Study in Standardizing of Undergraduate Marine Engineering Curriculum

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

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

In the summary a series of practical recommendation is offered.

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

0 Introduction and background

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

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

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

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

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

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

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

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

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

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

1 Analysis of marine engineering programs

1.1 Program duration

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

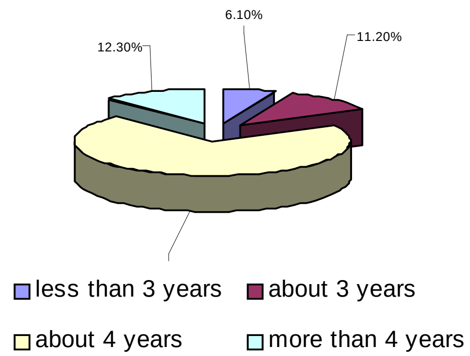

Fig. 1 Duration of marine engineering programs in various countries

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

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

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

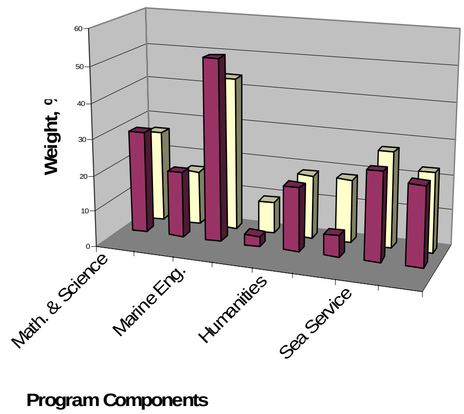

Fig. 2 Structure of marine engineering programs at USMMA, New York

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

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

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

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

1.2 Program composition

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

Table 2 Comparison of program structure at three maritime schools

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

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

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

1.3 Program license component

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

Table 3 IMO Module Course 7.04 Curriculum

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

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

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

1.4 Academic degree component

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

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

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

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

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

2 Developing a uniform marine engineering curricula

2.1 Program components and group subjects

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

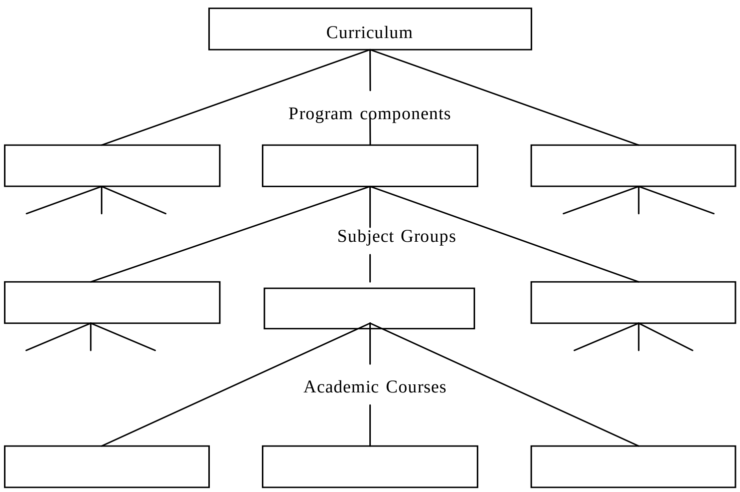

Fig. 3 Hierarchy of the Curricula Elements

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

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

Table 5 Building Blocks for License Oriented Program

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

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

2.2 Proposed structure of beng curriculum in marine engineering

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

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

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

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

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

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

Table 7 Proposed License/Degree Oriented Program

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

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

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

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

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

Table 8 Comparison of Curricula and Model Course

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

X. Final Examinations				
Program Total	90.5	59		163.5

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

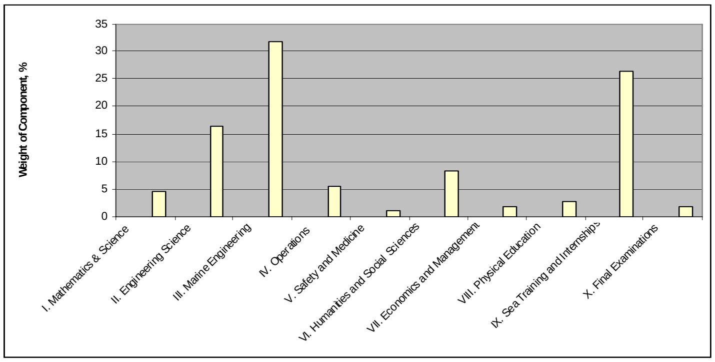

Fig. 4 Structure of the License Oriented Standard Curriculum

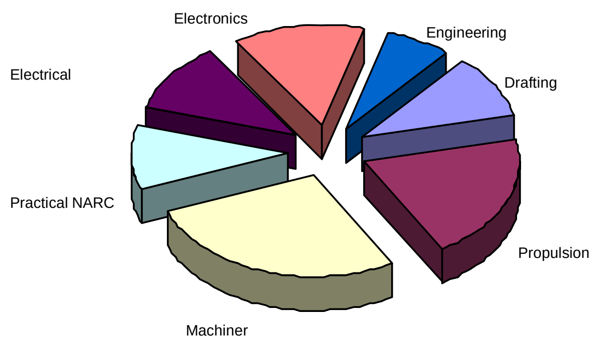

Fig. 5 Marine Engineering Component Structure (by Subject Groups) in the Suggested Uniform Curriculum

3 Standard curriculum and program accreditation

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

3.1 Certification of license component of programs

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

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

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

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

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

3.2 Accreditation of degree oriented component of programs

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.3 Summary and recommendations

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

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

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

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

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

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

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

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

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

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

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

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