Ship Handling Simulation in Approach Channel and Harbour Design

by

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ABSTRACT

Ship handling simulation became a basic and vital part of training of seafarers all over the world. Along with the ever increasing fidelity of the simulators available, they were used more and more regularly for other purposes like feasibility studies, whereas the aspect of no risk for life and environment is paramount. Nevertheless, the demands and requirements of proofs of concept and approachability checking on the simulation and simulator technology differ from those of training and education. There is a huge overlap, which makes use of full mission bridge installations at nautical schools and training centres for approachability checking so widespread and common, but also some substantial differences. This contribution discusses the strengths and weaknesses of full mission bridge simulation applied to channel approachability and harbour layout checking.

1. INTRODUCTION

Ship handling simulators are part of the education schedule of mariners and nautical personal. Training is mandatory according to the STCW-95 convention adopted by the IMO and there is a procedure of certification installed by the classification societies. For instance the Norske Veritas alone lists 164 Simulators world-wide, certified to their standard “2.14 Maritime Simulator Systems”. There is a long history of constant development and improvement before the simulators in the training centres reached the level of fidelity today’s full mission bridge installations offer. It started with small heading control handles and a radar screen for radar training and later on followed the development and improvements of computational power and instrumentation installation aboard ocean going ships. A major step towards enhanced training experience was the availability of full integrated bridge installations together with recognizable pilotage areas in the display system of the environment. The fast development and tremendous efforts of the gaming industry was helpful to gain ever better and deeper levels of virtual reality, also for this kind of so called serious games. The viewing systems of today’s ship handling simulators display spray of water at the bow, shadows, reflections on water, different colouring according to solar altitude, starry sky at night, moon phases, glare of deck lights and lantern ashore and the like.

It is well accepted from simulator training research that the level of immersion into the scenery and the exercise requires a certain degree of realistic, which is easily interrupted or even abruptly destroyed by any disturbance from outside and/or an unexpected and unrealistic appearance in the virtual reality. An unnatural behaviour experienced by the trainee abruptly changes his perception from being in the scenery to being part of a computer game – which obviously has to be avoided as far as possible.

With the availability of full mission bridge simulators and well recognizable displays of the environment, the use of these assets for approachability and harbour layout checking started. It is an alluring offer to approach a channel or a complete harbour with all buildings before breaking ground.

In the past decade there was a trend towards tailored and specifically developed simulators in the maritime field. Today, there are simulators available for training of very specific skills, to name a few: manoeuvring in ice, offshore and harbour tug operations, emergency salvage tugging, crane handling

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on board, offshore supply vessel operations, ship to ship operations and lightering, dynamic positioning, search and rescue, firefighting and so on.

Some of the specific task simulators required additional and/or refined manoeuvring and ship dynamic models to reach the required level of reality. Each further development of dynamic models is a gain in capabilities also for using the simulator in terms of layout checking. This is important since the demands on a ship handling simulator differ for training to checking of approach channels and harbour layout design.

2. DIFFERENT DEMANDS OF TRAINING AND CHECKING

Training at the ship handling simulator aims at gaining experience and application of freshly acquired knowledge. Usually there are scenarios and sceneries prepared to specifically answer to this need. The simulator's hardware needs to provide every single instrument and handle the student needs to fulfil the particular task. Furthermore it is required that the simulated environment including the vessel under command acts realistic, but it is not necessarily precisely a certain ship and channel.

As for training and education purposes, the aim of the simulator study needs to be defined first when a ship handling simulation is considered for checking of channel and harbour design. After the aim is precisely defined, there are many significant differences to a simulation for training. It is mainly the level of detail of almost every aspect which has to be higher or go deeper.

Based on the gist the scenarios to be examined are chosen, this is a general habit. For training purposes reasonable and regular conditions of wind and visibility, sea state and so on are chosen suitable to the task. In the case of a definite pilotage area and location, the selection of environmental conditions requires careful consideration in terms of specific local peculiarities and demanding or risky nautical situations. At the best the decision on the environmental conditions is based on the statistical analysis of long term measurements in the particular area and agreed on by all parties involved.

The next step consists of proper tuning of the ship dynamics in the simulator. For training it is usually sufficient to match a typical behaviour of a ship of the particular size and type. If the simulation is the basis for later authoritative decisions, usually on speed or size limits, the conformance of the modelled ship dynamics with the particular ship in operation in the area needs to be satisfactory high. This is a demanding task; on the one hand results of sea trials are rare and usually not performed at recommended weather conditions. On the other hand even if reliable sea trials are available, the adaptation of the simulator's manoeuvring model to match the data is not trivial.

In the vast majority the pilotage areas, approach channels and harbours constitute shallow water conditions to the ships sailing there. This is further demanding for the simulator's mathematical model of ship dynamics, especially since sea trials in shallow water are scarce to not existent. Shallow water effects are more or less prominent, depending on the proportion of under keel clearance to the ship's draft. For small values the shallow water effects become dominant and alter the deep water manoeuvring characteristics of the particular ship completely. There is ongoing research in generalized mathematical modelling of shallow water effects, but for the time being the tuning of the simulator model still relies on the experience and knowledge of the personal in charge.

In approach channels the waterway is not only restricted in water depth, but also in width by side walls or banks. Amongst other effects the shallow water conditions include ship to bank interactions, which shall serve as an example for illustration. The ship to bank interaction may lead to unsafe situations or cause accidents if the ship gets close to bank's side at higher speed. The effect is a combination of a sucking force towards the bank accompanied by a bow-out moment changing ships heading. Therefore the occurrence and the intensity of the effect are eminent for a channel to be approachable for a particular ship, and accordingly the model's tuning gets a dominant role in the

set-up of the simulation. A sophisticated and sufficiently accurate mathematical model of this effect in combination with careful calibration is essential for the simulation's success if this effect is considered prominent for the approach channels width declaration.

It is a quarter of a century ago, that recommendations on set-up of ship handling simulations and evaluation of mathematical models were felt missing and according reports were assembled by specialists groups in the US [Webster (ed.) (1992)] and international [PIANC (1992)]. Today, 25 years later, there is a further report in progress which shall update the latter one as well as serve as kind of a handbook and reference for use of ship handling simulation to approach channel and harbour layout checking.

3. HUMAN ELEMENT IN SIMULATION

Basically the human element is the reason for setting up a scenario and using a full mission bridge simulator when checking an approach channel or a harbour layout. Otherwise, pure geometrical considerations supplemented by mathematical-physical calculations were sufficient.

Besides this elementary premise, the human element is inherent in almost all steps of a simulation. One of the most important parts of the simulation process is the validation of the existing conditions. Experienced pilots familiar with the pilotage area judge the simulator's ship behaviour and environmental effects calibration based on their expertise to be as realistic as considered necessary.

Another part consists of the experience and psychological effective acting of the instructors of the simulation. Mainly their expertise keeps the level of immersion in the simulation at the required level and to gain meaningful results. This especially includes the ability to spontaneously react on difficulties and incidents of misbehaviour of the simulator by work-arounds they can find due to their deep knowledge of the facility.

Even more difficult is to balance the typical gap between the expectations which result of a properly set-up simulation and the actual level of mathematical-physical modelling. A careful and experienced prepared simulation, even more in combination of today's display systems and their photo-realistic capabilities, creates the impression of a perfect virtual reality. This often leads to unrealistic and excessive expectations on the results of the simulation by the spectators not directly involved. But also the pilots may experience similar impressions and conclusions and ending up with a less reflected judgement of the nautical situations based on the fact that it worked easy in the simulator.

The most important and the most difficult part of a simulation to check a new and nautically unknown harbour layout or approach channel is the evaluation of the experience in the simulation performed. To harvest the first impression and first thought, it is essential to have sufficient debriefing after each exercise or run. But the complete judgement can only be done after the whole figure of situations is simulated and checked. The challenge consists in a proper division of individual experience and opinions to get an honest, appropriate and reliable judgement of the nautical situation which is the basis to draw correct conclusions.

Therefore, the success of such a simulation basically depends on the ability and the honest support of each participant, especially the pilots on the simulator's bridge to bring in their expertise to properly evaluate each run. It is essential that the pilots compare the result of a simulation, how deep and close to perfection the immersion into the virtual reality has ever been, with their experience and reflect openly and with good grace what they have experienced in the simulation some minutes ago on their knowledge of the particular pilotage area and experience in ship handling.

4. SUMMARY

Ship handling simulators equipped with full mission bridges and fitted with real instruments are the only and a very efficient tool to judge and check new approach channels and harbour designs before being build. Continuous development and improvement of mathematical-physical models together with increasing computing power and photo-realistic displays make the SHS paramount to any other approach, as long as the flaws, drawbacks and imperfections of this virtual reality are known to the involved parties and are considered in the evaluation phase of the results. The report of the PIANC WG 171 aims at spreading the knowledge on the actual performance of state of the art ship handling simulator technology as well as providing recommendations on further development and improvements by scientific research on ship hydrodynamics as well as of the software and hardware available for full mission bridge ship handling simulators.

References

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