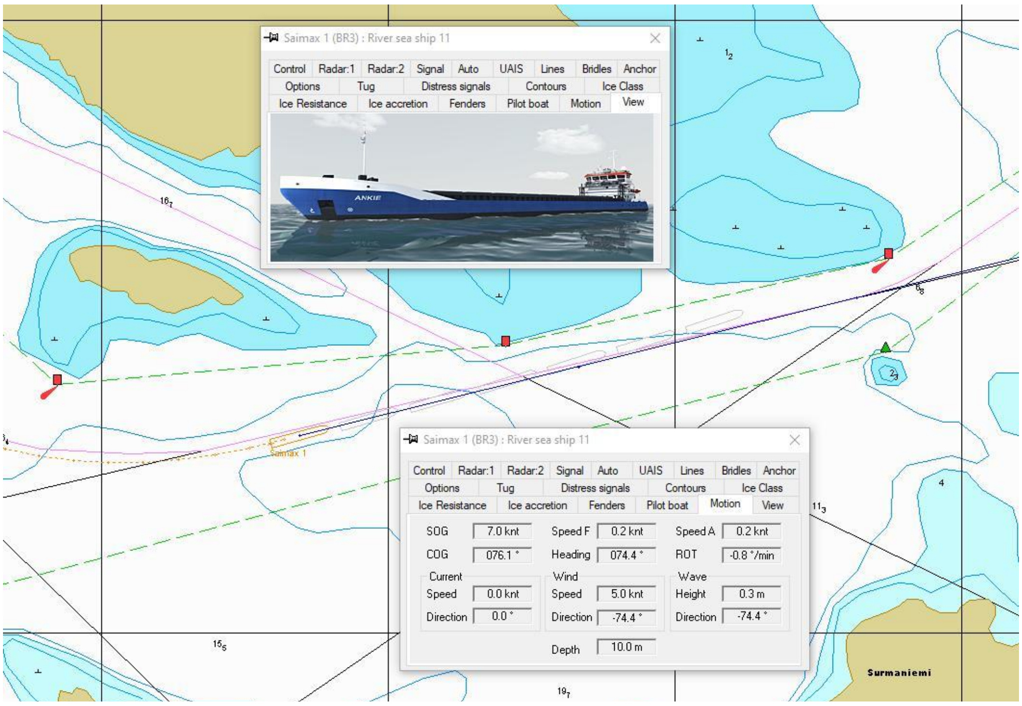

SIMULATIONS OF FAIRWAYS IN LAKE SAIMAA

Presentation and proposals

Prepared as part of: Future Potential of Inland Waterways, INFUTURE project

Funded by the European Union, the Russian Federation and the Republic of Finland

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Kaakkois-Suomen ammattikorkeakoulu

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SOUTH-EAST FINLAND - RUSSIA

INFUTURE

CONTENT

1 INTRODUCTION

The Future Potential of Inland Waterways, INFUTURE project has carried out preliminary planning for the possibility of developing a simulation method for the maritime assessment of inland waterways (Saimaa) at the South-Eastern Finland University of Applied Sciences (Xamk). Simulation can be of great benefit to a wide range of stakeholders and project partners. Modern simulator technology enables realistic modelling of maritime situations, such as fairway navigation, waterborne traffic, vessel steering and fairway design. This presentation gives a summary overview of the possibilities of simulation and a few suggestions for examples and as a basis for ideas.

The main sponsor of the project is the South-East Finland – Russia CBC 2014–2020 programme, which has the following project partners: Kotka Maritime Research Centre, Aalto University, South-Eastern Finland University of Applied Sciences, Meritaito Oy, Association of Finnish Waterways, Admiral Makarov State University for Maritime and Inland Shipping, and North-West Russia Logistics and Information Development Centre.

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2 MARITIME SIMULATOR

The South-Eastern Finland University of Applied Sciences uses simulators from Kotka Maritime Centre (KMC) in its training and RDI activities. The maritime simulators are navigation, radio and engine room simulators supplied by Wärtsilä (formerly Transas). The most relevant for this demonstration is the navigation simulator, which operates with NaviTrainer Professional 5000 software version 5.40 and consists of eight (8) navigation workstations, three (3) navigation bridges and two (2) *instructor* workstations. The vessel models represent the types of ships used by the Finnish merchant fleet and the ships most commonly sailing in Finnish ports. Vessel types can be purchased according to the current operational or research needs. All major Finnish ports and merchant shipping routes have been modelled as operating areas. In addition, we also have a comprehensive library of international shipping areas, which are mainly used in different educational and learning situations [1].

Figure 1. Bridge simulator in Kotka. Photo: Tuomala, V.

3 VESSEL MODEL AND AREA

The KMC simulator has several different vessel models, from small boats to large ocean-going vessels. For the purpose of this demonstration, a so-called river sea ship with the dimensions of the 'new Saimax' class, i.e. a vessel that could be accommodated in the Saimaa Canal in accordance with its proposed lock extension project [2], has been used as a model. The main dimensions of the vessel model are given in Table 1.

Table 1. Main dimensions of the simulated vessel model (*"River Sea Ship 11"*)

"New Saimax"	
Deadweight (DW)	3,619 t
Length	89.99 m
Width	12.69 m
Draft (part load)	4.45 m
Height (air draft)	21.35 m

The setting can be changed between the draft in the full load situation (5.35 m) and the draft with partial load (4.45 m). The ship's info box is shown in Figure 2 and the *Pilot Card* downloaded from the system in Appendix 1.

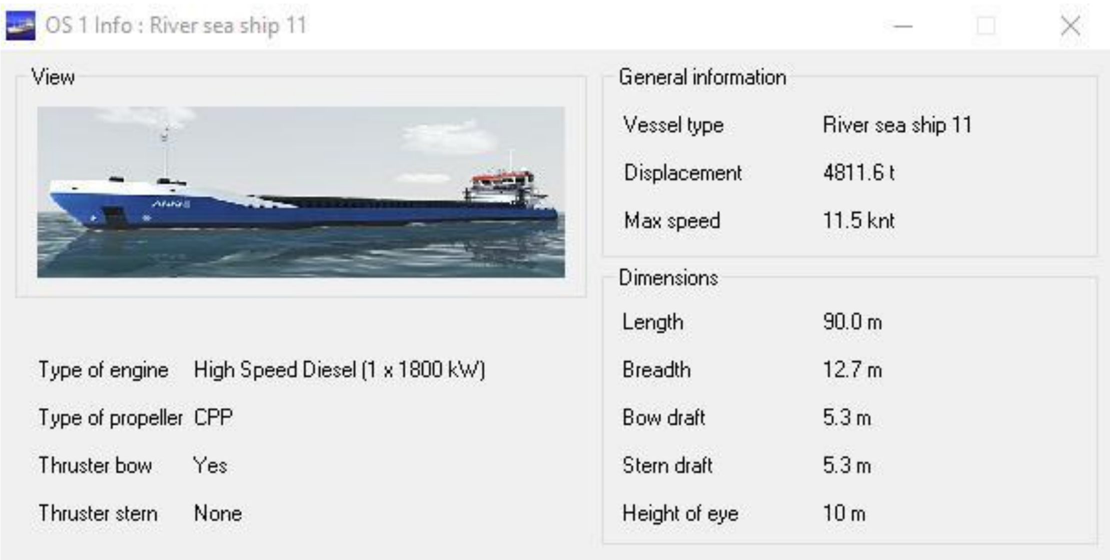


Image 2. Vessel model information box in the NTPro system (full load situation).

In this presentation, the vessel has been run in the *Savonlinna – Joensuu* area of the Saimaa deep fairway, section: Kiviselkä, near Reposaari.

4 SIMULATION WITH A MARITIME SIMULATOR

Simulation is a broad concept that means modelling or imitating reality on a device or software. The navigation bridge simulator is a system for controlling a modelled vessel in a virtually modelled geographical area. The simulator creates a **comprehensive experiential experience** – as if navigating a ship "for real". Experiential simulation with such a device is much more efficient and faster than in a real-world environment. Simulation also facilitates an unlimited number of repetitions and variations in a short period of time.

This chapter highlights some examples of the use of simulators that can be useful to stakeholders and project partners in different contexts. These are only a few of the opportunities that simulations can offer, and they should be further developed in cooperation, for example, as project work or in small working groups. The examples are divided into three (3) themes:

1. **Modelling of external conditions**
2. **Traffic situation modelling**
3. **Modelling of vessel-specific limit values**

Situations and simulation can be tracked in real time, but it is also possible to save log files and later play them on another workstation (which must have the same software). The situation is managed from an *Instructor station*, where you can add, modify or remove objects. Cameras can also be added to areas, so that the situation can be monitored, for example, from a 'bird's-eye view'.

4.1 Modelling of external conditions

External conditions, such as weather phenomena and visibility, can be modelled extensively with a simulator. Changing conditions can make the same situation feel different. Such simulations can answer questions such as:

- **Navigating a fairway in the dark**
- **Performing a fairway or turn in strong winds**
- **Performing a fairway or turn on rough seas**
- **Navigating a fairway with limited visibility** (fog, rain, etc.)

Conditions can be changed quickly, and the interface of the simulator device is versatile. (Figure 3)

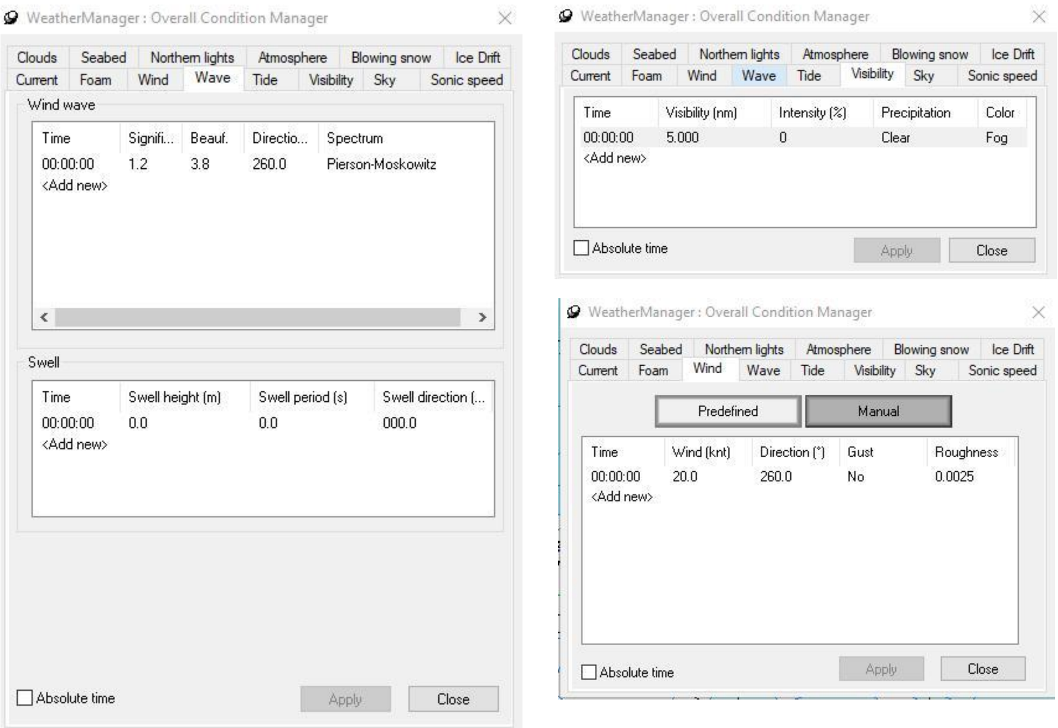


Figure 3. Wave, wind and visibility control windows in NTPro.

Figure 4. The vessel in strong winds and heavy rain. Photo: Lanki, A.

4.2 Traffic situation modelling

Traffic situations can be modelled in a versatile way with a simulator. A traffic situation means an interaction between two (2) or more vessels or objects. Modelling can be used to examine, for example, the functionality of pilotage or vessel steering in different environments and conditions. Simulation can answer questions such as:

- **Passing situations**
- **Meeting situations**
- Interaction situations between **different objects** (vessels of different sizes)
- **Interaction situations with obstacles or other objects** (e.g. an unmanned vessel preventing the use of the fairway)

The illustrations below (Figures 5 and 6) show a simple meeting situation between the two ships in the turning area. Objects and vessels can be controlled by navigating from the bridge, but it is also possible to create a variety of "*target ships*" and control them directly from the steerer's station.

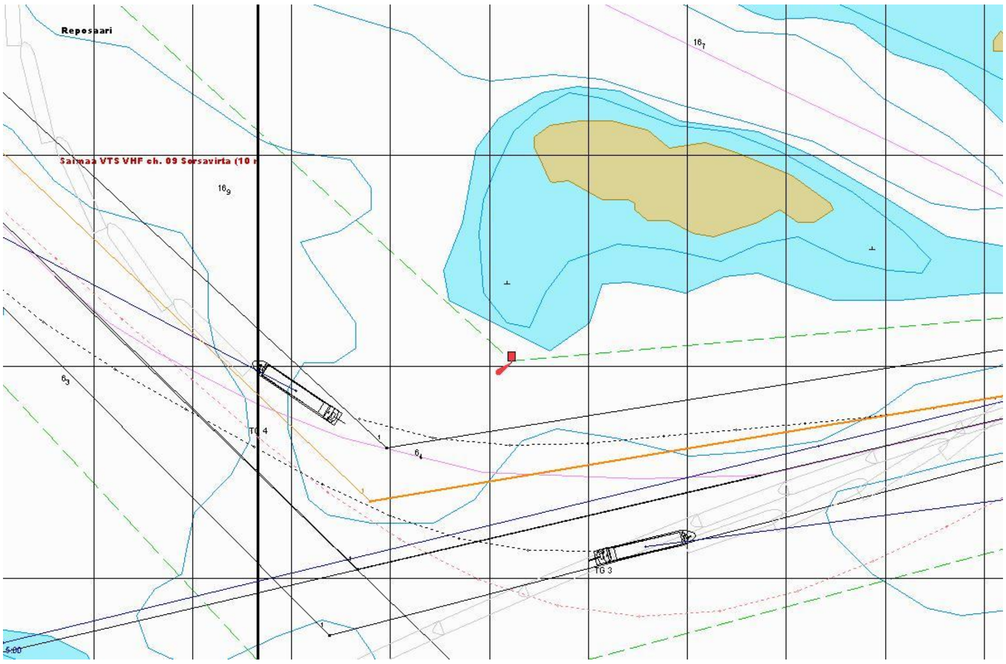


Figure 5. Meeting ships in the Reposaari turn, steerer's view.

Figure 6. Meeting ships in the Reposaari turn, camera view. Photo: Lanki, A.

4.3 Vessel-specific impacts and modelling of limit values

Vessel-specific impacts refer to all situations in which the interaction between the model vessel and area is considered. Limit values can be searched for, for example, by repetition (iteration). Limit values should always be defined separately between the partners. Such simulation can answer questions such as:

- **Steering feel from the perspective of the vessel**
- **Steering feel from the perspective of the fairway** (e.g. safety devices)
- **Fairway test runs**
- **Trueness of the vessel model**
- **Trueness of the area model**
- **Flow Interactions** (Bank, Ship-Ship)
- **Verification/validation of the modified area**

During the simulation, it is possible to gather information about the different influences and forces that the modelling involves. Figure 7 shows an example of the interaction between the vessel model and the water floor.

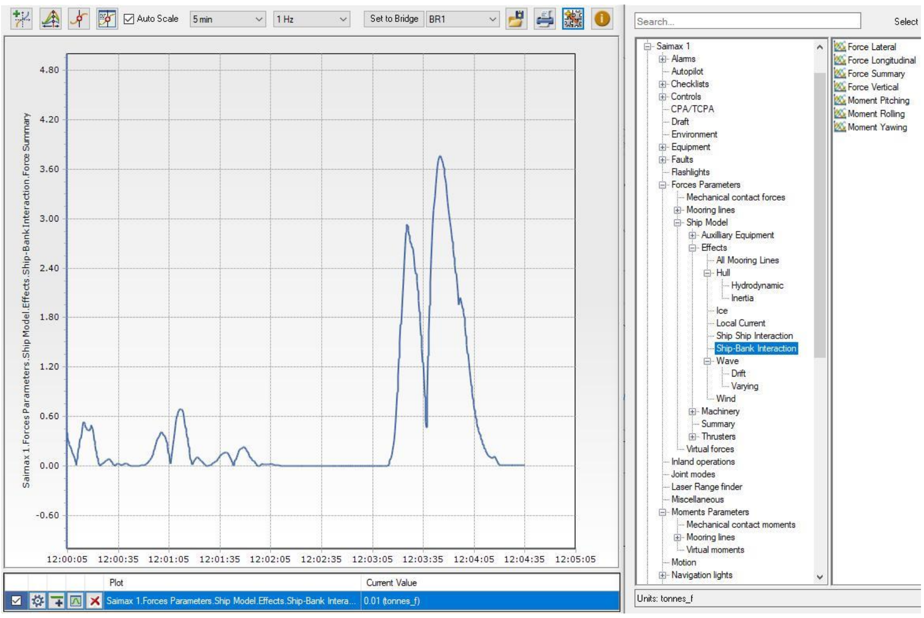


Figure 7. Summary of interaction forces of the vessel model hull and water floor as a graph in the NTPro system.

5 SIMULATION EXAMPLES

The practical examples on the following pages (1–3) illustrate possible targets, situations and uses of the simulation.

Example 1

Plan and navigate a turn on a 0.5 nautical mile turning radius along the centre line of the fairway (Figure 8). How much can the navigation line be moved from the centre line of the fairway to the side at the same (0.5 nm) radius (Figure 9)? Navigation lines can be planned and navigated several times in a row. The results may give information about, for example, the fairway area or the location of the safety devices.

Figure 8. Planned turn with radius 0.5 nm along the centre line of the fairway.

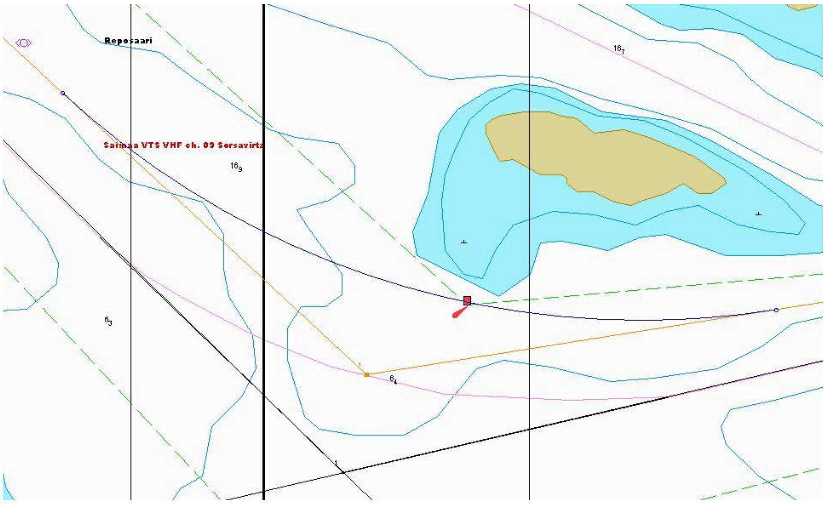


Figure 9. Intended turn with radius 0.5 nm moved north from the centre line of the fairway.

Example 2

During fairway navigation, just before the turn, information comes in that there is an obstacle or another factor that prevents the use of the fairway. Consider ways to take a different route, stop or turn the ship, and find out where on the fairway it is as safe as possible to do so. Figure 10 shows an emergency turn (“all over to the port side”) before the turn start point (WOP).

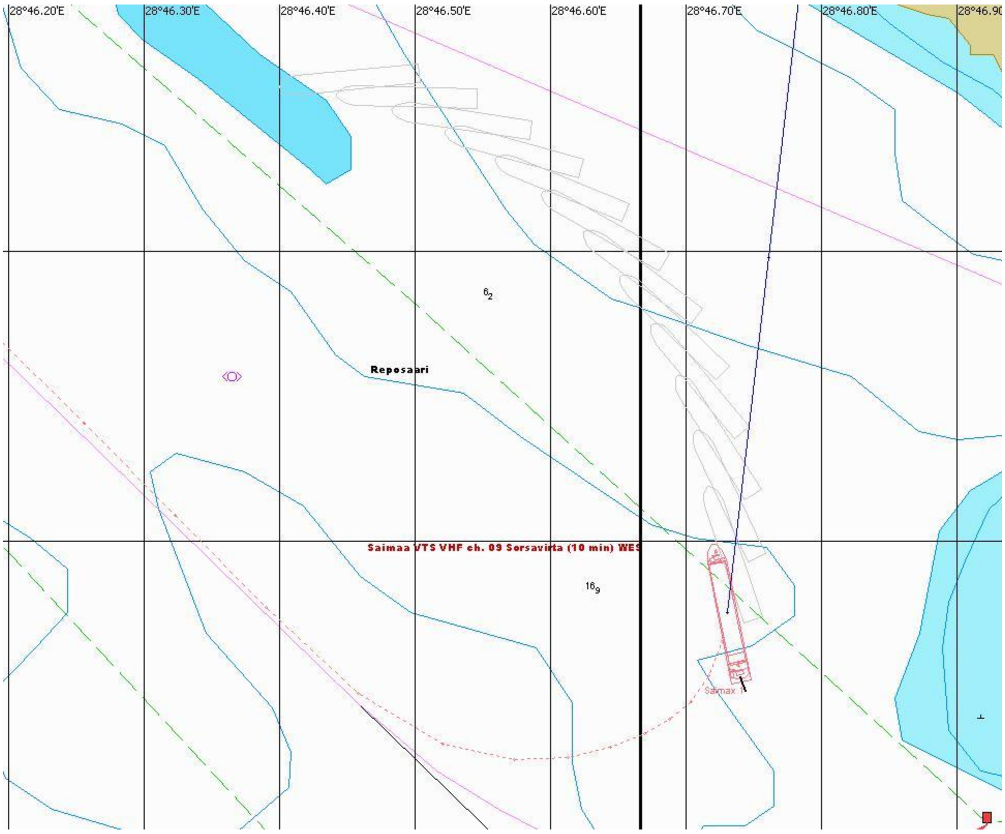


Figure 10. Emergency turning and stopping through the port side before the actual starting point of the turn.

Example 3

Information is wanted about the water floor of the fairway area (topography) and the passage of various vessels in the fairway. A model vessel of the desired size can be placed in the area – and its passage can be monitored, for example, visually with a camera placed on the bottom of the vessel model.

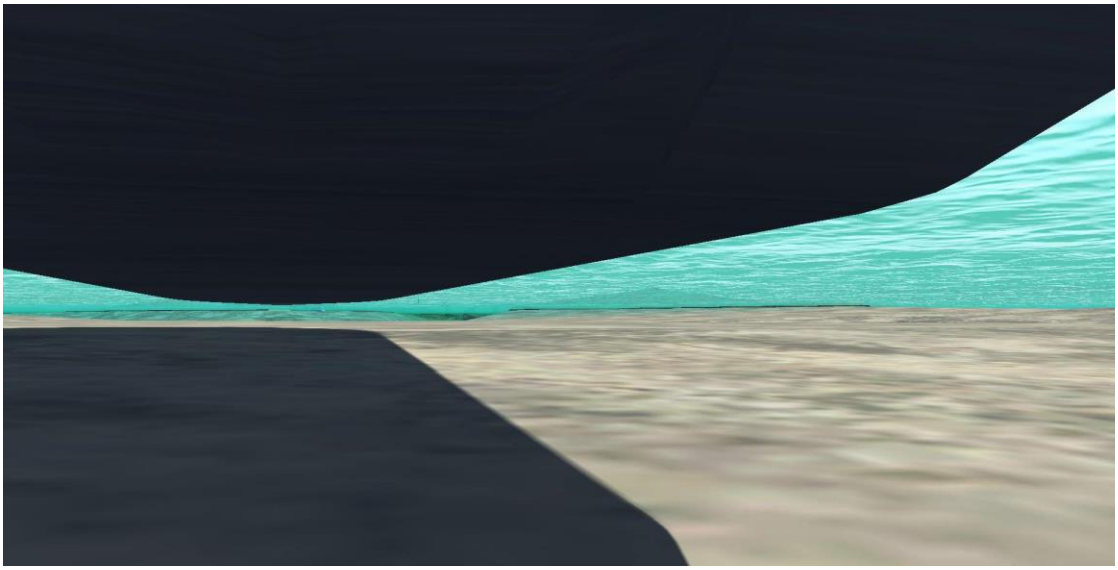


Figure 11. Vessel model's fairway navigation monitoring with a camera positioned level with the bottom. Photo: Lanki, A.

Notes:

The examples described above are only drafts and ideas. They require joint development and definition. Example 3; the topography of the water floor is influenced by the depth data accuracy of the area model.

Area models can be modified with separate software, depending on the conditions, topography and simulated situation. The software is available to the South-Eastern Finland University of Applied Sciences.

REFERENCES

[1] Kotka Maritime Centre Simulator Centre. Website. Available at: https://kotkamaritimecentre.fi/en/simulator-centre/

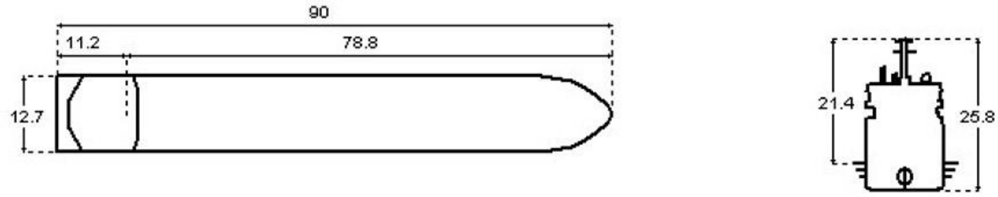
[2] Finnish Transport Infrastructure Agency 2020. Extending the locks of the Saimaa Canal. Project evaluation. Finnish Transport Infrastructure Agency publications 31/2020. Available at: https://julkaisut.vayla.fi/pdf12/vj_2020-31_saimaan_kanavan_web.pdf

APPENDICES

Appendix 1

PILOT CARD					
Ship name	River sea ship 11 3.0.2.0 *			Date	29.09.2020
IMO Number	9331359	Call Sign	PHKA	Year built	2007
Load Condition	Part load 4.45				
Displacement	4032 tons		Draft forward	4.45 m / 14 ft 7 in	
Deadweight	3619 tons		Draft forward extreme	4.45 m / 14 ft 7 in	
Capacity			Draft after	4.45 m / 14 ft 7 in	
Air draft	21.35 m / 70 ft 2 in		Draft after extreme	4.45 m / 14 ft 7 in	

Ship's Particulars			
Length overall	89.99 m	Type of bow	Bulbous
Breadth	12.69 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	7 / 7		(1 shackle =27.5 m / 15 fathoms)
Max. rate of heaving, m/min	18 / 18		



Steering characteristics			
Steering device(s) (type/No.)	Becker's rudder / 1	Number of bow thrusters	1
Maximum angle	45	Power	250 kW
Rudder angle for neutral effect	0.25 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	14 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping			Turning circle	
Description	Full Time	Head reach	Ordered Engine: 100%, Ordered rudder: 35 degrees	
FAH to FAS	112.6 s	1.74 cbls	Advance	1.22 cbls
HAH to HAS	136.8 s	1.55 cbls	Transfer	0.46 cbls
SAH to SAS	178.6 s	1.32 cbls	Tactical diameter	1.15 cbls

Main Engine(s)			
Type of Main Engine	High speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Left
Maximum power per shaft	1 x 1800 kW	Propeller type	CPP
Astern power	76.39 % ahead	Min. RPM	500
Time limit astern	N/A	Emergency FAH to FAS	38.2 seconds

Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	12.3	1683	190.7	1.15
"FAH"	10.5	1334	190.7	0.86
"HAH"	8.1	982	190.6	0.6
"SAH"	5.4	665	190.6	0.37
"DSAH"	2.7	378	190.5	0.17
"DSAS"	-1.7	343	190.5	-0.15
"SAS"	-3.5	578	190.5	-0.32
"HAS"	-5.1	818	190.6	-0.52
"FAS"	-6.6	1077	190.7	-0.75
"FSAS"	-7.7	1354	190.7	-1