A Model Proposal to Trawler Yachts from Hull form Importing to Superstructure, Interior Space Arrangement and Modelıng With Set of Numerical Parameters

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ABSTRACT

In this study, parametric design with set of numerical parameters of trawler yachts design and modeling are presented. This parametric design is utilized to find a superstructure form and interior space design by considering hull, superstructure, lower deck, staircases and cocpit area. Within the scope of this study, the design phases are based on the desire to achieve a faster and more accurate result by creating a design process sequence according to the determined yacht typology. Based on the numerical values of the yacht form, it is aimed to make the superstructure and interior designs suitable for the desired typology. This study attempts to visualize trawler typology as a step to be taken by automatically modeling the desired typology. This approach does not completely replace the experts' design knowhow's but at least it suggests a guideline to initial layout of interior spaces and superstructure design.

Keywords: Trawler yacht, CAD, Modeling, Grasshopper, Interior space arrangement, Superstructure

1. INTRODUCTION

Trawler boats are used for fishing purposes. The trawler yachts that will be examined in the scope of the study are re-sesigned yachts used for pleasure by using the powerful features of the fishing boats. In the scope of the study, special purpose yachts will be examined; commercial, freight, passenger and fishing vessels shall be excluded.

Once the desired yacht type has been identified in the preliminary design phase, it is necessary to decide on the hull type and to search for previously made yachts that are similar to this yacht. The research is carried out by examining at least 10 yachts in the required dimensions. Then, in order to reach the target yacht, average values are found for systematic analysis or graphic methods to find the main dimensions. The yacht's hull is a three-dimensional shape that is difficult to define simple mathematical expressions. Features of a craft; dimension, such as height, width and draft, or slenderness ratio (height / displacement) (Larsson & Eliasson,2000).

Marine vehicles are a part of styling and interior design. The styling creates space by exterior form also affects exterior form by the partitioning and the incoming interior spaces. Without a distinction between the two, not only from inside to outside but also outside to inside must be worked. General arrangements should be made in accordance with the external filling and space positioning. If a typology is desired, styling dictates the characteristics of typology.

In the scope of the study, a model proposal will be done to make the styling and interior analysis of the trawler typology together to provide this integrity. The concept of partitioning, which is the most important issue in general arrangements, is being used with the inclusion of the design of head, back and machine bulkheads, as well as the arrangement of living areas, so that the vehicle can maintain its watertight integrity.
Formation for the study, first of all database is created, styling and interior analyzes of 12-22 meter yachts with trawler typology will be carried. Superstructure and interior space partitioning will be done by applying parametric formulas and standarts obtained from sample yachts in database.

2. AUTOMATIC GENERATION OF SUPERSTRUCTURE AND INTERIOR SPACE DESIGN

Jo and Gero (1998) proposed using a genetic algorithm to solve allocation problems as formulating the design problem with n number of spaces.Lee et al. (2002) proposed an approach using a modified genetic algorithm as meeting the need of better space utilization. Daniels and Parsond (2006) proposed an approach to allocate spaces. Recently, Nam et al. (2010) proposed an approach to computerized preliminary design procedure of mid-size superyachts interior space arrangement. But all of the studies have been worked with two dimensions about interior space layouts. In this study, it is aimed to design three-dimensional mass settlements parametrically.

Yachts are masses with organic forms. While yacht is designing, thoughts sketched in papers and the three-dimensional modeling is started on the other hand. Yachts have angled walls and their sections are constantly changing. For this reason it is necessary to see what is going on with the three-dimensional model. This model proposal also emerged to help the designers in the first stages of the design in which the ideas and the masses are decided. It is aimed to support the designer, not take the designer's job. Nam et al. (2010) mentioned that most interior designs are executed by some experts in advanced shipbuilding countries. Therefore, a preliminary guideline for the superyacht design is strongly desired to help the designer find a good starting point. Even the experts can verify their design using the guideline suggested here.

Yacht designers use the Rhinoceros program all over the world among the three-dimensional modeling programs. Grasshopper, a free plugin in the Rhinoceros program that allows parametric design, is used to create this model proposal. The model is divided into five main parts: Hull, superstructure, lower deck, stairs, and cockpit area. Superstructure also have subparts: open deck walking area, main superstructure, handrail, superstructure deck floor. Lower deck also has subparts: bulkheads, floors, walls, beds, WC and cabinets.

2.1. Hull Form

Many publications regarding the parametric hull form design have been released. The study by Foster, I. T. (1979) titled 'Computer Aided Yacht Design' is one of the pioneering studies in this area. The work titled 'Numerical Investigation of a Systematic Model Series for Fast Monohulls' (1997) and' Parametric Design and Hydrodynamic Optimization of Ship Hull Forms' (1998) by S. Harries and D. Schulze, 'Parametric Generation of Yacht Hulls '(1997) was done by M. Bole. 'Parametric design of sailing hull shapes' (2006) was done by Mancuso, A. The work titled 'Automatic surface modeling of a ship hull' (2006) was done by F. Perez-Arribas, J. A. Suarez-Suarez and L. Fernandez-Jambrina. These studies are to develop ideas on how to make the hull form using computer aided methods. 'A Mathematical Model to Simulate Small Yacht Behavior' (1990) is a work by A. W. Browning that presents a mathematical model to simulate the behavior of small yachts on water.

On the other hand there are many geometric modeling systems used in naval architecture. Rhinoceros software is already used a lot in the Marine Industry. Not everybody is aware of the marine design capabilities of Rhino as a lot of users only apply Rhino in superstructure design or visualisation purposes by importing geometry in Rhino from other CAD tools. It is not designed specifically for naval architecture. FastShip, AutoShip, MaxSurf, MultiSurf, BEAN – The Virtual Shipyard, DELFTship, Pilot3D, ShipConstructor, MasterShip and MAAT 2000 softwaresare designed specifically for naval architecture. The aim is not use a program only prepared for the use of naval architects but use a program with different modeling potentials. So the model proposal is integrated with the RhinoCeros program.

The first task was importing the hull to the model. The hull form is created by the naval architect according to the required dimensions and specifications in the desired program or any parametrical models and then converted to the 3dm extension that RhinoCeros can run to work in the proper format.

2.2. Superstructure

In order to examine the correct examples of the trawler yacht typology, the survey was limited to 12 to 22 meters.The first step was to collect the profile views of these trawler yachts. The most important of the trawler yacht manufacturers in the sector are: Selene, Grand Banks, Nordhavn, Kadey-Krogen. In order to resolve the yacht typology and settlements, these producers and modern trawler yacht brands will be investigated and a common deduction will be tried to be done.

Table.112-22-meter trawler yachts main superstructure partitioning

Model	First superstructure	Second superstructure	Third superstructure	Fourth superstructure
Nordhavn 40	-	x	x	x
Benetau Swift 44	x	x	-	x
43 Heritage EU	x	x	x	x
41 Heritage EU	x	x	x	x
Selene 38	-	x	x	x
Nordhavn 43	-	x	x	x
Benetau Swift 50	x	x	-	x
Selene 42	x	x	x	x
Euro Trawler 450ce	-	x	x	x
Selene 45	-	x	x	x
Bering B50	-	x	x	x
Euro Trawler 550ce	-	x	x	x
52 Heritage EU	x	x	x	x
Selene 49	-	x	x	x

54 Heritage EU	x	x	x	x
Nordhavn 52	-	x	x	x
580	-	x	x	x
Bering B55	-	x	x	x
Euro Trawler 650ce	-	x	x	x
610	x	x	x	x
Selene 54	-	x	x	x
Nordhavn 60	-	x	x	x
630	x	x	x	x
Selene 58	-	x	x	x
Nordhavn 64	-	x	x	x
B65	-	x	x	x
Selene 60	-	x	x	x
650	-	x	x	x
700	-	x	x	x

Nordhavn 40, Benetau Swift 44, 43 Heritage EU, 41 Heritage EU, Selene 38 have been examined for yachts ranging from 12 to 13 meters. Nordhavn 43, Benetau Swift 50, Selene 42, Euro Trawler 450ce have been examined for yachts ranging from 13 to 14 meters. Selene 45, Bering B50 have been examined for yachts ranging from 14 to 15 meters. The range of 15-16 meter trawler yachts has not been studied. Selected brands do not have yacht production at this size. Euro Trawler 550ce, 52 Heritage EU, Selene 49, 54 Heritage EU, Nordhavn 52 have been examined for yachts ranging from 16 to 17 meters. 580 and Bering B55 have been examined for yachts ranging from 17 to 18 meters. Euro Trawler 650ce, 610, Selene 54 have been examined for yachts ranging from 18 to 19 meters. Nordhavn 60, 630, Selene 58, Nordhavn 64, B65, Selene 60, 650 have been examined for yachts ranging from 19 to 20 meters. 700 has been examined for yachts ranging from 20 to 22 meters First, second, third and fourth, the mass of superstructure was divided into 4 parts shown in Fig.1. 29 vessels between 12 and 22 meters are investigated and their superstructures are summarized in Table1.

The selected brands for the determination of the upper and lower limits of the parametric variables were examined according to the criteria shown in Fig.2.These values are tabulated,the minimum and maximum values are shown in Table 2.

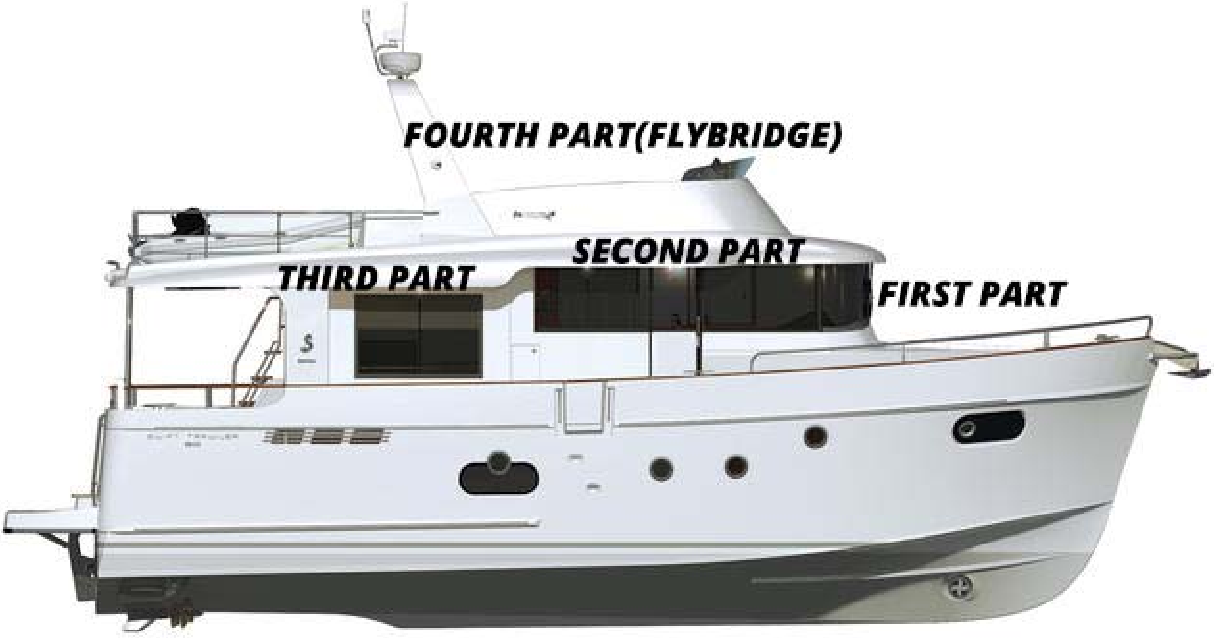
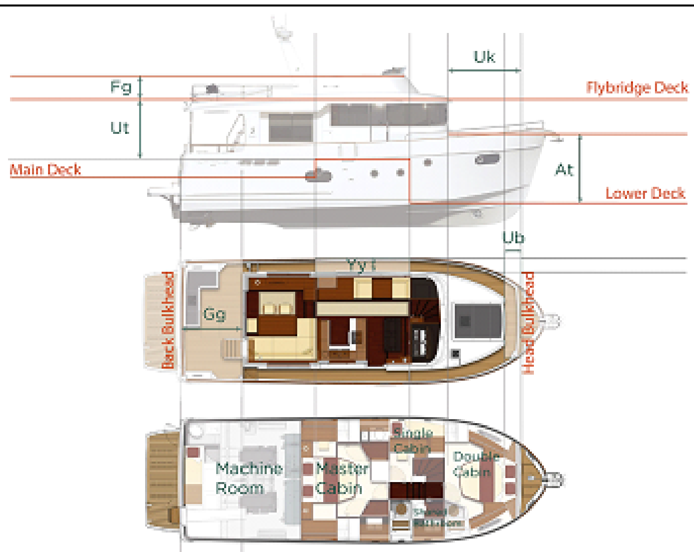


Fig.1 Main superstructure partitioning [URL-2]



Term	Explanation
LOA	Length of overall
Mm	Machine room bulkhead distance from stern post
Bb	Head bulkhead distance from head post
Yy	Walking distance
Ub	Superstructure start from head post
Uk	Superstructure cocpit windows from head post
Ut	Superstructure ceiling height
At	Sub-deck ceiling height
Gg	Open deck width
Fg	Flybridge deck height

Fig.2 Analysis of the Benetau Swift 50 yacht upper structure and interior, terms are used in the schedules for expressions of values [URL-1]

Superstructure also have subparts: open deck walking area, main superstructure, handrail, superstructure deck floor. Open deck walking area: In order to create an superstructure, the border must first be specified. This boundary starts to form the walking distance of the open deck. In order to create this distance, the upper surface curve of the hull is drawn again and the first variable is defined. Offset is applied up to the desired distance.

Table.212-22-meter trawler yachts superstructure min and max values

	Mm	Bb	Yy	Ub	Uk	Ut	Gg	Fg	At
Min Value	370 cm	90 cm	30 cm	40 cm	245 cm	190 cm	130 cm	55 cm	185 cm
Max Value	1065 cm	322 cm	84 cm	511 cm	654 cm	250 cm	420 cm	244 cm	230 cm

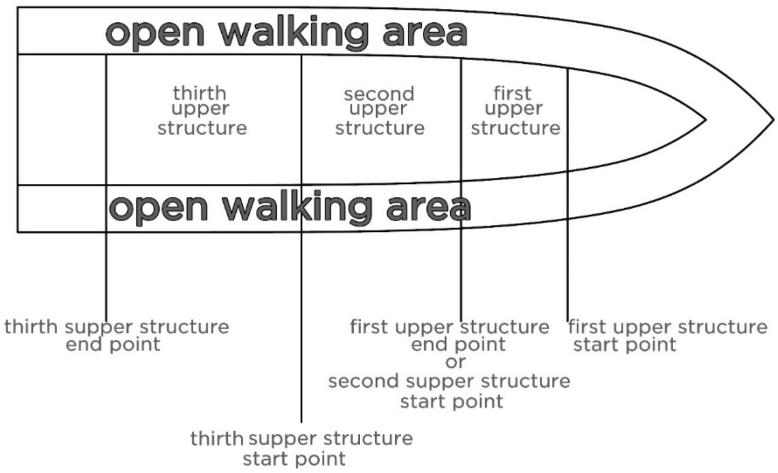


Fig.3 Main superstructure parameters

For main superstructure as a result of Table 1, it can be seen that the first and thirth superstructures are in some models, with the second and fourth superstructures present in every trawler. The parameters must be set so that these four can also be created. It was also found that the first superstructure was inclined due to the difference in front and back heights. When looking at the cockpit windows of the second superstructure, it was seen that there were vertical, front angled or back angled glasses. In the third superstructure that there were vertical, front angled or back angled structure. The parameters for first upper structure is beginning of the structure, frot height and back height for making angled structures. If first superstructure doesn't want, values have been set to be entered 0 and the creation of the second superstructure has been continued. The parameters for second and thirth upper structure is beginning and ending of the structure, height of the structure and if there is angled glasses, the angle value variable needed (Fig.4). The parameters for fourth upper structure (fly bridge) is beginning and ending of the structure, height of the structure and if there is angled glasses, the angle value variable needed. And also, second superstructure front and thirth superstructure side glasses numbers and window platen width added to variables. Superstructure variables are summarized in Table 4.

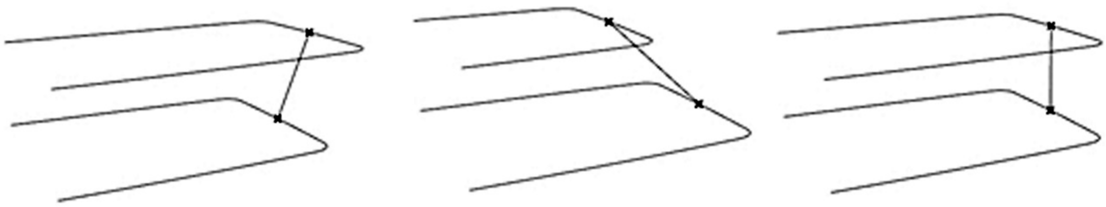


Fig.4 Main superstructure angled or vertical structures

2.3. Handrails

Handrail is located on the entrance deck for safety on yachts head of the yacht and on the third superstructure. The handrail on the entrance deck starts at the head of the yacht and continues until the second super structure. This distance information was determined in the previous steps. The outer curvature of the hull is cut according to this distance information and is moved on the z axis according to the height variable. And it is automatically modeled without asking user of the radius dimension. The second handrail on the third superstructure modeled in the same way.

2.4. Upper deck floors

There has been upper deck exterior and interior decks when the samples were examined. When the 12-22 meter trawler samples are examined by upper exterior deck, there is not a single deck, especially on these surprisingly decked yachts. There is a variable number of digits between these decks. In terms of flexibility, it can be made according to the variables given to one, two or three decks. Since it is a structure rising from the bottom to the top, the point is moved on the z-axis relative to the distance from the bottom of the yacht hull. This point is the most midpoint of the back of the yacht. This point is moved along the x-axis according to the stern distance of the first deck (Fig. 5) This point is moved along the x and z axes according to the value of the step height and the step width (Fig. 5) If the third deck is present, it is moved along the x and z axes according to the value of the step height and the step width; If there is no third deck, the remaining distance is calculated and continued until the surface is reached. On the other hand, upper interior deck has only one or mostly two decks on the inside floors. These deck formations can be made according to given variables.

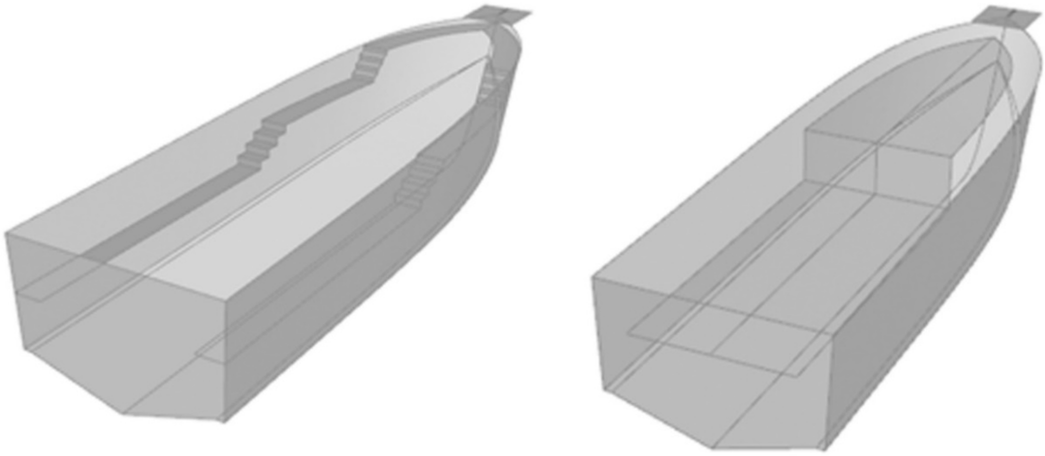


Fig.5 Upper exterior and interior deck floors

Table.3.12-22-meter trawler yachts interior design arrangement

Model	**At**	**Master cabin**	**Double cabin**	**Single cabin**	**Kitchen**	**Communal bathroom**	**Storage/ Common Area**
Nordhavn 40	195 cm	Existing	1	None	None	Existing	None
Benetau Swift 44	190 cm	Existing	1	None	None	Existing	None
43 Heritage EU	175 cm	Existing	1	None	None	1	Existing
41 Heritage EU	175 cm	Existing	1	None	None	None	None
Selene 38	189 cm	Existing	1	None	None	Existing	Existing
Value Ranges	**175-195 cm**	**Existing**	**1**	**None**	**Existing/ None**	**Existing**	**Existing/ None**
Nordhavn 43	195 cm	Existing	1	None	None	Existing	None
Benetau Swift 50	190 cm	Existing	1	1	None	1	None
Selene 42	192 cm	Existing	1	None	Existing	Existing	Existing
Euro Trawler 450ce	190 cm	Existing	1	None	None	Existing	None
Value Ranges	**190-195 cm**	**Existing**	**1**	**Existing/ None**	**Existing/ None**	**Existing**	**Existing/ None**
Selene 45	180 cm	Existing	1	None	None	Existing	None
Bering B50	220 cm	Existing	2	None	None	Existing	None
Value Ranges	**180-220 cm**	**Existing**	**1 /2**	**None**	**None**	**Existing**	**None**
Euro Trawler 550ce	220 cm	Existing	2	None	None	Existing	None
52 Heritage EU	185 cm	Existing	1	1	None	1	Existing
Selene 49	180 cm	Existing	1	None	None	Existing	None
54 Heritage EU	190 cm	Existing	1	1	None	1	Existing
Nordhavn 52	200 cm	Existing	1	None	None	None	None

Value Ranges	**185-220 cm**	**Existing**	**1 /2**	**Existing/ None**	**None**	**Existing/ None**	**Existing/ None**
580	195 cm	Existing	2	None	None	Existing	None
Bering B55	230 cm	Existing	2	None	None	Existing	None
Value Ranges	**195-230 cm**	**Existing**	**2**	**None**	**None**	**Existing**	**None**
Euro Trawler 650ce	220 cm	Existing	2	None	None	Existing	None
610	200 cm	Existing	2	None	None	Existing	None
Selene 54	195 cm	Existing	2	None	None	Existing	None
Value Ranges	**195-220 cm**	**Existing**	**2**	**None**	**None**	**Existing**	**None**
Nordhavn 60	210 cm	Existing	1	None	None	None	None
630	200 cm	Existing	2	None	None	Existing	None
Selene 58	195 cm	Existing	2	None	None	Existing	None
Nordhavn 64	210 cm	Existing	2	None	None	Existing	None
B65	220 cm	Existing	1	1	None	Existing	None
Selene 60	200 cm	Existing	2	None	None	Existing	None
650	200 cm	Existing	2	None	None	Existing	None
Value Ranges	195-220 cm	Existing	1 / 2	None / 1	None	Existing/ None	None
700	200 cm	Existing	2	None	None	None (every cabin has its own)	None
Value Ranges	**200 cm**	**Existing**	**2**	**None**	**None**	**None**	**None**
ALL VALUE RANGES	**175-220 cm**	**Existing**	**1/2**	**None / 1**	**Existing/ None**	**Existing/ None**	**Existing/ None**

2.5. Interior design

The selected brands for the determination of the interior design parametric variables were examined according to the master cabin, single cabin, kitchen, communal bathroom, storage/common area existance criteria shown in Table 3. The value ranges of the 12-22-meter trawler yachts are given also in the same table. The values vary according to the design of each model. It is very difficult to determine an average value. When looking at the interior layout, however, only the presence of the master cabin can be mentioned. Apart from this, one or two double cabins can also be mentioned or single cabin. Communal bathrooms are available on some samples. There is only two example has kitchen or storage area on the lower deck in any case.

2.6. Lower deck

To designate lower deck, the space between engine room and head bulkhead must know. Head bulkhead, engine room bulkhead and engine room walls are modelled parametrically. The head bulkhead is according to the rules of implementation for the technical characteristics of the ships; In general, the watertight impact range is not less than 0.05L, not more than 0.1L from the head. The minimum and maximum values of the variable are set according to these calculations. The knowledge of how much space we need for the width of the engine room space is taken from the naval architecture. In this information frame, the machine bulkhead created using the stern distance of the wall. To designate lower deck floor, the height variable from the bottom of the yacht is enough. The surface extruded by this height is cut by the hull to form the deck floor (Fig. 6).

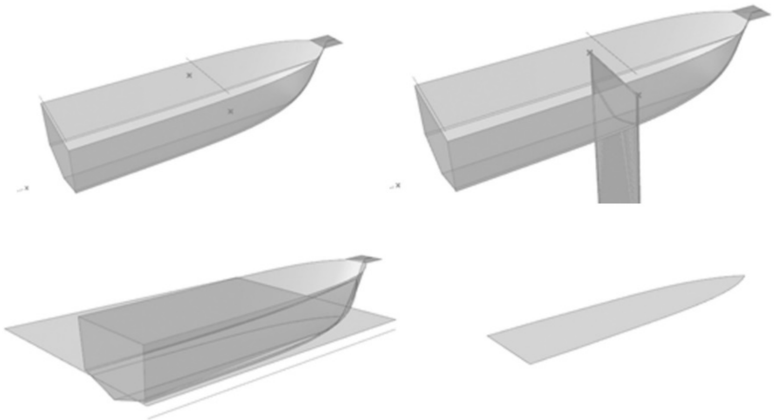


Fig.6 Back bulkhead and lower deck floor formation

For interior wall partitioning, the location of the trawler yachts between 12 and 22 meters was examined. It has been investigated how many vertical and horizontal divisions should be made as shown in Fig. 7 in order to be able to make a suitable partition for the yachts with the most interior spaces. As a result, dividing 3 divisions horizontally into 4 vertically will allow both the implementation of the model with the most interior space and the implementation of the model with the least interior space.

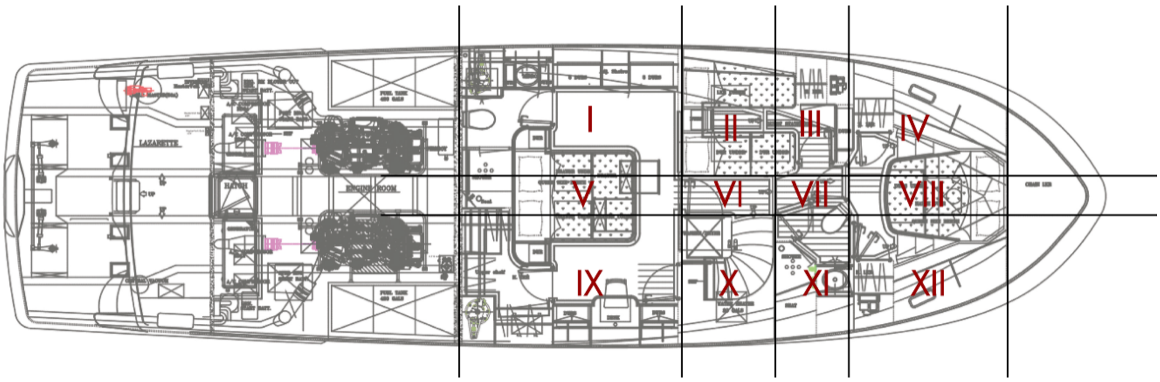


Fig.7 Trawler yacht interior wall partitioning

To create vertical walls, back bulkhead line is used and moved from this wall using the distance variable. This line reflected to the upper deck floor and also onto lower deck floor. The surface to be created between these two new lines formed the first vertical wall (Fig. 8).Vertical walls are constructed in the same way. Wall 1 is defined by its distance from the wall of the back bulkhead, wall 2 is defined by its distance from wall 1, and wall 3 is defined by its distance from wall 2.To create horizontal walls, this space is divided into maximum three parts. The line which connected back bulkhead and vertical wall 1 is used to create the walls. This line is moved according to the Y distance variable. It is reflected to the upper deck floor. As in the vertical wall, the thickness is given by 5 cm displacement and the surface is created. This surface is split with the lower deck floor. It won’t be possible to create the example in Fig. 13 in this case for wall partitioning. For this reason, vertically formed walls are horizontally divided into 3 pieces by cuts, and giving angle to each piece.

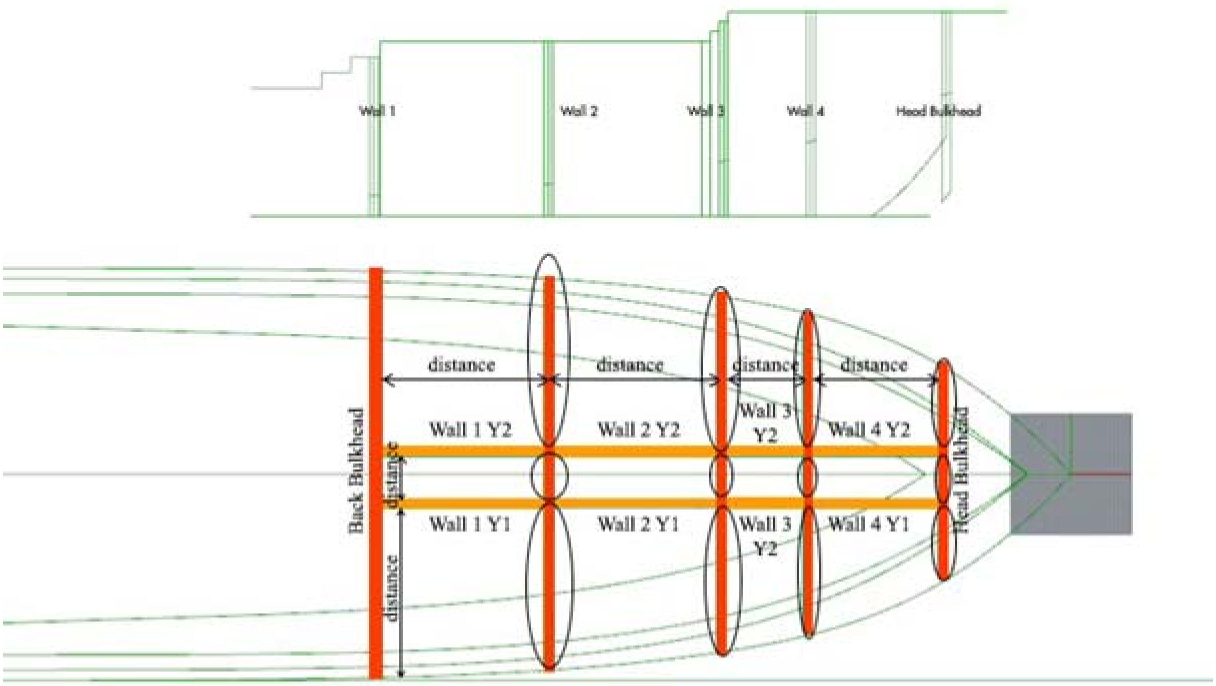


Fig.8 Wall partitioning

Modules that can be automatically added to each volume created in the interior are decided. These modules are set as cabinet, bed and WC. The cabinets are fitted with width, height and depth variables, position variables, and positioning in any size and position, in accordance with each module to be added. It is possible to add 8 cabinets in 12 sections. Bed types used in yachts were examined, dimensions were connected to the standard; There are 6 alternatives, single, double, single-angled, double-angled, single berth beds and double narrow beds. It is possible to add 4 beds to the model. The position and angle of the added beds can be changed. The types of WC used in yachts are examined, dimensions are connected to the standard; wall mounted, electrical large and small, marine type large and small WC 5 alternatives are offered. 3 WCs can be added to the model. It is ensured that the position and angle of the inserted WCs can be changed. Modules such as washbasins and washrooms located in wet spaces are not added to the model. Especially the shower areas are specially manufactured for the yacht depending on the geometry of the vessel and without using standard shower yachts. Very rarely ready-made products are used. The use of washbasin is sometimes made with ready-made products, mostly with booth-specific countertops. The purpose of the model is to prepare the draft of the general layout by adding the masses that can be prepared and connected to the standard. The seating area and kitchen areas on the upper deck are excluded from the model due to the same reasons. Flybridge has been added to the model by changing the position change and height on the superstructure. Cockpit area and cockpit seat were also added to see the mass and general layout. Cockpit control areas used in yachts are reviewed and 3 alternatives are presented: right-based, left-based and covering the whole area. The depth and height of the cockpit seat are kept constant, and the width, back height and position can be changed.

In this study, grasshopper commands and their relations used in modeling phases of walls, floors, stairs, superstructure, interior fittings are not given in detail in the article. What is important for the study is what variables are needed. As shown in Table 4, a total of 110 variables are needed for superstructure and interior space layouts. New variables for each new module added will also be added to this variable numbers.

3. COMPARISON OF THE YACHT MADE BY MODEL PROPOSAL AND THE MAIN YACHT

Selene 49 yacht was created with the model proposed in the article. The model with the main boat was constructed with profile, lower deck plan, upper deck plans.For better understanding the comprehension of the profile comparison, as seen in Fig. 9, the Selene 49’s hull is assembled instead of the model's hull. Fig. 10 shows the comparison of upper deck layout of Selene 49 and the model yacht.

Fig. 9 Selene 49 and the model profile comparison [URL-3]

Fig. 10 Selene 49 upper deck layout and the model comparison [URL-3]

Figure 11 and Figure 12 shows the comparison of lower deck layout of Selene 49 and the model yacht.

Fig. 11 Selene 49 lower deck layout and the model comparison [URL-3]

Fig. 12 Selene 49 lower deck layout alternative 2 and the model comparison [URL-3]

4. CONCLUSIONS

Research on the hull modeling and interior space arrangement was carried out to provide a background of the preliminary trawler yacht design. A computerized design system for superstructure and interior space arrangement with 3d modelling was developed. In the Rhinoceros software, this model proposal was created using the Grasshopper plugin commands that allow parametric design by this software. Within the scope of this model proposal, work is started by importing the naval architect's hull into the model. The formation of the upper structure, the placement of the floors on the desired height and floors, the descent to the lower deck and the stairs that lead to the flybridge have been established. With the lower deck head and back bulkheads installed, the remaining floor areas were made vertical and horizontal to form the walls. In line with general layout principles, the settlement has been established with the main lines of cabins, WC and bathrooms.

Yacht design is a design that does not have flat walls and floors, which requires three-dimensional thinking. Decisions made with two dimensional drawings do not reach the correct conclusion because they have organic forms. This model has been created in order to be able to overcome these problems while still in the sketch phase and to see how the decisions to be given outline affect the external and internal design of the yacht. Designers are advised to be able to make faster and more accurate decisions and gain speed in their work. By changing the variables repeatedly, it is possible to perform many alternatives quickly. As a result, both 3D models can be reached and plan and cross-section output can be obtained.

There are few experienced designers in yacht design especially in interior and superstructure design. However, the field of yacht design is one of the fastest growing economies in the world and it is necessary to carry out studies for designers and also naval architects to serve this area. It is thought that a basic design guideline can help designers and contribute to this field.

Table.4 Superstructure and interior design variables for parametrization

SUPERSTRUCTURE	**Walking area**	**First superstructure**	**Second superstructure**	**Thirth superstructure**	**Fourth superstructure**				
	Open walking area width	First superstructure beginning point from head	Second superstructure beginning point from head if first superstructure doesn't exist		Fourth superstructure (fly bridge) beginning point from head				
		First superstructure length	Second superstructure length	Thirth superstructure length	Fourth superstructure length				
		First superstructure head height	Second superstructure height	Thirth superstructure height	Fourth superstructure height				
		First superstructure back height	Second superstructure angle (+, -, 0)	Thirth superstructure angle (+, -, 0)	Fourth superstructure angle (+, -, 0)				
			Second superstructure front glass number	Thirth superstructure side glass number					
			Second superstructure glass platen width	Thirth superstructure glass platen width					
HANDRAILS	**Entrance handrail**	**Third superstructure handrail**							
	Entrance handrail length	On the third superstructure handrail length							
	Entrance handrail height	On the third superstructure handrail height							
UPPER DECK FLOORS	**Upper deck exterior**	**Upper deck interior**							
	Upper deck exterior	Upper deck interior first floor height							

	first floor height								
	Upper deck exterior first floor length	Upper deck interior first floor length							
	Upper deck exterior second floor height	Upper deck interior second floor height							
	Upper deck exterior second floor length								
	Upper deck exterior thirth floor height								
	Bulkheads	**Lower deck floor**	**Walls**	**Beds**	**Cabinet**	**WC**	**Staircase**	**Cocpit**	**Cocpit seat**
LOWER DECK	Head bulkhead distance from head of the yacht	Height from the bottom of the yacht	Wall 1 distance from back bulkhead	Alternative 1: single bed	Cabinet move x axis	Alternative 1: WCL2 (wall mounted electric toilet) move x axis	Alternative 1:Straight staircase Number of steps	Alternative 1: Left hand area width	Seat width
	Aft bulkhead distance from the bottom		Wall 1 Y1 distance from starboard	Single bed Move x axis	Cabinet move y axis	Alternative 1: WCL2 (wall mounted electric toilet) move y axis	Alternative 1:Straight staircase move x axis	Alternative 1: Left hand area length	Seat length
	Machine		Wall 1 Y2	Single bed	Cabinet	Alterna	Alterna	Alterna	Seat

	room wall distance from aft bulkhead		Distance from Wall 1 Y1	Move y axis	Rotation angle	tive 1: Vetus WCL2 (wall mounted electric toilet) Rotation angle	tive 1:Straight staircase move y axis	tive 1: Left hand area height	height from floor
			Wall 2 distance from Wall 1	Single bed Rotation angle		Alternative 2: Vetus WCS2 (electric large) move x axis	Alternative 2:Left-turning staircase move x axis	Alternative 2: Right hand area width	Seat back height
LOWER DECK			Wall 2 Y1 distance from starboard	Alternative 2: double bed		Alternative 2: Vetus WCS2 (electric large) move y axis	Alternative 2:Left-turning staircase move y axis	Alternative 2: Right hand area length	
			Wall 1 Y2 Distance from Wall 2 Y1	double bed Move x axis		Alternative 2: Vetus WCS2 (electric large) Rotation angle	Alternative 3:Right - turning staircase move x axis	Alternative 2: Right hand area height	
			Wall 3 distance from Wall 2	double bed Move y axis		Alternative 3: Vetus WCS2 (electric small) move x axis	Alternative 3:Right - turning staircase move y axis	Alternative 3: Whole area length	
			Wall 3 Y1 distance from starboard	double bed Rotation angle		Alternative 3: Vetus WCS2 (electric small) move y axis	Alternative 4:Spiral staircase move x axis	Alternative 3: Whole area height	
			Wall 3 Y2 Distance	Alternative 3:		Alternative 3:	Alternative		

			from Wall 3 Y1	single-angled		Vetus WCS2 (electric small) Rotation angle	4:Spiral staircase move y axis		
			Wall 4 distance from Wall 3	single-angled Move x axis		Alternative 4: RASKE RM69 (marin type large) move x axis			
			Wall 4 Y1 distance from starboard	single-angled Move y axis		Alternative 4: RASKE RM69 (marin type large) move y axis			
			Wall 4 Y2 Distance from Wall 4 Y1	Alternative 4: double-angled		Alternative 4: RASKE RM69 (marin type large) Rotation angle			
			Wall 1 X1 rotation angle	double-angled Move x axis		Alternative 5: RASKE RM69 (marin type small) move x axis			
			Wall 1 X1 hide/unhide	double-angled Move y axis		Alternative 4: RASKE RM69 (marin type small) move y axis			
LOWER DECK			Wall 1 X2 hide/unhide	Alternative 5: single berth		Alternative 4: RASKE			

						RM69 (marin type small) Rotation angle			
			Wall 1 X3 rotation angle	single berth Move x axis					
			Wall 1 X3 hide/unhide	single berth Move y axis					
			Wall 2 X1 rotation angle	Rotation angle					
			Wall 2 X1 hide/unhide	Alternative 6: double narrow beds					
			Wall 2 X2 hide/unhide	double narrow beds Move x axis					
			Wall 2 X3 rotation angle	double narrow beds Move y axis					
			Wall 2 X3 hide/unhide	double narrow beds Rotation angle					
			Wall 3 X1 rotation angle						
			Wall 3 X1 hide/unhide						
			Wall 3 X2 hide/unhide						
			Wall 3 X3 rotation angle						
			Wall 3 X3 hide/unhide						

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