Running shipwreck simulations backwards helps identify dangerous waves

October 1 2007

Big waves in fierce storms have long been the focus of ship designers in simulations testing new vessels.

But a new computer program and method of analysis by University of Michigan researchers makes it easy to see that a series of smaller waves---a situation much more likely to occur---could be just as dangerous.

"Like the Edmund Fitzgerald that sank in Michigan in 1975, many of the casualties that happen occur in circumstances that aren't completely understood, and therefore they are difficult to design for," said Armin Troesch, professor of naval architecture and marine engineering. "This analysis method and program gives ship designers a clearer picture of what they're up against."

Troesch and doctoral candidate Laura Alford will present a paper on their findings Oct. 2 at the International Symposium on Practical Design of Ships and Other Floating Structures, also known as PRADS 2007.

Today's ship design computer modeling programs are a lot like real life, in that they go from cause to effect. A scientist tells the computer what type of environmental conditions to simulate, asking, in essence, "What would waves like this do to this ship"" The computer answers with how the boat is likely to perform.

Alford and Troesch's method goes backwards, from effect to cause. To use their program, a scientist enters a particular ship response, perhaps the worst case scenario. The question this time is more like, "What are the possible wave configurations that could make this ship experience the worst case scenario"" The computer answers with a list of water conditions.

What struck the researchers when they performed their analysis was that quite often, the biggest ship response is not caused by the biggest waves. Wave height is only one contributing factor. Others are wave grouping, wave period (the amount of time between wave crests), and wave direction.

"In a lot of cases, you could have a rare response, but when we looked at just the wave heights that caused that response, we found they're not so rare," Alford said. "This is about operational conditions and what you can be safely sailing in. The safe wave height might be lower than we thought."

This new method is much faster than current simulations. Computational fluid dynamics modeling in use now works by subjecting the virtual ship to random waves. This method is extremely computationally intensive and a ship designer would have to go through months of data to pinpoint the worst case scenario.

Alford and Troesch's program and method of analysis takes about an hour. And it gives multiple possible wave configurations that could have statistically caused the end result.

There's an outcry in the shipping industry for advanced ship concepts, including designs with more than one hull, Troesch said. But because ships are so large and expensive to build, prototypes are uncommon. This new method is meant to be used in the early stages of design to rule out problematic architectures. And it is expected to help spur innovation.

A majority of international goods are still transported by ship, Troesch said.

The paper is called "A Methodology for Creating Design Ship Responses."

Source: University of Michigan