ABSTRACT

One of the growing markets in the shipping industry is the transportation of heavy cargo with ship cranes on board of ships. These loads can be turbines, complete Gantry cranes or small ships for example. Often this cargo goes to the limits of ship’s stability and capacity.

The loading and unloading process needs an experienced well trained crew to avoid damages of cargo or of the ship and to carry out the loading process in the shortest possible time.

In that process, several members of the crew have their specific task, which have to be fulfilled. First of all there is the Cargo Loading Officer, who has the responsibility about the process. He needs the complete overview about the actual status. In addition, the crane operators and the operator of the loading computer and the ballast system have to operate and control the situation.

These procedures can be trained in the Heavy Lift Simulator specially designed from Rheinmetall for the complete loading process of heavy cargo.

This speech gives a presentation about the concept for such a simulation which can improve the safety and the workflow in the loading process of heavy cargo.

Keywords: Heavy Lift Simulator, Rheinmetall, Operation of Ship Cranes

1. INTRODUCTION

Globalisation is the mayor factor that rules our life today. Products are traded between the continents and value creation chains have been established through the entire world. The backbone of this development is the maritime logistic industry that guarantees fast, efficient and affordable transport of all kinds of goods. The maritime logistic industry profits from the development of the globalisation but is also under increasing commercial pressure through rising costs for energy and personal.

Closest timetables and high interdependency in the global logistic networks forces the participating parties to decrease lay time with process optimisation and to prevent fatal accidents as a result of human failure.

So especially in the maritime logistic industry the applied proverb is today “time is money”. This can create a dangerous situation when people with no proper training and different linguistic background are confronted with time pressure and high skill tasks as they are usual for heavy lift operations with modern infrastructure used.

To prevent accidents and costs caused by human failure a special focus has to be set on the training of crew members.

Decades ago a crew member went through the ranks and learned from the older crewmen all what was important to know. But this changed and the fluctuation of personal increased.
Today cross-generation learning has become marginal. Training in the shipping business has to be fast, efficient and affordable.

To fill the gap between the commercial and human demands on the training of crewmen a unique and new solution has to be invented. This solution is the training for the loading and unloading process of heavy lifting with Simulators.

Rheinmetall Defence Electronics GmbH in its position as one of the leading companies in simulator technology now develops a new concept of simulators for heavy lifting.

2. GENERAL CONCEPT OF SIMULATOR TRAINING FOR HEAVY LIFT CARGO

Research shows that we remember 10 % of what we have read, 30 % of what we have seen and 90 % of what we did.

These results show how efficient simulator training is. So even years after training the trained behaviours are remembered and can be used when they are needed. Due to the fact that a simulator based training concept connects a theoretical part with practical operation all of our senses are affected and the training experience is very intensive.

This results in a decreased education time effort. In response to the “time is money” principle the financial effect is a proper answer towards rising personal expenses.

Speed of operation and the responsible use of equipment depend on the experience level of a ships crew and the communication with the team.

This experience can be gathered in a simulator, because the simulator creates an environment in which a trainee can practice in safe virtual world under a variety of realistic conditions.

In the simulator the trainee can train alone or in a team. Special situations like operation under extreme weather conditions or emergency procedures after serious malfunctions or accidents can be simulated with a minimum of costs and under a maximum of safety.

3. ADVANTAGES OF MODERN SIMULATORS

The biggest advantages of simulator based training are:

- Dangerous situations can be simulated with low effort and high efficiency.
- Flexible simulator design allows training of different operations without special adaptations.
- Simulator training can be adapted online to the trainees’ skill and so differently skilled trainees can train in one simulator.
- Special tools offer assistance in assessment and evaluation of training progress.
- Team communication can be trained and language barriers can be reduced.

The result: Quality of training is increasing and expenses are decreasing.

3.1. Exemplary for Realisation

The advantages of simulator training are obviously but up to now there have been no fitting products on the world market for the training of cargo loading processes with ships cranes for heavy and unwieldy goods. Rheinmetall Defence Electronics, as the leading company in simulator development, now develops a new unique concept for a “Heavy Lift Simulator”.

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3.2. The Heavy Lift Simulator Concept in Detail

The task for the design of the HLS is to find a solution for a maximized flexibility that ensures a proper team training and also gives the possibility to train single operations for each workplace in a very practical way.

The concept is designed together with a Bremen based shipping line with a good reputation in heavy lift cargo business.

The simulator concept includes simulation stations for:

- Cargo Loading Officer
- Two Crane Cabin Workplaces
- Workplaces for Ballast and Anti Heeling
- Workplaces for Stability Control
- Bridge Workplace

The whole simulation process can be supervised by one instructor from his Instructor Station. The workplaces are located in different rooms so that the trainees need to use their communication devices to communicate.

All workplaces are connected via TCP/IP and all actions done by one workstation inflict the operation of all other workstations accordingly. This will generate a realistic feeling of interdependency between the team members.

Figure 1: Example of a room layout for a Heavy Lift Simulator
Its main simulation components can be subdivided into five parts:

- The visualisation of the workplaces for the Crane Operators, the Bridge Team and the Cargo Loading Officer.
- The simulation of the technical systems for Ballast Systems as well as the systems for Power Supply, Anti Heeling and last but not least the Stability Calculation Station.
- The Simulation of the Ship itself including the influence of external forces, like wind.
- The simulation of the crane operation and the crane model.
- The simulation of cargo out of a library of different cargo models and physically realistic collision calculation.

On board, teamwork is absolutely necessary. A well functioning team is highly motivated, flexible and can handle critical situations better and faster. The key to successful teamwork is communication, especially when crew members of different nationalities and language backgrounds have to work properly together. The simulator will unite all relevant workplaces for loading and unloading operations in one simulator concept. This enables highly efficient training of team situations and team communication.

The simulator will be specially designed for crew member communication training and close to reality training of cargo loading processes. Normal operations in loading and unloading as well as special emergency and break off situations will be simulated properly. Different options in the simulation parameters can be selected and achieve a well adaption to different simulation conditions.

To ensure good training results the communication during the cargo operations is as listed in the sketch below.

The main actor in the loading operations is the Cargo Loading Officer. He instructs the Crane Operators how to handle the cargo. He has to communicate via communication devices with the Crane Operators and the team at the Ballast and Stability Station. Due to a near to realistic operation, real devices modified for the special needs of simulation should be used.
3.3. Workplaces

Because the Cargo Loading Officer has to move over the deck and the pier to get the best view on the scene he hasn’t got a fixed workplace. Up to now simulators like Ship Handling Simulators have been designed for a fixed workplace on the bridge for example. The challenge is to give near all freedoms of movement and to ensure the corresponding proper visual simulation.

The resulting requirements for the Visual System are enormous. Different types of cargo have to be simulated as well as the fully modelled ship, the cargo hold and all actions of the two cranes. The Cargo Loading Officer Workplace is designed for a full mission operation unit. The angle of view will be controlled through a Viewing Direction Panel and the location will be controlled with a computer system.

Well trained and experienced Crane Operators are a key to success in Heavy Lifting Business. Most of the fleets for heavy lifting are equipped with two cranes for independent loading operations.

These facts require also special attention on the design of the Crane Workplaces. Due to a realistic training scenario a real functioning crane cabin should be used and for communication purposes all crane cabins will be equipped with specially modified VHF-Communication systems.

The Ballast System, the Stability Calculator and the Anti Heeling System are essential for all loading operations.

![Figure 2: Operation of Ballast System](image)

Wrong stability calculations and inattentively use of the Ballast System and Anti Heeling has caused serious accidents in maritime history. Consequent training of crew members is necessary for the security of the ship, the cargo and the crew itself.
The simulated cargo ship will include a Ballast and Anti Heeling System which are connected to the cargo vessel model and the Load Calculator. During the loading and storage process the operator can observe and modify the ballast distribution. The Anti Heeling System can be activated and used to balance vessel during loading of heavy cargo. The shear forces, the bending moments and the stability of the vessel depending on the actual load situation will be calculated.

The Ballast and Anti Heeling System include the ballast tanks, pumps and valves with all important operating elements.

3.3.1. Visual System

The visual system must be adapted to the special demands of a Heavy Lift Simulator. To guarantee an authentic training, the visualisation system has to fit several requirements.

These requirements are:

- Close to reality graphics.
- High frequency of updates for simulation of fast moving objects.
- Implemented Edge Blending for proper transitions between adjacent channels.
- Synchronization of the channels.
- Presentation via projectors.

To fulfill these requirements the visualisation system generates a virtual environment with water surface, coastline, fixed and moving objects like the ship, the harbour and the different cargo. The whole visualisation is based on leading edge COTS hardware to guarantee a state-of-the-art performance and high-quality pictures.

3.4. RESEARCH ASPECTS

The human being is the source of all economical activities but is also the cause of many accidents with massive economical and ecological damage.

The task of the twenty first century is to maintain the economical development of the world and to find technologies that can help us to prevent human failures and their consequences.
The simulator technology is a key to success in this struggle. With it we have the possibility to train our skills and to test our technology in a virtual and safe environment.

Because of their realistic and unique mathematical models Rheinmetall’s simulators are used for intensive research.

They can be used for detailed analyse of recent accidents and occurred malfunctions. Due to the reliability of modern simulator technology, operational processes can be simulated with accordance and the causes of accidents can be identified. The research about the reliability of new technologies and work flows can also be accelerated through the use of simulator technology.

4. CONCLUSION

There are several benefits in the use of simulation for Heavy Lift Cargo handling.

First of all is the safety aspect. Ship crews which are well trained can handle the loading process in a safer and faster way. The second important aspect is the possibilities of researching activities and accident evaluations.

We hope that Heavy Lift Simulators for Ship Cranes will be accepted as a good and reliable tool in the education of seafarers in the future.

5. REFERENCES

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