OCEANIC CONSULTING CORPORATION

Making Waves

Newsletter of Oceanic Consulting Corporation
Fall 2004

Team Alinghi and BMW-Oracle Racing in Newfoundland?

Each year in August, the Royal Newfoundland Yacht Club organizes a Race week. It is a local Performance Handicap Racing Fleet (PHRF) regatta with international overtones; the passionate competition between Team Alinghi and Team BMW-Oracle Racing drives the racing on Conception Bay in much the same way as it did during the 2002 Louis Vuitton Cup and in the same way it is driving the run up to the 2007 America's Cup in Valencia, Spain.

Asylum is a J-24 with a PHRF rating of 168. Her skipper and owner is Caroline Muselet, Oceanic's Technical Authority for Alinghi's model test program for their 2007 defense of the America's Cup. *Serendipity* is a Soling with a PHRF rating of 156. Her skipper and owner is Rob Pallard, Oceanic's Technical Authority for our client, BMW-Oracle, the Challenger of Record for the 2007 Cup.

According to the PHRF time on time rating system, *Serendipity* must give *Asylum* 61 seconds per hour of race time. Throughout the course of the regatta, points are accumulated after each race inversely proportional to a boat's finishing position and the boat with the least points at the end of racing wins the regatta. On the morning of the last day of the event there were three races outstanding. *Serendipity* and *Asylum* split the first two races. When the race committee decided to run the final race, *Asylum* and *Serendipity* were nearly tied, and the winner for the final race would win the regatta. Both boats raced almost flawlessly, but the Soling had a better start and soon secured a sufficient lead in the heavy air that had made time available for the final race. *Serendipity* won the regatta and avenged her loss to *Asylum* in last year's competition.

The seriousness of Caroline and Rob on the race course is mirrored in their approach to providing top quality services to our clients, Alinghi and BMW-Oracle, and in our teams' efforts to help their respective clients win the 2007 America's Cup. Beginning earlier this year, Oceanic Consulting Corporation has been providing model testing services to both teams and will be doing so up until the 2007 Cup. This work follows on from the reputation the company built with both clients in their preparations for the 2003 America's Cup in which Alinghi defeated Team New Zealand in a 5-0 knockout. Alinghi's competition in that series came not from the Cup's defender but rather from BMW-Oracle in the Louis Vuitton Challenger Series when BMW-Oracle won race four and came very close to winning two other races in the best of nine series .

The competition continues to build towards 2007 and permeates every level of preparation. The America's Cup has long proven to be the grand prix of sailing: pitting sailor against sailor, designer against designer and builder against builder. While in this case the tension between Alinghi and BMW-Oracle doesn't pit Oceanic against its competitors, since the company and its partners, the Institute for Ocean Technology and Memorial University, are providing the services to both teams, it does pit team against team. Caroline Muselet and Project Manager Tim Moore are leading a team of Oceanic engineers, designers and naval architects that aim to help Team Alinghi defend the America's Cup. Rob Pallard with Project Manager Blaine Stockwood and another team of Oceanic people, plan on helping BMW-Oracle take the Cup back to the United States.

In this issue...

Charting the Course: Fall 2004.

Baccalieu Island is a slender tract of land about two miles long and half a mile wide that lies about a mile off the northernmost tip of Newfoundland's Avalon Peninsula. Since it sits at a slight angle, the island and the mainland create a wind funnel called the Baccalieu Tickle in which wind, sea, swell and current combine to make a toxic mix of weather.

In early July, I helped Dr. Neil Bose and one of our colleagues sail a Contessa 26 about 80 miles from Holyrood, Conception Bay, to Catalina, Trinity Bay. With little or no wind, we sailed North from Holyrood through the Baccalieu Tickle with the aim of sailing some 100 miles to one of Canada's national marine parks. As we reached the Tickle, the wind picked up from the Southwest to over 40 knots. With no safe harbor nearby, we had no choice but to put on our foul weather gear, douse our jib, fully reef the main and continue towards Catalina.

Although the wind continued to blow in excess of 40 knots, the night was pleasantly clear and I could see the flash of Green Island Lighthouse outside of Catalina Harbor from some 20 miles off. Strangely the lighthouse often appeared to be in two locations. As we approached the entrance to Catalina, we passed Green Island and the Lighthouse on our port side to finally reach the calm of the inner harbor. The double vision proved to be real, though, as the light was reflecting off the face of a huge iceberg to our starboard side, aground just out of the entrance channel. It was only after daybreak, after we tied up, that we saw the berg.

There is nothing like a face-to-face confrontation with the ocean environment to bring home the significance of Oceanic's work. In this issue of *Making Waves*, some of our profiled work is coincidentally relevant to that trip. On the cover, we profile those sailors among us who are working to help our clients Alinghi and BMW-Oracle compete for the 2007 America's Cup. Ocean challenges can be natural or human; the America's Cup is one of the greatest of those human.

The *Titanic* may be the most famous of vessels sunk off Newfoundland by collision with ice, but it is by no means the only one. We were very lucky that the iceberg was aground out of the channel to Catalina. On page three we profile three projects related to arctic environments, ranging from structural research on-going at MUN and IOT to the performance of a SWATH vessel in ice covered water.

In an article on page four about interpreting seakeeping data for the purpose of assessing habitability, we outline some of criteria used to assess the likelihood of seasickness. Sailing across Trinity Bay showed though that these criteria vary for individuals. I was fortunate to fall into the 'Imperceptible' region of the chart. Neil found himself in the region noted as 'Threshold of Malaise'. Our colleague was at the far limits of 'Intolerable'!

On page five you will find a summary of work Oceanic undertook for a client who has developed a novel method of evacuation from offshore platforms. Seascape 2000 recently completed trials of their integrated system of evacuation that provides a safe and dependable system on which one could embark with confidence. The four-man liferaft lashed to the deck of the Contessa 26 during a 40 knot blow with a 15 foot sea pales in comparison.

Finally, on page six we profile Neil Bose's work in underwater vehicles. Neil is the Canada Research Chair in Offshore and Underwater Vehicle Design, Professor of Ocean and Naval Architectural Engineering at Memorial and the skipper/owner of the Contessa 26. I just hope that it isn't Neil's experience sailing with me that gives him his interest in vessels under water. Thanks again for reading *Making Waves*.

For Oceanic Consulting Corporation
Best Regards,

Dan Walker, Ph.D., P.Eng.
President

Enhancing Ship Structural Design.

When designing ships for operations in extreme environments (waves & ice), the inherent possibility of overload must be considered. To mitigate against the consequences of overload, there has been a trend towards post yield based limit state design. Plastic limit state design criteria are now more complex than the present elastic design, and there are significant advantages in applying plastic criteria, particularly for a range of commercial, naval and icebreaking ships.

A comprehensive program of ship structure research is underway at the NRC Institute for Ocean Technology (IOT) and Memorial University, stemming from the development of new Polar Ship Regulations. A new international standard for polar ship design will soon prescribe minimum frame dimensions through a set of structural formulae and will specify a number of conditions that the frame must meet.

Optimal and effective use of the rules requires that the designer understand the interactions between shear and bending, and the various ways that one may arrive at a compliant design. This is an ambitious new step in ship structural design, and one that requires full-scale physical validation of the proposed rules.

Validation of this design is being conducted through a joint project of IOT and Memorial University's Ocean Engineering Research Centre. Funded by Transport Canada, the US Coast Guard and the Ship Structures Committee, the project will aid designers and improve the integrity of ship structures.

As part of the experimental study of ship structural elements, full-scale ship frames and sections are being designed, instrumented, tested and analyzed under various loads, while numerical modeling is also being done in a parallel project. The experimental data will be corroborated numerically, with the added benefit of improving the applicability of numerical simulations.

The results of both investigations will be applied to the new international standard, and will help to develop a tool for rapid analysis of plastic behavior of ship structures. Ultimately, the project will improve the standards of polar ship design, ensuring greater safety and reliability.

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Deep Water Pipe-Lay Vessel Midnight Express Nears Completion.

Acquired by Torch Offshore, Inc. ("Torch" or the "Company") in 2002, the *Midnight Express* (formerly the *Smit Express*) is nearing completion and will soon be heading to the Gulf of Mexico for testing and commissioning before entering the Company's active fleet sometime later this year. Following Torch's acquisition, the vessel underwent conversion at the Industries Davie yard in Quebec, Canada. At that time, Oceanic Consulting Corporation was contracted to examine various factors related to the ship's conversion (see the Fall 2002 edition of *Making Waves* available at www.oceaniccorp.com). Wind and current loading, vessel powering requirements and seakeeping performance were all assessed by Oceanic using numerical tools. Shown in the photograph, the vessel is currently being outfitted with its pipelay system and crane at the Huisman-Itrec yard in Schiedam, The Netherlands. Oceanic is pleased to have been of assistance to Torch on this project and we wish them the best as the vessel makes its way into the Company's active fleet.

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SWATH Performance in Ice.

Oceanic Consulting Corporation recently completed a testing program for Lockheed Martin to evaluate the performance of a SWATH in ice.

The design was evaluated physically in the 90 Meter Ice Tank at the Institute for Ocean Technology. The test program focused on the Resistance and Maneuverability in level ice of a SWATH with different bow configurations. During the test period two 25 mm thick ice sheets were grown and two icebreaking bow attachments were tested. The Planar Motion Mechanism (PMM) was successfully employed to measure the turning moment and the yaw angle during the tests in ice.

Oceanic is currently working with Lockheed Martin on evaluating the icebreaking performance of a revised hull form at a larger scale.

Evaluation of Roll Stabilization Options.

In this era of globalization where vessels cruise the world's oceans in greater numbers and sizes than ever before, it is increasingly important to consider the seakeeping characteristics of such vessels. Minimization of vessel motions is crucial to passenger comfort. On working vessels, motion reduction can expand the operating envelope to include more severe environmental conditions. On large ships, the prevention of cargo damage is a critical concern.

Of the basic oscillatory motions, roll is the least damped by vessel form, but it can be significantly affected by the installation of motion stabilization devices. Compared to larger ships, motor yachts and other smaller vessels tend to have relatively quick roll periods and thus are prime candidates for the installation of such devices. However, it is important to ensure that any motion control device is properly designed for the specific vessel in question since the installation of an inappropriate device may increase vessel motions rather than decrease them.

If seakeeping is assessed during the design process, modifications to hull geometry and/or loading conditions may aid in motion reduction. For vessels already constructed, the impact of adding motion stabilization devices can be assessed before a refit is undertaken. Bilge keels, passive fins and anti-roll tanks are among the more common motion stabilization devices.

For seakeeping assessments, Oceanic uses the in-house numerical prediction code MOTSIM. This code is a non-linear time-domain seakeeping prediction program that simulates vessel motion, as a rigid body, in six degrees of freedom with zero or forward speed in any wave conditions. A powerful feature of MOTSIM is its ability to model any combination of motion stabilization systems concurrently and it can simultaneously accommodate customized control algorithms for the active systems.

For more information on MOTSIM, please see page 8.

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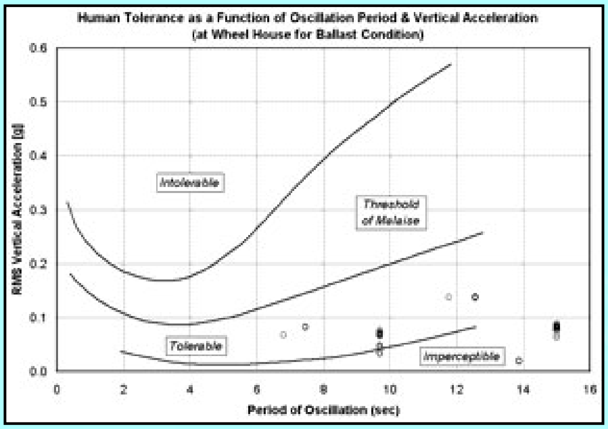
Habitability Analysis – Interpretation of Seakeeping Data.

Once the seakeeping characteristics of a vessel have been assessed, it is often quite useful to further interpret this data from a habitability perspective. Passenger and crew comfort are increasingly important as more vessels take to the water for pleasure and working vessels are often required to remain operational in more severe weather conditions. By assessing habitability and the potential for motion sickness during operation in certain sea conditions, operators can ensure that their vessels are operated with the view of minimizing such occurrences. As well, if habitability is assessed at the design stage, then the naval architect can take appropriate steps to mitigate excessive motions and produce a design that has a more comfortable ride.



While many methods exist to quantify the assessment of habitability, it is still difficult to make absolute predictions due to the wide variety of tolerances that each individual may have to vessel motions. Human nature being as diverse as it is, there will be some individuals who will experience no ill effects from the motions while others may become violently ill. Physiological differences play a large role in the susceptibility of individuals to motion sickness, and these differences also make it difficult for there to be one method that will clearly assess habitability. As a result, a useful strategy for such assessments is to examine data from a variety of methods and draw conclusions based on informed interpretations of the available methods and their limitations.

Using seakeeping data generated from either a physical model test or a numerical simulation, a habitability analysis can be completed to determine whether a vessel is able to comply with relevant habitability codes (e.g. ABS Guides for: Passenger Comfort on Ships, Crew Habitability on Ships and Offshore Installations, etc.). Most habitability measures are interpretations of vertical acceleration measurements and various methods exist for such analysis. Common quantitative measures include calculations for MSI (Motion Sickness Incidence) and VI (Vomiting Incidence). Additional qualitative measures include assessing accelerations relative to a "Tolerance Limit" plot or a "Severe Discomfort Boundary" plot. Other measures that may be considered include MIF (Motion Induced Fatigue) and MII (Motion Induced Interruptions).

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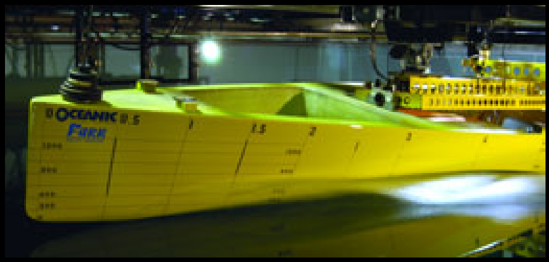

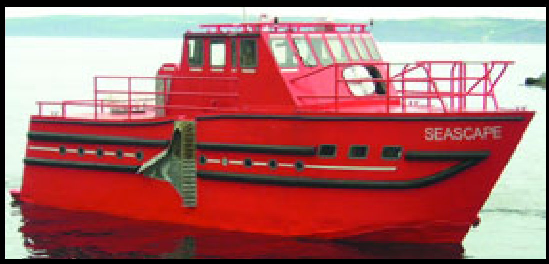

Seascape Life Rescue Craft (LRC®) and Full Scale Testing.

In its Winter 2001 edition, *Making Waves* covered the 1:4 scale model tests carried out by Oceanic to confirm the design and operational parameters for Seascape 2000 Inc.'s Life Rescue Craft (LRC®). The performance evaluation included physical model tests and numerical simulations.

Since then, Seascape has built a vessel prototype and a land-based installation for demonstrating the company's unique offshore evacuation method. The Seascape System of Evacuation (SSE) consists of three major components: the vessel, the deployment arm and fall arrestors. For full scale testing and demonstrations, a supporting tower structure was built to represent the platforms on which the SSE would be mounted.

The LRC, is a 70-person, 12.8m aluminum-alloy vessel powered by twin turbo-charged diesel engines. It is installed to point away from the platform and is mechanically pivoted at the end of the deployment arm so that during launch zero degree trim is maintained at all times.

The deployment arm guides the LRC, from the stowed position atop the SSE to a fixed distance away from the installation at water level. Specialized winches and hydraulic fall arrestors provide a controlled deployment of the LRC and the deployment arm during launch, and also facilitate retrieval. The winch and fall arrestor rely solely on gravity requiring no external power for launching.

In the previous performance evaluation carried out for Seascape, Oceanic conducted resistance, self propulsion, and seakeeping tests on the LRC. Since construction of the vessel Seascape has continued to successfully demonstrate the capability of the design in operation including maneuvering in ice.

In the most recent round of testing, Oceanic has mounted an accelerometer array (three accelerometers mounted in orthogonal directions) in the LRC to record acceleration measurements, collect acceleration data during launch of the vessel, and report acceleration statistics during launch and splashdown. The data generated during the testing will be used in refining the existing design and fine tune the operation of the launching arm.

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Directional Stability of an Articulated Tug Barge.

Oceanic was contracted to conduct a model test program to evaluate a 425′ x 78′ Articulated Tug and Barge (ATB) for Bay Shipbuilding Corporation on behalf of Moran Towing Corporation. Testing was conducted in the 22 Meter Flume Tank and the 200 Meter Tow Tank.

The objectives of the test program were to evaluate the directional stability of the barge, determine the calm water resistance of the ATB, the added resistance of the ATB in Beaufort 4 seas at a specified speed, and conduct self-propulsion tests of the ATB to determine typical Quasi Propulsion Coefficient (QPC) values.

Directional stability tests were conducted in the Flume Tank. The model was initially displaced laterally (~1 to 1.5 x beam), then released in the flow and the subsequent motion recorded. If the motion oscillates about tank centreline with decreasing amplitude, the vessel was considered stable. If the motion increased the vessel was considered directionally unstable. Several configurations and conditions were evaluated and the test program was successful as Oceanic was able to assist Bay Shipbuilding Corporation determine the correct vessel conditions that would allow the vessel to maintain directional stability when being towed.

The calm water resistance tests and the added resistance tests were also successfully completed. It was confirmed that the tug chosen for the design was acceptable and had sufficient power installed to push the barge in the ballast and deep conditions at the required operating speeds in both calm water and Beaufort 4 seas.

Overall, the project was a success, and we look forward to continuing our working relationship with Bay Shipbuilding Corporation and Moran Towing Corporation.

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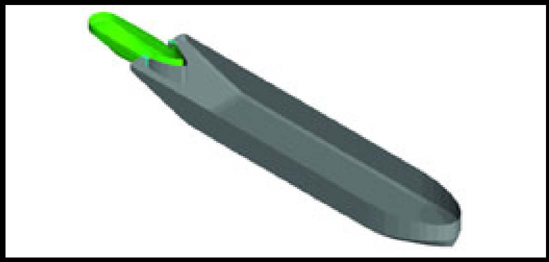

Memorial Engineering Researchers One Giant Step Closer to Autonomous Underwater Vehicles.

Memorial University is partnering with Northstar Technical Inc. and the NRC Institute for Ocean Technology (IOT) to give a significant boost to oil and gas research.

Under the agreement, Northstar will provide sonar technologies such as obstacle avoidance, water depth and temperature, bottom finding and vehicle pitch and roll to the autonomous underwater vehicle known as C-SCOUT, on which MUN and IOT have been collaborating. In turn, Northstar will receive test data for cutting edge sonar technologies being developed under the Aquacomm program. C-SCOUT has been developed to research environmental monitoring of discharges of produced water, drilling mud and cuttings in the offshore oil and gas industry.

Northstar's Acoustic Modem will serve as the primary communications channel between C-SCOUT and the surface enabling the AUV to communicate in real time during complex missions. The technology itself, originally developed for the fishing industry, uses a nose cone with several sensors that look forward and down.

"The Acoustic Modem will be a modular design focusing on high data rate/security, long range, size and reduced power consumption," said Dr. Wilson Russell, CEO of Northstar Technical. "This approach will allow Northstar to be very responsive to product requests from a variety of industry sectors."

Dr. Neil Bose, Canada Research Chair in Offshore and Underwater Vehicle Design and professor of Ocean and Naval Architectural Engineering in the Faculty of Engineering and Applied Science, called it an ideal opportunity based on a match of expertise – IOT's in underwater vehicle technology and Northstar's in sonar development.

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Seakeeping Assessment as Part of the Design Process.

In recent work for Langan Design Associates, Inc. of Rhode Island, two hull variations of a 150′ expedition motor yacht design were assessed to determine which would provide the best seakeeping characteristics for a range of conditions.

For this particular vessel, ride comfort is of prime importance for the owners, so various roll stabilization systems were examined to determine the potential roll reductions that could be achieved. A habitability analysis was also completed to provide insight into the comfort level that can be expected for the vessel. Study results will be used to choose the optimum hullform and roll stabilization system combination to achieve the desired ride comfort.

Assessment of the hullforms was completed in moderate sea conditions using Oceanic's numerical seakeeping prediction code MOTSIM. For operation at zero speed and transit speed (12 knots), simulations were completed first with the unstabilized hulls to determine baseline motions characteristics. Subsequently, anti-roll tank and roll stabilization fin systems were examined to gauge their effectiveness. Anti-roll tanks were examined at two locations: the preferred position from a layout perspective, and a second position higher in the vessel. The second position was included to demonstrate potential roll reductions that could be achieved by increasing the lever arm for the forces generated by the tank.

Since this vessel will likely spend a significant proportion of time at anchor, zero speed roll stabilization is also quite important. Langan Design is considering installing two sets of roll stabilization fins as these systems are increasingly popular for stabilization at zero speed, with the added benefit of providing roll reductions while underway. As development of zero speed roll stabilization fin systems is relatively new, Oceanic created a new module for MOTSIM to evaluate such systems. The module includes a generic control algorithm as well the ability to model multiple fin sets.

While roll motions could be excessive for either unstabilized hull, and response differences were identified between each hull, the evaluation showed that both the higher position roll tank and the zero speed active fin systems will be quite effective. Roll reductions on the order of 50% can be achieved in beam seas at zero speed for Sea State 5 with the active fin system. Similar reductions can also be achieved with the roll tank located in the second position. The habitability analysis showed that vertical accelerations, which are a primary cause of motion sickness, can be reduced by using either the roll tank or the active fin systems.

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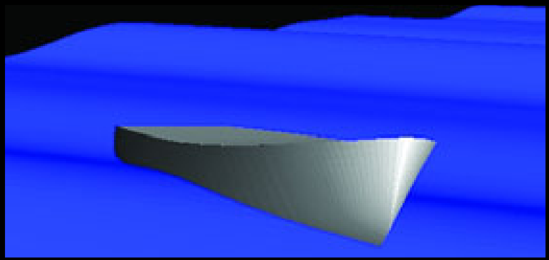

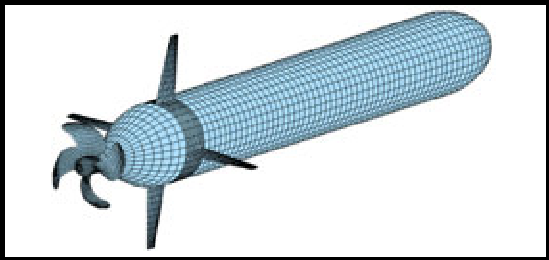

Oceanic Creates New Vice-President Position.

Don Spencer has been appointed to the post of Vice-President, Technical Development, assuming responsibility for the coordination of Oceanic's internal technical development programs. Current initiatives include deepwater mooring truncation techniques and modeling of vortex induced motion (VIM) in shear flows. In addition, Don will manage Oceanic's collaboration with the research community in St. John's, Newfoundland which includes programs investigating podded propellers in ice and simulation of operations in ice covered waters. Don will also be responsible for the firm's efforts within Joint Industry Projects such as Deepstar.

Don has an extensive background in research and engineering. His career started over twenty years ago at the National Research Council of Canada's Institute for Marine Dynamics, now the Institute for Ocean Technology. With responsibility for developing testing techniques for the 90 Meter Ice Tank, his work included establishing techniques and standards for testing icebreaker hulls and developing new methods for modeling ice density. Drawing on his experience in modeling vessel maneuvering, he developed the large amplitude horizontal Planar Motion Mechanism (PMM) for use in either the 90 Meter Ice Tank or the 200 Meter Towing Tank.

Recently, he has been involved in VIM studies of risers and has been Oceanic's representative on Deepstar projects. Additionally he has been a Senior Project Manager on projects ranging from the evaluation of wave loading on offshore platforms off the coast of Russia to the effects of heave plate damping on deep water structures.

Don is a Professional Engineer and holds a Bachelor of Science and Mechanical Engineering from Acadia and a Masters of Marine Technology from the University of Newcastle. His work has been documented formally through papers published and presented at various international conferences, including the Conference on Port and Ocean Engineering under Arctic Conditions (POAC), the IAHR Ice Symposium, and the American Towing Tank Conference (ATTC).

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Journal Publications and Conference Papers.

Akinturk, A., S. Jones, B. D. Duffy and B. Rowell (2004). "Ice Loads on Azimuthing Podded Propulsors." 23rd International Conference on Offshore Mechanics and Arctic Engineering, Vancouver, Canada, June 2004.

Akinturk, A., S. Jones, B. Rowell and D. Duffy (2004). "Measuring Podded Propeller Performance in Ice." The 1st International Conference on Technological Advances in Pod Propulsion, Newcastle upon Tyne, UK, April 2004.

Cumming, D. (2004). "Accuracy Issues And Measurement Complications Pertaining to Standard Ship Trials." 27th American Towing Tank Conference (ATTC), St. John's, NL, August, 2004.

El Lababidy, Said; Bose, Neil; Liu, Pengfei (2004). "Evaluation of a Dynamic Positioning Thruster Wake using Laser Doppler Velocimetry." 23rd International Conference on Offshore Mechanics and Arctic Engineering, Vancouver, British Columbia, Canada, June 2004.

El Lababidy, S.; Bose, N.; Liu, P.; Di Felice, F.; Felli, M. and Pereira, F. (2004). "Experimental Analysis of the Wake from a Dynamic Positioning Thruster." 25th ONR Symposium on Naval Hydrodynamics, St. John's, NL, Canada, August 2004.

Lau, Michael, Jiancheng Liu, Ahmed Derradji-Aouat and F. Mary Williams (2004). "Preliminary Results of a Ship Maneuvering in Ice Experiments Using a Planar Motion Mechanism." 17th International Symposium on Ice, Saint Petersburg, Russia, June 2004.

Bass D., Molyneux D. and McTaggart K. (2004). "Simulating Wave Action Inside the Well Deck of Landing Platform Dock Ships Using Computational Fluid Dynamics." Proceedings RINA Conference Warship, London UK, June 2004.

Allan R. & Molyneux, D. (2004). "Escort Tug Design Alternatives and a Comparison of their Hydrodynamic Performance." Trans. SNAME, Washington D.C. USA, September 2004.

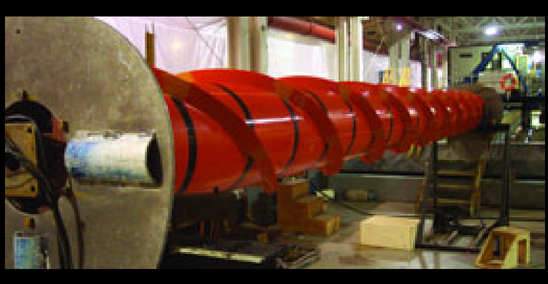
Sarkar, Sritama; Bose, Neil; Sarkar, Mridul; Walker, Dan (2004). "Concept of a mathematical model for prediction of major design parameters of a submersible dredger/ miner." 3rd. Indian National Conference on Harbour and Coastal Engineering. Goa, India December 2004.

Sarkar,Sritama; Bose, Neil; Sarkar, Mridul (2004). "Measurement techniques for full scale test of a walking dredger/ miner." 27th American Towing Tank Conference, St. John's, NL, August. 2004.

Cumming, D; Pallard, R.; Molyneux D. (2004) Standard Monohull Resistance Experiments: Investigation of Issues Related to the Derivation of the Probaska Form Factor. Published as Technical Report TR-2004-02, NRC Institute for Ocean Technology, St. John's Newfoundland 2004.

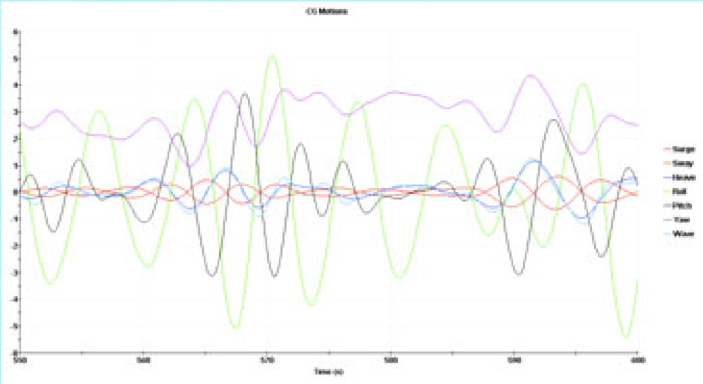
Cumming, D., D. Hopkins, J. Barrett (2003). "Description of Seakeeping Trials Carried Out on CCGS Shamook – December 2003". Published as Technical Report TR-2004-01, NRC Institute for Ocean Technology, St. John's Newfoundland 2004.

Cumming, D., D. Hopkins, J. Barrett. "Description of Seakeeping Trials Carried out on CCGA Nautical Twilight-November 2003". Published as Technical Report TR-2003-27, NRC Institute for Ocean Technology, St. John's Newfoundland 2004.

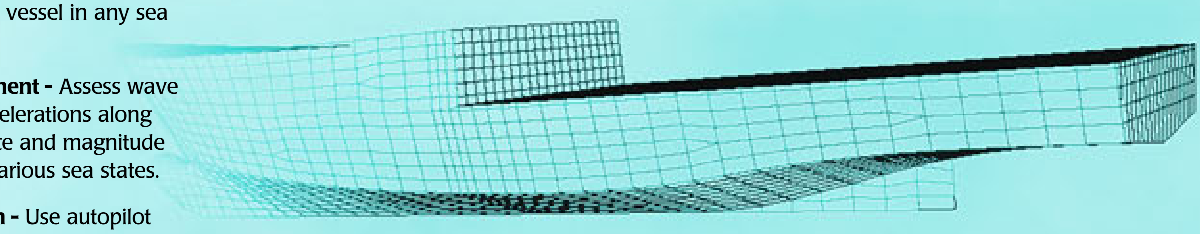


MOTSIM Seakeeping Code.

Code Type	Non-linear Time-domain Panel Method
Vessel Parameters	Unrestricted – any displacement vessel, monohull or multihull with or without appendages, special features or systems
Vessel Geometry	Defined by Sets of Panels
Range of Motion	Six Degrees of Freedom
Range of Speed	Up to 0.45 Froude Number (approx.)
Vessel Heading	Any, 180 (head seas) to 0 (following seas) deg.
Environmental Forces	Wind, Wave, Current – may be modeled as forces acting on hull
Wave Spectra	Regular or Irregular (Bretschneider, JONSWAP, or User-defined)
Wave Height and Period	Unrestricted
Water Depth	Deep or Shallow Water
Wave Model	Second-order Stokes



- **Seakeeping/RAO Analysis -** Analyze motions and accelerations at any location on vessel in any sea state and heading and speed.
- **Slamming/Greenwater Assessment -** Assess wave height (hull emergence) and accelerations along hull bottom to predict occurrence and magnitude of slamming or greenwater in various sea states.
- **Dynamic Positioning Evaluation -** Use autopilot and DP control algorithms to evaluate propeller and thruster forces required to maintain station in a given seaway.
- **Habitability Analysis -** Analyze motions and accelerations at key vessel locations to predict fatigue levels and sea sickness.
- **Roll Reduction System Evaluation -** Evaluate effectiveness of various designs (e.g., passive and active fins, u-tube and flume type rolltanks, and bilge keels)



Specification Sheets are Available for all Major Facilities, Including:

• Offshore Engineering Basin • 200 Meter Wave/Towing Tank
• 58 Meter Wave/Towing Tank • 90 Meter Ice/Towing Tank
• Cavitation Tunnel • 22 Meter Flume Tank • Centre for Marine Simulation

Specification sheets can be obtained from the Oceanic website or by contacting our office.

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