Integrated Maritime Simulation Complex Management, Quality And Training Effectiveness From The Perspective Of Modeling And Simulation In The State Of Florida, USA (A Case Study)

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INTEGRATED MARITIME SIMULATION COMPLEX MANAGEMENT, QUALITY AND TRAINING EFFECTIVENESS FROM THE PERSPECTIVE OF MODELING AND SIMULATION IN THE STATE OF FLORIDA, USA (A CASE STUDY)

by

YASER H. SENDI
B.Sc. Nautical Sciences, King Abdul-Aziz University, Saudi Arabia, 2008

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the Department of Modeling and Simulation in the College of Graduate Studies at the University of Central Florida Orlando, Florida

Fall Term
2015

Major Professor: J. Peter Kincaid
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ABSTRACT

Naturally, maritime training simulators at all events are valuable instructional and pedagogical tools. Through the history, the maritime simulation was utilized to train prospective maritime apprentices in whom it has filled the gap left by the acute shortage of opportunities for jobs onboard vessels around the globe. However, professional seafarers are the axis of success and competitiveness in the field of maritime training. They are the ones that, who are well trained and have the responsibilities of their work and the surrounding environment. In order to achieve the success along with effective training skills, both maritime companies and seafarers should implement a management of safety onboard ships, which only can be executed through the effective usage of the Bridge Resource Management (BRM) and righteous maritime simulation training.

Qualitative upgrading of the maritime training process at higher education levels depends predominantly on the instructive value of the instructors’ educational software and the content of these programs which contains advanced and intelligent scenarios that benefit positively in providing effective training in order to, transfer and implement their gained skills from virtual reality to the actual environment with minimal risks and additionally to avoid the unforeseen occurrences at sea. The outcomes of the evaluation have shown the instructional suitability of the maritime educational scheme and significant capabilities, it provides, as well as the domains and frameworks for its instructional development. The above facts are substantial in the refinement and improvement of the current maritime education and growth of the apprentices’ capabilities and the professionalism of their skills, along with the farthest purpose of creating more educated marine navigators in the worldwide merchant fleet.

This research proposes and demonstrates in details the purpose of the maritime simulation training complexes, the elements that if provided, will lead to an effective
maritime simulation training, types of maritime simulation, the International Maritime Organization (IMO), its tools and its power for the effectiveness of the maritime simulation training through different conventions & codes and the future for the maritime simulation training, in order to emphasize and accentuate the interplay between instructors and apprentices in an integrated maritime simulation complex on which a serious maritime event is taking place.

The distillation of this thesis draws an attention to the effectiveness of the partnership between maritime apprentices and their instructors across a maritime simulation training complex scheme during a virtual maritime scenario event in an advanced facilities located in the state of Florida, which is armed with modern technology, provides both added stimulation for the apprentice himself and elevates the simulator a degree toward a vessel for practical training and/or sailing.
To Prophet Mohammad (peace be upon him)

To my beloved father may he rest in peace, Hamed Sendi

To my beloved mother may Allah extend her life, Maha Fageerah

To my lovely brother, Ammar Sendi

To my lovely brother, Ahmad Sendi

To my lovely brother, Ra’ef Sendi

To my lovely sister, Rawan Sendi

To my lovely, Aunt and Uncles

To my little son, Alfaisal Sendi
ACKNOWLEDGMENTS

I would like to thank my master’s degree supervisor Dr. J. Peter Kincaid, Associate Professor, Institute for Simulation & Training at the University of Central Florida for his guidance throughout my academic career. I am also grateful for Dr. Luis Rabelo, and Dr. Gene Lee, for serving as committee members for my thesis defense and their valuable suggestions. I would also like to thank Dr. Randall Shumaker for aiding me in the final preparations of my thesis, and guiding me as I developed my own perspectives as I concluded my research.

I would also like to express my appreciation to all my friends at UCF and all who worked on this project. I would like to give my absolute thanks to my parents for their help and support throughout my life.

Lastly, I would like to show my appreciation to the Resolve Maritime Academy, Maritime Professional Training and STAR Center for providing me with precious information about their complexes via responding to the given surveys and providing substantial information gained by Face-To-Face and telephone interviews which help to complete this research project.
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<th>Description</th>
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<td>ARPA</td>
<td>Automatic Radar Plotting Aid</td>
</tr>
<tr>
<td>C.R</td>
<td>Command Responsibility</td>
</tr>
<tr>
<td>COC</td>
<td>Certificate Of Competency</td>
</tr>
<tr>
<td>COLREGS ‘72</td>
<td>International Regulations for Preventing Collisions at Sea</td>
</tr>
<tr>
<td>CRM</td>
<td>Crew Resource Management</td>
</tr>
<tr>
<td>CRMT</td>
<td>Crew Resource Management Training</td>
</tr>
<tr>
<td>DNV</td>
<td>Det Norske Veritas “A classification society”</td>
</tr>
<tr>
<td>FMBS's</td>
<td>Full-Mission Bridge Simulators</td>
</tr>
<tr>
<td>GMDSS</td>
<td>Global Maritime Distress and Safety System</td>
</tr>
<tr>
<td>IBS</td>
<td>Integrated Bridge System</td>
</tr>
<tr>
<td>IMO</td>
<td>The International Maritime Organization</td>
</tr>
<tr>
<td>IMSC</td>
<td>Integrated Maritime Simulation Complex</td>
</tr>
<tr>
<td>IMSF</td>
<td>The International Marine Simulator Forum</td>
</tr>
<tr>
<td>ISPS Code</td>
<td>The International Ship and Port Facility Security Code</td>
</tr>
<tr>
<td>MCBS</td>
<td>Maritime Computer-Based Simulators</td>
</tr>
<tr>
<td>MSBT</td>
<td>Maritime Simulation-Based Training</td>
</tr>
<tr>
<td>MSC</td>
<td>Maritime Simulation Complex</td>
</tr>
<tr>
<td>OOW</td>
<td>Officer Of the Watch</td>
</tr>
<tr>
<td>RADAR</td>
<td>Radio Detection And Ranging</td>
</tr>
<tr>
<td>RSE</td>
<td>Recognition of Stressor Effects</td>
</tr>
<tr>
<td>SME</td>
<td>Subject Matter Experts</td>
</tr>
<tr>
<td>STCW ’95</td>
<td>The International Convention on Standards of Training, Certification and Watch-keeping for Seafarers</td>
</tr>
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</table>
CHAPTER 1: 
INTRODUCTION

1.1 General

One of the most important purposes of writing this thesis is to address the acute shortfalls in the Saudi Arabian Maritime cadres. These shortfalls are due to the scarcity of expert knowledge and qualified personnel, especially the cadres which serve instructional roles in the maritime simulation complexes, and are responsible for teaching new apprentices. Apprentices rely on quality instruction to gain skills that will enable them to work in all sectors of the maritime transportation field for both international and local levels.

In order to respond to national appeal, and to keep up with the development of maritime transportation plans in the Kingdom of Saudi Arabia, King Abdul-Aziz University felt it was important to address the rising demand from agencies that have a close relationship with maritime transportation industry (such as but not limited to, Ministry of Defense and Aviation represented in the Military Survey Administration, Ministry of Transportation represented by the Maritime Transport Administration, and the General Organization of Ports and the Office of the Civil Services). King Abdul-Aziz University is working on a project to establish the Complex of Maritime Simulation Training in Faculty of Maritime Studies, which is aimed to accomplish a variety of goals. This facility is aimed at the preparation of both governmental and commercial Captains and Engineers who will work onboard vessels, distinctive competencies in the management and operation of ports that work according to the international standards, and the requirements of the international maritime organizations.

If we took into our consideration that the job performance is significant, the quality of the maritime training program preparing for a job position onboard a ship will be substantial. The quality of the maritime training scheme will depend essentially on different quality components such as software, hardware and human factors, which affected by the situations
applied to the way of learning and teaching. The hardware in most of the modern maritime simulation complexes is highly focused on the items, which will allow the demonstration of the required competencies. The quality of such simulators is affected by several elements: the trainee, the instructor, the program and the simulation facility. These elements per se and other quality indicators and their influence on the end result are the items that they lead to the effectiveness of the maritime training and the quality management for the maritime simulation centers. (Cross, 2011)

As we can see in most areas of transportation, a suitable education and training for the people who are working or even intending to work in such sector is highly significant. The maritime educational scheme is instituted in some patterns: occupational training centers, technical colleges, polytechnics, and universities. Essentially, through these centers or complexes the courses are offered through traditional certificates of competency programs or a part of an accredited educational award. In the traditional shipboard manning facilities, there is one function area, which is covered by a single group of specialists which commonly known the mono-valent system. It means that the requirements of the operations and seafaring officers’ training focused on both the deck and engine departments and that the methodologies and innovations in training schemes are developed fundamentally within these two sectors. The combination of deck and engine crew training is an alternative phenomenon to fill in the demand for the varying requirements for shipboard operation. As the integrated maritime simulation complex started to develop integrated training systems, here simulators play an essential role, which will be explained throughout the thesis itself. (Cross, 2011)

Maritime Simulation training is replacing the in-service training of maritime apprentices and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW 1978), gives an extra value to the training performed in a maritime simulation complex. Currently, this type of emulators can imitate a various ship
types and scenarios that in the real environment may seldom occur. Particularly, this is raising the validity of the simulation training vis-a-vis the in-service practices. (Ali, 2006)

The simulation operation points to the application of computational models to a desired study and foretelling of physical consequences and systems' behaviors. The evolution of the computer simulation science depicted resources from the sectors of scientific, mathematical and engineering knowledge. Computer simulation is accentuated as a powerful tool and the promises to revolutionize the way research in nautical sciences are performed in the 21st century. The simulation technology had played a distinguished role in promoting the technological competitiveness worldwide. Several scientific communities are aware that computer simulation is an essential instrument for solving a great number of current technological issues. Essentially, computer simulation science is representing an expansion of theoretical sciences, which grounded on mathematical models. These models are trying to portray the physical predictions of scientific hypotheses. Together with maritime simulation technologies, there are better capabilities to forecast and optimize systems affecting various aspects of our working environment through oceans, our security and safety, and the different products we commonly used for both import and export. Before half a century, the usage of maritime simulations in nautical sciences was commenced. Just in the past decade, simulation theory and technology created a tremendous effect on the maritime field. (Sulaiman, Saharuddin, & Kader, 2011)

Nowadays, most sophisticated maritime simulators have high-fidelity visual representation systems along with hydraulic motion systems. However, maritime simulators are built in order to drill seafarers; they are mostly used to emulate very large vessels. They consist of a replication of a vessel's bridge, with an Integrated Bridge System (IBS), and a number of visual screens with advanced technology on which the virtual realities are portrayed. The complexity of shipping activities from the design phase to operation training
and maintenance phases are remaining one of the agents that have made IMO to create robust regulations to ensure the safety of life at sea. (Sulaiman et al., 2011)

Due to the fact that recent issues of asymmetry in human actions and environmental behaviors, vessels and its operation zones that covers almost two-thirds of the world, put the maritime work a target by land-based maritime agencies whose pressure has given IMO more challenges of environmental protection that has called for a new manner of doing things based on risks. Simulators are distinctly one of the tools that fit in such advanced measures in order to prevent incidents as it leads to severe environmental dilemmas. Whereas International legislations are best implemented and enforced by local authorities, the third parties are the best to achieve the control. The Det Norske Veritas (DNV) is a Norwegian classification society, which works as a provider of services for managing risks, and it has laid down some guidelines maritime simulators. Certifying a maritime simulator via DNV means that simulator systems have qualified personnel giving authentic and high-quality simulation training corresponding to the STCW requirements. The table below shows an example for the most recent certified simulators by the type of certificate. (Sulaiman et al., 2011)
## Simulators by Type of Certificate

<table>
<thead>
<tr>
<th>Cert. No.</th>
<th>Name</th>
<th>DNV Id</th>
<th>Simulator Name</th>
<th>Simulator Type</th>
<th>Expiry Date</th>
<th>Country</th>
<th>Cert. Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>002/131107</td>
<td>Kongsberg Maritime AS</td>
<td>135908</td>
<td>K-Sim Offshore</td>
<td>Bridge Operation</td>
<td>07.11.2018</td>
<td>Norway</td>
<td>SOC A</td>
</tr>
<tr>
<td>001/120119</td>
<td>Kongsberg Maritime AS</td>
<td>135908</td>
<td>Polaris Ship's Bridge Simulator</td>
<td>Bridge Operation</td>
<td>19.01.2017</td>
<td>Norway</td>
<td>SOC A</td>
</tr>
<tr>
<td>002/121210</td>
<td>Transas Marine International AB</td>
<td>120102</td>
<td>NAVI-TRAINER 5000</td>
<td>Bridge Operation</td>
<td>18.12.2017</td>
<td>Sweden</td>
<td>SOC A</td>
</tr>
<tr>
<td>002/120323</td>
<td>Shanghai Maritime University</td>
<td>120816</td>
<td>SMU-NAVI-Pilot 1000</td>
<td>Bridge Operation</td>
<td>23.03.2017</td>
<td>China</td>
<td>SOC S</td>
</tr>
<tr>
<td>001/101007</td>
<td>FORCE Technology, Dept. for maritime</td>
<td>118246</td>
<td>SimFlex Navigator</td>
<td>Bridge Operation</td>
<td>01.10.2015</td>
<td>Denmark</td>
<td>SOC A</td>
</tr>
<tr>
<td>021/120201</td>
<td>Rheinmetall Defence Electronics GMB</td>
<td>162346</td>
<td>Advanced Nautical Simulator ANS6000</td>
<td>Bridge Operation</td>
<td>01.02.2017</td>
<td>Germany</td>
<td>SOC A</td>
</tr>
<tr>
<td>001/100618</td>
<td>Applied Research International (ARI)</td>
<td>142684</td>
<td>ARI Full Mission Ship Maneuvering Simulator</td>
<td>Bridge Operation</td>
<td>18.06.2015</td>
<td>India</td>
<td>SOC A</td>
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<tr>
<td>001/130409</td>
<td>Elektro LB</td>
<td>131096</td>
<td>ELAB NAV-E</td>
<td>Bridge Operation</td>
<td>09.04.2018</td>
<td>India</td>
<td>SOC S</td>
</tr>
<tr>
<td>001/000623</td>
<td>Transas Ltd.</td>
<td>119287</td>
<td>Navi-Trainer Professional 5000 (NTPRO 5000)</td>
<td>Bridge Operation</td>
<td>23.06.2014</td>
<td>Ireland</td>
<td>SOC A</td>
</tr>
<tr>
<td>001/130906</td>
<td>ECA SINDEL SRL</td>
<td>10070217</td>
<td>Mistral 4000</td>
<td>Bridge Operation</td>
<td>06.09.2018</td>
<td>Italy</td>
<td>SOC A</td>
</tr>
<tr>
<td>001/120705</td>
<td>Korea Institute of Ocean Science &amp; Tec</td>
<td>102806</td>
<td>Full Mission Ship Handling Simulator (KNTS - 2010)</td>
<td>Bridge Operation</td>
<td>05.12.2017</td>
<td>Korea</td>
<td>SOC A</td>
</tr>
<tr>
<td>001/140305</td>
<td>VSTEP</td>
<td>10053962</td>
<td>Neutilus Ship Simulator</td>
<td>Bridge Operation</td>
<td>05.03.2019</td>
<td>Netherlands</td>
<td>SOC A</td>
</tr>
<tr>
<td>05.12.2006</td>
<td>ST Electronics (Training &amp; Simulation S</td>
<td>116290</td>
<td>Trident Full Mission Ship Handling Simulator - FMS</td>
<td>Bridge Operation</td>
<td></td>
<td>Singapore</td>
<td>SOC A</td>
</tr>
</tbody>
</table>

**Figure 1:** Example for Certified Simulators by Certificate Type
1.2 Definitions

- **Simulation**: this word specifically has several definitions:
  
  - It is a process to implement a model over time. (Banks & Sokolowski, 2009)
  
  - It is a technique for testing, analysis, and training in which the real environment schemes utilized. (Banks & Sokolowski, 2009)
  
  - It is a methodology for educating information from a model by observing the behavioral aspects of the model as it performed. (Banks & Sokolowski, 2009)

- **Model**: is a physical, mathematical and logical representation of an entity. They are serving as representations of events and things that are real. (Sokolowski & Banks, 2010)

- **System**: is a construction of different elements that together produces results not attainable by the theses elements alone. Whereas, elements could include people, hardware, software, facilities, policies and required documents in order to produce system-level qualities, properties, functions, behaviors, and performance. (Sokolowski & Banks, 2010)

- **Modeling & Simulation (M&S)**: are together referred to the overall process of improving a model and then simulating that model to gather data concerning the performance of a system. Modeling & Simulation use models and simulations to develop data as a basis for making managerial, technical and training decisions and depend on computational science for the simulation of a large-scale event. (Sokolowski & Banks, 2010)

- **Visualization**: is the ability to represent data as a way to interface with the model. Both computer graphics and visualization are used to construct two-dimensional and three-dimensional models of the modeled system. It allows for the visual plotting and display of system time response functions to conceive complex sets of data and to
animate visual representations of systems in order to understand its effects and
dynamic behaviors more suitable. (Sokolowski & Banks, 2010)

- **Development Technologies:** is a software design project, the computer code should
  be written to represent algorithmically the mathematical statements and logical
  constructs of the model. (Sokolowski & Banks, 2010)

- **Verification:** is ensuring that M&S development carried out correctly. (Sokolowski
  & Banks, 2010)

- **Validation:** is ensuring that the model is representing the genuine system and is truly
  representative of that specific system. (Sokolowski & Banks, 2010)

- **Human Factor:** it is when humans are placed in the simulations as system
  components within the model. To perform that effectively, simulation designers must
  have the basic comprehension of both human cognition and perception. (Sokolowski
  & Banks, 2010)

1.3 A Glance About The International Maritime Organization (IMO)

The *International Maritime Organization* (IMO) is a dedicated bureau of the United
Nations. Established in 1948, with headquarters in London and 170 member nations and three
associate members. Its governing body is meeting once every two years. It has the full
authority of the international standard-settings, legislation of rules and regulations that seeks
to maritime safety, promoting secure navigation, environmental protection, the performance
of international shipping, and to eradicate the maritime pollution. It holds the power to
impose and administer matters related to these objectives. Its main function is to make a
regulatory framework for the shipping industry that is equitable and operative, to be adopted
and implemented universally. Also, it organizes technical assistance and maritime traffic. The
organization’s members are representing their countries' maritime interests. Implementation
of the regulation lies on the signatories of the organization. On the other hand, as an another
function is to create a level playing field so that both ship owners and operators cannot treat and manage their financial issues by merely cutting corners and compromising on the maritime safety, security and environment. ((IMO), 2014b)

In the early 21st century, it has placed an increased emphasis on maritime training and security standards through its different codes and conventions. It has developed some instruments that facilitate the organization performs its duty effectively. These instruments include, but not limited to, The International Convention for the Safety Of Life At Sea (SOLAS), International Safety Management Code (ISM), International Ships and Port Facility Security Code (ISPS), The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), International Convention on Load Lines (ILL) and the International Convention for the Prevention of the Pollution from Ships (MARPOL). ((IMO), 2014b)

Figure 2: The IMO’s Headquarter in London

IMO measures are covering all aspects of the international shipping, including ship designs, constructions, equipment, manning and operations in order to assure that this vital
sector for remains safe, environmentally sound, energy efficient and secure. Most of its tasks are carried out in some committees and sub-committees as the following ((IMO), 2014b):

- **Committees:**
  2. The Marine Environment Protection Committee.
  3. The Legal Committee.
  4. The Technical Co-operation Committee.
  5. The Facilitation Committee.

- **Sub-Committees:**
  1. Sub-Committee on Human Element, Training and Watchkeeping (HTW).
  2. Sub-Committee on Implementation of IMO Instruments.
  3. Sub-Committee on Navigation, Communications and Search & Rescue (NCSR).
  4. Sub-Committee on Pollution Prevention and Response (PPR).
  5. Sub-Committee on Ship Design and Construction (SDC).
  6. Sub-Committee on Ship Systems and Equipment (SSE).
  7. Sub-Committee on Carriage of Cargoes and Containers (CCC).

All IMO's technical bodies and Assemblies are open to involvement and collaboration by all Member Governments on an equal basis. The Secretary-General Mr. Koji Sekimizu, who assisted by professional personnel of around 300 international civil servants, heads the IMO Secretariat. The Council, along with Assembly’s approval, appoints him. ((IMO), 2014b)
1.4 An Overview Of The STCW Convention

The STCW Convention was adopted on 7 July 1978 and entered into force on 28 April 1984. It was the first to set up essential requirements for training, certification and watchkeeping for seafarers on an international level. Formerly, standards of training, certification and watchkeeping of marine officers and ratings were founded by individual governments, without any referencing to practice in other countries that has the same attention. As a consequence, standards varied excessively, although shipping is the most international of all industries. ((IMO), 2014a)

This convention per se determines minimum standards and requirements related to training, certification and watchkeeping for seafarers that coastal countries are bound to fulfill. However, it did not deal with manning levels, as IMO's provisions in this area are well covered by a regulation in Chapter V of the International Convention for the Safety of Life at Sea (SOLAS 1974). ((IMO), 2014a)
The convention's articles contain the requirements which pertaining to affairs that surrounds Certification and Port State Control. The 1995 amendments, adopted by a Conference, exemplify a fundamental revision of the Convention, in response to a recognized necessity to bring the Convention up to date. Also, to respond to critics who pointed out many ambiguous phrases, such as "to the satisfaction of the Administration," which has resulted in various interpretations being made to be negatively understood. The 1995 amendments had entered into force on the 1st February 1997. A substantial feature of the revision was that the division of the technical annex into regulations, split into Chapters as before, and a new STCW Code, to which many technical rules transferred. Splitting regulations by such manner, makes both the administration and the task of revising and updating them easier, for procedural and legal purposes, there is no need to call all parties to a full conference to make changes to the codes. ((IMO), 2014a)

Furthermore, another revision was the requirements of the parties to the Convention that they are asked to provide itemized information to the IMO, which concerning administrative measures needed in order to ensure conformity with the Convention. However, under Chapter I, regulation I/7 of the revised Convention, member states are obliged to provide itemized information to the IMO concerning administrative measures taken to ensure compliance with the Convention, education and training courses, certification procedures and other elements which are relevant to the execution. ((IMO), 2014a)

**STCW convention chapters:**

- Chapter I: General Provisions
- Chapter II: Master & Deck Department
- Chapter III: Engine Department
- Chapter IV: Radio-Communication & Radio Personnel
- Chapter V: Special Training Requirements for Personnel on Certain Types of Ships
The Manila amendments to the STCW Convention were adopted on 25 June 2010, which marks a large revision of the convention. These amendments had entered into force on the 1st January 2012 under the tacit acceptance and were aimed at bringing it up to date with improvements since they were initially adopted. Also, to enable them to address matters that are expected to emerge in the future. There are a number of significant amendments to each chapter of the Convention, ((IMO), 2014a) as the following, but not limited to:

- Improved measures to prevent fraudulent practices related to certificates of competency and strengthen the evaluation procedures. ((IMO), 2014a)
- New certification requirements for able seafarers. ((IMO), 2014a)
- New requirements for maritime environmental awareness training and training in leadership and teamwork. ((IMO), 2014a)
- New training and certification requirements for electro-technical officers. ((IMO), 2014a)
- The Introduction of modern training methodology, including distance learning and web-based learning. ((IMO), 2014a)
- New training guidance for personnel operating Dynamic Positioning Systems (DPS). ((IMO), 2014a)
- Revised requirements for work and rest hours. ((IMO), 2014a)
- New requirements for the prevention of drug and alcohol abuse, and updated standards relating to medical fitness standards for seafarers. ((IMO), 2014a)
• New requirements relating to training in advanced technology such as Electronic Charts and Information Systems (ECDIS). (IMO, 2014a)

There are a number of Resolutions adopted by the 1978 Conference, which adopted the STCW Convention. These resolutions are designed to back up the convention itself. The resolutions, which are recommendatory rather than mandatory, consolidate more details than some of the Convention regulations ((IMO), 2014a), and they are as the following:

• **Resolution #1** - Basic Principles to Be Observed In Keeping a Navigational Watch.

• **Resolution #2** - Operational Guidance For Engineer Officers In Charge Of Engineering Watch.

• **Resolution #3** - Principles and Operational Guidance for Deck Officers In Charge Of a Watch in Port.

• **Resolution #4** - Principles and Operational Guidance of Engineer Officers In Charge Of an Engineering Watch in Port.


• **Resolution #7** - Radio Operators.

• **Resolution #8** - Additional Training for Ratings Forming Part of a Navigational Watch.

• **Resolution #9** - Minimum Requirements For A Rating Nominated As The Assistant To The Engineer Officer In Charge Of The Watch.

• **Resolution #10** - Training and Qualifications Of Officers And Ratings Of Oil Tankers.
• Resolution #11 - Training and Qualifications Of Officers And Ratings Of Chemical Tankers.

• Resolution #12 - Training and Qualifications Of Masters, Officers, And Ratings Of Liquefied Gas Tankers.

• Resolution #13 - Training and Qualifications Of Officers And Ratings Of Ships Carrying Dangerous And Hazardous Cargo Other Than In Bulk.

• Resolution #14 - Training for Radio Officers.

• Resolution #15 - Training for Radiotelephone Operators.

• Resolution #16 - Technical Assistance for The Training And Qualifications Of Masters And Other Responsible Personnel Of Oil, Chemical And Liquefied Gas Tankers.

• Resolution #17 - Additional Training for Masters and Chief Mates of Large Ships and Of Ships with Unusual Maneuvering Characteristics.

• Resolution #18 - Radar Simulator Training.

• Resolution #19 - Training of Seafarers In Personal Survival Techniques.

• Resolution #20 - Training In The Use Of Collision Avoidance Aids.

• Resolution #21 - International Certificate of Competency.

• Resolution #22 - Human Relationships.

• Resolution #23 - Promotion of Technical Cooperation.

1.5 STCW’s Requirements For Maritime Simulation

In order to standardize minimal degrees of cognitive awareness and skills capabilities to the worldwide seafaring people who are practicing their skills and testing their proficiencies through MSC's, the IMO developed a series of regulations that govern the simulation training and its appropriate global standards. The STCW Convention revision should certainly provide stringent guidelines as a basic degree for seafarer training in the very
near future. The simulation training forms a significant section in the new STCW Convention documents. Concentration and deep focus are put on the kind of maritime simulators, assessment of competency by the means of simulators and instructors’ qualifications and assessors operating the simulators. (Cross, 2011)

The training of RADAR and ARPA skills is the only area described as a mandatory simulator application for all OOW. In the present STCW 95 revision from 2007-2010, additional competencies are being made compulsory, which will necessitate the implementation of more simulators. According to the convention, other areas of simulation applications in training purposes are substantially recommended. The growth in utilizing other maritime simulators would be shown as an encouragement of the potential to ensure better quality training standards. Particularly the assertion of training by engine room simulator and cargo handling simulator would be reasonable, complementing training on all primary systems on board various types of ships. (Cross, 2011)

Manila's 2010 STCW amendments make the usage of simulators for training for the Electronic Chart Display and Information System (ECDIS) a compulsory requirement. Under these particular conditions, simulators are the only approved technique of proving competence. Other than these instances, accepted simulator training and assessment is non-compulsory. Optional simulator training and assessment covers the categories: navigation and ship handling, cargo handling, GMDSS communication, propulsion and auxiliary machinery. Maritime simulators are needed to comply with STCW standards. In addition, it does not mean that all simulators need to be highly expensive and electronically complex. (Federation, 2013)

The convention is discussing simulators based on three significant categories (Ali, 2006):

- The usage of simulators.
- Minimal standards of competencies.
- Training & assessments.

Also, it mentioned the possibilities of using simulators as a tool during the discussion on Training & Assessment of OOW under the following regulations and sections (Ali, 2006):

- **Regulation-I/6: Training & Assessment.**

  This regulation requesting all STCW Convention signatories to ensure highly that training & assessment of OOWs is in accordance with the STCW Code A and all instructors are suitably qualified in order to perform their tasks to the fullest. (Ali, 2006)

- **Section A-I/6: Training and Assessment (Mandatory).**

  This section demanding two conditions to be applied, if the training is being conducted utilizing a maritime simulator:

  1- The instructor employed should receive appropriate guidance in both pedagogical and instructional techniques which involving the usage of maritime simulators. (Ali, 2006)

  2- He has gained practical and operational experiences on the particular type of simulator used for the training and assessment. (Ali, 2006)

- **Section B-I/6: Guidance regarding Training & Assessment.**

  This section mentions the IMO Model Courses for Instructors and examination & certification of OOWs. On the other hand, there is a special part of STCW convention, which is highlighting the usage of simulators, as below:

- **Regulation I/12-Use of simulators.**

  This regulation states and illustrates that “The performance standards and other provisions set forth in Section A-I/12 and such other requirements as are prescribed in part A of the STCW Code for any certificate concerned shall be complied with in respect of:

  1- All mandatory simulator-based training;

  2- Any assessment of competency required by part A of the STCW Code which is carried out by means of a simulator.
3- any demonstration, using a simulator, of continued proficiency required by part A of the STCW Code.” (The International Maritime Organization, 2010a)

- **Section A-I/12-Standards Governing the Use of Simulators (Mandatory).**

  This section includes two parts:

  - **Part #1:** is providing performance standards of the simulators that can be used for the training & assessment of OOWs separately. The convention desires physical and behavioral realism of the simulators is convenient to both training & assessment objectives. Abilities & limitations of the original equipment alongside the potential errors should form part of the simulation. Maritime simulators should be capable of generating emergency, hazardous and unforeseen conditions that lead to efficacious training value. A substantial aspect of the performance standards of STCW convention is, the requirement of simulators to provide the simulator instructor with the command, control and monitoring facilities side by side with the proper recording devices for an effective debriefing to the maritime apprentices. (The International Maritime Organization, 2010b) (Ali, 2006)

  - **Part #2:** is providing other provisions whereby training & assessment are discussed for the simulator instructors to have a standard behavior of the simulator training. The briefing, planning, familiarization, monitoring, and debriefing are parts of any maritime simulation-based exercise. In addition, the convention highlights the importance of guidance and exercise stimuli by the instructor himself through the observations along with the usage of peer assessment techniques in the phase of de-briefing. Maritime simulator exercises are required to be designed, created and tested by the instructor in order to assure their appropriateness for the specified training aims. (Ali, 2006) (The International Maritime Organization, 2010b)
• **Section B-I/12-Guidance regarding Use of Simulators.**

  The STCW Convention has made only the RADAR / ARPA simulator training compulsory for the OOW. Therefore, this section gives a detailed guide on how to use these types of simulators for purposes of training & assessment. (Ali, 2006) (The International Maritime Organization, 2010b)

  ❖ **The ARPA Simulator.**

  STCW convention highlighted the following sectors of the ARPA simulator when it is used for the maritime training & assessment of OOWs (The International Maritime Organization, 2010b):

  • Possible hazards of over-dependence on ARPA.

  • Principle types of the ARPA systems and their presentation feature.

  • IMO performance standards for ARPA.

  • Factors affecting system's performance & accuracy.

  • Tracking abilities & limitations.

  • Processing delays.

  • Operational warnings, their benefits & limitations.

  • System operational tests.

  • Manual & automatic acquisition of targets and their respective limitations.

  • True/relative vectors and typical graphic representation of target information & danger areas.

  • Information on past positions of tracked targets.

  • Setting up procedures and maintaining displays.

  • Obtaining information from ARPA’s display.

  • Application of the International Regulations for Preventing Collisions at Sea (COLREGS 1972)
The RADAR Simulator.

The STCW Convention highlighted the following sectors of the RADAR Simulator used for the maritime training & assessment of OOWs (The International Maritime Organization, 2010b):

- Factors affecting performance & accuracy.
- Detection of misrepresentation of information, including false echoes and sea turns.
- Setting up procedures and maintaining displays.
- Ranges and bearings.
- Plotting techniques and relative motion concepts.
- Identification of critical echoes.
- Course and speed of other vessels.
- Time and distance of the closest approach to crossing or overtaking vessels.
- Detecting course and speed changes of other vessels.
- Effects on the changes of the own vessel’s course or speed or both.
- Application of the International Regulations for Preventing Collisions at Sea (COLREGS 1972)

The non-mandatory Simulators.

The STCW Convention mentioned the following non-compulsory simulation systems (The International Maritime Organization, 2010b):

- The navigation and watch-keeping simulator.
- The ship handling & maneuverings simulator.
- The cargo handling and stowage simulator.
- The radio communications simulator
- The main and auxiliary machinery operation simulator.
1.6 Competence Based Education and Training

Certificates Of Competency (COC) are issued by authorized maritime authorities onto testing apprentice's knowledge in an exam, and supposing that the obtained knowledge will be transferred perfectly to a skill, and then the desired competence of skills will be executed in the job. As achieving the competence on the job is a dilemma, the supposition that skills are sufficiently performed is a doubtful matter, and the later assessments of these skills are obsoleted. This is the specific domain where the application of lifelike simulation technology is founded to be a righteous substitution. (Cross, 2011)

As according to the operating environment of the vessel, which is represented in a bridge, engine room or cargo handling simulators, the required training & assessments of the obtained skills would take place in the controlled situations of the IMSC. That particular aspect is recognized very well in the revised edition of the STCW convention and addressed in a manner that the maritime simulation tools are deemed a substantial factor in the safety refinement of the seafaring operations over the seas. The multitude of simulation systems and its technologies will call for a comprehensive inventory, classification and matching with the desired learning & training aims. A precise consideration should be taken into account when relating a type of simulator to a skill that has to be acquired. (Cross, 2011)

1.7 Training Tools

To elucidate the equipment aspects, it would be simplified by stating that, the maritime education is fundamentally a cognitive procedure and training more of a psychomotoric event. It includes systems required to transmit the knowledge scheme from one area to another. For instance, for spoken transfer the audio and recording equipment to be used. In addition, for writing transfer, pins, boards, typewriters, printed materials, viewgraphs, pictures, and video. However, for training purposes, these training tools are interrelated to the skills to be achieved, will be a requirement in the learning process. The maritime profession
is considered as a highly specialized field in which it requires the availability of advanced and sophisticated tools for teaching these skills. (Cross, 2011)

The skills, which are being performed, are plentiful, and the equipment are often expensive. From a fiscal perspective, although single task teaching tools are affordable, the complicated equipment are excessively difficult and expensive. For better illustration, the main engine of a seagoing vessel, cargo handling system on a very large crude carrier or even the navigation bridge on board ship are not learning tools that could be bought from any teaching equipment center. In the more expensive case of teaching and learning tools, there is one option, is to have a real training merchant vessel to apply the drills onboard it. Whilst, this is overwhelmingly laborious, troublesome and hard to achieve and expensive to maintain, the next preferable solution could be an advanced technology of a maritime simulation system that holds all aspects and concepts located on a real merchant vessel. (Cross, 2011)

1.8 Project Management

The application of the maritime simulation process, which is intended to solve real maritime environment problems, is considered to be a tricky job, and if it is not managed precisely and wisely, it will be a dilemma per se. (Sokolowski & Banks, 2010) Furthermore, the growing number of maritime merchant apprentices, combined with the necessity for increased quality for simulation centers, has, in turn, increased the complexity of managing the maritime simulation complexes around the world. At present, the workflow of the maritime simulation environments is included cooperative work of individuals and technical teams who are delivering particular elements in their respective field of expertise. Such sectors are including guidance and control, virtual vessel structures, and testing. (Tamayo, Gage, Walker, & MathWorks, 2012)
For example, there might be a tremendous number of people and a long period of time of efforts, which is invested in a project requiring functional and professional management tools to facilitate smooth training and outlay. When computer simulation technology is the only technique available to investigate such large-scale projects, the process becomes a huge technical project, which involves oversight and management. (Sokolowski & Banks, 2010) Therefore, the direct implementations of the project management aspects of such simulation complexes that support collaborative efforts and the accelerated development have proven successful in other areas as well. (Tamayo et al., 2012) Consequently, the maritime simulation professionals and assessors must be aware of the project management essentials. (Sokolowski & Banks, 2010)
2.1 Maritime Simulation Training Background

The management and designing of Maritime Simulation-Based Training (MSBT) is a sophisticated and complicated process. There were a number of serious developments in modeling & simulation technology to prop training layout, manage, model the training, training control and after training briefs. The modeling of maritime simulation ought to be adaptable and supple to mutate promptly in reaction to the decisions of the nautical trainees. Without having such types of capabilities and capacities, the expensive training sessions will not attain training purposes and broad goals. Notwithstanding, the abilities to amend training sessions at the midst as a subroutine of the progress and functioning of the nautical trainees will remain restricted to be manual. (Simpson & Oser, 2003)

The Maritime Simulation Training (MST) is very intricate than the conventional training methods in the order of the magnitude of instructional information provided to the nautical trainees or even further from both methodology and technology of training perspectives. It should bear in mind and to emphasize that the MST is more than a revolution in the world of educational technology for virtual reality. It depicts the most revolutionary way of rational and logical imagining about commercial maritime training and its theories. This type of training per se is exhibiting and introducing modernistic defiance to the maritime training communities, which have confined experiences to make assessments for such complicated training. (Simpson & Oser, 2003)

Learning activities encompass both isolated trainings of particular maritime navigational proficiencies and adeptness on desktop simulators and students’ reconnaissance of the dynamics that depicts and identifies the full entire environment of the ship's bridge. Hollnagel has defined simulators as “a representation of certain features of a real
environment to achieve some specific objective”. Numerous maritime simulation training for commercial ships are utilized to provide learning practices and experiences, particularly in nautical studies through an impressive and immersive material such as Full-Mission Bridge Simulators (FMBS’s). (Hontvedt & Arnseth, 2013)

The maritime simulation training is deemed as a key strategy for improving all aspects that covers and governs maritime safety. A previous research within the field of simulation training has studied levels of fidelity and learning, simulator training of Crew Resource Management, the significance of debriefing, and social aspects of how maritime simulator activities need to be contextualized and to learn to simulate needs to be part of the training. (Hontvedt & Arnseth, 2013)

Conventionally, the shipping industry has been a significant milestone of the world's economic system in the past decades, while working on board commercial ships has been considered as a high-level career. However, recently, it is not anymore a workmanship with a robust demand amongst nautical students. Nevertheless, educational colleges for nautical sciences which they are presenting maritime studies appears well to progress and are characterized by lower rates of dropout amongst such students. This kind of orientation may comprise various explications. Anywise, according to modern records and notices on maritime education affairs, instruction strategies together with the wide usage of simulators and the joint integration with training are serious factors. (Hontvedt & Arnseth, 2013)

A substantial background for ship simulation training interests meeting aims for safe passages for shipping, which identified within studies of Human Factors that looks into human performance across environments, which are condensed with technology. Collected data on ship incidents indicated that Human Factors are the main cause associated with around 70% of the incidents in the USA, the UK, Canada, and Australia (ABS 2004). Maritime simulators are providing chances for several training criteria and aspects in ship
handling, bridge team management and communications, and reactions towards unforeseen incidents. Numerous educational training are oriented towards certifying courses in the different maritime different sectors, such as Crew Resource Management Training (CRM). Such training per se, focuses on team cooperation and depend intensely on simulation training. CRM training is positively illustrated the outcomes, But it is still fighting in some views, particularly with evaluating training and learning outcomes and over and above connecting CRM training to the enhanced safety. (Hontvedt & Arnseth, 2013)

Generally, maritime simulators are usually utilized for training purposes, which include a very much time, cost, and hazardous practice in real sea environments. This type of simulation training furnishes hazard-free training for serious and imminent conditions, such as accidents, loss of lives and property damages. Also, it provides chances to repeat activities in ways that it is not possible in real situations, for example, the capability to ‘freeze’ scenarios for active instructions. Instructors of maritime simulation training are putting considerable effort into debriefing and peer technological support. Debriefing is commonly advocated as a crucial aspect of simulator training, and its sessions may employ to transform experience into learning. (Hontvedt & Arnseth, 2013)

As noted previously, providing maritime training in a real environment situation is both costly and timely. Anywise, the real environment will not offer possibilities and to make it impossible to repeat a simulation sessions and revisions. Thus, teaching goals are not completely met. Furthermore, computer simulation is progressing in the training and perceptual proficiency of apprentices. In addition, to providing and enhance the quality of the training style, which is mainly, lies into both verbal and textual interaction. Maritime simulation instructors are usually captains, have the full command and control of a computer simulation. That, per se, means that they can begin, cease, check or even restart a simulation at any time promptly, which is not possible in a real environment conditions. This type of
simulation could be carried out in a virtual maritime environment, which will take into account the high engagement for apprentices. Interactivity, time constraints, and competitive nature, motivating them to use all their skills, knowledge and to show their proficiency in dealing with the solid missions in order to seek and find solutions for issues and troubles they have confronted. (Šimić, 2012)

There are three types of simulation systems in maritime training and educational purposes, they are utilized and lies in the level of complexity, utilized methodology and the scale of the targets (Šimić, 2012):

- Live simulators – held in a pragmatic environment, apprentices’ onboard real training vessels that are designed for training purposes only. (Šimić, 2012)
- Virtual simulators – held in a virtual reality environment such as ship's virtual bridges, virtual engine rooms for the purpose of the capacity improvement in the maritime industry of individual or team training schemes which specifically designed for learning particular cases and field terminologies. (Šimić, 2012)
- Constructive simulators – held in a virtual reality environment, it is considered a very complex level of simulators for the purposes of allowing instructors (i.e. captains) to analyze the performance of apprentices and evaluate their master of skills after using the simulation. (Šimić, 2012)

Constructive simulations are strongly used amongst maritime training societies for several objectives such as maritime education, training and validation/revalidation for new navigational aids. The intensive interaction provides quality to the training operations. Apprentice's behaviors and reactions are obviously observed within the simulation session, as they are recorded in order to be analyzed and processed in later stages. The instructor could make derivations about the apprentice’s skills, particular knowledge based on the information derived from the simulation session. By following this trend, he can easily concentrate on the
weakest features of each apprentice and try to make discussions throughout the debriefing sessions in order to develop them. Furthermore, possessing recorded information about how each apprentice has performed on his given training tasks makes it possible to create cohesive teams. (Šimić, 2012)

Specifically, in constructive simulators, the training scheme has a cooperative sense that could take into account in a non-traditional way. Apprentices are typically proficient adults, which they normally have experience in different domains, organized into joint staff and expert teams. They are required to know how to collaborate, be more effective, use resources and to give support to/with each other according to particular issues given by the created scenario and following typical communication processes. (Šimić, 2012)

Maritime constructive simulators are vastly used while teaching apprentices from the commercial maritime sector. They are constructed from the curriculum of various maritime competency courses such as navigating in narrow channels or high seas, personal safety and social responsibilities, tactical processes, international maritime security which adapted from The International Ship and Port Facility Security Code (ISPS Code) and from numerous nautical aspects which the learning process is too sophisticated when a cooperative technique is required to be highly utilized. Though, it's been covered in the previous literature in the last two decades to affirm of the usefulness of this type of simulation systems, which includes time diminishing, and expenses devaluation. Yet, still there are issues. (Šimić, 2012)

During the preparation phase, scenario structuring and efforts last for several weeks needs the elevated engagement of instructors and what's called Subject Matter Experts (SME). Then, during the implementation phase, besides instructors and SME, lots of technical backup engineers are involved additionally. Their primary role is to give a balanced and continued implementation of the simulation process. Arrangements of human resources for the effectiveness of maritime simulation training and their prolonged engagement, in
addition to the insufficient planning of trainings are causing the major issues, which they are related to the constructive simulations. (Šimić, 2012)

Commercial Maritime constructive simulators should appeal apprentice’s attraction for the progression of the educational process and to gain their interest. For such reason, the scenarios should be comprehensible, rational and pragmatic, adapted to the apprentice’s awareness and proficiency, which merged with obvious objectives. If such matters are not serviceable, then it leads to that the maritime educational objectives are being missed. (Šimić, 2012)

There are two prime elements in which they are contributing the increasing of simulation technologies that are affecting positively on the training scheme across commercial maritime simulations complexes. The first one is the rising availability of quality simulation resources, which can be either found through the Internet or maritime companies that prepare and develop navigational software for educational purposes. They are developing such as virtual reality displays, interactive display devices and so forth, are giving vital support in order to make advanced simulation technologies more accessible and reliable. The second is the increasing concentration on the outcomes of the maritime education for seafarers and it is not merely to transfer information or having apprentices passing training courses but to instruct and evaluate wider efficiencies in a precise manner. Maritime Simulation technologies are showing to be serviceable and applicable tools for high functional competency-based training. (Damassa & Sitko, 2010)

The usage of maritime simulation for training and improving the competencies of apprentices and teams has been traditionally applied to several situations where imminent risk is associated with the skills being trained. The focus on assessing maritime competencies is now moving into worldwide education. By looking at new approaches to teach maritime skills in this century, it is postulated that “deciding what students need to know and should be
"able to do in the context of a changing panoply of computing, information, and communications technologies is a critical first step." says Anne Moore. Recent researches focus on the rapid growth in the use of maritime simulation technologies, and the implications will have for IT planning and policy decisions. (Damassa & Sitko, 2010)

Maritime apprentices hope that the knowledge, behaviors, and skills, which have been learned in the classroom, will be transferred to relevant situations in the real world, which located at the sea. There are no two different situations are identical, but it is in common that the regularly practicing skills, with supervision, in a simulated environment are promoting the effective transfer of these skills to the real-world mediums. Therefore, the advancements in computer sciences, visualization, and related technologies are enhancing the rapid development in the use of the maritime simulation for training purposes, which will lead to this type of transfer. Driven by the demands of the maritime-related studies for “safe” learning mediums, the Maritime Computer-Based Simulators (MCBS) are now being incorporated into the curricula of the Nautical Sciences education. The screen-based simulation was the earliest type of computer simulation technology. They possess the demonstration of the track record in both trainings and evaluations. (Damassa & Sitko, 2010)

2.2 Maritime Simulation Management Background

2.2.1 Bridge Resource Management (BRM)

It's been admitted that the necessity for non-technical training for the first generation of Bridge Resource Management (BRM) was developed in the early 1980s. On the basis of incident reports, it’s presupposed that changing seafarers attitudes (e.g., in regards to the captain's authority and responsibilities of all crew members on board a ship which would reinforce the safety of a voyage). Part of previously reported dysfunctional attitudes were in fact very common throughout the first methodical assessment of seafarers’ attitudes. One of the well-known examples being that recently two-thirds of the seafarers believed their
Decision-Making (DM) capability to be as perfect in emergencies as in any routine situations. It's been shown that on the basis of the ship's bridge simulation management, attitude, that roughly 96% of these seafarers could be correctly classified as having received above-average performance ratings. Consequently, empirical data are supporting the assumption that attitudes influence the performance, and they are a worthwhile aim for maritime simulation training. (Rottger, Vetter, & Kowalski, 2012)

Affirmative attitudes in which will take part in a safe and more efficient voyage are, for example, that the Officer Of the Watch (OOW) should clearly state his or her plans, which will lead crew members to monitor and observe each other for symptoms of stresses and fatigues. Thus, briefings and debriefings are one of the most important elements for effective and collaborative teamwork through maritime simulation training complexes. Then, the second scale of the attitudes is the Command Responsibility (C.R), in which it reflects the sense of joint responsibility for the voyage (as it is contrary to assigning all responsibilities to the captain only) and to endorse captain’s obligation to not to engage in an individual task but to delegate tasks in emergency situations. The third scale is the Recognition of Stressor Effects (RSE), which contains statements in regards to human performance in counteractive conditions. "Effective attitudes are to acknowledge that stressors can impair individual performance even when the motivation to carry effectively out one’s task is high, as, for example, in emergencies." (Rottger et al., 2012)
CHAPTER 3:
MARITIME SIMULATION-BASED TRAINING, HARDWARE, QUALITY MEASURES AND HUMAN FACTORS USED WITHIN THE MARITIME SIMULATION COMPLEX

3.1 Maritime Simulation-Based Training

3.1.1 Maritime Simulation Models

Nowadays, the precept and the foundation of maritime training simulators is the simulated vessels in the form of programs in which it basically consists of software, hardware, databases and models of the simulated maritime environment. The hardware itself is apparent and obvious, therefore, easy to evaluate. On the other hand, the software is the program that will have an interface in which the instructor is communicating with the maritime simulator, the contents of the database is what appears and become clear in the pictured scene, but the models are controlling the method the diverse components behave, such as devices and vessels. The validation for both realism and quality of such models is difficult and will contain a considerable amount of subjectivity. Senior seafarers are often consulted for validation of models based on their experiences, such as a ship maneuvering behavior. Though this is a useful input, it says little when trying to fulfill the quality standards to compare advanced models and consequently the maritime simulator performance. Basically, models in ship bridge simulations are based on extrapolation of hydrodynamic coefficients from towing tank tests for some hull shapes. For an instance of deep and open waters, these data are normally accurate to not to cause obvious differences. However, shallow water effects, anchoring forces and ship-ship and ship-shore interactions are really more complicated to quantify in mathematical formulas. Therefore, comprehensive research is required in order to achieve quality results for such example. (Cross, 2011)
3.1.2 Types of Simulator Training

A maritime simulator is a training tool, in which it has to be fully integrated into a training program. That signifies a simulator must be used for training of standard and emergency operations. This can be possible without causing any hazards to both people and the maritime environment. The design of the simulator training will offer a sectioning of this type of training under five basic types as follows:

1. Operator training.
2. Decision-making training.
3. Procedure training.
4. Team training.
5. Maintenance training.

Without identifying a certain type of maritime training that will be utilized and performed, it will be complicated to reach the desired quality of the training and in specific the training using simulators. (Cross, 2011)

3.1.3 Training Program Development

With a view to achieving a quality maritime simulator training program, which has several components that can be audited within a quality assurance context, the items, which constructed such program should be described in details. (Cross, 2011)

3.1.3.1 Program Objectives

The framework of a maritime training program is considered critical in a simulator-based training scheme. It is the system, which is directing the efforts of the maritime apprentices and instructors towards the achievement of a desired simulation training objective and a plan to ensure that extreme benefits are gained from the available simulator time. In addition, to impart basic navigational knowledge and skills to the new maritime apprentices. Furthermore, to assist the trainees to function more efficiently in their simulation training
session by showing them the latest concepts and techniques of the maritime navigation through the desired scenario. (Cross, 2011)

3.1.3.2 Duration

To set the proper duration of a maritime training program, some issues are to be brought into our consideration as follows (Cross, 2011):

1- Nature of the navigational skill to be trained and developed.
2- Knowledge level of trainees.
3- Program cost allowance.
4- Time availability of the trainees to conduct his training session.

3.1.3.3 Group Size

Group sizes for maritime simulation training are depending on many factors:

1- The availability of apprentices and instructors.
2- Level of training.
3- Configuration of the simulator.

In fact, the major factor is that all maritime apprentices should have sufficient simulator hands-on opportunities in order to gain the desired skills and transfer them within the operational level in the real maritime environment. Based on previous experiences, within the maritime simulations complexes there are more than (6-8) apprentices in one ship bridge simulator will only allow for scenarios, which illustrates the demonstrative tasks. On the other hand, the number of apprentices from (3-6) in a group is the size, which is ideal for Ship Bridge, oriented training objectives. (Cross, 2011)
3.1.3.4 Instructor Guide

It would be ideal if a proper instructor guide is developed, improved and then to be provided to all maritime simulation instructors who are participating in the training scheme. In its ideal form it holds to hold all information about the framework of the simulation training program, the planning and strategies employed, if any, a detailed methodology, and the materials to be used through a given scenario in order to boost and consolidate the training procedure. This type of guide, will provide a detailed instructions to the maritime simulation instructor, ensure relevant issues are handled in an appropriate manner and standardize to some limits the capacity & contents of the training program and the scenarios in case if more than one instructor takes a part to run the session. (Cross, 2011)

3.1.3.5 Number of Exercises

In order to allow sufficient maritime simulation training and exercises for several sequences of tasks, in fact, it will be based on the training and gained skills objectives that have to be achieved. Actually, there must be at least two or more dissimilar training exercises available for each and every objective listed in the training record logbook. Therefore, the ratio of achieving one training objective is (2:1). However, if there were many variables included in the type of exercise, then this will lead to an increment in the number of exercises. Furthermore, is there were too few various exercises, the maritime apprentices could be over-confident of their capabilities and have the impression that they have been able to master certain machine or system onboard the ship. (Cross, 2011)

3.1.3.6 Supporting Material

Types of material available for the instructor in order to be used in the briefing and debriefing sessions are adding the effectiveness of the maritime simulation training exercises. Thus, there are different types of materials and media that have been used in which it showed
the successfulness along with training tools and its advanced technology, which indeed advancing with the same pace as the maritime simulator itself. (Cross, 2011)

3.1.3.7 Exercise Scenario Design

In the event that simulator-based training scheme along with its targets has been defined, exercise scenarios have to be improved and expanded. (Board, 1996) The next fourteen factors should be taken into consideration in which is distinguished for the designing of simulated drills (Cross, 2011):-

Factor #1: Type of simulator (e.g., special task, full mission)

Factor #2: Geographical database

Factor #3: Mathematical model of the vessel type

Factor #4: Exercise objectives

Factor #5: Vessel’s model fidelity with respect to its maneuverability in shallow waters

Factor #6: Type & structure of exercise’s scenario required to achieve certain targets

Factor #7: Exercise Duration

Factor #8: Briefing & Debriefing

Factor #9: Cost effectiveness

Factor #10: Specific instructions for the instructor

Factor #11: Specific instructions to the apprentices

Factor #12: Number of students per instructor

Factor #13: Validation

Factor #14: Evaluation

The design and creation of a scenario are categorical in order to optimize training's value. However, designing a realistic scenario has not resulted in operating conditions that will evoke desired reactions of the apprentices and even creating real-life pressures. Developing situations to challenge apprentices is sometimes accomplished through training
scenarios in which it involves role-playing. Only, in one situation, missions are reversed, where seniors placed in subordinate positions and junior personnel in senior positions. Therefore, the aim is behind that is to create a pressure situation in which it becomes apparent to participants that improved interpersonal dynamics and communications are indeed needed in order to minimize the chances for organizational and human errors. This shape of role-playing seems to work. However, it must be debriefed carefully in order to sidestep any unfavorable effects on the confidence of junior personnel. (Board, 1996)

3.1.3.8 Briefing & Debriefing

Generally, both of the briefing and debriefing sessions have to be taken earnestly for the reason that they are providing valuable information through numerous trends. The duration needed to be specified with the exercise in the training program is based on apprentice’s level, the complexity of the maritime simulation system and the exercise session. The briefing can be estimated and documented if the apprentice's level is known. On the other hand, debriefing is actually based on the performance of the apprentice and the group discussions. (Cross, 2011) It is particularly the final part of each training session, in which it takes place when the maritime simulation exercise is accomplished whether it was successful or unsuccessful. In that stage, the lessons gained from the exercise are reinforced, and the apprentice is reminded of the objectives of that specific task. (Board, 1996)

The simulator is considered to be an effectual tool in the debriefing session. The capabilities of the simulation's IT system to record and playback a scenario and to analyze the actions and the skills performed by the apprentices will assist in assessing both the teams and individual performances. To ideally apply debriefing methods with the instructor, one or more apprentices are delegated prior to the simulator session in order to keep an eye on the behaviors of their colleagues during the training session. Then, as an observer, they will open
the debriefing session by examining two essential questions: what went right and what could be improved in their skills? (Board, 1996)

The role of the instructor during the debriefing session is to allow apprentices to discover why some things went right, and others went wrong by themselves through their group discussions. The instructor should focus his attention on lessons learned and illustrate the best way to deal with common errors throughout the simulation sessions in the future. Each apprentice will be asked to comment before the instructor summarizes and ends up the session. The relationship across the maritime simulation complex between instructors and apprentices should be considered as a relationship between professionals. As debriefings are beneficial, apprentices have to have their liberty to express and admit for errors without fear of penalties which lies under their unintended failures during the training session and that eventually will lead to level up their confidence. (Board, 1996) Advantages of group discussions shall include: -

1- The apprentice learns to justify his statements.
2- The apprentice learns to systematize his thoughts.
3- The discussion is stimulating critical thoughts.

Throughout any group discussions, the instructor should be away from (Board, 1996):-

1- Misdirection of group discussions.
2- Time consuming in the discussions.
3- Session domination by a few apprentices.
4- Hostility among apprentices.

3.1.4 The Kirkpatrick Model

In general, it is a way and a process for the evaluation scheme that had been effectively utilized in an array of training and educational environments then has become an industry standard in the maritime simulation training. Also, it is an evaluation system in which it is
upholding the idea of arranging proofs to make arguments valid. Although, its basic structure has not been changed, it has been modified over the time. Levels of such model are looking over a gradation of evaluations queries; each level is providing specific information that has a direct impact on the next level. The figure below shows the four levels of evaluation in Kirkpatrick’s model. (Bewley & O’Neil, 2013)

![Kirkpatrick’s Four Levels of Evaluation](http://knowbyart.com/welcome/wp-content/uploads/2013/07/4-levels-of-evaluation.jpg)

Figure 4: Kirkpatrick Evaluation Model

The evaluation process is performed at each level of the model. It starts from Level #1 and transitioning towards the upper level respectively. Each level supplies the proof for a valid argument and a datum that supports the simultaneous interpretation of the results at the following level. For instance, if there wasn't any proof for the maritime apprentice who is learning within Level #2, the responses at Level #1 tells why apprentices couldn't be stimulated to learn from the assigned scenario in the maritime simulation bridge. Level’s
difficulty rises up as you transit towards the next level. However, the information's value also increases at each level. (Bewley & O'Neil, 2013)

Kirkpatrick recommends performing the evaluation process at all levels. However, in practical exercises, both difficulty and costs are increasing at each level, especially Level #3 and Level #4 might be more difficult in the real work environment, it might be stopped at Level #2 or sometimes at Level #1, but he contends the effect of misalignment of measures to goals on validity. For instance, if the objective of the maritime simulation training is to transfer the knowledge and skills to performance on the job, it is required to go to Level #3 for a valid evaluation. On the other hand, if the aim was to evaluate a maritime training facility, a Level #4 of the evaluation process is indeed required. (Bewley & O'Neil, 2013)

3.2 Hardware

3.2.1 The Rationale for Using Simulators

The simulator denotes to the hardware or the device that is generating the simulation effects. In addition, it refers to the representation of actual or operational conditions. Furthermore, it can be formalized into scenarios that used for teaching, illustrating maritime aspects and performance assessment. The training scenario is a specific simulation with a specific target. The theoretic rationale for the usage of simulators for training purposes is depending on the notion of skill proficiency transfer in which it is the ability to adapt the skills gained in one context to execute the performance in another. It is known that skills gained in a classroom will be utilized effectively in pertinent cases outside of it. In fact, the apprentice will become skillful with the recurrence of a similar task attests to the fact of knowledge transfer. (Board, 1996)

In order to ensure that all training objectives are achieved, it will be appropriate to supplement the learning scheme with apprenticeships to boost learning. Traditional teaching through lecture rooms has been an effective and influential method for teaching theory.
Teaching methods are usually included the instructor, an overhead projector, whiteboard and videos to expand training targets. With the insertion of simulation technology to the curricula, the instructor can easily and effectively fill up the gaps between theory and application. He has the capability to create an interactive environments where he and the apprentices actively participating in a demonstration applying their theories to a real environment. (Board, 1996)

3.2.2 Types of Maritime Simulators

Generally, any complex or dynamic process is appropriate to be simulated. In the training of seafaring skills, there are diverse areas in which they are obviously where both elements are present. Maritime Simulation training began as radar and ship handling simulation for the reason of the complexity. Then the new radar equipment is created, and there was a need to research vessel movements in an economic way. However, in principal, any complex or dynamic maritime operation has to be mastered, particularly the ones that are invisible and remote, for example, pumping in/out cargo or ballast waters, are holding high opportunity for modeling, thus, training by means of a simulator. (Cross, 2011)

The most well-known maritime simulators are the Radar and Ship-handling simulators, However, there are other types of activities and equipment have become models for a maritime training simulator scheme in which they are updated and installed in many maritime simulations complexes around the world, (Cross, 2011) they are as the following:

1- Navigational equipment simulator.
2- Communication procedures and GMDSS simulator.
3- Radar and navigation simulator.
4- Ship and cargo handling simulator with/without motion.
5- Inland waterways simulator.
6- Dynamic Positioning Simulator (DP).
7- Crane handling simulator.
8- Vessel Traffic Services management simulator (VTS).
9- Search And Rescue management simulator (SAR).
10- Oil spill management simulator (MARPOL & SOPEP).
11- Propulsion plant simulator.
12- Electrical power plant simulator.
13- Refrigeration plant simulator.
14- Ballast control simulator.
15- Dredging ship simulator.
16- Offshore process simulator.
17- Drilling technologies simulator.

This list is not including all simulators currently present in the maritime simulation complex industry. As the technology develops and advances, new systems are created with a certain regularity, from both shipping industry and the simulation techniques and its technology.

3.2.3 Classification of Maritime Simulators

The physical environment that transfers the learning outcomes is consisting of hardware, software, conditions simulated and the resulting interactive displays. The capabilities of the physical environments are varied amongst the maritime simulators. However, the highly structured environment of aircraft simulators within the commercial sector, with its clear definition of classifications and technical standards, the commercial maritime industry just develops the standard terminologies for describing its simulators. (Board, 1996)

Hence, Nowadays, the training in maritime simulators is becoming very conventional and the international maritime community demands and requirements will prescribe and highly recommend a maritime simulator as an effective training tool towards acquiring and
assess the competencies. However, to assess these competencies, the training objectives should be well-described. In addition to this, adequate and proper maritime training tools have to be identified. In fact, there are differences in the maritime simulation training systems. Thus, their relevance to the training objectives is considerable to the furthest degree. There is, indeed, a necessity to sub-divisions the maritime simulation systems. (Cross, 2011)

A various number of proposals have been put forward by various groups the Subject Matter Experts (SME). The IMO had gathered consultants as an advisory input to the development of technical standards for simulators that will supplement the STCW '95 convention's revision and its guidelines, in which it also contains a team of SME’s to have a focused look into maritime simulation classes. (Cross, 2011) These SME’s are a combination of the maritime community, the International Marine Simulator Forum (IMSF), an organization of simulator facility operators and the International Maritime Lecturers Association (IMLA), an international professional organization of marine educators and trainers. (Board, 1996) In addition to this, the IMSF had set up a working team who is putting an effort in order to find and attain an accepted and idealistic classification system. Furthermore, some of the IMO's member states have submitted proposals regarding the classification schedules. Then, finally, initiatives from a classification society has actually resulted in a functional method and practical outcomes. The classification society Det Norske Veritas (DNV) from Norway, found an advantageous way to develop a new standard for the maritime simulation training tools which has recently been revised and updated under (DNV, 2000, 2007, 2010) In this recent set of standards preceding tasks and ideas are taken into consideration and reference made to varied teams within the maritime simulation community around the world. (Cross, 2011)

The simulator classification scheme has been suggested for the adoption by the IMO is used in this thesis for following up the consistency with the existing international
developments within the maritime industry. As a matter of fact, the maritime simulators are classified into four major categories as shown in the following table. (Board, 1996)

Table 1: The Four Main Categories of the Maritime Simulators

This information has been adapted and quoted from (Board, 1996)

<table>
<thead>
<tr>
<th>CATEGORY NO.</th>
<th>TYPE</th>
<th>CAPABILITIES</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATEGORY I</td>
<td>Full-Mission</td>
<td>1- Simulating full visual navigation bridge operations, which have the capability to be appearing quite realistic.</td>
<td>Integrated Bridge Simulators (IBS) *(The trainee is inside a bridge mockup with actual bridge devices)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2- Operated in real-time.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3- Capable of advanced maneuvering in restricted waterways.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4- Pilotage training in restricted waterways.</td>
<td></td>
</tr>
<tr>
<td>CATEGORY II</td>
<td>Multi-Task</td>
<td>1- Simulating full capabilities as shown in Category I, but excluding capability of advanced restricted water maneuvering.</td>
<td>Integrated Bridge Simulators (IBS) *(The trainee is inside a bridge mockup with actual bridge devices)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2- Operated in real time.</td>
<td></td>
</tr>
<tr>
<td>CATEGORY NO.</td>
<td>TYPE</td>
<td>CAPABILITIES</td>
<td>EXAMPLES</td>
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</table>
| CATEGORY III | Limited Task | 1- Capable of simulating environments that include a limited instrument for navigation and collision avoidance scenarios. 2- Operated in real time. | 1- RADAR Simulator.  
2- Blind-Pilot simulator. *(The trainee is inside a bridge mockup with actual bridge devices)* |
| CATEGORY IV | Special Task | 1- Using computer graphics to simulate bird’s-eye view of the operational area. 2- Simulating specific Bridge devices with limited maneuvering navigational scenarios. 3- Providing highly focused practices for particular nautical information tasks |  
Computer-Based Training Simulator  
*(The trainee is outside a bridge mockup)* |


3.2.3.1 Computer Based Training Limitations

As a rule, desktop computers providing single workstation, in which it is designed to be used by an individual at a time, even though they are networked for training purposes. Apprentices are secluded from each other so that there is no interaction in that case with other bridge members or pilots. Apprentices can also be secluded from the instructor, explicitly if the training session is not being held at the training complex. The CBT environment, neither providing the same instructional and pedagogical insinuations nor the instructional supervision with a vessel-bridge simulator. (Board, 1996)

Both pedagogical and Instructional supervisions for CBT could be improved by positioning microcomputer simulation workstations in the laboratory and link all of them together to an instructor control station in which it has the capabilities for diagnosing apprentice's skills and outcomes during the training session. Fundamentally, this technique had been adopted by various manufacturers of maritime training software for Rules-Of-the-Road (ROR). In addition, providing diagnostics for each workstation will enhance the individual training concept. Nevertheless, it cannot substitute for apprentices-instructor debriefings, communications, and interactions. (Board, 1996)

Microcomputer-simulators are providing an artificial training environment compared with the most recent and advanced generation of ship-bridge simulators. Substantially, there are different ways of motivating the human-performance as they are vastly various. These differences per se, do not show any meaning that CBT simulators are having a lack of the maritime simulator training values, but that the limitations of this kind of simulators need to be comprehended. There hasn't been found any information, inspecting that whether these differences are affecting the outcomes of the training. Obviously, the effectiveness of knowledge transfer for microcomputer-simulators is less developed than ship-bridge simulators. (Board, 1996)
The training environment of CBT simulators can be simplified via separating input devices to require movement from apprentices, the participation of individuals in the simulator and including various monitors. Different training system developers and companies had innovated and improved training software and entry devices that mimics certain nautical simulation systems for training purposes, such as RADAR and GMDSS’s. The abilities of such systems approach small-scale and limited-task simulators. (Board, 1996)

3.2.3.2 A Glance about Engine Room Simulator

It is extremely important to make sure that the safety and work efficiency is implemented on board vessels by a full-scale training for marine engineers. For example, but not limited to, the L-3 DPA Engine Room Simulator is innovated by L-3 DPA as they are leaders who supply solutions for human performance. Therefore, they are supplying the MSC’s around the world by training simulators for engineers who are serving on board vessels, from basic to advanced levels with a full compliance with the requirements provided by the STCW code and the IMO Model Course 2.07. (L3, 2013)
The engine simulator includes the propulsion, electrical and auxiliary systems that enable the marine engineers to adapt with recent vessel's engine room layouts and with all types of diesel engines. As a matter of fact, more than 80% of maritime accidents are caused by human error factor. Therefore, training through maritime engine room simulators provides the marine engineer apprentices the capability to learn more about and to interact with different scenarios which might be critical in the real situations onboard vessels and this type of training will mitigate serious consequences that in some circumstances lead to environmental disasters and loss of lives. (L3, 2013)
Extensive training done by using engine room maritime simulators has a fringe
benefit leads to (L3, 2013):

1- Specialized crew training (individual).
2- Specialized crew training (team).
3- Increase the level of safety at seas.
4- Lower Running Costs.
5- Experience In operating and deal with different marine propulsion systems.
6- STCW code certification for engine room officers.
7- Better evaluation of competencies that required by marine industry companies.

The engine-room maritime simulator software is based on a carefully designed structure
that allows the simulator to be easily maintained and expanded to keep tracking the evolution
and advancement in both maritime technology and its legislation. This software can be
configured as a single system which has the capability to operate independently in a single
PC, or conjunction with the other components (networked) in a lecture-room or as a FMBS complete with real controls. So, it is really important to figure out the aims of the engine-room simulator training by the engine-room apprentices, (L3, 2013) as the following points:

1. The role of main and emergency propulsion system controls.
2. Pre-preparations of machinery and engines for full operation after “cold ship.” situations.
3. The operation of the propulsion system during maneuvering at sea and while docked in ports.
4. The operation of propulsion system during several unforeseen situations.
5. Troubleshooting.
6. The safe operation of the systems during routine and emergency situations.
7. The effective use of power plant for utmost safety.
8. Achieving building teams, leadership, social responsibility on board ship, especially within the engine-room and better decision making.

https://www.link.com/media/datasheets/DPA_Maritime_Engine_Room.pdf
Figure 7: CBT for Engine-room training (Class-room)
Nevertheless, this type of simulators is certainly designed to re-create the real-world situations, and this includes (L3, 2013):

1- Visualization and presentation systems for displaying scenarios are more pragmatic, stimulus for interaction and to expand the cognitive decision making.

2- Train and create extensive drills for maritime engineers with a full scale of capabilities from the basic to advanced levels.

3- Simple procedures for scenario editing, cognitive and intuitive system's interface allows the instructors to create and control time-based scenarios.

4- Over more than two hundred engine-room simulated fault cases testimonials.

https://www.link.com/media/datasheets/DPA_Maritime_Engine_Room.pdf
Figure 8: Engine-room simulator

3.2.3.3 A Glance about Fire-Fighting Simulator

Essentially, shipboard firefighting simulators are particularly designed for maritime firefighting training for both decks and engine departments. The use of real fire training in a pragmatic scenario, providing maritime apprentices the skills and trials of real smoke, heat
and dealing with several types of fire in a flooding situation while they are actually performing shipboard firefighting tactics. (RMA, 2015)

http://www.resolveacademy.com/our-facilities/tv-gray-manatee/
Figure 9: A symbolic picture for fire-fighting simulator at RMA

Frequently, the maritime fire-fighting training is held with a well-coordinated. Thus, there is a huge demand for shipping companies that its vessels sails through international waters to have and learn various tactics and strategies to deal with different types of fire onboard vessels. For instance, but not limited to, The Port Manatee (FL) Fire Brigade is handling this necessity of a specialized fire-fighting mechanisms for contingency situations that may happen within maritime environments. (THORNTON, 2003)

The fire-fighting simulator is invented to provide a real life situation as when it is onboard a ship. Port Manatee, located in Manatee County, Florida. This port had gradually grown to become the 5th largest Florida's fourteen deep-water ports and accommodated more than 1,100 vessels in the year 2002. The different types of products handled within the port claim that the firefighters have to be fully trained and capable of handling a huge number of contingencies. (THORNTON, 2003)
They have built this simulator from leftover materials of the port projects. It consists of two cargo containers, one of them is 40 FEU, and the other is 20 TEU. They worked several months to put the simulator in this shape as seen below. (THORNTON, 2003)
Built-in features of the firefighting simulator are including three floors with stairs and hatches. It is also fitted with a water sprinkler system, alarm panel, standpipes, and an International Shore Connection (ISC). The construction includes two escape trunks with hatches and a rescue hatch aid in making the atmosphere a rescue officer may face during a shipboard operation. (THORNTON, 2003)

Figure 12: Inner stairs and hatches

Figure 13: International Shore Connection
Various bulkheads with watertight doors are located throughout the construction of the simulator. The bottom floor doubles in order to create an atmosphere as found in real vessel's engine room. The second floor is designed by a multi-movable walls to create a confined space situations. In addition, this level provided by a movable gangway. It can be easily moved and relocated to the bow or stern, depending on the given scenario. The third floor consists of the wheelhouse that includes the control panel of the sprinkler system. (THORNTON, 2003)

They have constructed in the external part of the Navigational Bridge the pilot's wings. In addition, there is a hatch leads to the bridge at the very top part of this simulator. Every hatch is hedged with handrails. Furthermore, all open areas on each floor of this simulator are installed with handrails. For extra safety precautions, ventilation doors, emergency exits, and exhaust stacks were built-up to prevent personnel injuries who are using the simulator for training purposes. In a live-fire training, spotters are used to ensuring the safety of trainees by leading them to the nearest emergency exit. Communication is really important, on a certain signal, the whole simulator structure can be drained of smoke and gasses in a period not exceeding a minute. (THORNTON, 2003)


Figure 14: Pilot's Wings
A 48-hour training course was formed especially for that facility in marine firefighting. The course combined lecture-room instruction with tours of real vessels docked at Port Manatee and some live-fire scenarios in the simulator. The instructors ask the trainees for two textbooks which published by the International Fire Service Training Association (IFSTA). These books are devoted to the study of fire different types onboard vessels. The first textbook is, Marine Fire Fighting, published in 2000, was directed at vessel crew members which contain an explanation of vessel construction, systems, and various types of cargoes, etc., (THORNTON, 2003)

On the other hand, the second textbook is, Marine Fire Fighting for Land-Based Firefighters, was published 2001. Both textbooks are resulted from five years of work by the IFSTA Marine Fire Fighting Committee, which compiled information outlined in the National Fire Protection Association (NFPA) 1405. (THORNTON, 2003)

Even though the trainees spent a long time to study those textbooks, the simulator was an integral part of the trainee's hands-on training. It's pragmatic construction and several features give the firefighters the feeling of what might be the shipboard emergency. Scenarios are designed to mimic various numbers of possible hazards that might face the crew members during shipboard incidents. Other scenarios in accordance with what is likely or achievable, in particular, it includes a confined-space rescues, rappelling operations, high-rise rescue situations, and hazardous materials emergencies. The firefighting simulation training possibilities is enormous because the simulator can be adapted to various hazards and situations as required by maritime shipping company's needs. (THORNTON, 2003)

3.3 Quality Measures

3.3.1 Elements of Maritime Simulator Training Quality

STCW convention founded a recent method to approach the job of seafarers. They found that instead of certify the maritime personnel on the basis of the knowledge they
gained, the new scheme is looking at the skills which is desired from a personnel and it is described as a grade of competence to be executed. Some SMEs are calling this method the functional approach and it's been utilized in the revised STCW Convention in order to give an extensive breakdown list of the competencies, and these are needed from the maritime personnel, at a certain grade, within a specific function group. These competences are mandatory and are listed in tables under the STCW '95 Convention Part A. (Cross, 2011)

The DNV as a classification society made an effective effort in order to help in the outgrowth and the refinement of maritime training simulation business, by means of setting, inserting, implementing and asserting the rules for the classification of maritime simulation and training complexes. The fulfillment of such rules will create a framework to be followed up by an assigned external party in which they have to ensure that both the global standard levels is executed and the internal procedures are initialized to make staff members aware of the need to inspect and document their way of rational, reflective thinking and operational work. Nevertheless, this will lead also to accredit that complex by several classification societies and the International Standardization Organization (ISO) in which that eventually leads to the total quality improvement and assurance and to award this complex with an ISO certificate. (Cross, 2011)

3.3.2 Simulation Validity

The maritime simulators are tools fitted for the purpose of the learning process. Therefore, the requirements to measure the effectiveness to use it to reach the optimum learning targets is considered valid as it is with any other instrument made for similar aims. (Cross, 2011) They vary amongst maritime training facilities. (Board, 1996) To find out the efficiency of a maritime simulation training session is commonly being the final step in the maritime training process. The process of assessing this efficiency is called Validation. (Cross, 2011)
Validation is defined as the process of evaluating particular features of a maritime simulator versus a set of prearranged criteria. In general, to assess maritime simulators validity is including the consideration of two different elements, accuracy, and fidelity. Where fidelity is describing the degree of realism between the simulated situation (scenario) and real operation. On the other hand, accuracy is describing the degree of appropriateness and rightness of the maritime simulation, with a deep focus on the ship's track, location of the aids to navigation and other critical navigational signs to enhance the safety degree. (Board, 1996)

Validation procedures differ, but at least limits it has to include both approval and inspection of the contents of the training program, methods, facilities, the entry qualification of maritime apprentices, the degree of qualified simulator instructors and the assessment devices. (Cross, 2011)

3.3.3 Simulation Reliability

Reliability is depending on and relates to the consistency. It necessitates that the outcomes have to be consistent from one measurement to another. For example, different times with different tasks. Also, It necessitates that the evaluation method is providing same outcomes whenever it is used. Thus, this will be achieved only by means of the usage of clear and typical procedures along with an ideal instrument of measurement. (Bewley & O'Neil, 2013)

In general, is not possible to have the perfect consistency for the reason that most people are not completely consistent. Maritime Simulation users might have learned and might forget things, or they have exposed to different rates of stress at different intervals. Evaluators might not accept the interpretations of all judgment criteria, as their criteria may change over time. Assigned tasks vary in difficulty levels for different users in which it depends on the previous practices. These factors introduce the measurement error into the
evaluation outcomes. Therefore, the greater the consistency of outcomes, the smaller the measurement error, and thus the greater the reliability. (Bewley & O'Neil, 2013)

The usage of evaluators will introduce some errors, beside the characteristics of the maritime simulation users, tasks given and other factors such as the time of day. The theory of Generalizability is designed to identify the origin of errors and appraisement of behavioral measurement contribution. Error origins are generally called facets. To evaluate the reliability, the generalizability study is used to estimate each facet contribution and the interaction between them. Then, the decision study is used to determine the elements of a measurement procedure that will decrease the amount of errors. For instance, the usage of generalizability theory to determine how many judges needed in order to make reliable assessments of maritime simulation apprentice's performance. If judges varied in their interpretation of the criteria, more judges are needed to obtain more accuracy. (Bewley & O'Neil, 2013)

3.3.4 The Evaluation and Assessment in Maritime Simulation Training

In most of the training fields, both terms assessment and evaluation are used to refer to each other. But specifically when we are talking about the studies in the field of maritime simulation training, these terms represent a tightened definition. Whereas, Evaluation applied to the formal and informal reviews of maritime simulation training practice results. For instance, the input is the training program, and the output is the evaluation. In this context, evaluation is nothing but an element of the instructional design process. (Board, 1996)

On the other hand, the Assessment is only used in the licensing and certification process situations. Thus, Assessment is the testing of competency versus particular criteria used for licensing or certification. The input is the formal test of competence against a list of standardized criteria. The output is the assessment, either objective or subjective. This use of more-tighten defined terminologies extends to the terms Instructors and Evaluators in the
context of maritime training programs and Assessors in the context of maritime licensing and certification. (Board, 1996)

There are several forms of evaluation and assessment within the maritime simulation field. Performance evaluations for maritime apprentices may be formal or informal, objective or subjective and/or both at the same time. Performance assessments for licensing candidates, which conducted in the maritime simulation environment are constantly formal. The first type is Informal Evaluations as it is considered to be the common type of evaluation. This type of evaluation is routinely conducted as an integrated part of the maritime simulation-based training courses. Typically, it is conducted on an ad-hoc basis, and it is usually not written. The common form of it is the undocumented debriefing of an exercise by an instructor. It is used to adjust exercise's content, duration and to guide apprentices to achieve the well-planned learning objectives. (Board, 1996)

3.3.5 Maritime Simulation Training's Assessment Criteria

To evaluate skills, performance and the outcomes of the maritime apprentices, there should be a set of basic standards and criteria in which it is indeed required to measure their achievements. However, it is absolutely necessary to set these criteria's values, but as a matter of fact, this process is complex and needs huge time. Several factors will influence the criteria's values, and they might change in time. In addition, criteria for specific phenomena are possibly different for the varied levels of simulation training. The criteria's values to be applied can be obtained from previous experience of the assessor, average results of previous apprentices, the required examination levels, international standard values, etc. It is recommended that the actual monitoring and assessment of parameters versus criteria's values is best done online by the computer of the simulator, as this process will eventually lead to immediate evaluation. Recently, these systems are now available through the maritime simulation training industry, and it is extremely important to have such assessment
and evaluation systems contained as part of a maritime simulator. The development of this type of evaluation system is really essential to confirm the quality level while utilizing maritime simulators for training purposes, to elevate the performance levels and to mitigate the acuteness costs. (Cross, 2011)

Furthermore, the IMO and it's parties on their conference number STCW/CONF.2/34 which had been held in the 3rd August 2010 in Manila as the Manila Amendments to the Seafarers’ Training, Certification and Watchkeeping (STCW) Code took place, they have stated in part 2 of resolution 2 under the assessment procedures, the assessors shall ensure that (The International Maritime Organization, 2010b):

1- Assessment criteria are specified obviously and available to the candidates.

2- Assessment criteria are established distinctly in order to ensure the reliability and consistency of the assessment procedure.

3- To make the best and the most effective use of objective measurement and evaluation, and mitigate the usage of the subjective judgments.

4- The candidates are clearly briefed on the tasks to be assessed, tasks and performance criteria in which their competency will be decided.

5- Assessment of performance takes into account normal operating procedures and any behavioral interaction with other candidates on the simulator and simulator staff.

6- Scoring procedures for assessing the performance of the candidates are used with caution until they are validated.

7- The major criterion is that the candidate is demonstrating the ability to carry out a task safely and effectively in order to achieve assessor's satisfaction.
3.3.6 Quality Policy

Towards demonstrating distinctly the commitments to the delivery of quality education and training through MSCs, the top management is obliged to ensure that an adequate and suitable quality policy is documented, communicated, and implemented at all levels of the complex. However, this kind of policy should focus on maritime education and training service delivery and the top management’s approach for guiding the decision making involved in the continual improvement of educational and maritime simulation training procedures. (ABS, 2013) The quality policy must address the following minimal criterion:

1- Customer satisfaction achievement.

2- Setting and reviewing quality targets.

3- Commitments to quality management and continual improvement processes.

This policy has to be fully aware of and understood by all staff of the complex, because they are impacting the quality of the acceptance and maritime simulation training monitoring. The top management which leads the maritime simulation complex shall sign the quality policy, and they have to ensure it's continued appropriateness. (ABS, 2013)

3.3.7 Quality Standards

The ABS recommends that the overall Quality Standards have to be applied to both levels of activity, the operation, and management. In addition, the management level of a maritime simulation training complex should have in their considerations how the system is managed, organized and evaluated in which that will lead to the achievement of the identified goals (ABS, 2013) and the coherent acknowledgement by accrediting and/or quality standards authorities. (The International Maritime Organization, 2010b). On the other hand, it recommends that the quality management system coverage of the academic and administrative, organizational structure of a maritime simulation complex, responsibilities, procedures, staff and devices are to be distinctly defined. (ABS, 2013)
Furthermore, quality control functions applied to teaching, training, examination, and evaluation activities should be distinctly defined (ABS, 2013) in order to ensure their suitability for their purposes and the fulfillment of their defined goals. The quality management functions in which it determines the quality policy relates to the aspects of the task which affects the quality of what is provided, including supplies for determining progression of a maritime simulation course. (The International Maritime Organization, 2010b)

3.3.8 Quality Commitment

The MSC has to show a proof of institution commitment to the operation of a quality complex. The commitment of top management is considered to be critical towards the success of the quality management. The extent of the elements in a quality management system in a maritime simulation training complex is based on the goals, techniques and managerial skills and practices unique to a complex. This commitment has to be demonstrated by establishing a quality management system that complies with the requirements of the ABS-guide for certification of maritime education facilities and training courses. Maritime Simulation complexes that are ISO 9001 quality management system certified already demonstrated this commitment, and proof of ISO 9001 certification is satisfying this requirement. (ABS, 2013)

3.3.9 Quality Manual

According to the ABS-guide for certification of maritime education facilities and training courses, the documented quality manual shall:

1- Mention and illustrate the extent of the maritime simulation training complex, quality management system and interactions between the core and support processes. (ABS, 2013)
2- Include all references to all usable and applicable documented steps of procedures which the quality management system is basically based on. (ABS, 2013)

3- Include terms, definitions and conditions required by the complex, applicable laws and regulations, accreditation and certification programs. (ABS, 2013)

3.3.10 Documentation

The maritime simulation complex has to maintain and ensure all needful documentation for the internal management control in which it identifies various procedures that promote the fulfillment of the predefined policies and objectives. This type of documentation should include at least the (ABS, 2013):

1- Quality Policy statements.
2- Quality Manual and Objectives.
3- Organizational hierarchy structure and responsibilities.
4- Any records required by statutory, regulatory, and accreditation parties.
5- Needful procedures for effective planning, management, and control of the maritime simulation training, education and improvement processes.

3.3.11 The Transfer Of Maritime Simulation Knowledge

The usage of maritime simulators to educate nautical apprentices highly relies on the assumptions of transferring this intricate type of knowledge. For instance, skills learned from the lectures can truly be applied to relevant cases outside the classroom. In earlier studies, it's been demonstrated that there was an obvious effectiveness of the maritime simulators as a tool to instruct apprentices for a wide range of maritime navigational skills and the transferability of the gained skills to the real world. (Board, 1996)

For further illustration, in the Caorf study, in order to evaluate the equivalence of diversity of simulator experience to maritime simulator applicable skills, a number of nautical apprentices with different grades of skills should participate. A set of apprentices were
compared of who have had sea experience and some had not. After applying maritime simulation training that specific group they scored better than the group with only sea experience. It has also been admitted to other researchers and studies that apprentices who had longer maritime simulation training scored better than the other groups. (Cross, 2011)

As a result, there is an obvious effect of maritime simulation training in the improvement of apprentices skills. In addition, this study resulted that maritime training using advanced simulators will enhance the sea training and providing a powerful base to prepare the future apprentices for effectual sea training. (Cross, 2011)

3.3.12 Quality Standard System

Different maritime classification societies are considered as QSS organization. They are reviewing and approving a wide range of STCW training on behalf of the US Coast Guard (e.g. ABS). (ABS, 2013)

3.3.13 Management Responsibility

3.3.13.1 Management Commitment

Higher management in any maritime simulation complex shall furnish a proof of its commitments to their progress in the implementation of the quality management system and its continual development as the following (ABS, 2013):

1- To make communications to the organization for the importance of meeting customer, statutory and regulatory requirements.

2- To establish a quality policy.

3- To establish quality objectives in order to realize the goals of the quality policy.

4- To consider the future goals of the organization, by taking into consideration core competencies, strategic challenges, and advantages.

5- To promote ethical behaviors.
6- To create an environment for organizational performance amelioration and leadership.

3.3.13.2 Internal Communication

Higher management in any maritime simulation complex should set up and implement effective processes for communicating any issue, which relates to the effectiveness of the training quality management system, such as objectives, requirements, policies and achievements. In addition, they have to encourage communication, feedback from personnel in order to involve them and to confirm that communication is executed at various organizational levels and departments. (ABS, 2013)

3.3.13.3 Responsible Person

Higher management in any maritime simulation complex should designate a Responsible Person (RP) as he acts as its representative for the training facility, to confirm that the requirements are implemented and maintained in an ideal manner. The RP shall provide reports and communicate with apprentices and management on issues related to the training quality management system. There might be one or more RP(s) designated, provided their respective tasks and duties are distinctly spelled out. The RP(s) shall also serve as a link with the certifying and accreditation parties. (ABS, 2013)

3.3.13.4 Customer Focus

The higher management at any maritime simulation complex must ensure that the requirements of the nautical apprentices are specified and are met with the goals of promoting customer satisfaction. Methods of listening to and capturing the voice of apprentices and other stakeholders shall be established. (ABS, 2013)

3.3.13.5 Functions and Responsibility

The higher management at any maritime simulation complex should distinctly describe its organizational hierarchy structure, they should put a concentration on the
processes in which it supports the development of the training quality management system, as well as the organization’s goals. This must include the responsibility for each functional area of the employee who is involved in the quality management system processes, especially those that affect the quality type of the provided services. These employees who manage and carry out jobs that affect the quality monitoring function should be identified, and appropriate authority has to be delegated to these individuals in order to allow them to find, record, and resolve issues within their responsibility framework. (ABS, 2013)

3.4 Human Factors

3.4.1 Instructor Requirements

According to the guidelines described in Resolution 2 of the Conference for The Manila Amendments to the Seafarers’ Training, Certification and Watchkeeping (STCW) Code, which has been held on August 3rd, 2010, that each higher management who's responsible for the running of maritime simulation complex must ensure that instructors are qualified for particular types of maritime simulation training and assessment of competence of seafarers, as officially compulsory under the STCW Convention. (The International Maritime Organization, 2010b)

The higher management also has to have and look after as a part of the quality system, a list of all authorized instructors who are serving in the complex. In addition, to identify the modules of each maritime simulation training course that they are qualified to educate effectively. (ABS, 2013)

3.4.1.1 General Knowledge

The authorized instructor must have an operational experience and another experience on practical assessment for certain type of maritime simulator being used and to receive proper guidance for the instructional techniques on the usage of such type of simulators. These techniques are used to process and show the development of simulated scenarios which
have specific assessment aims in order to measure the apprentice’s performance. (ABS, 2013)

3.4.1.2 Subject Matter Related Knowledge

The maritime simulation instructor must have at least the same qualifications as the nautical apprentices he will educate. This level of qualifications will prove to send the message thoroughly. However, in fact, this will not always be possible. The more specialized the training, the more difficult it will be to have these instructors holding the same qualifications as the apprentices. (Cross, 2011)

3.4.1.3 Experience

The higher management at any maritime simulation complex must keep a description of experience and qualifications for each authorized instructor, to prove that they are capable to deliver the courses and assess the apprentices adequately to what's being taught. (ABS, 2013) Each instructor the following records shall be maintained:

1- Certificate of successful completion of a “train-the-trainer” course based upon IMO Model course 6.09.

2- An endorsed resume by the training facility Responsible Person detailing experience, qualifications, and training courses completed.

3- Letter of acceptance by the training facility as an instructor for certain courses.

It is really important to have the skills required from any instructor to prepare lessons, transfer knowledge that relates to people in maritime simulation training field. (Cross, 2011) The required skills and experiences are gained by different methods:

1- Appropriate educational teacher training from methodical teachers training institute.

2- Maritime Simulator instructor course.

3- Previous instructional experience using simulators.
3.4.1.4 Motivation

Instructor's enthusiasm for the designed maritime simulation training program, exercises (scenarios) and equipment (simulation devices) are together considered as one critical element towards the success of a course. He must recognize the importance of the training and transfer this to his apprentices. Any instructor who doesn't believe strongly in the importance of instruction and its various methodologies can hardly be taken seriously by his apprentices. (Cross, 2011)

3.4.2 Instructor’s Guide

3.4.2.1 Scope

Generally, the instructor’s guide is prepared to meet the requirements of (USCG) Navigation and Vessel Inspection Circular NO. 6-97 and familiarization with Guidelines to Assessors (used in conjunction) with the National Assessment Guidelines. (Training Unlimited Group, 2012)

3.4.2.2 Objectives

1- Familiarization with concepts on how to formulate and conduct maritime simulation courses.
2- To develop a maritime simulation-based learning.
3- To develop a maritime simulation-based exercises and scenarios.
4- Document a maritime simulation-based lesson plan.
5- List instructor attributes.
6- Brief a maritime simulation-based exercise.
7- Run a maritime simulation-based exercise.
8- Debrief a maritime simulation-based exercise.
9- Discuss the different limitations of maritime simulators.
10- Discuss the usage of the maritime simulator for assessments.

3.4.2.3 Entry Standards

Trainee instructors should be either qualified Officers In Charge of the Navigational Watch (OICNW) or Engineer Officers of the Watch (EOW), or equivalent and have simulator training and/or evaluation duties assigned to them. They should already have the technical knowledge and to be qualified for the task for which the maritime simulation training is to be conducted. For instance, trainee instructors who are teaching marine navigation using bridge simulators will have had experience as deck officers, while those who wants to teach marine engineering using simulators should be qualified marine engineers. This course and guide assumes that the trainee instructors are qualified in the technical aspects of their subjects. (Training Unlimited Group, 2012)

3.4.2.4 Class Size

The maximum class size for classroom lessons is nine students. (Training Unlimited Group, 2012)

3.4.2.5 Student/Teacher Ratio

There will be nine students to one teacher (9:1). When more than the instructor is present, the course will be run by the designated lead instructor who will sign the certificates and direct the activities of assisting instructors. (Training Unlimited Group, 2012)

3.4.2.6 Course Equipment

1- Maritime Simulator (Bridge, engine, communications, cargo, or radar).
2- Whiteboard.
3- a Laptop computer.
4- Portable LCD projector.
5- Portable projector screen.
6- Pad of paper, pencil, highlighter and name board for each student.

3.4.2.7 Teaching Aids

1- Visual aids: A Power-Point presentation. (Training Unlimited Group, 2012)

2- Textbooks: The textbooks will be a U.S. Coast Guard Academy Simulator Instructor Course Interactive Note-Taking Guide (INTG). (Training Unlimited Group, 2012)

* For more information and details on how the instructor’s guide looks like and to know more about its contents please visit http://www.etuginc.com/
4.1 Introduction

This chapter describes and examines several characteristics of the MSBT performed through three different MSC’s located in Fort Lauderdale in the State of Florida, USA. These complexes work as an effective hub for other states and worldwide maritime facilities by sharing ideas and experiences specifically for simulation training and other maritime affairs. In order to gain useful information about the operation of such facilities and the instruction that they provide, these MSC’s were studied via questionnaire. Such insights could indicate standards or success criteria for potential training facilities in other settings.

4.2 Background

4.2.1 (Resolve Maritime Academy – RMA)

Resolve Maritime Academy (RMA) was established twenty years ago to provide safety and emergency response training to meet the demands of the maritime industry at the time.
As the maritime industry demands change from time to time in order to increase the level of safety and environmental protection, RMA has expanded their complexes and added maritime simulation courses for supporting the massive requirements of their cruise line clients. They are in the process of improving new courses on a persistent basis, and they are modifying these special courses in order to suit their clients’ demands. Although the cruise line industry is considered to be their primary clients, they also serve the offshore, oil & gas and yacht sectors. (RMA, 2015)
Figure 16: Lecture room at RMA

Figure 17: Transas Global ECDIS Training Network at RMA
Their MSC contains a Transas ERS 5000, Engine Room Simulator with models for conventional vessels, diesel electric and slow / medium speed plants. The ERS 5000 is linked to the main bridge simulator, which is a Transas NT Pro 5000 Class-A Full Mission Bridge, enables combined bridge and engine room training with numerous options for a wide range of courses. Moreover, they have recently built a two-story wet trainer who provides real experience for the Stability Damage Control course. They have future plans to add an additional 7,000 square feet of space for the current 15,500 square feet, as well as provide firefighting and safety training sessions to the civilian firefighting departments, yachts and marinas. (RMA, 2015)
Figure 19: Engine-Room simulator at RMA


Figure 20: Firefighting Simulator at RMA’s Port Everglades Location

4.2.2 (Maritime Professional Training - MPT)

MPT is located in Fort Lauderdale, Florida, a few minutes away from Port Everglades. Their institute is considered the most complete full-service maritime training school in the USA and has been training maritime apprentices from different sectors of the maritime industry since 1983.
Their campus has over 45,000 square feet of lecture rooms, deck and engine training labs, ship's stores, and student service facilities. Their effective and special maritime training courses take place at the SMART Simulation Center that they have run for 11 years, with the Marine Tech Shipboard Fire Fighting Site, and the Sea Survival Training Facility. An important distinction between their different facilities is that they own and run a fleet of training vessels. (MPT, 2015)
Over three decades, MPT has trained a high number of commercial mariners and yachting officers. This has qualified them to improve their courses that are success oriented, and efficient with regard to cost and time. This success shows that they have a staff of
dedicated, licensed maritime affairs professionals who care about maritime apprentices, as to ensure that each of them is successfully trained with the required skills that enable them to work safely and efficiently on-board vessels. (MPT, 2015)
In addition, MPT offers all maritime certification levels, licenses, and document study courses that are approved and recognized by the USCG and several foreign maritime administrations. Their maritime training courses are carefully designed to meet the IMO standards and are compliant with the guidelines of the STCW convention. Their clients include commercial shipping companies, marine corporations, the military, vessel management firms, the world's super yachts, and a tremendous number of maritime individuals. (MPT, 2015)

4.2.3 (Simulation, Training, Assessment, and Research Center - STAR)

The Star Center is a maritime training institute in which it is one of the best options ocean-going commercial mariners and port administrators worldwide. Originally, the Institute had been established in 1983 in Toledo, Ohio. Then in 1986, they expand this type of maritime training business to their current location located at Dania Beach, Florida to consolidate all courses and advanced training in October 2008. (STAR, 2015)
Furthermore, in 1993, STAR Center went through a comprehensive development of their leading complex. They installed a number of simulators, including the world's first 360° FMBS in addition to a 270° field of view bridge simulator, a Dynamic Positioning Simulator (DP), slow speed diesel engine room simulators, the world's first Full Mission Diesel Electric simulator, Liquid Cargo Simulator, LNG Simulator, Radar/ARPA simulators, ECDIS simulators, and GMDSS simulators. (STAR, 2015)
Figure 29: 360° FMBS Console's inner view

https://www.star-center.com/images/galleryphotos/360-1-800x489.jpg

Figure 30: 360° FMBS Chart-Room inner view

https://www.star-center.com/images/galleryphotos/360-2-800x489.jpg
Figure 31: 270° field of view bridge simulator

Figure 32: Lecture room for DP simulators
Figure 33: DP simulator’s console

Figure 34: Engine room simulator
STAR Center has recently been offering more USCG and different other approved courses more than any other maritime simulation center. Their courses meet and are recognized by the USCG, STCW convention, and IMO requirements. Also, they have a wide range of special courses that are prepared carefully by their curriculum development team that aim to meet global maritime companies’ specific training requirements and other affairs of maritime skills. (STAR, 2015)

Then in 1999 they upgraded their 360° bridge simulator with Sperry 2100 IBS. In this upgrade, they equipped the SIMRAD Dynamic Positioning control system, and this state-of-the-art technology is fitted onboard most modern vessels in the world. (STAR, 2015)

They are dedicated to furnishing top quality instruction at competitive prices. Their maritime courses are well-tailored to commercial mariners’ training demands and fully integrated with ISM code and policies required by any maritime parties around the world. Also, the center features in-house modeling capabilities for port improvements, vessel response models, and research. (STAR, 2015)
Figure 36: Vessels Modeling & Research at STAR Center

Figure 37: Ports Modeling & Research at STAR Center
4.3 Methodology

Two methods of study were utilized in order to collect information for this thesis. This chapter will address the first method, a survey / questionnaire, which was created to gain vital information from the selected complexes. These surveys were created in a PDF document and sent to each SME individually, taking into account giving SME’s free time to answer it carefully and send it back. Qualitative data analysis was used to organize data from responses. Each questionnaire was organized and categorized into three groups of questions in order to make the interviewee’s analysis more topic focused, and to make it easier for each SME to answer the questionnaire. The first group of questions focused on the SME’s operations and instruction, while the second group focused on training and certification, and the last pertained to quality management. To learn more about this survey, please proceed to APPENDIX-C.

The second method was conducted via face-to-face and telephone interviews based on the availability of the SME and their congested schedule. There are eight questions in these interviews which came from the perspectives of Dr. J.Peter Kincaid, Graduate Research Professor and Graduate Program Director at the Institute for Simulation and Training, which is located at the University of Central Florida. These findings are presented in Chapter 5. To know more about these questions, please proceed and see APPENDIX-C.

4.4 Results

This section illustrates and investigates the outcomes of the conducted case study in order to determine different relationships between these complexes. The results are categorized into three different groups as is follows and constructed for the surveys/questionnaires. These groups is operational, maritime simulation training & certification and quality management.
4.4.1 Operational

Questions in this section were oriented toward numerical aspects of operation and instruction, including the frequency of simulator use per month, and the number of permanent staff and apprentices. Concerning operation history, RMA reported a history of 2 to 5 years of active training, with MPT reporting 10 to 12 years, and STAR Center reporting 5 to 7 years. Common simulation product providers from each participant included TRANSAS, KONGSBERG, and others, as detailed in figure 38 below, along with other common providers.

![Figure 38: Maritime products utilized](image)

RMA reported using simulation products to train nautical apprentices 60-80 times per month, in a facility with a total of 40 weekly operational training hours. MPT reported using simulation products 15 times per month with over 40 weekly operational training hours, and STAR Center reported using simulation products 20 times per month with more than 40
weekly operational training hours. All SMEs reported the intermittent use of facilities during weekends.

The SMEs were also questioned about their navigation equipment present at their simulation facilities. They reported a multitude of common ground, offering emergency and survival training, ship handling and navigation, and more. Specific navigation equipment used by each participant is detailed in figure 39 below.

![Figure 39: Navigational equipment by simulation complex](image)

The maximum number of apprentices able to use these types of navigational equipment ranged between four and 15 apprentices at a time for RMA, and between five and seven apprentices for both MPT and STAR Center’s equipment. In total, MPT and STAR Center reported training a total of 10936 and 2000 apprentices per calendar year, with RMA reporting more than 500, as seen in figure 40. To train these apprentices, the number of permanent staff members and training experts serving in simulation complexes for RMA, MPT, and STAR Center were 30, 20, and 40, respectively.
Furthermore, with the data provided from this section of the questionnaire, some additional facts were interpolated. Table 1 was created using data from responses regarding the frequency of simulation use and the number of apprentices trained by each SME. The number of apprentices trained per month, the number of apprentices participating in training activities, hours spent in training sessions, and a yearly number of training sessions were calculated from questionnaire responses. These calculations are only approximate, particularly due to RMA’s approximation provided for their number of trained apprentices per year. When asked about maritime references, MPT and STAR Center responded by stating that they possess a maritime library for their facilities while RMA reported that they didn’t.
4.4.2 Maritime Simulation Training & Certification

This portion of the questionnaire focused on certification and training and also explored sources of funding and the duration of these programs. The SMEs were asked to describe the likelihood of their continued position in the maritime simulation community, on a scale from 1 to 5, with 1 being “very unlikely”, 2 being “somewhat unlikely”, 3 being “neutral”, 4 being “somewhat likely”, and 5 being “very likely”. MPT and STAR Center responded with “very likely”, and RMA did not provide an answer. The SMEs were also asked to detail any financial support received from foreign governments, international bodies, and ship-owners or other organizations to fund their training programs. STAR Center was the only participant who responded as receiving financial support, specifying that they received

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<th>RMA</th>
<th>MPT</th>
<th>STAR Center</th>
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<td>8.33</td>
</tr>
<tr>
<td><strong>Hours spent per product use</strong></td>
<td>2.29</td>
<td>10.67</td>
<td>8.00</td>
</tr>
<tr>
<td><strong>Number of training instances per year</strong></td>
<td>33.33</td>
<td>1822.67</td>
<td>333.33</td>
</tr>
</tbody>
</table>

Table 2: Interpolated data from questionnaires
such funding from shipping companies who held contracts with the American Maritime Officers Union. When asked about certifications that each complex offered to maritime apprentices, each SME detailed certifications and licenses ranging from Yacht licenses to high seas and coastal types. These results are further detailed in figure 41.

Figure 41: Certificates and licenses offered

4.4.3 Quality Management

This section posed some free-response questions and “yes” or “no” questions toward the SMEs, to gain more insight on the quality management of their programs. SMEs were first asked for their suggestions for improving products or services provided by maritime simulation companies that they frequently dealt with. RMA responded by stating that since the maritime simulation industry is still adapting to new technological tools, no improvements could be made to products or services and that suppliers are currently ahead of current training. MPT responded by stating that services should be more oriented toward
simulation and that facilities could improve by reducing time spent in classrooms and increasing time spent in these simulators. STAR Center responded by stating that their needs for products had always been met with among some of the suppliers they have worked most closely with, including Kongsberg and TRANSAS.

The SMEs were additionally asked how the shipping industry participates in their simulation complexes. STAR Center responded by stating that they were funded via their affiliate’s contracts. Their affiliate, the American Maritime Officers Union, provides trained officers to shipping companies, which in turn fund the operation of the STAR Center through a Safety and Education Plan. MPT responded by stating that a variety of apprentices has trained in their facilities, including shipping companies, offshore corporations, the military, super yachts, and others. They also mentioned the involvement of their SMART Center in forensic modeling to recreate shipping accidents for investigations. RMA did not provide a response.

All SMEs reported that they offer refreshment training and updating for their academic staff, through a variety of ways. RMA reported that they offer workshops and courses for instructors, but didn’t specify how frequently. MPT elaborated by stating that their “Train-The-Trainer” training must be refreshed every five years and that they maintain licenses according to Florida’s state requirements. STAR Center responded by stating that they provide such training to their staff to maintain their credentials with the USCG, and they also provide specialized training to their staff in some cases. All respondents cited the DNV as an auditor for their Quality Standard System. When asked about ISO awards, MPT and STAR Center reported that they were accredited with ISO 9001, as detailed in figure 42.
All SMEs responded that they were in compliance with STCW’95, and currently follow their guidelines. STAR Center reported that they have been in compliance with SCTW’95 since 2000 and are currently implementing STCW 2010. MPT also reported that they were working on becoming compliant with STCW 2010 guidelines by 2017.

4.5 Discussion

Qualitative data from the operations portion of the questionnaire provided some insight to the capacity of each SME and what their instruction looks like on a weekly, monthly, and yearly basis. Based on the calculations from data in Table 2, MPT and STAR Center see approximately 911 and 167 apprentices per month, where training / simulation products are used 15 and 30 times per month, respectively. RMA reported more than 500
apprentices per year so that no accurate estimate can be made on a monthly basis with this data alone. Based on how many apprentices are able to use navigational equipment per instance in each facility, there must be at least 1823 instances of apprentice training at MPT every year, and 334 at STAR Center. While comparing the high number of apprentices and training instances at MPT to their number of employees, their capacity for apprentices appears to be much higher than RMA and STAR Center, despite having the lowest report number of permanent employees. MPT’s business model was elaborated upon during their interview, where it was revealed that they also have a compliment of 60 temporary adjuncts.

The data from the survey revealed that each school has unique characteristics, and while they all have common characteristics, each school specializes their facilities to serve their needs. MPT offers the highest number of certifications polled, which indicates they are able to instruct a wide range of maritime apprentices seeking different certifications at varying levels. STAR Center possesses more types of navigational equipment at their maritime simulation complex for their specialized purposes. RMA reported using their products up to 70 times per month, indicating a high frequency-of-use of certain products in their facilities.

4.6 Conclusions

Data collected from the questionnaire allowed each MSC to be characterized, to understand better how they operate and how their facilities suit their needs. With different purposes, these MSCs use different business strategies, equipment, and instruction to accomplish their objectives.

While the Resolve Maritime Group has been in the maritime industry for many years, their simulation facilities at their academy are relatively young. RMA has facilities that are equipped with simulators that are specifically tailored to shipboard safety and bridge navigation. RMA utilizes their products often during a monthly period, and since they
specialize in shipboard safety and bridge navigation, they do not have to maintain all of the services that a typical academy would offer. Even though RMA caters to a smaller group of mariners, they maintain compliance with STCW and other standards that other top companies are held to, and they are still growing.

MPT is one of the most complete maritime facilities in the United States and has the facility space and equipment needed to train over 10,000 apprentices per year. In addition to owning training vessels, their SMART center helps provide training to a wide variety of clients, the majority of whom are commercial businesses. Despite having a small permanent staff, they maintain more temporary structures and adjuncts to support full-time instructors. This allows MPT to operate more efficiently with their large size. This business strategy also allows them to maintain competitive prices, which can make them an option for students seeking certifications at any level.

STAR Center has recently been expanding their curriculum and accepting different types of students, but traditionally they are defined by their relation to their AMO trustees. As a not-for-profit trust, they provide training for commercial businesses that contract the AMO. In turn, these businesses fund the STAR Center’s operations. Staffed by full-time instructors, technicians, and specialists, STAR Center is able to tailor their simulators in-house for their client’s needs and possess the widest variety of polled simulators.
CHAPTER 5:
THE FUTURE OF THE MARITIME SIMULATION TRAINING

5.1 Introduction

This chapter highlights different perspectives by SME’s from the three visited complexes and their vision towards the future of maritime simulation training. This information is gathered from the Face-to-Face and Telephone Interviews. Excerpts from the interviews are provided, highlighting insightful moments from the interviews conducted with the SME’s.

5.2 RMA SME’s Perspectives for Maritime Simulation Future

According to a telephone interview made on March 13th, 2015 by using a digital voice recorder with Mr. Dave Boldt, manager, RMA Simulator Center, he mentioned vital information and facts about the shipping industry and the future of the maritime simulation centers especially the centers located in the state of Florida. Mr. Dave said “The interesting thing with maritime schools is while some of them are certainly located at traditional maritime centers; the industry is such that we have people coming to places like Jacksonville, Wyoming and Oklahoma and Winnipeg Canada. These guys are all over the place, so the location is not that critical now. We are branching to dynamic positioning and more training for the offshore market for supply vessels and that type of thing, and the first a lot of people are questioning why we would do that in Fort Lauderdale, and there is not a supply vessel within several hundreds of miles of here. And again it doesn’t matter, these guys their companies based in New Orleans and they live anywhere in the lower 48. So, I think that in general the market is booming. I think even though the simulation is not yet mandated. When you go to these conferences and these trades shows and things like that it seems to be very clear that there is almost nobody else there that does not think it is a good idea. It is widely accepted that doing this type of thing makes for a safer fleet, and safer fleet saves you money
in the long run, that’s why they gonna spend money on training. I hope that ten years from now we are at least looking at the onset of the mandatory simulation training. I’m not gonna hold my breath, but I really hope that’s the way we are going I know that there a lot of applicants for that. There are a lot of MTSP so that’s really trying to boost their profile on the marine side of their operation and, of course, they can’t mandate anything but they can certainly recommend marine ensures, P&I clubs if they are all pushing their clients to do more of this kind of thing. So, hopefully, it does become mandated and handled, and there is somebody who stands to gain from that but you know I really believe that the further we push towards the model of aviation where you have a mix of onboard training, simulator training and then the regular school lecture type training. Then you really expect to get towards a really efficient training system and really producing much higher quality manners.”

5.3 MPT SME’s Perspectives for Maritime Simulation Future

According to a telephone interview made on March 26th, 2015 by using a digital voice recorder with Captain. Al Stiles, Vice President of curriculum development at MPT, and Mrs. Joanne Louise, Administrator at curriculum development department at MPT. They provided vital information and significant facts about the shipping industry and the future of the maritime simulation centers especially the centers located in the state of Florida. They said “We see nothing but expansion. There is a major explosion of simulation training simply because there a lot for the new competencies that are required by the international training requirements can only be satisfied really in simulators because some of the things that in other words to demonstrate competence and being able to navigate nights, very few people have the opportunity to go up and navigate nights and advanced ship handling, for example, to demonstrate competencies in advanced ship handling and learning to pier or dock or getting underway there are limited opportunities for individuals to do that out in the real world. So for them to be able to demonstrate those competencies, they have to do it in the
simulators. The reason its limited opportunities is that first of all, most of the time the pilot or the master handling the ship won’t want to trust the ship to somebody - even the chief mate or somebody at the operational level so there are limited opportunities for those individuals to get signed off on those competencies. Whereas in simulation as you all know, if something goes wrong in the simulator you go “oops, okay” push the reset button, and everything’s okay. So within simulation when I teach my simulation training courses, one of the big points that I make is that in the simulators there’s really no harm no foul, you can try things that are different or whatever or dumb and demonstrate difficult competencies your very willing to risk. There may be some wounding of pride or something like that, but there’s always the reset button that you can restore the world to where you started. So just the sheer amount of competence that has to be demonstrated now, prior to 1995, as they say, licensing was the matter of accumulated sea time, and also written examinations. After 1995, the international rules of training required the demonstration of competence, and there are few ways you can demonstrate competence. And the Manila amendments in 2010 increased the amount competencies that had to be demonstrated, and I only envision them increasing in the future too. The next time the national maritime organization gets together to consider the licensing or training requirements for seafarers, I only envision they’re not going to cut back; they’re probably going to increase those training requirements, so really in the next 5 to 10 years we are going to be so busy -in the next 2 years just trying to meet the requirements that were instituted by the Manila amendments in 2010. All those Mariners have to meet a lot of the gap requirements by January 1st of 2017, we are busily writing courses to meet the gap requirements, and after that we have to focus on the new Mariners who began their training after the implementation date of the SCTW 2010 which was March 24th of last year, any mariner who began their training after the 24th of last year has to meet all the new 2010 requirements, not just the gap requirements, but all of the requirements, so again I’m looking
at probably – I can only guess at this point in time- but probably at least 2 dozen new courses that we’re going to have to write over the next year to implement some of these new requirements. So as I said I see nothing but expansion in the next 5 to 10 years.”

5.4 STAR SME’s Perspectives for Maritime Simulation Future

According to a Face-to-Face interview made on April 9th, 2015 by using a digital voice recorder with Captain. Brian D. Long, Director of STAR Center. He provided vital information and important facts about the shipping industry and the future of the maritime simulation centers especially the centers located in the state of Florida. He said, “This is a difficult question of course. There is as far as the industry goes, we’re concerned about a shortage of mariners, as an overall industry. That’s one of the reasons why we started this tech program on the engineering side; we’re not getting enough engineers into the American maritime officers union, and the ones that we are getting in, usually at about 7-10 years leave the industry. And we’ve found that the engineers that have come up through the hose pipe meaning not through the academy and time at sea and going through the coast guard and taking exams to increase their license, they tend to stay longer in the industry and make a full career out of it, so that’s why for the engineers, we’re trying to start this the program to grow our own engineers and have them stay at long amp term. So a lot of what we see is people coming through the academies, but not going to sea as a full career, or dropping our early. So that’s kind of as an industry why we’re a little concerned about that. As far as our facilities go, I see that we’re going to be busy –quite busy well into the future, and have an opportunity to grow, what I didn’t mention is the engineering labs over there, there’s a whole plot of land behind it, and we actually own all of that land, so we’re in a position to grow as STAR center, going forward to provide more training if needed. I made a couple of notes here: the other trend I’m seeing is assessments. If you look at my business card, STAR is an acronym, right? It’s simulation, which we’ve talked quite a bit about, training, which we’ve
talked quite a bit about, assessment which haven’t talked about, and research which we have talked about, so the assessment, which is part of our name, is a growing area. We’re having – and STAR Center has actually, we have a lot of experience in the area of assessment and specifically using simulators to assess mariners. Back in 1994, we had a program with the coast guard, where instead of some of the testing that you did at the coast guard, you could get your license through an assessment program on the simulator. That was again 1994, but since then we have done assessments for the Alaska pilots, every pilot in Alaska has had to, at the time, got through a formal assessment, we took a year to develop the program, and over the next 3 years we cycled through all the pilots, and it was kind of a navigational assessment of their skills, and now we have companies coming to us saying “ok well the coast guard and IMO want this, but we want an even higher level of proficiency” so we’ve worked with some other companies to set up assessment programs on the bridge side, navigational assessments, and now we’ve had inquiries on the engineering side. So as far as where we’re going in the next 5-10 years, I think we’ll see a lot more of simulators used for assessment, as they are of course used in aviation. You hear about that everything there’s an aviation accident, every 6 months the pilot needs to go and kind of get a check ride, so I see that happening mostly out of the industry, requiring it, and not right now IMO or SCTW doesn’t require, but some of the companies kind of want to take an extra step and do that, so that’s what I see. Let’s see what else I wrote here. One area- I just made a note of it- it has more to do with technology, but as far as simulation goes, there’s – I started here 22 years ago, and since then there’s been quite an expansion in simulators, because the prices come down as the technology has changed quite a bit. For instance, I mentioned the simulator on the 360 has 10 different images that we blend together, well each image need- and you guys may know already, but the computer we call the image generator, those used to cost about 50,000 dollars a channel each, now with the advent of gaming and so on, the graphics are accelerated to a point where
they’re so realistic, and the whole PC costs maybe 1,500 dollars for a high end, versus 50,000 dollars. But the projectors were – they’re quite expensive, but in my job previous to this, each project was a quarter of a million dollars, now they might be- for a nice high end projector, might be 20,000 dollars, so the whole price of the simulator comes down so that the trend in simulation now of course is flat panel displays for bridge simulators. It costs a lot more to do what were’ doing here, which is the forward projection. First off, you can see all of the real estate, all the room we need to – we’re taking up 2 decks and the screen is 10 meters in radius, so the forward projection costs a lot more money, but we feel that’ its’ a much better system- you might agree after your tour up there. That’s kind of insight on the technology side of life, we again, are still investing in forward projection, we think that’s a much more immersive technology in terms of really being in the simulation.”
CHAPTER 6: CONCLUSIONS & RECOMMENDATIONS

The implementation of simulation-based training, along with the development of simulation centers, is crucial for implementing safety management for the future of the maritime industry. The objective of maritime training has always been to increase safety and reduce the risk of maritime related accidents, in addition to increasing the efficiency of operating vessels through competently trained crewmembers. Organized international regulations have raised the standards for maritime safety and have become more inclusive, and will continue to do so well into the future. For many maritime companies, this means continually keeping up with maritime regulations and conventions, which can be more easily done through the mechanisms of educational software, which has become key to upgrading institutionalized training. This research presents several important conclusions for the development of maritime simulation in Kingdom of Saudi Arabia under the guidance of project established by King Abdul-Aziz University.

Simulation-based education is a benefit to apprentices and instructors alike. For instructors, it allows for the better implementation of specialized programs, meaning that instructors can pass along knowledge more easily by constructing specific scenarios that apprentices can train within a simulator. For apprentices, it becomes easier to adapt their training from virtual reality to real world conditions, without assuming the risks that accompany training shipside. Furthermore, simulation-based training can be more effective and efficient by creating structured lessons that implement specific scenarios, which one may or may not encounter when training on seagoing vessels. Training can also happen at a controlled pace, and scenarios can be revisited, or virtual reality training can be paused or turned back to offer instructors the ability to maximize learning.
An important key to the success of training programs is the effectiveness of the relationship between apprentices and instructors. Simulation-based training can better facilitate the sharing of experience between instructor and apprentice, by allowing the instructor to draw on their knowledge and implement it in software created from the same field of knowledge. Simulators are unique training tools, as they allow for the collaboration of multiple relevant fields within maritime training to participate in using knowledge to predict reality, and create learning tools that represent it. Hydrodynamicists, experienced crewmembers, and other subject matter experts representing the fields of knowledge from software and maritime operations can collaborate in simulation complexes to create learning tools. Some MSCs have the ability to create and tailor simulation programs and products in-house and have a high degree of mobility when it comes to instructing apprentices and specializing instruction.

While the collaboration of different professionals can clearly be beneficial for training, it cannot be easily done without sophisticated management and oversight, especially for larger facilities. Effective management structures must be in place to create curricula, programs, and quality standard systems which will allow for organized use of simulators and training in a complex. These complexes will increasingly rely on a diverse background of maritime professionals, to ensure that regulations are met for certifications offered at an MSC, and to ensure quality of training offered at every level. Therefore, in order to accomplish sophisticated and diverse training, larger facilities are becoming necessitated to house and run maritime simulation complexes.

The growth of maritime simulation has partly been fueled by its acceptance by STCW regulations and other maritime authorities in lieu of sea based training time. Since simulation time can be more effective through its use of structured scenarios, it has gained acceptance as a superior form of training, which has led to its growth in many maritime training complexes.
which seek to train students to updated standards. By being able to save time and money in
avoiding longer sea time, training facilities are incentivized to implement simulation based
training. As facilities begin to implement newer and more diverse simulation products, the
need to expand their facilities leads to larger training centers, and an increase in the use of
simulator products. As technology progressively becomes better in terms of graphics and
simulation, the value of simulation based training will only increase as virtual reality
becomes closer to real conditions.

Simulators which are already in use can hone in on specific skills when students are
trained at such facilities. While ship-handling simulators are among the most well-known
types of simulation, some MSCs also offer simulation for dynamic positioning, crane
handling, propulsion plants, drilling, and more. Navigation simulation makes use of advanced
technology, like the 270° field of view bridge simulators, and others also possess the ability
to coordinate with other simulators to realistically replicate the operations of a ship in tandem
with other on-board systems. The benefits of recreating reality without the real world costs of
operating vessels goes far beyond monetary value, as the quality.

This research offers insight to researchers and simulation centers alike by exploring
the current state of simulation based training and its future. It focuses on the operation of
maritime simulation complexes, drawing on knowledge from professionals within the field to
construct an understanding of simulation education’s increasing role in maritime training.
Conventions of the SCTW and the IMO were studied to explore the relationship of training
and simulation as determined by international standards, and maritime simulation complexes
themselves were studied to offer insight into how maritime training both responds to and
influences the regulations on maritime training. Ultimately these findings add to the body of
knowledge of maritime training which is working to increase maritime safety through better
training. When maritime accidents occur, a lack of training among particular officers or
crewmembers is often cited as a primary cause, in which cases there can be multiple problems. There could be a problem with instruction, such as facilities being unable to train for specific scenarios, or crucial aspects of it, such as learning collision regulations, or rules of the road, which may not developed effectively in a program’s curriculum. The studied MSCs are at the forefront of development and have experience with the simulators they have implemented for many years, and their operational management and quality standards are important aspects which can be studied for implementing new simulation complexes. In the future, it is likely that training effectiveness at many MSCs will rely on how different complexes share their success through knowledge in simulation and scenarios shared in digital libraries. Perhaps just as importantly, complexes can share their issues and management structures with each other, to help other developing complexes overcome challenges in developing their training program in addition to building a knowledge base for simulation. It is not enough to merely implement a simulator; the proper management structures must be in place to ensure that the training equipment is properly used, facilitated by a qualified instructor, and is part of a training program that maximizes the simulator’s benefit to students by ensuring quality of instruction.

Researchers who conduct further study on maritime simulation will always benefit from conducting some of the same methods presented in this thesis. Particularly, the review of current major or recent maritime facilities will provide researchers with perspective on the current state of maritime simulation, since simulation complexes can often act as a hub for activity when it comes to maritime training. As regulations change, simulation complexes will be aware of those changes, and will be on the forefront of creating new ways of training apprentices to meet new standards set forth by regulating bodies. Researchers would also do well to investigate current simulation products, assessing how they have improved over time, and identifying the needs that created those products. It will also be beneficial to study how
simulation based training is being made more mandatory, as future conventions will almost certainly utilize more frequently. For the time being, SCTW 2010 will be the standard for many MSCs to upgrade their training, and although these standards are relatively new, eventually newer standards will be released, almost certainly incorporating more regulation for simulation based training. These changes will need to be carefully studied and reviewed to understand the future of simulation products and training.

It is recommended that practitioners in the field of maritime simulation consider the benefits of improving their collaboration with other training facilities. Simulation centers could benefit by sharing training scenarios developed in simulators, which can be shared globally to train any apprentices in any part of the world. One way to accomplish this is by maintaining a full digital library of simulated training scenarios. Creating an accessible database of training content would not only allow instructors to offer more specialized training, but it would also allow students to access scenarios themselves, and enable their success in personalized training. In addition, the sharing of experiences and issues would further benefit collaborating MSCs, as sharing the knowledge to overcome problems in implementing training will assist newer MSCs to step into the world of maritime training, while assisting existing MSCs to upgrade their facilities to meet changing requirements.

Based on the research conducted in this thesis, it can be predicted that the integration of simulation in maritime training will continue to prove to be beneficial for learners, instructors, and mariners alike. As expensive equipment is increasingly implemented, there too should be an increased focus on familiarization provided to course apprentices. For their safety, and to avoid damaging devices, familiarization courses can help apprentices use training equipment safely and responsibly, to avoid higher maintenance costs. This process in itself may yet become just as important as simulation training in the future as simulation products become better and more wisely used. It may also become important for future
researchers to study the types of learning that take place in simulators and how learners use them, in order to design newer simulators. For instance, while new motion-based simulators are being developed, 360-degree projection-based simulators are more attractive due to several drawbacks with motion-based simulation. Motion based simulators are expensive to buy and set up compared to other products, and their advantages over projection simulation are yet to be clearly defined. Motion sickness is the primary drawback of motion-based simulation, due to the high quality of projected graphic images and moving environments. These drawbacks demonstrate that if care is not taken, better technology will not necessarily mean better training. It would, therefore, be recommended that the government of Saudi Arabia seek contracts with world leading companies specialized in advanced maritime simulation projectors to establish projection-based simulation. Currently, the Dean of Maritime Studies Faculty in Saudi Arabia is interested in seeing the use of 360-degree simulators for training, evaluation, and licensing of marine officers, as it will be the first application of such a simulator in the entire country. These simulators would benefit the MSC under construction as they have a high reliability and their ability to recreate designated scenarios would offer the high quality of training to apprentices that would be expected from the size of this new facility. Their use will allow familiarization and training for the use of similar equipment throughout the country, providing opportunities to trainers.

The research presented in this thesis has demonstrated that simulation-based training is a powerful educational tool, and it allows for a deeper relationship between instructor and apprentice. The future of maritime training will afford more opportunities for the use of simulation, and there is still potential for facilities to grow. The implementation of digital libraries could change the way that current maritime simulation centers work within their respective regions. Simulation centers could act as hubs of knowledge for a given country or continental region, by accessing knowledge from other centers, and offering collected
knowledge to those same centers. It is clear that simulation is changing the nature of maritime training and its relationship to mariners, and its adoption is becoming more streamlined for newer and existing MSCs alike, seeking to share experience and knowledge, for the ultimate goal of increasing safety aboard operating vessels, and promoting more developed competencies within trained mariners.
APPENDIX-A

Miscellaneous
Member States of the IMO

Currently, the IMO has (170) member states and three associate members. They are listed in the following table:-

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<td>Palau</td>
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<td>Panama</td>
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<td>Papua New Guinea</td>
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<td>Paraguay</td>
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<td>Peru</td>
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<td>Poland</td>
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<td>Portuguese</td>
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<td>Qatar</td>
<td>1977</td>
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<tr>
<td>The Republic of Korea</td>
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<tr>
<td>The Republic of Moldova</td>
<td>2001</td>
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<tr>
<td>Romania</td>
<td>1965</td>
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<td>Russian Federation</td>
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<td>Saint Kitts and Nevis</td>
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<tr>
<td>Saint Lucia</td>
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<td>Saint Vincent and the Grenadines</td>
<td>1981</td>
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<tr>
<td>Samoa</td>
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<tr>
<td>San Marino</td>
<td>2002</td>
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<td>Sao Tome and Principe</td>
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<td>Sudan</td>
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<td>Sweden</td>
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<td>Switzerland</td>
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<tr>
<td>The Syrian Arab Republic</td>
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<td>Thailand</td>
<td>1973</td>
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<tr>
<td>The former Yugoslav Republic of Macedonia</td>
<td>1993</td>
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<td>Timor-Leste</td>
<td>2005</td>
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<tr>
<td>Togo</td>
<td>1983</td>
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<tr>
<td>Tonga</td>
<td>2000</td>
</tr>
<tr>
<td>Trinidad and Tobago</td>
<td>1965</td>
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<tr>
<td>Tunisia</td>
<td>1963</td>
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<td>Turkey</td>
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<td>Tuvalu</td>
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<tr>
<td>Uganda</td>
<td>2009</td>
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<tr>
<td>Ukraine</td>
<td>1994</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>1980</td>
</tr>
<tr>
<td>United Kingdom of Great Britain and Northern Ireland</td>
<td>1949</td>
</tr>
<tr>
<td>United Republic of Tanzania</td>
<td>1974</td>
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<tr>
<td>United States of America</td>
<td>1950</td>
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<tr>
<td>Uruguay</td>
<td>1968</td>
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<tr>
<td>Vanuatu</td>
<td>1986</td>
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<tr>
<td>Venezuela (Bolivarian Republic of)</td>
<td>1975</td>
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<td>Viet Nam</td>
<td>1984</td>
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<tr>
<td>Yemen</td>
<td>1979</td>
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<td>Zimbabwe</td>
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**Associate Members:**

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<th>Country</th>
<th>Year</th>
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<td>Faroes</td>
<td>2002</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>1967</td>
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<tr>
<td>Macao, China</td>
<td>1990</td>
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</table>
List of Best Maritime Simulation Complexes (M.S.C) Around the World

Excluding the U.S. Facilities

**Table 4: International Maritime Simulation Complexes**

This information is adapted and quoted from different websites in which each simulation complex listed in this table is gained from its original website.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Complex Name</th>
<th>Address</th>
<th>Details</th>
</tr>
</thead>
</table>
| 1    | **The California Maritime Academy** | 200 Maritime Academy Drive Vallejo, CA 94590 | - Bridge Simulation  
- Multi-Team Simulation  
- Crisis Management  
- Diesel Simulation  
- GMDSS  
- Liquid & Gas Cargo  
- Oil Spill Simulation  
- Radar/ARPA/ECDIS  
- Steam Simulation  
- Research & Validation  
- Design Projects  
- Environmental Safety |
| 2    | **Maritime Simulation and Resource Centre** | 271 de l'Estuaire Street Suite 201 Quebec (Quebec) G1K 8S8 | - Bridge Simulation  
- Tug Simulation  
- Radar/ARPA/ECDIS  
- Crisis Management |
| 3    | **Maritime Simulation Institute (A part of the United States Maritime Resource Center)** | Newport 344 Aquidneck Avenue Middletown, RI 02842 | - Modeling & Simulation Of Maritime Operation  
- Simulation Research, Studies And New Ship Design Trials  
- Bridge Team Ergonomics & Mariner-Machine Interface  
- Port, Terminal, Waterway And Navigation Assessments |
<table>
<thead>
<tr>
<th>S.N.</th>
<th>Complex Name</th>
<th>Address</th>
<th>Details</th>
</tr>
</thead>
</table>
| 4    | Centre for Maritime Simulations / University of Tasmania / The Australian Maritime College | Australian Maritime College  
Maritime Way  
Newnham Tasmania  
7250  
Australia | • Integrated Marine Simulator (IMS)  
• Machinery Space Simulators  
• Tug Simulator/Reality Centre  
• Ship Handling Simulator |
| 5    | Center for Simulator Maritime Training                                       | Antennestraat 45,  
Almere  
The Netherlands          | • Providing High-Quality Maritime Simulation Training  
• Latest Simulation And Training Equipment  
• Research And Develop Training Courses For Maritime Simulation |
| 6    | Centre for Marine Simulation / Marine Institute of Memorial University of Newfoundland | Marine Institute  
P.O. Box 4920  
St. John's, NL Canada  
A1C 5R3 | • Full Mission Ship's Bridge Simulator  
• Lifeboat Launch Simulator  
• Tug Simulator  
• Dynamic Positioning Simulator  
• ECDIS Simulator  
• GMDSS Simulator, Etc. |
| 7    | Broome Maritime Simulation Centre / Kimberley Training Institute             | 68 Cable Beach Rd,  
BROOME WA 6725              | • Maritime Simulation Services for New and Existing Ports.  
• R&D For Simulators  
• Tug And Barge Operations  
• Emergency Procedure Training |
<table>
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<tr>
<th>S.N.</th>
<th>Complex Name</th>
<th>Address</th>
<th>Details</th>
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<td>8</td>
<td><strong>Fremantle Maritime Simulation Centre</strong></td>
<td>1 Pakenham Street, Fremantle, WA, 6160.</td>
<td>• Three Full Mission Bridges&lt;br&gt; • Marine Pilot Training&lt;br&gt; • Tug Master Training&lt;br&gt; • Ship Simulators For Port And Harbor Investigations&lt;br&gt; • Development Of Port Models For Use In Simulations&lt;br&gt; • Leasing Of Facilities To Partner Companies&lt;br&gt; • Specialist Ship’s Master Training</td>
</tr>
<tr>
<td>9</td>
<td><strong>Integrated Simulation Center / Maritime and Port Authority of Singapore</strong></td>
<td>Integrated Simulation Centre of Singapore Hub Port Cluster Maritime and Port Authority of Singapore 500 Dover Road (Next to Block T1A, Singapore Polytechnic) Singapore 139651</td>
<td>• 2 Full Mission Ship Handling Simulators&lt;br&gt; • Crisis Management Simulator&lt;br&gt; • ECDIS Simulator&lt;br&gt; • VTS Simulator&lt;br&gt; • Engine Room Simulator&lt;br&gt; • Liquid Cargo Handling Simulator&lt;br&gt; • GMDSS Simulator</td>
</tr>
<tr>
<td>10</td>
<td><strong>Marine Training Center / Hamburg</strong></td>
<td>Schnackenburgallee 149 22525 Hamburg</td>
<td>• Ship Handling Simulator&lt;br&gt; • Radar / ECDIS Simulator&lt;br&gt; • GMDSS Simulator&lt;br&gt; • Engine Simulator&lt;br&gt; • Liquid Cargo Simulator&lt;br&gt; • Dynamic Positioning Simulator&lt;br&gt; • Fire Fighting Simulators</td>
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U.S. Maritime Simulation Complexes with Category I and Category II Simulators

Table 5: US Maritime Simulation Complexes
This information is adapted and quoted from (Board, 1996)

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<th>Region</th>
<th>Location</th>
<th>Maritime Simulation Center</th>
</tr>
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<tr>
<td>North</td>
<td></td>
<td>1- Maine Maritime Academy, Castine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2- Massachusetts Maritime Academy, Buzzards Bay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3- Marine Safety International, Newport, Rhode Island</td>
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<tr>
<td></td>
<td></td>
<td>4- U.S. Merchant Marine Academy, Kings Point, New York</td>
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<tr>
<td></td>
<td></td>
<td>5- SUNY Maritime, Bronx, New York</td>
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<td></td>
<td></td>
<td>6- Seaman's Church Institute, New York</td>
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<tr>
<td></td>
<td></td>
<td>7- Maritime Institute of Technology and Graduate Studies, Linthicum Heights, Maryland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8- Harry Lundeberg School of Seamanship, Piney Point, Maryland</td>
</tr>
<tr>
<td>East Coast</td>
<td></td>
<td>1- STAR Center, Seattle, Washington</td>
</tr>
<tr>
<td>West Coast</td>
<td></td>
<td>2- Pacific Maritime Institute, Seattle, Washington</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3- California Maritime, San Francisco</td>
</tr>
<tr>
<td>Region</td>
<td>Location</td>
<td>Maritime Simulation Center</td>
</tr>
<tr>
<td>--------------</td>
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</tr>
<tr>
<td>South</td>
<td>East Coast</td>
<td>1- STAR Center, Dania Beach, Florida</td>
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<tr>
<td></td>
<td></td>
<td>2- Resolve Maritime Academy, Fort Lauderdale, Florida</td>
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<td></td>
<td>3- Maritime Professional Training, Fort Lauderdale, Florida</td>
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<td></td>
<td>West Coast</td>
<td>1- Marine Safety International, San Diego, California</td>
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<tr>
<td>Mid-Continent</td>
<td>Mid-Continent</td>
<td>1- U.S. Army Corps of Engineers, Vicksburg, Mississippi</td>
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<tr>
<td>Great Lakes</td>
<td>Great Lakes</td>
<td>1- Great Lakes Maritime Academy, Traverse City, Michigan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2- STAR Center, Toledo, Ohio</td>
</tr>
<tr>
<td>Gulf Coast</td>
<td>Gulf Coast</td>
<td>1- Texas Maritime, Galveston</td>
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</table>
## List of Best Maritime Simulation Technology Provider Companies

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<tr>
<th>Company</th>
<th>Key Information</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transas Marine Limited</td>
<td><strong>Headquarters, Cork, Ireland</strong>&lt;br&gt;Address: 10 Eastgate Avenue, Eastgate Business Park, Little Island, Cork, Ireland&lt;br&gt;View map&lt;br&gt;Phone: +353 21 4 710 400&lt;br&gt;Fax: +353 21 4 710 410&lt;br&gt;E-mail: <a href="mailto:info@transas.com">info@transas.com</a></td>
<td></td>
</tr>
<tr>
<td>Transas Americas Inc., Bothell, United States</td>
<td><strong>Address:</strong> 18912 North Creek Parkway, Suite 100, Bothell, WA 98011, USA&lt;br&gt;View map&lt;br&gt;Phone: +1 425 486 2100&lt;br&gt;Fax: +1 425 486 2112&lt;br&gt;E-mail: <a href="mailto:sales@transasusa.com">sales@transasusa.com</a></td>
<td></td>
</tr>
<tr>
<td>Transas Marine UK Ltd., Portsmouth, United Kingdom</td>
<td><strong>Address:</strong> Explorer 4, Voyager Park, Portfield Road, Portsmouth, Hampshire, PO3 5FL, United Kingdom&lt;br&gt;View map&lt;br&gt;Phone: +44 23 9267 4000&lt;br&gt;E-mail: <a href="mailto:tmuk.sales@transas.com">tmuk.sales@transas.com</a></td>
<td></td>
</tr>
<tr>
<td>Transas Latin America, Buenos Aires, Argentina</td>
<td><strong>Address:</strong> Domingo de Acassuso 1412, La Lucila, Buenos aires, Argentina&lt;br&gt;View map&lt;br&gt;Phone: +54 11 4790 8569&lt;br&gt;Fax: +54 11 4790 8569&lt;br&gt;E-mail: <a href="mailto:sales@transasusa.com">sales@transasusa.com</a></td>
<td></td>
</tr>
<tr>
<td>Transas Marine Pacific Pte Ltd., Singapore</td>
<td><strong>Address:</strong> Cyber Centre, 16/18 Jalan Kilang Barat, Singapore, 159358, Singapore&lt;br&gt;View map&lt;br&gt;Phone: +65 627 10 200&lt;br&gt;Fax: +65 627 10 300&lt;br&gt;E-mail: <a href="mailto:info.asia@transas.com">info.asia@transas.com</a></td>
<td></td>
</tr>
<tr>
<td>Transas Middle East, Dubai, United Arab Emirates</td>
<td><strong>Address:</strong> #120, Al Nasr Plaza, Oud Metha Road, Dubai, PO Box 117148, United Arab Emirates&lt;br&gt;View map&lt;br&gt;Phone: +97 14 357 3625&lt;br&gt;E-mail: <a href="mailto:tme@transas.com">tme@transas.com</a></td>
<td></td>
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</tbody>
</table>

1. Is the world’s leading manufacturer of systems for professional training and certification of sea specialists.
2. Have been used extensively by specialists in commercial fleets, navies, and coast guards.
3. More than 5,500 of its simulators are installed and operated in over 950 maritime training & simulation centers in 91 countries.
4. Holds 45% of the international commercial maritime simulation market.
5. Its simulators are developed in line with international maritime requirements (STCW, IMO model courses).
6. Hold certificates from leading classification societies.
<table>
<thead>
<tr>
<th>Company</th>
<th>Key Information</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> - Deliver systems for dynamic positioning and navigation, marine automation, safety management, cargo handling, subsea survey and construction, maritime simulation and training, and satellite positioning.</td>
<td><strong>Kongsberg Maritime, Headquarters, Norway</strong>&lt;br&gt;Address: Kirkegårdsveien 45&lt;br&gt;NO-3616 Kongsberg&lt;br&gt;Norway&lt;br&gt;Mailing address: P.O.Box 483, NO-3601 Kongsberg, Norway&lt;br&gt;Phone: +47 32 28 50 00&lt;br&gt;Web: <a href="http://www.km.kongsberg.com">www.km.kongsberg.com</a></td>
<td><strong>Kongsberg Maritime Simulation Inc., Groton, United States of America</strong>&lt;br&gt;Phone: +1 (709) 582-1112&lt;br&gt;Fax: +1 (709) 582-3769&lt;br&gt;E-mail: <a href="mailto:clayton.burry@km.kongsberg.com">clayton.burry@km.kongsberg.com</a>&lt;br&gt;Contact person: Clayton S. Burry</td>
</tr>
<tr>
<td><strong>2</strong> - Offer additional competence in providing turnkey engineering services within the shipbuilding and floating production sectors.</td>
<td><strong>Kongsberg Maritime Inc. - Training Department, New Orleans, United States of America</strong>&lt;br&gt;Address: 125 James Drive West Suite 150&lt;br&gt;St. Rose, LA 70087&lt;br&gt;United States of America</td>
<td><em>For more KONGSBERG contacts, please visit:</em> <a href="http://www.km.kongsberg.com">http://www.km.kongsberg.com</a></td>
</tr>
<tr>
<td><strong>3</strong> - Key markets are coastal countries with large offshore, shipyard and energy exploration &amp; production industries.</td>
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<td></td>
</tr>
<tr>
<td><strong>4</strong> - Provide sophisticated underwater, positioning technology and systems for survey vessel operation.</td>
<td></td>
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<tr>
<td><strong>5</strong> - Supply navigation, automation, training and safety simulation systems.</td>
<td></td>
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</tr>
<tr>
<td>Company</td>
<td>Key Information</td>
<td>Contact</td>
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</tr>
</tbody>
</table>
| NAUTIS | It has a new generation of maritime simulators for the civilian and military industries. | VSTEP World HQ  
Weena 598  
3012 CN Rotterdam  
The Netherlands  
Telephone: +31 (0)10 – 201 4520  
Fax: +31 (0)10 – 201 4522  
Mail: info@vstepsimulation.com  
Web: www.vstepsimulation.com |
<p>| NAUTIS | NAUTIS simulators fulfill training requirements and comply with the most updated international maritime standards and regulations. | |
| NAUTIS | Their simulator includes a full range of simulators, from computer-based trainer to full mission bridge. | |
| NAUTIS | Its simulators complies with the following international regulations: | |
| | • The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) | |
| | • IMO Model Courses | |
| | • Approved and Certified by DNV with class notation for Integrated Simulator System, Tug, HSC – to be compliant with the Class A the standard for certification of Maritime Simulator No.2.14 January 2011 and compliance with the requirements of the STCW Convention, Regulation I/12 | |</p>
<table>
<thead>
<tr>
<th>Company</th>
<th>Key Information</th>
<th>Contact</th>
</tr>
</thead>
</table>
| 1- Established in 1998 as a software house specializing in virtual reality in the marine simulation sector. | Europe Atlantic Offices  
John Carpenter House  
John Carpenter Street  
London EC4Y 0AN  
United Kingdom  
Tel: +44 207 936 6400 | |
| 2- Provides expertise in fast and high maneuvering boat simulation. | General Enquires  
navalsales@kable.co.uk | |
| 3- Develops its knowledge in this sector thanks to cooperation with navies, research institutes, shipyards and onboard systems manufacturers. | Editorial  
onlineditorial@kable.co.uk  
Marketing  
marketing@kable.co.uk | |
| 4- They Developed JTTS joint tactical theater simulation for military and civilian maritime industry and research, JTTS is a next-generation advanced naval scenario simulator. The simulator provides a wide-range of training scenarios and scalable software/hardware architecture, from desktop trainer to full mission bridge simulator with complete real scale mock-ups. | Asia Pacific Office  
Suite 1608, Exchange Tower Business Centre  
530 Little Collins Street, Melbourne  
3000, Victoria, Australia  
Tel: +61 3 99 097 757  
Fax +61 3 99 097 759 | |
| IBR Sistemi  
Via Luigi Canepa 7D/1  
Genova  
Italy  
Contact: Claudio Donato  
Tel: +39 010 803885  
Email: CLAUDIO@IBRSISTEMI.COM  
URL: www.ibrsistemi.com | |

*For more information about their simulators and software products, please visit: http://www.navaltechnology.com/contractors/simulators/ibr-sistemi/*
<table>
<thead>
<tr>
<th>Company</th>
<th>Key Information</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-3 D.P. Associates</td>
<td>L-3 DPA offers a suite of maritime training solutions, including instructional systems, mobile courseware design and training simulator products for bridge operations, port and harbor security systems, engine room operation and other maritime related applications.</td>
<td><strong>L-3 D.P. Associates</strong> 2961 West California Avenue Salt Lake City, UT 84104 USA Toll-Free (888) 259-4746 Main Line (801) 983-9900 Fax (801) 983-9901</td>
</tr>
</tbody>
</table>
| Display Systems | Using an integrated approach to improve human performance within any organization faces challenges in:  
*Improving employee productivity and safety and lowering operating costs.*  
*Meeting mandated state and federal training requirements.*  
*Educating new employees and training for existing staff.*  
*Gathering and analyzing workforce improvement.* | **Display Systems** 1355 Bluegrass Lakes Parkway Alpharetta, GA 30004 United States Phone: (770) 752-7000 |
| Dynamic Positioning & Control Systems | They are providing:  
Thorough analysis of training requirements, Individual Task and Skills Analysis, Classroom Curriculum Analysis and Design, Training effectiveness, and evaluation reviews, Learning center design and electronic classroom configuration. | **Dynamic Positioning & Control Systems** 12131 Community Road Poway, CA 92064 United States Phone: (858) 679-5500 |
<p>| Advanced Programs | | <strong>Advanced Programs</strong> 1 Wall Street Burlington, MA 01803 United States Phone: (781) 270-2100 |
| Link Simulation &amp; Training | | <strong>Link Simulation &amp; Training</strong> 2200 Arlington Downs Road Arlington, TX 76011 United States Phone: (817) 619-2000 |
| Mission Integration | | <strong>Mission Integration</strong> 10001 Jack Finney Blvd Greenville, TX 75402 United States Phone: (903) 455-3450 |
| Maritime Systems | | <strong>Maritime Systems</strong> 750 Miller Drive SE Leesburg, VA 20175 United States Phone: (703) 443-1700 |
| Middle East Operations | | <strong>Middle East Operations</strong> Marina Office Park, A40 P.O. Box 60846 Abu Dhabi UAE Phone: +971 635 9814 |</p>
<table>
<thead>
<tr>
<th>Company</th>
<th>Key Information</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- The Maritime Research Institute Netherlands was founded in 1929.</td>
<td>MARIN Main office, Wageningen</td>
<td>Visiting address 2, Haagsteeg 6708 PM Wageningen The Netherlands Postal address P.O. Box 28 6700 AA Wageningen The Netherlands Phone +31 317 49 39 11 Fax +31 317 49 32 45 E-mail <a href="mailto:info@marin.nl">info@marin.nl</a></td>
</tr>
<tr>
<td>2- As early as 1970, MARIN extended its activities to include nautical research and training.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3- The Maritime Simulation &amp; Software Group (MSG) provides MARIN’s simulators.</td>
<td>MARIN Ede (branch office)</td>
<td>Visiting address 20, Marconistraat 6716 AK Ede The Netherlands Postal address P.O. Box 28 6700 AA Wageningen The Netherlands Phone +31 317 49 39 11 Fax +31 317 49 32 45 E-mail <a href="mailto:info@marin.nl">info@marin.nl</a></td>
</tr>
<tr>
<td>4- MSG has a successful history in the development of (full-mission) bridge simulators in addition to the Vessel Traffic Service simulators.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5- The bridge simulators are based on the DNV certified Mermaid 500 software.</td>
<td>MARIN USA (branch office)</td>
<td>4203 Montrose Blvd. suite 460 Houston TX 77006 USA Phone +1 832 533 8036 E-mail <a href="mailto:usa@marin.nl">usa@marin.nl</a></td>
</tr>
<tr>
<td>6- The uniqueness of this software lies in the unrivaled high level of modeling that can be expected from a renowned model testing institute such as MARIN.</td>
<td></td>
<td></td>
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<tr>
<td>7- Being completely modular in set-up and configuration, this software package is used successfully in small, medium and large bridge simulators.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8- The VTS simulator is an ideal training tool for VTS-Operators in compliance with relevant IMO and IALA Guidelines.</td>
<td></td>
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</tbody>
</table>
APPENDIX-B

Examples for DNV Maritime Simulator Certificates
CERTIFICATE NO. A-11359
This Certificate consists of 2 pages

This is to certify that the
Electronic Logbook

with type designations
Navi Sailor 4000 ECDIS MFD/ Navi Sailor 4100 ECDIS MFD

Manufactured by
Transas Ltd.
CORK, Ireland

is found to comply with
IMO Res. A.916(22) Guidelines for the recording of events related to Navigation;
IMO Res. A.604(17) General requirements for shipborne radio equipment forming part of
the global maritime distress and safety system (GMDSS) and for electronic navigational
aids

Place and date
Havik, 2006-08-21

for NATORSKE VERITAS AS

Frode Bried,
Head of Section

This Certificate is valid until
2011-12-31

Arve Løvseth
Surveyor

DNV Gothenburg

http://www.transas.com/Media/TransasEng/ImageGalleries/News_17215/16410.jpg
Figure 43: DNV sample for type examination certificate (ECDIS)
http://www.oceansaver.com/images/certificate.jpg
Figure 44: DNV sample certificate for ballast water management system
Figure 45: DNV sample for integrated bridge operation simulator
Figure 46: DNV sample for dynamic positioning simulator
APPENDIX-C

Interview Materials
List of Interview Questions

1- Kindly sir, could you describe briefly your training facility?
2- What's making your training effective?
3- Please describe your business model and strategy.
4- Please describe your active staff who are running the facility.
5- Your approximate students per year.
6- Please, could you describe the progression of training captains and chief officers?
7- How do you categorize the people who are having training in the bridge simulators?
8- What do you see and anticipate in the next 5-10 years in the shipping industry and the future of the maritime simulation facilities? What major trends are driving these changes?
A Questionnaire/Survey For The Maritime Simulation Complexes In Florida State, U.S.A

Purpose of This Study: To gain vital information about the Maritime Simulation Complexes located around the USA especially the ones that are located in the state of Florida. In addition, after only qualitative studies being made from the provided answers of that questionnaire in which it is considered as a rough database, it will be used to build one of the most important chapters in my Thesis under the Case Study chapter. Furthermore, some of these results will be used to build the Methodology part of a peer reviewed publishable paper.

Questionnaire/Survey Guide: This questionnaire/survey is divided into 3 different groups of questions some of them are in the MCQ form and just 3 of them are open-ended questions and they are as the following:

Group #1: Operational (10 Questions)
Group #2: Maritime Simulation Training & Certification (3 Questions)
Group #3: Quality Management (11 Questions)

Duration: Around 20 minutes per participant

NOTE: Information gathered from this questionnaire is confidential, anonymous and will not be connected directly to your company/institute unless you give the permission to state the name of your company/institute obviously. Your company will only be identified in general broad ways (e.g., a large maritime simulation training company mostly serving the commercial maritime community...)

Copyright © 2015 by Yasser R. Saeed
All rights reserved.
Disclaimer: This Questionnaire or any portion thereof may not be reproduced or used in any manner whatsoever without the express written permission of the investigator.
Group #1: Operational

1- How long have you used your maritime simulation complex for training purposes?
   o Less than 2 years
   x 2 year to less than 5 years
   o 5 years to less than 10 years
   o 10 years or more? Please specify …………….. years

2- Which of the following maritime products do you use, please select all that applies?
   x TRANSAS
   o SEAGULL
   o KONGSBERG
   o NAUTIS
   o GARMIN
   o MARIN
   o KELVIN HUGHES
   o THOMAS GUNN
   o All above
   o None
   x Others? Please specify ………………..

3- Approximately, on a monthly bases, how many times do you use the simulation products selected above while you train the nautical apprentices?
   - Every week, most of our courses have reapv. 14-20 sim sessions.
   - So by individual training evolution it'd say 60-80 per month. We are at 50% capacity FYI (no evenings yet)
4- What are your simulation facility's operational weekly hours?
   - Less than 40 Hrs
   - 40 Hrs
   - More than 40 Hrs

5- Do you use the simulation products selected above in weekends?
   - Yes
   - No
   - Intermittently
   - Increasing, as with evenings.

6- What are the navigational equipment do use within your maritime simulation complex for the training scheme (please select all that apply)

- RADAR
- ARPA
- Navigational Aids
- Ship-handling
- GMDSS
- Cargo Handling
- Engine Room
- Training Vessels (operational or permanently anchored)
- Seamanship Laboratory
- CBT Laboratories
- Workshops for Basic Training
- Firefighting Simulation Centre
- Survival Techniques Training Centre
- Life Boat and Raft Launching Platform
- Fast Rescue Boat
- All above
- Others? Please specify ..................
7- For how many apprentices do you use navigational equipment selected above at a time?

- One apprentice
- Two to five apprentices
- Five to seven
- Eight or more

Course dependent. Min 4 max 16+

8- How many apprentices do you train in a calendar year?

- Less than 100 apprentices/year
- 100-200 apprentices/year
- 200-300 apprentices/year
- 300-400 apprentices/year
- 400-500 apprentices/year
- More than 500 apprentices/year? Please specify.... apprentices/year

9- Do you have a maritime library for a wide range of maritime references within your simulation complex?

- Yes
- No

10- How many employees and training experts do serve in your simulation complex?

- 30 employees and training experts
Group #2: Maritime Simulation Training & Certification

11- How likely do you think you are persisting in serving the maritime community with such training?
   - Very likely
   - Somewhat likely
   - Neutral
   - Somewhat unlikely
   - Very unlikely

12- Do you have any financial support, from Foreign Governments, International Bodies and Ship-owners or any other organization for the training purposes?
   - Yes
   - No
   - If Yes? Please Specify .........

13- What are the different types of certification do you offer for the maritime apprentices? Please select all that apply.
   - Ratings - Deck
   - Pre-sea/Foundation Training - Deck
   - Officer In-charge Navigational Watch (High Seas)
   - Chief Mate (High Seas)
   - Master (High Seas)
   - Officer In-charge Navigational Watch (near coastal voyage)
   - Chief Mate (near coastal voyage)
   - Master (near coastal voyage)
   - Pre-sea/Foundation Training - (Engineering)
   - Officers/In-charge Engineering Watch
   - Second Engineer (3000 kw or more)
Group #3: Quality Management

14. From your own experience/expertise, are there any suggestions for improving products/services provided by the maritime simulation companies that you frequently deal with in order to enhance the maritime training effectiveness?

No, suppliers are way ahead of current training. While it is great to keep getting advanced tools, the marine community is just starting to get the hang of the real power of these tools.

15. What is the Internal Management Structure of your simulation complex? Kindly, provide us with a PDF copy.

To be e-mailed to: captain.yasser@hotmail.com
16- Briefly, would you inform us how the shipping industry is participating with your simulation complex?

17- Is there any provision for the refreshment training and updating for the academic staff?
   - Yes
   - No
   - If Yes? Please specify

18- Is there any Quality Standard System (QSS) you are following within your facility?
   - Yes
   - No
   - If Yes? Please specify

19- From the previous question, if your response is “Yes”, are there any Auditing/Certifying Authorities for your QSS?
   - Yes
   - No
   - If Yes? Please specify
20- Is your facility awarded and/or approved by the ISO? If Yes, since when?
   - Yes, Since (   )
   - No

21- From the previous question, if your response is “Yes”, which of the following ISO award does your facility accredited with?
   - ISO 9000
   - ISO 9001
   - ISO 9004
   - ISO 19011
   - ISO 31000
   - ISO/IEC 31010
   - Others? Please specify .....................

22- Is your facility awarded and/or approved by the IMO? If Yes, since when?
   - Yes, Since (   )
   - No

23- Is your facility complying with and implementing the STCW’95 convention’s guidelines for training sessions?
   - Yes, Since (   )
   - No

24- Is your facility participates in the national/international certification process?
   - Yes
   - No

..................................................END OF QUESTIONNAIRE..................................................
Group #1: Operational

1- How long have you used your maritime simulation complex for training purposes?
   - Less than 2 years
   - 2 years to less than 5 years
   - 5 years to less than 10 years
   - 10 years or more? Please specify - 12 years

2- Which of the following maritime products do you use, please select all that applies?
   - TRANSAS
   - SEAGULL
   - KONGSBERG
   - NAUTIS
   - GARMIN
   - MARIN
   - KELVIN HUGHES
   - THOMAS GUNN
   - All above
   - None
   - Others? Please specify ……………..

3- Approximately, on a monthly bases, how many times do you use the simulation products selected above while you train the nautical apprentices?
   - 15 times/month
4- What are your simulation facility’s operational weekly hours?
   o Less than 40 Hrs
   o 40 Hrs
   x More than 40 Hrs

5- Do you use the simulation products selected above in weekends?
   x Yes
   o No

6- What are the navigational equipment do use within your maritime simulation complex for the training scheme (please select all that apply)
   x RADAR
   x ARPA
   x Navigational Aids
   x Ship-handling
   x GMDSS
   o Cargo Handling
   o Engine Room
   x Training Vessels (operational or permanently anchored)
   x Seamanship Laboratory
   x CBT Laboratories
   x Workshops for Basic Training
   x Firefighting Simulation Centre
   x Survival Techniques Training Centre
   x Life Boat and Raft Launching Platform
   x Fast Rescue Boat
   o All above
   x Others? Please specify: Cargo Handling and Engine simulation will be installed Summer of 2015.
7- For how many apprentices do you use navigational equipment selected above at a time?
   - One apprentice
   - Two to five apprentices
   - Five to seven (usually limited to no more than six)
   - Eight or more

8- How many apprentices do you train in a calendar year?
   - Less than 100 apprentices/year
   - 100-200 apprentices/year
   - 200-300 apprentices/year
   - 300-400 apprentices/year
   - 400-500 apprentices/year
   - More than 500 apprentices/year? Please specify…10,936 in Calendar Year 2014

9- Do you have a maritime library for a wide range of maritime references within your simulation complex?
   - Yes
   - No

10- How many employees and training experts do serve in your simulation complex?
    - 20 employees and training experts
Group #2: Maritime Simulation Training & Certification

11- How likely do you think you are persisting in serving the maritime community with such training?
   - Very likely
   - Somewhat likely
   - Neutral
   - Somewhat unlikely
   - Very unlikely

12- Do you have any financial support, from Foreign Governments, International Bodies and Ship-owners or any other organization for the training purposes?
   - Yes
   - No
   - If Yes? Please Specify ..........

13- What are the different types of certification do you offer for the maritime apprentices? Please select all that apply.
   - Ratings – Deck
   - Pre-sea/Foundation Training – Deck
   - Officer In-charge Navigational Watch (High Seas)
   - Chief Mate (High Seas)
   - Master (High Seas)
   - Officer In-charge Navigational Watch (near coastal voyage)
   - Chief Mate (near coastal voyage)
   - Master (near coastal voyage)
   - Pre-sea /Foundation Training - (Engineering)
   - Officer/In-charge Engineering Watch
× Second Engineer (3000 kw or more)
× Chief Engineer (3000 kw or more)
× Second Engineer (750-3000 kw)
× Chief Engineer (750-3000 kw)
× Others? Royal Yatching Association and UK MCA Yacht training

Group #3: Quality Management

14- From your own experience/expertise, are there any suggestions for improving products/services provided by the maritime simulation companies that you frequently deal with in order to enhance the maritime training effectiveness? The most frequent suggestion is to increase the amount of time spent on the simulators and reduce the time spent in the classroom.

15- What is the Internal Management Structure of your simulation complex? Kindly, provide us with a PDF copy. See attached.

To be e-mailed to: captain.yasser@hotmail.com

16- Briefly, would you inform us how the shipping industry is participating with your simulation complex? Thousands of Masters, Mates & Engineers have trained at MPT’s SMART (Simulation) Center. This includes passenger ship companies, shipping companies, harbor pilots, towing, offshore corporations, management firms, military sealift command, insurance companies, super yachts, as well as independent students from all over the world. There has also been extensive research projects for port development and familiarization training. Finally, the SMART Center has been used for forensic modeling to recreate ship accidents for accident investigations.
17- Is there any provision for the refreshment training and updating for the academic staff?

- Yes
- No
- If Yes? Please specify...

18- Is there any Quality Standard System (QSS) you are following within your facility?

- Yes
- No
- If Yes? Please specify...

19- From the previous question, if your response is “Yes”, are there any Auditing/Certifying Authorities for your QSS?

- Yes
- No
- If Yes? Please specify...

20- Is your facility awarded and/or approved by the ISO? If Yes, since when?

ISO does not approve anything. ISO is a Standardization Organization and they develop & publish standards. Certification bodies (i.e. ABS, DNV, Lloyd's) approve, award, and certify but MPT is ISO approved.

- Yes, by DNV since August 15, 2008
- No
21- From the previous question, if your response is “Yes”, which of the following ISO award does your facility accredited with?

- ISO 9000
- ISO 9001
- ISO 9004
- ISO 19011
- ISO 31000
- ISO/IEC 31010
- Others? Please specify …………………

22- Is your facility awarded and/or approved by the IMO? If Yes, since when?
Not applicable. IMO does not approve, award or certify facilities.

- Yes, Since ( )
- No

23- Is your facility complying with and implementing the STCW’95 convention’s guidelines for training sessions?

- Yes, Since 1997. We are working on implementing the STCW 2010 guidelines and will be compliant by January 1, 2017 (the deadline).
- No

24- Is your facility participates in the national/international certification process?

- Yes, MPT courses are certified by the United States Coast Guard (USCG), the United Kingdom Maritime and Coastguard Agency (MCA), the Marshall Islands (MI) and several other national authorities. There is no international certification process.
- No

…………………………………… END OF QUESTIONNAIRE ……………………………
Group #1: Operational

1- How long have you used your maritime simulation complex for training purposes?
   - Less than 2 years
   - 2 year to less than 5 years
   - 5 years to less than 10 years
   - 10 years or more? Please specify...years

2- Which of the following maritime products do you use, please select all that applies?
   - TRANSAS
   - SEAGULL
   - KONGSBERG
   - NAUTIS
   - GARMIN
   - MARIN
   - KELVIN HUGHES
   - THOMAS GUNN
   - All above
   - None
   - Others? Please specify...GMDES
   - MPRI Liquid Cargo

3- Approximately, on a monthly bases, how many times do you use the simulation products selected above while you train the nautical apprentices?
   - Every Day times/month
4- What are your simulation facility’s operational weekly hours?
   - Less than 40 Hrs
   - 40 Hrs
   - More than 40 Hrs Bridge simulators run 2 shifts a day

5- Do you use the simulation products selected above in weekends?
   - Yes Occasionally
   - No

6- What are the navigational equipment do use within your maritime simulation complex for the training scheme (please select all that apply)
   - RADAR
   - ARPA
   - Navigational Aids
   - Ship-handling
   - GMDSS
   - Cargo Handling
   - Engine Room
   - Training Vessels (operational or permanently anchored) Fast Rescue Boats Life boats
   - Seamanship Laboratory
   - CBT Laboratories
   - Workshops for Basic Training
   - Firefighting Simulation Centre 3rd Party
   - Survival Techniques Training Centre
   - Life Boat and Raft Launching Platform
   - Fast Rescue Boat
   - All above
   - Others? Please specify .....................
7- For how many apprentices do you use navigational equipment selected above at a time?
   
   - One apprentice
   - Two to five apprentices
   - Five to seven
   - Eight or more

8- How many apprentices do you train in a calendar year?
   
   - Less than 100 apprentices/year
   - 100-200 apprentices/year
   - 200-300 apprentices/year
   - 300-400 apprentices/year
   - 400-500 apprentices/year
   - More than 500 apprentices/year. Please specify.

9- Do you have a maritime library for a wide range of maritime references within your simulation complex?
   
   - Yes
   - Divided among departments
   - No

10- How many employees and training experts do serve in your simulation complex?
    
    - 40 employees and training experts
Group #2: Maritime Simulation Training & Certification

11- How likely do you think you are persisting in serving the maritime community with such training?

- Very likely
- Somehow likely
- Neutral
- Somehow unlikely
- Very unlikely

12- Do you have any financial support, from Foreign Governments, International Bodies and Ship-owners or any other organization for the training purposes?

- Yes
- No

- If Yes? Please Specify. Shipping companies that have contracts with American Maritime Officers union

13- What are the different types of certification do you offer for the maritime apprentices? Please select all that apply.

- Ratings – Deck
- Pre-sea/Foundation Training – Deck
- Officer In-charge Navigational Watch (High Seas)
- Chief Mate (High Seas)
- Master (High Seas)
- Officer In-charge Navigational Watch (near coastal voyage)
- Chief Mate (near coastal voyage)
- Master (near coastal voyage)
- Pre-sea/Foundation Training - (Engineering)
- Officer/In-charge Engineering Watch
- Second Engineer (3000 kw or more)
Chief Engineer (3000 kw or more)

Second Engineer (750-3000 kw)

Chief Engineer (750-3000 kw)

Others? Please specify.............

Group #3: Quality Management

14- From your own experience/expertise, are there any suggestions for improving products / services provided by the maritime simulation companies that you frequently deal with in order to enhance the maritime training effectiveness?

22 years and we believe that their simulation systems on BCDIS simulation for many years and believe they are

15- What is the Internal Management Structure of your simulation complex? Kindly, provide us with a PDF copy.

To be e-mailed to: captain.yasser@hotmail.com
16- Briefly, would you inform us how the shipping industry is participating with your simulation complex?

....

17- Is there any provision for the refreshment training and updating for the academic staff?

X Yes
○ No

X If Yes? Please specify...Typically provide all the training required by our staff to maintain their USCG credentials. Specialized training is provided where needed.

18- Is there any Quality Standard System (QSS) you are following within your facility?

X Yes
○ No

X If Yes? Please specify...ISO 9001

19- From the previous question, if your response is “Yes”, are there any Auditing/Certifying Authorities for your QSS?

X Yes
○ No

X If Yes? Please specify...NA, AAS audited by ABS
20- Is your facility awarded and/or approved by the ISO? If Yes, since when?

- Yes, Since (9001 )
- No

21- From the previous question, if your response is “Yes”, which of the following ISO award does your facility accredited with?

- ISO 9000
- ISO 9001
- ISO 9004
- ISO 19011
- ISO 31000
- ISO/IEC 31010
- Others? Please specify .................

22- Is your facility awarded and/or approved by the IMO? If Yes, since when?

- Yes, Since (  )
- No The IMO does not approve training facilities to the best of my knowledge. That is left to the flag state, which in our case is the US Coast Guard.

23- Is your facility complying with and implementing the STCW’95 convention’s guidelines for training sessions?

- Yes, Since (  ) Since about 2000. Now we are implementing STCW 2010 guidelines.
- No

24- Is your facility participates in the national/international certification process?

- Yes We participate in IMO and MERPAC meetings to stay ahead of the regulations.
- No

.................................................... END OF QUESTIONNAIRE ....................................................
APPENDIX-D

IRB Human Subjects Permission Letter
From: UCF Institutional Review Board #1  
FWA0000351, IRB00001138

To: Yaser H. Sendi

Date: October 20, 2015

Dear Researcher:

On 10/20/2015, the IRB determined that the following proposed activity is not human research as defined by DHHS regulations at 45 CFR 46 or FDA regulations at 21 CFR 50/56:

Type of Review: Not Human Research Determination
Project Title: Integrated Maritime Simulation Complex Management, Quality, And Training Effectiveness From The Perspective Of Modeling And Simulation In Florida State, USA (A CASE STUDY)
Investigator: Yaser H. Sendi, MASTERS
IRB ID: SBE-15-11692
Funding Agency: N/A
Grant Title: N/A
Research ID: N/A

University of Central Florida IRB review and approval is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are to be made and there are questions about whether these activities are research involving human subjects, please contact the IRB office to discuss the proposed changes.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

[Signature]

Signature applied by Joanne Muratori on 10/20/2015 11:02:45 AM EDT

IRB Manager
REFERENCES


