SSPA HIGHLIGHTS

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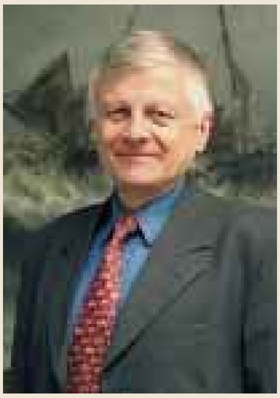
Opportunities for ports in the intermodal transport chain



Intermodal transportation and naval ship systems are examples of very complex chains of different technologies and activities. The sum of individually optimised links does not necessarily constitute the best and most efficient functional chain. It is necessary to apply a systems approach, where different specialties in concert build the optimised chain. It takes a very special development climate where specialists must co-operate and develop an efficient balance between ship size and speed, methods of loading and unloading, and the best alternative for the final set of land transportation- All this must be done while taking into account appropriate information flow and the different needs of a mix of customers with varying preferences. It takes a very creative use of appropriate technology while keeping the end customer in focus.

There is a need for a team of specialists who are willing to share information and opinions, keeping the overall success in mind. The real success – or failure – is acknowledged only when the system has operated at full scale for a reasonable period of time and with an extreme risk exposure. In order to reduce the risk, a properly tailored model test expanded with simulations can verify the system with acceptable confidence at a small fraction of the cost of full scale.

We are tuning all our production systems to come ever closer to achieving perfection.

Lars Afzelius

The term 'Intermodal transport' can be defined as conveying goods in one and the same loading unit or vehicle, which uses successively at least two different modes of transport. Standardised carriers called Intermodal Transport Units (ITU), such as containers, swap bodies and semi-trailers, are used to transfer goods between modes more efficiently.

The reality behind the term 'intermodal transport' is well known, it is not a new invention. But the term shows the change of perspective. Economic growth and increased transport demands, congested roads and environmental concerns have raised the requirements for increased efficiency of transport to meet current and future demands on integrated transport chains. Ongoing technological advantages and changes in institutional approaches ensure that the potential of intermodality is constantly evolving.

Each mode of transport has its own advantages, for example potential capacity, levels of safety, flexibility, energy consumption and environmental impact. Intermodality allows each mode to take its part in the transport chain, which overall is more efficient, cost effective and sustainable. Because of the heavy congestion in many densely populated areas of the world and pollution associated with road transport, efforts are above all focused on finding alternatives to this mode, particularly on the long leg of the journeys, while trucks are still needed to reach the end user in an origin–to-destination transport.

Intermodalism – opportunity and threat

The new approach to transport has a large effect on seaports. Intermodalism can be used as an instrument in opening new markets beyond the traditional hinterlands, but it also increases the competition between ports. The hinterland from which the port draws its cargo or to which it sends it is no longer to be taken for granted. To meet the customers' requirements for more efficient transshipment operations, ports are forced to make new investments in terminal facilities and cargo handling equipment. This could result in significant over-capacity and intensify the search for extra goods.

SSPA's port group

The highest potential for improvement of intermodal transport is probably in the transshipment points between modes. Ports are, and have been for a long time, one of the focus areas for SSPA. It should be clarified that the port is not only regarded as an integral part of transport, but as an intermodal interface between land and sea.

SSPA's research and consultancy activities as well as discussions with ports, maritime administrations, shipping companies, road and rail hauliers, and cargo owners have resulted in an increased understanding for the situation at ports because problems have been described from different angles.

Skills have been accumulating in SSPA's Port Group

In the past, cargo handling was hard and personnel-intensive. A large quantity of goods were loaded and discharged piece by piece. PHOTO: HARRY DITTMER, TIOPHOTO

With the advent of containerisation, transshipment of goods between the modes has become a faster and more cost efficient operation. Today, the container crane driver can move more than 700 tonnes of goods ship to shore in an hour.
PHOTO: BY COURTESY OF THE PORT OF GÖTEBORG

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Jim Sandkvist, Lic. Eng., Vice President, SSPA Infrastructure Development. He graduated from Lund University of Technology, Civil Engineering, in 1975 and was then employed as a research engineer, dealing with arctic engineering, at Luleå University of Technology, where he also presented his thesis focusing on accelerated ice growth in ship channels. Since 1984 he has been employed at SSPA, working especially in the marine environment field.
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which has experience in the field of logistics, port layout, physical planning and transport system development. Together with SSPA's experts on risk and safety assessments, environmental impact assessments, economic assessments and analysis, we have been able to create a comprehensive picture of port processes. We are also participating in several EU projects that are focussed on ports using a logistic approach, and this has resulted in increased capabilities in the field.

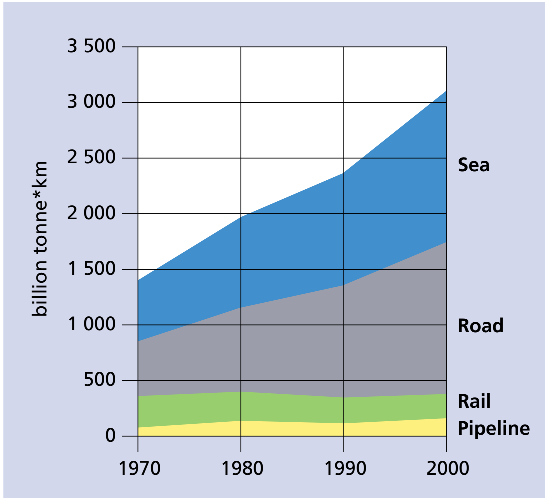
The co-ordination challenge

An important issue is to assess which modal combination, including transshipment nodes, offers the best overall level of performance on a particular link in a network. The interactions between the stakeholders in the transport system are becoming increasingly complex, and the question is who is responsible for the overall intermodal transport system? There are also limitations such as availability of relevant data to compare different alternatives. Another important barrier for intermodal transport is non-integrated information systems and complicated documentary and administrative procedures.

Upcoming work

In the coming years the goods transport system will face challenges requiring the development of entirely new approaches to operations and planning, and smooth flows of goods is the key to strengthening the concept of intermodal transport. Deregulation, technological advances, changing trading patterns and adoption of information and communication technologies are fuelling progress in intermodality, and SSPA are ready to provide support to meet the upcoming needs in the subject.

Jim Sandkvist / Linda Styhre



Growth of traffic by mode of transport within the EU shows that sea and road have the major market share. Sea includes inland waterways and short sea shipping.
Source: EU energy and transport in figures, Statistical pocketbook 2002.

Important areas of expertise for port development and improvement.
PHOTO BENGT ANDREASSON, EYEQNET

Systems engineering in the ship design process

Carl Fagergren, Project Manager, (Cdr, Royal Swedish Navy) joined SSPA in 2001. He has an M.Sc. in Naval Architecture from the Royal University of Technology in Stockholm. His previous assignments include duties at the Defence Material Administration (FMV) as Technical Manager for the test vessel SMYGE and the VISBY Class Corvette, Head of Projects Section at FMV Ships Directorate and Project Manager for the next generation of Swedish naval combatants (YS Ny). He has also been Technical Manager of an MCM Flottilla, Test Engineer at Sea Trials Unit SMYGE and is a member of the Royal Swedish Society for Naval Sciences.
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The art of ship design involves many aspects and many disciplines ranging from hydromechanics, strength and structure, electrical power, etc. to environment, Man System Interface (MSI), IT and logistics. A modern ship is a complex system consisting of a number of subsystems that all have to work together. A typical example is a warship that has quite a number of systems in addition to the traditional ship systems (i.e. weapons, sensors, and command and control systems, etc.). The ship designer's task is to create a good compromise that meets all requirements at the lowest possible cost.

There is a strong need for thorough Systems Engineering in order to succeed. Following the experiences from the design work with the Visby Class Corvette SSPA is now developing, on commission from FMV, a tool for high-level system performance analysis.

System performance optimisation on the Visby Class Corvette

During the development of the Swedish navy's new multi-mission surface combatant, the Visby class corvette, exhaustive work was carried out by the Swedish Defence Material Administration (FMV) to optimise the total concept on the highest level. New methods for systems engineering have been developed, including e.g. Requirement handling, System performance analysis and optimisation, Integration, Validation and Verification.

During the early project stages there is often a need to compare different concepts, which requires a way of describing the overall 'Ship System Performance'. During the work on the Visby, the need arose for a flexible, easy-to-use tool for systems engineering on the highest level. Optimisation of the total ship, including trade-offs such as the performance of a sensor against hull size, the number of missiles or perhaps ship speed, caused a great deal of trouble. Much of the high-level systems engineering work on the Visby was performed with 'pen and paper', as no useful tool was available at the time.

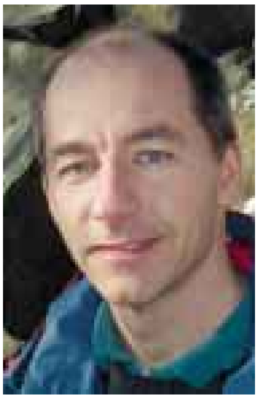
SSPA' s tool for high-level system performance analysis

This tool was built primarily by further development of the program suite consisting of Shipgen, Seaman and Opanalysis. One of the objectives is to validate and compare the effectiveness of different systems and the overall effectiveness of cooperating systems that are to be modelled at a fairly high level. Therefore we seek the main properties that should be modelled and then study how they relate to time and what major factors degraded them. In this specific project the air-defence system is considered. The model is divided into a number of subsystems/models:

- **Threat** – A threat scenario is created with a number of missiles with different initial positions and speeds.
- **Gun** – The ship is equipped with a number of guns, all with individual positions, limitations and effectiveness number (likelihood to succeed in mission if limitations are overcome). Each gun is dedicated to one or a number of target(s).
- **Chaff launcher** – Chaffs are launched under specified conditions so that they drift with the wind. If the criteria for the chaffs are fulfilled, the chaffs are given a specific effectiveness number.
- **Jammers** – The ship is equipped with a number of jammers. Each jammer is dedicated to one target and given an effectiveness number.

The threat scenario, weather condition and system properties are conveniently set up by macro commands. In addition to the air-defence system a manoeuvre command sequence can be set up (e.g. thrust lever setting, steering device angles and autopilot reference course at specific times).

In the Visby design work new methods had to be developed to optimise the total ship system performance. The Visby is a multi-mission warship with the following main functions: Surface Warfare, Anti Submarine Warfare, Mine Counter Measures, Air Defence, Underwater Defence, Command Support and Basic Functions. On the Visby a great deal of work dealt with optimising the overall system performance and balancing the cost and performance of the different weapon systems against each other and against the ship systems. An important issue has also been to present the results in a way future users can understand and to define System Performance. For example the unit for "Mine Countermeasures (MCM)-performance" is defined as "Risk for customer", which means the risk for the ships that will use the passage after the mines are cleared away. The unit for "Air Defence-performance" can be specified as "Probability of survival".



Erland Wilske, Project Manager. He graduated in 1988 (M. Sc. in electronic engineering) from Chalmers University of Technology. After graduation he worked with research of opto-electronics sensors (at Chalmers) and software development of cargo handling systems (at Saab Rosemont). In 1994 he joined SSPA and has since then been involved in projects linked to development and use of simulation tools, mainly in the area of manoeuvring and seakeeping.
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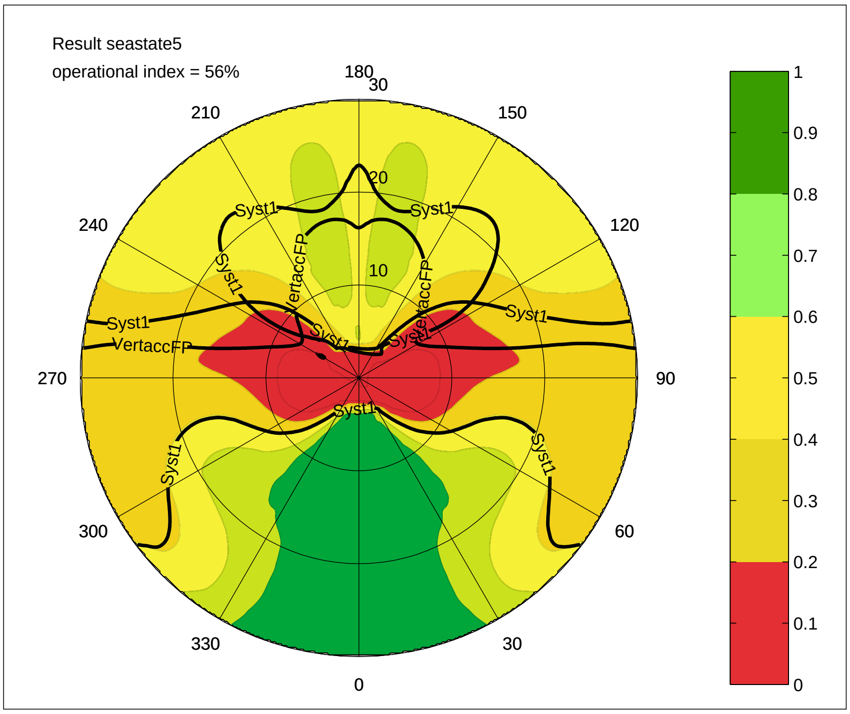

An example of system performance of the Air defence system in sea state 5 based on ship speed and direction of wave encounter. The black lines show criteria limitations for some parameters. The colour indicates the overall operability when all criteria are considered.

SSPA' s high-level system performance analysis tool 'Opanalysis' will be used in the design work on the upgrade of the Göteborg Class Corvette.

All air-defence subsystems are given an effectiveness number that reflects the likelihood of mission success. For a given scenario defined by the threat, weather conditions, operational degree and a given air-defence configuration, the total effectiveness number of the whole system can be calculated and compared with the required criteria limits. We now have a tool to calculate the effectiveness of the system taking into consideration the environmental conditions and the manoeuvring and seakeeping properties of the ship. By making systematic simulations with the systems in the loop and combining them with the results of sea keeping analysis performed in a traditional manner an overall operational index can be calculated. By setting up a number of concepts, where we combine systems with different properties and effectiveness we will clearly see which solution best suits the requirements.

Since these systems are modelled on a high level, they are easy to configure, maintain and develop. The results can be presented in a variety of ways, for example as polar plots or as a matrix/table. The architecture of the program suite is very flexible and additional systems can be incorporated. The long-term goal is to include modules for all weapon and self defence systems. We believe this program has great potential to be a very powerful tool, not only for the naval ship designer, but also for any ship designer about to design a complex ship of any kind.

Carl Fagergren / Erland Wilske

Predicting wake wash

Björn Forsman, Project Manager, M. Sc. in Mechanical Engineering, graduated from Chalmers University of Technology in 1979. In 1980 he joined SSPA where he has worked with development of oil spill recovery equipment, arctic offshore engineering, model testing and simulation of ship manoeuvring, and has been responsible for leading and co-ordinating commercial projects in the area of marine environment. He has also been programme manager for a number of advanced international and regional training programmes on Coastal and Marine Environment Pollution Prevention and Maritime Safety Management.

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When a vessel is moving through water, it generates wake wash, i.e. waves and other water motions. There is a risk that the wake wash causes environmental and/or safety problems. Special attention has been directed towards the wake wash from high-speed ferries, since it has caused accidents resulting in injured people or damaged boats etc. The wake wash from high-speed ferries is also suspected to cause additional shoreline erosion. The wake wash generated by large displacement vessels, such as conventional ferries, also causes environmental impacts.

SSPA was coordinator for an interdisciplinary research project where wake wash components were analysed and numerically modelled. The project participants (SSPA, SMHI, WET, WRE) represented several different disciplines, which is an advantage in a project with such an extensive purpose. The project was focused on two types of vessels: large vessels and high-speed vessels, respectively. A typical example of a large vessel is a conventional Ropax ferry with a length of about 200 metres and a travel speed of about 20 knots. A typical example of a high-speed vessel is a high-speed ferry with a length of about 100 metres and a travel speed of about 40 knots. Other vessels, similar to the ferries described, were also studied by this project.

Which waves are important?

Three different wake wash components were analysed in the project.

- The Bernoulli waves: the formation of the water surface around the vessel hull due to the pressure distribution in the water around it.
- The Kelvin waves: the pattern consisting of divergent and transverse waves, and the corresponding pattern in shallow water.
- The solitary wave: a single wave that is sometimes generated and that travels ahead of the vessel.

It was concluded that Kelvin and Bernoulli waves are important for safety and shoreline erosion in archipelagos, while solitary waves probably are not.

Wake wash generated by high-speed vessels in deep water may cause problems when reaching shallow nearshore waters.
PHOTO: CONNY WICKBERG

Bernoulli wave

That the Bernoulli wave can cause a large lowering of the water level along the banks when the vessel is operating in a canal, a so-called drawdown, is a well-known phenomenon. In the present project, it was found that the Bernoulli wave can also cause a significant drawdown in bays and other seemingly sheltered areas along the fairway, when a large vessel passes outside them. This drawdown can be a direct result of the vessel's passage but it might also be a result of the Bernoulli wave being scattered by e.g. an island outside the bay. It is also possible for a seiche, i.e. a periodic variation of the water level, to be generated in the bay. Shoreline effects of the drawdown vary depending on whether the shore has a mild or a steep slope. Shoreline erosion on mildly sloping shores will be negligible. On steep shores (banks), the temporarily lowered water level during drawdown causes outward hydraulic pressure gradients that decrease the structural stability of the bank resulting in erosion.

Traffic with large vessels in archipelagos can generate wave interaction effects with islands and irregular coast-line topographies.
PHOTO: OLA JENNERSTEN, NATURFOTOGRAFERNA

Jessica Johansson, Project Manager at SSPA since 2002. She received her M.Sc. degree in Mechanical Engineering in 1996 and her Lic.Eng. degree in Environmental Sciences in 2001 from Chalmers University of Technology. During her employment at Chalmers she gained research experience in areas of importance for a future sustainable society. At SSPA she works with environmental related issues in the marine area.
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Kelvin waves

The appearance of Kelvin waves (and corresponding waves in shallow water) is governed by the length, shape, and speed of the vessel, and the water depth. Certain combinations of these factors will result in maximum wave generation. A special situation is when Kelvin waves generated at high speeds in deep water reach shallow water. The wavelength becomes shorter and the wave amplitude increases as it approaches the shore. The sudden appearance of high waves along the shore may surprise people who are bathing or navigating small boats nearshore. Kelvin waves can cause shoreline erosion or accretion depending on the state of equilibrium of the profile with the ambient wave conditions.

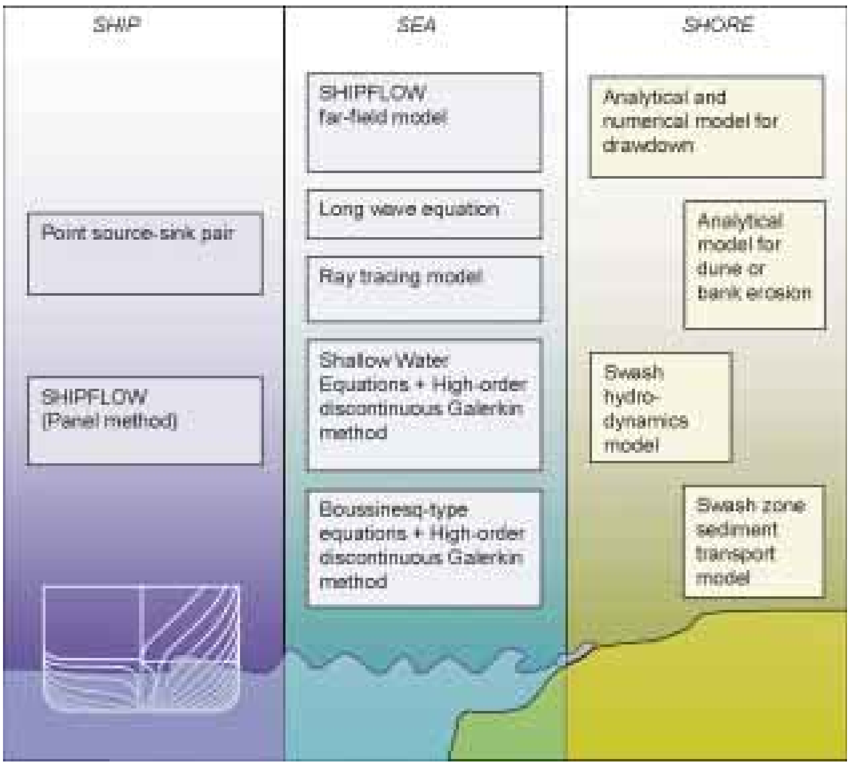
How to avoid problems

Instead of experiencing safety problems or shoreline erosion due to large and high-speed vessels, it is desirable to predict the possible problems before they occur by using various modelling tools. Several different tools have been developed or used in the project. Together they cover all steps from vessel to shore. As drawdown is a long period event, the long wave equation and the shallow water equations are suitable model equations, and the vessel can be sufficiently represented by a simple point source-sink pair. Details of drawdown at the shore are modelled with an analytical and numerical model. The Kelvin waves close to the vessel, i.e. in the near field, can be predicted by SHIPFLOW. For simulation of the propagation and transformation of Kelvin waves, the SHIPFLOW far-field model, the ray tracing model, and a Boussinesq-type model are suitable. It is possible to couple the Boussinesq-type model for the far field with SHIPFLOW for the near field. This approach gives an accurate prediction and should be further pursued. The shallow water equations and Boussinesq-type equations are solved numerically using high-order discontinuous Galerkin methods, giving computationally efficient models. The swash hydrodynamics model describes the water movements at the shore due to Kelvin waves. The resulting erosion due to Kelvin waves is obtained by coupling the swash zone sediment transport model or the analytical model for dune or bank erosion to the swash hydrodynamics model.

With the knowledge gained and the modelling tools developed during this project, SSPA and the other project participants are today well prepared to effectively tackle a wide range of environmental and safety related wake wash issues like

- environmental impact assessment and permit processes addressing vessel generated shoreline erosion,
- rulemaking with regard to speed limitations and guidelines for interaction with moored vessels and,
- port and fairway design with a minimum of wake wash related interaction effects.

Björn Forsman/Jessica Johansson



Modelling tools developed or used in the project in order to describe generation, propagation, and transformation of wake wash components, and the resulting shoreline erosion caused by them.

Purpose

- To investigate which components of the wake wash, *i.e.* waves or other water movements, generated by large and high-speed vessels operated in archipelagos, are important for safety and shoreline erosion.
- To show how computer-modelling tools can be used to describe the generation, propagation, and transformation of such components, and the resulting shoreline erosion caused by them.

Project participants

- SSPA Sweden AB (SSPA)
- Swedish Meteorological and Hydrological Institute (SMHI)
- Water Environment Transport (WET) at Chalmers University of Technology
- Department of Water Resources Engineering (WRE) at Lund University

Financial support

- The Swedish Agency for Innovation Systems (VINNOVA)

Short comments

Comprehensive tests for a submarine

Izar Construcciones Navales, S.A. has commissioned SSPA to carry out speed power prognosis, manoeuvring simulation modelling as well as development of propeller geometry for the P650 Submarine Project. To support the development work SSPA has carried out model tests including resistance and self propulsion tests, captive manoeuvring tests and cavitation tunnel tests.

Lennart Byström

The magnificent view from SSPA's new Stockholm office.

SSPA's new Stockholm office

SSPA's branch office in Stockholm continues to grow. The most recent development was the move to new premises, quite in the centre of Stockholm, in January 2003. This will help us to better serve our customers on the Swedish east coast and in the Baltic area.

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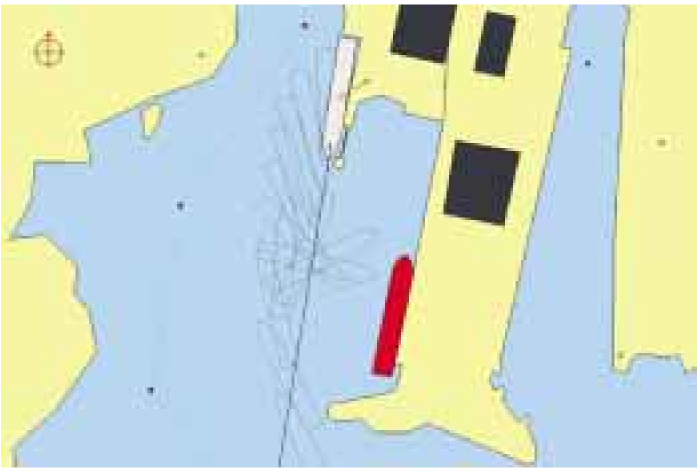

Simulation study for Karlshamns Hamn & Stuveri AB

The Port of Karlshamn is currently investing about 55 million SEK in a new RoRo terminal in Stilleryd's Harbour. SSPA was contacted to provide information on the possible of approach/departure routes for the new terminal. The initial discussions lead to commissioning SSPA to carry out a simulation study using our software PORTSIM.

The main purpose was to study the risk involved with manoeuvring a 200-m RoPax vessel with the influence of wind and waves both at the approaches and inside the harbour. About 30 simulations in total were carried out in southwest to southeasterly wind and wave directions. The maximum wind speed used for the study was 18 m/s.

The simulations conducted using the higher wind speeds resulted in the following important observations:

Ships calling at the port must have sufficient bow thruster power installed.

Tug assistance is necessary if the bow thruster power is insufficient.

To increase operability and safety margins simulator training is recommended for the crews.

Thorsten Thorstensson

Rewarded for development of submarine propulsors

Per Lindell, Lic. Eng, Project Manager at SSPA, was one of this year's prize winners at the Kockums Jubileumsfond (Jubilee Fund) awards ceremony.

Per Lindell received the award for his work on the development of submarines with respect to hydromechanics, propulsion and hydroacoustics. He has increased the knowledge of propeller singing and the design of propeller blades. He has developed design and test methods for submarine propellers and been a central person in the realization of unique full-scale tests. The award was given out by Rear Admiral Jörgen Ericsson at a ceremony on the 18th of March 2003.

Li Fredrikson

Please visit our website!

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SSPA

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