Comparison Research on the Sino-US Maritime Development in Marine Engineering

Li Feifei¹, Dang Kun²
¹Department of Marine Engineering, Tianjin Maritime College, Tianjin 300350, China
²Marine Engineering College, Dalian Maritime University, Dalian, China
Email: lifeifei2835@sina.com

Abstract. Marine engineering, applying engineering sciences, mostly mechanical and electrical engineering, to the development design, operation and maintenance of the vessels. China and the United States have made rapid progresses in the maritime development for decades, among which, the development in marine engineering between two countries is analyzed and compared through maritime education, training ships, etc in this paper. It is found that there are many differences in selecting the marine propulsion and transmission system, sea practice and ship types and so on.

1. Introduction
The immense ocean is the cradle of life, and the development of our society is closely bound up with the ocean. Since ancient times, oceans provide a lot for human beings. Nowadays, shipping plays an inevitable role in the economic development all over the world. In the recent years, China’s development captured the worldwide attention. Similarly, China is a great power country in shipping as well instead of a strong one. Therefore, a number of developments of maritime education strategies are presented through a series of comparisons between China and United States in this paper.

2. Resources Comparison in Shipping between China and United States

2.1. Comparisons in Maritime Education System
In China, the maritime education system includes regular high education, adult high education and vocational and technical education and so on. Regular high education is divided into undergraduate education and academy education. Adult education contains a number of multilevel and multimode systems, e.g. special training and certification training and continuing training and so on. The vocational and technical education expands the enrollment every year, mainly includes three educations, i.e. navigational vocational education, ordinary navigational secondary school and navigational skilled education respectively.

A table will be given to show the typical universities and colleges to present the maritime education.

| Educational Level | Names of Institutions          | Length of Schooling | Majors       | Organizer                                |
|-------------------|-------------------------------|---------------------|--------------|-----------------------------------------|
| DMU (Dalian Maritime University) | Navigational | Ministry of Transport of P.R.C. |
America is a developed country and a strong shipping one as well. Most of shipping companies in the US are private, however, typical seven maritime universities and colleges are public which are subordinated to government. Among all the maritime colleges, the United States Merchant Marine Academy belongs to Federal Government. The others belong to State Government. The maritime education in the US is single-track mode instead of vocational and ordinary one. There is only undergraduate or above level in education level. US Government pays high attention to the shipping industry and regards it as a very important factor to ensure the state economy and safety. As far as the US concerned, there are seven typical navigational universities or colleges at present. A table will be given as follows:

| Universities | SMU (Shanghai Maritime University) | JiMei University | Wuhan University of Technology | Ningbo University | Guangdong Ocean University | 4-year | Technology, Marine Engineering, etc. | Local and Central Government | Local Government | Ministry of Education of P.R.C. | Local Government | Local Government |
|--------------|----------------------------------|-----------------|-------------------------------|-----------------|----------------------------|--------|-------------------------------------|-----------------------------|----------------|-------------------------------|----------------|--------------------------|
| Academies    | Qingdao Ocean Shipping Mariners College | Guangdong Communication Polytechnic | Zhejiang Institute of Communications | Nantong Shipping College | Jiangsu Maritime Institute | Shanghai Maritime Academy | 3-year | Navigational Technology, Marine Engineering, etc. | COSCO | Local Government | Local Government | Local Government |
| Thirds       | Wuhan Maritime Institute | | | | | | | | China COSCO Shipping Corporation Limited | China Changjiang National Shipping Corporation |
| Secondary Technical Schools | More than 20 navigational secondary technical schools in China | | | | | 2-year/ 3-year | Shipping Navigation, Marine Engineering | Local Government | | | | |

Table 2. Main High-level Maritime Education Institutions in the US

| Name | Organizer | Majors |
|------|-----------|--------|
| United States Merchant Marine Academy (USMMA) | Federal Government | Marine Transportation, Maritime Logistics and Security, Marine Engineering, Marine Engineering and Shipyard Management, Maritime Operations and Technology, etc. |
| State University of New York Maritime College | New York state | Engineering, Global Business and Transportation, Humanities, Marine Transportation, NRTOC, Science, etc. |
| Massachusetts Maritime Academy | Massachusetts state | (a) Marine Transportation and Marine Engineering, Environmental Protection & Safety, Facilities Engineering, International Maritime Business, Emergency Management, Energy Systems Engineering |
| California State University Maritime Academy | California State | International Business and Logistics, Marine Transportation, Marine Engineering Technology, Facilities Engineering Technology, Mechanical Engineering, etc. |
| Maine Maritime Academy | Maine State | Marine Engineering Operations, Marine Engineering Technology, Marine Transportation Operations, Power Engineering Technology, International Business & Logistics, Marine Science, etc. |
| Texas A&M Maritime Academy | Texas State | Marine Biology, Marine Sciences, Marine Engineering Technology and Offshore Coastal and Systems Engineering, Marine Sciences, and Maritime Administration, etc. |
| Great Lakes Maritime Academy | Michigan State | Maritime Technology, Marine Engineering, etc. |

2.2 Comparisons in Curriculum
The curriculum system in marine engineering is taken out to compare between DMU of China and USMMA of the US.

Table 3. The curriculum of Marine Engineering in DMU
The duration of navigational majors in the USMMA is four years which are divided into 12 terms and there are three terms every year. Every major has two cultivation methods, i.e. split A and split B, split A is chosen to be presented as follows:

Table 4. The curriculum of Marine Engineering in USMMA

| TERM 1 | TERM 2 | TERM 3 | TERM 4 | TERM 5 | TERM 6 |
|--------|--------|--------|--------|--------|--------|
| T| T| T| T| T| T|
| **Introduction to Marine Engineering** | **Introduction to Marine Engineering II** | **Introduction to Electrical Engineering** | **Thermodynamics** | **Machine Shop (Sea Project)** | **Electric Circuits** |
| **Engineering Graphics** | **Engineering Shop I** | **Engineering Shop II** | **Dynamics** | **Main Propulsion I (Sea Project)** | **Introduction to Materials Engineering** |
| **Basic Firefighting and Safety** | **Statics** | **Safety of Life at Sea** | **Physics II** | **Shipboard System I (Sea Project)** | **Introduction to Materials Engineering Laboratory** |
| **Calculus II** | **Mathematics** | **Differential Equations I** | **History of Sea Power** | **Deck Operation** | **Fluid Mechanics** |
| **Physics I** | **Technical & Professional Communications** | **Literature** | **First Aid** | **Chemistry of Marine Engineers** | **Probability & Statistics** |
| **First Aid** | **Aquatic Survival** | **Sailor** | **Self Defense Tactics** | **Medical Care Provider** | **Chemistry of Marine Engineers** |
| **Self Defense Tactics** | **Maintenance Management** | **Marine Propulsion III (Sea Project)** | **Thermodynamics** | **Engine Room Resource Management** | **Advanced Firefighting** |
| **Social Responsibility** | **Naval Arch Sea Project** | **Maritime Business** | **Main Tanker Operations-Dangerous Liquids** | **Basic Tanker Operations-Dangerous Liquids** | **Naval Science Senior Seminar** |
| **Composition & Literature** | **Marine Propulsion II (Sea Project)** | **Humanities Sea Project** | **Marine Steam Plant and Components** | **Electronics** | **Modern World History** |
| **Basic Swimming** | **Refrigeration (Sea Project)** | **Internship** | **Marine Steam Plant Simulation** | **Marine Engineering Management** | **Free Electives** |
| **General Chemistry** | **Shipboard Systems II (Sea Project)** | **Marine Propulsion II (Sea Project)** | **Internal Combustion Engines** | **Gas Turbines and marine Auxiliary Equipment** | |
| **Physics I** | **Electrical Engineering (Sea Project)** | **Marine Refrigeration** | **Marine Refrigeration** | **Marine Engineering License Seminar** | |
| **First Aid** | **Thermodynamics** | **Engine Room Resource Management** | **Engine Room Resource Management** | **Marine Plant Automation and Controls** | |
| **Self Defense Tactics** | **Thermodynamics** | **Thermodynamics** | **Thermodynamics** | | |
| **Social Responsibility** | **Thermodynamics** | **Thermodynamics** | **Thermodynamics** | | |

It shows that USMMA arranges much more periods of navigation lessons and maritime practice time than DMU from the comparison. The same courses, e.g. marine refrigeration and marine propulsion, are arranged and finished by the training ship in USMMA while they are done in the classroom in DMU. It can be inferred that navigational universities and colleges in China emphasize the on-campus study, however, American ones emphasize the sea practice. It can also be seen that the sea practice time is different, USMMA has much more practice time which is almost finished through vocation than DMU that has only four week’s sea practice time.

2.3 Comparisons in Training Ship
Practical teaching is restricted for a long term and becomes a choke point in the development of China navigation. The following two tables show the differences between the training ships in USMMA and DMU.

Table 5. Basic Parameters of Training Ship in DMU and SMU

| | Shanghai Maritime University (SMU) | Dalian Maritime University (DMU) |
|---|---|---|
| Ships’ Name | YUMING | YUKUN |
| Launching Time | 2013/1/10 | 2008/4/17 |
| LOA (m) | 189.9 | 116 |
| Beam (m) | 32.26 | 18 |
| Draft (m) | 10.3 | 5.4 |
|----------|------|-----|
| GT (t)   | 31113| 6000|
| M/E HP (kw) | 798 | 4440 |
| Max. Speed (kn) | 15.3 | 17.5 |
| Personnel Quota | 198 | 240 |
| Students | 160 | 208 |
| Crew and Teachers | 8 | 32 |

Most of the training ships in American maritime colleges are retired navy ships:

| Ships’ Name | United States Merchant Marine Academy | State University of New York Maritime College | Massachusets Maritime Academy | California State University Maritime Academy | Maine Maritime Academy | Texas A&M Maritime Academy | Great Lakes Maritime Academy |
|-------------|----------------------------------------|---------------------------------------------|-------------------------------|---------------------------------------------|-----------------------|---------------------------|-----------------------------|
| LOA (m)     | 68.27                                  | 172.21                                      | 166.60                        | 152.35                                      | 152.35                | 152.35                    | 159.20                      |
| Beam (m)    | 13.11                                  | 23.16                                       | 25.9                          | 21.95                                       | 21.95                 | 21.95                     | 7.9                         |
| Draft (m)   | 4.6                                    | 7.65                                        | 8.87                          | 9.29                                        | 13.11                 | 7.9                       | 4.6                         |
| GT (t)      | 1914                                   | 12304                                       | 12400                         | 12517                                       | 12542                 | 2005                      | 2002                        |
| Displacement (t) | 2285                          | 19403                                       | 15821                         | 16590                                       | 16680                 | 2535                      |
| M/E HP (kw) | 713×735                              | 14707                                       | 15127                         | 12495                                       | 5914                  | 8600                      | 2445                        |
| Max. Speed (kn) | 10                                 | 22                                           | 20                            | 16                                          | 18                    | 11                        |                             |
| Manning (trainees) | 43 (36)                        | 791 (684)                                   | 308 (288)                     | 322 (302)                                  | 123                   | 80 (70)                   |

It shows that the training ship is specially constructed in China. However, the training ships are reassembled by warships or navy ships in the US which can not only save the cost, but also strengthen the sea practice.

3. Conclusion
Maritime development in China has had a rapid development and improvement in recent years, however, a big gap exists in the maritime development between China and the US due to being late starters. Therefore, some efficient actions can be taken by the analysis to improve the maritime education which in turn strengthens sea practice.

First of all, there is not a complete legal system about maritime development, which decreases the legal protection for the maritime universities and colleges. While American maritime colleges have rather complete legal systems that could work out relative measures to ensure the colleges and students meet their own demands.

Secondly, the education mode between these two countries is totally different. Double-track mode is adopted in China which leads to more and more undergraduate students are not likely to work on board and students from vocational colleges have not enough capabilities and English level. This is totally different from American single-track mode which set out a series of reward policies to encourage the undergraduate students to work on board.

Thirdly, sea practice is a very important part during college time, which not only can improve the practical abilities but also the understanding to the professional knowledge. Students can get the time and opportunities to accumulate the sea experience before they have a job.
China has got a leap-forward development in various industries in recent years, so does the shipping industry. However, disadvantages which prevent the maritime education still exist. Therefore, it is necessary to rethink profoundly and take relative measures to remedy the deficiencies.

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