Researchers assessing harbor safety using simulations

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Smooth as the simulation; Fraunhofer CML in Hamburg offers comprehensive services for safe harbor. Credit: Fraunhofer IML

One of the most important means of connecting with foreign countries is by sea, especially for the transport of freight. Researchers are assessing harbor safety using simulations in order to help provide smooth and efficient navigation.

Most imported goods reach us by sea – and the traffic volumes in

German ports will be expanding over the coming years. Forecasts indicate that the trade volumes will rise from about 269 millions tons at present to around 468 million tons by 2030. Port operators are faced with the challenge of providing safe and efficient harbor traffic. How should harbor basins or shipping channels be arranged so that large ships can safely navigate the waters also? What must be taken into account in event of adverse weather or complicated traffic situations? How can unnecessary time spent in port be avoided?

Answers to these kinds of questions are being provided by researchers of the Fraunhofer Center for Maritime Logistics and Services CML, an institution which is part of the Fraunhofer Institute for Material Flow and Logistics IML in Dortmund, Germany.The experts in Hamburg simulate realistic scenarios in real time and assess the nautical safety based on the results.

Each of the simulated ships is closely matched to its original shipyard specifications and modeled hydrodynamically using the science of streaming fluids. CML is providing strategic support services during harbor reconstruction, expansion, and new construction.

Simulations with real data

As a first step, the researchers carefully examine the actual conditions in the surroundings – the harbor layout, the approaches, and data on currents, for example – in other words, significant movements of water at the site. The researchers carry out a preliminary assessment based on this information that enables identification of possible critical points. "An approach perpendicular to the direction of the main current is unfavorable, for example. In such a case, we look for alternatives right at the beginning," explains Hans-Christoph Burmeister, project manager at CML. The harbor environment is then digitally displayed in the simulation in keeping with the actual key features.

In addition, the researchers create a 3D model of a reference ship as well as a hydrodynamic computer model. "This consists of various hydrodynamic coefficients that permit the ship's track to be determined from the force of the propeller or bow thrusters. That is important in order to realistically re-create the turning or stopping behavior of the individual ship," explains Burmeister. Finally, realistic scenarios must be worked out for the simulation. Standard situations can be represented just as extreme conditions can be. The set up and running of the simulation can be presented just like flight simulators.

The core is the simulator that the trained maritime personnel use to drive the ship. Actual instruments are utilized just like on a genuine ship's bridge, with radar displays as well as an electronic chart system available. Three monitors provide a 120-degree view of the virtual harbor environment. Piloting commands are incorporated into the computational model in real time.

From these results, predictions can be made for the wind and tidal conditions under which the reference ship can safely enter the harbor, for example, as well as which approach is best. "In some cases, we have attained significantly longer reaction times by modifying the approaches – this means ships can still make port even under poor weather conditions," according to Burmeister. Tug maneuvering can also be simulated to determine the minimum number of tugs required to safely bring a ship to its berth, for instance. "The results nevertheless apply for just one specific situation – if even one parameter is changed, it can lead to a different assessment," Burmeister points out. For instance, a fully loaded ship maneuvers differently from one which is carrying only half a load. This must be taken into account in the hydrodynamic model. There is no such thing as a standard test run. The data are adjusted for the specifics of the situation in consultation with customers – these are port authorities, terminal operators, or maritime engineering firms as a rule.

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