USING SIMULATION TO IMPROVE SAFETY IN THE FISHING INDUSTRY

by Derek Howse and John Sutcliffe

The dangers and risks of the fishing occupation are well known and have often been viewed as part of the culture of the sea. The view that this is simply "the nature of the game" has really only begun to change in recent years.

Commercial fishing is often described as one of the world's most dangerous occupations. Environmental conditions of heavy seas, high winds and swells would seem to support such a claim. Specific occupational hazards such as shifting gear, loading fishholds at sea, and working on moving decks increase the risk. Additionally, depressed economic conditions and depleted fish stocks place added pressure on the fish harvester to fish in foul weather during short seasons, maximize the carrying capacity of his vessel, install gear or operate on fishing grounds for which a vessel was not originally designed, or simply disregard principles of good seamanship. Taken cumulatively, these risk factors increase the fishing vessel's chances of experiencing hazardous conditions while at sea. The end result may be an accident or, at worst, a fatality.

Often overlooked but of equal importance are the all too frequent and unreported incidents that might have also resulted in a catastrophe. Accident rates and the loss of vessels and lives in the fishery are grim evidence that safety issues in the fishery must be addressed.

For generations, fish harvesters have managed the risks of the occupation with the knowledge and resources available to them. Knowledge was based on a traditional informal learning

system where experience and mentorship were key. Resources in the sense of safety programs were very limited and their implementation has typically been limited to sporadic local activity.

Industry and government response to the unacceptable levels of vessel loss and fatalities has been focused primarily on vessel stability issues. Regulatory measures to address vessel stability are part of the regulatory regime introduced with the new Canada Shipping Act (2001). Stability testing for small fishing vessels will be required and training for certain personnel in some sections of the fishery fleet is required as well.

Industry response to the regulatory approach to vessel stability issues has been very qualified. Concern has been widespread about the costs of vessel modifications, and the effectiveness and accessibility of training that may be required to meet the new regulations.

A study of health and safety issues in the fishing industry conducted by the Canadian Council of Professional Fish Harvesters (CCPFH) in 2004 clearly identified that vessel stability issues needed to be addressed. In October 2005 the CCPFH convened a national Safety Conference and the vessel stability issue was a key focus. The outcome was a plan to develop a vessel stability program that could address knowledge and awareness of stability concepts for Canadian fish harvesters.

Other research undertaken by the CCPFH had identified significant barriers to training and formal learning for fish harvesters. These included geographic, cultural, political / jurisdictional and financial barriers, as well as the diversity of the fishing industry itself.

A broadly representative national industry safety committee established by the Council proposed a solution that could effectively address the learning needs of fish harvesters. They proposed an e-learning vessel stability simulation program with video game like features. The first step was a feasibility study supported by Human Resources and Skills Development Canada, Sector Council Program (SCP). Key to the project initiation was the outcome of a workshop involving naval architects, educators, technical simulation expertise, fish harvesters, CCPFH staff and representatives from Transport Canada and SCP.

The workshop concluded that a vessel stability e-simulator would be a very useful tool and have a variety of applications. It was considered to be technologically possible and affordable. It was also proposed that a comprehensive approach to stability training was needed and that designing a training program to be used with the simulator would be important.

A project work-plan was launched in collaboration with the School of Fisheries and Centre for Marine Simulation at the Marine Institute. This collaboration engaged two project advisory committees, an industry advisory committee and a technical committee. Initial project development activities were supported with funding from SCP, the Government of Newfoundland and Labrador and industry. Over a two year period the overall design, structure and content for the fishing vessel stability e-simulator was developed.

In the spring of 2008, the CCPFH in partnership with the Marine Institute submitted a proposal to the National Search and Rescue Secretariat's New Initiatives Fund for the development of an electronic Simulator Distance Education Program for Stability Management on Inshore Fishing Vessels. Transport Canada was a supporting government partner to the project. Funding was approved and work began on the development of the simulation tool in the fall of 2009. The project is now (February 2011) past the midway point and the expectations that cutting edge technology and innovation will produce an effective learning program are nearing fulfillment.

Simulation as a Training Tool for Fishers

Before continuing, it is important that a proper definition for simulation be provided. The word simulation itself derives from the Latin word *simulare* meaning to mimic or imitate. The purpose of a simulation is to imitate a real system and then provide a means of manipulating this system so that the end behaviour or result can be studied. This ability to simulate, change input parameters and then re-run the simulation has many advantages for training courses:

- the risk to students and expensive equipment is removed
- many different scenarios can be represented and investigated, including uncommon and life-threatening situations in which a rapid response is required
- students can see the results of their decisions and actions
- full working environments can be simulated allowing for investigations into the roles, relationships, leadership skills and communication between team members

A fishing boat in rough seas.

- student evaluation can be based on recordings of actions and simulation outcomes
- student performance can be reviewed during debriefing to identify areas requiring improvement
- students can make multiple attempts at scenarios to try and improve decision making
- the use of simulation makes the learning experience highly realistic

A simulator is a "What if…" tool. It provides the student with a mechanism to investigate various scenarios and adjust subsequent actions based on the provided results. Simulators have been successfully used in many areas of endeavour, including business, medicine, military training, aeronautics and engineering.

The effectiveness of any simulation relies on two important criteria. The first is the degree to which the simulation has been designed to mimic reality; often referred to as the *fidelity* of the simulation. The fidelity of the simulation need not be high tech to be an effective simulation. For example, the game of chess was reputedly created as a representation of the various military units and the power that each wields. While a game of chess may appear to be a far cry from an actual war, the skills of problem solving, anticipating an opponent's move and employing a winning strategy based on defined variables are directly transferrable to the decision making process of the modern battlefield.

Indeed the skill in designing a simulation is in identifying those characteristics that provide the end user with an environment that accurately imitates the real world experience. The focus of the simulation designer will depend greatly on the audience and purpose of the final product. Unlike the recreational gamer for whom reality may be suspended, the educational simulation must always accurately mimic reality. Student buy-in is based on the trust that the simulation will react in a manner consistent with his life experiences. If the student observes any discrepancy between what the simulation shows and what they know to be the case in practice then the simulation and any associated

training will immediately become suspect.

The second criterion for an effective simulation is its implementation, which typically involves a strategy of creating relevant and focused scenarios and using briefing and debriefing sessions to enhance the learning experience. Briefing sessions provide the student with the purpose of the simulation, a description of the scenario into which they will be immersed, and what it is that they will need to address during the scenario. Student actions are then observed and recorded. Debriefing sessions critically assess these actions and provide the student with specific feedback on how to improve performance. Using this formula a student may be guided through a training exercise and extract the full benefit from it.

Implementation of Simulation for Fishers at the Marine Institute

The use of simulation as a training and education technique is well-established at the Centre for Marine Simulation (CMS) at the Fisheries and Marine Institute (MI) of Memorial University of Newfoundland. Primarily servicing the merchant mariner client, CMS also provides training for the Commercial Fishing Master core, the Canadian Navy, and private clients from around the world. Its facilities include a fleet of eleven simulators comprised of:

- Full Mission Ship Bridge Simulator
- Cargo Operations Simulator (Mobile Offshore Drilling Unit and Tanker Operations)
- Ballast Control Simulator
- Dynamic Positioning Simulator
- Navigation and Blind Pilotage Simulator
- Propulsion Plant Simulator
- Global Maritime Distress and Safety System Simulator
- Remotely Operated Vehicle Simulator
- Process Control Simulator
- Lifeboat Launch Simulator
- Web-based Navigation Instruments Simulator

Simulation training for the fish harvester client base has been relatively small to date, limited primarily to the training requirements for the Senior Fishing Master Certificates of Competency. This however is on the cusp of change and has been the result of both a change in marine regulations at the national level as well as a change in attitude towards safety and risk management at the industry level. Two recent additions in training for fish harvesters have been the NETSIM product and the Fishing Vessel Stability Simulator (due to be released in Beta form in April 2011). Both simulators are the result of CMS/MI projects with external clients and will greatly expand the application of simulation training over a wider range of fishing vessel officers and fishing vessel sizes.

NETSIM

NETSIM is a web-based navigation instruments simulator. Originally developed by the Centre for Marine Simulation and Virtual Marine Technologies for the Canadian Coast Guard Auxiliary-Pacific (CCGA-P), NETSIM provides simulation in radar control, the electronic charting environment, compass reading, depth gauge monitoring, and GPS.

Already in use at the Centre for Marine Simulation for its nautical students, NETSIM has recently been adopted by the School of Fisheries at the Marine Institute for use in delivery of the Simulated Electronic Navigation Limited (SEN L) course. The course is delivered both in house and in remote community centres.

The NETSIM simulator may be incorporated into a curriculum to provide training at a number of different levels for the student. The training can provide the student with an overview of the typical layout and functionality of various types of navigational instruments. Training sessions have been developed to guide the student through menus and basic operational procedures. Students new to the

NETSIM provides simulation in radar control, the electronic charting environment, compass reading, depth gauge monitoring, and GPS.

use of a GPS, for example, can be shown how to plot waypoints, routes and courses and then how to use the GPS to select a route and follow it through to the final destination.

When used for more advanced training, the instructor may introduce system faults to examine a student's situational awareness and decision making processes. Search and rescue patterns can be practiced in various weather, sea and current conditions. Collision avoidance techniques may be practiced without risk to either vessel or crew.

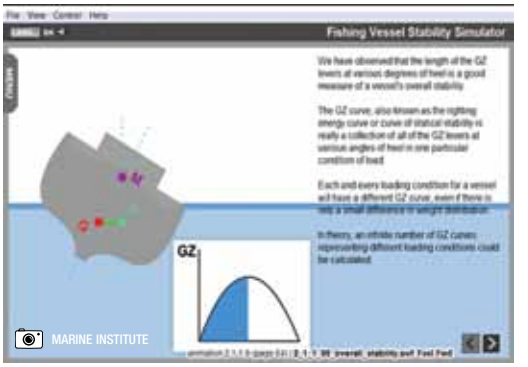
Originally designed as a distance learning tool for the widely dispersed volunteer membership within the CCGA-P, NETSIM includes the ability to capture a student's progress through a presented scenario and then transmit this to a remote site for evaluation. Communication between the practical training of the student and the debriefing and evaluation by the instructor is critical to ensuring the success of the product and curriculum when presented at a distance.

Fishing Vessel Stability Simulator

Many decisions made during fishing operations, whether consciously or subconsciously, hinge on maintaining the vessel in a positive state of stability. For most fish harvesters the decision making process is often influenced by their experiential knowledge of their vessel rather than any formal understanding of stability theory. Unfortunately the gap between experiential and theoretical knowledge in the areas of free surface effect, downflooding, proper loading techniques and seamanship practices can be substantial and may lead to incorrect decision making by fishers at critical times.

In an effort to address the knowledge gap concerning fishing vessel stability, CMS and MI's School of Fisheries, with support from the Canadian Council of Professional Fish Harvesters, has developed the Fishing Vessel Stability Simulator. Based on the course outlines for recommended instruction of Transport Canada's *Ship Construction and Stability* courses for Fishing Masters (SCS 1&2), the Fishing Vessel Stability Simulator presents the concepts of vessel stability using a combination of video, interactive animations, student self-evaluations and a fully functional hydrostatic stability calculator. Materials are offered in either English or French and provide the student with multiple options regarding vessel hull style, size, and type of fishery. Simulation options have been designed to be representative of the pan-Canadian fishing fleet, with the ability to adjust conditions of load to mimic a wide range of fishing scenarios.

The simulator has been divided into two main areas. The first five modules cover the theory of fishing vessel stability. Concepts such as statical stability basics and terminology, transverse stability principles, vessel design and construction techniques, existing regulatory constructs and stability booklets, and fishing vessel operations are covered in detail. Throughout the five modules the fisher is provided with multiple opportunities to apply these concepts through guided simulations and interactive animations.



(left) Opening page to Module One; (right) Module One: The Fishing Vessel Stability Simulator presents the concepts of stability using a combination of video, interactive animations, and student self-evaluations; it employs a fully functional hydrostatic stability calculator.

Providing immediate and accurate visual cues is crucial in reinforcing the presented material. Towards this end students are presented with both visual and numerical feedback concerning the current state of their vessel's statical stability. A 3D animation displays how the vessel is currently sitting in the water. At the same time the vessel's GZ curve is presented, as well as a visual indication of how the vessel's current stability measures against the minimum stability requirements as established under the Canada Shipping Act (*Stability, Subdivision, and Load line Standards - TP 7301 E*).

The sixth module provides the student with the opportunity to further investigate vessel stability concepts by interacting with the 3D simulation engine. Using this hands-on process the student chooses a hull type and size, engine size and location, tank types, size and location, topside design and specific equipment. Fishing gear, fuel, fresh water, ice and consumables are also loaded. The student is then able to assess the vessel's stability characteristics in multiple loading scenarios and how best to manage loading of the vessel in varying sea states. What-if scenarios can be manipulated by the student to determine how vessel management decisions would affect a vessel's theoretical stability before the vessel leaves the dock.

"What-if" scenarios can be manipulated by fishers to determine how vessel management decisions would affect a vessel's stability before the vessel leaves the dock.

Summary
Employing simulations and simulation techniques in the training and educating of fish harvesters will not eradicate the risks surrounding commercial fishing. However, harvesters who have had an opportunity to investigate the efficacy of choices in a variety of conditions of load will have a definite advantage when working in the harsh marine environment. Ensuring the safety of the crew and bringing the vessel safely home should not be a matter of luck but of sound decision making based on an understanding of the significant forces at play. In an industry which continues to rate as one of Canada's most dangerous occupations, and which exempts a large percentage of smaller vessels from a full inspection regime and compliance with regulatory stability requirements, addressing gaps and misconceptions through practical hands-on training through simulation is a significant step forward. ≈

O Captain my Captain! our fearful
trip is done,
The ship has weathered every rack,
the prize we sought is won,
The port is near, the bells I hear, the
people all exulting,
While follow eyes the steady keel,
the vessel grim and daring;

Excerpt from *O Captain! My Captain!*
by Walt Whitman

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John Sutcliffe has been the Executive Director of the Canadian Council of Professional Fish Harvesters since February 2002. Prior to becoming the CCPFH Executive Director, he served as Vice President of the CCPFH and Vice President of the United Fishermen and Allied Workers Union in British Columbia. After completing a Bachelor of Arts at the University of British Columbia (BC) in 1971, Mr. Sutcliffe began a career in the BC commercial fishery. He owned and operated a salmon fishing enterprise for 25 years and was active over the period on a broad range of industry issues and committees.