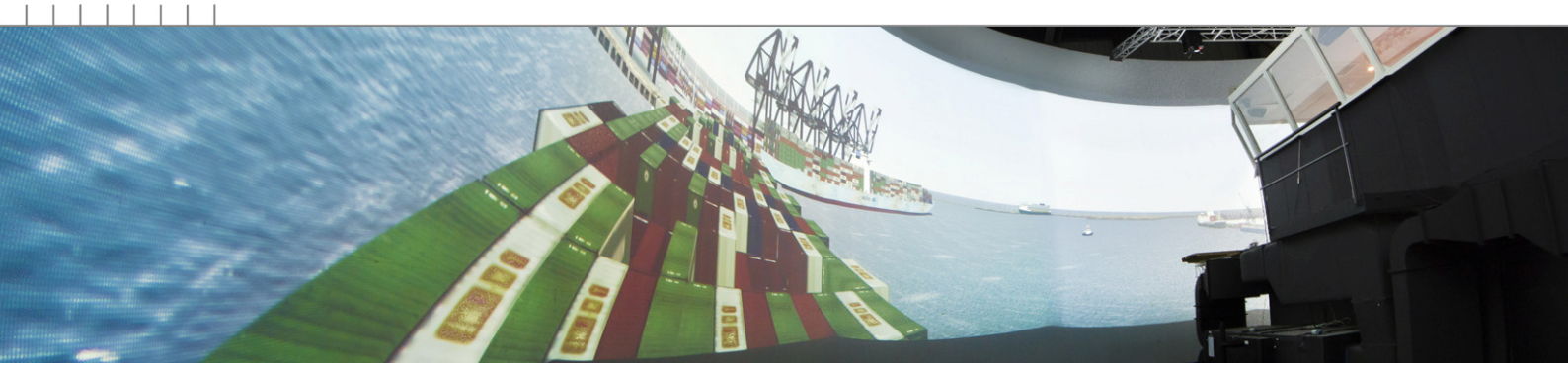


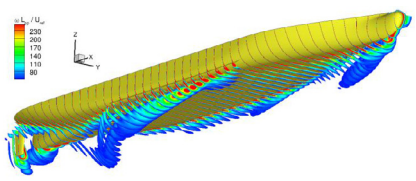
DOLPHIN: New tool for advanced nautical studies

Simulator well equipped to handle the most complex hydrodynamic challenges

Maritime Operations has a vast experience with nautical studies in which bridge simulators are used to evaluate port designs. Now, a new generation of bridge simulator software has proven itself in a nautical study for a new port.

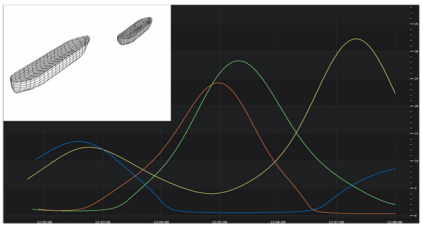
Dolphin simulator

Since 2015 MARIN uses it in house developed Dolphin simulator software in nautical studies and training. This new simulator is especially valuable when complex hydrodynamic effects need to be taken into account.
Over the past years MARIN has migrated its engineering calculation tools into MARIN's eXtensible Modelling Framework (XMF) platform. The result is that different XMF based tools can be integrated in one another, functioning as one software tool. Also the simulator software uses this XMF code. This means that software packages from MARIN's hydrodynamic toolbox can be included in the real-time simulator. The six degrees-of-freedom manoeuvring models in DOLPHIN take into account the influence of all external effects like wind, waves (first-order motions, wave drift), tidal currents, shallow water, bank suction, ship-ship interaction, tug and mooring line forces, collision forces etc. The models are water depth/draft dependent. The hydrodynamic effects are calculated with the most advanced hydrodynamic software available.

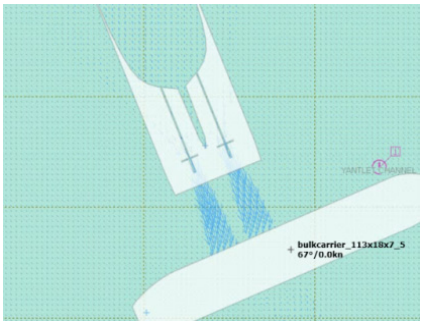


Multi-layer current

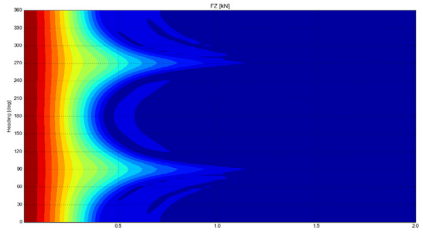
One of the first Dolphin studies involved a terminal situated in an area where fresh water river outflow and tidal driven salt water flow create complex current patterns. It was vital that the effects of this multi layered current were modelled correctly. To achieve this, the ship model measures current from a 3D current field at ten layers over the draft of the vessel and within each layer at multiple points along the vessel. The manoeuvring model calculates the hydrodynamic forces working on each layer taking into account the relative current velocity and direction. These forces are scaled with a weight factor depending on the depth of the layer and summed to get the total forces on the ship.



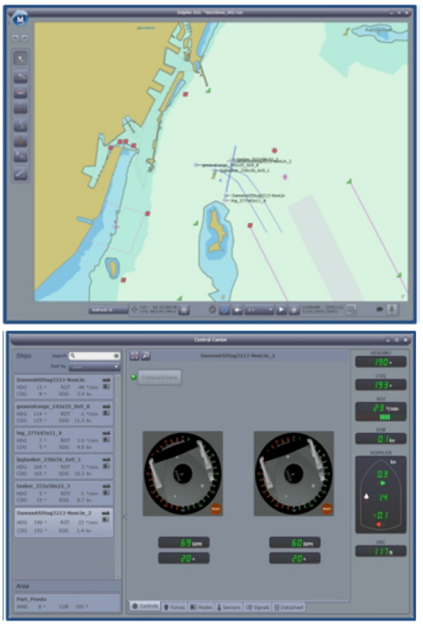
Line loads induced by passing ship



The effect of propeller wash



Wave response force Fz per direction and frequency



Dolphin User Interface

To obtain the correct weight factor per layer the results of Computational Fluid Dynamics (CFD) computations were used. For flow problems in which viscous effects play an important role, CFD calculations can be used to obtain reliable answers. CFD results on bulk carriers in deep and shallow water were used to determine the load distribution over the layers. Experienced local pilots validated the behaviour of the vessels in the layered current model.

Flow interaction effects

Another step forward was made with respect to how interaction effects are dealt with. The effects of ships and objects on other ships in the vicinity are calculated by the hydrodynamic module, called Flow Interaction. Based on 3D potential flow theory the interaction forces are calculated real time. Since fendering and mooring configurations can all easily be incorporated in DOLPHIN, it is possible to have a real-time analysis of the line forces in the mooring configuration when one or more ships pass by vessels at berth.

Dolphin can also take into account the influence of propeller wash on other ships. Especially when working with tugs this is a very realistic add on. The tug will experience the wash of the ship it assists, and when working on a line its effectiveness is reduced when its own propeller wash hits the ships hull.

Behaviour in waves

Also the way in which waves are handled in DOLPHIN takes full advantage of the sophisticated tools that MARIN has developed over the years. Tools like Fatima and Diffrac provide the first and second order wave forces, added masses and damping for a specific hull form. This data can be directly fed into the ship manoeuvring model where it is coupled to the ships manoeuvring forces. This ensures the most realistic performance in waves. By making the coupling on the forces level the effect of other external forces on ship motions is realistically felt. Combined with the fact that hydrostatics is calculated each time step using the actual immersion of the ships hull, the ship-tug relation can be simulated very accurately.

User interface

For many studies and trainings it is important to be flexible. In DOLPHIN additional ships can be entered on the spot, and routes and start settings can be set with a mouse click. All feels very intuitively. The control of ships can be done by automats or using soft screen controls. Of course, it is also possible to couple bridge simulators with hardware controls. It is even possible to establish a coupling between the hardware and a ship ‘on the run’. Simulations can be set-back in time, re-played and debriefed with immediate access to all recorded data.

DOLPHIN incorporates a lifetime of experience with hydrodynamic and nautical research. It is able simulate the most demanding hydrodynamic phenomena most realistically and it is therefore an extremely powerful tool for both the researcher and the sailor.

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