HIGHLIGHTS

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Contents

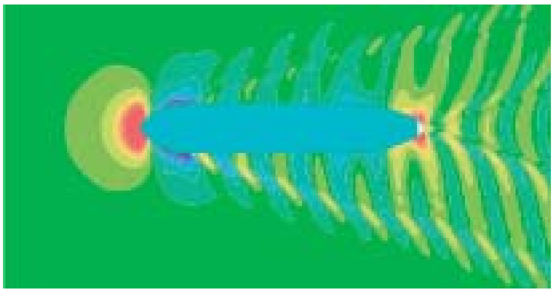
'NORTHERN LIGHTS' PHOTO: PRESSENS BILD

Broader range of applications for numerical flow simulations

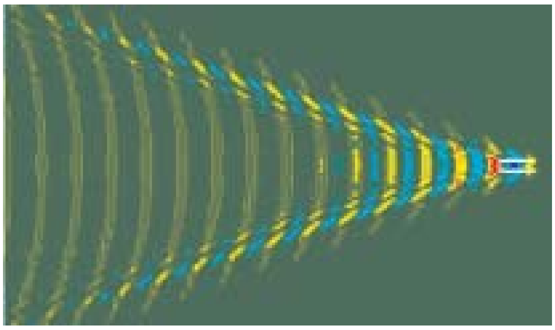
SSPA has a long tradition of simulating flow around marine entities. In the seventies SSPA developed boundary layer techniques for frictional resistance, and in the eighties potential flow and RANS models were introduced. In 1989, the code development was moved from SSPA to FLOWTECH, and the commercial code SHIPFLOW was released in 1991. SSPA has continued to offer our customers numerical flow simulations mainly using SHIPFLOW, but multi-purpose RANS (Reynolds Averaged Navier-Stokes) computations are also used.

Computational Fluid Dynamics (CFD) has been used extensively at SSPA for many years, and more and more customers take advantage of our expertise within the field. The most common approach is to use CFD in connection with model tests, but using CFD in projects as the only tool is becoming increasingly common. In cooperation with SSPA's subsidiary company FLOWTECH, we can offer a wide variety of CFD calculations. Also in cooperation with FLOWTECH, strong efforts to develop codes and applications are being made.

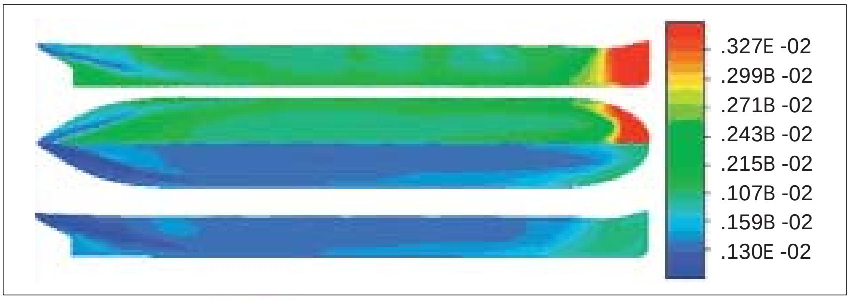
Depending on the problem at hand, the best-suited solver is selected, often either SHIPFLOW or FLUENT. SHIPFLOW was designed for flow around ships and is very well suited for initial design, as it can quickly render results. FLUENT, on the other hand, is a multipurpose solver, offering solutions to a variety of problems.



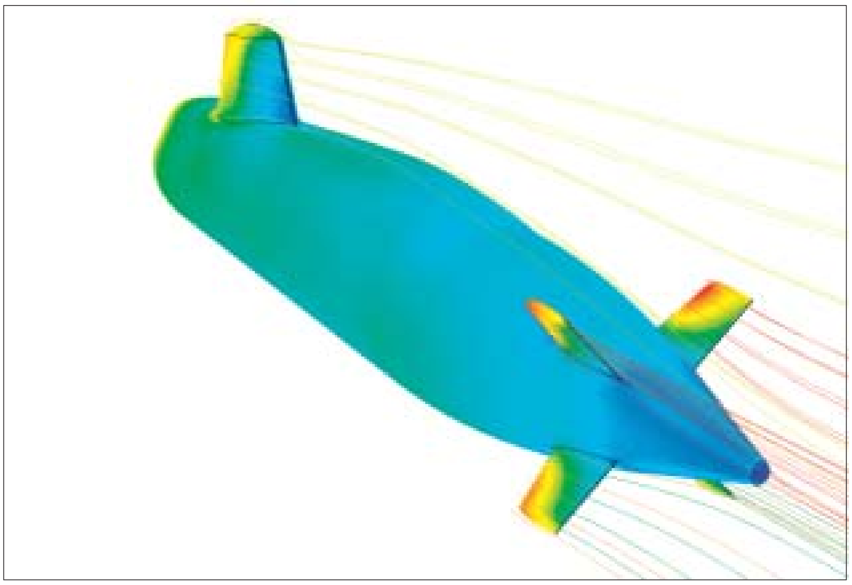
Wave and pressure contour plot showing a typical result from a hull shape optimisation using SHIPFLOW. The lower half of the picture shows the original hull design of a VLCC and the upper half shows the improved design.



Very large free surface far-field calculation generated from a catamaran in deep water.



Local friction coefficient calculated using a smooth and a rough surface (top: barnacle surface). The data needed to hydrodynamically simulate the surface roughness was obtained experimentally.



Pressure contours on a submarine (generic model) with sail and rudders. Compared with cavitation tunnel tests, the total resistance coefficients calculated are very close to the measured value.

At SSPA we have a solid maritime heritage to preserve and develop for the benefit of the maritime community – being a Naval Architect I feel passionately about the task.

As an international and independent company SSPA offers a business environment with influences from all over the world, a fertile soil for new technical innovations and a meeting place for people. Advanced technology is a step on the way to success, but is not always enough. I believe that the greatest successes are achieved when well developed technology is placed in the hands of people who have a deep understanding of the market and the system and are trained in managing them. We like to take responsibility for both the advanced technological development and increasing knowledge and understanding of human factors.

We favour a working process with long-term commitments and close cooperation with our clients and partners. It does not prevent us from working as trouble-shooters when quick action is requested. A combination of the two keeps our organisation dynamic and competitive in the best interest of our clients.

Common values of importance in our assignments are to seek sustainable solutions where safety, economy and environment are prioritised. For us, as well as for many of our clients, intellectual property is of great concern; that's why we always deliver solutions that are exclusive for the client.

Let us together explore and develop new maritime business opportunities for the benefit of us all.

Susanne Abrahamsson

Michael Leer-Andersen, Project Manager and Ph.D. student at SSPA. He received his M.Sc. in 1996 from the Technical University of Denmark. He was employed at SSPA in 1997 as a Researcher, specialising in hull resistance due to rough surfaces and wash wave simulations using CFD and measurements. He has carried out several commercial and research projects using CFD.
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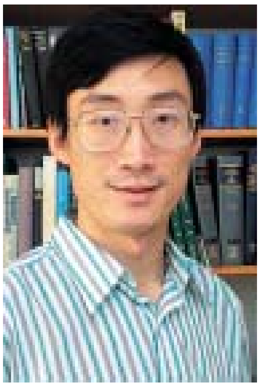

Da-Qing Li, Project Manager and researcher. He received his B.Sc. in Naval Architecture from Huazhong University of Science & Technology in 1986 and his Ph.D. in Ship Hydrodynamics from Chalmers University of Technology in 1994. Prior to joining SSPA in 1998 he worked as a post-doc at Chalmers. He is currently working with propeller/waterjet propulsion, cavitation/erosion and shallow water problems.
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Overall hull design

In this category SSPA uses SHIPFLOW, and the most common application is the use of the potential flow module. The wave resistance can be extracted and the pressure can be studied to make design changes with the purpose of lowering the resistance. Furthermore, SHIPFLOW's RANS module can be used to improve the wake flow. CFD is almost always utilised when SSPA performs design optimisation for our customers.

SHIPFLOW is often used also for other types of applications. The wash waves themselves can be interesting for environmental purposes, and to be able to extract the wave heights at great distances from the ship a far-field model for SHIPFLOW was developed at SSPA. Another application is the prediction of the increase in skin friction due to rough surfaces. These applications are only a few examples of the use of SHIPFLOW at SSPA, both for commercial and research projects.

Detailed flow simulation

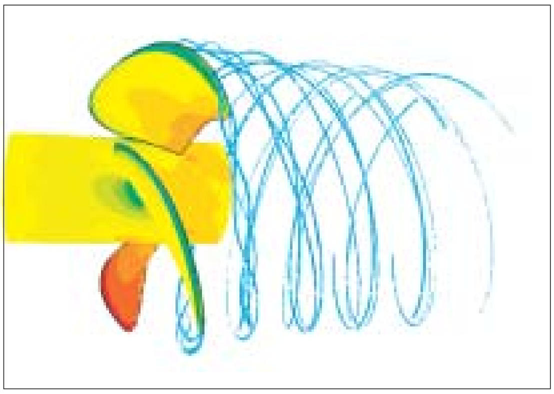
The use of viscous flow solvers, such as SHIPFLOW or FLUENT, makes it possible to analyse complex flow around detailed geometries or highly viscous domains such as the stern region behind a ship. Some recent examples of such simulations at SSPA are described below.

Submarines have a fairly complex shape as compared to most ships, due to rudders and sail. The rudders in particular will have an important effect on the wake in the propeller disc. Such phenomena are well predicted by RANS solvers. Even unsteady computations can be performed to predict noise generation better.

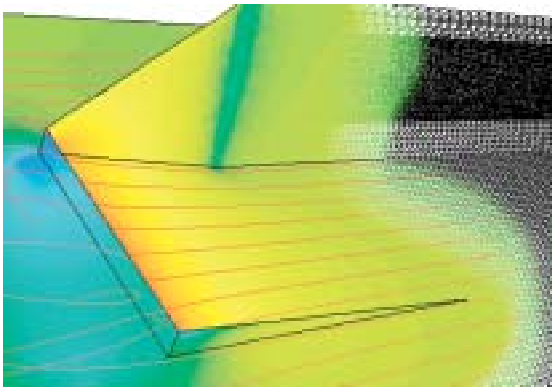
By participating in the EU research project 'Leading edge' SSPA has gained more experience in meshing and simulating viscous flows around highly skewed propellers. The pressure contour on blades and path lines behind a generic propeller, shown here, illustrates the load distribution on blades and the tip vortical flow structure in the slipstream. The predicted model scale thrust coefficient is usually within a difference of 3~4% of the measured one. If the results are accurate enough, a method is available to quickly and inexpensively improve on a propeller design.

Another example is an improvement of the fins surrounding an interceptor on a high-speed catamaran, in order to increase the pressure on the interceptor. Obviously, for a geometry like this, viscous effects such as the wake behind the interceptor are very important. Several different fin geometries and sizes were examined until an optimum design was found.

As only the aft-most 10 per cent of the high-speed catamaran is of interest in this case, a method combining the advantages of SHIPFLOW and FLUENT was used. SHIPFLOW was used to calculate the flow some distance upstream of the fins and interceptor, and this result was utilised as an inlet to do the detailed flow simulation around the interceptor and fins using FLUENT.



Calculation of a highly skewed generic propeller model using a RANS solver (pressure contour and tip vortical flow structure.



Interceptor design. The fins are the two plates parallel to the flow direction. This work was completed for Stena Rederi AB, Technical division. The fins were calculated using a method in which both SHIPFLOW and FLUENT were utilised.

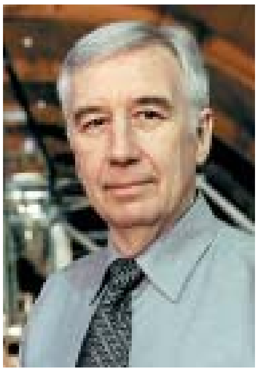
Pros and cons

Compared with model tests, CFD has both advantages and disadvantages. Using CFD is usually much cheaper than doing model tests. It is easy to examine design changes, and the range of applications possible with the CFD approach is larger. Additionally, not only integrated results are available, such as for instance resistance measured in the towing tank, but also the entire flow field around the structure can be studied. In terms of accuracy though, CFD cannot yet compete with model tests, and for this reason CFD at SSPA is often used in combination with model tests.

When using CFD, it is often possible to automate the optimisation process, thus decreasing both man-hours and delivery time. Using a parameterised geometry formulation linked to the solver used, it is possible to quickly examine a large number of geometries (for instance different hull shapes), and even to guide this towards an optimised result.

Michael Leer-Andersen / Da-Qing Li

Very Large interest in Crude Carriers



Hasse Olofsson, Project Manager and one of SSPA's most experienced Senior Consultants. He has been employed at SSPA since 1964 and has primarily been working with hull form development for tankers, bulkers, LNG, and Ro-Ro vessels. Hasse Olofsson is an expert in hull design and ship trial predictions.

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Henrik Andreasson Project Manager at SSPA. He received his M. Sc. degree in Naval Architecture 1999 at Chalmers University of Technology and has since then been employed at SSPA. He is primarily working with model tests and CFD calculations for hull form optimisations.

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The strong interest in the tanker segment shows no signs of slackening. The new building prices for VLCCs have risen almost to levels that were last seen around a decade ago, when Golden Ocean Management hit problems. As one of the world's most complete commercial maritime test facilities with a reference list of over 25 per cent of all VLCC tankers built, SSPA has been commissioned for hull form development of several ongoing VLCC projects all over the world.

The new-building market for VLCC is still very strong and shows no signs of declining. The first year of the new millennium over 64 VLCCs were ordered from shipyards the world over. This record could very well be beaten this year.

Revival of size

Since the seventies both displacement and beam have continuously increased and today a majority of the VLCCs ordered have a beam of 60 m. An interesting aspect of this is that the size of today's VLCCs is starting to approach the size of the smaller ULCCs of the seventies. For example, the Kockums 350 000 DWT ULCC Series, which was developed at SSPA, had a displacement close to today's VLCCs and a beam of 60 m. Revival of size will also mean a revival of technical problems and solutions particular to these sizes.

SSPA VLCC record

SSPA has been involved in the development and model testing of a large percentage of the crude oil tanker fleet. As early as the late 1960's a standard series of VLCCs was developed and tested at SSPA. The hull forms of the Kockums, Uddevalla and Eriksberg tankers were all developed at SSPA. Other European shipyards that commissioned SSPA are Chantiers de l'Atlantique and Odense Staalskibsvaerft. SSPA has been involved in the development and testing of standard series of VLCCs for many of the Korean Shipyards such as Daewoo Shipbuilding and Marine Engineering (DSME) and Samsung Heavy Industries (SHI).

SSPA has experience from carrying out work for over 25 per cent of the VLCCs built in the world and, in addition to VLCCs, over 35 per cent of the ULCC fleet.

The 442500 DWT ULCC TI Africa was launched at Daewoo in 2002 and built for Hellespont. SSPA had the hydrodynamic knowledge needed and was commissioned by Daewoo to carry out the model tests of the hydrodynamic design. These first ULCCs to be built since the seventies are now owned by Tankers International and named TI Africa, TI Asia, TI Oceania and TI Europe.

The Iran Delvar is one of five in the first ever series of VLCCs built in China. The Iran Delvar was launched in 2003 at Dalian New Shipyard. Hull form development in order to find the most optimised design was performed at SSPA. These five VLCCs were built for National Iranian Tanker Company (NITC).

The very beamy single-screw tanker Silba was launched at Uljanik Shipyard in 1986. The hull form of this tanker, with an Lpp/B of only 4.22, was optimised and tested at SSPA. To assure good course-keeping characteristics special measures were taken, e.g. the course keeping fins, which can be seen in the photo.

Within the European EROCAV research project (www.erocav.de) Chalmers/SSPA developed methods for detecting erosive cavitation using a high-speed video technique in SSPA's large cavitation tunnel. The series of pictures is from a high-speed film showing the collapse pattern of erosive cavitation on a foil.

At the initial design phase SSPA offers speed – power calculations, and in the hull optimisation phase recommendations are given regarding fuel saving modifications. These recommendations are based on SSPA's knowledge of model testing combined with CFD computations carried out using SHIPFLOW or FLUENT. Full-scale predictions are given based on scale-model tests in SSPA's towing tank and correlated to an extensive sea trial data base.

New method for detecting erosion

Single screw VLCC propellers are heavily loaded; consequently the wake distribution is critical with respect to vibration and erosive cavitation. SSPA has 50 years of experience from cavitation testing. Most full ships have been tested in our cavitation tunnel, where the propeller is observed working behind the large towing tank model. The hull geometry produces transverse wake components close to reality, which is essential to generate the right cavitation pattern. SSPA has a unique and well-proven erosive paint testing method for detecting erosion caused by cavitation. This is a very cost-effective method for avoiding future problems.

Recent progress with quality, method and cost of HSV filming has made this an attractive complement to erosive paint tests. The combination of high-speed video filming and erosive paint testing is very efficient at producing crucial information regarding the risk of erosion that can be missed by other methods.

The challenge of beam

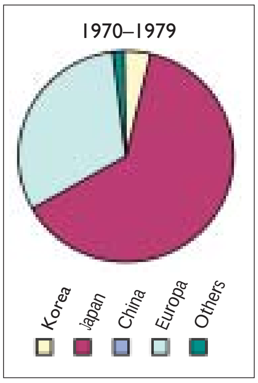
For VLCC tankers, with their very full hull form, it is essential to focus on more than calm water resistance and propulsion. Very often the turning ability of the VLCCs may be excellent; however, this is at the price of reduced course keeping performance, which results in poor yaw checking, among other problems. Poor performance on the zig-zag tests is a common problem for ships with a large block coefficient (CB > 0.80) and a small length to beam ratio (Lpp/B < 6). Today a VLCC has a CB around 0.83 and Lpp/B < 5.4.

The SSPA Maritime Dynamics Laboratory (MDL) is a very useful tool when analysing whether a new project fulfils the IMO Resolution MSC.137(76) concerning turning ability as well as yaw checking and course stability. The width of the basin allows most manoeuvres to be performed with fairly large free sailing models. The great advantage of a free-sailing test compared with captive and PMM tests is that integrated results can be delivered directly after the test without using complicated formulas to translate the results. SSPA has experience from manoeuvring tests with single-screw tankers of CB above 0.89 as well as from tankers with Lpp/B below 4.3.

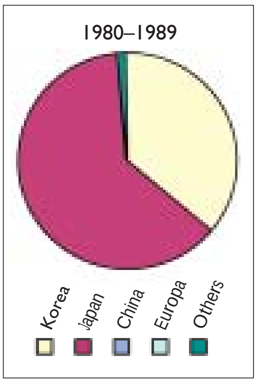
For further increased beam it is advisable to consider a twin-skeg design, which is successful not only from a manoeuvring point of view, but it can also achieve the lowest power required and eliminate the risk of cavitation related problems. The Stena V-max, built at Hyundai Heavy Industries (HHI) and model tested at SSPA, is a splendid example of such a design.

Hasse Olofsson / Henrik Andreasson

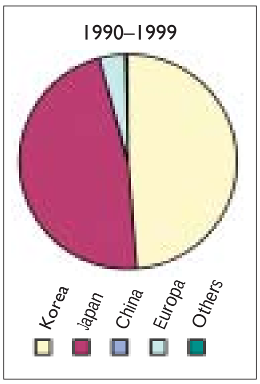
A résumé of the VLCC market



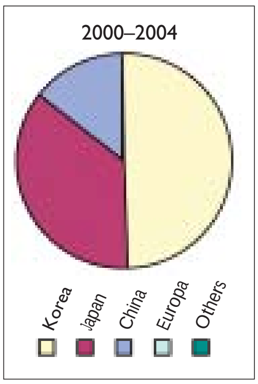
In the seventies Japan dominated the shipbuilding market of VLCCs and ULCCs. Europe was in second place with approximately one third of the market. It was within this period that the real giants of the sea were built, mainly in Europe. Almost all VLCCs and ULCCs were built before 1975. It took 25 years until the next ULCC was built.



In the eighties not very many VLCCs were built. In 1984 the market started to recover, and Korea entered the scene. Europe lost its share of the market to Korea, while Japan continued to dominate the market.

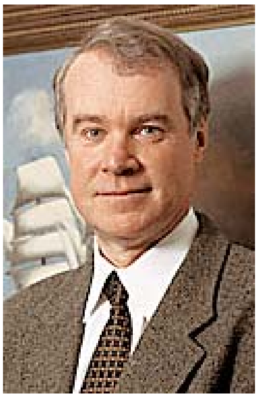


In the nineties Korea and Japan shared the world market. In Europe Odense Steel Shipyard was still building VLCCs until 1994. In 1999 a new player entered the scene. DNS got China's first order for a series of 5 VLCCs for NITC. During the nineties more than 260 VLCCs were ordered. Worth mentioning is that in 1999 DSME got an order to build the first ULCCs since 1974.



With over 60 VLCCs ordered in the first year of the new millennium and as of mid-20004 over 170 VLCCs ordered, this decade seems to be the golden era of the VLCC shipbuilding market. Korea has increased its share to half the world market, while Japan has dropped slightly. The new player China has over 10 % of the market.

Submarines in surface condition – a seasickness nightmare



Björn Allenström, Vice President. He received his M. Sc. degree in Naval Architecture in 1976 at Chalmers University of Technology and has since then, except for two years, been employed at SSPA. Telephone: +46 - 31 772 9066 E-mail: bjorn.allenstrom@sspa.se

Måns Magnusson, Professor at the Department of Otorhinolaryngology at the University Hospital, Lund, Sweden. Måns Magnusson's research has been concentrated on disturbances in the organ of equilibrium, visual orientations and coordination – adaption – of the brain and the sensory organs contributing to equilibrium and orientation of humans.

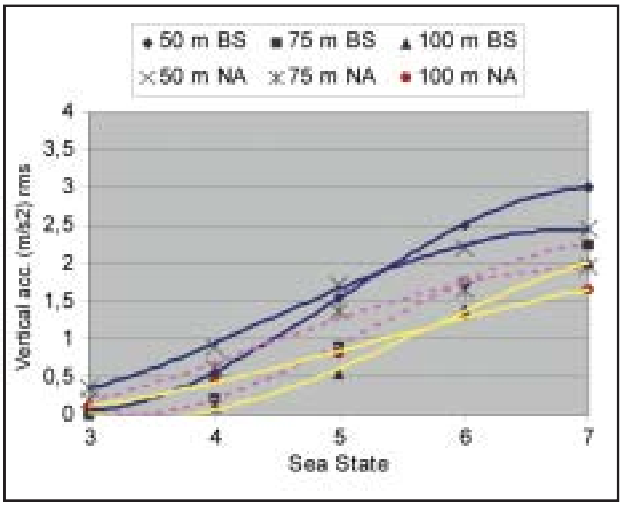
Seasickness – or to use the proper term - motion sickness, is probably the most uncomfortable condition the human body experiences on board a ship. In the literature this problem is often connected to high-speed passenger ships. However, submarines on the surface are often witnessed to have the most severe motions that a person at sea can experience.

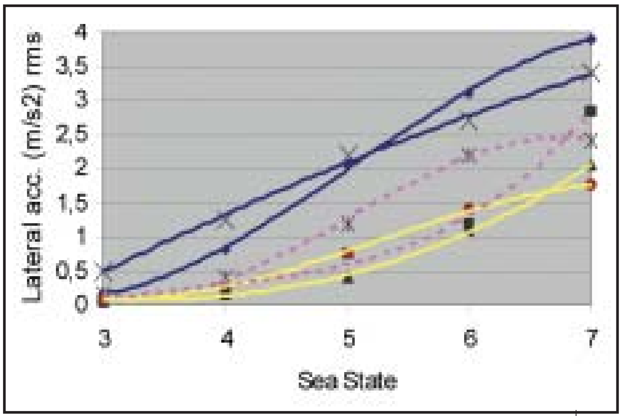
Human motion sickness is considered to be a result of what is termed a 'sensory mismatch' between the receptor systems involved in orientation and balance. These systems are vision, vestibular sensation of the inner ear and somatosensation. When information on human movement from receptors disagrees, a sensory mismatch occurs along with the possibility of developing motion sickness.

Calculation of accelerations in surface condition

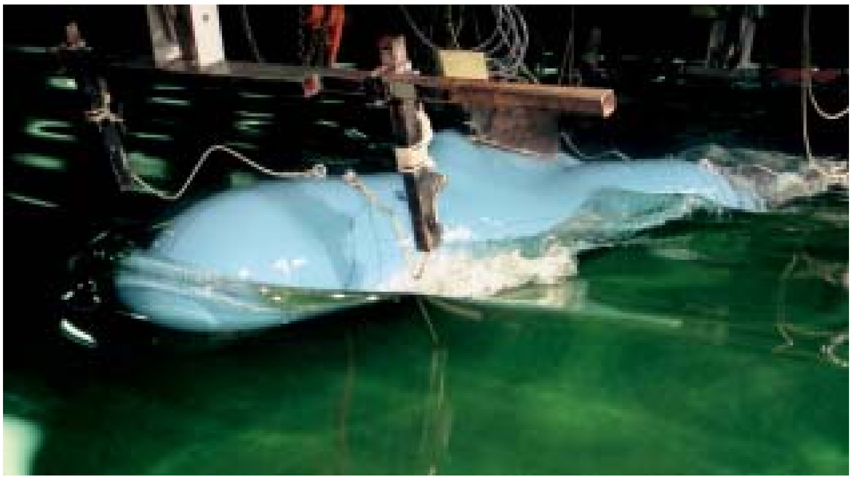
To illuminate the risk of getting seasick in a submarine in surface condition, calculations of vertical and lateral accelerations, using SSPA's strip theory program and experience from model tests, have been carried out for three different sizes of submarines, a 50-m, a 75-m and a 100-m submarine. Accelerations were calculated for different headings and sea states. For each case the accelerations were calculated for a typical restricted sea spectrum (Baltic Sea) as well as for a typical non-restricted spectrum (North Atlantic). It is well known that the human body is most sensitive to frequencies below 0.3 Hz. From the calculations it was seen that in almost all cases the frequencies were in the order of 0.1 to 0.2 Hz.

The knowledge of maximum accelerations a human can tolerate without being seasick is mainly based on experience from ships, and then normally only vertical accelerations are specified. However, on submarines in surface condition the lateral accelerations are very high due to the heavy roll motion. When designing ships the ISO criterion is often used. This states that for low frequencies the maximal acceptable vertical acceleration is 0.25 m/s^2 rms to eliminate the risk of motion sickness for

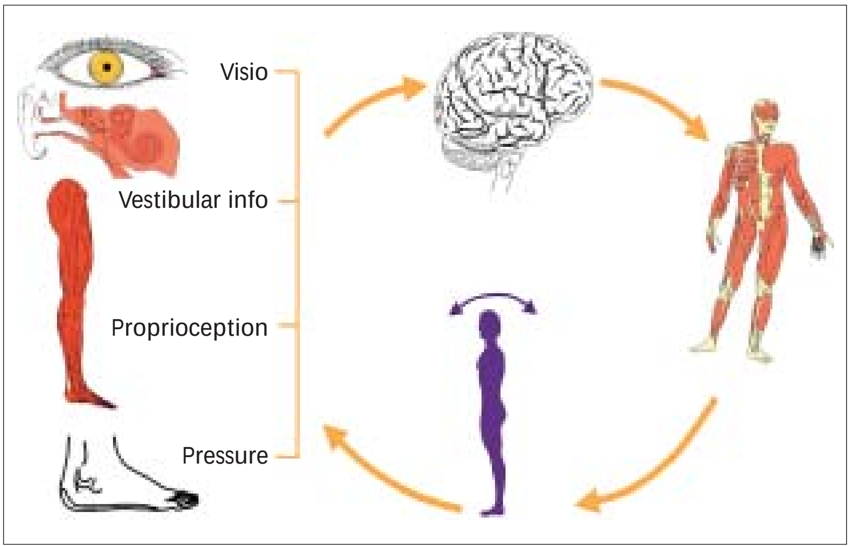




Vertical and lateral accelerations calculated for three different sizes of submarines: a 50-m, a 75-m and a 100-m submarine both in restricted water (the Baltic) and in unrestricted water (the North Atlantic).



Tests with different submarine models have been performed in SSPA's Maritime Dynamics Laboratory. The models are freesailing, and tests can be carried out in all headings.



To maintain orientation and balance the human being depends on sensory information from visual (eye), vestibular (inner ear), proprioceptive and mechanoreception of pressure from loaded body surfaces.

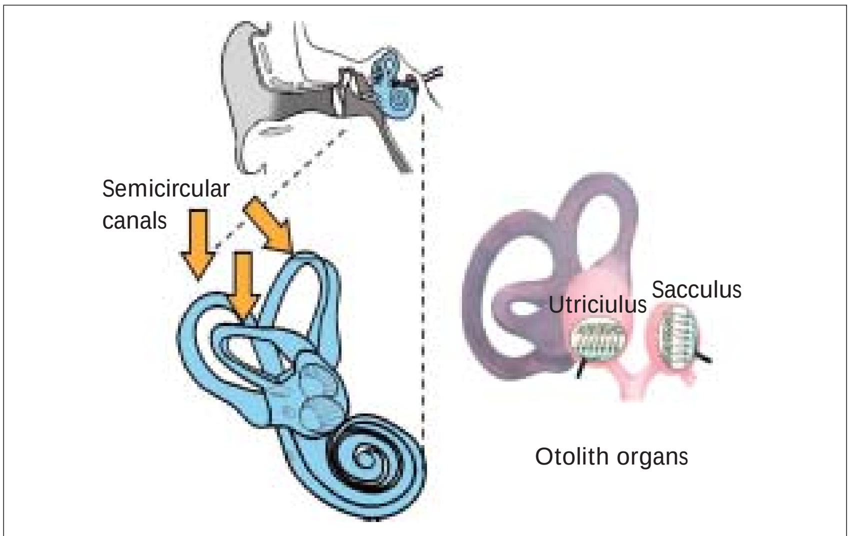
The vestibular transducers are situated in the inner ear. They are semicircular canals and otoliths organs of the utricle and the saccule. There are reasons to believe that the otolith organs are quite sensitive to high lateral accelerations, which often occur for submarines in surface condition.

a longer journey. For just a half-hour trip vertical accelerations up to 1 m/s^2 can be accepted. In the literature one can find that 1 m/s^2 can be regarded as the upper limit for performing intellectual work on board.

Looking at the vertical accelerations for the three different submarines, one can see that the 50-m submarine reaches 1 m/s^2 in the North Atlantic at Sea State 4. At high Sea States like 6-7, the vertical accelerations are in the order of 2.5-3 m/s^2, which has to be regarded as very high. It can be noticed that the 100-m submarine shows approximately half of the accelerations that the 5-m submarine does, and that the 75-m one is somewhere in between. If the level 0.25 m/s^2 were to be used on board, only the 100-m submarine would be 'safe' from a motion-sickness-point-of-view, and then only up to Sea State 3-4.

The unique submarine problem

The big problem for the submarine is, however, the lateral accelerations. Even if they are in the order of the vertical ones, there are reasons to believe that these very high lateral accelerations are more difficult for the human to handle than the vertical accelerations. To avoid high lateral accelerations one had better head the sea. However, in head sea the vertical accelerations are at a maximum. In beam sea, both vertical and lateral accelerations are high, but only half of the value presented in the figures.



Reduced alertness

In addition to a possible motion sickness, it can be stated that the motions themselves on a submarine in surface condition can have a severe impact on the personnel on board. Drowsiness is common during motion sickness, and one of its cardinal symptoms. Most often, this symptom occurs together with other and more well known symptoms of motion sickness.

Under certain conditions reduced alertness may occur as a sole manifestation and has been termed the 'sopite syndrome'. It includes symptoms such as yawning, drowsiness, disinclination for work, either physical or mental, and lack of participation in group activities. The sopite syndrome may occur when the intensity of the eliciting stimuli is close to the subject's boundaru of susceptibility. In this case the sopite syndrome develops either before other symptoms of motion sickness appear or in their absence. It may also occur under prolonged exposure to motion, when adaptation results in the disappearance of motion sickness symptoms, except for those responses of the sopite syndrome described above. This implies that crews exposed to motion stimuli may suffer from reduced capacity even without the observed motion sickness symptoms.

Motion sickness

Human orientation as well as postural reflexes depend on coordinated sensory information from visual, vestibular and proprioceptive receptors signalling movement of the body relative to the surround and, in case of visual information, also movements of the surround it self. The vestibular transducers are situated in the inner ear. They are semicircular canals and otoliths organs of the utricle and the saccule. The vestibular information is that of 3-dimensional head rotation, picked up by the semicircular canals, and linear acceleration detected by the otolith organs. The vestibular information evokes reflexes as well as cognitive experience of motion. Vestibular stimulus invokes both eye movement and direction and postural responses. The vestibular ocular reflex – the VOR – will immediately move the eye relative to the head to keep the gaze on target when the head is moved. In an enclosed space, such as that of a submarine, the visual surroundings typically move with the head, and the eye movements created by the VOR create a conflicting movement of the visual surroundings instead of stabilizing gaze. This creates a sensory mismatch, which is the requisite of motion sickness.

Björn Allenström / Måns Magnusson

Short comments

Port simulation study for ConocoPhillips Company

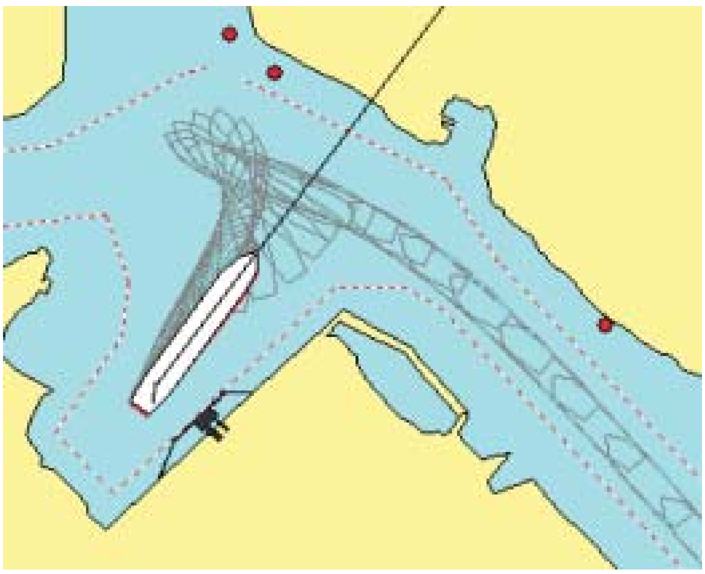
ConocoPhillips Company recently commissioned SSPA to carry out port simulation studies of large LNG carriers calling at different possible LNG terminals on the Gulf coast of the US, using the SSPA simulation software PORTSIM/SEAMAN.

The port simulations are carried out in order to assess present harbours and to find out necessary modifications of present harbours for safe arrival and departure of large LNG carriers. Port simulations have become an important tool in the development and evaluation process of new LNG transport concepts.

SEAMAN is a program for simulation of ship motions in 6 degrees of freedom in the time domain. Thus both seakeeping and manoeuvring performance can be studied, including effects of wind, waves, current, restricted waters, misc. equipment such as high efficiency rudders, bow thrusters, roll stabilising fins or tanks, etc. PORTSIM is the graphical interface showing an ECDIS-like view of the actual ports and plotting of the ship outline.

SSPA's Compact Bridge Simulator was used for the simulations that were carried out in the presence of the client's representatives.

Henrik Andreasson



ECDIS view of a large LNG Carrier entering possible LNG terminals on the coast of the US.

Road safety management is a vital part of Risk Management in Community Development Planning.

Asian Risk Management Workshop in Manila

30 experts in Risk Management and Natural Disasters, representing 12 Asian countries, participated in the Risk Management in Community Development Planning Follow-Up Workshop, which was held in Manila from June 1 to 9. Bangladesh, Cambodia, China, Indonesia, India, Lao-PDR, Mongolia, Nepal, the Philippines, Sri Lanka, Thailand and Vietnam were represented.

The workshop was successfully conducted by SSPA´s Björn Forsman, Christina Backman and Jim Sandkvist in close and fruitful cooperation with the Department of Environment and Natural Resources (DENR), the Philippines.

All workshop members have earlier participated in the RIMC training programs performed on a yearly basis since 1994 in Gothenburg by SSPA. The main objectives of the follow-up workshop were:

– to evaluate the results and outcome of the yearly RIMC Programs,
– to serve as an avenue for the exchange and sharing of information and insights on managing risks from various natural and man-made environmental disasters in participants' countries,
– to guide Sida in order to develop new programs within this important field.

The nine-day workshop was filled with well-prepared case presentations, active discussions, lectures and study visits. The discussions and cases covered items such as flooding and flooding effects in transboundary contexts, slides, industrial safety matters, gender issues, coastal hazards, preventive planning and organization build-up. A number of lectures regarding Philippine risk and environment management were also given.

The workshop was opened and actively supported by the Swedish Ambassador, Mrs Annika Markovic, and Mr Rolando Metin, Undersecretary, DENR. SSPA now looks forward to forthcoming cooperation possibilities together with the DENR organization.

Jim Sandkvist

Conference on 'Maritime Safety and the Human Factor'

An international conference on 'Maritime Safety and the Human Factor' was organised by SSPA as the leader of the research project 'SÄSAM- Safety and the human-machine interaction in waterborne transport'. The conference took place on May 18, 2004, at Kalmar Maritime Academy, Kalmar, Sweden, and about 70 experts from Sweden, Denmark, Finland, Estonia and Latvia participated. Results from the SÄSAM Project and other maritime safety projects were presented, and co-operation between the Nordic and Baltic countries was discussed under guidance of NTF (Nordic Transport Research) and VINNOVA (Swedish Agency for Innovation Systems).

Claes Källström

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