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Reducing Risks of Arctic Operations with Ice Simulator

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ABSTRACT: During the process of development of the Full Mission Bridge Simulator, I have come in to a conclusion that an important part of a successful learning process is the ability to train with a high fidelity bridge simulator. The Polar areas are harsh environments and to survive there, one must have special training and experience. This surviving means that the polar ecosystem will survive from pollution and the vessels and their crew from the bad judgments or misconduct of vessel operators. The most cost-effective way to improve special skills needed in the Polar waters is to include bridge simulator training to the Deck Officers requirements. In this paper I will introduce a real life situation in which an icebreaker assisting a merchant vessel gets into a "close call" situation and how this was handled. Maritime industry hasn't studied much about the influence simulator training has to the navigators. Here the maritime industry could learn from aviation and medical industry, since they have done some extensive scientific studies to prove the need for simulators.

1 INTRODUCTION

The polar area has been explored in the search of minerals, oil and gas for many decades. It shows that this area has large natural resources. Production and exploration is ongoing in the Beaufort Sea, the Greenland Sea, the Norwegian Sea, the Barents Sea, the Kara Sea, the Laptev Sea, the East Siberian Sea and the Chucksi Sea.

Oil and gas developments and shipping have grown rapidly since the reduction of the sea ice; these developments face challenging conditions,
- darkness in winter
- extreme coldness
- remoteness
- unpredictable weather
- ice in many forms.

These challenges have not stopped the desires to develop the area in terms of collecting natural resources for commercial use.

The polar area is a unique environment and it is something that we want and need to protect from any kind of pollution. Oil spill amongst arctic species would be utterly harmful.

A disaster in these waters would create severe environmental consequences and especially risk the lifes of the crew.

These environmental and life threatening disasters can be avoided with adequate bridge simulator training.

2 RISK MANAGEMENT

Many companies are now taking the risk of commercializing natural resources. Ship-owners have started to use the Northern Sea Route and the North West Passage for their ships. These areas are tough on vessels and crew. If you are new to the job and environment, learning on the actual workplace on an unfamiliar vessel and in an unfamiliar environment is a risky business.

I believe that companies which have arctic experience plus are using technologies and services specially adapted to arctic conditions are the ones to succeed.

Part of the risk management is having a suitable ship with experienced ship crew. This crew in the near future need (from the year 2017 onwards) a certificate for operating in the polar waters (Polar Code). In this accredited polar code certificate training process, the bridge simulator will most likely be one of the approved methods of training the polar navigators.

One important point in which the simulator is really useful and suitable, is in designing a new port or a production plant. In my opinion these new designs would require a feasibility study to be performed. To make a study with exact port visualization, vessels and weather conditions one can find out design mistakes and set environmental operational limits.

3 SIMULATOR

3.1 *Why need a simulator?*

Some years ago we in Aker Arctic noticed that the Ice Simulations were not present, and that the ones we saw were merely using ice as a color in visualization. We decided that we will create a proper Ice Simulator in which the actual ice forces to the vessel would be present in various ice conditions. Our aim was to create a high fidelity simulator, i.e. a simulator that physically and functionally imitates the real equipment and environment as well as possible.

The simulator is needed for different reasons: cost, safety, easiness of teaching, efficiency in teaching, testing of design and in finding out operational limits. It could also be used in accident investigations by visualizing the incident. One can make independent analyses of the accidents or incidents. It is possible to create many "near miss" or "what if" scenarios. Simulator can be tailored just for your vessel and its operations.

In many cases it is not possible to organize training in a real environment, and arctic especially should not be the place where real life practicing takes place. Simulator enables training of risky and hazardous operations safely and operators' insufficient skills can't harm real nature, lives or material. Risks on real life vessel operations are smaller.

Simulator training is less expensive compared to real vessel operations. Bridge simulator is cheaper than real bridge on a vessel, and operational costs are low. Service and maintenance is less demanding. Time aspect is also favorable for simulator, the actual place and a mission where the skills need to be practiced can be set up immediately, and no time is wasted for travelling to the job or assignment.

3.2 *Bridge Simulator*

In Maritime Institutes where the deck officers are educated, one of the first tasks is to learn how to navigate in darkness with radar only as the navigational aid. This is done by using a bridge simulator. When the course is successfully over, the student has gained self-confidence on handling a VLCC, RoRo or any other vessel in congested waters, or in a challenging archipelago like we have in the south west of Finland. Then the students study further and vessel operations in simulator play a key part in the process of becoming an experienced seafarer. This is how I was trained and I think it was adequate for me at that time. These kinds of simulators are in every corner of the world and for sure they have bought safety in navigation and operations performed at sea.

Operations in ice and below freezing temperatures are always challenging. The vessels should be ice strengthened and winterized and commercial vessels should follow the pre-set procedures given by authorities of the area. Icebreaker assistance and convoy has certain procedures. For a person who has never experienced such things the only way to practice is in simulator, and I believe that the safe unexpected situation training is only possible with simulator.

The Ice Simulator should have:

- Tailor made simulation models
- Accurate own ships with correct control systems and real equipment
- Machinery behavior and interaction with ice
- Validated ship and icebreaking behavior
- Dynamic ice models
- Good and tailored visual system (correct visual observations)
- Multiple ship operations (many bridges)
- Ice load correctness
- Purpose built exercises
- Port layout and operation studies possibility
- Route study possibility
- Radar / Ice-radar and ECDIS simulation

Navigation in ice, practical training for the icebreakers and operations with icebreaker and ice navigation for ice strengthened vessels would be most useful for personnel entering ice infested waters. The Ice Simulator development Aker Arctic has done is aiming to fulfill these above mentioned needs and requirements.

Figure 1. Bridge of a Baltic Icebraker (IB OTSO)

Figure 2. Ice Simulator Bridge (Aboa Mare)

Correct interaction between a merchant vessel and an icebreaker is important for safe and successful operations. There are certain procedures that the escorted vessel should do and follow, and icebreakers have their own procedures. After normal simulator practices the student (operator) should be familiar with the merchant vessel or icebreaker procedures. I believe that the role reversal exercises would be important in understanding the actual ice operations and grasp what it is all about. Safely practice icebreaker vs. merchant vessel role reversal is only possible in simulator environment. It would not be possible to be a Captain of Kara Sea icebreaker leading a convoy of merchant vessels, or a Captain of the LNG tanker following that icebreaker in same convoy. With simulator this is possible, and safely.

What are the simulator properties that are important for learning? In aviation industry this is studied: Koonce and Bramble (1998) stated that it is not known why, in some complex cognitive psychomotor tasks, some simulator properties affect transfer more than others. They assume, based on Lintern (1991), that certain cognitive principles are important, not because the physical similarity of a simulator to an airplane. Baudhuin (1987, p.218) states that functional similarity rather than physical similarity affects the transfer of learning.

Cues are those simulator properties, properties of the simulator display or sounds that the user uses to make decisions. These are, for instance, the center line of the runway that helps the pilot to land, or sound of an engine: they provide the user with information that helps him/her to make decisions. In a simulator, these cues have an essential role because the user's decisions are based on them. In many simulators, the characteristics providing essential information have been enhanced. This is called augmented cueing (augmented = having been made greater in size or value). (Taylor & Lintern 1993)

3.3 *Learning, action and technology*

Learning to use a simulator is based on doing, experimenting and making errors to a great extent (learning- by-doing approach). The focus is on learning practical skills.

When actual work environment is simulated, the real equipment, -materials and –time frame is used, so theory can be put to tests. It is important that skills learned in simulator can be practiced soon thereafter in real environment in order to make the transfer of learning more effective.

Venkula (1993, p.61-80) studied the connection between activity and creation of knowledge. The fact that the individual does something him/herself and is thus concretely involved in events has a significant effect on the creation of knowledge. To achieve technical knowledge (psychomotoric skills and learning theory) importance is in repeated practice and periodic refresh. When we do something in practice we use and develop our mental capacity in a holistic way, not only memorizing details.

Chain of events that ends in collision is something everybody wants to avoid. Hours spent in bridge simulator will pay back when the operator will act in real life situation safely and as practiced. With simulator it is possible to practice various situations under circumstances that closely resemble real situations. Learning in virtual environment is different from the traditional learn-by-doing in real environments. It is possible to experiment without risks, and try to find new ways to perform the task. One can use the imagination and create new innovative solutions. A simulator is a safe environment because the actual accidents and faults do not lead to any casualties or major oil pollution. This "without risk" learning may bring to some operators wrong self-confidence and may lead to practices where the operator takes too high risks. In simulator training it is possible to create situations that subject the operator to errors, and thus decrease operators' excessive self-confidence.

Aviation industry has studied much about the simulator in training the pilots and crew, and their goal is to make operator and airplane work in effortless cooperation. They also have the most advanced simulators giving an authentic immersive experience of flying an airplane.

Medical education has adapted the simulation-based training environments for the reason it is a safe way to teach and practice practical skills, without endangering the patients. Smith (2000, p.633) characterizes simulation based training in surgery as follows: it enables active participation and makes it possible to use scenarios that are suitable for the skill level of the student. Performance can be evaluated and feedback given immediately. In my opinion this same can be said about maritime simulation training.

After the practices the important part of the learning process is the Debriefing. My own experience of this is that debrief / feedback after each ship bridge simulation session was of utmost importance. Valuable comments from instructor were helpful, and finding out what went well and what was the reason for something that didn't go as it should. An important part after the exercises and debriefing was the opportunity to get back and carry on with exercises. Dismukes, McDonnell and Dope (2000) studied debriefing sessions after LOFT ((line-oriented flight training) the entire flight is simulated instead of isolated tasks) training. According to the results of their research:

- in addition to the instructors evaluation, the students/operators self-evaluation is important
- during the debriefing, the instructor should act as a facilitator so that the students will take a more active role in discussion
- instructor needs training how to lead debriefing session
- student/operator needs to be trained to participate in debriefing session.

4 STUDY CASE

4.1 *Example of real icebreaking operation*

I give a real life example of the icebreaking escort that could have ended in a collision. This was avoided due to the experienced icebreaker crew and pilot in escorted vessel.

This happened April 2014 in The Gulf of Botnica. I was onboard doing research of icebreaker operation. There were a lot of drifting ice-fields, new and old ice, big ice foes and smaller ones in the area of vicinity. Icebreaker had two engines running, since the ice had been soft all day and she had full speed during the incident. When IB suddenly encountered a field of hard ice, two engines were not enough to keep up the marching speed. To start the additional two engines would have not helped in this situation because in 80 seconds it is not possible to get the propulsion up and running. Escorted vessel speed is not known, but engine command is expected to be full ahead.

IB OOW was First Officer / Captain, a very experienced sailor and has been working in icebreakers for over 10 years.

Escorted vessel:

General Cargo, GT 12993, length 143 m, beam 22,8 m, draft 7 m.

Icebreaker:

Baltic icebreaker, GT 7066, length 99 m, beam 24,2 m, draft 8 m.

Figure 3. 0 sec. IB meet the hard level ice

Figure 4. 40 sec. IB speed reducing, IB evaluate the situation

Figure 5. 52 sec. IB informs escorted vessel pilot to take "hard to port"

Figure 6. 65 sec. Distance closes, no course change

Figure 7. 74 sec. Vessel start to turn

Figure 8. 86 sec. Vessel steer away from the channel

Figure 9. 99 sec. Vessel cut into hard level ice field

Figure 10. 110 sec. Situation clear

This situation could have ended in a collision if either one of these parties would have been occupied with any distracting element, causing escorted vessel hitting the fork, or side of the IB. In image 8 one can clearly see that escorted vessels bow was not far from the IB's made channels edge. If the bow would have entered the IB's made channel, the vessel would have not been able to break out from the channel, the impact angel being too small and vessel would stay on the channel. The time in which the important decisions were made was a matter of tens of seconds.

4.1.1 *Alternative manoeuver for IB to avoid collision*

From IB point of view there would have been one more thing to do, if the vessel would have not succeeded to avoid the channel and would have approached on collision course. IB would have made hard to Starboard intending to make way out of the straight channel she has made, thus allowing escorted vessel a change to break out from the channel in the curve IB just made, maybe there could be some other solutions as well, but this is the known and used way to react in this situation.

This real life operation could be easily transferred to simulator exercises. In my opinion this and other dangerous operations should be practiced in simulator before entering the real vessel. Operational simulations and vessel familiarization would lead to safer operations in polar waters.

Figure 11. IB operator station in starboard bridge wing, 180° panoramic view

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