SSPA HIGHLIGHTS
A NEWSLETTER PUBLISHED BY SSPA SWEDEN AB 2/2003

Contents

Globalisation is here to stay!

Alien invasion is associated with science fiction, but today it is reality. We find new clams in the waters of the Swedish west coast. We do not yet know if this is bad or good, but we know that the change is extremely fast compared with natural evolution. The natural obstacles for the long distance journey of the clams are surpassed by new technology. Fast changes are hard to appreciate and handle, and we get frightened.

Information is also travelling around the world faster than we can handle. An Old Russian Nobel Prize winner was asked: 'What is the most important change in your lifetime?' He took a few seconds to think about this, and concluded: 'I think it is the information pollution.' This was judged to be more significant than two world wars, invention of the automobile, airplane, nuclear power, transistor, and much more. When the market reacts to new statistics from the US, followed by a counter reaction next day, the financial consequences are very significant.

WTO is having problems developing a world without trade obstacles. A Swedish referendum has just voted No to joining the European common currency. Swedes in general are very pro-globalisation, but we have so many views on what is the right concept.

The world is becoming ever smaller. Products and ideas find their way fast and irrevocably to new markets. We can be pushed into a new situation or we can choose, develop and control the process. Life is something in between!

Lars Afzelius

Stopping the alien invasion: Ballast water treatment

Living organisms are being transported around the globe in ships' ballast water. Some of these alien species have successfully established themselves in new locations, often to the detriment of the existing aquatic ecosystems. Ballast water management to prevent the spread of alien species has been receiving a lot of attention recently, both from regulatory agencies such as the International Maritime Organization and from research and development groups. SSPA is a partner in MARTOB, a three-year European Commission project that is addressing the issue of ballast water management.

Alien troublemakers on the high seas

Some examples of alien species introductions include the zebra mussel, the Chinese mitten crab, and the American comb jelly. These introductions have had substantial economic and environmental consequences. It has been estimated that a new species is introduced to a region somewhere in the world once every nine weeks. Although there are a number of ways new species are introduced, ballast water is considered to be one of the main vectors. Once alien species are introduced, it is extremely difficult and in some cases impossible to remove them. Prevention, therefore, is the best approach to this problem.

The regulatory response: fighting back

The International Maritime Organization (IMO) has published voluntary guidelines for the control and management of ships' ballast water. In addition, a number of countries and regions have implemented mandatory regulations. Ballast water exchange, the management method that is currently practised, is described in IMO guidelines. The guidelines are considered an interim measure and IMO's Marine Environmental Protection Committee (MEPC) has been working to prepare a ballast water convention that would eventually become mandatory. The MEPC prepared a draft convention in July 2003 and this will be dicussed at a diplomatic convention in February 2004. The draft convention sets out standards for ballast water exchange, management, and treatment.

The zebra mussel was introduced into the Great Lakes and fouls water intakes and underwater structures, while the comb jelly caused the decline of the Black Sea anchovy fishery. Both of these species were introduced by ships' ballast water.

PHOTO: CHRIS PARKS/IMAGEQUEST3D.COM (PICTURE TO THE RIGHT)

Preparing the nutrient solution for on board testing of the biological de-oxygenation method.

Zooplankton that have passed through a laboratory-scale ballast water treatment system are examined under a microscope.

PHOTO: BY COURTESY OF DR. ESHAN MESBAHI, UNIVERSITY OF NEWCASTLE

Ballast water exchange not completely effective

Ballast water exchange is the only ballast water management method that is widely used today. The method is not, however, considered to be completely effective at removing organisms from the ballast water. Organisms may remain in sediments in ballast water tanks during the exchange procedure, and it is often not possible to completely flush out the water that was taken on at port. Many new techniques are being investigated and tested as a more effective method of managing ballast water. A goal of the MARTOB project is to develop recommendations for alternative ballast water management methods that involve treating the water on-board the ship.

Joanne Ellis is a Project Manager and PhD student at SSPA. She has a Licentiate Degree from Chalmers University and an M.A.Sc. (Environmental Engineering) from the University of British Columbia. She has worked at SSPA since 1999 and has been involved in a variety of projects including dangerous goods transport risk assessment and studies related to the environmental impact of transport. Prior to joining SSPA, she worked with environmental assessments, water quality issues, and transportation projects.
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The MARTOB project: searching for a solution

The MARTOB project began in April 2001 and is funded through the Transport and Energy Directorate of the European Commission (GROWTH Programme). SSPA is one of twenty-five partners from eight countries that are participating in the project. Within the project, selected ballast water treatment methods are being tested at laboratory scale, on board ships, and at large scale on shore.

Measuring performance

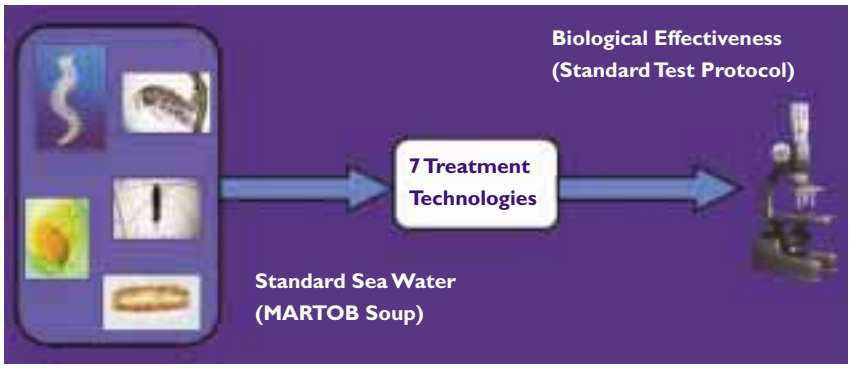
The goal of ballast water treatment is to reduce the risk of releasing alien species: it is therefore important to be able to measure the biological effectiveness of each treatment method. Within the MARTOB project, a set of organisms was selected for testing the effectiveness of each method at laboratory scale. In addition to being effective at reducing the transport of alien species, ballast water treatment methods should also be safe, cost-effective, and environmentally friendly. These characteristics were also assessed for each of the methods tested within MARTOB.

Starting small: laboratory scale testing

The following methods were tested at laboratory scale in the MARTOB project:

Laboratory-scale testing of ballast water treatment technologies was carried out to measure their effectiveness against 5 target species.

PHOTO: BY COURTESY OF DR. ESHAN MESBAHI, UNIVERSITY OF NEWCASTLE



MARTOB Partners involved with Ballast Water Study

University of Newcastle (UK)
Åbo Akademi University (FIN)
VTT Industrial Systems (FIN)
TNO Environment, Energy and Process (NL)
TME Institute for Applied Environmental Economics (NL)
Fisheries Research Services (UK)
French Research Institute for the Exploitation of the Sea (F)
Association of Bulk Carriers (London) (UK)
Alfa Laval AB (S)
SSPA Sweden AB (S)
Souter Shipping Ltd (UK)
Environmental Protection Engineering S.A. (EL)
Three Quays Marine Service (UK)
International Chamber of Shipping (UK)
SINTEF Applied Chemistry (NO)
Bureau Veritas (F)
INTERTANKO (UK)
V/den Heuvel Watertechnologie BV (NL)
Berson Milieutechniek B.V. (NL)
Wallenius Wilhelmsen Lines (NO)

- High temperature thermal treatment
- Biological de-oxygenation
- Ultraviolet irradiation and ultra-sound
- Ozone
- Oxicide method
- Oxidation / UV + Ozone + Catalysts (Advanced Oxidation Technology)
- Hurdle technologies (combinations of the above methods).

A standard mixture of seawater and target organisms was used to test the effectiveness of each method. The testing took place in June 2002 at the Marine Technology Department of the University of Newcastle upon Tyne (MARTOB project coordinator).

The big test: on board and large scale testing

On-board and large scale testing of ballast water treatment methods began in the spring of 2003. Thermal treatment, advanced oxidation technology, and biological de-oxygenation are all being tested on board a RoRo vessel. Ozone, UV, US, and oxicide will be tested on shore at large scale. Results are expected in the fall of 2003.

Towards a solution: fighting aliens in the future

The MARTOB project has contributed towards development of methods for treating ballast water on board ships. In addition, the MARTOB group has gained expertise in assessing effectiveness, environmental effects, safety and cost of ballast water treatment methods. It is expected that in the future there will be technologies available that are capable of treating ballast water to a very high standard and protecting the aquatic environment from the threat of invasion.

Joanne Ellis

Sampling equipment used during the on board testing of ballast water treatment systems. Ballast water was filtered through sieves to determine the effectiveness of the treatment against specific size ranges of organisms.

PHOTO: BY COURTESY OF DR. ESHAN MESBAHI, UNIVERSITY OF NEWCASTLE

LNG – Future market demands provide future challenges

Hasse Olofsson, Project Manager. He has been employed at SSPA since 1964 and has mainly been involved in hull form development work for tankers, bulkers, LNG, and Ro-Ro vessels. Hasse Olofsson is an expert in hull design and ship trial predictions.
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Lars T. Gustafsson, received his Master of Science in Naval Architecture at Chalmers University of Technology in 1993. After graduation he participated in a one-year job rotation program and joined SSPA in 1994. His earlier work was mainly with model tests and CFD calculations and from Jan. 1999 he has been Market Manager at SSPA Ship Design. He has from 1996 to 2002 been a member of technical committees within the 22nd and 23rd ITTC.
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Natural gas is overtaking coal as the second largest source of energy after oil and is contributing to the shift to lower carbon fuel. There are expectations that the world consumption of natural gas will double by 2020 and could even, in the not too distant future, become the dominant source of energy. The world's reserve of gas is today the energy equivalent to that of oil, and gas is still being discovered in large quantities.

Today (autumn 2003) the total world LNG ship fleet consists of 199 vessels, of which 29% are on order. Furthermore, there are options for another 24 vessels.

SSPA LNG record of over 40%

During recent years SSPA has developed and model tested a large percentage of the LNG tankers being built in the world. Out of the 128 LNG vessels contracted after 1990 SSPA has, in co-operation with shipbilders, developed and tested 42%. If options are included the number increases to 51%. Currently SSPA is investigating several new LNG projects.

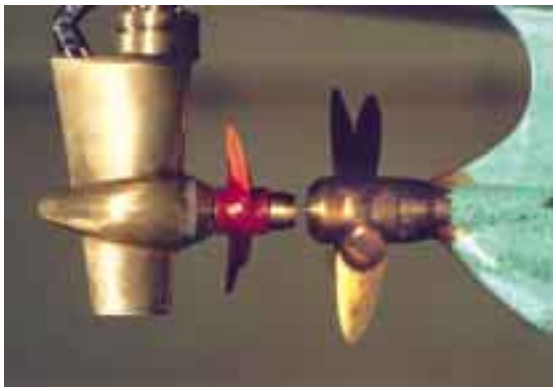
Examples are many Korean LNG ships for DSME, Hyundai, Samsung and Samho (Halla) for ship owners such as SK Shipping, KLC, Bergesen, Exmar, BP Shipping, Tapias, Shell (on behalf of Bonny Gas Transport) and A.P. Möller. SSPA has also developed and tested the first Chinese LNG tankers to be built at Hudong Shipyard in Shanghai. These vessels were designed by Chantiers de l'Atlantique. Model tests have also been performed for the IZAR LNG tankers of which the first is the Inigo Tapias. The projects include ships with both membrane type (GTT) and Moss Rosenberg spherical tanks.

SSPA has investigated LNG vessels in all testing facilities comprising towing tank, cavitation tunnel, and manoeuvring and seakeeping laboratory. During recent years SSPA has also performed feasibility studies for new vessel concepts, harbour manoeuvring simulations and LNG terminal risk analyses.

Sizes start to increase

The year 1990 seems to mark the turning point when the majority of LNG vessels ordered rose over 130,000 m^3.

POD used as a contra-rotating propulsion unit (CRPu) combined with a conventional propeller is a concept that SSPA has investigated for ships with high power demand. The picture shows model tests in the SSPA large cavitation tunnel, where the complete towing tank model is mounted in front of the tested propulsion arrangement. The tests with an ABB CRP Azipod® unit were performed in 2003 on behalf of Daewoo Shipbuilding and Marine Engineering CO, LTD (DSME).

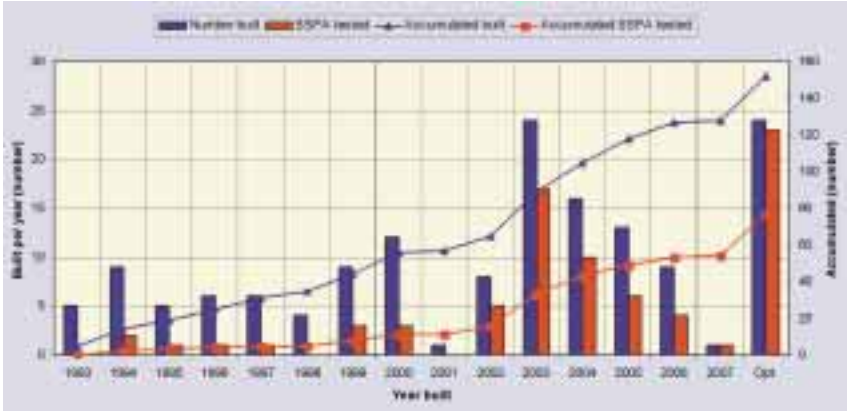


The hydrodynamic principles for POD used as a CRPu are the same as for a thruster used as a CRPu, which were studied at SSPA as early as 1984/1985. These investigations led to a patent, which later was sold to KAMEWA (Rolls Royce). The picture shows the model of a 20 knot RoRo vessel. Tests were performed as a part of a research program financed by the Swedish Board for Technical Development (STU). Note that the thruster has many similarities to the POD configuration above.

*DSME/Exmar, **'Excalibur'***

*DSME/Bergesen, **'Berge Boston'***

*SHI/BP Shipping, **'British Trader'***



The number of LNG vessels contracted after 1990 for each building year (1993-2007) is shown above. The bars after 2007 show the current number of options (Opt.). As can be seen in the diagram SSPA has tested the parent hull form for as many as 42% of the vessels contracted after 1990 and as many as 51% if including current options.

The SSPA statistics shown above consist of both LNG and LPG vessels where the majority is LNG vessels. LPG vessels are generally smaller with similar Lwl/B, slightly larger block coefficients (CB) and lower speeds resulting in similar Froude numbers compared to those of today's LNG vessels. The obvious trend for LNG vessels with increasing size is to go for larger block coefficients approaching those of LPG vessels.

Before this point in time only 13% had a capacity equal to or larger than 130,000 m^3, compared to 87% of the vessels ordered after 1990 (built, contracted and options).

Since the beginning of the 1990's the size of LNG ships has slowly been increasing. Current vessels have capacities around 138,000 - 145,000 m^3, but designs are being developed for capacities of 165,000 -250,000 m^3.

The market demands for larger freight volumes are pushing the conservative LNG industry towards larger vessels, new concepts and new technical solutions. Alternative machinery installations are being investigated ranging from one steam turbine to one/two slow speed diesel(s) or one/two diesel electric installation(s) (with dual fuel medium speed engines). Twin skeg hull form and contra rotating propellers are two alternative propulsion solutions possible for larger LNG ships.

Twin skeg hull form – a proven concept

The first twin skeg (or twin gondola) aftbody hull form was tested at SSPA in 1943. Since then over 200 different twin skeg configurations in 100 projects with block coefficients (CB) ranging from under 0.60 to over 0.90 have been tested. The design Froude number has been between 0.13 – 0.30.

The twin skeg concept is well proven with obvious advantages for designs with full hull forms, restricted draft or highly loaded propellers. For CB over 0.8 our statistics show that twin skeg hull forms in general have 6% lower propulsion power compared with a single screw ship with the same capacity. For the best quartile of the same statistics the twin skeg hull forms still have 2.5% lower propulsive power than the corresponding single screw designs. For CB around 0.75 the propulsion power is getting close to that of the corresponding single screw hull form. In addition, the manoeuvrability is improved, redundancy is added and the risk of propeller-induced vibrations can be reduced.

Contra Rotating Propulsion unit studies begun in mid 1980's

The contra rotating propeller (CRP) is almost as old as the propeller itself and was included in John Ericsson's patent from 1836. Conventional CRP on one shaft was studied at SSPA in the 1960's, when a systematic series of CRP was developed and tested.

Today PODs are used as Contra Rotating Propulsion unit (CRPu) behind a conventional propeller. The hydrodynamic principles are the same as for a thruster used as a CRPu, which was studied at SSPA in the mid 1980's. These investigations showed power reductions in the order of 8-12 % compared with the single screw case. SSPA held a patent for this concept for some years and has investigated CRPu (thruster and POD) for RoRo ships, tankers and LNG vessels. The main application is for single screw vessels with high power demand where the high propeller loading may cause propeller-induced vibrations.

Hasse Olofsson / Lars T. Gustafsson

*Chantiers de l'Atlantique/ MISC, '**Puteri Firus**'*

*HHI/Bonny Gas Transport, '**LNG Sokoto**'*

*DSME/SK Shipping, '**SK Summit**'*

*IZAR/Naviera F. Tapias, '**Inigo Tapias**'*

Reality confirms the model

Lennart Byström graduated from the Royal Institute of Technology in Stockholm (Eng. Phys.) in 1970. After working with traffic control systems at the Swedish Air Force he joined SSPA in 1974. He is working as a project manager for seakeeping and manoeuvring test of merchant and naval ships. He is also working with simulation models of various dynamic systems.
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Due to their size and many innovative design features those ships began to attract attention while they were still on the drawing board – M/S Costa Atlantica and her sisters, all of them of the so-called Spirit-class. This class consists of six close to 86000 GT cruise vessels built or under construction at Kvaerner Masa-Yards Helsinki shipyard; the sixth ship in this series will be completed in February 2004. The manoeuvring and seakeeping model tests of the Costa Atlantica were carried out in the SSPA Maritime Dynamics Laboratory (MDL).

M/S Costa Atlantica of Costa Crociere, which was delivered in June 2000 to Costa Crociere, part of the Carnival Group, is the first vessel in a series of six Panamax-size cruise ships. In this size range Costa Atlantica is the first contracted vessel that was designed from the start to have azimuthing pods as the main propulsors.

Joint development work

Kvaerner Masa Yards started the joint development work with Carnival Corporation for this class as early as in the first half of the 1990's. The outcome of this development process was a new generation of Panamax-size cruise vessels with many innovative design features.

One of the most visible external characteristics of the ship is the large number of balconied staterooms. In the Spirit-class the relative number of outside passenger staterooms and staterooms with balconies is very high; 80% of the staterooms give a view of the sea and 70% have a private balcony.

Even more interesting is that at an early stage of the design process, podded propulsors had already been selected as the first choice for the ship's propulsion concept. This meant that the hull lines of the aft ship were specially designed to fit this arrangement.

Advantages of pods

In addition to good propulsive performance, low propeller excitation level and benefits in general arrangement, the podded propulsors offered high transversal force capacity for berthing operations. This was very important for the Costa Atlantica, because it has a relatively large transversal wind area due to the increased height of the superstructure.

Model tests

The manoeuvring as well as seakeeping model tests of the Costa Atlantica were carried out in the SSPA Maritime Dynamics Laboratory (MDL). The scale ratio of 1:47

M/S Costa Atlantica
Main particulars
Length o.a. 292.5 m
Length b.p. 260.6 m
Breadth, max 38.8 m
Breadth, dwl 32.2 m
Draught, dwl 7.8 m
Block coefficient (C_B) ca. 0.65
Gross tonnage 85700
Passenger capacity, max 2680
Passenger staterooms, total 1057
– outside / with balconies 845 (80 %) / 742 (70 %)
Crew capacity 961
Speed, service 22 knots
Speed, maximum 24 knots
Propulsion 2 x 17.6 MW Azipod®

Azipods® 2 x 17.6 MW

Manoeuvring performance of M/S Costa Atlantica in model and in full scale has been documented and discussed in a paper by Kurimo* R and Byström L.: 'Manoeuvring with Pods: Model Tests and Sea Trials of M/S Costa Atlantica', presented at IMDC in 2003.

* Kvaerner Masa Yards Inc.

was adopted to match the diameter of the selected stock propellers with the diameter of the full-scale propellers, and it gave to the model a length of 6 m. The hubs of the stock propellers were modified to fit them to the shape of the pod-unit models, which were manufactured accurately to be the same shape as the full-scale Azipods®. The turning rate of the Azipod® models was also scaled correctly.

The tests were performed using a free-running (free-sailing) model. In a free-running test the model is first accelerated by the carriage and then at the appropriate speed disconnected from the carriage. The model continues self-propelled with constant propeller revolution and it is controlled by an autopilot. During the measurements, the model is free to move in all six degrees of freedom.

Turning ability

The turning circle tests at the sea trial of the Costa Atlantica, are presented below together with the results of the free running model tests. The tactical diameter was made non-dimensional using the length between perpendiculars (Lpp).

When comparing the results from model and full scale tests it can be seen that the turning ability is somewhat over-predicted in model scale.

According to SSPA's experience the difference in tactical diameter between full scale and model scale would be less for conventional twin-screw/twin-rudder ships. A well-known scale effect for free running model tests is that the propeller load is larger in model scale than in full scale, and therefore the propeller race is somewhat larger in model scale, due to the larger frictional resistance coefficient. And with a comparatively larger propeller race in model scale, a somewhat better turning ability is expected. Therefore, the tactical diameter for a 260 m conventional twin-screw /twin-rudder Cruise Vessel is expected to be about 5–10 % larger in full scale than in the corresponding free running model test.

The results indicate that the over-prediction of the turning ability in model scale is somewhat larger in the case of pod propulsion than for a conventional twin-screw vessel.

Course-keeping performance – reality predicted

Sometimes the turning ability of the vessel may be excellent, but at the price of poor course-keeping performance which can result in large overshoot angles in the zigzag tests, among other problems.

Although the turning ability of the Costa Atlantica is very good the overshoot angles in the 10°/10° zigzag tests are also very small, only about 5° to 6° at both 15 and 22 knots. The results at 22 knots are shown below.

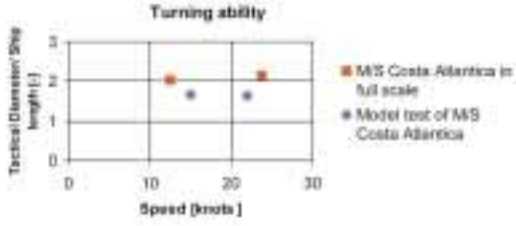
The results of the 20°/20° zigzag tests at 15 knots show that the overshoots are about 12°–13° for sea trials and 11°–12° at the model tests. The period is almost the same in model and full scale. For the 20°/20° zigzag tests at 22 knots the overshoots are slightly larger.

Conclusions

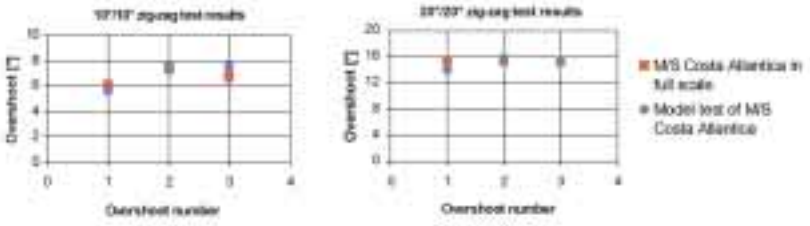
The sea trial of the Costa Atlantica confirmed the ship's excellent manoeuvring characteristics. The ship fulfilled the criteria in the Interim Standards for Ship Manoeuvrability of the IMO by a substantial margin. The superb turning ability of the Costa Atlantica was reached by selecting azimuthing pods as the main propulsors – and as a whole it was confirmed by the SSPA tests.

Lennart Byström

Turning test results versus speed in model and full scale. Steering angle 35°



10°/10° and 20°/20° zig-zag test results. Overshoot angles at 22 knots



Short comments

Swedish Match 40

SSPA Sweden AB has been involved in the development and manufacturing of a new boat for the Swedish Match Tour, the Swedish Match 40. In this project we worked closely with the yacht designer Pelle Petterson.

Mr. Petterson told us why he likes to work with SSPA: 'The possibility of handing over my drawings in paper format and receiving an almost photo like picture to review and discuss with SSPA's project manager before production is most valuable. SSPA's long experience and ability to put new technology like CAD/CAM to good use have been a great help and support.' Mr. Petterson then reminded us that he was the designer for the Swedish America's Cup Challenge yacht in 1977. An extensive test programme was carried out at SSPA at that time, and the experience he gained has helped him in his work with the 6mR class. In this class his designs have won most 6mR World Cup championships since 1977. Eight wins out of eleven by the same designer – one can't help being really impressed. With the Swedish Match 40, SSPA's work has comprised the hydrodynamics of the boat, development of CAD models and milling of plugs for the keel, bulb arrangements and rudder.

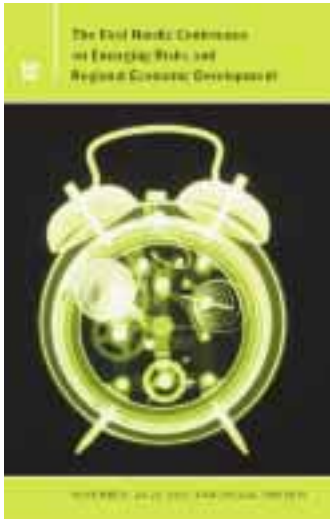
The rudder shape was milled in two halves to produce a plug to make a production mould. The keel blade was also milled in two halves to produce a plug for sand casting of the steel blade. The bulb plug was milled in one piece, which was used for sand casting of the lead bulb.

Matz Brown/Krister Snyder

Pelle Petterson, designer, and Matz Brown, project manager at SSPA, inspecting the new Swedish Match 40.

The Swedish Match 40 is about half the size of an America's Cup yacht and has the main dimensions l.o.a 12 m, width 2.3 m, weight 3.8 ton.

PHOTO: DAN LJUNGSVIK



Nordic conference on emerging risks and regional economic development

The Organisation for Economic Co-operation and Development (OECD) has studied the new risks threatening humanity today.

In order to start a dialogue on the impacts of new emerging risks on the economic development of regions, the productive capacity of businesses, and the investment propensity of capitalists, a Nordic conference on the report is now being organised by The Swedish Rescue Services Agency (SRV) / the National Centre for Learning from Accidents (NCO) in close co-operation with SSPA.

Several of the world's leading experts on risk assessment, risk communication, and risk management will take part in the conference. There will be four parallel themes:

- Regional development
- Technology as a risk and an opportunity
- Climate change – risks and impacts
- Threats to public health and financial systems

The conference will take place 24 - 25 November in Karlskoga, Sweden. For more information, see www.sspa.se or www.srv.se.

Christina Backman

Development of a cost-effective survival suit for ship passengers

Ship passengers do not normally have access to survival suits in the event of emergency, even if the risk of ending up in the water is very high during an evacuation. Below 15°C, fatalities are mainly caused by hypothermia and not by drowning. This means that there is, in addition to a life vest, a need for protection from the cold water.

The main hypothesis of the survival suit project was to regard the survival suit as waterproof packaging, using materials and technology from the packaging industry and to mass-produce survival suits in a cost-effective way. The project goal was to produce a survival suit, which should not cost more than 10 Euro.

In parallel with the theoretical specification of material and design, a number of prototypes for technical details and full-size models were made. Finally, they were all assembled into the first test suit, which is undergoing evaluation and tests in order to prepare for the first alpha series of the final product. With few exceptions, the survival suit will comply to the ISO 15027-2 and 3 standards as well as SOLAS 1974, Ch. III, reg. 32,33. It will comply to a so called 1-hour immersion suit, meaning that when worn in conjunction with warm clothes the wearer's body core temperature should not decrease by more than 2°C during 1 h in a water temperature of 5°C.

The project is supported by the Swedish Agency for Innovation Systems, VINNOVA.

Per Stefenson

The first prototype was tested in order to solve a number of details, e.g. how to adjust the size, and the position of flotation.

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