CHALMERS
UNIVERSITY OF TECHNOLOGY

# Intra-connected bridge and engine simulators and their use in training

## Training onboard work communication and cooperation between maritime officers.

Diploma thesis in the Master Mariner Programme

MARCUS SÖDERSTRÖM
RICHARD SJÖGREN

Department of Shipping and marine technology
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2017

REPORT NO. SK-17/227

# Intra-connected bridge and engine simulators and their use in training

## Training onboard work communication and cooperation between maritime officers

MARCUS SÖDERSTRÖM
RICHARD SJÖGREN

Department of Shipping and Marine Technology
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden, 2017

**Intra-connected bridge and engine simulators and their use in training**
Training onboard work communication and cooperation between maritime officers

MARCUS SÖDERSTRÖM
RICHARD SJÖGREN

© M. SÖDERSTRÖM, 2017
© R. SJÖGREN, 2017

Report no. SK-17/227
Department of Shipping and Marine Technology
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Phone no. + 46 (0)31-772 1000

Cover: Transas FMSHS Simulator at Chalmers. Photo: Richard Sjögren

Printed by Chalmers
Gothenburg, Sweden, 2017

**Intra-connected bridge and engine simulators and their use in training**
Training onboard work communication and cooperation between maritime officers

MARCUS SÖDERSTRÖM
RICHARD SJÖGREN
Department of Shipping and Marine Technology
Chalmers University of Technology

## Abstract

The major cause for accidents within the maritime industry is human error. Therefore, maritime training has been focused on solving this problem over the last two decades. The training that deals with human factors is labeled resource management and has greatly improved the safety at sea. Simulators have also been a key tool in the training of technical and non-technical skills. But there is one part of the human factors that has mostly been left unexplored: the relation between the engine room and the bridge and the influence it has on the safety of operations.

Through interviews with people who are involved in the training of mariners and a survey that investigate how active seafarers appreciate the teamwork and cooperation onboard, this study has attempted to show if intra-connected simulators can be an effective tool for improving the teamwork onboard the vessels.

The survey concluded that the active officers are positive toward a more teamwork oriented course, because the general perception is that the teamwork and communication between the departments is worse than within the departments. For the interviews, topics such as previous courses where cross-department training had been used, the influence of MRM on mariners and the attitude toward using simulators in training were discussed. The resulting conclusions were that the cross-department simulator training is something that would be appreciated by sailors and instructors alike, but only if the training is done with a crew that works together on the same vessel. Cross-department training would also be beneficial for improving the cooperation, communication and teamwork through the setting in connected simulators that would make working as a team a necessity.

**Keywords:** Simulator, MRM, Communication, Cooperation, Cross-department, Training, Connectivity, Maritime, Crew training, Human factors

## Sammanfattning

Den största anledningen till olyckor inom sjöfartsbranschen är mänskliga fel. Därför har den maritima utbildningen varit fokuserad på att lösa detta problem under de senaste två årtionden. Utbildningarna som berör den mänskliga faktorn kallas för resource management och har bidragit mycket till att öka säkerheten till sjöss. Simulatorer har också varit ett nyckelverktyg i träningen av tekniska och icke-tekniska färdigheter. Dock finns det en del av de mänskliga faktorerna som hittills nästan varit outforskade: förhållandet mellan maskinrum och brygga och påverkan det har på operationella säkerheten.

Genom intervjuer med personer som är involverade i att utbilda sjöfolk samt genom en enkät som undersöker vad aktivt sjöfolk tycker om teamwork och samarbete ombord, så har denna studie försökt svara på om sammankopplade simulatorer kan vara ett effektivt verktyg för att förbättra samarbetet ombord på fartygen.

Enkäten visade att de aktiva befälen är positivt inställda till en samarbetsorienterad kurs, då samarbetet och kommunikationen överlag är sämre mellan avdelningarna än de är inom avdelningarna. Under intervjuerna diskuterades ämnen såsom tidigare kurser där träning för ökat samarbete mellan avdelningarna ombord hade genomförts, påverkan av MRM på sjöfolk samt inställningen till att använda simulatorer i utbildning. Slutsatserna som kunde dras av resultatet var att simulatorträning för ökat samarbete mellan avdelningarna är något som skulle uppskattas av både sjöfolk och utbildare, men endast om utbildningen hålls för en besättning som redan arbetar tillsammans på ett fartyg. Samträning för ökat samarbete mellan avdelningarna skulle också vara nyttig för att förbättra samarbete, kommunikation och teamwork genom att använda sammankopplade simulatorer vilket hade gjort det nödvändigt att arbeta som ett team.



**Nyckelord:** Simulator, MRM, Kommunikation, Samarbete, samarbete mellan avdelningar ombord, Utbildning, Sammankoppling, Sjöfart, Besättningsutbildning, Mänskliga faktorer

## Acknowledgments

This report would not have been possible without the help of a number of people and therefore the authors would like to express our gratitude to all the people that took their time to make sure that this report could be as accurate as possible.

We would like to thank the following: Our supervisor Johan Cimbritz for all the support and ideas provided during the writing process and our examiner, Henrik Pahlm for the inputs during the writing process and for reviewing this paper. Chalmers Lindholmen Library for support with the research and Chalmers Division for Language and Communication for writing tips and writing support. The Swedish Maritime Officers' Association (Sjöbefälsföreningen) for help in getting the survey to as many officers as possible. Martin Viktorelius, Chalmers, for inputs regarding cooperation and energy usage onboard.

We are really grateful to the following persons for participating in the research interviews: Johan Eliasson, Chalmers, for support related to the marine engineers' training. Reto Weber, Chalmers, for providing information about the simulator usage. Torbjörn Holkner, 3H Hagnilsk AB, for providing us with firsthand experience of intra-connected simulator usage in cooperation training. Martin Hernqvist, The Swedish Club, for great information regarding The Swedish Club's concept of MRM. Lars Axvi, Chalmers, for the information about Chalmers BRM. Per Larsen, Maersk Training Svendborg A/S, for inputs on Maersk Training's cooperation training.

We would also like to extend our thanks to everyone who participated in our survey, everyone who reached out to us with feedback and to everyone who motivated us with positive comments about the subject.

# Table of contents

## List of figures

## Abbreviations and definitions

**Aviation-CRM:** Aviation Crew Resource Management. Previously known as Cockpit Resource Management, it is a form of Human Element training for aviation crews.
**BRM:** Bridge Resource Management. The maritime variant of Cockpit Resource Management: a Human Element training for bridge personnel.
**CBT:** Computer Based Training. A part of MRM training to introduce subjects to the trainee before the discussion part of the MRM training.
**CHIRP:** Confidential Human factors Incident Report Programme. A reporting programme for incidents and near misses in the United Kingdom aviation industry and the international maritime industry.
**COLREG:** Convention on the International Regulations for the Prevention of Collisions at Sea. A set of “rules of the road” for preventing ships from colliding.
**CRM:** Crew Resource Management: Also see Aviation-CRM and Maritime-CRM
**ERM:** Engine room Resource Management. The engine room version of BRM.
**ERS:** Engine Room Simulator. A simulator that is capable of replicating the systems in a vessel’s engine room.
**ETO:** Electro Technical Officer. Officer in charge of the electrical systems onboard a vessel.
**FMSHS:** Full Mission Ship Handling Simulator. A simulator that is capable of replicating a ship’s navigational bridge and accurate ship handling models.
**HSB:** Hochschule Bremen (Bremen University of Applied Sciences). A University in Bremen, Germany.
**IBS:** Integrated Bridge System. A bridge where all the navigational and sensory systems are connected together to allow for an easier overview of all the systems.
**IMO:** International Maritime Organization. A United Nations Organ that is responsible for making international guidelines and regulations for the shipping industry.
**Junior Officer:** Any officer that is in an operational level position onboard. 2nd officer, 2nd engineer and 3rd engineer are junior officer ranks.
**MCA:** Maritime & Coastguard Agency (United Kingdom). The organ that is responsible for shipping regulations in the United Kingdom.
**Maritime-CRM:** Maritime Crew Resource Management. The maritime version of Aviation-CRM. Developed from Bridge Resource Management.
**MRM:** Maritime Resource Management. Human element training within the maritime industry.
**NTSB:** United States of America National Transportation Safety Board. An American agency that investigates accidents and promotes safety in the transport sector.
**Senior Officer:** Any officer that is in a management level position onboard. Master, Chief Engineer, Chief Officer, 1st officer and 1st Engineer are all senior officer ranks.
**STCW:** International Convention on Standards of Training, Certification and Watchkeeping for Seafarers. The regulations that control the education and training of seafarers.

**TSB:** Transportation Safety Board of Canada. A Canadian agency that investigates accidents in the transport sector.
**UMS:** Unmanned Machinery Space. Automation technology that allows a vessel to not have any Watchkeeping personnel in the engine room.

# 1 Introduction

For many years the focus of training within the maritime industry has been on technical skills, such as navigation and engineering systems to improve the safety of the vessels (HSB, 2013). This is not without reason as automation of merchant vessels has provided reliable and cost effective technologies to reduce the amount of crewmembers onboard vessels, as well as changing the traditional roles of deck and engine officers (Puglisi & Hartwig, 1996). Technological advances led to a reduction in accidents, but unfortunately accidents still happen but with another major cause: the human element (HSB, 2013).

Because of this, a new type of course was developed, the resource management course (The Swedish Club Academy, 2011). This type of training was aimed at improving the non-technical skills of people, and to reduce the human errors (The Swedish Club Academy, 2011). Resource management has been effective in improving the team work within the departments. But one challenge still remains, the teamwork between the departments.

A very good tool for training seafarers today is the use of simulators and life like exercises. This type of training does not only remove the risk of real life accidents whilst training inexperienced students or dangerous situations like rudder failures, but also enhances the student's capabilities by the possibility of proper supervision from an experienced instructor that can assess the student's performance and skills. However in order for the simulators to give the proper levels of training, they have to be realistic enough to make the students participate actively in the exercises.

This study looks at resource management from a different perspective than many others today, the perspective of the whole crew as a unit, instead of keeping the different departments onboard separate. It will examine the potential for training crews as one big team using connected simulators and cross-department training. The introduction of a cooperation training, utilizing the modernity of todays' simulators could result in seafarers with a better cooperation ability that could be attractive for the shipping companies.

To be able to look at this more in-depth, existing research has been studied together with interviews with people that are involved in the training of seafarers and surveys with active seafarers.

## 1.1 Purpose

Studying the need and possibility for using intra-connected bridge and engine room simulators to enhance the skills of todays' maritime officers by improving the communication, cooperation and understanding between the different departments.

## 1.2 Questions

The thesis will attempt to answer the following questions.

How can MRM training using intra-connected simulators be used to:

- Enhance the domain understanding between the bridge and the engine room?
- Improve the communication between the bridge and the engine room?
- Extend the cooperation between the bridge and the engine room?

## 1.3 Delimitations

This study used interviews with simulator instructors and company representatives in the Nordic countries and the result might be influenced by their personal opinion and their ability to disclose the information that the study needs. A survey was sent to officers that are members of the Swedish Maritime Officers' Association (Sjöbefälsföreningen) and therefore the answers to the survey might not be representative of the international shipping industry as a whole. The survey does not look at any differences in segments in the industry. It does not take into account any reasoning behind the given answers. The survey is also subject to showing false results since the answers are anonymous and the honesty of the answers cannot be confirmed. Both the interviews and the surveys are liable to getting non-representative results if the participation rates are low. Due to lack of time and resources, the research was limited to the geographical area around Gothenburg. The lack of resources and time also affected the choice of method and did not allow for any experimental studies. The subject was a fairly unexplored one and therefore the amount of available sources was not great for all areas covered by the study.

# 2 Background

This chapter will present an insight into human factors, maritime simulators, human resource management and resource management in simulator training. These subjects are important for understanding how maritime training works.

## 2.1 Human Factors

Between 75% and 96% of all maritime incidents are caused to some degree by human factors (Hetherington, Flin & Mearns, 2006) (Hanzu-Pazara, Barsan, Arsenie, Chiotoroiu & Raicu, 2008). Human factors can be divided into three different categories: personal issues, personnel issues and organizational issues (Hetherington et al., 2006). Working on ships has become more technical than it used to be, but one part that is still relevant and always will be relevant is the non-technical skills required for onboard personnel (Hetherington et al., 2006). This is especially true since the implementation of technology has reduced the crew sizes and the roles of deck and engine officers have been changed (Puglisi et al., 1996). Examples of these automated technologies is the possibility to have an Unmanned Machinery Space (UMS) without a watchkeeping engine officer or an integrated bridge system (IBS) with only one watchkeeper on the bridge. A benefit of having automation is that it reduces the risk of errors when an officer has to use all the available sensor data to make a manual calculation instead of having a computer doing them (Puglisi et al., 1996).

### *2.1.1 Personal issues*

Hetherington et al. (2006), argues that personal issues can be considered to be issues that affect a person in the crew and their fitness for duty and decision making. These are defined as *Fatigue, Stress* and *Health.* Fatigue is a very common cause of accidents and is cited as a contributing cause of 23% of the accidents in one study (Hetherington et al., 2006). Stress is in their paper not cited as a cause of accidents but affect crewmember health and health-related costs within organizations. Research from other industries show that good health management is related to improved safety performance (Hetherington et al., 2006).

### *2.1.2 Personnel issues*

The personnel issues featured by Hetherington et al. (2006), consist of non-technical skills, such as *situational awareness, decision making and cognitive demands, communication, language* and *teamwork*. Situational awareness is stated as the ability to understand a situation and how it will develop with the help of a mental model. Lack of situational awareness contribute around 70% of all human errors according to two studies cited in their report (Hetherington et al., 2006). According to the incident reports collected in the CHIRP, lack of situational awareness is the most common key factor in near misses, being the primary cause in 22,5% of all cases (MCA, 2016). High cognitive demands lowers the ability to perform multiple tasks at once (Hetherington et al., 2006). Hetherington et al. (2006), argue that teamwork is very important,

citing a NTSB statement that “lack of good crew interaction is a contributing factor in many incidents” (p. 407).

Communication is one of the key skills related to performance and safety in high-risk industries (Hetherington et al., 2006). Furthermore, communication is also heavily influenced by the language skills of the people who are communicating with each other. The language problem Hetherington et al. (2006), found to be especially noticeable when people are forced to speak a language which is not their primary language in a stressful situation. The term misunderstanding is often used as a cause of accidents, often meaning poor communication, teamwork and lack of situation awareness (Hetherington et al., 2006).

In a study by the Transportation Safety Board of Canada (TSB) (2013), maritime pilots, bridge officers and masters were interviewed and surveyed about communication and teamwork in the bridge team with a pilot onboard. The general opinion was that teamwork and challenging each other is an important factor for creating a good working place for all parts. The majority also agreed that communication is an effective method for solving problems inside the team. (TSB, 2013)

The pilots surveyed by TSB (2013) felt that their orders are acknowledged a majority of the times and officers and masters felt that they acknowledge pilot’s orders more often than not. When asked about how frequently the bridge team asks pilots for clarification the bridge team members answered that they often do, but the pilots felt that this was not the case most of the time. The survey also found that it is not uncommon for officers to hesitate in questioning a pilot’s decision even if they think the decision might be wrong. An effect noted in the study was that the respondents think that they communicate better than the recipients of the communication can agree with (TSB, 2013).

Having issues with communication and challenging decisions onboard can lead to errors and accidents (Hetherington et al., 2006). Douwsma & Crooks (1989), state that crewmembers sometimes hesitate to question a superior officer about an upcoming situation because they know challenges might not be tolerated by the superior. In the book: *Marine accidents. Normal accidents: Living with high risk technologies*. Perrow (1999), states that “It is not unusual for a deck officer to remain aghast and silent while his captain grounds the ship or collides with another” (p 178).

Further on in the TSB (2013), study, the participants were asked about teamwork and almost all of the respondents thought that teamwork is as important as technical proficiency. When asked if it is possible to establish a good working relation with the bridge team the pilots answered that it was possible in a majority of situations, but the feeling of proper teamwork did not develop between the bridge team and the pilot too often (TSB, 2013).

### *2.1.3 Organizational issues*

Organizational issues are the third and last kind of issues mentioned by Hetherington et al. (2006), and are defined as issues within a specific organization. They are mostly related to *safety training* and *safety culture.* Safety training is any training that improves the safety of the crew and the vessel and safety culture is the attitude toward safety within an organization (Hetherington et al., 2006).

### *2.1.4 Crew skillsets*

According to HSB (2013), the skills of crew members can be divided into two categories: *technical skills* and *soft skills.* Technical skills are skills related to the performance of a crewmember within their specialty, for example navigation, understanding of engine systems or the operation of cargo equipment. Soft skills are skills that relate to human behavior, such as social skills, communication and leadership - skills that can enhance a person's existing technical skills (HSB, 2013).

Technical skills are fairly easy to measure as you can clearly define the desired outcome (HSB, 2013). There is however a real challenge in assessing the effect of training soft skills as each person may develop these skills to different levels even if they are put through the exact same training (HSB, 2013). Within the maritime industry, BRM-, ERM- and MRM-training is used to develop the soft skills of officers (Hetherington et al., 2006) and these concepts are elaborated on further in chapter 2.3.

## 2.2 Maritime simulator training

In a research paper by Hontvedt & Arnseth (2013), simulators are said to be considered a major part of training mariners to improve safety in the maritime industry. They argue that the simulators are mostly used to train skills that would be connected with large risks, costs or much time consumption if they were performed in a real ship. This can include critical situations like close quarter situations, accidents and malfunctions, something that would be really hard to recreate in real life for training purposes (Hontvedt et al., 2013). Initially, simulator training was introduced as a tool to enhance passage planning skills and Master/Pilot cooperation (Hanzu-Pazara et. al., 2008) and to cope with the increase of automation onboard ships (Malik & Zafar, 2015). Previously, students had mostly learned by listening to a lecturer in a classroom and their knowledge was tested through a paper exam, Malik et al. (2015) argues. They state that the changes in work tasks needed new kinds of competency in officers and simulator training was the best way to proceed. Simulation is a way to improve the ability of the onboard personnel to optimize solutions and predict outcomes, therefore improving decision making (Olanrewaju, Kader & Saharuddin, 2014).

Malik et al. (2015), argue that it is a lot easier to understand how to handle a ship if you can try it in a simulated scenario instead of just listening to someone telling you how to handle a ship.

Many of today's simulators are large enough to handle an entire engine room or bridge manning to train different scenarios with all the equipment that one will find onboard ships (Malik et al., 2015). Malik et al. (2015), states that simulators are also used in research and not only for educational purposes. They argue that simulator training can contribute to improve capability and efficiency in many fields and can for example result in a reduction of accidents. With the help of well trained and experienced instructors and in an environment with minimal risk, students can enhance their skills and become more confident in their working capability (Malik et al., 2015). Due to low costs and the efficiency in training method, simulator training are becoming more and more common (Malik et al., 2015).

According to Malik et al. (2015), benefits of simulator training can include the following:

- The simulators of today are highly advanced, so advanced that they can be complete copies of a real ship's engine room and bridge.
- Instructors can design scenarios that focus on specific skills in different situations.
- Training critical scenarios without endangering life or property.
- Scenarios can be repeated over and over again, unlike in real life where every situation is different.
- Enhancing student's confidence and skills by maximizing the training value.
- The scenarios can be recorded and shown to the students to highlight good performance and areas that need improvement.
- Because all conditions in the simulators are known and repeatable, the execution of a given scenario can be evaluated.
- Scenarios can be much more advanced and complex in simulators compared to what can be achieved for training purposes onboard.

Additionally, simulators are a very good way to train the students in teamwork onboard ships (Malik et al., 2015). As mentioned in the previous chapter, nearly all accidents that occur at sea are caused by human error (Hanzu-Pazara et al., 2008). In a simulator, students can make several mistakes without causing any real life damage and later on they can get feedback from an instructor on what went wrong to be able to improve themselves and repeat the exercise until they have learned the required skills (Malik et al., 2015).

According to Malik et al. (2015), the equipment onboard today's ships are highly advanced and the competence in the next generation of seafarers are high. Therefore the only way to train the new students is to have equally advanced simulators for them to train in. By letting students train in simulators, their confidence will be boosted in a way textbooks and written material cannot come near (Malik et al., 2015). They note that for example, training mariners in scenarios

where both the situation and the conditions are affecting the experience can be beneficial in training multi-tasking.

Even though simulator training are a good way to train students it cannot completely replace the real life experience onboard a real ship Malik et al. (2015), mentions. The depth of skills that one can acquire onboard is considered by them to be due to the real environment and operating in that environment over time. However, they also mention that the time can be taken advantage of if the training covers a specific area, then the student can enhance those skills in a short amount of time by using a simulator. Training done inside a simulator is starting to get more and more credibility against real life experience, but to become excellent in a specific field you need both kinds of training (Malik et al., 2015).

At the start of a training session in a simulator, Malik et al. (2015), recommends stating all the conditions to the students because doing so will increase the understanding of the session. Included in the conditions, all the equipment that will be and will not be used can be listed (Malik et al., 2015). To train new seafarers the industry needs to be aware of the modern trends in training and education, as this lets schools and educational centers invest in highly advanced simulators (Malik et al., 2015).

Malik et al. (2015), makes the case that the industry needs to understand that:

- Simulators as a stand-alone and as an integrated-system have different requirements and usages. They cannot replace each other, they strengthen each other.
- Simulators are highly advanced and can provide close to real life experience, but to really get close to real life the instructor must be competent enough to make exercises that students learn from in an effective way.

### *2.2.1 Bridge simulators*

A bridge simulator is often designed to physically represent a ship's navigation bridge with consoles, controls and screens being designed to make users feel like they actually are on a real bridge (Hontvedt et al., 2013). The visual representation of the ship and its' surroundings are then displayed on screens acting like bridge windows or projected on a wall outside the simulator bridge, to make the lookout feel more realistic (Hontvedt, 2015). Puglisi et al. (1996), defines it as a "medium to high fidelity visual bridge simulator with an adequate range of instruments and equipment to provide proper simulation." (p. 331). Many modern simulators have the ability to fully replicate an IBS (Malik et al., 2015).

The IMO has standards for bridge simulators that is suitable for use in a BRM model course. They require full instrumentation showing course, speed, rudder angle, rate of turn, engine and propulsion details and relative wind direction and speed (IMO, 2002). The computer models must realistically replicate responses to rudder and engine usage and the visual representation

should be able to display land masses and ships. Furthermore, the radar should display realistic echoes and be able to simulate the possibility to determine the ship's position in more than one way (IMO, 2002). The simulator should also contain a VHF radio communication simulator, an internal communication to the instructor station/"engine room" and the possibility to produce sound signals required by COLREG (IMO, 2002).

### *2.2.2 Engine room simulators*

A marine engine room simulator (ERS) is an equipment that can simulate the operation of the technical systems onboard a vessel (Wang, P., Cheng, Ma, Song, Liu & Wang, L., 2012). Engine room simulators were introduced in the 1980's and are used to improve the engineers' skills in routine operations and problem solving (Hanzu-Pazara et al., 2008). The setup of ERS's can vary; commonly they can be a type of desktop simulator, where an engine system model is simulated on a single computer workstation and the actions are made by clicking on equipment with the computer mouse (Cicek & Uchida, 2002). The second common type of ERS is a full mission simulator which also has the hardware to represent the equipment of an engine room and engine control room (Cicek et al., 2002).
ERS's are an efficient, economic and safe way to train today's marine engine officers to a competent level that is appreciated by the industry (Wang et al., 2012). An engine room simulator can also be used to test new technology before it is implemented onboard a vessel (Gourgoulis & Yakinthos, 2008).

In the STCW-code (IMO, 2011), there are standards and recommendatory standards in training an engine officer. In some countries the engine simulator training is considered to be a substitute to a training period at sea. To train a new officer one should start with single items training and gradually increase the difficulty and the integrated systems. (Wang et al., 2012)

Wang et al. (2012), compared the skills of three engine officers. One of the engineers had been chief engineer for 10 years and had no simulator training experience (named "X"), one had been chief engineer for 7 years and had simulator training experience (named "Y") and the last one had been chief engineer for 5 years and had a lot of simulator training experience (named "Z"). These three performed some tests in a simulator and was evaluated by the system and other experienced chief engineers. Some of the things evaluated were routine maintenance skills, ability to handle emergencies and situational judgement in unusual situations. The tasks were scored based on performance and were then weighed against each other based on how important the skill is perceived to be to an engine officer (Wang et al., 2012).

When the officers in Wang et al. (2012), were compared, "Y" performed better than both "X" and "Z" overall, due to the mix of simulator experience and real life experience. "X" did however perform better than both "Y" and "Z" in areas that benefit from more working experience, and "Z" performed better than both "Y" and "X" in areas that benefit more from simulator experience. This result shows that simulator training generally benefits skills needed

in the simulator, but when combined with real life experience, the overall performance of an engine officer can be better than it would be without simulator training (Wang et al., 2012).

### *2.2.3 Simulator fidelity*

Hontvedt (2015), defines the level of simulator fidelity as the degree to which a simulator matches reality which means that a simulator that is more realistic is said to have a higher fidelity and vice-versa. In a simulator environment he argues, fidelity can be divided into visual fidelity and physical fidelity. He defines visual fidelity as the level of photorealism of the graphical representation of the outside environment and physical fidelity as the realism of the control surfaces and the design of the simulator room (Hontvedt, 2015). A very high fidelity simulator can be immersive enough to fall under the description of Virtual Reality, where the user is tricked to believe they are actually onboard a real ship (Puglisi et al., 1996).

During the last decades huge improvements in mathematical modeling, computational algorithms and the technology of data intensive computing have resulted in highly advanced simulators (Olanrewaju et al., 2014). To be able to accurately use simulators for training, the level of fidelity must meet the required levels to ensure that the trainees will utilize the proper techniques and meet the desired learning outcomes (Hontvedt, 2015).

## 2.3 Human resource management

The maritime industry has adopted resource management training, but until the STCW Manila amendments (IMO, 2011) there was no real standard for the training programmes and therefore many different types of resource management courses exist. Some courses have also been developed that exceed the STCW requirements. This chapter will explain these differences.

### *2.3.1 Aviation crew resource management*

Aviation-CRM is a type of training based on the non-technical or soft skills used to improve safety and operational performance, and is a concept that was developed after several major incidents in the aviation industry (Hetherington et al., 2006) as *Cockpit Resource Management* (The Swedish Club Academy, 2011) and after recognizing the importance of effective teamwork and crew co-ordination (Littlepage, Hein, Moffet III, Craig & Georgiou, 2016).

The research from the airline industry by Littlepage et al. (2016), demonstrate that most of their Aviation-CRM training is focused on training teams of people with a single specialization, for example pilots. Something that is therefore left out of the training is the co-ordination between different roles in the industry, for example between pilots and the flight coordinator (Littlepage et al., 2016). There has been little effort to research the benefits of this kind of multi-team training, but a study of the cooperation between cabin crews and pilots showed that teams with a good co-ordination between the cabin crew team leader and the pilots were more effective in carrying out the team goals (Bienfeld & Grote, 2014).

A study performed by Littlepage et al. (2016), looked at multi-team performance in the aviation industry based around a simulated airline flight operations center, coordinating the fleet of a smaller airline. The participants of that study, who were all students studying a relevant educational programme, took on different roles that match different occupations in the real industry, some being in the operations center and some being in other rooms, like a cockpit simulator. They were then tasked with running the airline operations, starting with routine operations and then facing different non-routine events which needed to be dealt with while trying to minimize delays and financial loss (Littlepage et al., 2016). The study showed that even though the simulations got progressively harder, the teams performed better each time, suggesting that Aviation-CRM training is very useful as a tool for training professionals to work together between different departments, leading to more effective operations (Littlepage et al., 2016). It also suggested that this kind of multi-team training could be very beneficial for other industries that rely on specialized teams performing separate tasks but are dependent on each other (Littlepage et al., 2016).

### *2.3.2 Bridge resource management*

The concept of BRM was proposed in the early 1990's because there were no human elements focused training in the maritime industry (The Swedish Club Academy, 2011). Hetherington et al. (2006), argue that improving the non-technical skills through resource management training is likely to reduce the amount of incidents caused by human factors. They included a survey of seafarers in several countries that revealed that human factors in shipping are similar to those in aviation and this suggests that using a kind of CRM in training seafarers is a valid concept. Eight companies and organizations went together to tackle this problem and because of the similarity between the maritime industry and the aviation industry, Aviation-CRM was used as the basis when BRM training was created (The Swedish Club Academy, 2011).

According to the STCW-code (IMO, 2011), BRM is a training tool that is utilized to improve an officer's ability to maintain a safe navigational watch in a bridge team environment by training the ability to properly allocate resources, communicate, challenge, perform effective leadership and have a shared understanding of the situation. It is mandatory for officers to take a BRM course, but the STCW-code does not outline a standard for the full course content (IMO, 2011). Therefore IMO developed a model course (IMO, 2002) to outline the basic requirements for a BRM course. Because it only outlines the basic requirements, the final course content can vary from country to country depending on the expected previous competence of the course participants, but the basics will always be the same.

The model course is a partially practical and theoretical course, with the theoretical part consisting of lectures or computer based training and the practical part is the use of bridge simulators where the trainees do the exercises as teams to emphasize the bridge teamwork. The

simulators are also used to train ship handling, passage planning & execution and bridge procedures (IMO, 2002).

### *2.3.3 Engine room resource management*

According to Wu, Miwa, Shimamoto & Uchida (2015), ERM is an approach to make the ship's navigation safer by managing the resources of engine room personnel, equipment and information available to the personnel. Hetherington et al. (2006), states that ERM training is usually used to train engine room personnel in crisis and systems resource management. Similarly to BRM, ERM courses are based on the CRM from the aviation industry (Wu et al., 2015). The courses that have been conducted have usually been based in simulators and the focus has been on human errors like communication, teamwork, situation awareness & fatigue (Hetherington et al., 2006).

Wu et al. (2015), argues further that even if the ERM and BRM are almost identical regarding communication, teamwork, situation awareness etc. there are differences in the technical skillset of the departments and operations in the engine room are more complex and complicated then on the bridge.

### *2.3.4 Maritime resource management*

When the requirements for BRM and ERM in the STCW-code (IMO, 2011) are compared, one thing is clear: there is no real difference between them nor between the requirements for deck and engine department. Therefore, The Swedish Club Academy proposed that they should be combined into a single MRM course that can train both engineers and deck officers together because the non-technical skills are the same for all departments (The Swedish Club Academy, 2011). The main reason for this is that whilst technical training is all about a person's skills and ability to perform their job duties, non-technical skills is mostly about attitude (The Swedish Club Academy, 2011).

In a recommendation to training providers that run MRM courses, The Swedish Club Academy (2011), suggested keeping courses that train non-technical skills separate from technical skills, to avoid focusing on the technical skills of one department and ignoring the other. This allows all the course participants the chance to receive the same level of benefit, without feeling that they got left out of the training (The Swedish Club Academy, 2011). One aspect of MRM training is to make sure every person in a given team understands the intentions of the one in charge and ensure they are not afraid to ask for a clarification if anything is unclear. Doing this creates, according to Douwsma et al. (1989), a social community onboard which lets the whole crew get information from each other and by adding the crews' combined knowledge increasing the safety for the vessel.

## 2.4 Resource management in simulator training

According to Barsan & Stan (2015), a course for combined bridge and engine room resource management was developed specifically for different shipping companies by Constanta Maritime University in Romania. The companies who had ordered the course wanted their departments to have a better understanding of the problems faced by the other department, especially in emergency situations. A specific focus of the course was on the bridge teams' understanding of why it can take a long time for the engine team to carry out repairs and orders from the bridge (Barsan et al., 2015).

The main simulator run of their course focused on the failure of the remote control of the steering and the engine controls on the bridge, meaning that the ship had to be maneuvered from the engine room. This in turn meant that the officers on the bridge had to communicate with the officers in the engine room, since the engine officers can't navigate on their own but the bridge officers can't control the vessel (Barsan et al., 2015). In this course however, it was not possible to physically connect the simulators, so the events had to be coordinated by the simulator instructors (Barsan et al., 2015).

Barsan et al. (2015), claims that senior officers from the bridge and the engine room that trained together gained more confidence when they were faced with difficult situations.

# 3 Method

This study utilized a multi-method research to be able to approach the questions from different angles and to increase the overall quality of the collected data (Denscombe, 2016). The methods chosen were a literature study, interviews and a survey and they are elaborated on further in this chapter.

## 3.1 Literature Study

The literature study is the base for the background and is therefore presented in chapter 2. It will be used to cross-check the results of the other methods and to be able to compare differences.

## 3.2 Interviews

The study conducted interviews with former mariners, company shore personnel, MRM-developers and training instructors in Sweden and Denmark. The instructors and representatives were chosen based on their relevant experience of the type of training that the report is addressing or with other relevant courses, such as BRM and ERM. These interviews provided valuable information on the current state of cross-department training and general Resource Management training in the maritime industry.

The interviews were qualitative, semi-structured interviews (Denscombe, 2016). Face to face interviews were the primary type, but telephone interviews were also used when it was not possible to conduct a face to face interview due to geographical or time constraints. The questions and topics were provided to the interviewees before each interview so they could properly prepare.

To comply with the ethical standards of research, each participant were provided with a Document of Consent that also worked as a contract between the authors and the participant and a confirmation of anonymity should the participant request it. For participants that the authors could not interview in person, the Document of Consent was sent via e-mail and the participants were allowed to confirm their consent via an e-mail reply. This Document can be found in Appendix II.

## 3.3 Survey

The survey was developed to collect data on the experiences of resource management and teamwork in active maritime officers as well as their views on the potential for the cooperation training addressed by the report. After the survey was created using Google Forms, a small test group of 4 master mariner students tested it in a pre-pilot test. When that test was completed successfully, the survey was sent to a larger test group of master mariner students to further

check it for errors and uncertainties. When the survey was determined to be finished, the answers of the test groups were wiped to not affect the final results.

With the help of the Swedish Maritime Officers' Association (Sjöbefälsföreningen), the survey was sent out to their member base which consists of officers and cadets from both the deck and engine department. The answers collected from the survey are subjective to each respondent and are therefore colored by their own perception. All respondents answered the survey anonymously to encourage honest answers without risk. The full survey is included in Appendix I.

# 4 Results

This chapter presents the results of the interviews mentioned in chapter 3.2. The topics covered in the interviews were for example the structure of different courses, the goals with the training and why there was a need for resource management.

The results presented in section 4.2 come from the survey and are displayed in charts with accompanying clarifications and elaborations. The survey results are based on how today's seafarers feel about the need for MRM training to improve cooperation and communication onboard today's ships.

## 4.1 Interview results

### *4.1.1 Why start with resource management?*

When asked why they chose to start with MRM, the interviewed answered similarly. They all stated that it is to change human behavior and create a safer operation onboard with better teamwork, communication, cooperation, situational awareness etc. The Swedish Club was one of the companies that were involved in creating BRM and Martin Hernqvist, one of the initial promoters for human factors training, has been a part of BRM training (later renamed MRM to promote the concept for all onboard personnel) for a long time. Today Martin works as Managing Director at The Swedish Club Academy and is still one of the driving forces behind the concept. He said that he was hired to prevent losses for The Swedish Club's clients and his focus became human factors in order to improve the safety onboard trough resource management training. Martin also stated that one of the main reasons for MRM training is to change the attitude of the participants because a change in attitude towards somebody or something can lead to change of behavior. If you for example have negative thoughts about pilots then the teamwork with them will not work well, but if you have a positive attitude towards the piloting experience, then the teamwork will be better. Lars Axvi, a lecturer at Chalmers University of Technology said almost the same, Chalmers reasoning behind MRM training is to increase the safety onboard. He said: "There is a lot of technology that can help the people to create safety, but it is people who create safety. In order to create safety, you have to be aware about the human element - that is how you make decisions, that's how you communicate, how you take risks etc., etc."

The MRM done by Maersk Training Svendborg by Per Larsen and his colleagues, started through the old ERM and BRM, which had been conducted for 20-25 years, and with input of maritime accident cases from the International Association of Oil and Gas Producers, International Maritime Contractors Association and the customers of the courses they created the courses that they run today. Johan Eliasson Ljungklint, head of the marine engineering programme at Chalmers University of Technology, has the same approach in relation to investigation reports about technical issues, for example reports from the Marine Accident

Investigation Branch of the United Kingdom Government as a base for creating scenarios with a high level of realism. The answer from Reto Weber, Lecturer at the master mariner programme at Chalmers University of Technology, and Torbjörn Holkner, who previously worked for another company as DPC in charge of training and now is the owner of 3H Hagnilsk AB, were that they were not pleased with the way MRM training was conducted at the time. Torbjörn wanted to have his officers, from both the deck and engine departments, work better as a team instead of thinking: "The stupid guys up there or the stupid guys down there". He was also tired of sending officers to courses where they didn't learn anything, they just took the course and was asleep for four days to get a certificate. A similar answer came from Reto, he and Chalmers thought the Computer Based Training (CBT) started to get boring and a way to make it easier for the participants to learn anything during the four days the training was conducted was to improve the training material. So the course on Chalmers went through a facelift to better train officers in MRM. The facelift was to use simulators in the course instead of the CBT that The Swedish Club Academy was using.

### *4.1.2 Course structure*

Martin's and The Swedish Club's approach to training seafarers is to first let them meet the facilitator. The facilitator is not an instructor, an instructor's job is to transfer her/his knowledge to the ones taking the course. A facilitator's job is to let the participants share their knowledge and open up for discussion between them. He/she can also show case studies and talk about incidents to further emphasize the relevance of the topics. To be able to start a discussion, all participants need to complete a CBT session where you introduce the terminology and explain the meaning of things like situation awareness, closed-loop communication, challenge and response etc., and when everybody is on the same page the discussion can take place. The discussion is intended to make the participants talk about their own experience and for example open up about problems they have encountered but due to hierarchy they could not say anything.

The training concept with CBT was used by Chalmers but after a while they thought that it needed a facelift. Reto expressed that the CBT sessions can be boring for the participants and even more so for the instructor, something Torbjörn had also thought about. After the facelift, Chalmers now use their own documents and films coupled with training in the simulator at the school. The way Chalmers conduct their MRM training is through a three day course. First they start with lectures that deal with communication, cooperation, human factors and relevant case studies. The training is then complemented with simulator exercises that focus on the different areas of the human elements. After the simulator exercise there is a debriefing with discussion which is the main part of the MRM course. There the trainees can compare the exercise with their own experiences. This is the format used in the version of MRM training Maersk Training is using, though they use the time roughly equally between lectures and simulator exercises. The theoretical part focus on six core competences defined by the International Association of Oil and Gas Producers and these are "communication, teamwork, decision making, situational

awareness, leadership and then it's what they call performance shaping factors which include stress and fatigue" and these are later trained in the simulator exercises.

The course that Torbjörn was coordinator of was executed in the simulators at Chalmers and was a course with connected bridge and engine simulator. They started the course with lectures about leadership, behavior and similar things and then they had simulator exercises. The first exercise was to start up the ship and have the ship leave the port. This was carried out with the chief engineers in the bridge simulator and the captains in the engine room simulator, to allow them to understand the different procedures and tasks that each team has to complete before departure. Both sides learned that it takes time to do different tasks in the other department, something that they didn't fully understand before this exercise. The course continued with more lectures and then went back to the simulator with the chief engineers back in the engine room and the captains on the bridge, but with one captain down in the engine simulator as assistant and one chief engineer on the bridge as a helmsman. That way they could get an understanding of what happens in the other department during extraordinary situations. He also said that the simulators were always connected so when one button was pressed on the bridge, it was reflected down in the engine room and vice versa. He further explains the focus on the course was teamwork with all components of human factors, such as communication, challenge and response etc., all components needed for good teamwork.

### *4.1.3 Simulator usage*

The course that Torbjörn was a part of was company specific and it differs from Chalmers normal course that is open for anyone that needs MRM training. From the beginning the MRM was more of a BRM with only bridge officers taking the course. However, when more and more engineers applied for the course, Chalmers needed to decide if they should skip the simulator part or change it. Lars and Reto said that they changed the simulator training, they still do the simulator exercises in the bridge simulator but you can participate without any navigational skills. Lars also reasons that it would be difficult to have a connected simulator exercise. With just 10 people taking the course at any given time, which is the number of seats in the course, you wouldn't know if there would be three engineers to seven bridge officers or vice versa. So the simulator part is done in the bridge simulator but the focus is on communication, coordination and leadership, not on technical skills.

Where most of the other MRM training programmes are focused solely on deck and engine officers, Per stated that Maersk will usually train an entire crew. "Often I also have senior ETO's, Chief Electricians, sitting in. And sometimes I also have crane drivers or lead deckhands sitting in." Maersk decided to name their MRM training CRM or Crew Resource Management because they often work with offshore crews and in the offshore industry they often change the whole crew at once and therefore the whole crew can attend the same training course. This allows for the use of connected simulator exercises more often to train bridge, engine and other

departments together. The way that Maersk's exercises are constructed differs from Torbjörn's mentioned earlier. Maersk does not mix the bridge and the engine personnel, instead the engineers are in the engine simulator and the bridge officers are in the bridge simulator. There they are evaluated and observed by their colleagues from the opposite department, meaning that deck officers observe the engineers and vice versa.

While Chalmers and Maersk Training use simulators in almost all of their MRM training, Martin Hernqvist is a little bit cautious with the use of simulators. He has told the training providers he works with to choose for themselves if they should use simulators. He continues by stating that with simulators there are both pros and cons, for example when trainees enter a simulator they tend to become focused on the equipment and some may think more of it as a technical course than as a resource management course. On the other hand it can also help with testing the things talked about in the lectures, for example closed-loop communication, cooperation and challenge & response. He is supportive of mixing training groups with officers and engineers in lectures to tear down the barriers that exist in shipping, it could be barriers between deck and engine, ship and shore, cultures and different nationalities. But if simulators are used then the scenario should either be simple, so there will not be any focus on the technical aspects, or it should be as close to real life as possible with connected bridge and engine room simulators to really train the different parts of human elements. He further says that it is important to make sure all participants feel that they are just as important and contributes as much as everybody else.

### *4.1.4 Simulator effectiveness*

From some participants Martin got comments about the feeling they have when they do simulator training, they say that a simulation is just a made up situation and not that life like. Martin then argues that even real life sometimes isn't the real situation as decisions are based on a person's mental picture of reality and it rarely matches the actual situation. If you know that the decision making process is the same, both in the simulator and on a real ship, then it's a positive thing. However it can have some negative sides as well, for example, when a simulation has something to do with emergency training, participants will often be thinking: 'what is going to happen?' and 'when will it happen?'. This will not be the case in a real life situation, as accidents are often unexpected. "Situation awareness or lack of situation awareness is identified as one of the most important factors as well as complacency because we don't expect things to happen. So, complacency is a factor in real life but maybe not in a simulator." He also says that he is positive towards simulator exercises, mainly in the technical parts of training. But from a MRM perspective he is still not sure if it's good or bad, it can be good but it may not necessarily add any value.

Per has a different thought process, he thinks that there are some parts of the CRM training that can be completed without simulator training. But to prevent seafarers from going back to their

old ways, with the same routines, same culture onboard and the same environment even when they have learnt new tools. So through training in a simulator in a controlled environment the new tools can be practiced and as they are often successful, there is a greater chance the trainees will use the tools in real life situations and maybe even change their behavior. That is the benefit of CRM according to Per, the whole crew train together and can apply it when they come back to the ship. If you don't have a whole crew or department but all participants come from different companies and ships, it is only those that have completed the course and not their colleagues on the ship that have the tools, something that might neutralize the effect that the course had in the first place. This is also something Lars mentioned, there is no good reason to train bridge officers and engineers together if they come from different companies. Lars state that the main tasks for the teachers is to create an environment for the students to open up for discussion of the MRM training. There could be doctors, master mariners, marine engineers, nuclear power plant workers and aviation pilots in the same course because topics like communication, situation awareness, risk taking and decision making are the same for all. The problem would then be how well you understand what is happening in nuclear power plant and if you could draw parallels to a similar situation on the bridge. But if a person from a company suggested training whole departments to increase teamwork within a ship or a company then it would be a different story.

Martin was asking himself why some companies succeed and others do not after they have done the same course and concluded that some companies may see the course as just a course and nothing more. If there is no effort to change things in the company or on the ship then people will go back to their old ways. Companies that instead have at least one person who really believes in the concept of MRM and is constantly asking questions about what the crews learnt at MRM and making them think about it, then change will eventually happen. That process of change is what Martin describes as a cultural change of the company and that's what he is looking for with the MRM courses. In a contrast, Johan thinks that improvement lies on the individual level, in a person's willingness to take part of the course and make an effort to change the way they think about themselves. He said he has been looking at other ERM courses and saw that some companies did not let their employees get a promotion if they were unwilling to change their attitude in regards to resource management.

### *4.1.5 Course reception*

When asked about the course reception and how it was, then it seems that the participants are happy with them. Johan wonders about the possibility of changing a person's behavior with a single course and argues that there is need for more discussion around it. He still thinks it is an eye opener to a lot of the trainees and if they use or at least start thinking about some parts of the course then it is good enough. Per was on the same track with his trainees, they were saying the course was an eye opener for them and that is coming from people who have been in the industry for fifteen to thirty years. They get interested in the whole concept of non-technical

skills and resource management and almost 90% are positive towards the training form, then there are always some people that are not interested at all but generally the results are good. Some participants even contact him after a couple of months and say that they have used some of the tools they had been taught and it worked out well, so he gets a lot of good feedback. Torbjörn has also got good feedback from the participants he was in charge of, even years after the course took place. The participants felt they learned so much and there was a lot of discussion that resulted in a reformation of the company's muster lists so the chief engineers are posted on the bridge to lead operations like firefighting and evacuation. Then, a year after this change in structure and taking in other aspects from the course, they had an annual audit on one vessel and didn't get any remark whatsoever. "I would never ever work with this today if I did not get continuous positive feedback." says Martin. He has not met anybody who has said the course was not useful and even if he does not give the course personally, the general opinion of the course are positive. When studying CHIRP reports collected between 2003 and 2015 that clearly show that a majority of all accidents are caused by human errors, Martin felt that the statistics show that they are focusing on the right things even though it is still a long way to go before the problem is eliminated. "...it is exactly what we talk about so, for me this is like I have not seen a better confirmation on what we are doing is really what we should do."

Lars says the reception of Chalmers MRM course it is quite good but that is just based on the course evaluations. After the course they don't know how it effects the participants since there is no follow up survey. He says that it would be very good to get the opinions because it could help develop the training and would measure the effect. Further he argues that this is one of the problems with open course seats because you don't know why the participants really take the course. Reto also says that is the problem with MRM, it is not just a course, it is a lot of work after it when the company should push forward to make a change with the new MRM tools in focus. The MRM training should not just be a course, it should be a continuous education to get all the important parts to stick.

### *4.1.6 Course goals*

The interviewed had similar goals with the MRM courses but they differ when it comes to determining if they reach them or not. Per said his goal is to make crews more aware about the non-technical skills and how important they are to safety. Further he wanted the trainees to think more about the other departments onboard and not just their own, thinking about safety for the whole vessel and the third parties hired for some tasks, like agents. To make them a part of the team there needs to be an understanding of teamwork for that to work. He says that it is difficult to see if you have reached the goal or not but you can see a change during the course period. Reto talked about the difficulties in knowing if you reach the goal or not. The goals for him are to improve communication, human limitations and to get a better understanding. In the end, since they don't do any follow ups they don't know if they succeed or not.

Johan's approach and goals was to get the trainees to talk and discuss difficult topics like communication and management skills. He hopes that they are making people re-think situations and using the tools they have learnt to create better teams. The surveys they got on the course shows positive results so he thinks his goals are reached. For Torbjörn teamwork was his goal, to train his captains and engineers in communication, cooperation and decision making. With positive comments towards the course from the participants, he says that his goal was reached and he was very pleased with the course that Chalmers provided. Increase safety, efficiency and job satisfaction are the goals Martin have on the MRM training. Job satisfaction is an important aspect of the training as well, creating an environment where everybody can feel that they are contributing and that they are important to the team. In the end also getting results for the seafarers, companies, themselves and for the industry as a whole.

Lars has two different ways of looking at the goals. One part is all about the open course seats that are available for everyone. The companies that send their personnel to those courses, might not care too much about the course, they are more interested in the certificate. This is a guess and taken little out of the blue, more of a feeling he has because when the participants are asked why they are taking the course, many of them answer that they do not know or "the company sent me." For those courses Lars and his colleagues want to make a course that is good for the three days the course is running, to transfer the knowledge the instructors or the participants themselves have to increase their knowledge of human elements. The other part of the goals is when there is a company buying a course for their whole departments and crews. These companies are more interested in increasing safety onboard and have found human factors to be an important aspect of safety. Even if the goals of the courses are different, the contents are similar and the main objectives are to change behavior and create safe attitudes and those are difficult to measure. The course survey are getting positive results but after the course is finished that is out of Chalmers reach.

## 4.2 Survey results

This section will present the results of the Survey included in Appendix I.

### *4.2.1 Respondents*

The survey, included in Appendix I, received 91 answers in a time period between January 18, 2017 and February 14, 2017. A majority of respondents of the survey in this thesis, around 56% (51 respondents), are deck officers or cadets. This means that 44% (40 respondents) are engineers or engine cadets. From the total amount of respondents, almost 72% are senior officers (Master, Chief Engineer, Chief Officer, 1st Officer or 1st Engineer), circa 23% are junior officers (2nd Officer, 2nd Engineer and 3rd Engineer) and 5,5% are cadets (deck and engine).

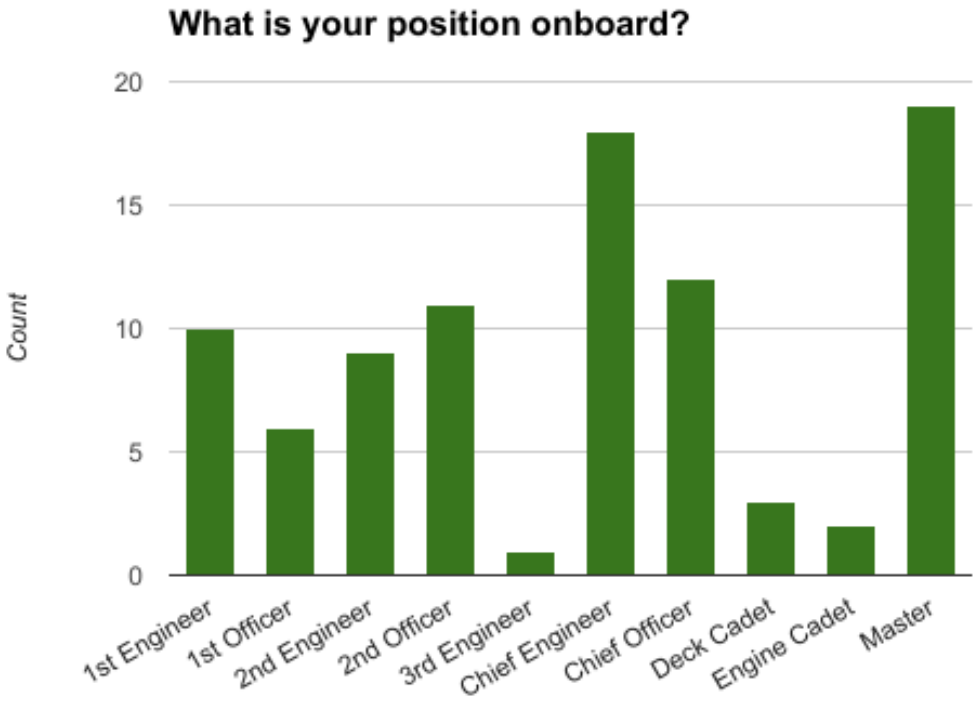


**Figure 4-1: Respondents position onboard**

Around 58% (55% of the deck officers, 63% of the engineers) stated that they had at least 11 years of experience within a bridge or engine room team.

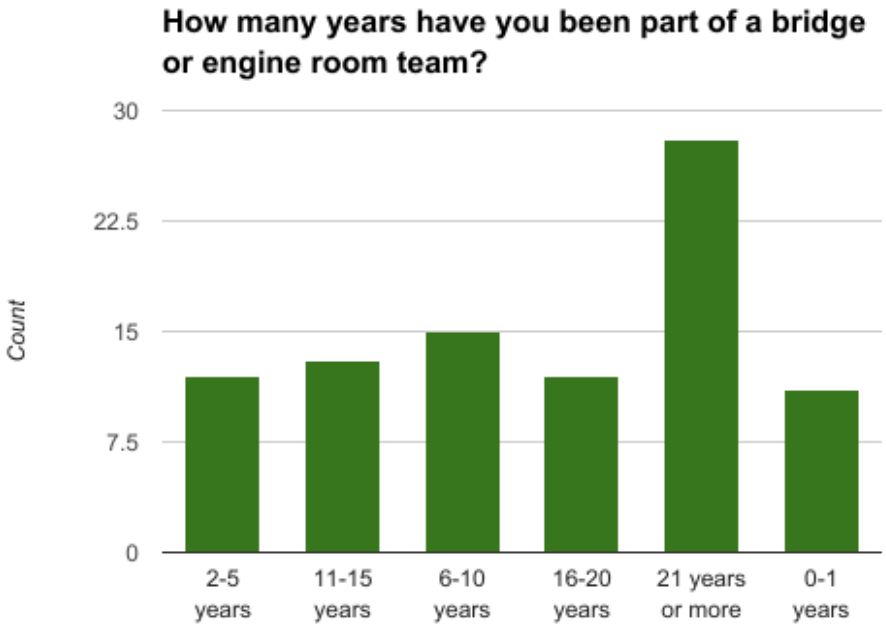


**Figure 4-2: Years of experience, all respondents**

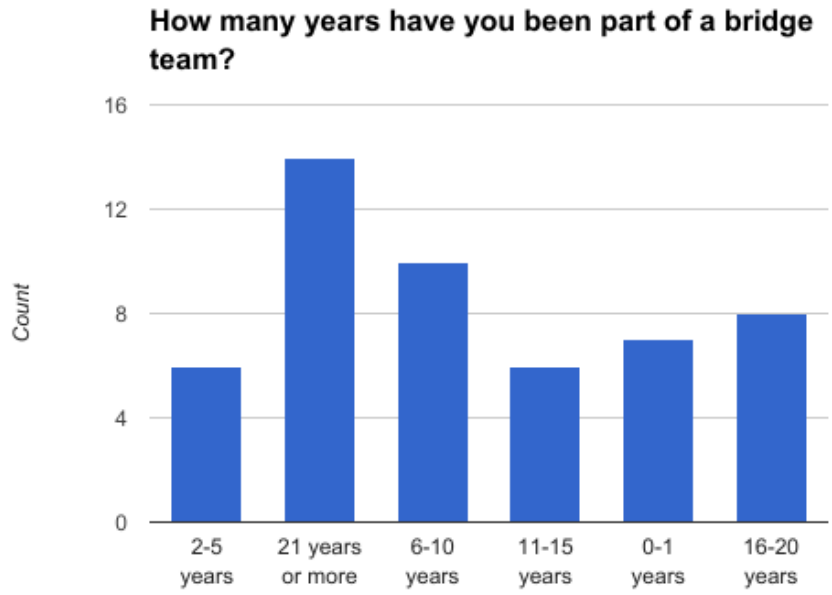


**Figure 4-3: Years of experience, bridge officer respondents**

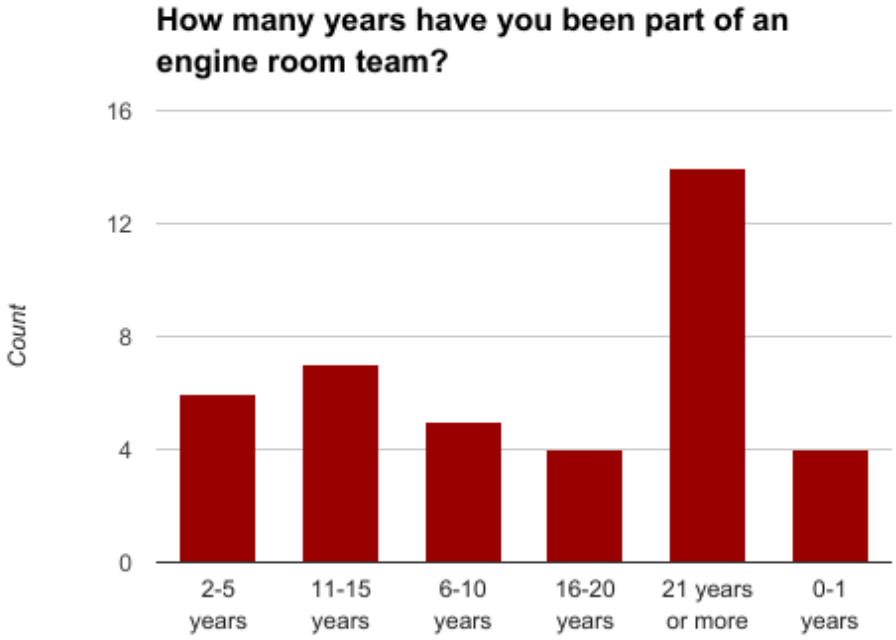


**Figure 4-4: Years of experience, engine officer respondents**

The respondents had varying degrees of experience with Resource Management courses, most notably differing a lot between departments. On the deck side almost everyone (96%) had taken a BRM course sometime in their career, with a majority (59%) having been to one in the last 5 years.

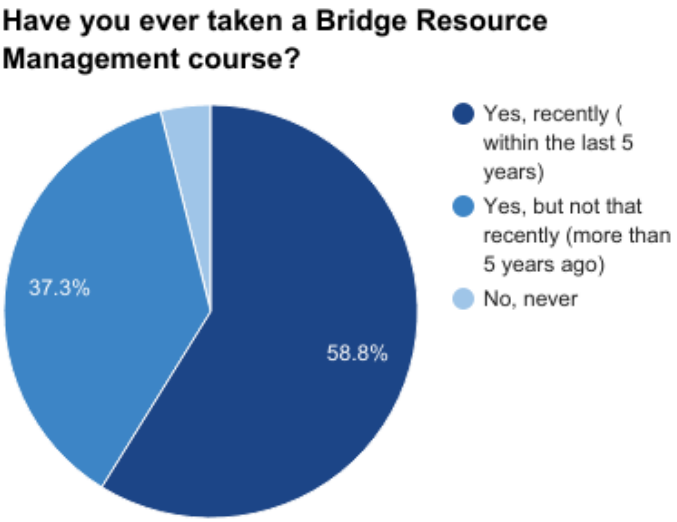


**Figure 4-5: Experience with BRM courses, deck officers**

When looking at the engineers however, the story is different. Only 50% of the respondents have taken an ERM course, meaning that half of the engineers that responded has never had any experience with ERM training.

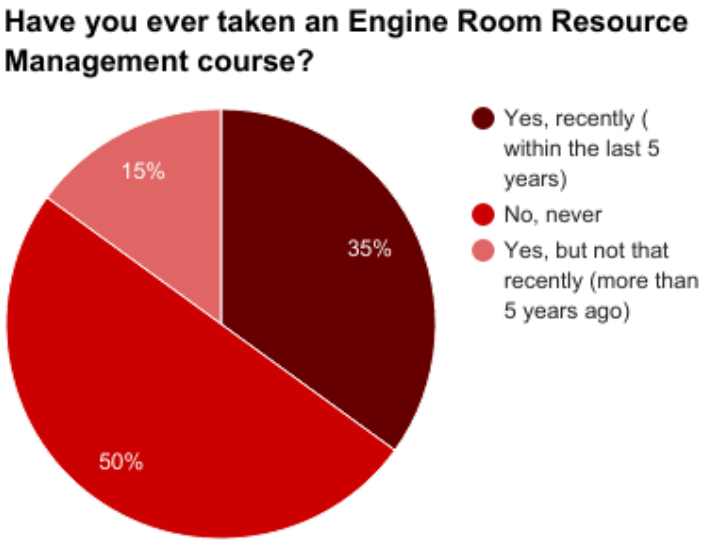


**Figure 4-6: Experience with ERM courses, engine officers**

### *4.2.2 Deck officers' views on the bridge team*

The deck officers that responded gave the following answers for communication within the bridge team:

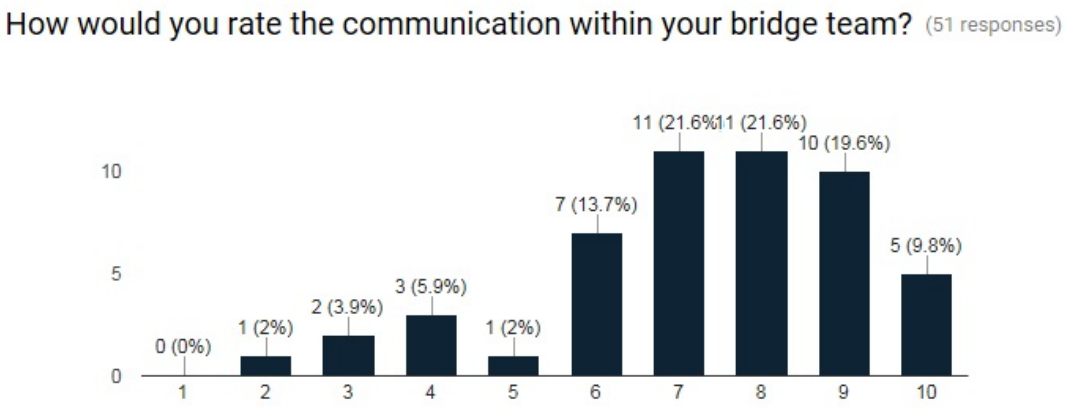


**Figure 4-7: Deck officers' bridge team communication rating**

When the scores are averaged, the rating is around **7,3** and shows that the deck officers think that the communication on the bridge is fairly good in most cases. When looking at the answers for the cooperation, this was the result:

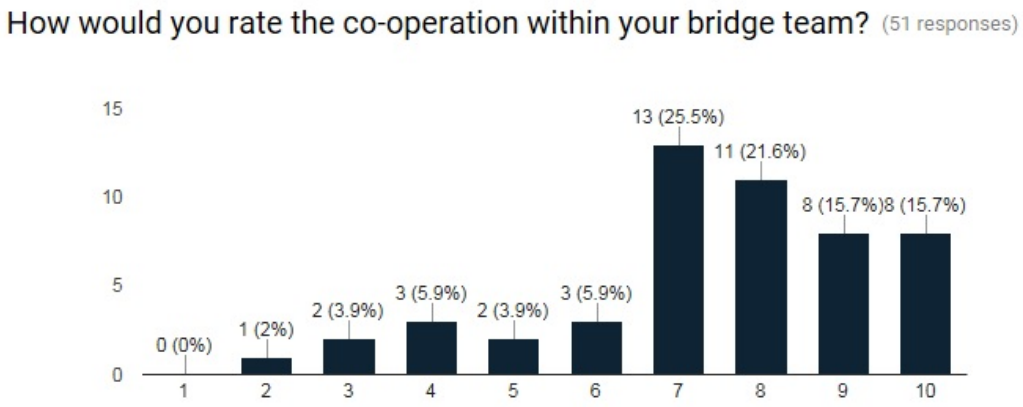


**Figure 4-8: Deck officers' bridge team cooperation rating**

The cooperation aspect scores slightly higher than the communication, with an average rating of **7,4**.

### *4.2.3 Engine officers' views on the engine room team*

The engineers rated the communication in the engine room in the following way:

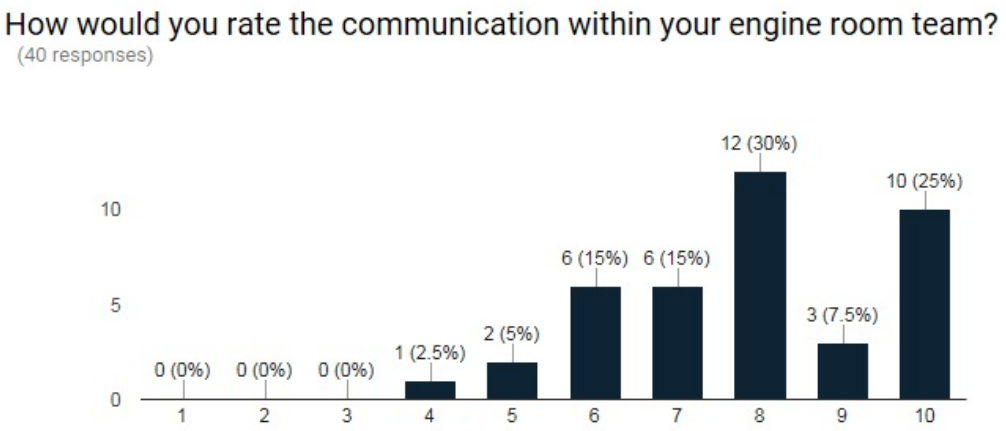


**Figure 4-9: Engine officers' engine room team communication rating**

The engineers' perceived communication got an average rating of almost **7,9** - a better result than the deck officers'. The results for the cooperation in the engine room were the following:

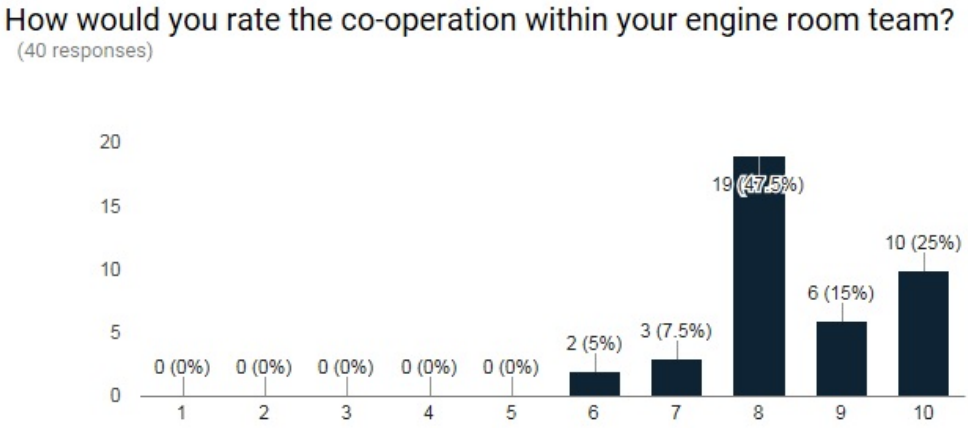


**Figure 4-10: Engine officers' engine room team cooperation rating**

The engineers rate their cooperation really high, with an average rating of **8,5**, much better than the deck officers.

### *4.2.4 Teamwork between the departments*

The deck officers rated the communication between the deck and engine department as follows:

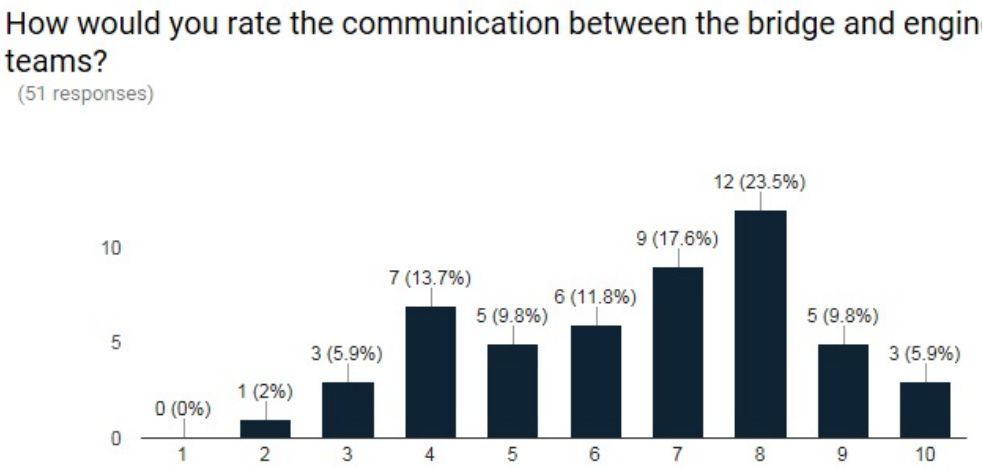


**Figure 4-11: Bridge officers' rating of the communication with the engine room team**

This shows an average rating of almost **7,0**, which means that it is slightly worse than it is in the bridge team itself. Looking at the deck officers perceived cooperation rating between the departments it is the following:

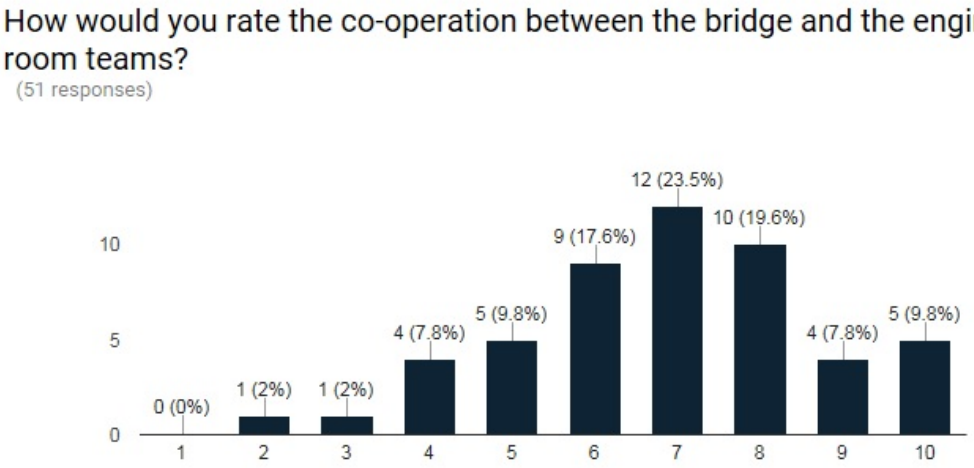


**Figure 4-12: Bridge officers' rating of the cooperation with the engine room team**

The average rating of the cooperation is even worse according to the deck officers, with an average of **6,9**.

When looking from the point of view of the engineers on the communication between the bridge and engine teams, this was the result:

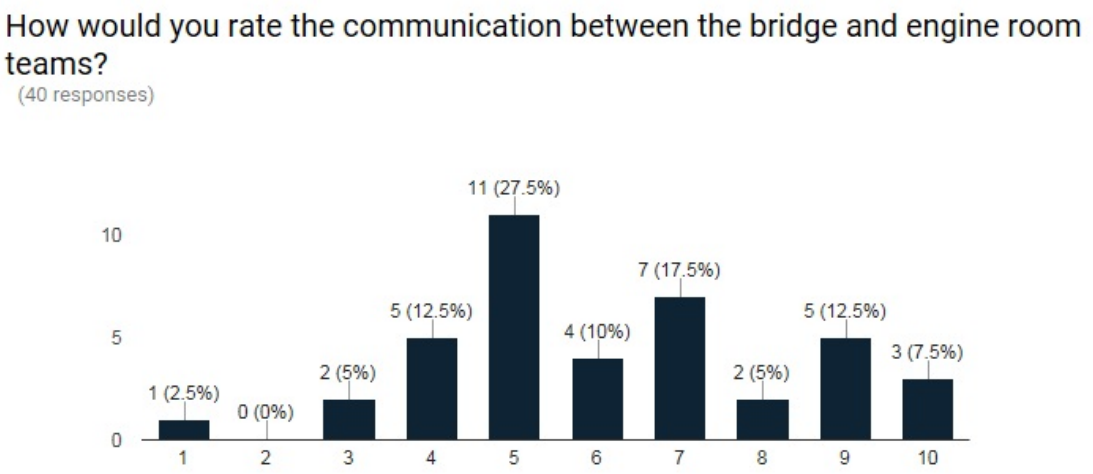


**Figure 4-13: Engine officers' rating of the communication with the bridge team**

It is apparent that the engineers do not think that the communication between them and the bridge team is very good, with an average rating of around **6,2**. The engineers' views on the cooperation with the bridge is the following:

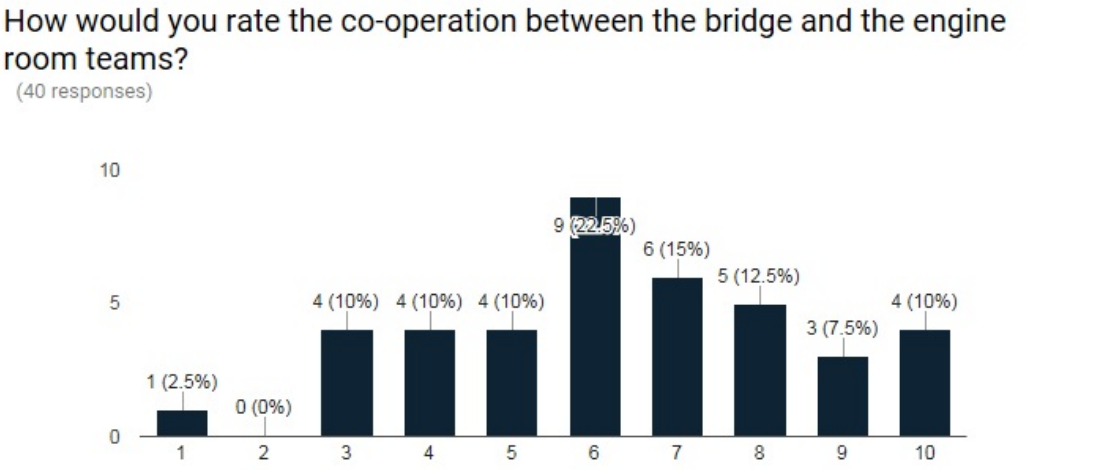


**Figure 4-14: Engine officers' rating of the cooperation with the bridge team**

The average rating of the cooperation is **6,3**, which is slightly higher than the communication rating, but still fairly low compared to the rating within the teams. When the cross-department teamwork ratings are compared to the ratings of teamwork within the engine department, one thing is immediately clear: the cross-department teamwork trails the internal teamwork by 2 points on the scale

### *4.2.5 Knowledge of the other department's daily work and tasks*

The knowledge of the other departments' daily work differs between both the engineers and deck officers. Most of the respondents claim to have some knowledge of the other departments' activities, but where a majority (55%) of the engine officers feel that they know "most things" of what the deck officers do on a daily basis, a majority (57%) of the deck officers claim to only know "some things" of what the engine room team does during everyday operation.

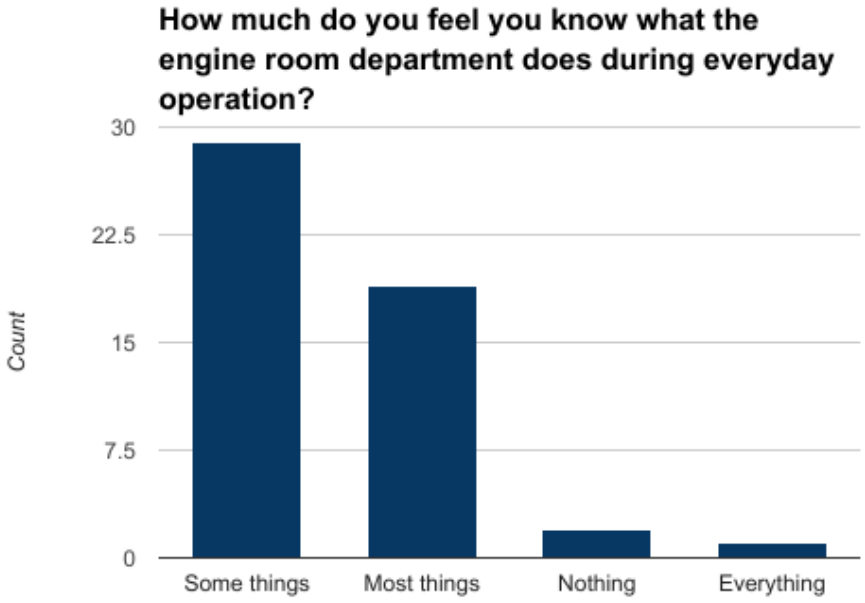


**Figure 4-15: Bridge officers' knowledge of the engine department's daily work**

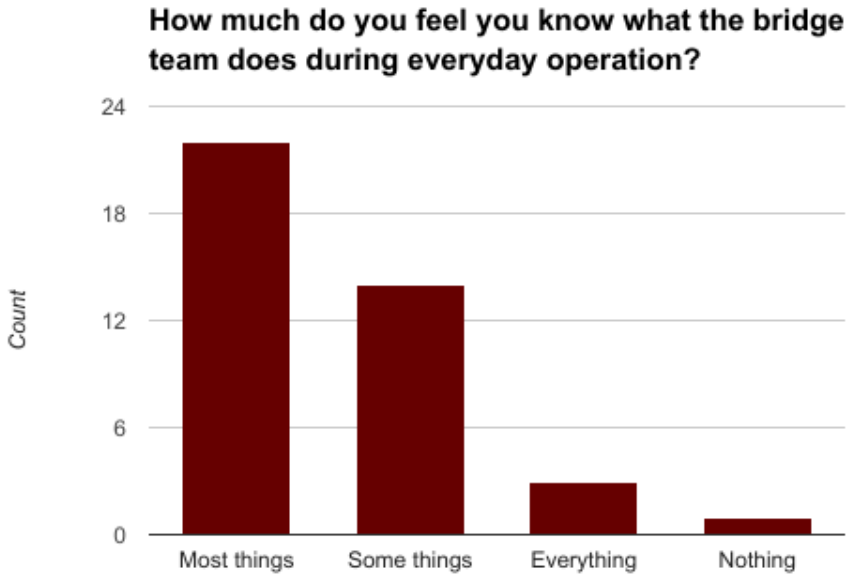


**Figure 4-16: Engine officers' knowledge of the bridge department's daily work**

### *4.2.6 Officers' views on a cross department MRM training course*

The views on cross-department training differ from the bridge team and the engine team as well. The deck officers are more inclined to believing that a cross-department course will be beneficial for the cooperation and communication with 43% answering *"Yes"* on the question *"Do you think a Maritime Resource Management course that is training deck and engine officers together could improve the cooperation and communication between the bridge and engine room teams?"*. Another 33% are positively inclined to it. Looking at the engineers' answers to the same question, only about 28% answer *"Yes"* while 45% are positively inclined.

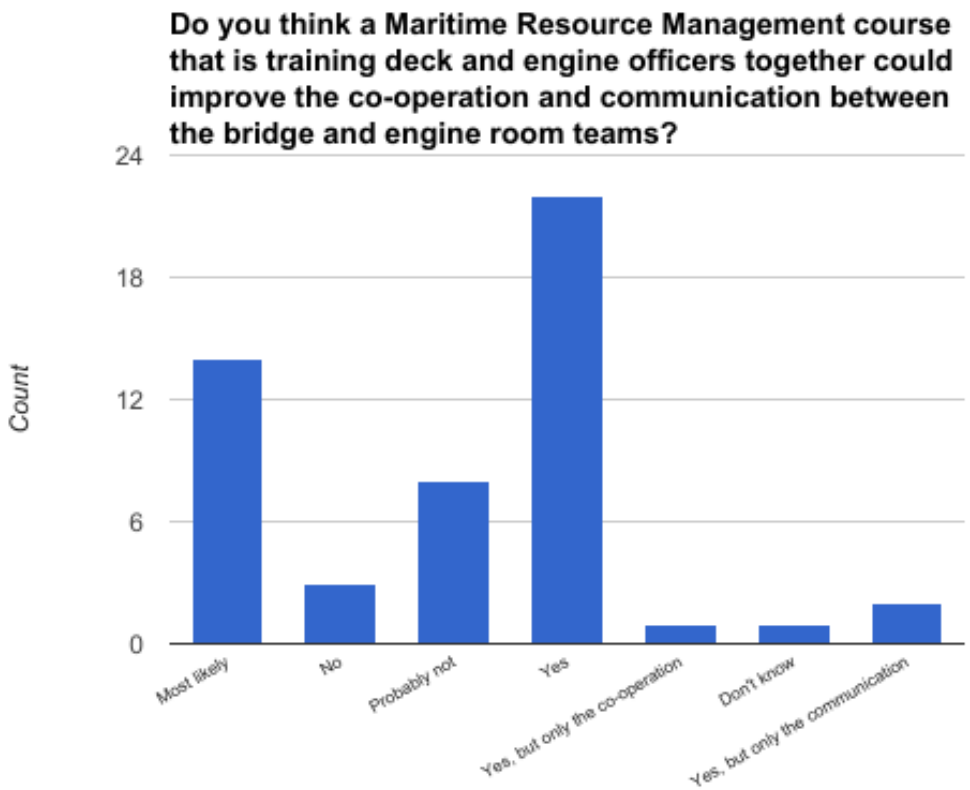


**Figure 4-17: Bridge officers' views on a cross-department MRM course**

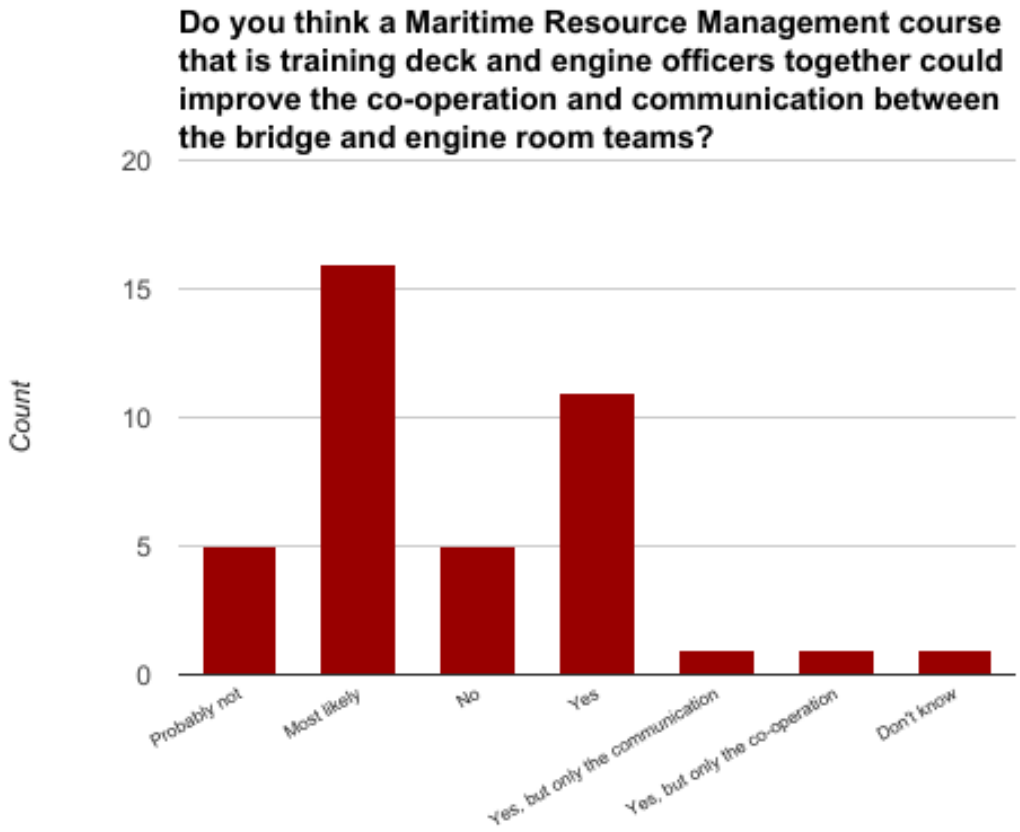


**Figure 4-18: Engine officers' views on a cross-department MRM course**

When analyzing the answers to the question *"Do you think simulator training where the bridge and engine simulators are connected would be useful in such a Maritime Resource Management course?"* the engineers are again more reserved in their answers. 25% of the engineers answered *"Yes"* and another 38% were positive. Among the deck officers, almost half (49%) answered "Yes" with 29% being positive.

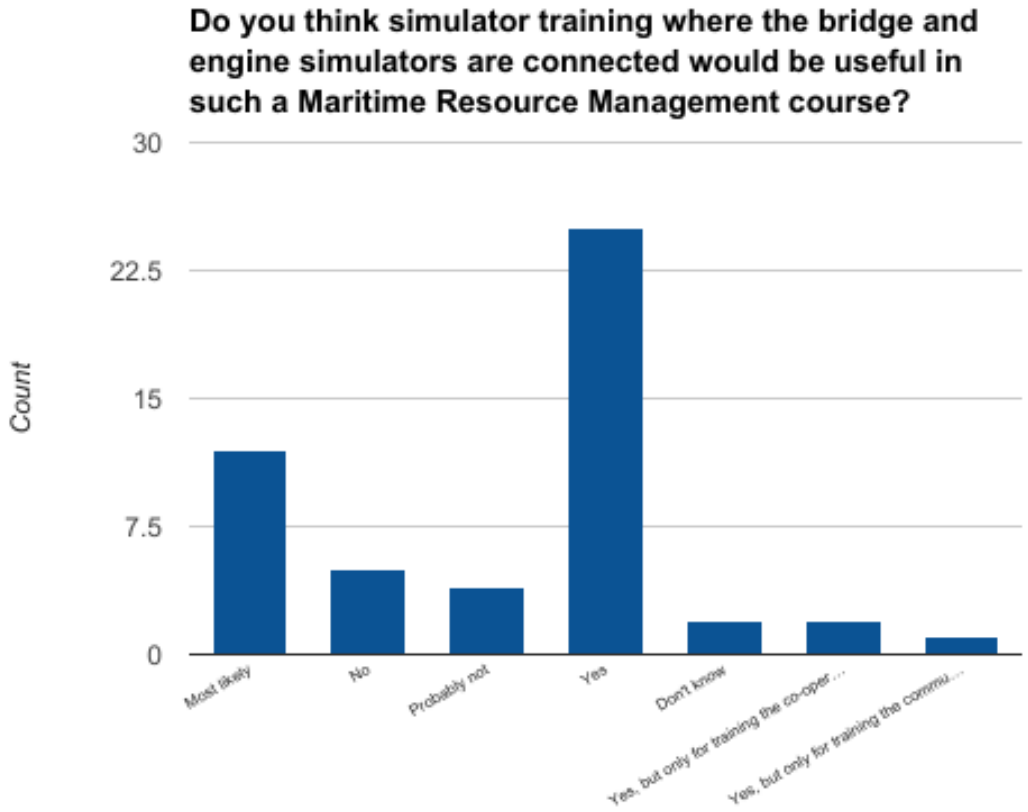


**Figure 4-19: Bridge officers' views on using connected simulators in a cross-department MRM course**


**Figure 4-20: Engine officers' views on using connected simulators in a cross-department MRM course**

# 5 Discussion

The names and abbreviations of resource management is a jungle. There is BRM, CRM, ERM & MRM just to mention the most common ones in the maritime industry and even when trying to figure out the meaning of one, different companies have different ways of referring to them. For the sake of avoiding confusion, this report has mostly used the broader term MRM to describe modern resource management in the maritime industry, but the other terms have naturally been used where they are warranted.

The point of MRM training is in the end to improve safety onboard vessels through understanding the non-technical skills. That is what each of the interviewees want to accomplish with MRM training but with different approaches. The possibility for confusion is very evident when comparing what Per Larsen and Martin Hernqvist said about their courses, both are focused on human resource management and improving the non-technical skills in seafarers from different departments. The Swedish Club Academy has elected to call it Maritime Resource Management, while Maersk chose to call their version Crew Resource Management. This is reflected in the way the companies approach the training as well, where The Swedish Club Academy has a more general approach where they can train any group of seafarers together, no matter their department or company. Maersk has taken a more specific approach with their training and they are mostly training full crews together.

According to Martin at The Swedish Club Academy, they worked with a number of other companies to develop BRM after looking at Aviation-CRM and realizing that the subjects brought up in that type of training could be applied to the maritime industry as well. Eventually the IMO picked up on its usefulness and implemented it in the STCW-code (IMO, 2011) as BRM for the deck officers and ERM for the engine officers.

## 5.1 Survey

Analyzing the results of the survey show that the demographic of the respondents has a lot of experience in the maritime sector. More than two thirds are senior officers and more than half have more than 11 years of seagoing experience. This should be an indication that most of the respondents have a lot of knowledge of and personal experience with these topics.

The biggest conclusion that can be drawn from the survey is that there is a difference between the departments' views on the teamwork within and between them. On an average, the engine department rated their internal teamwork better than the bridge department did. This might be due to many different reasons, but a major one might be the way the departments function from the core, where the engineers tend to often do their tasks as a group since, according to Wu et al. (2015), the operations in the engine room are more complex than those on the bridge. On the bridge an officer can have a solo watch and only work as part of a team when

approaching/leaving harbors. The difference in perceived teamwork between the departments is another thing of note. Compared to the rating of the internal teamwork, the bridge officers does not really think the teamwork with the engine room is much worse. When looking at the engineers' ratings of the teamwork, there is a bigger difference. On average, the difference between internal and external is 2 points on a 1-10 scale. The reasons for this is not researched in the survey, but it could be due to bad communication, isolation or a "we against them" thought process.

An interesting difference noticed in the survey results was that the experience with BRM/ERM training varied so greatly between the departments. The cause for this may be due to several factors, for example confusion about what actually counts as an ERM course, that the selection isn't representative of maritime engineers in or it might just be caused by the fact that the ERM requirement has only been in the STCW-code (IMO, 2011) for six years, meaning that many engineers might not have had the time to take an ERM course yet.

Another interesting difference is the perceived understanding of the other departments' activities. The engineers felt that they had a much better understanding of the deck officers' tasks than the other way around. This might be due to an actual lack of knowledge, the different complexities of the systems or a faulty perception. The reasons are however not identified by the survey and the cause for the difference is therefore not possible to conclude.

## 5.2 Potential benefits of cross-department training with connected simulators

Almost immediately after the implementation of BRM in the STCW-code, The Swedish Club Academy changed the course name to MRM to be able to include both deck officers and engineers into the same training course, since the STCW requirements of the courses were so similar (The Swedish Club Academy, 2011). This, was according to Martin a positive thing as the possibility for tearing down the walls between the departments presented itself and expanding the discussions about non-technical skills became possible. Tearing down the walls are necessary because there cannot be people onboard that do not talk to each other. When there is only between twelve and fifteen people onboard there must be teamwork, because no one else will come and help if there is an emergency, the people onboard are on their own.

Seeing as The Swedish Club Academy were pioneers in the field of resource management, Chalmers adopted the MRM programme from them but after a while they changed the approach and decided to use simulators in the training process. This was a step in the direction of helping participants train things in a lifelike environment and also a step toward the cooperation training that Torbjörn Holkner was involved in proposing.

The interviewees answered unanimously in favor for the usage of simulators in training. When the simulators are run fully connected or with very simple exercises is where you are really able to train the participants in non-technical skills, since the focus is on human factors. Simple scenarios are for example used in the Chalmers open courses held by Reto and Lars where anyone can take the course. There they do all the exercises in a bridge simulator, but the engineers can still participate without any nautical skills due to the focus being only on human factors.

As is shown in previous research, using simulators for training is a cost-effective method of training (Malik et al., 2015). The interviewees agree that simulators are a good way to train and test newly learnt tools and skills in a safe and controlled environment. But for the simulators to have the best possible effect on the trainees, they need to have a certain degree of realism or fidelity (Hontvedt, 2015).

One fidelity aspect that was focused on by both Johan and Per was the use of real life incident reports to develop exercises for MRM training. These scenarios makes it easier to understand what kind of problems could arise onboard a real vessel and make the exercises more realistic. In addition to taking real-life scenarios, Per also used connected simulators in his training programme. He explained that using simulators are the best way to stop the trainees from going back to their old ways of operating the vessel. To be able to practice the new skills directly after the lectures and see that they work will help the trainees to apply these skills more easily. A scenario that they have practiced could happen in real-life and remembering the training can prevent that situation from becoming an accident.

Martin explained that the reality we experience is not the actual reality but just our mental picture of the situation. Everybody has their own picture of reality based on their own experience. That is the main focus of MRM training, making sure all parts of a team in one specific situation has the same or at least understand each other's different mental pictures. Together with changing behaviors and enabling a positive attitude towards safety and cooperation between departments, this was the main focus that all the interviewed had.

Martin also looked into why some succeed and others don't after the MRM training. He concluded that there has to be a person in the company that is convinced about change the behavior onboard the ships. A very good example of that is to look towards Torbjörn. He was and still is committed towards MRM. Even when the company was hesitant in the beginning he managed to get his will through and sent the captains, chief officers and chief engineers to a course at Chalmers. After the course all the participants were happy and it gave a good result as seen in an audit report with no remarks. That the participants were positive about the course was key, because change also needs to come from the crewmembers themselves, they need to, as stated by Johan, be willing to change their own attitudes. If the course is just seen as a course

to get a certificate, then change won't happen and situations can arise which could have been prevented with the use of MRM training.

The respondents of the survey are mostly positive to having MRM courses where they can train their teamwork and they are also positive to training the teamwork with connected simulators. This result can be considered very important for the success of MRM, because as Johan and Martin agreed, change can only start if people actively want or are positive to change.

When comparing the courses done by Barsan et al. (2015) with the courses done by Torbjörn and Per, the conclusions that can be drawn are very similar. Per talks about the training being an eye-opener for the crew and Torbjörn talks about how it affected the operations onboard with, as an example, changes in teamwork in emergency situations. Barsan et al. (2015) drew the conclusion that the participating officers gained more confidence in each other's abilities in difficult situations. These three results indicate that having the different departments training together leads to a positive change.

## 5.3 Potential drawbacks of cross-department training with connected simulators

When testing the newly learnt skills in a fully connected simulator the focus has to only be on the human elements that works with the highly technical parts of a simulator. Otherwise there is a risk that the trainees might start to focus more on operating the technical aspects, meaning that the desired learning outcome will not be met. For the simulators to have the best possible effect on the trainees, they need to have a certain degree of fidelity (Hontvedt, 2015). If this fidelity cannot be met, it is very easy for participants to start focusing on what seems to be wrong with what the simulator is displaying (Hontvedt, 2015) instead of focusing on what they are there to train.

Some of the interviewed were skeptical towards the possibility of changing a person's behavior. This is because any change begins with each individual and if someone does not want to change, it is not possible to get any change. Determining if the courses actually help the trainees after they have taken it is an issue for the training providers that is due to the lack of follow up in most companies. Even if the reception of the course itself can be good there is no guarantee the participants will use their new knowledge. Because as Martin said, a company need to have a person that are fully committed to MRM courses for it to have any effect. If there is no such person, the MRM training might just be forgotten after a while because it is easy to fall back into old habits. If a whole crew takes a course together, then it can be easier to see changes in the company. From a general perspective however, many training providers do not know if they do a good job or not when it comes to changing attitudes.

There is a rather big drawback with running the type of course that has been discussed in the study. The results seem to show that it is beneficial for full crews or parts of crews. However the problem is when a training provider is running a course where anyone can participate or as part of a training programme for cadets, since they will most likely not be working together on the same vessels, the simulator runs does not grant the same level of benefit. There might still be a benefit to it, but if the training will actually improve the seafarer compared to the more standardized form of MRM-training that is being run today is not certain. This is something that Lars pointed out, that the benefits might not outweigh the resources that this type of course demands.

## 5.4 Choice of method

The selected methods with the method combination worked well for researching this subject. The survey got an overwhelming response from the members of the Swedish Maritime Officers' Association (Sjöbefälsföreningen). One thing that is of note is that some feedback was given by respondents that argued that the survey was not fully covering all the aspects of the subjects, such as the reasoning behind their answers. The thought with the survey was however first and foremost, the gathering of information on how active officers rate the teamwork onboard and if they would appreciate more cooperation training. The survey could of course have been more in-depth, but a compromise always have to be made regarding the information you can receive versus the time that each respondent will be willing to put into answering. If the survey takes too long to answer, the more likely it is that less people will answer it (Denscombe, 2016).

The interviews seems to have been good choice and provided a lot of useful data. The interviews were as often as was practicable, held in environments where there was a lack of distractions for the best possible sound quality and to ensure the interviewees did not feel stressed by their surroundings. To make sure the answers could be as detailed as possible, the interviewees were sent copies of the intended topics so they could prepare. Because of the authors' relative lack of experience in conducting interviews, some nuances of the answers could have been missed and the interviews could differ in quality over time due to the learning process involved.

All of the interviewees were men and therefore any differences in views between men and women could not be observed. The reasoning behind the choice of interviewees had nothing to do with their gender however, but was based on their knowledge and involvement in the training of resource management. The same reasoning, together with the time and resource constraint governing travels, applies to the lack of major differences in nationality, as all the interviewees are from Sweden or Denmark. More telephone interviews could have been used, but they did not provide the same level of environmental control as the face to face interviews.

There could be problems with the chosen methods, mostly because both of them are based almost exclusively on personal experiences and opinions. In a situation with more time

available, more people than the six that were chosen could have been interviewed. A small issue arose with the recording equipment at times not recording all the words in an interview. When that was the case, most often the transcripts were left blank in those parts, but it did not affect the overall quality of the data.

Regarding the validity of the survey results, a greater response frequency would definitely have meant more accurate data. As mentioned, the survey was not in-depth enough to consider the reasoning behind the answers, something that could have provided some added insight to the seafarers' experiences and thoughts. Keeping the respondents anonymous could have been an issue as it is possible that some answers were given dishonestly, but at the same time the anonymity opens up for honesty as people might be too afraid to answer if they are forced to provide their identity. The anonymity also makes it impossible to determine if gender, age or nationality differences are present and therefore it is not possible to say how they affect the result.

A method that could have been applicable for this study would have been to conduct an experiment where the type of cross-department training could have been weighed against separate training. But under the time and resource constraints of this thesis, such an experiment was not possible to perform. It would however be an interesting project for future research.

# 6 Conclusions

Looking at all the results it is fairly clear that a course that trains different departments together could be beneficial for the maritime industry. The survey together with the interviews show that there is a need for the teamwork to improve.

As the interviews have shown, there is a benefit in using intra-connected simulators for increasing the understanding between the bridge and the engine room. This can be achieved through mixing the participants so the deck officers can work together with the engineers in the engine room simulator and vice versa. Another way this can be achieved is through participants supervising and observing their colleagues from the opposite department performing various tasks.

Running the simulators connected to each other forces the different teams to actively talk to each other to solve the various problems that can happen during a simulation. This is because since the simulators are connected, any action from one department will affect the other department. Therefore it is crucial to have an open dialogue with the other team so that everyone can have the same mental picture of the situation, something that is crucial for safe operations onboard.

Through changing peoples' attitudes and behaviors instead of trying to teach skills, a cooperative mentality can be fostered. Instead of thinking "us versus them" people will see themselves as one big team. As the survey shows, this is a change that the respondents are positive towards. Using simulations where people are forced to cooperate with each other can help overcome differences and make people adopt a different view toward their colleagues.

The results do support a MRM course with intra-connected simulators and cross-department training. However, to achieve maximum benefit from the training, whole crews need to train together instead of separately.

## 6.1 Further research

This study did not conduct an experiment where different test groups are used to run simulator exercises with connected simulators. Therefore this is knowledge that is still unexplored and could give a more definite answer on the benefits and negatives of that type of training compared to training the departments separately.

A follow up study on the seafarers that have already taken a similar course would also be of great benefit since it would demonstrate any positives and drawbacks to those who are working onboard with the course in mind compared to those who have never taken such a course. This could also be of value to the training providers that are not following up on participants in open courses.

## References


Barsan, E., & Stan, L.-C. (2015). Tailor made training for bridge and engine room teams' cooperation. *Universitatii Maritime Constanta. Analele,* 16(23), 17-22.

Bienfeld, N., & Grote, G. (2014). Shared leadership in multiteam systems: how cockpit and cabin crews lead each other to safety. *Human Factors*, 56(2), 270-286. doi: 10.1177/0018720813488137

Cicek, I. & Uchida, M. (2002). Improvement of marine engineering curriculum using engine room simulator. *Proceedings of the third general assembly and conference of the International Association of Maritime Universities (IAMU), Session IV, WG1*.

Denscombe, M. (2016). *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna.* (Original title*: The Good Research Guide - for small-scale social research projects*). Lund: Studentlitteratur AB. ISBN: 978-91-44-10914-5

Douwsma, D. G. & Crooks, H. J. (1989). Vessel resources management with full-mission simulator. *Simulation series, 21*(3), 192-196.

Gourgoulis, D. E. & Yakinthos, C. G. (2008). Behaviour of marine electro generators under abnormal conditions using engine control room simulator. *Journal of Maritime Research,* V(2), 23-38.

Hanzu-Pazara, R., Barsan, E., Arsenie, P., Chiotoroiu, L., & Raicu, G. (2008). Reducing of maritime accidents caused by human factors using simulators in training process. *Journal of Maritime Research,* V(1), 3-18.

Hetherington, C., Flin, R., & Mearns, K. (2006). Safety in shipping: The human element. *Journal of Safety Research,* 37(4), 401-411. doi: 10.1016/j.jsr.2006.04.007

Hontvedt, M. (2015). Professional vision in simulated environments – Examining professional maritime pilots' performance of work tasks in a full-mission ship simulator. *Learning, Culture and Social Interaction,* 7, 71-84. doi: 10.1016/j.lcsi.2015.07.003

Hontvedt, M., & Arnseth, H. C. (2013). On the bridge to learn: Analysing the social organization of nautical instruction in a ship simulator. *International Journal of Computer-Supported Collaborative Learning,* 8(1), 89-112. doi: 10.1007/s11412-013-9166-3

HSB. (2013). Technical Paper 3.2.3: TNA soft skills in shipping - a modern approach to a traditional industry. *KNOWME Deliverable D.3.2 Training needs assessment report - Final draft*, 64-104.

IMO. (2002). *Model course 1.22: Ship simulator and bridge teamwork. 2002 Edition.* London: IMO. ISBN: 978-92-801-41627

IMO. (2011). *STCW Including 2010 Manila Amendments: STCW Convention and STCW Code.* London. IMO. ISBN: 978-92-801-1528-4

Littlepage, G. E., Hein, M. B., Moffet III, R. G., Craig, P. A., & Georgiou, A. M. (2016). Team training for dynamic cross-functional teams in aviation: behavioral, cognitive and performance outcomes. *Human Factors*, 58(8), 1275-1288. doi: 10.1177/0018720816665200

Malik, A. A., & Zafar, N. (2015). Applications of simulation technology –pitfalls and challenges. *The International Journal on Marine Navigation and Safety of Sea Transportation*, 9(3), 391-396. doi: 10.12716/1001.09.03.12

MCA. (2016). *Marine Guidance Note - MGN 520 (M). Human element guidance part 2. The deadly dozen - 12 significant people factors in maritime safety.* Southampton: MCA.

Olanrewaju, O. S., Kader, A. S., & Saharuddin, A. H. (2014). Utilization of simulation for training enhancement. In O. Olanrewaju, A. Saharuddin, A. Ab Kader & W. Wan Nik (Eds.), *Marine Technology and Sustainable Development: Green Innovations* (pp. 277-290). Hershey, PA: IGI Global. doi: 10.4018/978-1-4666-4317-8.ch018

Perrow, C. (1999). *Marine accidents. Normal accidents: Living with high risk technologies*. Princeton, New Jersey: Princeton University Press. Available:

Puglisi, J.J., & Hartwig, R. (1996). The ship operation center (SOC) simulator - Integrated full bridge, engine room, cargo and navigation simulation. *Intelligent ships symposium II - Symposium proceedings*, 331-378.

TSB. (2013). *A safety study of operational relationship between ship masters/watchkeeping officers and marine pilots.* Retrieved 2016-11-25, Available: http://www.tsb.gc.ca/eng/rapports-reports/marine/etudes-studies/ms9501/ms9501.asp

The Swedish Club Academy. (2011). *Information to maritime administrators and training providers. Maritime Resource Management.* Gothenburg: The Swedish Club Academy.

Wang, P., Cheng, X., Ma, Q., Song, X., Liu, X., & Wang, L. (2012). Influence of marine engine simulator training on marine engineer's competence. *Proc. SPIE 8349, Fourth International Conference on Machine Vision (ICMV 2011): Machine Vision, Image Processing and Pattern Analysis, 834924*, 8349(834924), 1-7.

Wu, Y., Miwa, T., Shimamoto, K. & Uchida, M. (2015). Development of quantitative team performance evaluation method for ERM. *WMU Journal of Maritime Affairs*, 14(2), 333-347. doi: 10.1007/s13437-015-0088-y

## Appendix I – Survey

# Surveying the need for improving teamwork and understanding between bridge and engine teams

This survey is part of a diploma thesis at the Master Mariner programme at Chalmers University of Technology. It consists of 9 questions regarding your experiences of the teamwork between the bridge and engine room teams and your experience of resource management courses. It is aimed at deck and engine officers as well as cadets. All answers are collected anonimously. The survey will take between 2 and 5 minutes to fill out.

If you have any questions about the survey or the thesis, please feel free to contact us via e-mail at: ricsjog@student.chalmers.se

Thank you in advance for participating!

Best regards
Richard Sjögren and Marcus Söderström

*Required

### What is your position onboard? *

- ○ Master
- ○ Chief Officer
- ○ 1st Officer
- ○ 2nd Officer
- ○ 3rd Officer
- ○ Deck Cadet
- ○ Chief Engineer
- ○ 1st Engineer
- ○ 2nd Engineer
- ○ 3rd Engineer
- ○ Engine Cadet

## The bridge team

These are questions about your experiences with bridge teams.

### How many years have you been part of a bridge team? *

- ◯ 0-1 years
- ◯ 2-5 years
- ◯ 6-10 years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ 21 years or more

### Have you ever taken a Bridge Resource Management course? *

- ◯ Yes, recently (within the last 5 years)
- ◯ Yes, but not that recently (more than 5 years ago)
- ◯ No, never

### How would you rate the co-operation within your bridge team? *

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Very poor | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Very good |

### How would you rate the communication within your bridge team? *

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Very poor | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Very good |

## The bridge and engine room teams

These are questions about your experience with the teamwork between the bridge and engine room teams.

How would you rate the co-operation between the bridge and the engine room teams? *

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Very poor | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Very good |

How would you rate the communication between the bridge and engine room teams? *

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Very poor | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Very good |

How much do you feel you know what the engine room department does during everyday operation? *

- ○ Everything
- ○ Most things
- ○ Some things
- ○ Nothing

Do you think a Maritime Resource Management course that is training deck and engine officers together could improve the co-operation and communication between the bridge and engine room teams? *

- ◯ Yes
- ◯ Yes, but only the co-operation
- ◯ Yes, but only the communication
- ◯ Most likely
- ◯ Probably not
- ◯ No
- ◯ Don't know

Do you think simulator training where the bridge and engine simulators are connected would be useful in such a Maritime Resource Management course? *

- ◯ Yes
- ◯ Yes, but only for training the co-operation
- ◯ Yes, but only for training the communication
- ◯ Most likely
- ◯ Probably not
- ◯ No
- ◯ Don't know

## The engine room team

These are questions about your experiences with engine room teams.

How many years have you been part of an engine room team? *

- ◯ 0-1 years
- ◯ 2-5 years
- ◯ 6-10 years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ 21 years or more

Have you ever taken an Engine Room Resource Management course? *

- ◯ Yes, recently (within the last 5 years)
- ◯ Yes, but not that recently (more than 5 years ago)
- ◯ No, never

How would you rate the co-operation within your engine room team? *

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Very poor | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Very good |

How would you rate the communication within your engine room team? *

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Very poor | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Very good |

## The bridge and engine room teams

These are questions about your experience with the teamwork between the bridge and engine room teams.

How would you rate the co-operation between the bridge and the engine room teams? *

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Very poor | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Very good |

How would you rate the communication between the bridge and engine room teams? *

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Very poor | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Very good |

How much do you feel you know what the bridge team does during everyday operation? *

- ○ Everything
- ○ Most things
- ○ Some things
- ○ Nothing

Do you think a Maritime Resource Management course that is training deck and engine officers together could improve the co-operation and communication between the bridge and engine room teams? *

- ◯ Yes
- ◯ Yes, but only the co-operation
- ◯ Yes, but only the communication
- ◯ Most likely
- ◯ Probably not
- ◯ No
- ◯ Don't know

Do you think simulator training where the bridge and engine simulators are connected would be useful in such a Maritime Resource Management course? *

- ◯ Yes
- ◯ Yes, but only for training the co-operation
- ◯ Yes, but only for training the communication
- ◯ Most likely
- ◯ Probably not
- ◯ No
- ◯ Don't know

## Thank you! Please press submit to send your answer.

Thank you for participating in this survey, your answers really help us getting an understanding of your experiences onboard!

If you have any questions, please feel free to contact us via e-mail at:
ricsjog@student.chalmers.se

//Richard Sjögren & Marcus Söderström

# Appendix II – Document of Consent

**Document of consent**
**Participation in a research interview**
**Diploma Thesis at the Master Mariner Programme**
**Chalmers University of Technology**

By signing this document I (the interviewee) agree to the terms and conditions stated below of participating in a Diploma Thesis research project led by Richard Sjögren and Marcus Söderström at Chalmers University of Technology in Gothenburg, Sweden.

1. Participation includes being interviewed by the researchers about the use of integrated bridge and engine simulators in maritime officer training courses and similar subjects related to the topic of the research. A list of questions and/or topics will be sent to the interviewee by the researchers prior to the interview date.

2. My participation in this project is completely voluntary and I can at any time choose to withdraw my participation without stating a reason. I also confirm that I have not been coerced into participating.

3. I have been given sufficient information about the research project as a whole and the purpose of my participation in it.

4. I allow the researchers to take notes during the interview. I also allow the researchers to record audio of the interview. If I do not consent to the audio recording, I can choose to withdraw from participation at will.

5. If checked **yes** in the boxes below, I give my full consent to use my name and the name(s) of any company/companies I am affiliated with in the final report.
   If any/both of the boxes are checked **no** I do not give my consent to use the information specified by the statement related to the specific check-box. If the latter is the case, the information specified will be treated confidentially by the researchers. All of the information gathered will be treated securely.

I agree that my name can be used in the report: **YES☐** **NO☐**

I agree that the name(s) of any company/companies I am affiliated with can be used: **YES☐** **NO☐**

6. I have received a co-signed copy of this document from the researchers.

By signing I hereby confirm that I have read and understood the terms and conditions stated above.

| | | |
|---|---|---|
| Participant's Signature | Participant's Name | Date |
| Researcher's Signature | Researcher's Name | Date |
| Researcher's Signature | Researcher's Name | Date |


| For further information, please contact: | E-mail | Telephone |
|---|---|---|
| Richard Sjögren | ricsjog@student.chalmers.se | +46 76-800 39 64 |
| Marcus Söderström | mackansoder@hotmail.com | +46 70-787 48 22 |