Below you’ll find proposed topics for project and master theses. Most of the proposed topics are just sketches. The detailed topics will be made in discussion between student and supervisor.

Most topics can be both project and master thesis. It is most common to have the same main topic for both project and master. Several of the topics might even be continued in a PhD project. Some of the topics are related to ongoing research in the department, others have been proposed by industry or by MARINTEK.

You can also propose own topics. Then, you must find a supervisor who is willing to supervise the topic. The supervisor will have the last word in formulation of the assignment text.

Sverre Steen, [http://folk.ntnu.no/sverres](http://folk.ntnu.no/sverres)

**Contents**

- Rational calculation of sea margin ................................................................. 2
- Voluntary speed loss of ships ............................................................................ 3
- Steering and thrust loss while trawling ............................................................ 4
- The effect of changing the main propulsion system of coastal liner “Midnatsol” .... 5
- The potential benefits of using multiple small propellers instead of one large propeller .......... 6
- Development of simplified methods for calculation of speed loss and added power of ships due to wind and waves ................................................................................. 7
- Monitoring of ship hull condition using in-service data ........................................ 8
Rational calculation of sea margin

The speed-power performance of ships is usually predicted for an idealized trial condition, with a clean hull and negligible waves and wind. When the ship is in normal operation, with some hull fouling as well as waves and wind, the power required to reach a certain speed is higher than the speed originally predicted and measured on the delivery sea trial. This increase is usually expressed as a sea margin, which is normally added to the power. A typical value for the sea margin is 15%. The value of the sea margin is set according to tradition and some practical experience, but it is not normally based on proper calculations utilizing knowledge about the actual ship, her condition, and her operational profile.

It is known that added resistance due to waves and wind will be relatively larger for slow ships than for fast ships, and that they will be relatively larger for a given vessel if the speed is reduced. Also, the size of the ship and the area of operation might be important parameters. Thus, it might be argued that the sea margin should be speed dependent, and that it should be set using calculations including operational area and ship particulars. Furthermore, it is known that the frictional resistance increase due to hull condition can be more than 15% of the total.

The sea margin is important for accurate estimation of fuel consumption and therefore operating cost. It should probably depend on speed, as argued above, and it should also depend on the trade of the ship.

For the current suggested project and master thesis, a close co-operation with ship-owners participating in the SFI SMART Maritime www.smartmaritime.no is suggested. They can contribute with knowledge and guidance, as well as data from ship operation.

The following is suggested for project and master theses:

**Project:**

- Literature study on sea margin and other operational margins used, as well as calculation methods for calculating the effect of wind, waves and hull condition on speed-power relation of ships.

- Case study of a number of ships for which operational data are available, computing apparent sea margin and comparing with own calculations

**Master thesis:**

For the master thesis, the candidate shall:

- Give a thorough review of available methods to compute sea margin (like methods to compute added resistance and speed loss due to waves, and how such methods can be used to compute the sea margin), and service margin, which means a survey on methods to account for hull and propeller fouling.

- Show how the sea margin depend on speed for selected case vessels.

- Check the sensitivity of the sea margin to different factors (wind, waves, hull condition), as well as calculation methods for the same effects.

- Suggest a practical method for computation of sea margin.

- Test this method on the case vessels, for different speeds and trades.

Supervisor: Prof. Sverre Steen
Voluntary speed loss of ships

The actual ship speed attained during operation in various weather conditions is a result of both involuntary speed loss, due to resistance increase and loss of propulsive efficiency, and voluntary speed loss. The latter is a result of the crew of the ship reducing the power or propeller rpm. Since voluntary speed loss is ultimately a result of crew decisions to reduce power or rpm, there is an element of unpredictability. Still, there are experience and clear patterns that show what causes ship masters to slow down in heavy weather, such as slamming against the bottom and propeller racing, excessive amounts of water on deck, and then of course a number of more ship type specific criteria. There is a large number of published criteria, which show a great diversity.

The objectives of the combined project and master thesis is to:

- Give an overview of published criteria for voluntary speed loss
- Using the published criteria, together with information from ship masters, ship designers and other experts, compile a set of criteria for selected ship types
- Using a suitable simulation tool, compare the attainable speed during a longer period of time, using just involuntary speed loss and using in addition the selected voluntary speed loss criteria, and on that basis give your evaluation of including voluntary speed loss in attainable speed calculations

The project and master thesis will be a part of the SFI SMART Maritime. Through that project, the candidate will get access to the knowledge of our industry partners, which include a number of ship owners and ship designers. A suitable simulation tool might be a new discrete event-based simulation tool developed by MARINTEK. Depending on the interest of the candidate, he/she might also set up his/her own simulation.

Supervisor: Prof. Sverre Steen
Steering and thrust loss while trawling.

From practical experience, it is found that a large part of the propeller thrust is lost due to excessive use of rudder to maintain direction of the trawler while trawling. The use of rudder is necessary to keep wanted heading and track, which is offset due to environmental forces (wind, waves, current). Like for a tug, the forces in the tow lines are important for the control of the trawler while trawling. Although the magnitude of the forces are mainly given, the point of application on the ship might be changed to improve the control of the ship. The trawler “Prestfjord” has recently had an extensive measurement package installed – unique to such a ship. These measurement results will be made available to the candidate as an important resource in the project. The measurements are performed as part of the SITNEF-project Improvedo: http://www.sintef.no/Fiskeri-og-Havbruk-AS/Prosjekter/2010/Improvedo-Improved-vessel-design-and-operation/

Suggested activities in the project and master:

- Study the literature and results of previous studies to establish state of the art with respect to trawling and control of trawl and trawlers.
- Establish a simulation model of “Prestfjord”, including trawl. The simulation might be partly based on existing simulation models (there is no need to start from scratch!)
- Compare the simulation model against the available full scale measurement results.
- Establish some typical and some critical trawling conditions to be simulated. Contact with the captain of “Prestfjord” is recommended for this point.
- Simulate the defined conditions and compare against measurements.
- Test alternative locations of the attachment points of the trawl wires to investigate the sensitivity with respect to steering and power consumption.
- Make recommendations for improved trawling configuration (if possible) and suggest further work (if required)

Topic proposed by Rolls-Royce Marine (Leif Vartdal)

Supervisor: Prof. Sverre Steen.
The effect of changing the main propulsion system of coastal liner “Midnatsol”

The coastal liner M/S Midnatsol has had her main propeller system changed from twin contrarotating thrusters to twin CP Azipull thrusters. Reports from the operators tell that this has had major influences, mostly positive, on the performance. At the same time, the sister ship M/S “Trollfjord” still have the contrarotating propeller thrusters. The objective of the project and master thesis is to investigate the effects of changing the propulsion system through speaking to the ship crew, using available reports and documentation of the ships and propeller systems, and using the data that are currently measured during the operation of M/S Midnatsol. The project and master thesis will be performed in cooperation with the supplier of the thruster systems, Rolls-Royce Marine, and the operator of the ships, Hurtigruten Group.

Supervisor: Prof. Sverre Steen
Advisor: Leif Vartdal (Rolls-Royce Marine)
The potential benefits of using multiple small propellers instead of one large propeller

Traditionally, ships are equipped with one large propeller directly coupled to a diesel engine. Increasingly, ships are equipped with more complex machinery system, involving generators and electric motor for driving the propeller. We know that the theoretical maximum propulsive efficiency increase when we increase the total propeller disk area over which a given thrust can be distributed. When using one propeller, the maximum propeller disk area is limited by the diameter, which is again limited by the draught at the propeller and requirements for clearance between hull and propeller tip. When the propeller is electrically driven, the cost and complexity of lifting the restriction of a single propeller shaft is much reduced. If the thrust can be distributed on many small propellers instead of a single (or maybe two) large ones, the total propeller disk area can be significantly increased, as indicated on the sketches below. Also, the design and operation point (pitch, RPM) of each propeller might be tailored to the local wake. Together, this means that there is a potential for higher efficiency and much reduced cavitation problems. On the other hand, there are obvious practical issues with arranging for shafting and proper inflow conditions for many propellers in the same aft body.

The objectives of the combined project and master thesis are to:

- Describe and as far as possible Quantify the potential benefits of multi-propeller concepts
- Discuss the drawbacks and problems, and try to point out solutions to these

For the project thesis, it is suggested to carry out preliminary calculations for two different case vessels, using simplified propeller theory, looking at different propeller configuration. For the master thesis, it is suggested to carry out more detailed calculations, for instance using CFD to obtain the aft body flow field, and to further develop design of practical arrangements.

Supervisor: Prof. Sverre Steen
Advisor: Jarle A. Kramer (NTNU)
Development of simplified methods for calculation of speed loss and added power of ships due to wind and waves

There are many circumstances where one need to calculate the speed loss or added power requirements of a ship due to wind and waves. Such calculations can be based on model tests, advanced CFD calculations, potential flow based seakeeping calculations, or simpler methods. In cases where one need quick answers and/or when information on ship geometry is not readily available (many ship owners don’t have lines plans or geometry files for their ships), simple methods that don’t need detailed calculations requiring knowledge of ship geometry is needed. For calm water resistance, we have methods like Hol trop’84 for situations like this. For speed loss and added power, there is a multitude of different methods, each having their particular weaknesses and application areas. In addition, there is an increasing amount of in-service data from ships in operation that can possibly be used to validate or improve calculation methods.

The objective of the combined project and master thesis is to develop a tool (or tools) to predict speed loss and/or power increase due to wind and waves, using simple methods that don’t require detailed hull design or CFD

For the project, it is recommended to perform a detailed literature survey, and to draft the methods to be developed in the master thesis.

In the master thesis, the selected method(s) shall be implemented and validated against detailed calculations and/or experimental data.

The project and master will be performed in connection to the research program SFI SMART Maritime http://www.smartmaritime.no/ where a large number of ship owners and suppliers are involved. The main user group for the methods to be developed is ship owners.

Supervisor: Prof. Sverre Steen
Monitoring of ship hull condition using in-service data

The fuel consumption of ships increase with deteriorating condition of the anti-fouling paint and increasing fouling of the hull due to marine growth. Ship owners, paint suppliers and research organizations are interested to monitor how the resistance of the hull increases over time due to such effects, since the resistance increase due to increased roughness and fouling might increase the power consumption by more than 30%. Thus, maintaining a clean hull is easily one of the most effective ways of saving fuel and thereby reduce harmful emissions. However, hull cleaning and re-painting is expensive, and should not be done more often than necessary. Traditionally, ship performance was monitored by ship owners by means of “noon reports”, which are a short report from the ship crew on position, speed, fuel consumption etc. the last 24 hours. Nowadays, ships are increasingly equipped with data logging systems, so that similar data is collected much more frequently, for instance each 15 seconds. At the same time, meteorological data for wind, waves and current are increasingly available and accurate, so that correction of speed and fuel consumption for environmental effects might be possible.

As part of the research program SFI SMART Maritime http://www.smartmaritime.no/ we get access to in-service data from a large number of merchant vessels belonging to Norwegian ship owners taking part in the project. These data give a unique opportunity for researching how power and fuel consumption is influenced by wind and waves, and increase of roughness and fouling. The proposed objectives of a combined project and master thesis are:

- To develop a regression-based method for estimating the increase of power and/or decrease of speed due to wind and waves, using available in-service data for the actual ship.
- Using the regression-based method for power increase, correct the in-service data in order to detect the underlying trend due to increase of resistance caused by roughness and fouling.

The project and master will be performed in cooperation with Jotun, MARINTEK and several Norwegian ship owners.

Supervisor: Prof. Sverre Steen