals according to their advantages. For example, tug towing-barge convoys are used on lower reaches of the Changjiang River and of its tributaries, the Jinghang Canal and other waterway networks. The largest tug towing-barge convoy pulling cargo reaches approximately 3,000 tons.

- **Self-propelled vessels**
  Self-propelled vessels include passenger ships, tourist ships, ferry ships, cargo-passenger ships, river-sea cargo ships and self-propelled cargo barges. The largest passenger ship can carry more than 1,200 people.
2.1.1.3 The volume of inland waterways transport

The inland waterway shipping occupied certain scales in the whole inland transport. According to investigations, the volumes of inland waterway shipping in China are as shown in figure 2-2.
The volume of inland waterway shipping compared to the total volumes of inland transport including railway and highway is as shown in figure 2-3.

2.1.2 An overview of IWT in selected countries

2.1.2.1 European countries

Inland waterways transport is an important transport mode in the European transport networks (ICHCA, 1988). The main inland waterways include the Rhine, Main, Danube and Volga Rivers. After building the Main-Danube Canal, which is a linkage between the Main and Danube Rivers, the Rhine-Main-Danube waterway has been realised. The Rhine-Main-Danube waterway has the best credentials to become the most important European transport corridor. More than 400 million tons
are transported by water each year in the European countries. More than 60% of total international cargo transport occurs by inland shipping (Bv Interesting facts, 1999).

2.1.2.1.1 Main Rivers

• Volga River

The Volga is the longest river, of length 3,700Kms, in Europe. Near to its source it flows first to the north of the country into the Rybinskoye Lake, then it turns south, passing towns and culminating with the division of the river into numerous tributaries comprising the Volga delta on the shoreline of the Caspian Sea. In this extensive river system, canals have been built, connecting the Volga with other waterways. The Moscow-Volga canal extends 128Kms north of the Capital to the Volga river, providing a waterway for inland shipping, the 360Kms long Volga-Baltic canal links the Volga to the Baltic Sea, while to the south of the country the river is linked to the Don River by the Volga-Don canal.

• Danube River

The Danube is the second largest river in Europe, of total length of 2850Kms, with a collecting basin of 805,300 sq.km. Navigable for most of its route, the Danube plays an important role in the commerce of Europe. It is the only major European River from west to east, across seven countries. About 60 of the approximately 300 tributaries of the Danube are also navigable. Canals link the Danube to the Main, Rhine and Oder Rivers.

• Rhine River

The Rhine is used for transport from Basel to the North Sea. The Rhine is definitely one of the most important arteries of industrial transport in Europe, the river being navigable for 870kms from Basel to Rotterdam. The Rhine is in the middle of a vast European waterway network. The main tributaries of it include the Necker and Main, both channelled, the first over 203Kms and the second over 297Kms. The upper Rhine is connected via a dense network of rivers and canals with the waterways of Belgium and Netherlands. (Inland waterway networks in Europe see Appendix 1)
2.1.2.1.2 Types of vessel on the River Rhine and Danube

- **Self propelled**
  
  On the Rhine the biggest percent of vessels are those that are self propelled (75%). Out of the 75% of self-propelled vessels, 20% are in the 650-999 tons category, 27% in the 1,000-1,499 tons category and 22% in the 1,500-2,999 tons category. On the Danube, there are only 10% of self-propelled vessels. However, the Danube fleet tends toward larger capacities, 27% in the 1,500-2,999 tons category and 39% in the 3,000 plus tons category.

  The fact that the Rhine fleet is composed mostly of self propelled ship gives it two main advantages, i.e., a higher flexibility in choosing the cargo and route and shorter turn round times due to increase manoeuvrability and mobility of this particular type of ships.

- **Pushed-barges convoy**
  
  On the Danube, the pushed barges are in the greater number, 63%. On the Rhine the pushed barges are only in the 22%. Pushed barges include Ro-Ro barges and container carrying barges.

- **Towed-barges convoy**
  
  On the Danube, the level of towed barges equals 27%. But it is only 2% of towed barges on the Rhine.

- **River-Sea vessels**
  
  The River-Sea vessels provide users with a door-to-door through transport of goods, via inland waterways without the need for transhipment at coastal ports, yet retaining the flexibility, versatility or specialisation required of it. The River-Sea vessels have been developing rapidly since 1968 because they represent the most successful of the vessel types operating in the European inland waterways.

2.1.2.1.3 Capacity of inland waterways

- **Belgium**
  
  Belgium is one of the countries with a very dense waterway network. There are two main rivers used for navigation, Schelds and Meuse, together with a large
number of navigable canals. There are 1,514Kms of navigable inland waterways. There are 1604 river ships with total of 1,311,750dwt (1992).

- **Germany**
  Germany has accessed both the North Sea and the Baltic over a sea coastline of 2,389Kms and is crossed by the Rhine-Main-Danube canal. The inland waterways have a length of 4475Kms, of which almost 70% are used by craft of 1,000 tons capacity and above. Major rivers include the Rhine and Elbe. The Kiel Canal is an important connection between the Baltic and North Sea. The German inland shipping fleets is comprised of 3282 river ships totalling 3,121,750dwt (1992).

- **Netherlands**
  Of great importance for Netherlands's economy is the river Rhine with its low course and its delta. The Rhine, which is the most important waterway, is divided into two branches Lek and Waal. The navigable inland waterways measure 5,046Kms, of which 35% are use-able by craft of 1,000dwt capacity or larger. Inland waterway fleets is comprised of 9,358 vessels totalling 6,513,125dwt (1992).

- **France**
  France has two principal rivers used for inland navigation-the Seine River and the Rhone River. The total navigable inland waterways extend 6,406Kms, the fleets having 2373 vessels (1993).

- **The United Kingdom**
  The United Kingdom has 1620kms of inland waterways, which are officially designated as commercial waterways for inland shipping. The main inland waterways in the UK for commercial traffic include the Thames, Medway, Severn and Mersey Rivers.

### 2.1.2.2 The United States of America

The USA is one of the most developed of inland waterways transport countries. The system in the USA consists of approximately 40,875Kms of navigable waterways. It includes some 1,931kms of deep-draft coastal access waterways and almost 16,093Kms of waterways that are less than 2.7m in depth. The commercially viable inland waterway system consists of approximately
19,310Kms of waterways with depth of at least 2.7m or, in the case of the infra-coastal waterways, several hundred kilometres with depths of 3.7m to 4.6m. The inland waterways include the systems of the rivers Mississippi, Arkansas, Missouri, Illinois, Ohio, Great Lakes and others.

2.1.3 A comparison of several selected systems

2.1.3.1 The length of navigable waterways

In the ten selected countries, the total length of navigable waterways is 27,558Kms. The range in the length of navigable inland waterways in each country compared with the total length in percentage extends from 0.55% to 39.56%. China has the longest navigable waterways, of 39.56% within the ten countries. The second is Russia, of 36.65%. The third is USA, of 14.83%. The European countries total length of 24,683Kms represents 6.63%.

2.1.3.2 The Inland Waterways Freight Transport In 1997

Table 2-1 analyses the situation comparing China with the selected countries. The range of inland waterway transport compared to the total inland transport volumes in percents extends from 6.60% to 49.30%. The Netherlands is at 49.30%, which is advantaged by its great number of canals and rivers. Inland waterways transport shows a proportion of 18.40% and 13.40% in Germany and USA.
respectively. China has only 6.30%. The conclusion is that inland waterways transport in China has not been developed enough.

<table>
<thead>
<tr>
<th>Countries</th>
<th>Freight (billion tonne-kilometres)</th>
<th>Percentage of whole inland transport volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>2.00</td>
<td>6.60</td>
</tr>
<tr>
<td>Belgium</td>
<td>5.00</td>
<td>8.90</td>
</tr>
<tr>
<td>Germany</td>
<td>63.90</td>
<td>18.40</td>
</tr>
<tr>
<td>Netherlands</td>
<td>34.50</td>
<td>49.30</td>
</tr>
<tr>
<td>USA</td>
<td>642.80</td>
<td>13.40</td>
</tr>
<tr>
<td>China</td>
<td>913.50</td>
<td>6.30</td>
</tr>
</tbody>
</table>

Table 2-1 Inland waterways freight transportation

2.1.3.3 Comparison between four selected countries

The figure 2-5 selects four of the important inland waterways shipping countries in the world. Comparison between their lengths of navigable waterways and the freight transport clearly shows that China has the longest inland waterway system, the percentage of the length of navigable waterways being 53.2. However, the proportion of inland waterway freight transport is still at a lower percentage (7.21%) in comparison with the total volumes of inland transport.

![Figure 2-5 Comparison of the waterways and proportion of freight between four countries](image)

It demonstrates that the development of inland waterway shipping in China has a large potential capacity. How can inland waterway shipping be developed rapidly in China? Besides consideration of governmental policies, developing
infrastructure and improvement of waterways environment, the most important factor is the development of inland waterway transport education and training (IWTET).

2.2 An overview of IWTET in China

Inland waterway transport education and training can be defined as one of specific education and training system, through which to educate and train the specialists who serve needs of the inland waterway transport, such as river ship's officers, engineers and pilots.

2.2.1 History of IWTET

Chinese IWTET came into existence in the 1950s. The development can be divided into four stages.

2.2.1.1 Developments 1950 - 1965

From 1950 to 1965, because China has a richer inland waterway system compared with railways and highways, the new government (the P.R. China) had paid attention to the development of the mode of IWT. However, because of a lack of specialists in the field, the government decided to transfer and build IWTET institutions in China.

A college, Wuhan Water Transportation Engineering College was founded to educate and train higher level IWT specialists, through an undergraduate course of river ship navigation and engineering. There were three IWTET polytechnic schools for training middle level IWT specialists, who mainly served on river vessels as officers, pilots and engineers. Several lower vocational IWTET schools were founded for training ratings.

During these years, the Chinese government invited IWTET experts from the former USSR to introduce how to develop IWTET and to train instructors. First a set of textbooks, such as "River ship navigation", "The Changjiang River pilotage Chart" (for student), was published. The government (the Changjiang River Administration of Navigational Affairs of the Ministry of Communication) promulgated the first regulations for preventing collisions at inland waterways and the provision on examination and certification for mariners on board vessels in rivers.
The features of the first stage are:

- from no IWTET to having IWTET;
- starting at higher level;
- establishing multi-level of IWTET system;
- development gradually being increased.

2.2.1.2 Developments 1966 - 1976

From 1966 to 1976, higher level IWTET had been developed very slowly. The undergraduate course of river ship navigation and engineering stopped enrolments. The other level IWTET institutions also developed very slowly.

2.2.1.3 Developments 1977 - 1989

From 1977 to 1989, higher level IWTET developed more quickly. In 1978, one IWTET polytechnic school was promoted to a higher level IWTET institution, namely Wuhan Inland Waterway Transportation College. A course of river ship navigation and engineering (3years) was offered. The undergraduate course of river ship engineering was resumed. From 1983, river-sea ships were developed more and more in China, especially on the Changjiang River. The course in river ship navigation was gradually transformed to educate and train river-sea ship officers. The graduating students can serve on river ships or seagoing ships. The IWTET polytechnic Schools were also developed very quickly. Several river shipping companies set up their own IWTET centre for training company's employees. In order to fit in with the demand of shipping markets, higher level IWTET institutions started post education, offered the course of river ship navigation, engineering and water shipping management, etc.

In 1986, the State Council of the P. R. China promulgated a regulation concerning the administration of traffic safety on inland waters. Regulations for preventing collisions on inland waterways were revised.

A set of new textbooks, namely "River ship manoeuvring", "River ship avoidance of collision", "River ship navigation", "Electronic Navigation aids" and others were published. The first inland waterway radar navigation simulator was designed and built by Wuhan Inland Waterway Transport College. The first photo-
picture chart for radar navigation on the lower reaches of the Changjiang River was researched and published.

The features of this stage are:
- the size of IWTET institution was enlarged;
- the new regulations were legislated;
- the textbooks and training facilities were performed.

2.2.1.4 1990 onwards

From 1990 to the present day, the Chinese IWTET has faced new challenges, i.e., inland shipping companies extended service to sea shipping. They requested higher and more comprehensively qualified students from IWTET institutions. Under this situation, the largest IWTET University was structured in 1994, namely Wuhan Transportation University (WTU). WTU resulted from a merger between the Wuhan Water Transportation Engineering College and the Wuhan Inland Waterway Transportation College. In WTU, the undergraduate specialities cover almost the whole inland waterway transport, including on land and on water (see 2.2.3.1).

The undergraduate course of river ship navigation was resumed. However, the four years' course lays emphasis on educate and train combination specialists of river-sea ship officers. From 1996, the University started to offer a MSc course in river ship navigation.

The new regulations on examination and certification for mariners on board vessels in rivers were promulgated in 1992.

2.2.2 Role of Chinese IWTET

2.2.2.1 Changing only relying on experiences to navigate river ships

Before the establishment of IWTET institutions, the training of river ship officers was mainly left to the ship owners and mostly conducted on board ships. For example, if general crews want to become ship officers, they need to follow senior ship officers, who are called master, for several years. They, as apprentices gained much practical navigation experience, however they didn't know why. In particular when the waterways environment and vessel's characteristics are changed, they didn't know how to improve their own navigating skills. Traditional river ship officers or pilots training models had not kept up with changes in inland
shipping industry developments, especially in the introduction of sophistication navigational equipment. The needs to educate and train river ship officers and pilots through special institutions have become more and more important. School training model resolves the problems of the lack of theory for river ship officers. The graduate students not only have the theory knowledge of navigation but also have practical experience through on board training.

### 2.2.2.2 Provision of specialists for IWT development

From the early 1950s, the IWTET institutions were founded in China. They educated and trained a great number of specialists who have worked in the inland shipping industry as administrators, captains, chief engineers and chief supervisors. For example, more than 11,659 specialised marine personnel of varied ranks were cultivated by WTU during the past half century. They have greatly contributed to the development of the Chinese inland shipping industry.

### 2.2.2.3 River ships navigation safety

With the development of the inland shipping industry, large capacity river ships and large powered tug pushed-barge convoys are required. Traffic movements are thus more complicated and crowded, and results in more difficult ship handling. All of these conditions have changed the requirements for knowledge and skills for river ship officers, master and pilots.

Many facts provide evidence that more knowledgeable and skilled ship officers, masters and pilots can ensure the safety of ships navigation. One investigation demonstrated that most masters, chief officers and chief engineers of large river ships on the Changjiang River are graduates of IWTET institutions. The large ships are defined as having a capacity of 10,000dwt and above for tug pushed-barge convoys and of more than 800 people and above for passenger vessels.

### 2.2.2.4 Centre of education and science research

The main tasks of all Chinese IWTET institutions are to provide the students with general education and training for certification as river ship officers. Entrants are enrolled from senior high school graduates after they have successfully passed
the national higher education entrance examinations. The candidates are placed into a three-year or four-year course according to the scores they achieve and colleges or universities they apply for. During the years they study at the institutions the students should first acquire the basic knowledge stipulated for higher education, like advanced mathematics, general physics, philosophy, English language, physical culture before they are taught professional knowledge and skills. Normally the students who have been educated and trained with three-year's schooling are entitled to a diploma. Those who have come out with four-year's schooling can be conferred a bachelor degree.

Another relatively important role of Chinese higher IWTET institutions is to offer refresher and upgrading course for certificates of masters and officers. Ratings graduating from vocational IWTET schools can be promoted after some years of service on board ships. Lower rank officers can be further trained for higher certificates. In most case, the candidates for such certificates should receive approved education and training. Such education and training is often conducted on short courses of three to six months in IWTET institutions.

Science research is another important and indispensable part of work in higher education institutions. Apart from conventional teaching, Chinese higher level IWTET institutions are engaged in scientific research, which is mainly concerned with the inland shipping industry. In the institutions, there are a great number of experts, scholars, professors and researchers. By doing scientific research, the instructors and teachers have upgraded themselves in their particular field and the students in turn benefit from them.

2.2.3 Current situation of IWTET in China

2.2.3.1 Brief background to Chinese IWTET Institutions

The inland waterway transport education and training system in China can be divided into two kinds of education in accordance with functional levels in the field of the IWT, which are higher level IWTET and vocational IWTET. The higher level IWTET is open to all people and basic entrance requirements are that students must pass the national entrance examination. The vocational IWTET includes higher, middle and lower vocational IWTET.
There are one IWTET University, seven polytechnic schools, two higher vocational schools and five vocational technical schools. The only higher level IWTET institution, namely Wuhan Transportation University (WTU) is directly under the Ministry of Communication of the P. R. China. Other schools are either under the local governments or inland waterway shipping companies.

WTU has a long history and ample experiences for running a school. It is a multi-disciplinary University, including both land-based and water-based courses. WTU embodies education in Engineering, Science, Liberal Arts, Management, Law, Philosophy and Economics with the technology of inland waterway transport. Now, it runs five colleges and 10 departments with 33 specialities which cover the whole trade of communications and enrolment of 9000 full-time students among which there are 378 postgraduates for Master degree or Ph.D. The number of students in marine specialities is 1650, making up 18.6% of the total enrolment.

The University has a staff of 2850 among which there are 996 academic teachers and instructors, including 368 professors and associate professors, 446 people with other senior professional titles.

The courses of river ship navigation and engineering are under the Navigation College and the Marine Engineering College. In the two colleges, there are 154 academic teachers and instructors. The breakdown of academic titles, qualifications and experience are as shown in figure 2-6.

![Figure 2-6 Academic staff, qualifications and experience](image-url)
There are 14 research sections and 43 laboratories including 12 laboratories in the Navigation College and the Marine Engineering College. These laboratories are as follows:

- Inland waterway radar navigation simulator
- Marine engineering training simulator
- Ship radar and ARPA
- Nautical chart operation training
- Electronic positioning
- GMDSS
- Seamanship training
- Basic safety training
- Internal-combustion engine
- Power plant
- Auxiliary engine
- Marine engine automation

There are two Quality Control and Test Centres for inland waterway ships.

2.2.3.2 Common core of Chinese higher level IWTET curriculum

River ship officers training is incorporated into higher education in the Chinese education system and therefore the nurturing of officers is not only a matter of hands-on training. Students are supported to receive some formal higher education programs including basic theory and principles in addition to occupational training. Based on this concept the Chinese IWTET institution has developed its own curriculum. The curriculum can be divided into two categories, i.e., 4 years for river-sea ship officers and 3 years for river ship officers.

2.2.3.2.1 Curriculum for 4 years' river-sea ship navigation course

The curriculum for the river-sea ship navigation course is divided into common, basic, specialised basic, specialised and optional courses and practical projects. All the courses are made up of 38 subjects. Common courses contain 8 subjects in 770 teaching hours. Basic courses have 5 subjects in 396 teaching hours. Specialised basic courses consist of 6 subjects in 336 teaching hours. Specialised courses have 20 subjects in 1004 teaching hours, amongst which sea navigation comprises 784 teaching hours and river navigation some 220 teaching hours. Course Options are provided with 14 subjects in 450 teaching hours,
however the students are not obliged to take them all. Practical projects are allocated with 50 weeks, amongst which practice on river ship with 4 weeks and practice on seagoing vessel with 8 weeks. Graduation practice has 20 weeks, the students may be on sea vessels or on river ships according to how they are employed.

2.2.3.2.2 Curriculum for 3 years' river ship navigation course

The curriculum for the river ship navigation course is divided into common, basic, specialised basic and specialised courses and practical projects. All the courses are made up of 30 subjects. Common courses contain 7 subjects of 634 teaching hours, basic courses 2 subjects of 150 teaching hours, specialised basic courses 4 subjects of 198 teaching hours and specialised courses 19 subjects totalling 808 teaching hours. Practical projects are allocated with 44 weeks. Graduation practice has 20 weeks, the students being on river ships practice.

2.2.3.3 Teaching Methods

Teaching methods include classroom and practical teaching methods. The classroom teaching mainly uses the lecturing mode. The practical teaching has different teaching modes, such as laboratory teaching and on board teaching.

Most instructors are diligent and conscientious in their teaching. They do their best to improve their teaching practice. However, their teaching methods are what they remember from their former and senior teachers because they have not received special pedagogy or educational psychology training. Therefore most instructors have become accustomed to cramming (forced-feeding) methods of classroom teaching because they always try to get as much message across to the students as possible and they lack teaching technology tools to change their methods.

2.2.3.4 Examination and assessment practice

In the IWTET institutions any course offered is concluded with written examination or a comprehensive assessment. Written examinations are always predominant over other form of assessment because they are easy to supervise and grade. If a student fails an examination or an assessment he is given another re-
examination at the beginning of the next semester. If he fails a major subject, up to 3 examinations or assessments in an academic year, he must stay down. On the completion of all his studies the student who has failed one or more examinations or assessments will not be conferred with the bachelor degree or issued a diploma. In this case he should apply for another make-up examination after 12 months on board practical service. If this is approved the student is informed of the time of the examination. This is the final chance.

According to regulations on examination and certification for mariners on board vessels in rivers (article 46), higher level IWTET graduate students on the river ship navigation course have their first certification theories examination combined with the academic graduation examination. The requirements of the first certificate of competence for river ship officers will be stated in the following chapter (see 3.2.6).

Students of river-sea ship navigation course can enter the theory examination for first certificate of competence for seafarers before they graduate from the institution.

In conclusion, the Chinese IWTET has only 50 years' of history through the four-stages of development. Generally speaking, the IWTET system can satisfy the needs of development of IWT in China. However, along with the further development of IWT, the IWTET system has exposed some defects.

2.3 The general situation of IWTET in selected countries

2.3.1 Russia

Russia is one of the largest inland waterway transport countries, IWTET commencing in 1918. Nowadays, there are four higher level IWTET institutions, such as Moscow State Academy of Water Transport and St. Petersburg State University for Water Communications. There are one or two secondary vocational IWTET schools located at each river system. Russia began to educate and train river-sea ship mariners since the 1960s (Chen, 1999). For example, the Moscow State Academy of Water Transport, whose primary aim is to train specialists with higher and secondary vocational education and skilled workers for inland water transport. The Academy comprises six departments. There are 30 training
laboratories and four training vessels for the students' learning and training. The graduates of the Academy are assigned to work at the river shipping enterprises.

2.3.2 European countries

There are many inland waterways in the European countries. The inland waterway transport is an important mode of transport in Europe (see 2.1.2). So, there are specific training courses for mariners on board inland navigation ships applied in some European countries, such as Germany, Belgium, France, Netherlands, Austria and Switzerland. These countries offer three grades of professional mariners, i.e., able crewman (A.B), boatman and ship's master on the secondary vocational level. Duration of courses varies between 2 and 3 years with the exception of Belgium. In Belgium, the duration of courses varies between 4 and 6 years depending on the grades of occupation. Generally, the ratios between theoretical and practical parts of the course in particular programs vary from 15% to 20% in Austria. The ratios between theoretical and practical parts of practical oriented programs in the Netherlands and Belgium reach as much as 60% to 75%. In principle, the completion at this level does not offer a possibility for applicants to proceed with high education level, however it enables professional to apply for some further courses in specific field of inland navigation.

For example, there is a specific school - Schifferberufsschule RHEIN - for training inland navigation skippers in Germany. It offers a 3-year course, which divides into on board practice and instruction and 36 weeks' theoretical classes on shore. At the end of the training course, the trainees attend an examination for inland waterway A.B. The school offers preparatory training and updating courses for the examination and the radar-training course for the radar-operating certificate. In Germany, everybody can apply for the examination. He/she need not be qualified as A.B but should meet the requirements of the regulations (Marzeion, 1999).

2.3.3 The United States of America

In the USA, there was at one time a National River Academy at Helena, Arkansas, operated by the water transport industry on the Mississippi River, but it closed a number of years ago. Nowadays, there is no specific IWTET institution for river ships mariners' training (Mcmullew, 1999). The river ship mariners are
educated and trained in combination with seagoing ship mariners in maritime education and training institutions, such as in USMMA, SUNY maritime college and the Great Lakes Maritime Academy. The Great Lakes Maritime Academy (GLMA) is more intensively involved in training deck officers for inland waterway navigation because it is the only freshwater academy in the USA. GLMA offers three or four years' high level programs for the students. At the end of the program they are qualified to sit the Coast Guard examination for licensing as a Great Lakes mate and first class pilot (deck program) according to the Code of Federal Regulations (CFR), 46 Ch10 sec.430 - 459 Licenses for the Great Lakes and inland waters. The graduates of GLMA serve with every company sailing on the lakes as officers and masters and serve as pilots for seagoing ships sailing on the lakes.

In accordance with the CFR Ch10, sec.10.464, an applicant wanting to qualify as an operator of an uninspected towing vessel, has to show 3 years' service and must have training in first aid and radar operating and pass an examination including four test subjects.
Chapter Three

A COMPARISON BETWEEN THE IWTET AND MET SYSTEM IN CHINA

There are similarities and differences between inland waterway transport (IWT) and sea transport (ST) in aspects of history, navigational environment, characteristics of ship and requirements of quality for mariners. Hence, in a comparison between IWTET and MET, there are similarities and differences of that in several aspects as well and the aim of the chapter is to identify such characteristics.

3.1 Similarities and differences between IWT and ST

3.1.1 History

Both inland waterway transport and sea transport in China has a long history. Comparatively, the history of IWT is longer than that of ST in China.

For the history of inland waterway transport it is very difficult to say which year it started. According to recorded history, the Jinghang Canal was dug before 486 BC. So at least it is easy to demonstrate that inland waterway transport in China had been developed as early as this date. Because the natural waterways had not satisfied the demands of IWT, a man-made canal was considered. During the Qin dynasty, another man-made canal, the Ling Canal was dug and connected with five river systems, and IWT has been developed effectively by it.

The history of sea transport in China can be traced back to before 350 BC. The historical records show that some people from Yan (the name of a country in ancient China) and Chi (the name of another country) sailed to the "Three-God-Hill" (now Japan) in the year 350 BC. Qin Shihuang - the first emperor of Qin dynasty (219 BC) despatched Heu Fu to Japan taking along several thousand boys and
girls, in search of longevity herbs. In the year of 111 BC, the emperor of Han Wu opened the sea-borne silk route to the west, thus inaugurating maritime trade relations with Rome, via India. In the Tang dynasty, the longest sea trade at the time was inaugurated. Ships sailed from Guangzhou, going south to Java, and then westwards to Karachi. The Song dynasty inaugurated an ocean-shipping service connecting Asia and Africa - going from China to the Red Sea and East Africa. In the Ming dynasty, during a period of 28 years from 1405 to 1433, the great Chinese Navigator, Zheng sailed to faraway oceans seven times with his huge fleets, passing more than 30 countries in Asia and Africa. The distance covered in a one-way voyage was over 10800 nautical miles (Shen, 1998).

3.1.2 Legislation
The inland waterway transport only needs to comply with the national legislation. The national legislation includes the regulations on the administration of traffic safety for inland waterways, the regulation on management of documentation for coming in and going out of the river port of the P. R. China, the regulation on cargo transport by inland waterways, the regulations for preventing collisions on inland waterways and the regulations on examination and certification for mariners on board vessels in rivers.

However, sea transport not only complies with the national legislation, such as maritime traffic safety law, regulation on watchkeeping of seafarers for seagoing ships and regulation for minimum safe manning of vessels, but also needs to comply with international legislation, such as SOLAS 74, MARPOL 73/78, STCW 95 and Colregs 72.

3.1.3 Purpose of service
The purpose of inland waterway transport is to enhance national or regional trade through the extensive inland waterways.

The purpose of sea transport is to conduct international and national trade through the sea and ocean links connecting all continents in the world.

3.1.4 Navigational environment
Whether inland waterway transport or sea transport, they both utilise vessels to carry goods and passengers from one place to another place on water. Nevertheless, their navigational environment is different.
3.1.4.1 The navigational environment of inland waterway transport

The inland waterway transport utilises natural river systems, lakes and man-made canals to transport goods and passengers by ships. The navigational environment is described as follows.

- A river is a confined waterway because the width and depth of the river is limited generally.
- There can be a very strong current in a river, especially on mid- and upper reaches of the river.
- A river is a complicated waterway for ship manoeuvring. It can meander, bend, and be shallow, have shoals, point bars, dikes or other obstacle objects.
- The water level of a river is changed with the season. For example, higher water level in summer due to flooding and lower water level in winter due to little rain.
- The radius of natural meander of a river restricts the length of ship.
- Bridges and dams being built on a river make navigational circumstances more difficult for river ship handling.
- Navigation aids are usually more limited in the inland river system. There are only buoys, daymarks, and river mile marks and bridge navigation span lights.
- Visibility is limited since river systems are meandering, lined with trees and steep bank lines.
- Average density of traffic in river is higher than at sea.
- Average distance and time of a one way voyage for river vessels is shorter than that of seagoing vessels. The mariners of river ships have a good landscape.

3.1.4.2 Navigational environment of sea transport

Sea transport utilises sea and oceans to transport goods by seagoing vessels. According to ship navigation range or area, the types of sea transport in China can be divided into the unlimited navigation area, the greater coastal navigation area, the coastal navigation area and near-coastal navigation area (see 3.2.6.2). The navigational environment is described as follows.

- Generally speaking, sea and ocean is open and with deep waters. There are confined waterways only near coastal areas and harbours including their approaches.
- Average velocity of sea current is lower than that of a river. Near coastal areas, the direction and velocity of current is changed with the tide.
- Meteorological factors, such as typhoon, fogs and cold front systems influence sea transport greatly.
- The main navigation aids are electronic navigation aids, such as Decca, Loran-C, GPS and Glonass. Certainly, near coastal areas and harbours, there are several visual navigation aids, such as landmarks, lighthouse and buoys to be used. Astronomical navigation aids, such as sun, moon and stars can also be used when the ship is sailing on the oceans.
- Rough sea and swell influence sea transport greatly.
- Generally, average of distance and time of a one way voyage for seagoing vessels is longer than that of river vessels. For a time no clear landscape can be seen by seafarers.

3.1.5 Characteristics of river based ships

Due to ships navigating in the different environments, the requirements of the ships' characteristics are also different, such as ship construction, stability and manoeuvrability.

3.1.5.1 Construction and size

In comparison, the construction of river ships including tow/push-tug, barges and self-propelled vessels has less strength than that of the seagoing vessels.

The river ships' size including the length, width and designed draught is smaller than the seagoing vessels' because of the confined waterway. For example, in the Changjiang River, the longest self-propelled vessel is about 135m, and the largest dead-weight-tonnage of a river vessel is the tug-pushed-barges convoys, of 36,000dwt.

3.1.5.2 Ship manoeuvrability

In general speaking, the river vessels' manoeuvrability is better than the seagoing vessels'. Particularly, the river vessels' turn-ability is more flexible in order to suit a complex waterway situation. Conversely, the seagoing vessels' direction stability is better than the river vessels' in order to keep a fixed course for a long time.
For example, the difference between inland push tow operations and coastal and deep-water ship operations in port involves the use of tugs and anchor for ship manoeuvring. Towboats do not usually use anchors for manoeuvring or manipulating the tug. Sometimes they use spud anchors for fleeting operations or holding their place in the river, but barges making up the 'bow' part of the tug are not outfitted to anchors as a normal practice. Also towboats do not usually require other tugs to assist them in manoeuvring and docking; the towboats usually have enough control to perform the manoeuvring alone. One reason is the twin-engine independent control and the flanking and steering rudder sets. Another reason is the smaller size of vessel and special designing.

3.1.5.3 Navigation equipment and installation

Nowadays, the main navigation equipment and installation on river ships include rate of turn gyro (indicator), river navigation radar, echo sounder, electronic log, magnetic compass and VHF. The river ships in China have not been outfitted with electronic charts, ARPA, automatic identification system (AIS), GPS and automatic tracking aids yet. But, in the view of navigation safety, there is a tendency to outfit advanced navigation equipment on the river ships.

Apparently, seagoing ships' electronic navigation aids and communication systems are more modern and advanced than the river ships'.

Electronic navigation aids include navigation and position, and communication systems. The electronic navigation equipment involves gyro-compass, digital radar & ARPA, echo sounder, Doppler log, automatic tracking controller, rate of turn gyro (indicator), adaptive autopilot and AIS, etc. The position equipment includes satellite system, such as GPS, DGPS, GLONASS and DGLONASS and terrestrial systems, such as DECCA, LORAN-C/CHAYKA and so on. The GMDSS is a major communication system on seagoing vessels now. The GMDSS is composed of INMARSAT-A, B, C, M and INMARSAT-E (EPIRB), and terrestrial radio communication systems, such as VHF, DSC/VHF, DSC/MF/HF, NAVITEX and NBDP, etc.

Currently, many advanced and large seagoing vessels have installed integrated navigation systems. Integrated Bridge System has been installed on the seagoing ships (see 5.1.1.4).
3.1.6 Required characteristics for ship deck officers

Because inland waterway and sea transport serve different purposes and uses and different types of ship sail in the different navigational environments, the required characteristics for ship deck officers are different.

3.1.6.1 Knowledge/Understanding

According to the requirements of the regulations on examination and assessment for the certificate of competence for deck officers of river ships, the following subjects cover the required knowledge/understanding:

- Inland waterway navigation
- River ship manoeuvring and handling
- Watchkeeping and collision prevention
- Radar navigation
- Magnetic compass
- Steering control system
- Echo sounder
- Communication system (VHF)
- Visual signalling
- Meteorology and river hydrology
- Ship safety management
- Inland waterway shipping law
- Ship construction and stability
- Cargo handling and stowage
- Prevention of pollution of the river environment
- Emergency procedures
- Fire prevention and fire-fighting appliances
- Life-saving and medical aids

In accordance with the requirements of STCW 95 convention and the regulation on examination and assessment for the certificate of competence for deck officers of seagoing vessels, the minimum knowledge/understanding requirements are contrived with in the following subject areas:

- Terrestrial and coastal navigation
- Celestial navigation
- Electronic system of position fixing and navigation
- Radar navigation (ARPA)
- Compass - gyro and magnetic
- Steering control systems
- Voyage planning
- Meteorology and oceanography
- Watchkeeping and collision prevention
- Ship manoeuvring and handling
- Communication system (GMDSS)
- Visual signalling
- English language
- Ship safety management
- Maritime law and shipping law (international and national)
- Prevention of pollution of the marine environment
- Ship construction and stability
3.1.6.2 Practical skills and experience

The deck officers, whether working on river ships or on seagoing ships, need to get practical skills and experience, including basic sailor's skills, operation of navigation equipment, ship manoeuvring and collision prevention, etc. The reasons are because ship navigating involves the exercise of special skills and fine techniques, which can be perfected only by experience and careful practice.

Comparatively speaking, in the view of ship-handling, the river vessel's deck officers need more practical skills and experience than the seagoing vessel's because of complex waterways. The river ship's deck officers need to 'read the river', i.e., need to determine shallow areas, danger zones and current patterns. A skilled river ship's deck officer should know enough about the river and current conditions within specific familiar reaches of a river to identify their location along a river, anticipate current patterns and know flow conditions.

3.1.6.3 Physiological and psychological quality

A mariner, whether working on a river ship or on a seagoing ship, is required to have a good physiological condition, including good health of body and proper lifestyle, etc., and a good psychological quality, including altitudes/moods, expectation, confidence and mental/emotion state, etc.

Consideration of the navigational environment and time, the requirements of the physiological and psychological quality for the seagoing vessel's mariners are higher than the river vessel's.

Relatively, in the view of ship manoeuvring (pilotage) and collision prevention, the requirement of perceptions, reaction time, attention/concentration and information processing, etc. for the river ship's deck officers is higher than for the seagoing ship's. The reason is due to the confined, complex and changeable navigation circumstances.

To sum up, conclusion can be drawn from the required characteristics for ship deck officers as shown in the following diagrams (figure 3-1).
After the above statements of the similarities and differences between IWT and ST, the conclusions can be summarised as in table 3-1.

<table>
<thead>
<tr>
<th>Aspects of comparison</th>
<th>Inland Waterway Transport</th>
<th>Sea Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>longer</td>
<td>shorter</td>
</tr>
<tr>
<td>Legislation</td>
<td>National</td>
<td>International and national</td>
</tr>
<tr>
<td>Purpose of service</td>
<td>For national trade or regional trade</td>
<td>Global trade and regional and national trade</td>
</tr>
<tr>
<td>Average of one-way voyage distance and time</td>
<td>shorter</td>
<td>longer</td>
</tr>
<tr>
<td>Navigational environments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waterway</td>
<td>Confined</td>
<td>Open</td>
</tr>
<tr>
<td>Affection of current</td>
<td>Stronger</td>
<td>Weaker</td>
</tr>
<tr>
<td>Affection of weather</td>
<td>Less severe</td>
<td>More severe</td>
</tr>
<tr>
<td>Navigation aids</td>
<td>Visual</td>
<td>Electronic</td>
</tr>
<tr>
<td>Characteristics of ship</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Less stringent</td>
<td>More stringent</td>
</tr>
<tr>
<td>Average of size</td>
<td>Smaller</td>
<td>Larger</td>
</tr>
<tr>
<td>Manoeuvrability</td>
<td>Very good (turn-ability)</td>
<td>Good (direction-stability)</td>
</tr>
<tr>
<td>Equipment</td>
<td>Lower level</td>
<td>Advanced and higher level</td>
</tr>
<tr>
<td>Qualities of the deck officers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>Narrower, lower</td>
<td>Wider, higher</td>
</tr>
<tr>
<td>Practical skills and experiences</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Psychology</td>
<td>High</td>
<td>Higher</td>
</tr>
<tr>
<td>physique</td>
<td>Higher</td>
<td>Higher</td>
</tr>
</tbody>
</table>

Table 3-1 The similarities and differences between IWT and ST
3.2 Similarities and differences between the IWTET and MET system

3.2.1 History

In China, despite the history of inland waterway transport being longer than that of sea transport, the history of IWTET is shorter than that of MET. The Chinese IWTET came into existence in the early 1950s. The IWTET institutions were founded. The aim was to train mariners for river ships and other personnel with respect to the IWT industry.

Comparatively, the Chinese MET came into existence at the end of the nineteenth century. Two maritime academies were founded in Shanghai and Fuzhou respectively. Nevertheless the training of seamen in the early years was for the sole purpose of the navy. It was not until the 1920s that China began to train its own merchant seamen.

3.2.2 Legislation

Both the IWTET and the MET institutions need to comply with the legislation of education and training promulgated by the government. In the aspect of specialities, they need also to comply with the respective legislation.

The IWTET institutions only need to meet the requirements of the national legislation, such as regulations on examination and certification for mariners on board vessels in rivers and regulations for preventing collisions on inland waterways. There have been no special standards of education and training for the river ships mariners.

The MET institutions need to meet the requirements of the national legislation, such as regulations on examination, assessment and certification of competence for seafarers and regulations on quality control of education and training for seafarers of the P. R. China. They also need to meet the requirements of the international legislation, such as the STCW 95 convention.

3.2.3 Purpose

The purpose of IWTET, for the speciality of navigation, is to train eligible personnel in modern inland waterway navigation and management who have an all
round development of morality, intelligence and body and meet the requirements for a qualified mariner of river ships.

The purpose of MET, for the speciality of navigation, is to train eligible personnel in modern marine navigation and management who have an all round development of morality, intelligence and body and meet the requirements of the STCW 95 convention and corresponding requirements for qualified seafarers in China.

3.2.4  The education and training system
3.2.4.1  General situation

There are two kinds of education and training in the Chinese IWTET and MET system in accordance with the different function levels (see 2.2.3.1).

The academic awards of IWTET include the technical diploma, undergraduate diploma, and bachelor and master degree. The academic awards of MET include the technical diploma, undergraduate diploma, bachelor degree, master and doctor degree.

There are one IWTET University, seven IWTET secondary schools, two higher vocational IWTET schools and five vocational technical schools. There are seven higher MET institutions, twenty maritime technical schools, with eleven of them at secondary level and nine at elementary level.

3.2.4.2  Academic study, certification and service on board
3.2.4.2.1  Higher level IWTET (the speciality of navigation)

According to the regulations on examination and certification for mariners on board vessels in rivers (1992), the higher level IWTET system in China is as shown in figure 3-2.

3.2.4.2.2  Higher level MET (the speciality of navigation)

In accordance with the regulations on examination, assessment and certification of competence for seafarers of the P. R. China (1997), the higher level of MET system in China is as shown in figure 3-3.

3.2.5  Courses and curriculum

The main courses in the Chinese IWTET institutions are River-Sea Ship Navigation (4 years), River Ship Navigation (3 years) and Marine Engineering, and
Figure 3-2 The higher level IWTET system in China
Figure 3-3 The higher level MET system in China
Management of Inland Waterway Transport. The main courses in the Chinese MET institutions are Maritime Navigation and Marine Engineering. This paper concentrates on the course of navigation.

The curriculum of the course of navigation includes common, basic, specialised basic and specialised courses, optional courses and practical training. The contents of the common, basic and specialised basic courses are almost the same. The main differences in the contents are in the specialised courses and the practical training.

For example, the contents of the specialised courses of the River Ship Navigation concentrate on aspects of the river ships and river circumstances, such as river hydrology, inland waterway pilotage, river ship manoeuvring and collision prevention. Conversely, the contents of the specialised courses of the Maritime Navigation concentrate on aspects of seagoing ships and marine environments, such as maritime navigation, meteorology and oceanography.

The practical training for the students of the River Ship Navigation is arranged on river vessels. The contents of the practical training are concerning methods of piloting in an appropriate inland waterway. The practical training for the students of the Maritime Navigation is arranged on seagoing vessels. The contents of the practical training are concerning maritime navigation methods including terrestrial and coastal navigation, celestial navigation and electronic system of position fixing and navigation.

Another difference is that teaching time for each course is arranged differently. The concrete teaching time for each course is compared in table 3-2.

### 3.2.6 Examination and certification

In China, the academic examination and assessment of students is fully delegated to the institutions, including IWTET and MET. However, the examination and assessment for certificates of competence, whether river ships' mariners or seagoing ships' seafarers, are fully in the control of the appropriate Maritime Safety Administration (MSA) or Harbour Superintendency Administration (HSA).

#### 3.2.6.1 Stipulations of examination and assessment

According to the relevant requirements, the examination and assessment components of the first certification for the deck officers are listed in table 3-3. The
examination and assessment of competence for seafarers and river ships' mariners are conducted by the appropriate MSA twice each year.

<table>
<thead>
<tr>
<th>Name of courses</th>
<th>Common (hours)</th>
<th>Basic (hours)</th>
<th>Specialised basic (hours)</th>
<th>Specialised (hours)</th>
<th>Optional (hours)</th>
<th>Practical training (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maritime Navigation (4 years)</td>
<td>790</td>
<td>510</td>
<td>286</td>
<td>764</td>
<td>270</td>
<td>46</td>
</tr>
<tr>
<td>Maritime Navigation (3 years)</td>
<td>600</td>
<td>150</td>
<td>246</td>
<td>824</td>
<td>000</td>
<td>46</td>
</tr>
<tr>
<td>River-sea ship Navigation (4 years)</td>
<td>770</td>
<td>396</td>
<td>336</td>
<td>1004</td>
<td>230</td>
<td>50</td>
</tr>
<tr>
<td>River ship Navigation (3 years)</td>
<td>634</td>
<td>150</td>
<td>198</td>
<td>808</td>
<td>000</td>
<td>44</td>
</tr>
</tbody>
</table>

Source: see Appendix 2, 3, 4

Table 3-2 Comparison of the teaching time for courses in navigation

<table>
<thead>
<tr>
<th>The river ships' third officers</th>
<th>The seagoing ships' third officers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Items of examination</td>
<td>• Items of examination</td>
</tr>
<tr>
<td>2. Collision prevention and signals</td>
<td>2. Watchkeeping and collision prevention</td>
</tr>
<tr>
<td>3. Duties, rules and regulations</td>
<td>3. Navigational meteorology</td>
</tr>
<tr>
<td>4. Fairways and navigation</td>
<td>4. Maritime English</td>
</tr>
<tr>
<td>5. Seamanship</td>
<td>5. Marine transport of cargo</td>
</tr>
<tr>
<td></td>
<td>7. Ship construction and equipment</td>
</tr>
<tr>
<td>• Assessment of practical operation conducted on appropriate river ships.</td>
<td>• Items of assessment</td>
</tr>
<tr>
<td>The main items:</td>
<td>1. Chart work</td>
</tr>
<tr>
<td>1. Fairways and navigation</td>
<td>2. Route planning</td>
</tr>
<tr>
<td>2. Collision prevention</td>
<td>3. Ship's position fixing</td>
</tr>
<tr>
<td>3. Ship manoeuvring</td>
<td>4. Proper use of navigation aids</td>
</tr>
<tr>
<td></td>
<td>5. Determination of compass errors</td>
</tr>
<tr>
<td></td>
<td>6. Cargo stowage and securing</td>
</tr>
<tr>
<td></td>
<td>7. Maritime English listening and speaking</td>
</tr>
</tbody>
</table>

Table 3-3 The examination and assessment components of the first certification for the deck officers
If a candidate passes all stipulations of examination and assessment and at the same time meets the other requirements, such as professional training and on board training, the appropriate certificate of competence will be issued by MSA.

### 3.2.6.2 Types of the certificates of competence

The types of the certificates of competence (COC) for the river ship's master and deck officers are classified according to navigation area (line) and ship's gross tonnage (see table 3-4). Here, the navigation area (line) means the rivers, or inland waterways and lines of ship navigation, such as the Changjiang River's course, from Yichang to Najing, and Hanshui River, from Hankou to Xiangfan (MSA, 1992).

The types of the certificates of competence (COC) for the seagoing ship's master and deck officers are classified in accordance with navigation area and ship's gross tonnage (see table 3-4). In table 3-4, the unlimited navigation area means any navigable waters; the greater coastal navigation area means the Pacific waters between 55 degrees north latitude and the Tropic of Cancer and west of 142.5 degrees east longitude, and the Pacific waters between the Tropic of Cancer and Equator and between east of 99 degrees east longitude and west of 130 degrees east longitude; the coastal navigation area means the Chinese coastal waters; the near-coastal navigation area means the navigable waters of not more than fifty nautical miles out of the datum line of the Chinese territorial waters (MSA, 1997c).

### 3.2.7 Requirements of teachers/instructors

Generally, the requirements for teachers/instructors working in the IWTET and the MET institutions are similar, i.e., they not only need to get professional theoretical knowledge and teaching experience but also need to get appropriate service on board experiences and certificates of competence (COC). According to the relevant requirements, the teachers/instructors shall complete the approved academic education and training in universities or colleges and get a certificate of qualification for teacher/instructor.
The river ships

<table>
<thead>
<tr>
<th>Capacities</th>
<th>Types</th>
<th>Gross tonnage</th>
<th>Navigation areas (line)</th>
<th>Capacities</th>
<th>Types</th>
<th>Gross tonnage</th>
<th>Navigation areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master</td>
<td>1st class</td>
<td>≥ 1600</td>
<td></td>
<td>A</td>
<td>≥ 3000</td>
<td>Unlimited</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd class</td>
<td>600-1599</td>
<td>Appropriate navigation areas and lines</td>
<td>B</td>
<td>≥ 3000</td>
<td>Greater coastal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3rd class</td>
<td>200-599</td>
<td></td>
<td>C</td>
<td>≥ 3000</td>
<td>Coastal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4th class</td>
<td>50-199</td>
<td></td>
<td>D</td>
<td>&lt; 500</td>
<td>Near-coastal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5th class</td>
<td>&lt; 50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The seagoing ships

<table>
<thead>
<tr>
<th>Capacities</th>
<th>Types</th>
<th>Gross tonnage</th>
<th>Navigation areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>≥ 3000</td>
<td>Unlimited</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>≥ 3000</td>
<td>Greater coastal</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>≥ 3000</td>
<td>Coastal</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>&lt; 500</td>
<td>Near-coastal</td>
</tr>
</tbody>
</table>

* The 3rd and 4th classes river vessels are no 3rd mate.
** The 5th class river vessels have navigation operator only.

Table 3-4 The types of the certificates of competence

No special regulations lay down requirements for qualifications and experiences of teachers/instructors working in the IWTET institutions. Conversely, the requirements for qualifications and experiences of teachers/instructors working in the MET institutions are emphasised in the STCW95 convention (Reg.A-I/6) and regulations on quality control of education and training for seafarers of the P. R. China (article10).

3.2.8 Status of facilities

The status of facilities is different between the IWTET and the MET institutions. Generally, the status of facilities in the MET institutions is better than the IWTET institutions'. The breakdown of facilities is showed in table 3-5.
### Table 3-5 The status of facilities

<table>
<thead>
<tr>
<th>Facilities</th>
<th>IWTET</th>
<th>MET</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Simulations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Radar &amp; ARPA</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>• Ship manoeuvring</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>• River ship piloting</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>2. Computers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• CBT</td>
<td>Few</td>
<td>Many (commercialised)</td>
</tr>
<tr>
<td>• CAL</td>
<td>Few</td>
<td>Many (commercialised)</td>
</tr>
<tr>
<td>3. Electronic navigation lab.</td>
<td>Yes (limited in number of equipment)</td>
<td>Yes</td>
</tr>
<tr>
<td>4. Seamanship lab.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5. Meteorological lab.</td>
<td>Yes (limited in the basic observation)</td>
<td>Yes</td>
</tr>
<tr>
<td>6. Communication lab.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>7. Special training ship</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>8. Other equipment and facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Computer lab.</td>
<td>Yes (limited in number of computers)</td>
<td>Yes</td>
</tr>
<tr>
<td>• Language lab.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>• Physics lab.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>• Chemistry lab.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>• Classroom visual teaching aids</td>
<td>Yes (limited in number)</td>
<td>Yes (limited in number)</td>
</tr>
</tbody>
</table>

#### 3.2.9 Teaching methods

The teaching methods in the IWTET and MET institutions are very similar. The teaching methods include the methods in classrooms, in laboratories and on training ships.

If they have some differences, it is in the subjects of river ship navigation and manoeuvring and on board training. The practical exercises on board are arranged
during or after the lectures of the river ship navigation and manoeuvring. Memory of the fairway's characteristics and practical piloting are the main contents covered during the river ship training.

3.3 Features of the IWTET system

After comparison with the Chinese MET system, the IWTET system has its own features in aspects of purpose, system, curriculum, examination and certification, the requirements of teachers/instructors and facilities, etc. Apparently, the real reasons are because of the different navigational environments and characteristics of ships. Therefore, the IWTET should meet the special needs of characteristics for the river ship deck officers.

3.3.1 The features of the IWTET system

The concrete features of the IWTET system are illustrated as follows.

1. The history of IWTET in China is shorter.
2. IWTET only complies with the national legislation.
3. The purpose of IWTET is to educate and train the personnel to meet the requirements of a qualified river ship's mariner in China and serve the needs of the inland waterway transportation.
4. The size and scope of IWTET is smaller.
5. The examination and certificates of competence have an independent system.
6. There is strong purpose for the trainees because each river or inland waterway has its respective circumstances and features.
7. The importance of practice for the river ship deck officers is emphasised more.
8. The components of knowledge and skills of students or trainees concentrate on the needs of river ship navigation, collision prevention and manoeuvring in the confined and complex waterways.
3.3.2 Student standards and characteristics

Standards and characteristics of students for the course of river ship navigation includes academic knowledge, practical skills, sense of responsibility and as well as psychological, physical qualities.

3.3.2.1 Academic knowledge

The knowledge of students shall meet the needs of the development of IWT, especially in aspects of the navigational environments, shiphandling and navigation.

The main subjects covered are illustrated as follows:

1. Knowledge of navigation
   - Inland waterway navigation
   - River ship manoeuvring and handling
   - Watchkeeping and collision prevention
   - Radar navigation
   - Magnetic compass

2. Knowledge of safety
   - Ship construction and stability
   - Steering control system
   - Echo sounder
   - Meteorology and river hydrology
   - Emergency procedures
   - Cargo handling and stowage

3. Knowledge of management
   - Ship safety management
   - Inland waterway shipping law
   - Prevention of pollution

4. Knowledge of communication
   - Communication system (VHF)
   - English language (sea-river ship navigation course)
   - Visual signalling

3.3.2.2 Practical skills

Due to the confined waterway circumstances, the practical skills (hands-on ability) are more important for the students of the river ship navigation. The main practical skills stated as follows:

1. Seamanship
   - Basic sailor's skills
   - Helmsman' skills

2. Basic pilotage in appropriate waterways
   - identification of sailing passage
   - identification of ship's position by visual marks
   - methodology of 'read river'
   - watchkeeping and prevention of collision
3.3.2.3 Sense of responsibility

The sense of responsibility for work is a very important point for the students of the river ship navigation course. Any negligence from the river ship deck officers who are on duty can lead to an accident occurring due to the narrow and complex waterways. The requirement of high sense of responsibility for work on board is emphasised and cultivated by IWTET institutions.

3.3.2.4 Psychological quality

It is very important for the students of the river ship navigation course to cultivate a good psychological quality. The main psychological qualities include:

- good attitudes/moods for work on board;
- high capability of orientation and attention;
- fast of reaction times;
- good information processing;
- balanced mental/emotion state;
- high level of self-confidence.

Besides the above-mentioned four aspects of standards and characteristics of students, the physical quality is an important one as well. Every institution has paid more attention to train the physical quality of students.
Chapter Four

AN ANALYSIS OF PROBLEMS AND OPPORTUNITIES FACING IWTET IN CHINA

Confronted with rapid development of national economics and needs of inland waterway shipping, and comparison with the MET system in China, there were many problems because of external influences and internal factors. Meanwhile, there are many opportunities, which arise from the development of national economics, inland waterway shipping and new technology, facing the IWTET institutions. The aim of the chapter is to identify the problems and analyse the opportunities facing the Chinese IWTET system.

4.1 Identification of problems in IWTET system

Many basic problems in the field of IWTET are not easily solved, particularly, certain factors which have limited the development of Chinese IWTET. These factors may derive from outside and inside the IWTET institutions.

4.1.1 Problems derived from external influences

4.1.1.1 Lack of updated IWT legislation

The lack of updated IWT legislation is the most important problem. Some regulations are not adequate for the development of the IWT industry. These shortcomings not only hinder the development of IWTET, but also affect quality assurance of education.
4.1.1.2 Lack of awareness of IWTET

The lack of awareness of IWTET is another important problem. There has been a general opinion that IWTET is not important because it is not necessary for river ship officers to have much knowledge. Another opinion is that it is not necessary to have an independent IWTET system because the volume of IWT has been going down from 1995 onwards. These negative opinions seriously hinder the development of IWTET in China.

4.1.1.3 Lack of monitoring system of IWTET

The monitoring system of IWTET is imperfect. There is no special effective system to monitor and assess the IWTET system. Thus, the quality of students cannot be ensured because each IWTET institute can freely enrol students and train them according to its own curriculum and methods.

4.1.1.4 Difficult financial situation

The IWTET institutions have difficulty with their financial situation. The governmental budgets are not enough to maintain the running of IWTET institutions. Particularly, it is difficult to upgrade training facilities and teaching instruments.

4.1.1.5 Limited by the features of IWT industry

In comparison with sea transport, the inland waterway transport industry is limited by a natural environmental condition. In spite of improvement of navigation conditions of waterways from 1949 onwards, a great number of waterways have still been in original and natural condition. The capability of competitiveness of IWT has been less than that of highway and railway transport. This status has become more and more obvious since 1995.

There have been a great number of river ships whose gross tonnage was less than 600 due to limitation of waterways. These ships need not to be manned by ship officers who have a high level education and training. This factor does also limit the size of IWTET development. A lower wage for river ship officers was another factor limiting the development of IWTET.
4.1.2 Problems derived from internal factors of IWTET system

There are many problems in the Chinese IWTET system itself. It is necessary to identify these basic problems in order to take appropriate measures to overcome and improve them.

4.1.2.1 Curriculum and syllabus

The curriculum for the course of ship navigation has not changed form for a long time. The purposes and objectives are very general, so that they are difficult to assess how they have been achieved. There are too many subjects which emphases theoretical knowledge.

Some syllabuses for the course of ship navigation are out of date and they do not reflect changes in new technology. Some new technical applications in ship operations such as rate of turn gyro (indicator), information systems, integrated bridge system of high-speed craft and computerisation of ship handling, have not been introduced into the course. The aspect of environmental protection is not given sufficient attention in the teaching program. The practical training time is not enough for the course of river ship navigation, particularly pilotage practice. According to tracking investigation of the graduates, they generally have a good command of theoretical knowledge, skills and new technology. They are basically competent at their respective work. Most of them are eager to learn more and improve themselves. However some demerits are also found which are mainly as follows.

- Their knowledge is not wide enough being poor in organising ability, management techniques and social contact capability;
- They do not have a good understanding of maritime law, national and international rules and regulations;
- Their hands-on ability is not satisfactory;
- Students are poor in English language skills, most of them having difficulty in English communication;
- Some of the new graduates lack a sense of responsibility.
4.1.2.2 Teachers/instructors

Most teachers/instructors of specialised courses graduated from MET institutions. They lack the experience of service on river ships. For example, only about fifty percent of teachers working in the Navigation College of WTU have a short time experience on river ships. Particularly, there is a lack of senior river ship officers as teachers/instructors.

The knowledge of teachers/instructors is renewed too slowly. The younger teachers/instructors lack regular pedagogic training, which seriously affects the quality of teaching and training.

4.1.2.3 Facilities

There is a lack of facilities for IWTET institutions to train students of ship navigation. For example, there is only one Inland Waterway Radar Navigation Simulator, which was built in 1984 in China. There is no special training ship for river ship officers’ training.

4.1.2.4 Teaching methods

There is also a lack of utilisation of new technology and methodology in teaching and training, such as simulation, and CAL. Although there is training on the Inland Waterway Radar Navigation Simulator for river ship officers in the higher level IWTET institutions, there is no utilisation of simulators in the field of ship manoeuvring and comprehensive ship operations. There is little use of CAL programs in the IWTET institutions. The basic problem is that staff has neither understanding or experience of CAL, or lack funding for researching and buying them.

4.1.2.5 Assessments

There is a lack of self-assessment and review of education to improve the quality of teaching and training. A good IWTET institution has not only a good teaching program, but also a good educational management. Recently, higher level IWTET institutions undertook to establish a quality standards system, which refers to the requirements of regulations on quality control of education and training for seafarers.
The course of ship navigation lacks multi-methods of assessment, particularly application of new technology to demonstrate performance.

4.2 New developments and social changes

Since 1979, the government of China has adopted a development of economic policy, and along with the development of new technology, these factors have brought about new developments and social changes in China. There is no doubt many influences of developments and social changes impact upon inland waterway education and training.

4.2.1 Influence of national economic development

The Chinese economy has continuously risen since 1979. According to the statistics of World Bank in 1998/99, the Gross National Product (GNP) in China reached US$ 1,055.4bn, a rank of seven in the world in 1997. Average annual growth rate of GNP was 8.9%, which was 2.78 times of average level of average annual growth rate of GNP in the world, in 1997. Average annual growth of Gross Domestic Product (GDP) was 10.2% in the period of 1980 to 1990. Furthermore, average annual growth of GDP was up to 11.9%, which was more than 5.17 times the average level of that in the world, in the period of 1990 to 1997. The main reason for the rapid Chinese economic growth was that the policy of opening doors to the outside world and internal economic reform has been adopted. Another important reason was the large capital investment that was from outside of China. For example, the foreign direct investment (FDI) reached US$ 45.6bn in 1998 according to the statistics of the government.

At the same time, the total trade volume of China was US$ 324bn in 1998, among these, volume of export and import was US$ 183.8bn and US$ 140.2bn respectively, which was 14 times that of 1978.

The centre of development of the national economy is located at coastal and along river areas, particularly along the Changjiang River. From 1990 onwards, the average annual growth rate of economy of seven provinces and two municipalities, which are along by the Changjiang River, has reached 14.2%. According to an analysis of tendency for development, until the year of 2010, the gross national product of this area will account for 45% of the total gross national product of China.
In the twenty-first century, the economic corridor of the Changjiang River will become a backbone of economic expansion in China.

The water transport industry of China has forged strongly ahead in the past 20 years because of its fast-expanding foreign trade, which results from rapid growth of the national economy. The nation-wide waterborne cargo transport volume and turnover was respectively 619 million ton and 17.8 billion ton-km in 1997.

### 4.2.2 Influence of the needs of inland waterway transport

China is one of the largest inland waterway transport countries in the world (see 2.1.3). The inland waterway is being turned into one of the least polluting and most economical modes of moving goods and produce. The inland waterway shipping service is an important mode of transport in China. The inland waterway transport industry has witnessed rapid development. On one hand, the transport market has been further opened, thus bringing about prosperity in the inland waterway transport market and on the other, unprecedented improvement has been made in the inland waterway transport infrastructure.

The cargo transport volume of the inland waterway occupied 43.7% of the total nation-wide waterborne cargo transport volume in the period of 1995 to 1997. Since 1979, the IWT industry has adopted a policy of socialist market economy, thus has led to the fleet of IWT increasing rapidly. For example, China Changjiang National Shipping (Group) Corp., which is the largest inland waterway shipping company in China, possessed a fleet of 2526 ships, a total of 2.8 million gross tonnage in 1997. There will be 3119 ships in the company by the year 2000. In accordance with the Changjiang River System transportation planning report, the estimated demand of ships in the Changjiang River System will be around 190,000 ships, total of 15.0 million dead-weight-tonnage in 2000. The estimated volume of cargo transport in the main course of the Changjiang River will reach 348 - 392 million tons in 2000. The container transport will be developed more quickly in the main course of the Changjiang River. The handling capacity of ports in the Changjiang River will reach 1.2 - 3.4 million TEU in the period of 2000 to 2010. At the same time, a special cargo fleet, such as RO/RO car, LPG and Chemical product ships will be developed rapidly.
The government has paid more attention to investment of the infrastructure of IWT, for example, an investment of US$ 125m to assist China in the establishment of efficient and productive inland waterway transport services that will be competitive among alternative transport modes in Guangdong and Jiangsu provinces. Another investment of US$ 210m announced by the World Bank is for the modernisation of China's entire system of inland waterways through a US$ 557m construction program intended to take seagoing vessels deep into landlocked areas. The World Bank believes conditions in China are favourable for the development of inland waterway transport (Lloyd's list, June 24, 1998).

In accordance with a long-term plan made by the Ministry of Communications, great efforts will be made to further improve inland waterway transport infrastructures. As for the inland waterways, the target before the year 2000 is to upgrade the standard of navigable channels according to the navigation standard for 1000 ton vessels; to construct one north-to-south, two east-to-west waterways and two inland waterway networks so as to join up the main channels of the Changjiang River, the Zhujiang River and the Jinghang Canal as well as the waterway networks in the delta areas of the Changjiang River and the Zhujiang Rivers. It is expected to improve 2400kms of waterways and build 160 berths in the river ports.

With completion of the Three Gorges Dam Project (location see figure 2-1), which is now under construction and is attracting world wide attention, the navigation conditions below the municipality - Chongqing will be greatly improved as a result of the 660km long deep water channel to be formed by the reservoir backwater. As dangerous shoals are submerged and navigable depths increased, 10,000dwt fleets can directly navigate from Wuhan to Chongqing, the shipping efficiency will be boosted and transport costs will be reduced by 35%. Therefore, the Three Gorges Dam Project will have positive effects accelerating the development of IWT in the upper reach of the Changjiang River.

Confronted with a good situation for the rapid development of IWT, the question now focuses on the status of educational levels for river ship officers' manning. Based on a result of statistics of four typical inland waterway shipping companies, there was a lack of higher education level of river ship officers, which has posed a problem for IWT. The structure of educational level of river ship officers for over 600 gross tonnage vessels in the four inland waterway shipping
companies is shown in figure 4-1. A result of comparison between a requirement of manning standard for river ship officers provided by the Ministry of Communications in China is shown in figure 4-2. The result of problems is that shipping companies have to employ sub-standard ship officers sometimes in order to maintain their shipping activities.

Figure 4-1 The actual structure of educational level of river ship officers' manning

![Bar chart showing the number of employees in different educational levels.](image)

Figure 4-2 Comparison between the actual and optimal manning

Figure 4-2 Comparison between the actual and optimal manning

![Bar chart showing the percentage of employees in different educational levels.](image)

The IWTET institutions in China are faced with a challenge of how IWTET must be geared to the needs of the IWT industry. Meanwhile, the IWTET institutions are making continuous efforts to improve the educational quality in order to meet the needs of developing China’s inland waterway shipping market.
4.2.3 Influence of rapidly changing of science and technologies

Nowadays, the characteristics of the development of technology is illustrated as follows:

- The developing rate of technology is more quick, particularly information technology;
- The forms of development are both highly expanding and highly comprehensive, especially the latter;
- The rate of transforming technology into productive forces is very fast.

These changing tendencies of technology has led to many large size, high speed and modern vessels, such as 36,000dwt tug pushed-barge convoys, high-speed passenger vessels and modern tourist vessels being used in IWT. These vessels have used new operational systems including manoeuvring and navigation systems, which are not only for high efficiency but also for improving safety in river. Therefore, shipping companies should provide the most effective manpower arrangements needed to meet the challenges of technological change, new ships and new operational systems. In this case, each shipping company assigning ship officers for service not only has to ensure that every ship officer is properly certified, as appropriate in accordance with regulations, but also that the new qualification meets the high standard for working effectively.

The development of new technology has already and will still have an influence upon IWTET in China. The main influences are stated as follows:

- The specialities (courses) are dismembered and reintegrated process;
- The period of renewing knowledge is shortened;
- The new personnel qualities are required;
- The floating of professions is increasing;
- The education and training methods and organisations are changing;
- Initial education at colleges and universities will change into social lifelong education.
- Modern information and communications technology provides considerable promise to enhance teaching and learning in higher level of IWTET.
4.2.4 Influence of safety factors

The most important factor affecting safe operations of a ship is the human element, though the continuous advance in technology has provided more and more sophisticated solutions to safety problems. It is often claimed that up to 80% of accidents on water are caused by human errors. For example, about four hundred ship-traffic casualties, a total economic loss of US$ 25m, have happened in the main course of the Changjiang River in 1997. According to analysis of the accidents they most often occurred not because of faulty, deficient or inadequate regulations, but because the regulations and operational standard procedures that existed had been ignored, failed or were violated.

There are enormous differences in the accident rates of one shipping company compared to another, even though they have nearly all complied with the same major regulations dealing with safety. One main reason is a variable human factor where ship mariners and shore-based staffs of companies have a different level of qualification and skills. It is an obvious objective for IWTET to provide more qualified and high quality personnel to meet the needs of IWT safety.

4.2.5 Influence of international convention STCW 95

The STCW 95 convention, enforced on 1 February 1997, is an important international convention for providing the requirements of seafarers’ education and training. The main aims were covered by the convention:

- International minimum standards of competence of seafarers including masters, officers and key ratings;
- Global harmonization of standards of training, examination and assessment of seafarers;
- Clarification of the skills and competence required;
- Establishment of quality standards system required for ensuring quality of training and certification of seafarers;
- Definition of methods for demonstrating competence and criteria for evaluating competence;
- Mandatory use of simulation for training masters and deck officers;
- Mandatory minimum requirements for certification of seafarers;
- Safe and efficient manning;
This convention has made an impact not only on maritime education and training institutions, but also on IWETET institutions indirectly. Compared with the STCW 78 convention, the impact of STCW 95 upon maritime education and training institutions is as follows:

- Emphasis on the seafarers’ competence including acquisition of skills, practical abilities and capabilities.
- Indication of the requirements of the qualification and experience of training instructors and assessors which are clarified and defined.
- Stress on the use of simulators for training, demonstration and assessment. Radar and ARPA simulators are mandatory and non-mandatory simulators, such as navigation, cargo handling, ship handling, GMDSS and main and auxiliary machinery operation, are recommended.
- Emphasis on the establishment of quality standards which include an independent evaluation of the national education and training system; arrangement for the examination and issue of certification will be required.
- Adoption of functional certifications.

The main responsibilities of MET Institutions for implementation of the STCW 95 are as follows:

- to establish the teaching syllabus of maritime education and training and curriculum for each course under the requirement of the STCW 95;
- to establish an appropriate Quality Standards System and examination requirements for maritime education, training and assessment;
- to provide competent maritime teachers, instructors and assessors in accordance with the STCW 95 convention;
- to provide enough maritime instruments, equipment, simulators, seagoing training ships for training cadets and seafarers;
- to develop technical innovations such as use of computers and simulators for training and assessment purposes;
- to co-operate with Maritime Safety Administration and shipping companies in the training, assessment of seafarers’ competence and establishment of document of implementation.
The five main impact factors of the convention which promote the development of Chinese MET were:

- revision of the MET policies;
- definition of the new objective;
- renewing of the MET curriculum;
- definition of the requirements of teachers/instructors;
- improvement of facilities, equipment and the methods for teaching/training and assessment;
- establishment of a quality standards system.

The final aim is to produce competent mariners. Competence means the ability of people to carry out their work safely and efficiently.

The requirement of producing competent mariners is not only for the MET institutions but also for the IWTET institutions. A question is how to utilise the approach of the STCW 95 convention to improve the quality of IWTET in China. The indirect impact factors of the convention are illustrated as follows:

- to revise a policy of IWTET according to the needs of IWT;
- to define new purposes and objectives;
- to renew IWTET curriculum, syllabus and contents of textbook;
- to improve quality of teachers/instructors;
- to upgrade facilities and equipment, particularly use of simulators and CAL programs for training, examination and assessment;
- to reform methods of assessment, with emphasis on practical ability;
- to establish a quality standards system.

### 4.3 Opportunities for Chinese IWTET

Chinese IWTET is faced with a challenge of how it should fit in with the needs of development of IWT and the needs of China's modernisation. At the same time, it is confronted with favourable opportunities to develop IWTET.

The opportunity has arisen from China’s economic innovation and rapidly increasing rate of economy. This has thus required rapid development of IWT.
The opportunity resulted from the needs of development of IWT. The development of IWT needs a great number of qualified specialised personnel who have an appropriate educational level.

The opportunity also resulted from the requirement of shipping safety. To ensure shipping safety a number of personnel who have a higher level of qualification and skills and meet the requirement of a qualified mariner of river ship need to be trained.

The opportunity arose from the development of new technology. On one hand, IWTET needs to follow the needs of new technology, which influences the content of education and training. On the other hand, new technology also improves methods of education and training.

Further opportunity was brought about by the implementation of the STCW 95 convention, which provides a good approach for improvement of IWTET in China.
Chapter Five

IMPROVEMENT OF
THE IWTET SYSTEM IN CHINA

As the results of Chapter 3 and 4 showed, the IWTET system in China should be improved in order to meet the needs of development of IWT. It is not only a challenge but also a good opportunity for improving IWTET. The measures of improvement of IWTET system are application of new technology, establishment of a quality standards system and renewal of program. The aim of this chapter is to introduce new technology and a quality standards system into IWTET, and to propose a framework of higher level IWTET program for river ship navigation.

5.1 Application of new technology

The characteristics of new technology and influences were described in 4.2.3. The new technology applies not only to waterborne transport but also to inland waterway transport education and training.

5.1.1 New technology and waterborne transport

Along with the development of new technology, particularly with radio, satellite, computer and its network, digital, communication and information technology, a great number of new equipment and systems based on the new technology has been produced and applied to the waterborne transport.

5.1.1.1 Systems for navigation safety
5.1.1.1 GPS and DGPS

The Navstar Global Positioning System (GPS) system is a satellite-based system that can pinpoint an object's co-ordinate position anywhere on the globe, and which consists of the space segment (24 satellites), the ground/control segment (including monitor, master control and upload stations) and the user segment (receivers).

Differential GPS (DGPS) relies on the establishment of a local reference station at a precise location within the area of operation. The GPS satellite signals are monitored at the reference station and compared to their known values, the difference being a set of correctional values. Accuracy achieved with Differential GPS is less than, or equal to, 20 meters.

The GPS (DGPS) has application to a very wide range in the waterborne transport. It is in coastal and inland waterway navigation where GPS (DGPS) has the greatest number of users. A coastal and inland waterway passage is generally a more dangerous portion of any vessel's journey and the vast majority of marine casualties occur during it. The reasons for this are a greater risk of collision due to increased traffic densities and an increased risk of grounding either on the coastline or on off-lying obstructions or shoals. For example, an electronic information system including the electronic river map, the radar image and GPS (DGPS) for navigation channels in the Rhine was designed in order to increase the level of efficiency and safety of shipping on the Rhine.

The GPS (DGPS) also helps enhance safe navigation in congested or coastal waters or inland waterways, and is now mostly concerned about the management of vessel movement. For example, GPS (DGPS) - based model integrated navigation system has been installed on modern vessels to enhance navigation safety. GPS (DGPS) - based Vessel Traffic Management and Information Service (VTMIS) and River Information Service (RIS) have been applied.

GPS (DGPS) is a part of the worldwide radio navigation system (WWRNS) which consists of satellite navigation systems and terrestrial navigation systems. WWRNS is capable of providing adequate position information within its coverage area. The satellite navigation systems include GPS (DGPS) and GLONASS (DGLONASS) systems. The terrestrial navigation systems include Loran-C (Chayka) and Decca.
GNSS is a satellite system, which provides a worldwide position determination, time and velocity capability for multi-model use. GNSS includes user receivers, one or more satellite constellations, ground segments and a control organisation which facilitates the monitoring and control of the world-wide conformity of the signals processed by user receivers.

The applications of GNSS are as follows:

- shipborne applications - ECDIS interface, automatic position reporting interface, GMDSS interface, high speed craft requirements, track control, docking/mooring, ship motion monitoring, voyage data recorder, ship heading and attitude indication.
- external applications - SAR, hydrographic survey, buoy positioning, fairway design and dredging.

5.1.1.1.2 Digital radar

Radar technology has been developed and improved over 60 years from a prototype machine in the 1930s to analogue signal processing in the early 1960s, to the digital signal processing in the late 1980s. Digital radar is modern radar, which uses many high technologies, such as computer, signal digitisation and high-resolution display technology. Advantages of the digital radar are as follows:

- Full daylight picture;
- Suppression of clutter;
- Echo strengthening and stretching;
- No rotating sweep, flicker free and high contrast.
- Information overlay and features

The digital radar has been widely applied to waterborne transport. Digital radar is a significant breakthrough in daylight viewing raster scan radar technology for marine applications. For example, Sperry Raster scan river radar is a daylight viewing radar for river applications of close range and confined water navigation.

The digital radar has allowed electronic navigation chart and radar images to be combined together on one display. The benefits of that are as follows:

- One screen for navigation and collision avoidance;
- Targets and manoeuvring area on same display;
- Continuous radar fixing;
- Easy target identification;
- Mutual check.
The digital radar advance with overlaying display of radar image and ECDIS, and combined with GPS (DGPS) has great potential in the integrated navigation system, as the situation involving encounters with other vessels can at all times be assessed within the overall context.

By integrating the functions of ARPA and ECDIS, a system can be developed to help officers of the watch to deal with complex traffic situations by giving them suggestions for avoidance routes. This system can also be used in VTMIS and RIS. The benefits of ECDIS radar/ARPA integration include a synergistic improvement in navigation and collision avoidance, particularly in river-confined waters or during periods of reduced visibility. Also, the officer of the watch (OOW) does not have to monitor two displays at the same time. There are some factors that can cause a mismatch between ECDIS and radar, such as temporary loss of the differential correction signal of DGPS.

5.1.1.3 ECDIS

The IMO’s performance standard for electronic chart display and information systems (ECDIS) defined that ECDIS is a navigation information system which, with adequate back-up arrangements, can be accepted as complying with the up-to-date chart required by regulation V/20 of the SOLAS 74 Convention. It displays selected information from a system electronic navigational chart (SENC) with positional information from navigation sensors to assist the mariner in route planning and route monitoring, and by displaying additional navigation-related information if required.

The primary function of the ECDIS is to contribute to the safety of navigation. It is capable of displaying all chart information necessary for safer and more efficient navigation as well as facilitating simple and reliable updating of the electronic navigational chart, thus reducing the navigation workload of the officer of the watch. The primary functions of the electronic chart system (ECS) are to enhance the safety of navigation and to reduce the navigational workload of plotting compared with the paper chart. ECS is capable of displaying chart data related to the past, present and planned position.

The electronic chart can be divided into Vector chart and Raster chart. Raster chart display systems (RCDS) are scanned paper charts, which provide no real alternative to ECDIS data. Raster data consists of purely pixel pictures. The user
has to interpret them in order to recognise them as belonging to an object. In contrast, ECDIS data is vector data. Pixels of vector data can tell the user what object they belong to. With the cursor the user moves to any spot on the nautical chart and clicks on it. Then a window appears with the information on the point clicked.

ECDIS has emerged as a new aid to maritime and inland waterway navigation, the use of which results in significant benefits to vessels piloting and safety. ECDIS is a real-time geographic information system capable of integrating GPS/DGPS, echo sounder, gyrocompass, radar, and electronic chart information into one display. As an automated decision aid, ECDIS is capable of continuously determining a vessel’s position in relation to land, charted objects aids to navigation and unseen hazards. As a navigation system, ECDIS also displays such important information as cross-track distance, course made good, and speed over ground and time-to-go. ECDIS and other forms of electronic charts like raster chart display system (RCDS) represent an entirely new approach to the safety of maritime navigation and piloting. Another importance of ECDIS is that it is a base of modern VTMIS and RIS.

The ECDIS will integrate digital information, real-time environmental data, i.e. current, tide, wind etc., and the data of vessel systems into a display that is expected to improve the safety and reliability of coastal, harbour and inland waterway navigation. Using a combination of ECDIS and GPS (DGPS) it will be possible to monitor ship’s movements at all times, including when turning. Also, by using information from a rate of turn instrument and speed over ground it will enable navigators to make and monitor controlled turns with a constant radius.

5.1.1.4 AIS

Modern maritime technology has made it possible to identify and track ships in directions of ships to ships, ships to shore and shore to ships. The automatic identification system (AIS) can fulfill the demands from both the mariner on the ships and shore based stations, monitoring and supervising the coast and harbours with VTS stations. The implementation of AIS will substantially enhance the general safety on water, as well as giving ships and VTS operators improved control and surveillance of vessel traffic.
Nowadays, AIS includes radar transponder, which is only capable of interrogating and identifying ships as they appear on the radar screen, and radio transponder, which uses a broadcast and an interrogating self-organising technology. The components of radio transponder are a GPS (DGPS)-receiver, a VHF-transceiver and a computer.

AIS would improve safety and solve the limitations of radar. An AIS can:

- look behind the bend in a channel or behind an island in an archipelago to detect the presence of other ships and identify them;
- predict the exact positions of meeting with other ships in a river or in the archipelago to avoid meeting in a narrow river bend;
- know where and to which harbour a ship is bound for;
- know the size and draft of ships in the vicinity;
- detect a change in heading as soon as undertaken by other ships;
- detect and identify a ferry leaving the shore bank in a river;
- identify fixed obstacles, like oil rigs, ship wrecks, dangerous to shipping;
- identify slowly moving targets, like log rafts, sounding arrays, unable to make rapid evasive actions.

Because AIS can look behind the bend in a channel or island and detect and identify other ships, the AIS can help pilots and the master of a large ship to manoeuvre the ship in congested areas or narrow waters. It can predict the exact positions of meeting with other ships in a river, know where a ship is bound for, the size and draft of ships in the vicinity, and detect and identify a ferry leaving the shore bank in a river. For example, AIS has covered 40,225 Km of river and intracoastal shoreline in North America (USCG, 1999).

The AIS can also be widely used in the VTMIS and the RIS for the high update rate of tracking, broadcasting and interrogating. The AIS can be employed for shore-based pilotage by improving the tracking and detection of a course change of a ship from shore.

The AIS could perform a perfect function in collision avoidance by broadcasting the identification, heading and the change in heading of ships. The widespread use of AIS can be made for route planning, short message communication in case of limited radio system capacity, mobile VTS, and one-man bridge to reduce the workload of the OOW to a considerable extent.
The AIS also plays an essential role in anti-collision. Radar has been the primary means for preventing collisions on water in restricted visibility. With a broadcast AIS the identification, heading and the change in heading could be determined with a high update rate and solve some of the limitations in a river.

The AIS can help a maritime rescue co-ordination centre (MRCC) to search and rescue operations efficiently and quickly. During a search, all the ships could be tracked and plotted, enabling the MRCC to monitor the progress, to direct the available resources efficiently and to ascertain that search coverage is without gaps. Additionally, if a ship in distress installed AIS, it could be seen on the displays of all the surrounding ships and also at the MRCC.

5.1.1.2 Systems for ship control
5.1.1.2.1 Adaptive Auto Pilot

The adaptive auto pilot (AAP) is a good quality auto pilot apparatus with the addition of a digital control system (microcomputer) producing the final rudder command signal. The adaptive auto pilot is so designed that the ship can make the course steering more accurate taking into account the drag of the rudder angle and the ambient conditions, e.g. weather, wind, currents and tide.

The fully adaptive auto pilot is for automatic track control, assessment of vessel's dynamic behavior and radius controlled course alterations. The AAP utilises the vessel's natural steering characteristics and automatically adjusts the auto pilot to compensate for changing conditions and conditions change with each heading change, how the vessel is loaded, as well as when sea conditions change.

Steering is with fewer rudder corrections. As a vessel steered by AAP will use a minimum of rudder corrections, they reduce rudder drag. Reduction of rudder drag allows the vessel to travel faster between two points, use less fuel and reduce wear on the steering gear.

Turning is smooth. Once the new course is determined, the radius of the required turn can be calculated and the radius and new course set on the AAP because the AAP takes charge of the manoeuvre, from start to finish. It automatically and continuously corrects rudder angle, so that the vessel turns on the new course smoothly and precisely. At the same time, the ship loses less speed as it goes through the turn.
The ship manoeuvres safely because the order goes directly from AAP to the steering gear, OOW is free to concentrate on other equally urgent matters or keep an eye on the fairway throughout the manoeuvre. Modern ships are manned with fewer crews and one man bridge operation has come into reality, the AAP therefore could function more efficiently in a way that it helps to minimise the number of crew without threatening the safety of navigation.

5.1.1.2.2 Track Control Systems

In accordance with IMO's draft recommendation on performance standard for track control systems, the objectives of track control systems with their sources of position, heading and speed data are intended to keep a ship automatically on a pre-planned track over ground under various conditions and within the limits related to the ship's manoeuvrability.

The operational requirements of the system include the functions in steering the ship to or along a sequence of waypoints, change of waypoints, position monitoring, early course indication, actual course change and confirmation, turn performance, adaptation to steering characteristics, overriding function, heading monitoring and control. The visual and sound alarms are also required to warn the officer of the watch when a failure of the system or a deviation beyond the pre-set limit takes place. In modern ships, the track control systems may be integrated in ECDIS, GPS, Loran-C or other navigational equipment to enhance the safety of navigation. The officer may pre-plan the waypoints for a certain voyage to increase the safe navigation by using track control system.

5.1.1.2.3 Computerised navigation system

Application of computer technology has a profound influence on the entire shipping sector. A main advantage of the latest communication and information technology (CIT) development in the shipping sector lies in the fact that the use of CIT can increase the efficiency of shipping operations, it therefore ensures the safer navigation and operation of ships. Computerised navigation system means a system in which the vessel's operation and management of voyage planning, maintenance scheduling, communications, and engine room controls are computerised.
Computerised management allows data to be exchanged between applications and used for in-depth fleet-wide analysis. Computerised navigation systems may include those for ship control and monitoring, and administration systems. Ship control and monitoring include integrated bridge system, engine control and monitoring, ballast control, condition monitoring, and fire detection. The administration systems cover maintenance purchasing system, reporting system, load calculation, performance evaluation, operational database, document database and weather routeing.

5.1.1.3 Systems for maritime communication

Maritime communication system includes the satellite and terrestrial communication systems. The components of satellite communication system include Inmarsat system and COSPAS-SARSAT system. The terrestrial communication system involves the medium and high frequency radio communication systems.

The GMDSS represents a major upgrade of safety procedures and equipment used in maritime safety. It provides basic communications links, distress alerting and relay, and maritime safety information (MSI) to ships at sea. The primary goal of GMDSS is to essentially guarantee seamless communications for all complying vessels to a shore station regardless of location or atmospheric conditions.

The satellite communication is not only used for the GMDSS system, but also it is used for maritime commercial communication. As the satcom (satellite communication) industry becomes more competitive, Inmarsat will continue to position itself as a leading provider of advanced business communication services, while remaining deeply committed to the maritime community. Some service providers also operate Inmarsat land earth stations (LES), which receive and transmit communications through the Inmarsat satellites and provide the connection between the satellite system and the world's fixed communications networks.

Many ship operators have already realised that there is an increased need for timely and efficient communication and they are, therefore already using telex and fax for commercial communication. High Speed Data (HSD) and Digital High Speed Data (DHSD) will become an almost standard feature in future Inmarsat-B installations thus providing shipowners with a range of additional communication
services. For example, ECDIS can be transmitted and corrected update through the satellite providing the vital “missing link” in providing communications between ship and shore, anytime, anywhere. The weather routeing system can provide a reasonable and safety route based on the updating shipboard database, the actual weather observation reports and the coded weather data from shore through satcom. The crews who are on board can receive distance maritime learning and training programs via satcom.

There will be other satellite communication systems for maritime communications. A company named Iridium will offer full worldwide cellular compatible satellite (66 low earth orbit satellites) cover, using hand-held phones. Globlstar, ICO and Odyssey, which will follow in the next few years, will also compete for satellite communications business (Patraiko, 1998). For example, ICO will offer global communications including maritime services by the end of 2000.

5.1.1.4 Systems for integrated management

Major improvement of the safety and efficiency of waterborne transport and protection of the environment may be expected from the extensive use of modern information technology and telecommunication to collect, store, process the relevant information and making it available to all users involved in shore-based and on board ship. The main systems include vessel traffic services (VTS), river information services (RIS) and integrated bridge system (IBS).

5.1.1.4.1 VTS and RIS

Vessel Traffic Services (VTS) and River Information Services (RIS) are shore-based systems for integrated ship safety management. VTS is defined by IALA/IMO as a service implemented by a competent authority, designed to improve safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and respond to traffic situations developing in the VTS. The stated purpose of VTS is to improve the safety and efficiency of navigation, safety of life on water and the protection of the marine environment and/or the adjacent shore area, work sites and offshore installations from possible adverse effects of vessel traffic.
The VTS has internal and external functions. Internal VTS functions include data collection and data evaluation/decision making. External VTS functions include primary traffic management functions in terms of allocation of space, routine control of vessels, and manoeuvring to avoid collisions.

Demands for rapid, reliable intermodal transport chains require coherent and consistent information flow throughout the entire shipment process covered by the carrier. These demands led to the expansion of the VTS into the vessel traffic management (VTM). VTM is defined as the set of measures, provisions, services and related functions, which within a given area and under specified circumstances, intend to minimise risks for safety and the environment, whilst maximising the efficiency of waterborne and connecting modes of transport. Further development of VTM is a Vessel Traffic Management and Information Service (VTMIS), which is cater for public and private demand for facilitating vessel traffic management. VTMIS includes services distributed in a given area (at regional, national or transnational level), such as EU wide VTMIS, the pertinent information to be used both in real time and in retrieval modes by users involved.

The characteristics of VTMIS are the electronic exchange of information with services of the same kind in the neighbourhood, region or at distant locations ('horizontal information exchange') and electronic exchange of information with other maritime services - official or commercial - e.g., allied or logistical services ('vertical information exchange').

The technology used for VTMIS includes the AIS, ECDIS, radar, satellite communication system, telephone, facsimile, data transfer, Internet, and e-mail. VTMIS can serve many functions, for example:

- Vessel traffic management, such as VTS/pilotage, compliance monitoring and SAR/calamity abatement/salvage.
- Port resource management, such as towing/line handling and berth/terminal planning.
- Cargo flow management, such as intermodal connections and fleet management.

Here it should be stated that VTMIS is not a system or service, it is a concept, a kind of umbrella, for all activities improving the exchange of information for the services relating to movements of vessels or the cargo (Koopmans, 1998).
River Information Services (RIS) - VTS and VTMIS in inland waterways currently have been operating in European countries. The concept for River Information Services (RIS) is defined as a VTMIS concept for inland waterway navigation. The main objectives of the River Information Services are:

- To enhance the safety of inland waterway navigation in a preventive sense by the provision of information relevant for immediate navigation decisions;
- To improve the efficiency of transport and logistics by the exchange of planning-information on terminal, port and lock-operations and management information on traffic flow.

The RIS consists of three main elements called the tactical traffic information (TTI), the strategic traffic or logistical information (STI) and the fairway Information system (FIS).

For example, one of the projects in the 4th Framework of the Transport Research Program in the Waterborne sector in Europe is called Inland Navigation Demonstrator for River Information Services (INDRIS) project. The aims of this project are to achieve a standardisation of ship-shore communication with open standards including standards and definitions for data and communication. In the second phase of the INDRIS project it is proposed to demonstrate the functions of the RIS concept at three different sites in Europe. The project started 15 January 1998 and will be finalised before 1 January 2000.

5.1.1.4.2 Integrated Bridge System (IBS)

Integrated bridge system (IBS) is a shipboard-based system for the integrated navigation safety management. IBS is defined as a combination of systems, which are interconnected in order to allow centralised access to sensor information or command/control from workstations with the aim of increasing safe and efficient ship's management. IBS consists of integrated navigation system (INS), integrated control system (ICS), individual steering and propulsion control. IBS is not only applied to seagoing vessels but also to river vessels.

The purpose of IBS is to permit precise navigation, increase safety, reduce costs and manning, control shiphandling easily, decrease workload for the navigator, improve man-machine interface and manage the ship efficiently and effectively.
Tasks using navigation and manoeuvring workstations include observing all vessels and targets, recognising dangerous situations, deciding on collision avoidance action, checking own speed and course, keeping/changing own course/speed, checking own position, handling own internal communication on board, handling communication ship/ship and ship/shore and acknowledging watch alarm.

IBS is the multi-function bridge workstation that uses the latest advances in flat-panel display technology. The system uses high-resolution flat-panel color display screens. The workstation's compact design makes it suitable for any bridge size, and the electronics are remotely mounted to save space, reduce heat and minimise electronic interference on the bridge. It integrates inputs from radar/ARPA, ECDIS, AIS, autopilot, GPS, gyrocompass, speed log, echo sounder, engine monitoring systems, shipboard IT systems and other devices for presentation on multi-function display screens. The combination of advanced flat-panel technology and multi-function displays will reduce the number of separate consoles and workstations required for the current generation of integrated bridge systems. One man bridge operation is therefore possible to achieve through IBS.

5.1.2 New technology and IWTET

The application of new technology and methodology to the field of education and training has been considered widely, such as simulations, computer assisted learning programs, computer based training and video conferencing equipment.

5.1.2.1 Simulators

The simulator is defined as a device, designed to satisfy specific objectives, which mimics part of a real situation in order to allow an operator to practise, and/or demonstrate competence in, an operation in a controlled environment (Barnett, 1996). Nowadays, simulator training is a firm part of modern-day training concepts in many areas. Simulators offer numerous advantages in that every conceivable hazardous situation can be practised at no risk to man, equipment or the environment. Simulators are always available, irrespective of the weather conditions. Original equipment is used less extensively, thereby also reducing power consumption. An aspect of which is particularly importance of the quality of training improvement.

The maritime simulators can be divided into special (single) task, limited task, multi task and full mission simulators (see table 5-1). They also can be divided into
computer based training and hands-on instrument training simulators. The most suitable simulator can be chosen according to the training objectives.

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special task</td>
<td>Capable of simulating particular bridge instruments or limited navigation manoeuvres but with the operator located outside the environment (e.g. a desk top simulator using computer graphics to simulate a bird's eye view of the operating area).</td>
</tr>
<tr>
<td>Limited task</td>
<td>Capable of simulating an environment for limited (instrument or blind) navigation and collision avoidance (e.g. radar simulator with no visuals)</td>
</tr>
<tr>
<td>Multi task</td>
<td>Capable of simulating a total navigation environment, but excluding the capability for advanced manoeuvring in restricted waters.</td>
</tr>
<tr>
<td>Full mission</td>
<td>Capable of simulating a total environment, including the capability for advanced manoeuvring and pilotage training in restricted waters.</td>
</tr>
</tbody>
</table>

(Source: Cross, 1998)

Table 5-1 Category and definition of the maritime simulator

Simulators have been used to train mariners since the 1960s. Simulator application for trainees may include training in:

- knowledge of the International Regulations for Preventing Collisions at Sea (COLREGs)
- radar and automatic radar plotting aids (ARPA) operation
- navigation techniques
- electronic navigation systems
- global maritime distress and safety system (GMDSS)
- passage planning
- bridge watchkeeping
- shiphandling and manoeuvring
- bridge resource management (BRM)
- vessel traffic service (VTS)
- emergency procedures
- search and rescue (SAR)

Simulators have been applied to IWTET since the 1970s. In 1974, the first river radar and navigation simulator in the Rhine Boatmen's Training College, Germany was put into operation. The system incorporated an own ship control station, which was a replica of the one-man control station used in contemporary push tugs. In addition to own ship, six traffic ships could be controlled.
After ten years, in 1984, an inland waterway radar navigation simulator was designed and built by Wuhan Inland Waterway Transportation College in China. The simulation includes instructor control station, own ship bridge and six view and learning stations. The main functions include pilotage, collision avoidance and bridge command.

In the 1990s, the Norcontrol NMS-90/RS inland waterway simulator was built by NORCONTROL Company. The simulator has been developed specifically to train students in all aspects of inland waterway navigation. The system includes own ship bridge, instructor station and visual systems. A full set of environmental effects including day, dusk, night, fog, depth, current and wind are provided.

The maritime simulator as a training tool has a potential to improve training efficiency and effectiveness in many different training objectives. The main advantages are a highly effective form of training (figure 5-1), lower training cost, eliminated safety risks, covered emergency situation, exercise flexibility, assessment medium and increasing trainees’ confidence (Muirhead, 1998c). So, Radar and ARPA simulators are mandatory in STCW 95 convention (Reg. A-I/12) for training and assessment of seafarers’ competence or demonstration of their skills. The non-mandatory types of simulators, which include navigation and watchkeeping, shiphandling and manoeuvering, cargo handling and stowage, radio communications (GMDSS) and main and auxiliary machinery operation (STCW 95 Reg. B-I/12) are recommended.

![Figure 5-1 Training proficiency using simulators](image-url)
The level of instructor is the most important element in the simulator training equation because effective training equals suitable simulator plus completed program and plus qualified instructor. The qualified instructors can use even the most basic simulator and produce meaningful and valid training outcomes on it. Otherwise, the poorly skilled instructor may waste the resource and fail the training on a highly sophisticated simulator.

The different training objectives, simulators and trainees require different level of instructors (see figure 5-2). Otherwise, it is difficult to achieve the desired objectives and effectiveness.

![Figure 5-2 The level of instructors](image)

The simulator can also be used for assessment to evaluate training effectiveness and assessment of competence for the purposes of certifications. Simulators can be used in two ways for the assessment of competence, first, as an examination tool, involving the use of scenarios designed to assess specific performance criteria and second, the successful completion of simulator-based training courses being accepted as part of a portfolio of evidence.

Simulators still have disadvantages, which include high capital equipment costs, experienced instructors needed, skilled maintenance support needed and system limitations (Muirhead, 1998c). Limitation of simulators for training and assessment derives from the simulator system's limitations and shortcomings, lack of experienced and skilled instructors/trainers and trainees' experience and attitude.
In practice, even though the simulator training is never instead of ship training, it is an effective training facility and will be applied widely in IWTET. There are many evidences of the positive benefits and effectiveness of simulator training from instructors and users, both trainees and their sponsors.

5.1.2.2 Computer assisted learning (CAL)

'The concept of computer assisted learning (CAL) centres around the ability of the powerful personal computer of today to mediate in the flows of information in the learning and training process' (Muirhead, 1998f). The CAL includes Computer Based Instruction (CBI), Computer Assisted Instruction (CAI), and Computer Based Training (CBT). Basically, it is the use of the computer to deliver instruction or assist in the learning and training process. The latest generation of CAL applications are 'multimedia', mixing pictures, text and sound, and are often 'interactive' - responding to the user's input and proceeding accordingly rather than simply working through a preset sequence of exercises.

The computer assisted instruction (CAI) or computer based instruction (CBI) is to assist teachers/instructors teaching in the classroom or distance learning. However, computer based training is to assist learners learning and training individually. It includes, whether CAI or CBT, written information, photos, videos and animation.

The CAL can also be summarised as demonstration programs, man-machine interactive programs and imitated and intelligent programs.

- Demonstration programs have a pre-determined sequence of frames, the student's response in the learning process not being taken into account. This type of program provides students with fundamental knowledge and operating procedures. It is particularly useful for the introduction of new maritime technology and safe processes of ship operation, such as Principle of Radar and Dangerous Goods programs provided by Videotel, UK.

- Man-machine interactive programs are designed for interactive training during the process of program. There are many questions raised when the program is running and each next step is determined by the student's answer. The student can pass to the next step after choosing an answer or giving a corrected answer,
such as Ship Lights and Shapes and Rule of the Road programs provided by Videotel, UK.

- Imitated and intelligent programs give some situations for the student to make a decision on each step in the process. In some training programs, the instructor can set or justify several conditions and give different situations for the student's training on the computer, such as 'Mariner' bulk cargo loading program designed by Baron and Dunworth and GMDSS program provided by Poseidon.

The CAL is a new innovation in education and training due to the development of computer technology quickly. There are many advantages, which are summarised as follows:

- Interactive and individualisation
- User friendliness
- Learning and training flexible and available at all times
- Easy access and distribution
- Learning more effectiveness and efficiency
- Low cost learning and training
- Animation and graphics
- Ability to record and analyse data

- Directed to specific learning objectives or focus on needs
- Enhanced acquisition of knowledge and understanding
- Learning materials uniform and consistent
- Simulation of applied operational tasks
- Effective assessment of skills

There is evidence of benefits from computer based training, that is, Sperry's computer-based training provides a cost-effective way to keep the system operators well trained. With the Sperry CBT loaded on any multimedia Windows PC, any user of the system can take a course when convenient, and at his, or her, own pace. Further evidence is the CBT package for on board training provided by Seagull or Videotel. These CBT programs can be used with a standard PC and a CD-ROM disk, a flexible and cost-effective training environment. They are proven to increase retention up to 80% and reduce training time by almost a half which provides a cost saving for the shipowners.

Despite the fact that CAL has many advantages, it can not completely replace all traditional learning and training. For the IWTET case, there are three types of study material with which a student deals. The first case is the theoretical and basic principles of knowledge related to river navigation and ship control. In this case, a student should have a wide range of knowledge about mathematics, physics, radio
techniques and applied sciences. Hence, this case is more suitable for traditional learning. The second case is to acquire knowledge of the ship's practical operation and skills. In this case, the best way is to combine CAL and traditional learning. The third case is that the student should understand and fix the various rules, regulations and requirements for the ship's operation and management. The CAL is an effective method for this case.

In practice, the best way for IWTET is to combine the CAL with other methods of learning and training, such as traditional, hands-on simulation, video and practical learning or training.

The CAL has great potential for modern education and training. It can be expected that the development of multimedia and information technology will make CAL a suitable form in inland waterway transport education and training.

5.1.2.3 Multimedia learning systems

The term multimedia means combined use of several media, such as films, video, and music; today, multimedia has become closely associated with the computer-controlled, instructional delivery systems. Multimedia technology can be used as resources and tools for learning, to support a variety of learning settings, for information dissemination and retrieval and information retrieval from the Internet (WWW) resource based learning.

A multimedia learning system thus differs from a computer based learning system in that it adds to the computer-based learning experience, the dimension of computer-controlled integration of images, full motion pictures and sound for purposes of teacher/student interaction. A multimedia learning system includes all the components of a computer based learning system - the multimedia computer itself with a monitor, a printer, scanner, digital camera, and overhead projector for computer. The computer is connected with the server which has access to the Internet.

The multimedia learning system can be widely applied in modern education and training because vision is recognised as the most powerful data acquisition device for the brain (Poole, 1995). Visual displays of information encourage a diversity of individual viewer styles and rates of editing, personalising, reasoning, and understanding.
One of the most powerful uses of multimedia is to immerse the user in a learning environment, the key to this approach is achieving the imaginative engagement of the learner. The ultimate expression of simulation is full virtual reality, which is potentially one of the most powerful media for educational systems.

A multimedia learning system may require the use of speech, music or special sound effects. The use of digital sound may be divided into two distinct categories namely the use of speech, and the use of music and sound effects.

The multimedia learning system has great potential for modern education and training. It can be expected that the multimedia learning system will be applied to inland waterway transport education and training.

5.2 Application of Quality Standards System to IWTET

Quality standards system (QSS) is being widely applied in the shipping industry. Because the shipping industry is one of the most international industries in the world, it embraces virtually every nationality and culture, and the adoption of an internationally recognised standard is crucial to providing the necessary assurance to customers on a global scale (Marsh, 1991). Based on the philosophy of quality assurance, the International Maritime Organisation (IMO) established the International Safety Management Code (ISM Code), which was enforced on first of July 1998, for the purpose of shipping safety and pollution prevention. STCW 95 convention has stressed that each party shall establish a quality standards system in order to ensure the quality of maritime education and training. So, establishment of a quality standards system may be an effective method to improve the quality of IWTET.

5.2.1 Quality standards system and IWTET

5.2.1.1 Definition

**Quality**: common definitions of quality describe it as the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs (BSI, 1995).

**Quality assurance**: encompasses all the policies, systems and processes directed to ensuring maintenance and enhancement of the quality of educational provision in IWTET institutions.
**Quality standards system:** about having specific processes and procedures in place that are actively used by personnel to achieve the defined objectives (Muirhead, 1998g).

**Quality management:** that aspect of the overall management functions that determines and implements the quality policy of an IWTET institution.

**Quality system:** the IWTET institutional structure, responsibilities, procedures, processes and resources for implementation of quality management.

**Quality control:** the operational techniques and activities that are used to fulfil requirements for quality within IWTET institutions.

According to the above-mentioned definitions, it clearly shows a logical relation for the whole quality assurance conception. The following diagram shows a relationship between them (figure 5-3).

![Diagram of Quality Assurance Concept](image)

**5.2.1.2 Key elements of QSS**

An effective quality standards system is characterised by agreement throughout an institution on purposes and methods and includes a feedback loop to inform and improve the quality of provision of education and training. It is underpinned by wide participation, an effective channel of communication, the specification of standards and acceptable evidence, the acceptance of responsibility by staff and students, and an institutional commitment to staff development and training (HEQC, 1994).
The customers of IWTET institutions are shipping companies - employers. The employers are the focal point of the three key aspects of a quality system. The satisfaction of employers can only be assured when there is harmony of interaction between the management responsibility, the personnel and material resources and the quality system structure (see figure 5-4).

Based on the principle of the quality system, the key elements of a quality standards system should include quality policy, quality management functions, academic and administrative coverage, application of quality control functions, internal quality monitoring processes and reviews and external quality evaluation arrangements.

5.2.1.3 Models for quality standards system in education and training

There are several models for quality standards system in maritime education and training. The main models include ISO 9002 alteration model, classification society model and nation accredited model.

The ISO 9002 alteration model means that establishment of QSS in education and training institutions is based on the principle and requirements of ISO 9002, Quality System - model for quality assurance in production, installation and servicing. ISO 9002, Quality System is used when conformity to specified requirements is to be assured by supplier during production, installation and
servicing. The main point of alteration is product, which is person (student) when ISO 9002 is used in institutions. So, the quality system procedures and processes will be altered appropriately.

Several classification societies have offered models for use by maritime education and training institutions as quality standards system, such as models from the Det Norske Veritas (DNV) and the American Bureau of Shipping (ABS). The models indicate a very high level and a readily apparent slant toward an ISO 9000 series mentality. The models offer clear blueprint on how to organise, implement, and operate a QSS. For example, the standards provided by DNV consist of five parts (Jaeger, 1997):

- 'Certification requirements': (The two first parts): They are called 'quality assurance' principle, including all elements of quality required in QSS.
- 'Development activities': Any development of courses/simulator exercises and curriculum plans should be performed in a structured way - with specific verification activities to ensure that all courses/plans etc. fulfil any requirements.
- 'Operational part of training activity': Identifying instructors' trainers' needs and necessary equipment required for any specific training including maintenance requirements of equipment.
- 'Result phase of any training': Examination criteria should be specified and how it is to be carried out is stated. Procedures for certification must be identified. A system for ensuring that all mandatory elements are covered through tests/exams during the education and training must be established.

The national accredited model is a means of self-regulation based on the requirements of convention and maritime industry, by which the quality and integrity of maritime education and training institutions will be directed and sustained. For example, the government of China has provided a model of QSS for MET institutions in China based on the requirements of STCW 95 convention. The system covers such basic elements as quality policy, responsibilities and authorities, curriculum design, enrolment and management of trainees, teaching and manager staff, teaching and training facilities and activities, quality record control, inspection
and evaluation of teaching and training, corrective and preventive measures, documentation control and internal review, etc.

5.2.1.4 Importance of QSS

The importance of quality standards system in inland waterway transport education and training is illustrated in the following aspects.

5.2.1.4.1 Safety shipping

The products of IWTET institutions are graduates or mariners, and their quality will have direct influence upon safer shipping. Even minor errors made by those unqualified mariners could bring about catastrophic results, such as loss of human lives, loss of property and water pollution. Marine casualties' investigations show that most marine casualties (80%) are caused by human errors. One of the reasons for human errors is that mariners are lack of well-trained in IWTET institutions.

Thus it can be seen that quality assured education and training for safer shipping has a large potential for great payoff in saving lives, reducing injuries, avoiding pollution and protecting the economic investments in ships and cargoes. One of the most effective measures for preventing accidents caused by human error and for improving waterborne transport safety lies in the development and implementation of improved training (Colucciello, 1988). Improved training here refers to quality assured training or education.

5.2.1.4.2 Effective assurance of quality of education and training

It is obvious that quality assurance establishes consumer satisfaction and confidence. Without good quality, future business of a company will soon be undermined. Doubtlessly, it is strongly believed today that the quality of graduates of an institution means, to some context, the life of an institution.

In order to achieve quality assured education and training, the effective way is through establishment and implementation of a quality standards system within IWTET institutions. Furthermore, there has to be such a quality standards system, i.e., to take every possible measure to ensure IWTET quality throughout the whole process of education and training, thus to create confidence between IWTET institutions and the shipping companies.
In view of internal management, establishment of a quality standards system is useful for standardisation of management, teaching and training. Meanwhile, it enhances the quality-awareness of teachers/instructors.

5.2.1.4.3 Improvements in quality assurance

Establishment of a quality standards system may keep improving the quality of IWTET continuously because QSS adopts a continuous process improvement of quality model (see figure 5-5).

In comparison with the traditional approach to improvement of quality, the major advantages of it include:

- lower cost of achieving quality objectives;
- better employers' satisfaction;
- dedication to high-quality graduates;
- consistent pace with process technology;
- conducive environment for personnel involvement;
- ability to keep ahead of the competition;
- unambiguous expression of what is expected from the process.

5.2.1.4.4 Requirements of convention and national legislation

The STCW 95 convention, for the first time, put forward the regulation regarding quality standards. In accordance with A-I/8, quality standards are applied to education, training, assessment and certification, as well as qualifications and experience of instructors and assessors in both governmental and non-governmental areas. And section B-I/8 shows a guideline on development of quality
standards, including key elements of quality standards, quality standards model for assessment of knowledge, understanding, skills and competence and an independent evaluation.

In order to implement the STCW 95 convention, the government of China established a regulation on quality control of education, training, examination, assessment and certification for seafarers. The requirement of the regulation is that institutions for education and training of seafarers shall establish the quality standards system.

Every maritime education and training institution must set up a quality standards system so as to meet the requirements of the convention and national legislation. Certainly, the requirements of these can be applied to IWTET institutions indirectly in order to ensure quality of river ship mariners.

5.2.2 A framework of Quality Standards System for IWTET

There has been no specific quality standards system for IWTET yet. Generally speaking, the function of quality management, assessment and evaluation was undertaken in the Teaching Affairs Office and Student Affairs Office in IWTET institutions. This situation has not satisfied the needs of the development of IWTET. The following is a proposal for a framework of QSS for IWTET institutions.

5.2.2.1 A framework of QSS

1.0 Purpose, scope and application

The purpose of QSS is to ensure quality in IWTET institutions. All education and training activities are developed, planned, operated and evaluated by analysing and accounting for the interdependence and interrelation of the following key elements: course objectives, system and contents, course development, the teaching and learning process and methods, self-evaluation and external evaluation.

2.0 Definition

3.0 Management responsibility

3.1 Quality policy including a commitment to quality mission statement
3.2 Management responsibility and authority
3.3 Management resources
3.4 Management review
4.0 The quality system
   4.1 Overview of purpose and function
   4.2 Structure of the system
   4.3 Procedures
   4.4 Data and documentation

5.0 Records
   5.1 Teachers, instructors and assessors qualifications and experience

6.0 Student admissions
   6.1 Admissions policies
   6.2 Admissions standards
   6.3 Information for prospective students
   6.4 Facilitating student entry

7.0 Student outcomes
   7.1 Student progress
   7.2 Student assessment
   7.3 Student appeals

8.0 Teaching and learning
   8.1 Evaluation of programs of study
   8.2 Evaluation of teaching and learning
   8.3 Quality enhancement

9.0 Requirements of staff
   9.1 Staff appointment
   9.2 Staff development and training
   9.3 Staff appraisal
   9.4 Staff promotion

10.0 Equipment, simulators and training ship
   10.1 Use of equipment, simulators
   10.2 Use of training ship
   10.3 Maintenance of equipment and simulators

11.0 Internal review and evaluation

12.0 External audit and evaluation report
   12.1 Interim evaluations
   12.2 The five years evaluation
5.2.2.2 A framework of functions, procedures and processes of QSS
(See figure 5-6)

5.3 A proposal for establishment of a new IWTET program

The Chinese IWTET can be improved by the measures of redesign of an IWTET program, renewal of curriculum, definition of requirements of teachers/instructors, outfit of modern teaching/training facilities and improvement of teaching/training methodologies.
5.3.1 A framework of higher level IWTET Program

As discussed in chapter 4, because the existing Chinese IWTET system cannot meet the needs of the development of IWT industry and the changes in new technology, there is a need to develop a new Chinese IWTET program for improving it. The author proposes a framework for a new higher level IWTET program here.

The purposes of developing a new higher level IWTET program is to:
- achieve high standards of IWTET to meet the needs of the IWT industry;
- meet the changes of new technology;
- enhance the capability of competition to meet the changes of employment policies;
- overcome the present problems in IWTET.

In developing a new higher level IWTET program, the specific national situation, particularly the changes of new technology and employment policy should be considered. Based on this point, the IWTET institutions need to offer a flexible IWTET program for students. The figure 5-7 shows a new higher level IWTET program.

The features of the program are:
- Emphasis on the competence. There is more practical training than in the present program;
- Program flexibility. Provision of chance for students to choose their own developing track. After 2.5 years learning, students can choose any one of the three tracks. Track is a four years’ course for river-sea ship navigation. Track is a three years’ course for river ship navigation. Track is a combination of full time studying and distance learning course for river ship navigation, which provides a continuous course by distance learning after students finish the three years’ course.
- Integration of river and seagoing ship officers’ education and training, such as track ;
- The possibility of using distance learning for students continuing studying based on new technology, such as track ;
- The realisation and availability of the program, such as track .
- The students can get the diploma or BSc and first certificate of competence when they complete the first six months on board training.
**Figure 5-7 A framework of higher level IWTET program**
5.3.2 A framework of curriculum for ship navigation course

The purposes of developing a new curriculum for ship navigation course are:

- implementation of the new higher level IWTET program;
- moving the emphasis on competence of students;
- renewal of contents to meet the changes of new technology and the needs of shipping companies;
- standardisation of curriculum.

The framework of the curriculum is drawn up as follows:

1.0 Aim
To train modern river (river-sea) ship officers who have basic knowledge and skills of modern navigation and ship management by adopting the requirements of STCW for qualified mariner of river (river-sea) ships.

2.0 Objectives
2.1 knowledge
2.2 practical operation
2.3 communication (English language)
2.4 psychological quality
2.5 physical quality

3.0 Contents (Modules)
3.1 basic knowledge
3.2 specialised knowledge
3.3 practical operation (training)
3.4 psychological knowledge
3.5 physical education

4.0 Time of modules
4.1 3 years’ course for river ship navigation
   - theories: 40% of whole teaching time
   - practice: 60% of whole teaching time
4.2 4 years' course for river-sea ship navigation
   - theories: 60% of whole teaching time
   - practice: 40% of whole teaching time
5.0 Learning activities
The methods of learning activities are designed to satisfy the curriculum objectives and modules.
5.1 lectures
5.2 computer assist learning
5.3 simulations
5.4 demonstrations
5.5 on board practice
5.6 distance learning

6.0 Assessment
The methods of assessment should be suitable for the objectives and contents, and validity and practicality.
6.1 written examination
6.2 assignment
6.3 practical test
6.4 demonstration of competence

7.0 Evaluation
Based on the results of assessment, an appropriate evaluation should be done. The methods of evaluation include statistics, analysis and summarisation.

5.3.3 Requirements of teachers/instructors
The teachers/instructors are the most decisive factor in IWTET. Qualified teachers/instructors can produce qualified mariners. The teachers/instructors are in possession of profound knowledge and experience and able to apply proper methodologies in teaching and training. For Chinese IWTET institutions the following requirements of teachers/instructors should be considered.

- The educational background of the teachers/instructors should be at least a master degree in higher level IWTET institutions; and bachelor degree or above in middle level IWTET schools.
- The experience of on river ship service for the professional teachers/instructors should be not less than five years. Ideally they hold master or chief mate certificates.
• If possible in every four years, they should be given a 'free' semester for upgrading their own knowledge or on board practice.

• For institutions, there should be a balanced structure in their academic titles. Associate and full professors comprise 50%, among which 20% are full professors and 30% associate professors.

• For institutions, there should be an even distribution in the age structure of the teachers/instructors. Ideally the age structure should be oval-shaped, i.e., the middle-aged group of teachers/instructors consist of 50% of the whole.

An appropriate background in teachers or instructors in higher level IWTET institutions may be satisfied with the following model (figure 5-8).

Figure 5-8 An optimal background model for teachers/instructors in higher level IWTET institutions

An optimal standard for qualified teachers/instructors in higher level IWTET institutions should be satisfied with the following model (figure 5-9).
5.3.4 Outfit of modern facilities and training ship

A lot of teaching, learning and assessing activities in IWTET institutions depend to a certain extent on the equipment and facilities. The outfit of the modern teaching and training equipment and facilities should be considered.

- There should be simulators including CBT, special (single) task, limited task, multi task and full mission simulators (details see 5.1.2.1) for appropriate training purpose.
- There should be a number of computers assisted learning (CAL) programs (details see 5.1.2.2) for teaching, learning, assessing and training activities.
- There should be a specific training ship for students on board practice, such as piloting and manoeuvring practice during study at institutions.
- There should be a multimedia learning system (details see 5.1.3) to meet needs of modern teaching and learning.

5.3.5 Methods of teaching and training

The new technologies will influence IWTET methodologies including CIT, multimedia, Internet and e-mail, computers, and simulators. Therefore, many new
methodologies, such as using simulators, CAL programs and multimedia learning systems will be used in the IWTET institutions for teaching, learning, training and assessing.

The major developments of IWTET methodologies will be that:

- Computer assisted learning programs are widely used in teaching and learning.
- Simulator based training is widely used in river ship mariners' training.
- Computer based assessment programs are used in assessing activities.
- Multimedia learning system is used in teaching and learning within the institutions.

Distance learning may be used to help instruct students by means of computer technology and satellite communications. Technology will take on a greater role in the provision of distance learning programs. The development and delivery of distance learning is in transition and has an exciting future. The IWTET institutions need to make greater use of distance learning technology to take full advantage of the flexible mode of delivery. Getting involved in the flexible delivery of distance learning is to meet the IWTET challenge in the next century. In the new higher level IWTET program, a distance learning course for students continuing learning (track ) has been considered.

The following points should be considered when using distance learning methodology (Lewarn, 1998):

- good quality material able to be updated and upgraded
- good communications with students to enhance success
- speedy response to inquiries and requests
- rapid turnaround times for assignments and examinations
- good system of administration
- good partners for development and delivery
- not to become driven by technology

On board training is an important method for focusing on competence, which is a part of the new higher level IWTET program. The courses will need to have been reviewed to ensure that the training outcomes are linked to the competence required by shipping companies, and require the correct and intelligent application of all the associated knowledge, proficiency and skills. Close co-operation is needed between shore-based education and training and training on board before issuing a certificate of competence.
Chapter Six

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the investigation, comparison and analysis of the external and internal environments of the Chinese IWTET, taking into consideration the features of IWTET, the dissertation proposes a macro-program for improvement of IWTET in China. The following conclusions can be drawn from the research:

1. China is in possession of the longest inland waterway system in the world. Nevertheless, the proportion of the inland waterway freight transport is at a lower percentage in comparison with other inland shipping countries, such as Germany, Netherlands and the USA. The development of inland waterway shipping in China has a large potential capacity.

2. The Chinese IWTET has only a short history of development. Though the IWTET system needs to be further perfected, generally, it has made a great contribution to the development of IWT in China in the past half century. Some experience of IWTET in the selected countries may be used for reference.

3. There are similarities and differences between inland waterway transport and sea transport in aspects of history, legislation, purpose of service, navigational environments, characteristics of ships and characteristics for the deck officers (see table 3-1).

4. There are similarities and differences between IWTET and MET in aspects of history, legislation, purpose, education and training system, courses and curriculum, examination and certification, requirements of teachers/instructors, status of equipment and facilities and teaching/training methodologies (see 3.2).
5. In comparison with MET, the features of IWTET include a shorter history, only complying with national legislation, serving the needs of IWT, the smaller size of IWTET, having independent examination and certification systems and emphasis on knowledge and skills of river ship navigation, etc.

6. The problems in the IWTET system include the lack of updated legislation, the lack of awareness of IWTET, inadequacy of a monitoring system and the lack of financial support, and the internal factors covered in aspects of the curriculum, including syllabus, teachers/instructors, facilities, teaching methods and assessment.

7. Through an analysis of the influence of new developments and social changes upon IWTET, the opportunities for IWTET have arisen from the results of China's economic innovation, the needs for the development of IWT, the requirements for inland shipping safety, the development of new technology and the implementation of the STCW 95 convention.

8. Much modern equipment and shipping safety systems, such as the systems for navigation safety, ship control, communication and integrated management have been applied to the waterborne transport. High quality shipping personnel need to be trained for using these systems.

9. The modern equipment and facilities for teaching/training mariners, such as simulators, CAL programs and the multimedia learning system have been and will have been applied to IWTET. The river ship mariners' education and training will be more effective using this modern equipment and facilities.

10. As a result of such key elements, present models and the importance of QSS, a framework of a quality standards system for IWTET is necessary in order to ensure the quality of IWTET.

11. Establishment of a new IWTET program is the most effective way to improve the Chinese IWTET. The author concludes that such program will cover a framework of a new higher level IWTET program, curriculum for ship navigation courses, requirements for teachers/instructors, the support of modern facilities and the use of teaching/training methodologies.

12. For overcoming some problems of the Chinese IWTET, the following concrete measures can be used:
- Restructuring IWTET institutions to raise efficiency of IWTET;
- Enhancing teachers/instructors' upgrade training to improve the level of teaching/training;
- Outfitting simulators, CAL (CBT, CAI) programs, multimedia learning systems and training ship to improve the effectiveness of teaching/training.

13. Establishment of an IWTET committee is necessary to guide the development of IWTET; to promote the standardisation of IWTET; to approve the IWTET program and curriculum provided by IWTET institutions; and to ensure the quality of IWTET through external evaluation of IWTET institutions. The committee can be composed of experts who come from administrations, shipping companies and institutions respectively.

14. The development of IWTET should be satisfied with the distribution of the main river systems in China. The reasonable distribution of IWTET would be at five IWTET centres located on the Changjiang River, the Zhujiang River and the Heilongjiang River respectively (see figure 6-1).

Figure 6-1 The distribution of IWTET centres in China
The tasks of the five IWTET centres are illustrated as follows:

- **Wuhan Transportation University (WTU):** WTU is the highest IWTET institution in China. The main tasks of WTU will be to educate and train the highest educational level river ship mariners for all inland waterway ships, particularly for the large river ships on the course of the Changjiang River. Another important task is to educate and train river-sea ship mariners. The university will offer 3 and 4 years courses for ship navigation.

- **Nanjing IWTET institute (NIWTETI):** the main tasks of NIWTETI will be to train the higher and middle educational level river ship mariners for the lower reach of the Changjiang River, the Huihe River and the Jinghang Canal. The institute will offer 2 and 3 years courses for river ship navigation.

- **Chongqing IWTET institute (CIWTETI):** the main tasks of CIWTETI will be to train the higher and middle educational level river ship mariners for the upper reach of the Changjiang River system. The institute will offer 2 and 3 years courses for river ship navigation.

- **Heilongjiang IWTET institute (HIWTETI):** the main tasks of HIWTETI will be to train the higher and middle educational level river ship mariners for the Heilongjiang River system. The institute will offer 2 and 3 years courses for river ship navigation.

- **Guangdong IWTET institution (GIWTETI):** the main tasks of GIWTETI will be to train the higher and middle educational level river ship mariners for the Zhujiang River system. The institute will offer 2 and 3 years courses for river ship navigation.

The large river shipping companies, such as the Changjiang national shipping company can set up river ship mariners' training centres. The main task of the centre would be to train the post mariners of its own company, such as pre-examination training and update knowledge training.
6.2 Recommendations

As a result of the conclusions drawn from this research, it is strongly recommended that the following actions be taken in order to achieve improvements to IWTET in China.

1. The national IWTET legislation should be reformulated and updated by the Administration.
2. Regulations on standards of training, certification and watchkeeping for river ship mariners (based on STCW 95 standards) should be established by the Administration.
3. The responsibilities of administrations, shipping companies and IWTET institutions should be defined by legislation.
4. Guidelines on quality assurance for IWTET should be formulated.
5. An IWTET committee should be established by the Ministry of Communication.
6. The IWTET centres should be redistributed based on the distribution of the main river systems in China (see 6.1-14).
7. The conditions for supporting the introduction of the higher level IWTET program (see 5.3.1) for trial implementation should be initiated by the government, particularly the Ministry of Communication and the Ministry of Education.
8. The overall IWTET systems should be improved upon through innovation in IWTET, the establishment of a quality standards system and the application of new technology.
9. International exchange in the field of IWTET, covering aspects of IWTET programs, curriculum, equipment and facilities, teachers/instructors and relevant information, should be promoted.
10. A mutual communication relationship with other inland shipping countries, such as Germany, Netherlands, Russia and the USA should be established.
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Appendix 1

Inland Waterway Networks in Europe
# Appendix 2

## Curriculum for seagoing ship navigation course

<table>
<thead>
<tr>
<th>Teaching subjects</th>
<th>4 years (hours)</th>
<th>3 years (hours)</th>
<th>Category</th>
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<th>3 years (weeks)</th>
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Appendix 3

Curriculum for River-Sea Ship Navigation Course (4 years)

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Source: Wuhan Transportation University, Navigation College (1997)
Appendix 4

**Curriculum for River Ship Navigation Course (3 years)**

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