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‘Human-in-the-loop’ simulation: The right tool for port design

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Engineers, designers, and planners have come to rely on simulation as a means to gain data to design port improvements and to test those designs. They have recognised that computer simulation provides important insights that yield a superior product. Initial designs may overlook deficiencies that are readily identified using computer simulation. This saves considerable time, effort and expense in making post-construction modifications. Simulation can also save money even before construction begins by showing the designer where, for example, dredging is not required.

The question for project managers becomes: “What kind of simulation is required to properly define and identify requirements?” With the advent of powerful personal computers there has been a move toward ‘table top’ simulation; the process of using PCs, with special software, to generate data for use in port or waterway design. It can determine the forces a given ship will generate against a pier in order to design the scantlings of the pier members, generate data on stresses on the lines of a moored ship when a ship passes in the channel, or determine whether a specific design of ship can keep to the channel with given wind and current conditions. These, and other engineering details, can readily be determined by running fast time simulation. These simulation programmes, using various algorithms, calculate forces and ship motion, even at times using an autopilot. This provides the data in an event rather than a time domain and it is produced instantaneously, or as fast as the calculations can be made. The results are then used to prove or disprove the project team’s assumptions and theories. This kind of testing can yield significant statistical data, give an indication of forces that will be encountered and give the engineer a significant body of data for subsequent analysis.

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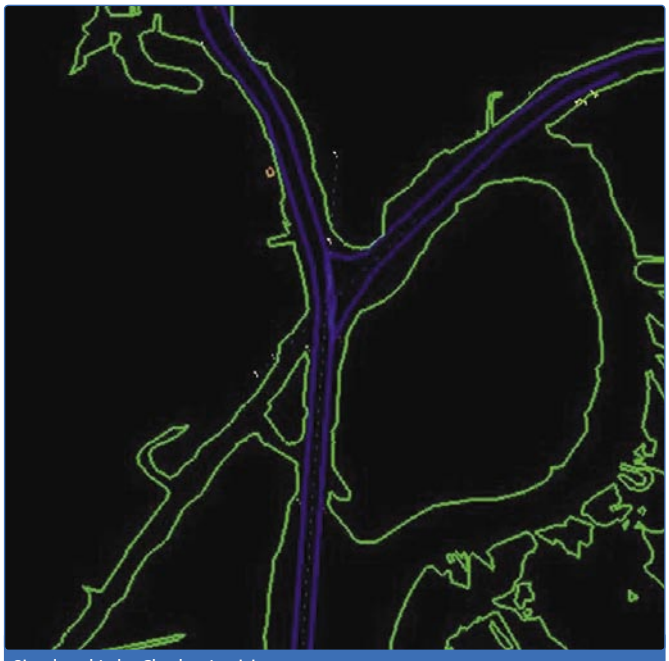
Real-time human-in-the-loop simulation is a more encompassing process. Here multiple computers are used to model both the geographic environment including detailed depth and current models and the hydrodynamic and physical characteristics of the ships to be employed in the study. Experienced mariners are inserted in the process to make the decisions and judgments as they would in actual practice. This human-in-the-loop testing is essential to obtaining accurate results because it is the way decisions would be made and

Actual photo of Lake Charles, Louisiana.



Simulated Lake Charles, Louisiana.

operations would actually be conducted. The human specified is normally a pilot familiar with the geographic area being tested. This is an important factor because their detailed knowledge of the area formulates judgments about the proper handling of the vessel.

Testing

In conducting recent studies at MarineSafety's Newport Center, human-in-the-loop testing has been the choice in every case. In the Lake Charles, Louisiana project one of the customer's objectives was to use the waterway and the LNG terminal 24 hours a day.

A navigation aid scheme was modeled, tested, and refined. Once all were in agreement that what had been simulated was an acceptable solution, the regulatory agency involved in navigation aid approval was invited to observe the results. The human-in-the-loop evaluation enabled all the appropriate stakeholders to observe that the solutions achieved were effective and proper. As a result, approval and installation of required aids was accomplished in record time.

Using this method, the individuals who will actually be performing the task of bringing the ship to and from its berth can determine: limits of current or wind that allow safe navigation in the waterway, the adequacy of the approach channel, the size requirement of the turning basin, the adequacy of existing aids to navigation and the identification of additions required, the berth configuration and its angle/position, and the identification of tug requirements.

Findings

As the projects mature, we find that customers demand the human-in-the-loop simulation methods because they are able to identify problems and requirements much more readily. Fast time, 'table top' simulation does a lot, but it also misses a lot. Port improvement, new terminal construction and siting, redesigned waterway and pier/terminal improvement are not merely engineering tasks. There always remains the human control element. Even in these days of microwave technology to determine position and distances, human beings still take the information and, through their judgment and experience, manoeuvre the ship, run the tugs, determine the risk and advisability of a manoeuvre. After one has done all the good engineering and precise calculations, there still remains one element that could confound it all, the human control element. Humans are called upon to do the job. Intelligent autopilots on fast time simulation can only do so much. In the final analysis, real humans in real time simulation are needed to make a final judgment on the efficacy of the design. The waterway/port 'system' has to be visualised not only as the channel, the pier, the ship and the tugs, but also as a system which includes the pilots, the ship's master and mate and tug masters.

Simulated LNG Receiving Terminal, Lake Charles, LA.

Table top simulation may be useful in the very early stages of project development for the purpose of collecting data to set broad parameters, but the important decisions require human-in-the-loop testing on a full mission simulator. Further, the essential step of providing training to the pilotage team can only be accomplished through full visual human-in-the-loop testing. Human-in-the-loop real-time simulation has reached a mature level and should always be included in work involving new/altered port or pier designs or when new ship or tug types are introduced. It can also provide real value in testing security procedures and verifying the adequacy of an area control system such as a Vessel Traffic Management and Information System (VTMIS).

ABOUT THE AUTHOR

Captain W. Frederick Bronaugh, Jr. holds a Masters of Science degree from Salve Regina University. In addition, he holds a certificate of Naval Warfare from the Naval War College. With over thirteen years of experience at sea, Captain Bronaugh has served as Chief Engineer, and master of three ships of the line in the US Navy. He has been employed at MarineSafety international for thirteen years, where he has served as Director of the Newport center, Senior Bridge Resource Management Instructor as well as the Senior Electronic Chart Display and Information (ECDIS) and Automated Information System (AIS) Instructor at the Newport facility. He developed the training programmes for MSI in ECDIS, IBS and AIS, and is an experienced ship auditor of those systems; highly regarded in his fields of specialty.

ABOUT THE COMPANY

MarineSafety International owns and operates ship handling simulator learning centres in Newport, RI and Norfolk, VA on the US East Coast, and San Diego, CA on the West Coast. These centres utilise the latest state-of-the-art simulation techniques to provide a realistic ship manoeuvring, navigation and decision-making environment without real-world risks.

ENQUIRIES

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