Study in standardizing marine engineering curriculum

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Abstract

This paper presents the preliminary results of an ongoing research study. In spite of the substantial efforts of the IMO and the maritime community aimed at developing standardized curriculum for training ship officers, the educational programs in different institutions vary quite substantially. Undergraduate marine engineering programs offered in various countries differ in their duration, content, onboard training, specific requirements, etc. For instance, the average length of a license/degree program, which leads to the Third Assistant (or just Fourth Engineer) license and a bachelor degree, is four years, including about a year of sailing. However, there are three-year programs on one side, and five-plus-year programs on the other side. Composition of the marine engineering programs varies. First is the share of the sea portion, which normally takes one year. However, there are exceptions when the cadets spent much more time at sea. Second, every program might be looked upon as a combination of building blocks. The distribution of time among the above portions of a program and the list of academic courses varies quite substantially from country to country, and even among different schools from the same country.
Keywords: marine engineering education, curriculum, programs, license and degree components of programs.

1 Introduction

The research project content is analysis and assessment of undergraduate marine engineering programs in various countries for possible standardization. The following are the principal objectives of the research as it is understood at this stage of study:

a. Classification of marine engineering programs being offered by the members of IAMU, as well as by non-member institutions based of the program academic and practical content, duration and final assignment (license, certificate, diploma, etc.).
b. Analysis of time distribution among the principal program components, such as:
   - mathematics and basic science;
   - humanities - language, history and culture;
   - basic engineering science (mechanics, materials, thermodynamics, electricity, etc.);
   - special engineering – propulsion and power plant, systems and machinery, etc.
c. Study of the sea-going training component in various programs (content, duration, specifics)
d. Assessment of program components regarding:
   - value for the future career;
   - response to maritime regulations and standards;
   - meeting licensing requirements;
   - meeting customer requirements;
   - meeting accreditation institution requirements (IME, ABET, etc.).

Not many publications have been devoted to the subject. In this research conference proceedings and magazine articles, and also the Government maritime and licensing institution materials have been reviewed. Substantial information has been found on the Internet. The pace of the research has been drastically slowed down for some unexpected circumstances. A very limited response of the IAMU members to the survey which has been initiated at the commencement of the project appeared to be the principal problem.

2 Survey of marine engineering programs

A survey questionnaire has been prepared and emailed to practically all IAMU member institutions. Unfortunately, only seven institutions have responded, and only four curriculum have been received and analyzed.

Websites of maritime institutions became the principal source of information. To date the curricula of about thirty institutions has been studied. The list of the institutions is presented in Table 3. There are still some clarification with the institutions is required. The most detailed information has been collected from the principal maritime universities and academies in the US, Canada, Australia, Philippines, Japan, India, Singapore, Taiwan, Egypt, Turkey, Croatia, Norway, Denmark, United Kingdom, Netherlands, Poland, Belgium, Estonia, Ukraine and Russia. This list makes an adequate representation of the variety of marine engineering programs.

3 Classification of marine engineering programs

3.1 Types of educational institutions

Several hundred educational institutions in the world provide various types of maritime education. All of them might be subdivided into four groups:

a. Maritime academies offering complete program leading to a license of a marine engineering officer.
b. Maritime academies and universities offering programs leading to an engineering license and to an academic degree.
c. Maritime schools, union schools and training centres offering individual marine engineering courses. There is a wide variety of such courses:
- advanced courses intended for upgrading the license;
- various certificate courses, such as ISM, security, new engine/equipment operation, etc;
- re-training courses, etc.
d. Vocational maritime schools (sail boats, motor boats, etc.).

The two first groups of the educational institutions are the subjects of this study.

3.2 Types of program orientation

Maritime academies and universities are offering two distinct types of marine engineering programs:

a. mariner license oriented programs;
b. mariner license and academic degree oriented programs.

According to STCW, the first engineering license is officer in charge of an engineering watch. Some school curriculum identify the first license as Engineering Officer Class 4. American maritime institutions, in accordance with the Code of Federal Regulations CFR 46 identify the first license as Third Assistant Engineer. Other schools and academies offer shorter programs leading to a Junior Engineer or Assistant Engineering Officer certificate. Normally, after a certain at sea training, the former cadet sits for a full scale first engineering license. Therefore, this type of a program should be considered in assessment of the college type license curriculum.

Obviously, the two types of programs, license oriented, and degree/license oriented, differ in content and duration. However, the core of license related courses should be identical, or at least similar. The main difference should be in the scope and content of academic subjects.

4 An analysis of marine engineering programs

4.1 Program duration

The average length of a program, which leads to the officer in charge of an engineering watch or Third Assistant (or just Forth Engineer) license, is four years, including about a year of sailing. However, there are three-year programs,

on one side, and five-plus-year programs, on the other side, like in Russia, Ukraine, Egypt and other countries. Figure 1 presents an approximate distribution of the duration of the marine engineering programs among 60 maritime schools. The program at U.S.M.M.A., Kings Point, represents a typical example of a four-year curriculum. Therefore, in the discussion below, this program is accepted as a basic one (see Table 1).

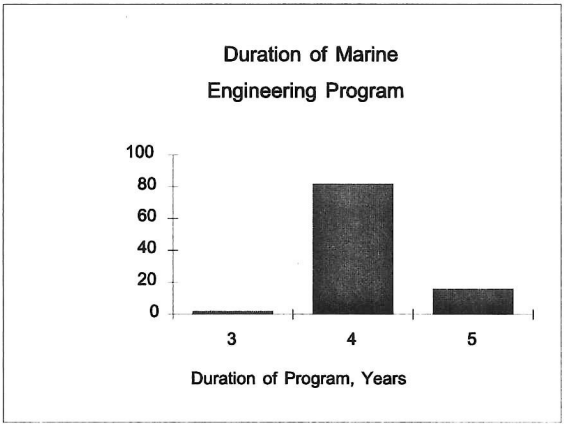

Figure 1: Distribution of program duration.

In the final report a detailed analysis of the program duration will be presented with identification of the time required for license related component, academic subjects and the at sea training.

4.2 Program structure

Composition of marine engineering programs varies. First to mention is the share of the sea portion, which normally takes one year. However, there are exceptions, when the cadets spent substantially less or more time at sea. Secondly, every program might be looked upon as a combination of the building blocks. In most of the marine engineering programs the following blocks or components might be found:

a. Mathematics and basic science.
b. Humanities - language, history and culture. Social science and economic courses, if offered, normally belong to this portion of the program.
c. Engineering science - mechanics, materials, thermodynamics, fluids, basic electricity, etc.
d. Special engineering - propulsion plant, power plant, systems and machinery, naval architecture, etc.
e. Physical fitness - offered either as mandatory classes, or as activities beyond the scheduled hours.

Table 1: U.S. Merchant Marine Academy, Basic-Level Curriculum.

Marine Engineering Systems Program

Year; Semester or Quarter	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Sciences	Engineering Topics	General Education	Other
4th Class	DN 110 Basic Fire Fighting				2.0
	HE101 English 1			3.0	
	KP100 Maritime Prof. Studies				4.0
Term 1	MM101 Calculus 1	3.0			
	MP101 Physics 1	4.0			
	PE 110 Swimming/First Aid				1.0
	EE120 Intro to Electrical Engr.		2.5		
	EG111 Engineering Shop 1				1.0
	ES110 Computer Engineering		2.0		
Term 2	MC100 General Chemistry	4.0			
	MM130 Calculus 2 (Eng.)	4.0			
	NS120 Intro to MMNR				1.0
	PE101 Self Defence				1.0
	EG100 Engineering Graphics				2.0
	EM100 Intro to Marine Engr.		2.0		1.5
Term 3	ES100 Engr. Mechanics		3.0		
	HH100 History of Seapower			3.0	
	MP130 Physics 2	4.0			
	PE120 Aquatic Survival				1.0
2nd & 3rd Class	DN100 Safety of Life at Sea				2.0
	ES200 Intro. To Materials Engr.		2.0		
	ES210 Transport Processes 1		3.5		
Term 1	HE202 English 2			3.0	
	MM232 Math for Engr. 1	4.0			
	NS 220 MMNR Officer				2.0
	DB210 Economics			3.0	
	EE300 Electric Circuits		2.5		
	EG211 Engineering Shop 2				1.0
Term 2	EM200 Marine Engineering 1		3.5		
	ES301 Strength of Materials		2.0		
	ES305 Materials Engr. Lab		2.0		
	MM332 Math for Engr. 2	3.0			
	PE Elective 1				0.5
	PE Elective 2				0.5

Table 1: Continued.

Year; Semester or Quarter	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Sciences	Engineering Topics	General Education	Other
Term 3	Mxxxx Math/Science Elective	3.0			
	EM301 Naval Architecture		3.0		
	ES310 Transport Processes 2		3.5		
	HC400 Topics in History			3.0	
	MC300 Engineering Chemistry	3.0			
	NS402 Naval Leadership/Ethics				2.0
	PE200 Ships Medicine				1.0
Sea Term 1	Sea Projects				6.0
Sea Term 2/3	Sea Projects				16.0
1st Class Term 1	EE400 Electrical. Machines		3.5		
	EM415 Internal Comb. Engines		3.5		
	EM420 Diesel Simulator		1.0		
	EM480 ME Systems Design		3.5		
	EM481 MES Design Project 1		0.5		
	HH310 Modern World			3.0	
	Exxxx MES Option 1		3.0		
	PE Elective 3				0.5
	PE Elective 4				0.5
Term 2	DB230 Management			3.0	
	EM400 Marine Engineering 2		3.5		
	EM410 Marine Refrigeration		3.5		
	EM482 MES Design Project 2		0.5		
	HH360 Modern Am. History			3.0	
	Exxxx MES Option 2		3.0		
	NS412 Adv. MMNR Officer				2.0
Term 3	DN410 Advanced Firefighting				1.5
	EE401 Electronics		2.5		
	EM470 License Seminar				1.0
	EM483 MES Design Project 3		1.0		
	Exxxx MES Option 3		3.0		
	Exxxx MES Option 4		3.0		
TOTAL CURRICULUM (173.5 credits)		32	66.5	25	50

f. Naval reserve training - offered by some schools as an integral part of the program.

g. Navigation and ship handling - several introductory courses are normally offered in a plain marine engineering curriculum and a special core of courses is provided for the integrated officers training.

h. Others, such as safety, medicine, operational procedures related to specialized ships.

The distribution of time among the above portions of a program and the list of academic courses vary quite substantially from country to country, and even among different schools of the same contra. Table 2 presents the comparison of marine engineering programs at the U.S. Merchant Marine Academy and the St. Petersburg State Maritime Academy of Russia

Table 2: Comparison of program components.

School	Share of the Program Component, %				
	Math. and Science	Humanities	Basic Engineering Science	Special Engineering	Others (Physical Ed., Navigation, Naval, etc.)
U.S. Merchant Marine Academy	20	13	20	26	21
St. Petersburg State Maritime Academy	16	18	18	35	13

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

4.3 Content and scope of subjects in marine engineering license component

STCW requirements are a base for the analysis of the license component of the marine engineering program. Column 2 of Table 3 provides the minimum required list of subjects (knowledge, understanding and proficiency) needed for marine engineering function on the operational level.

Another guidance document for assessing the required training is the IMO Module Course 7.04 developed for IMO by the Norwegian Maritime Directorate. Yet one more guidance material, specific for the American maritime academies, is the list of subjects for engineering licenses which is included in the Code of Federal Regulations 46 CFR Ch. 1 #10.950.

In continuation of the research project, it is intended to evaluate the surveyed marine engineering program relative to the above guidance documents.

Table 3: Subject areas for specific learning outcomes expected from BEng degrees.

No	Subject Area
1	Mathematics and Science
2	Engineering Analysis
3	Design
4	Economic, social, and environmental context
5	Marine Engineering Practice
6	Economic, social and environmental context
7	Engineering Practice

4.4 Content and scope of subjects in academic degree component

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

An important factor in setting the academic component of a marine engineering program is the requirements of the accrediting institutions. Even if the program is not intended for accreditation, many of the requirements should be evaluated and incorporated based on the available time space in the curriculum. As an example of the requirements, Table 3 contains the subject areas considered by the UK Institute of Marine Engineers in their accreditation of the marine engineering programs. Other accreditation bodies include Classification Societies, like DNV and Lloyd, American Accreditation Board for Engineering and Technology (ABET), National Educational Authorities, and others. In the final report the results of evaluation of the accreditation requirements as a factor in the development of the uniform academic component of marine engineering curricula will be presented.

4.5 Sailing component

As it was mentioned before, the average time to be spent onboard for a first engineering officer license is one year. However, actual requirements by different countries vary substantially. It is reflected in the career paths accepted by the national authorities. Two examples of a career path are presented in Figure 2 (a career path in India) and in Figure 3 (in the USA).

The statistical analysis of the information related to the required duration of the sea time will be continued in the project study.

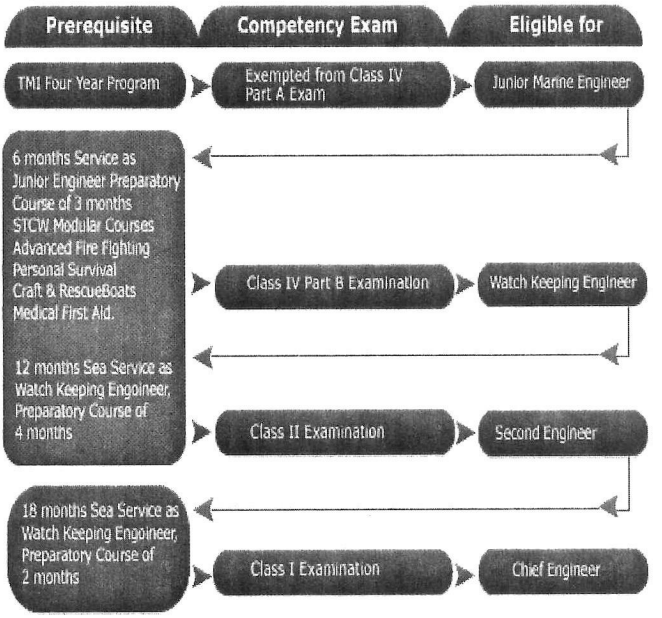

Figure 2: Career path as per Tolani Maritime Institute, India.

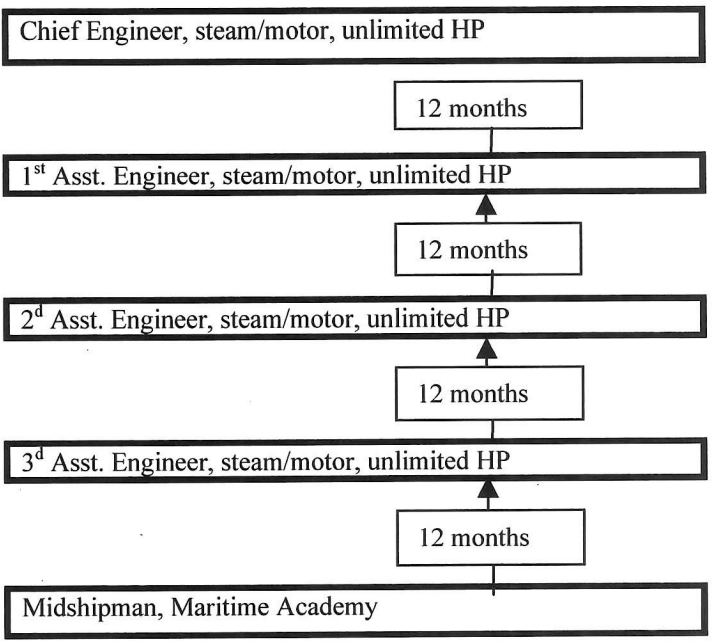

Figure 3: USA engineering license structure as per 46 CFR, #10.505.

5 Conclusion

In the process of preparation of the final report the following activities are intended to be carried out:

a. Some additional information will hopefully be collected. Another attempt to survey the member institutions will be undertaken.

b. Analysis of the programs will be finalized and working version of classification developed.

c. Available information and survey data re customer requirements will be assessed and the results incorporated into the curriculum proposals.

d. Analysis of program components will be finalized and draft versions of the sea-going license components developed.

e. Analysis of college related program components will be finalized, and draft versions of a BS curriculum identified.