

## **Baccalaureate Studies in Maritime Engineering and Management**

**Panagiotis D. Scarlatos, Dr.-Eng.**

Chair & Professor, Department of Civil Engineering  
Florida Atlantic University, Boca Raton, Florida, U.S.A.

### **Abstract**

Globalization, technological advances and safety concerns placed an enormous demand on the operations and management of intermodal transportation facilities such as harbors, airports, train stations, bus terminals, etc. The need of skilled managers and engineers with knowledge not only of the fundamentals but also of the specifics related to those facilities is becoming a necessity. Commonly that specialized knowledge is obtained either through graduate studies or years of on-the-job experience. There are very few programs around the world that offer specialized baccalaureate degrees outside of the traditional engineering or management disciplines. This paper investigates the requirements for a baccalaureate degree in Maritime Engineering and Management and proposes guidelines for a curriculum of studies.

### **Keywords**

Baccalaureate education, Intermodal transportation, Management, Maritime engineering

### **1. Introduction**

Socio-economic globalization and proliferation of electronic communications placed an enormous demand on the safe and timely traveling of passengers as well as the prompt delivery of goods throughout the world. In addition, increased security and safety concerns, along with the development of large intermodal transportation facilities creates a need for specialized skills in the associated areas of engineering and management. Commonly, managers and supervisors in those facilities may have a background in some of the traditional disciplines including civil, mechanical or offshore engineering, business administration, economics, applied mathematics, etc. However, for an effective and efficient management and operation of those facilities a more specialized educational background would be very advantageous.

Harbors, airports, railroads and other transportation hubs all share some common characteristics. They provide massive passenger and cargo transportation; they maintain extensive waterways/runaways/roadways for vessel/vehicle mobility, maneuvering, mooring/parking, loading/unloading etc; they maintain passenger terminals and merchandise storage areas, along with large fuel supplies; and they employ a large number of permanent and temporal workers. Therefore, an optimized coordination of all the activities is extremely important as well as the safety and security of the facilities from accident or terrorist events. Environmental concerns are also seriously associated with the operation and maintenance of those facilities. Acquiring an expertise in all of the areas involved may be an unsurpassable task but developing a basic specialized background may be feasible through an appropriate baccalaureate

education. The discussion in this paper focuses in the area of maritime engineering and management but with some modifications the curriculum can be modified to apply for any other intermodal transportation facility (i.e. railroad stations, airports, bus terminals). The proposed curriculum is modeled very closely to the standards of a traditional 128 credit hours engineering Bachelor of Science (BS) degree in the United States.

## 2. Educational Objectives and Outcomes

A Bachelor of Science in Maritime Engineering and Management program should serve certain goals that should guarantee that the students are provided with:

- **Preparation for Practice:** Graduates will be prepared for entry-level positions in the areas of maritime engineering and management; port and harbor engineering, operations and maintenance; and maritime-related organization, finance and labor. Graduates will also be prepared for further studies in graduate/professional programs in related areas of specialization.
- **Tools for Creativity:** Graduates will experience the creative and design processes and their application to typical maritime related situations involving engineering and management issues.
- **Societal Awareness:** Graduates will receive the breadth of education necessary to integrate maritime engineering and management practice with the needs and interests of a diverse multi-cultural modern society.
- **Leadership Skills:** Graduates will be prepared for future leadership in the maritime engineering and management profession.

The educational objectives of the Bachelor of Science in Maritime Engineering and Management would be achieved by ensuring that the graduates fulfill the following educational outcomes:

- An understanding of professional and ethical responsibility.
- A working knowledge of fundamentals, engineering and management tools, experimental methodologies, and safety skills.
- An understanding of the social, economic, and political contexts in which maritime engineers and managers must function.
- An ability to plan and execute a maritime engineering design and management plan to meet an identified need.
- An ability to function on multi-disciplinary teams and understand the basics of labor laws and economics.
- An ability to communicate effectively.
- A proficiency in several major areas in maritime engineering and management.
- An appreciation for infrastructure planning, sustainability, safety and security.
- An ability to obtain professional employment.

There are a small number of programs specializing in undergraduate or graduate level maritime engineering throughout the world. These programs are either independent departments or they are part of some broader academic program. Examples of some of those programs are at Queensland University of Technology (Australia), Technical University of Denmark (Denmark), National Taiwan Ocean University (Taiwan), SUNU Maritime College (U.S.A.), Texas A&M University at Galveston (U.S.A.), Tolani Maritime Institute (India), etc. Although some features of those already existing programs have been taken into consideration, the proposed curriculum varies on the fact that besides engineering it incorporates a strong component in management.

### **3. Proposed Curriculum for B.S. in Maritime Engineering and Management**

The proposed curriculum of studies is modeled after typical BS engineering programs in the United States. The curriculum is comprised of a total number of 130 credit hours. The curriculum is divided into six educational modules including General Education (27 credit hours), Basic Mathematics and Science (33 credit hours), Engineering Fundamentals (12 credit hours), Professional Engineering Core (36 credit hours), Professional Management Core (18 credit hours) and a Capstone Experience (4 credit hours).

Due to the specialized character but also the diversity expected from this program, it is suggested that throughout the baccalaureate curriculum the student is constantly exposed to maritime examples as related to social, historic, economic, geographic, and other issues. In addition, during both the Professional Engineering and Professional Management Cores coursework the students should be exposed to real-life project applications through projects and co-op and internship opportunities.

#### **3.1 General Education**

During the general education the student should acquire the basic verbal and writing language skills as well as a background foundation on economics, management and world related geography and history. More specifically, the general education will include the following nine 3-credit hour courses:

- Composition I
- Composition II
- Technical Writing
- Public Speaking
- Microeconomics
- Macroeconomics
- Management & Organizational Behavior
- World Geography
- World History

Total Credit Hours: 27 (Cumulatively: 27 Credits)

A basic understanding of an international foreign language (i.e. Spanish, French, German, Japanese, Chinese), as documented by at least 2 semesters of successful study (6 credit hours), should be part of the graduation requirements. High school credits on foreign language should be acceptable.

#### **3.2 Basic Mathematics and Science**

During the basic mathematics and science education the student will be exposed to traditional mathematical courses (e.g. calculus, analytic geometry, ordinary differential equations, etc) as well as numerical methods, probability and statistics at a total number of 15 credit hours. General chemistry and physics with the associated laboratories (12 credit hours) will also be included, along with introductory coursework in physical oceanography and marine ecology (6 credit hours).

- Engineering Mathematics I
- Engineering Mathematics II
- Discrete Mathematics
- Probability and Statistics
- General Chemistry with Lab
- Physics with Lab I
- Physics with Lab II
- Physical Oceanography

- Marine Ecology  
Total Credit Hours: 33 (Cumulatively: 60 Credits)

### **3.3 Engineering Fundamentals**

The engineering fundamentals education will provide the students with the basic engineering background necessary for the core curriculum. This would be accomplished with four 3-credit hour courses. The first two courses are required and introduce the students to the concepts of force balance and stress-strain relationship of materials. The last two courses can be selected from a choice of four and would assist the students to understand basic machinery, electronics and/or computer programming as needed.

- Statics and Buoyancy
- Strength of Materials
- Heat Transfer or Electrical Circuit Analysis
- Machine Design or Computer Programming  
Total Credit Hours: 12 (Cumulatively: 72 Credits)

During the period of the engineering fundamentals studies the student will be required to receive certification in one or more of extra-curricula skills such as first aid, survival at sea, diving and/or laboratory safety.

### **3.4 Professional Engineering Core**

The professional engineering core will include twelve 3-credit hour courses that would provide the student with a robust broad knowledge of structural analysis, design and foundations for inland and maritime facilities. In addition, the student will focus on specialized issues related to coastal, offshore and harbor engineering. Emphasis will also be given to intermodal transportation engineering, safety and security.

- Structural Analysis
- Structural Design
- Soil Mechanics
- Foundation Engineering
- Marine Structures Design
- Harbor and Port Engineering
- Fluid Mechanics
- Wave Mechanics and Offshore Engineering
- Coastal Engineering and Littoral Processes
- Naval Architecture
- Transportation Engineering
- Intermodal Transportation Engineering and Safety  
Total Credit Hours: 36 (Cumulatively: 108 Credits)

During the professional core curriculum the student will be encouraged to take co-op or internship with a maritime related agency or business in order to acquire practical experience and a more in-depth understanding of the field. This experience would be very valuable for the successful completion of the senior design capstone project.

### **3.5 Professional Management Core**

The professional management core will be comprised of six 3-credit hour courses. The courses will include topics on operational research, systems and infrastructure optimization and technology, environmental system risks and crisis management, and international trade economics and law. Again co-op or internship would be strongly encouraged,

- Operational Research & Systems Optimization
  - Economics of International Trade
  - Infrastructure Management & Technology
  - Law of International Trade
  - Crisis and Risk Management
  - Environmental System Management
- Total Credit Hours: 18 (Cumulatively: 126 Credits)

### **3.6 Capstone Experience**

The capstone experience will involve a real-life practical project that would require both engineering and management elements and will be completed in two consecutive semesters. At the end of both courses the students would submit a written report and would make a professional type public presentation.

- Design Project I
  - Design Project II
- Total Credit Hours: 4 (Cumulatively: 130 Credits)

Projects requiring a written report and a presentation will be incorporated in most of the senior year coursework.

## **4. Conclusion and Recommendations**

A baccalaureate program of studies in Maritime Engineering and Management has been proposed. The program is comprised of 130 credit hours and requires extra-curricula activities from the students in order to acquire practical hands-on experience. The program is unique since it encompasses a good balance of engineering and management coursework. With certain modifications the program can also be extended to a broader scope of Intermodal Transportation Engineering and Management that would apply to all major transportation facilities and operations.

Due to the focused nature of the program and to the possible specialized international/national/regional needs, it is strongly recommended that before its implementation an Advisory Board with members from maritime facilities and related agencies and industry is formed. This Board should carefully review the curriculum and make the appropriate recommendations to the education institution for adjustments/improvements.

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