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## THE USE OF SIMULATION METHODS TO DETERMINE THE MAXIMUM DIMENSIONS OF THE SHIP CAPABLE TO MANEUVERING ON THE SELECTED SEA AREA

### ABSTRACT

The paper presents one of the methods to determine the maximum vessel size allowed for the maneuver on tested sea area or harbour. This method is based on the Navi-Trainer PRO 5000 simulator by Transas Marine available to the authors at the Institute of Navigation and Hydrography of Naval Academy of Gdynia. In the paper was described the possible use of additional simulator software components to generate the necessary virtual sea area. The next stage of research work was making several tests based on the created virtual harbour. These simulations tests are carried out under variable weather conditions for various vessel sizes and maneuvering characteristics.

The result of simulation test are very important for determine the parameters of the maximum vessel size and hydro-meteorological conditions allowing safe navigation.

### **Keywords:**

simulation methods, navigation simulator.

### INTRODUCTION

Simulation methods are often used in research projects in navigation and other fields of sciences. Using classical methods of analysis allows easily determine the maximum size of vessel maneuvering on the fairway, but they do not allow to examine the influence of hydro-meteorological conditions on the behavior of the ship and determine the boundary conditions allowing safe navigation. It is also difficult to determine the maximum vessel size parameters that could maneuver in a specified port basin. Using simulation software gives the possibility to simulate all possible

conditions and emergency situations which classical methods do not allow you to visualize.

Modern simulator is not only simulation software, but also the additional components for modeling navigational waters, creating virtual ships models and software to perform analysis of the simulation tests. An example of such a simulator is a laboratory located at the Institute of Navigation and Hydrography at Maritime Naval Academy. This laboratory is based on the latest version of the Navi-Trainer 5000 simulation software manufactured by Transas Marine. This program consists of several components, which are:

- navigational and maneuvering simulator software — Navi-Trainer 5000;
- software for creating new vessels — virtual shipyard;
- software for modeling and editing training areas — model wizard.

The research process leading to the determination the maximum dimensions of the ship capable to maneuver on the selected water area and the boundary hydro-meteorological conditions consists of four main parts:

- creating of a ship model;
- creating of a virtual model of the harbor;
- simulation tests;
- tests results.

### **CREATING OF A VIRTUAL SHIP MODEL**

To create a virtual vessel model, we need to use one of the additional simulator software components. This program is called a Virtual Shipyard. To properly operate the program the operator is required to have knowledge of construction and ship hydrodynamics. The process of generating a virtual model of the ship consists of two main steps:

- creating a visualization of the ship;
- create the motion model of the ship.

The first step is using the external software cooperating with virtual shipyard to generate three-dimensional visualization of the vessel. This program is AutoCAD. This is software that works with the main application. It sends a visualization model and connects with the ship model, which will be used in simulation tests.

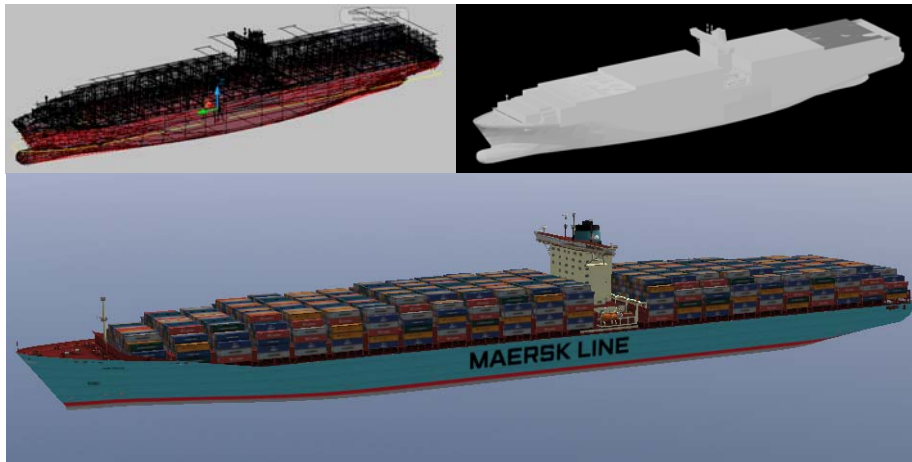


Fig. 1. Container ship 3D visualization

The second stage is one of the most important elements in the whole research process. Creation of the ship motion model the most similar to reality determines the degree of reliability of test results. To generate a virtual model of a vessel is necessary to know several maneuvering and construction parameters. These include not only data about propulsion and steering, but also other information like the area, which will have an impact on the wind. This is one of the important elements to determine the boundary of the meteorological conditions.

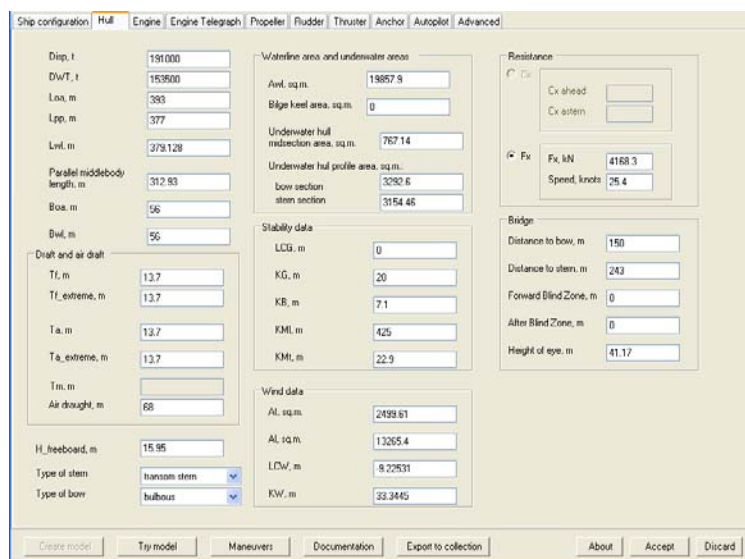


Fig. 2. Motion model creation application

After the creation of the virtual ship model in Virtual Shipyard the software is able to generate pilot card and wheelhouse poster. At the end we can set the preliminary maneuvering tests prior to model implementation to the simulator environment [2].

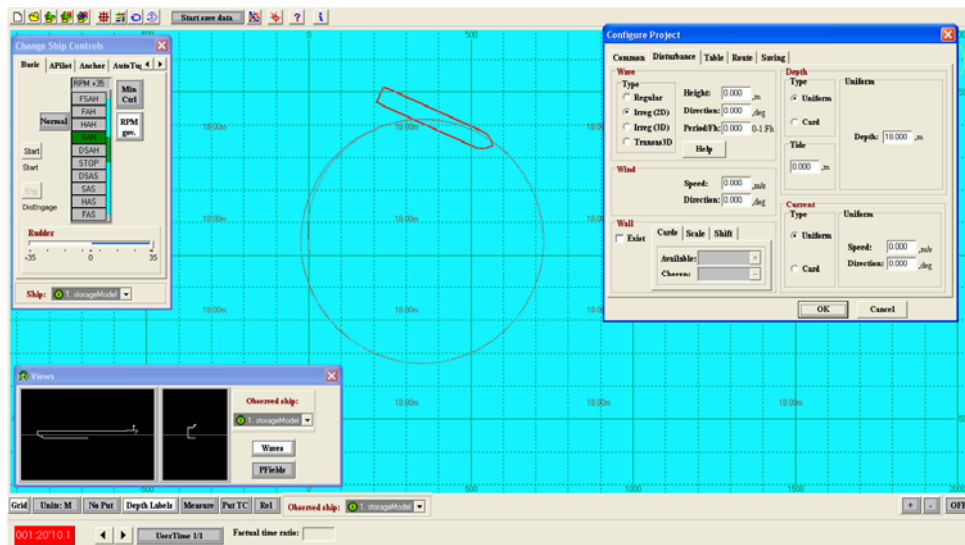


Fig. 3. Preliminary maneuvering tests

## CREATION OF A VIRTUAL MODEL OF THE HARBOR

To conduct maneuvering trials we should generate a virtual model of the basin covering the research area. For this purpose we have to use the application 'Model Wizard'. This software uses the electronic chart cells in S-57 format as a base to create a body of area. This process takes place through conversion to TX-97 format used by the program. During this process, the basic coastline, navigational marks and bathymetry is generated. To improve the generated coastline and navigational infrastructure we have to use additional information such as satellite pictures, maps, plans. This application makes it possible to generate three-dimensional model of the seabed and created a radar image of the area. Main program database contains all the essential elements of the navigational marks and navigation infrastructure. However the creation of unique objects in a given area requires the use of additional applications to generate three-dimensional objects. For this purpose you can use the same software, which was created a model of the ship. The following is a visualization of the reconstructed Northern Port and container terminal DCT (Deep water container terminal).

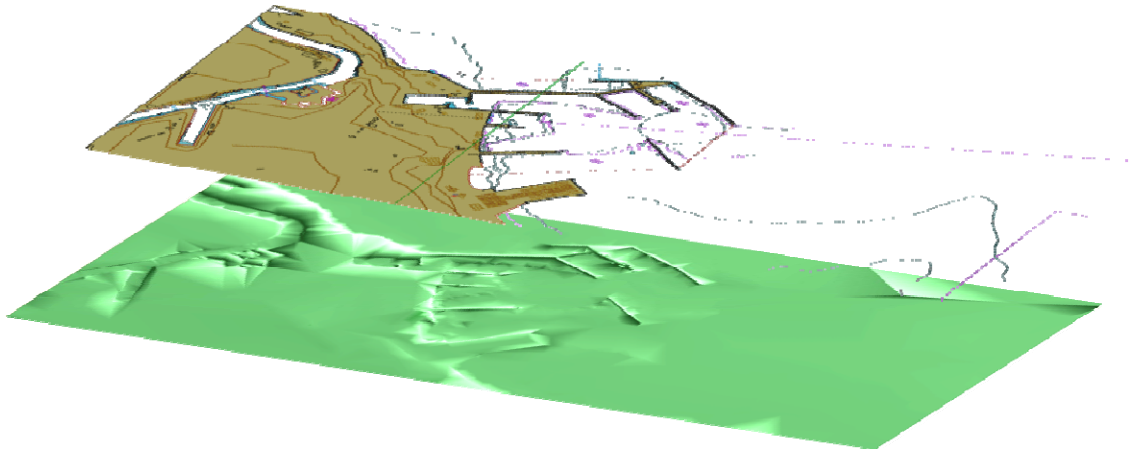


Fig. 4. Visualization of the created area

Upon completion of the work we start the verification process. The first part is done automatically when we run the installation file, which we implement the software simulator. In the absence of errors, we can generate 3D visualization to validate the project. The following is a screenshot of the generated visualization.



Fig. 5. DCT 3D visualization

## SIMULATION TESTS

Simulation software used in testing has advanced mathematical model that makes them very reliable. The latest version of software installed in the Naval Academy in Gdynia in 2011, has a very powerful weather model. Besides all standard hydro-meteorological parameters (wind, wave, current), you can choose the type of waves, depending on the type of the sea area covered by the tests. This is an important element of the test where wave types differ significantly from each other, like Baltic Sea and ocean waters [3].

Simulation tests consist of two main stages. The first one leads to determine the maximum size that of the vessel that could maneuver in a given basin. The second stage includes a number of trials using the vessel determinate in the first stage. These tests are held in variables, increasing hydro-meteorological conditions and lead to determine the critical allowing safe navigation.

An example of use this method may be testing the newly developed container terminal DCT Gdańsk. Construction of the quay allows entry to the port vessels of length up to 400m. The problem is very difficult weather conditions. The biggest threats to ships entering the port are the north-east and east winds [1].

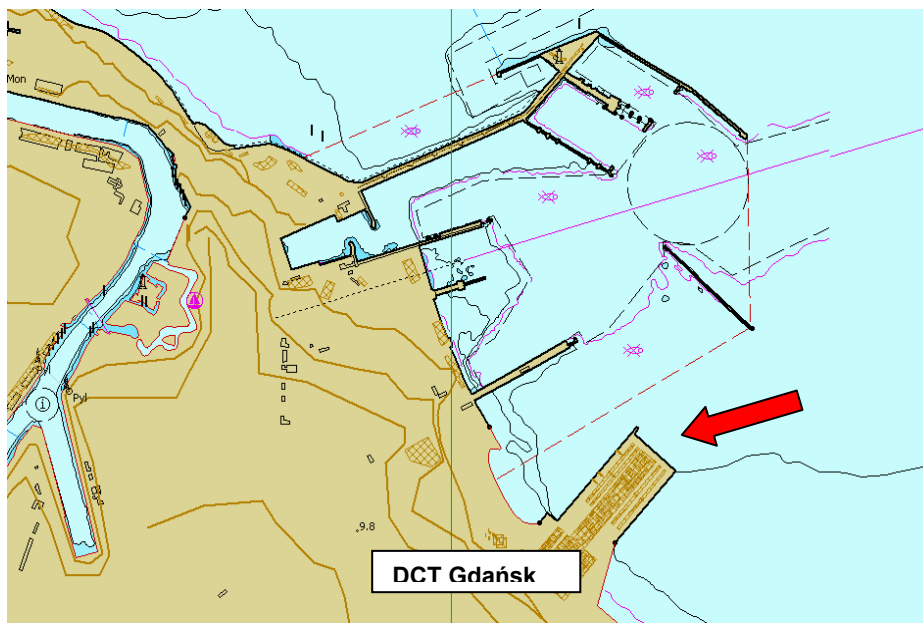


Fig. 6. Deep water terminal

As the figure shows, the location of the terminal and the construction of the port causes that the eastern and north eastern part is exposed and vulnerable to changing weather conditions. This situation makes that the most important element in the simulation tests is to examine the impact of winds blowing from these directions. Determination of boundary conditions for a given vessel may find its use in procedures for entry to the port and be helpful in deciding whether to permit entry and berthing. Port construction and large vessel dimensions makes necessary to use tugs in tests. There is therefore a need to analysis of co-operation vessel with the tugs and the forces acting between them.

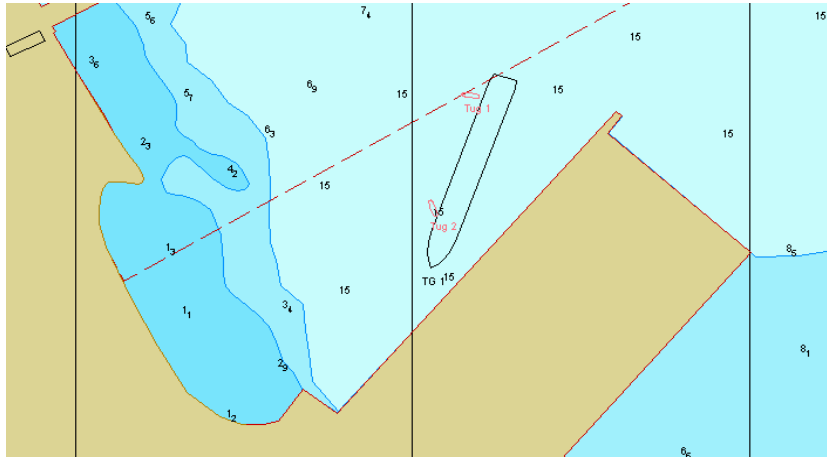


Fig. 7. Container Ship maneuver

### **ANALYSIS OF RESULTS**

For the analysis of results we should make use of an application that registers tens of different parameters of vessel motion model and forces acting on it. These parameters are recorded at a frequency of 1 second and saved in log file. You can print selected items in tabular form. The whole course of the simulation test is saved and there is a possibility to restore it.

### **REFERENCES**

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