Heavy Weather Ship-Handling Bridge Simulation

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ABSTRACT

The Naval Stability Standards Working Group (Australia, Canada, France, Netherlands, UK, USA) is examining the accepted risk associated with naval intact stability standards in extreme environmental conditions. Part of this programme is the inclusion of the assessment of the influence of the operator on capsize risk. Operator Workshops held by the Royal Netherlands Navy in 2005 & 2007 proved the feasibility of linking a bridge simulator and the dynamic stability tool FREDYN to achieve this goal. Building on the knowledge and recommendations from the Netherlands workshops the MoD held a Heavy Weather Ship-Handling Workshop at the TRANSAS bridge simulator, Portsmouth on 15-16th December 2009. The objective was primarily to benchmark the simulations with ship characteristics using Royal Navy Ship-handling doctrine. Whilst some further development is required on cues e.g. spray and ship manoeuvring characteristics the workshop successfully demonstrated, the integration of FREDYN v10, state of the art simulator graphics and the characteristics of heavy weather doctrine.

KEYWORDS

Ship-handling, Heavy Weather, Bridge Simulator.

INTRODUCTION

Modern Naval stability standards have had an exemplary record to date. These standards were developed over 40 years ago on hullforms different from today’s. It is the goal of the Naval Stability Standards Working Group (Australia, Canada, France, Netherlands, UK, USA) to understand the strengths and weaknesses of current criteria applied to today’s hullforms. In doing so, assumptions have been made about the influence of the operator in extreme seas. It is an unassailable fact that safety in such conditions is strongly influenced by good seamanship and command decisions. A series of Naval Operator Ship Handling Workshops were held at the Royal Netherlands Naval College bridge simulator facility (2005 & 2007). The basic intent of such has been twofold; firstly to allow insight into the beneficial effect of good seamanship upon the risk of capsize, and secondly introduce, to the naval operator training fraternity, the potential of the latest technological advances in heavy/extreme weather ship simulation and ship board operator guidance as a viable supplement to sea time experience.

The influence of the operator, derived from such a simulator, will be translated to scientific parameters such as the intensity of different cues to select speed and heading. These parameters will be used in FREDYN dynamic stability risk calculations to minimise or discount the probability of unreasonable speeds and headings in extreme environments.

This paper describes the findings of a workshop held by the Sea Systems Group to benchmark with operator experience the bridge simulator visual, audio cues together with FREDYN ship handling and motions characteristics

THE APPROACH

The goal was achieved through the integration of FREDYN v10 via a dll with the TRANSAS NTPRO 5000 software. The following architecture was used

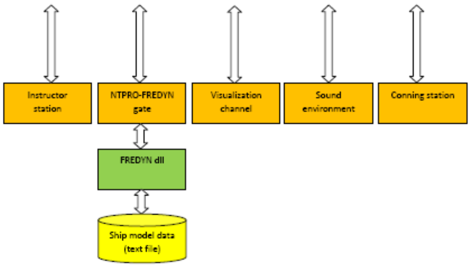

Figure 1: FREDYN/NTPRO Integration structure

On initialisation of the FREDYN program, data was passed to the NTPRO simulator based on the information defined in the FREDYN input files. This data consisted of the wind speed and direction, wave direction and the frequency, phase and amplitude of all of the wave components used to define the sea conditions. Other ship data parameters at time zero were also passed to the NTPRO simulator, such as ship attitude, initial velocities and RPM settings. Once the simulation was underway the visualisation parameters in the simulator could be modified to change the appearance of the visual effects to reduce visibility and change weather and light conditions

The following cues had been incorporated in the simulator triggered by FREDYN:

- Slamming noise
- Bow Spray & green seas (Figure 2)
- Propeller racing (temporary increase in RPM on bridge readouts and sound effect)
- Hull creaking

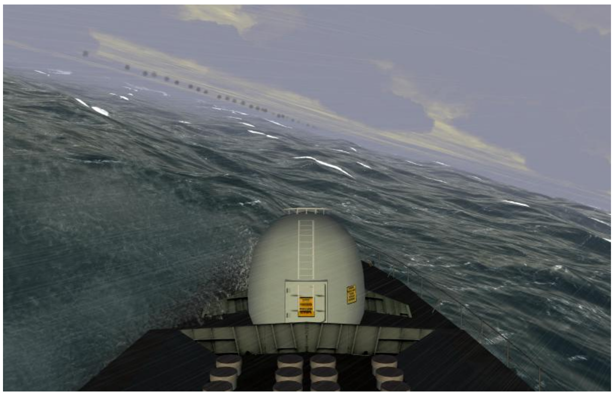

Figure 2: Bow Spray on SAR Stage 4

FREDYN provided the wave field and calculated the motions to suite in real time, triggering cues accordingly. A NTPRO overlay was applied to the waves to provide realism of definition such as white crests and streaking on the waves.

THE SIMULATIONS

The scenarios used a T23 frigate in ship conditions that are representative of the ship as compliant with its stability standard.

Figure 3: T23 frigate

The serials used selected environmental and ship conditions to best illustrate the handling behaviour of the ship. The key characteristics selected for demonstration were:

- Pitching (the effect of trim and speed)
- Rolling (the effect of wave period & speed)
- Stern to sea ship handling (avoiding broaching & pooping)
- Turning across a sea (starting into and down sea with wind)

A scenario was also exercised dedicated to combining the above characteristics into a

Search & Rescue and Storm scenario as described below.

SEARCH & RESCUE SERIAL (SAR)

The goal of the scenario was to exercise ship-handling doctrine benchmarking in an operational environment. It provided insight into operational considerations and the impact on ship-handling and the environment. The environment is progressively worsened throughout the serial although there was a necessary pause between each to facilitate reloading FREDYN. Wind was in the direction of waves and changed to deliver spreading and gusting in FREDYN.

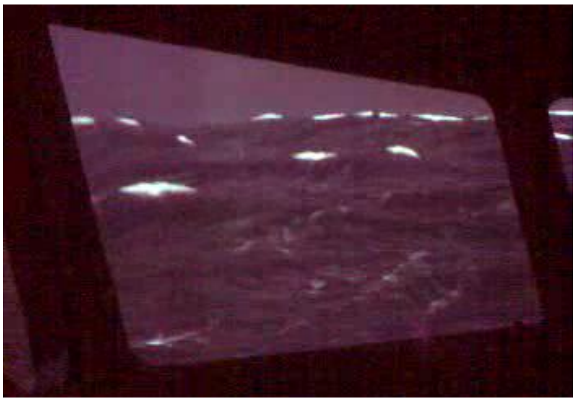

Figure 4: View from the bridge

Stage 1: Pilotage from Devonport with an Auxiliary ship to steam to Gibraltar at best speed. Building SAR scenario with 2 vessels in difficulty.

Stage 2: Low Sea State 6 (Hs=4m, Tm=10secs), Wind 30Kts. Goal to achieve best speed in bow quartering seas. Ship advised to proceed to sunken yacht to pick up life raft and person in water.

Stage 3: High Sea State 7 (Hs=9m, Tm=13.6secs), Wind 45Kts. Line of sight to casualty across the sea. Ship to adopt best speed to pick up casualties. Officer of the Watch (OOW) assesses conditions and adopts either a bow or stern quartering course. Scenario provided an opportunity to position ship for either deployment of rescue boat or swimmer of the watch.

Figure 5: SAR Stage 3 completion

Stage 4: Mid Sea State 8 (Hs=11m, Tm=15secs), Wind 45Kts. New casualty, tanker on fire ship advised to proceed at best speed to tanker and to standby vessel on arrival. Line of sight to casualty is stern quartering seas. OOW assesses conditions and selects a best speed whilst minimising motions and ensuring ship has steerage.

Figure 6: SAR Stage 4 Auxiliary ship Helo returning from tanker & smoke from tanker seen in the distance.

Stage 5: High Sea State 8 (Hs=13m, Tm=16secs), Wind 45Kts. SAR complete and ship to rejoin original track, OOW to advise best speed in conditions head seas. Man Over Board (MOB) from flight deck then reported and thus turning across the sea is exercised.

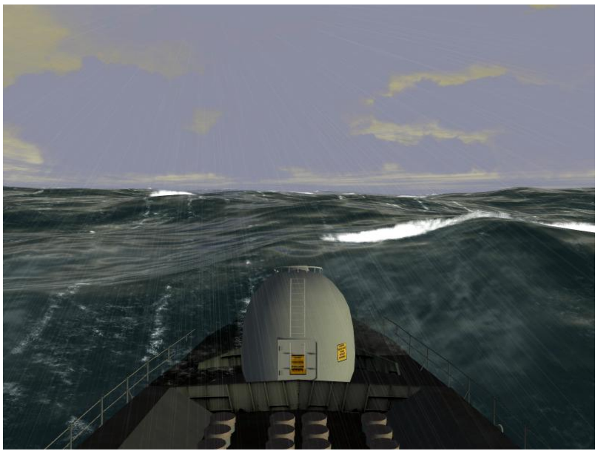

Figure 7: SAR Stage 5 Head Seas.

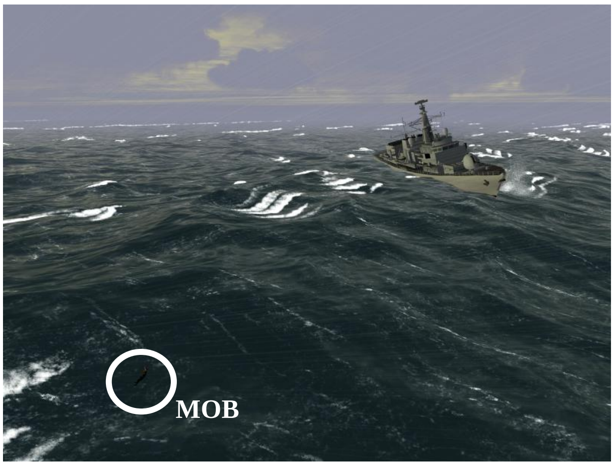

Figure 8: SAR Stage 5 Man Overboard (MOB).

The operators concluded " I certainly feel I have been through a storm". The simulations as they stood exercised all the ship-handling characteristics of naval doctrine. It was a significant step forward in technological development in heavy weather ship-handling using a bridge simulator.

The workshop also highlighted additional influences on ship-handling such as the command structure on the bridge and also machinery configuration and response times. For example in stern seas where the guidance advises 60% of wave speed, this speed whilst providing more responsive course-keeping, may not be adopted as it is not an economical speed.

CONCLUSIONS

In the development of the heavy weather simulator capability a much improved level of understanding of the effect of good seamanship upon the risk of capsize has been gained. Further advancement of the visual & audio cues, bridge environment and FREDYN code is required before the heavy weather simulator can be deemed benchmarked. The key enhancements required are:

Essential:

- Spray cues & impact on bridge windows.
- Slamming audio cues
- Validation of ship manoeuvrability & the effect of wind and waves
- Wind spreading and gusting including an audio cue.

Desirable:

- Inclinometer
- Small OOW motion platform
- Slam judder.
- Noises associated with machinery e.g. propeller racing, gas turbine

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DISCLAIMER

The statements made in this paper are those of the author and may not represent that of the Ministry of Defence.