Modelling Ice Breaker using Lines Plan

Contents

Lines Plan

Forming planar surface

Fairing

Hydrostatics

Aalto University

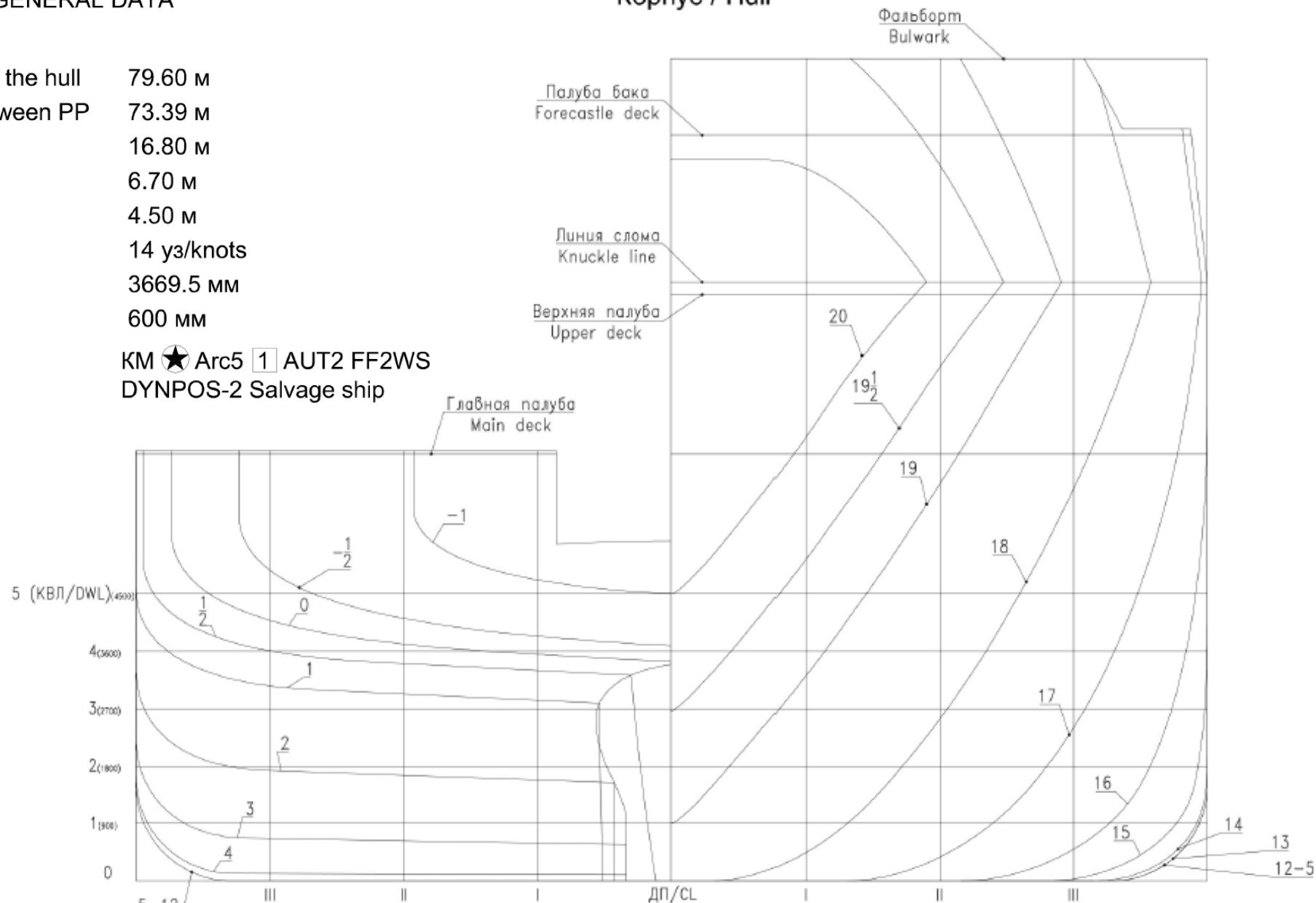# Modelling an Ice Breaker using lines plan

- In this tutorial we are going to use body plan, half breadth plan and profile of an ice breaker.

- There are many methods to create a 3D hull form from an existing lines plan; these methods depend on the designer experience. Here the simplest one is introduced.

- Steps involved in this tutorial

  - ✓ Importing lines plan images to Maxsurf Modeler
  - ✓ Forming planar surface into the shape of the vessel
  - ✓ Fairing
  - ✓ Trimming and final preparation for further stability and resistance analysis.
  - ✓ Hydrostatics.

A? **Aalto University**

ОСНОВНЫЕ ХАРАКТЕРИСТИКИ / GENERAL DATA
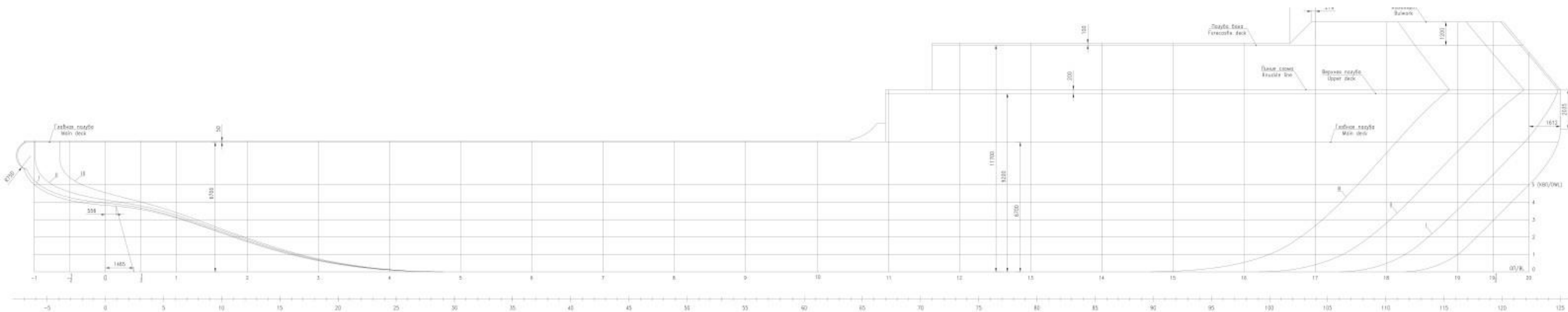
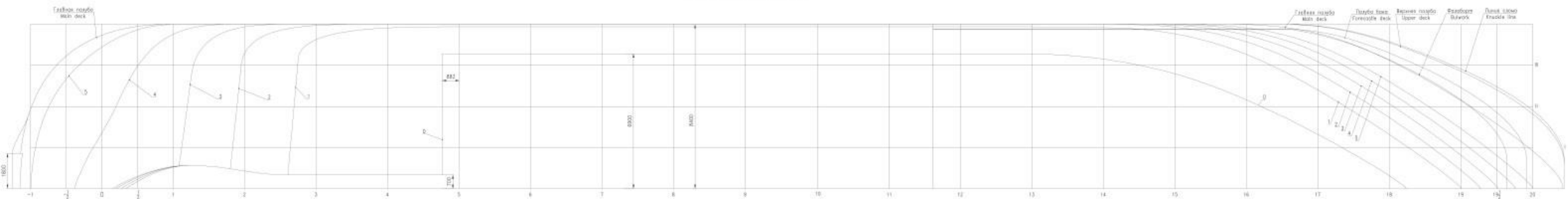|	
Длина корпуса наибольшая / Overall length of the hull	79.60 м
Длина между перпендикулярами / Length between PP	73.39 м
Ширина по КВЛ / Breadth DWL	16.80 м
Высота борта / Depth	6.70 м
Осадка / Draught	4.50 м
Скорость хода / Ship speed	14 уз/knots
Теоретическая шпация / Theoretical frame	3669.5 мм
Практическая шпация / Practical frame	600 мм
Класс РС / Ship class RS	KM ★ Arc5 1 AUT2 FF2WS DYNPOS-2 Salvage ship

Корпус / Hull

Фальборт
Bulwark

Палуба бака
Forecastle deck

Линия слома
Knuckle line

Верхняя палуба
Upper deck

Главная палуба
Main deck

5 (КВЛ/DWL)(4500)

4(3600)

3(2700)

2(1800)

1(900)

0

5—12

Ice Breaker Body Plan

A? Aalto University

Profile

Полуширота / Half-breadth plan

**Half Breadth Plan**

Aalto University

Setting background

- Maxsruf modeler has the ability to display background images in each of the design views (Plan, Profile and Body Plan views).

- The image can be re-positioned and resized to match the design and can then be used to assist in fairing to an existing design.

- Open Maxsurf Modeler

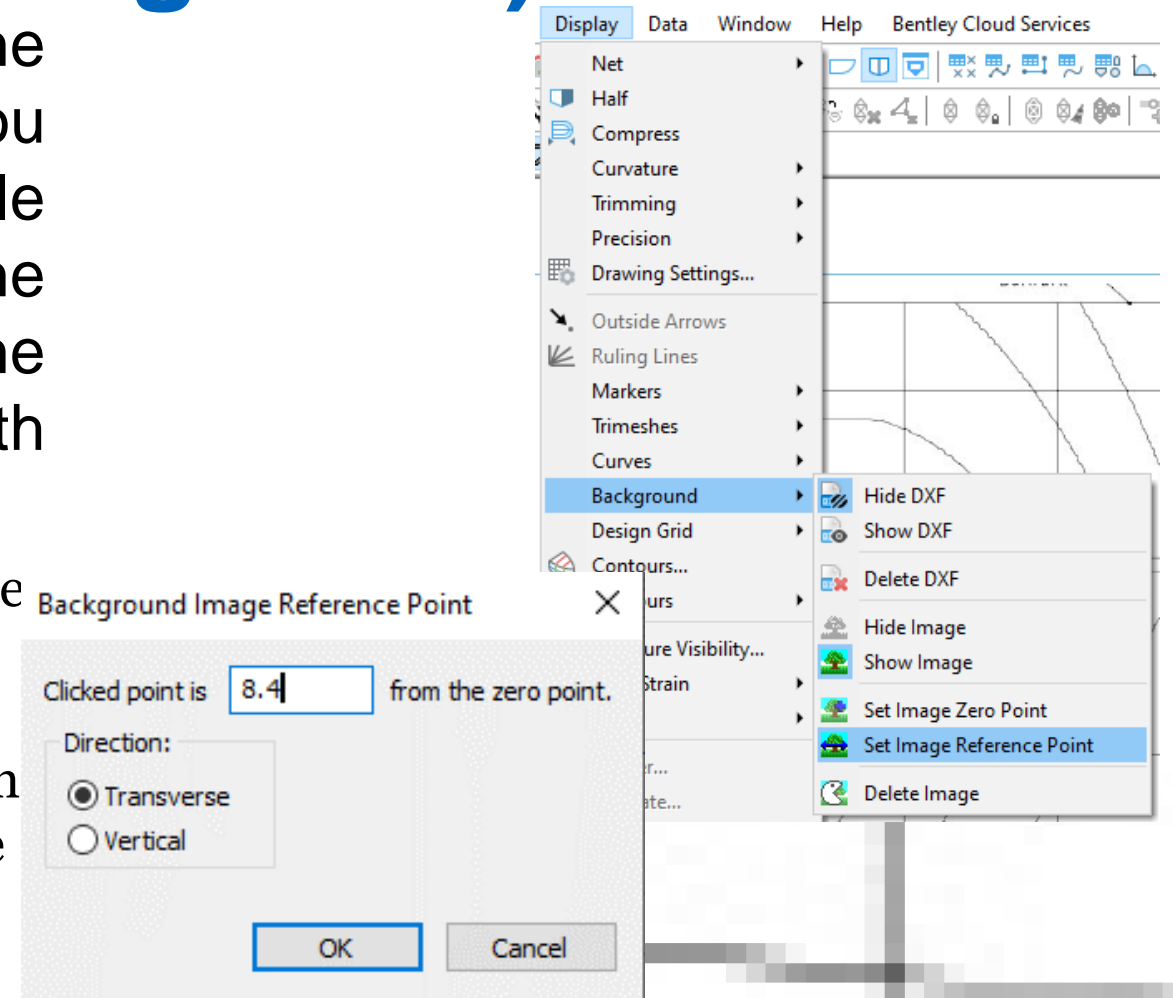 ➢ Switch to body plan view➤ File ➤ Import Background ➤ Browse Body plan image ➤ Open
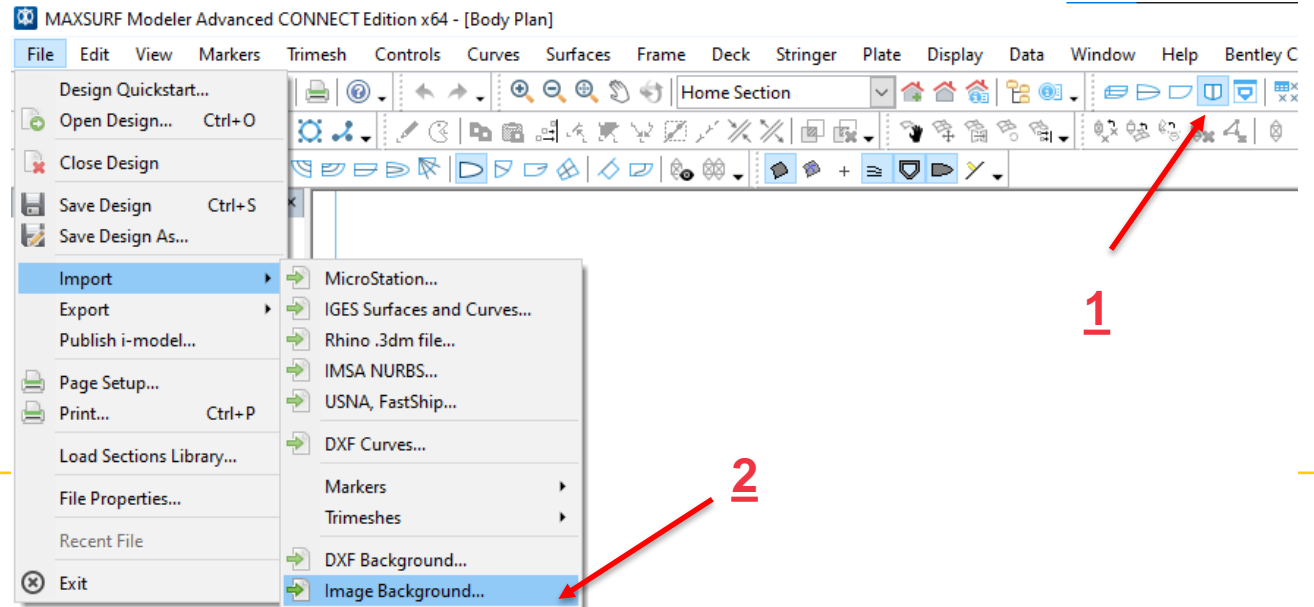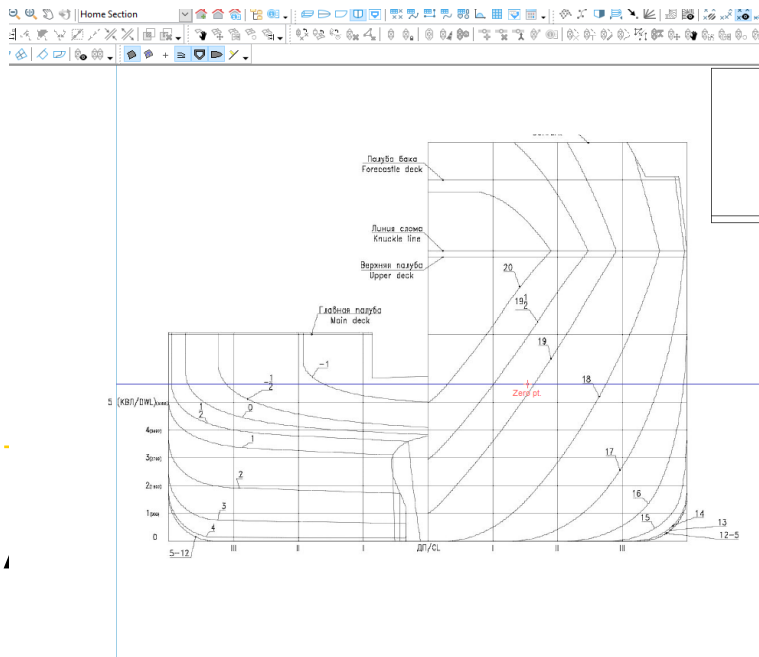
Defining Lines Plan (Background)

- The next step is to centre the image in Maxsurf Modeler's coordinate system.

    - Display ➤ Background ➤ Set image Zero Point ➤ Zoom in as far as you can and then click on the point on the image that you wish to be the zero point.
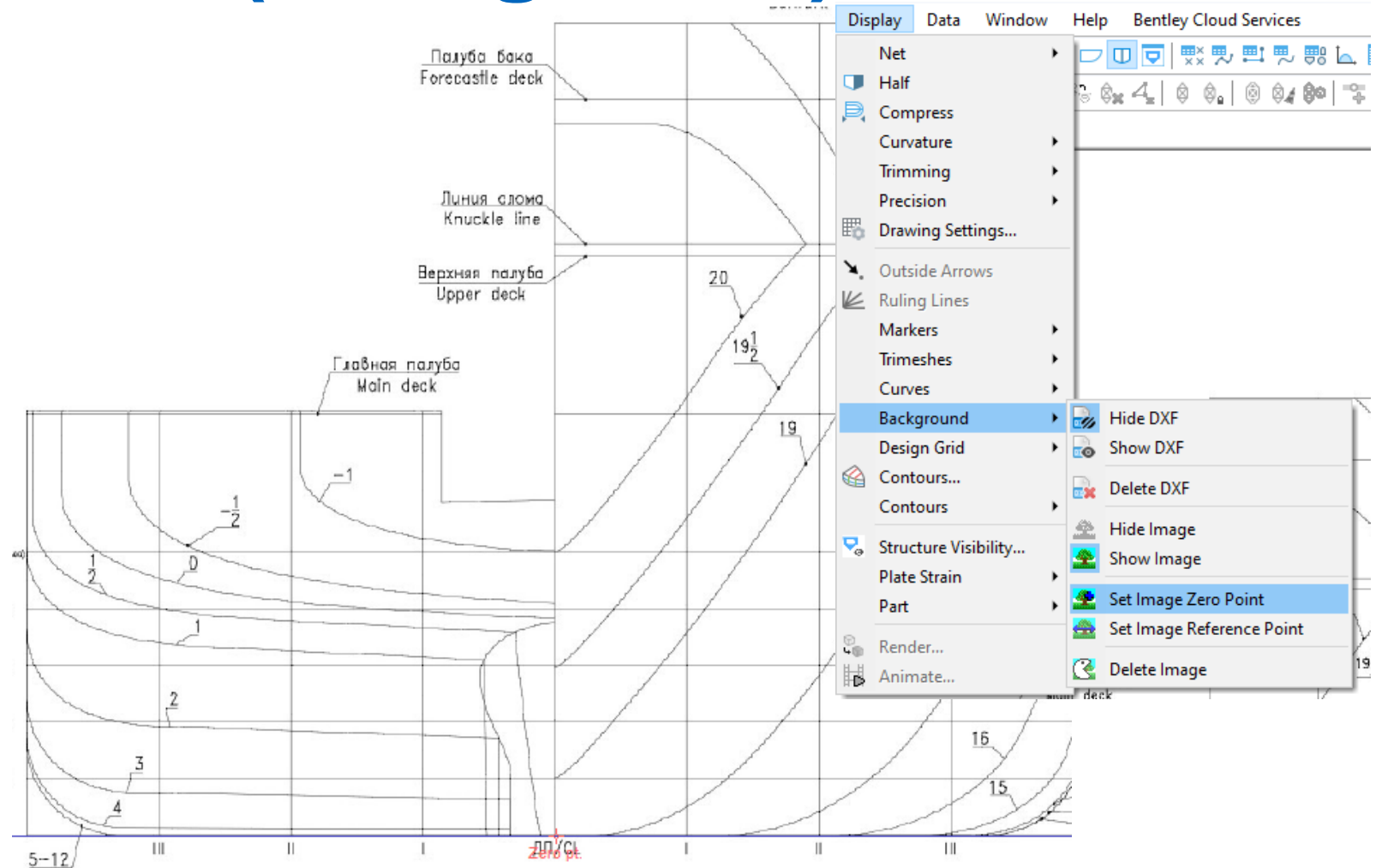
Defining Lines Plan (Background)

- You can specify a known position on the image to scale the image. To do this you only need to know the value of a single dimension on your drawing in either the horizontal or vertical direction (prefer the extreme dimension as breadth and length to reduce round off error).

  ➢ Display ➵ Background ➵ Set image Reference Point ➵ Zoom in as possible as you can and then click on the point on the image that you know its vertical or horizontal dimension from zero point (here point on the side) ➵ enter the dimension from zero point (transverse or vertical?) .

Background Image Reference Point

Clicked point is [8.4] from the zero point.

Direction:
- ◉ Transverse
- ○ Vertical

[OK] [Cancel]

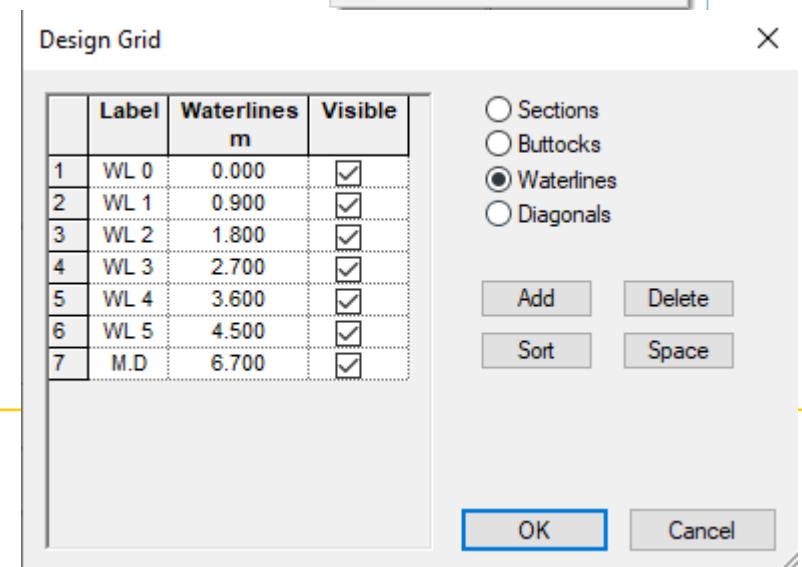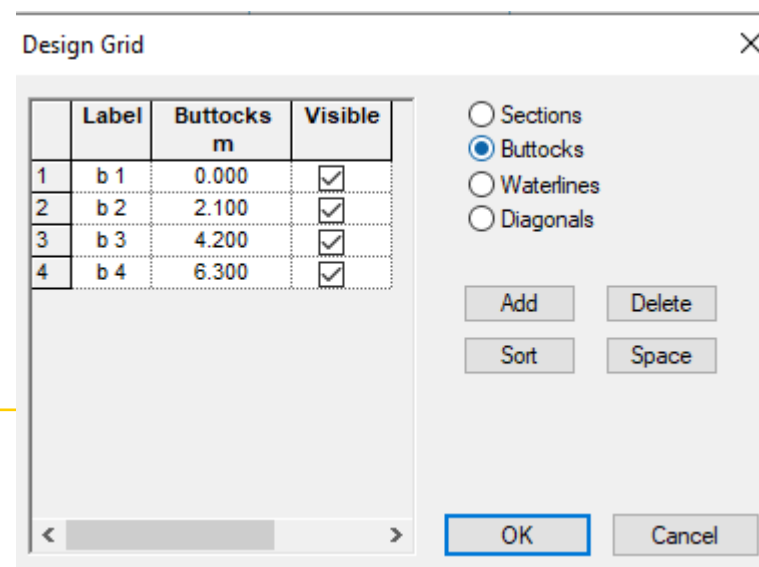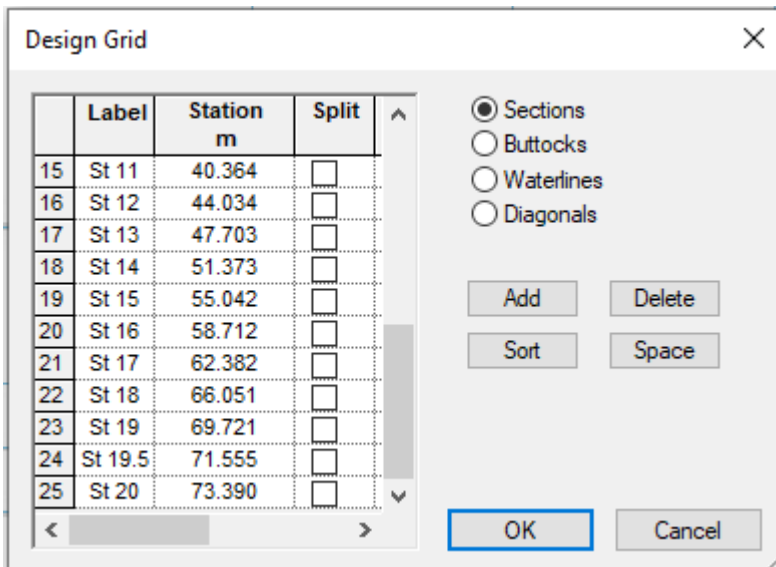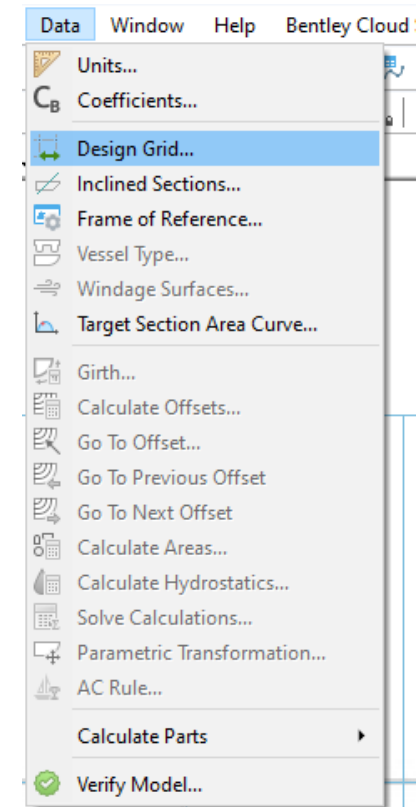**Aalto University**

Defining Lines Plan (Background)

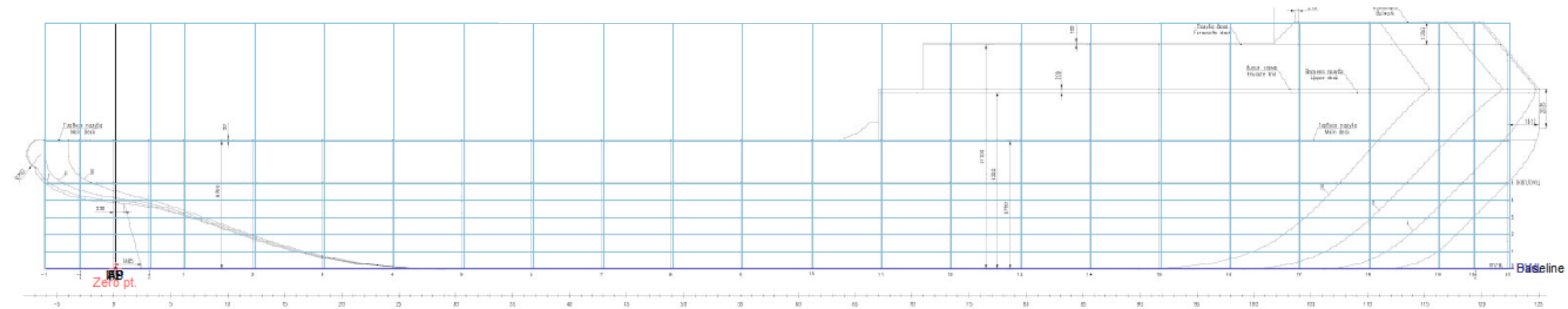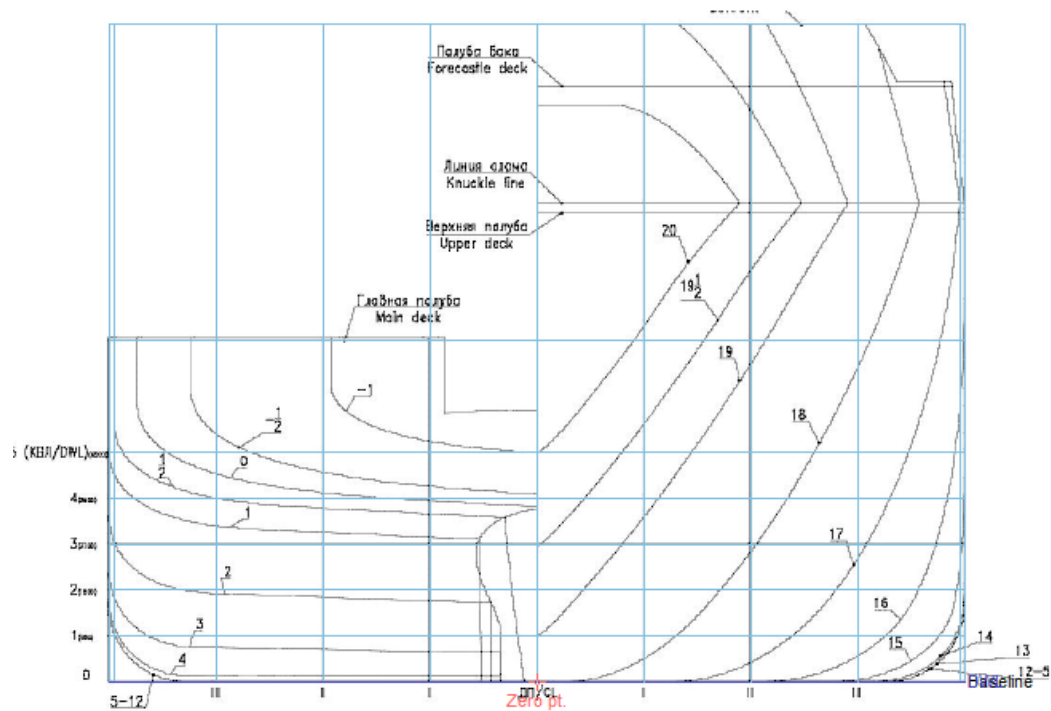- Add profile and half breadth plan images to the other windows (profile and plan)
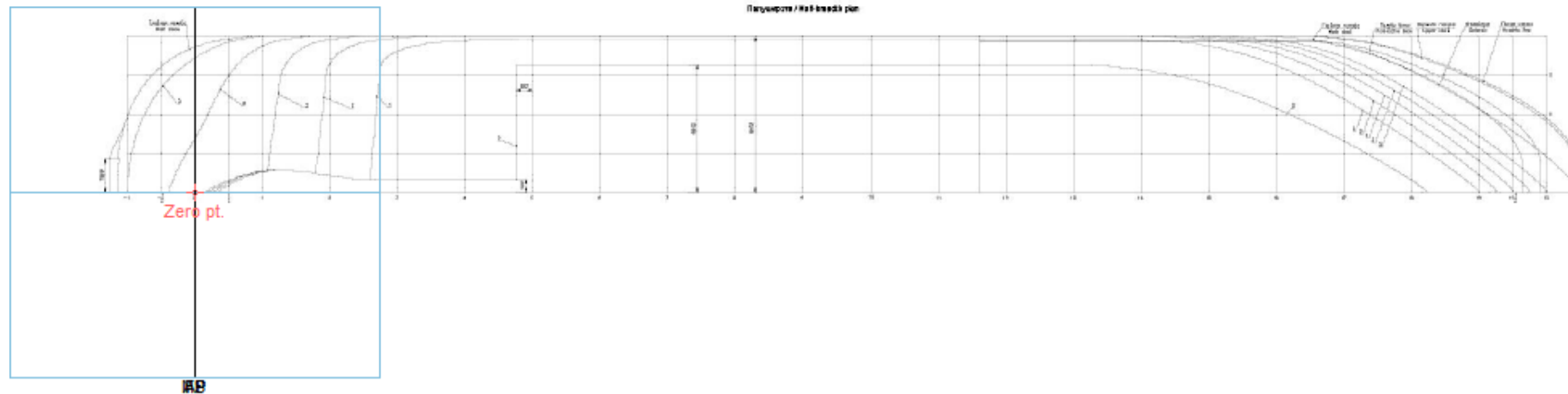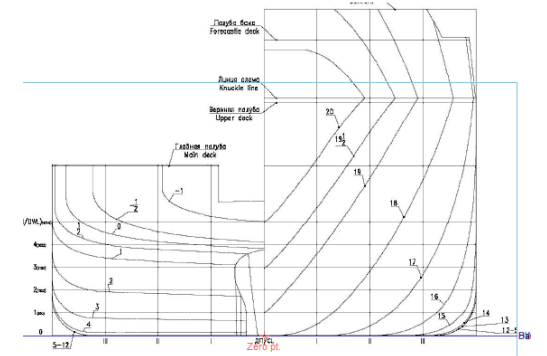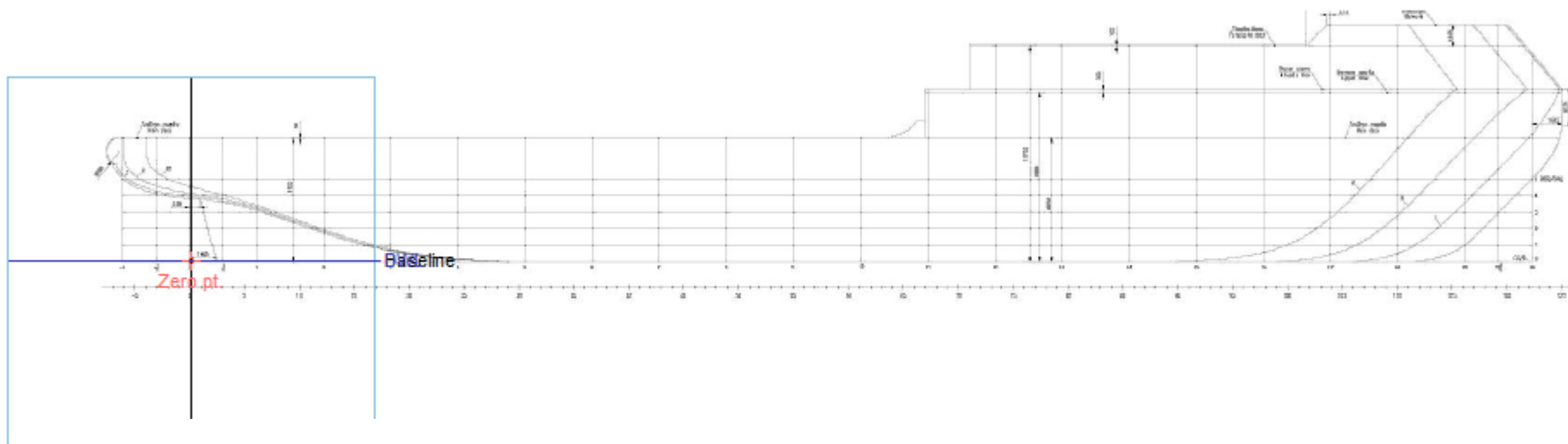
Defining Lines Plan (Grids)

The positions of the Sections, Waterlines, Buttocks, and Diagonals form what is called the Grid. To define grid

- Data ➤ Design grid... ➤ Add Section, Buttocks and waterlines and define label and positions.

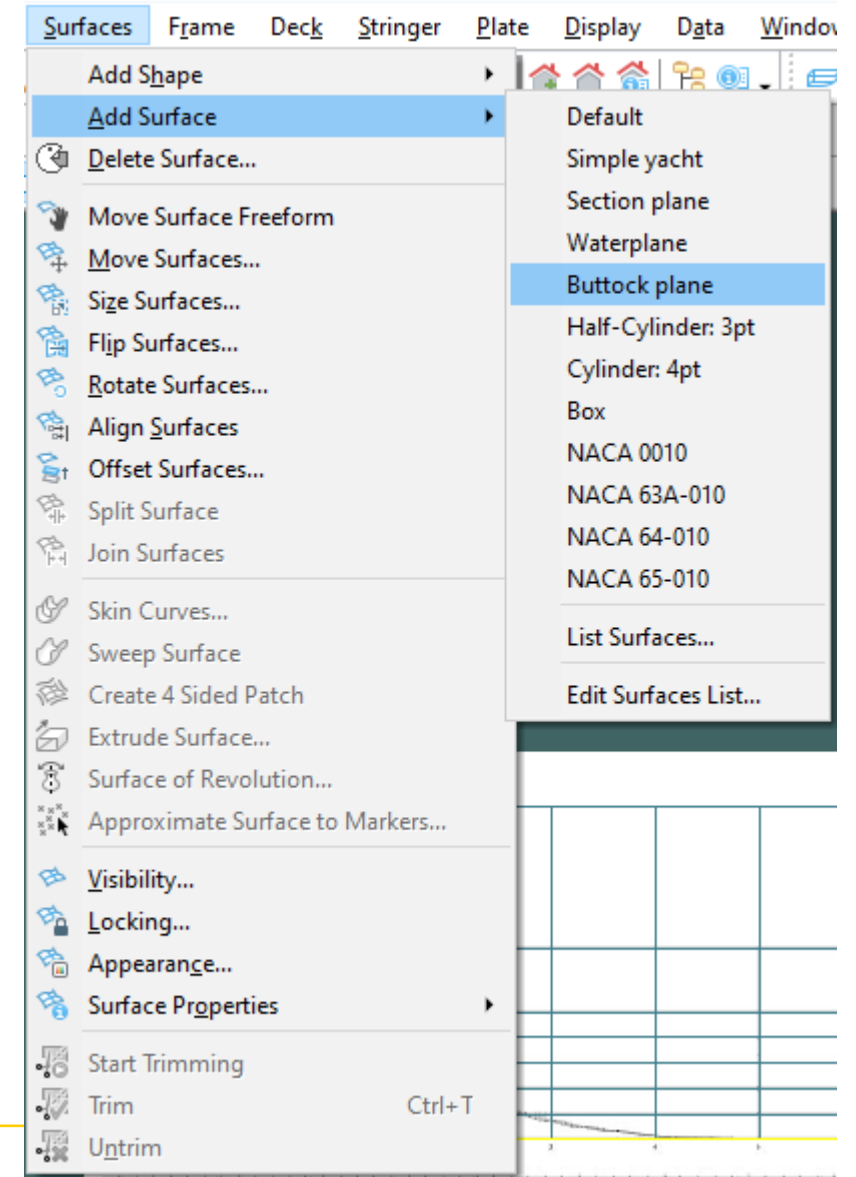# Defining Lines Plan (Grids)

Defining Lines Plan (Surface)

There are many methods to define the 3D hull form from lines plan

- **Skin surface** (By drawing curves follow lines plan and then create a lofted surface pass through the defined curves). This method can be used for simple bodies

- Align surface to projection lines plan (Better quality surface, can be used to create complex bodies).

The second method is used here to create the hull form of the ice breaker.

Create a buttock surface:

- Surface ➤ Add surface ➤ Buttock Plane

Surfaces menu showing Add Surface submenu with Buttock plane highlighted.

Aalto University

Defining Lines Plan (Surface)

- Go to profile view to amend the created buttock plane surface.

- The red control points define the surface edges.

- The new surface should appear also In the assembly tree

  ➢ Rename it "Hull"

- Change the surface size by dragging the control point (press "shift" to drag them horizontally or vertically) and let them bound the forward part to station 11
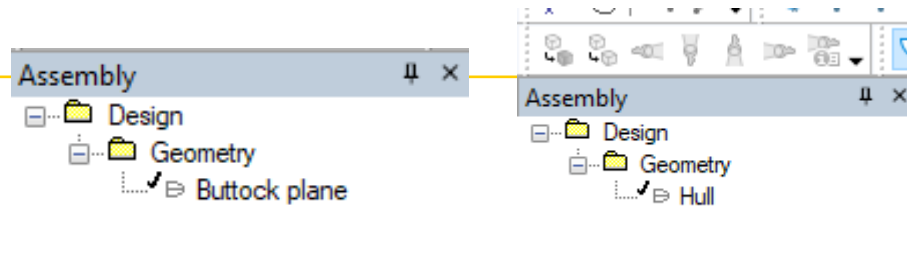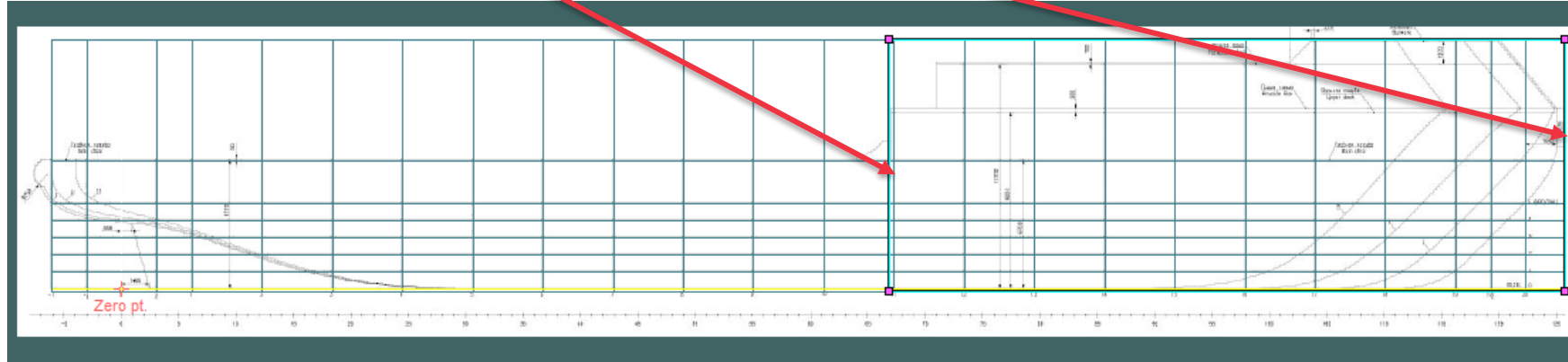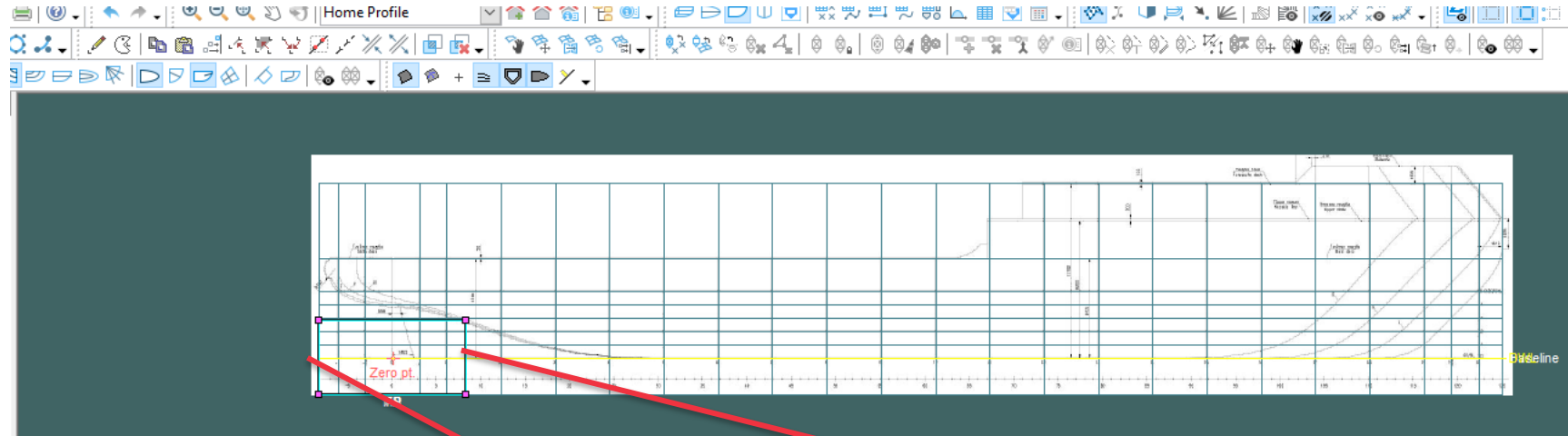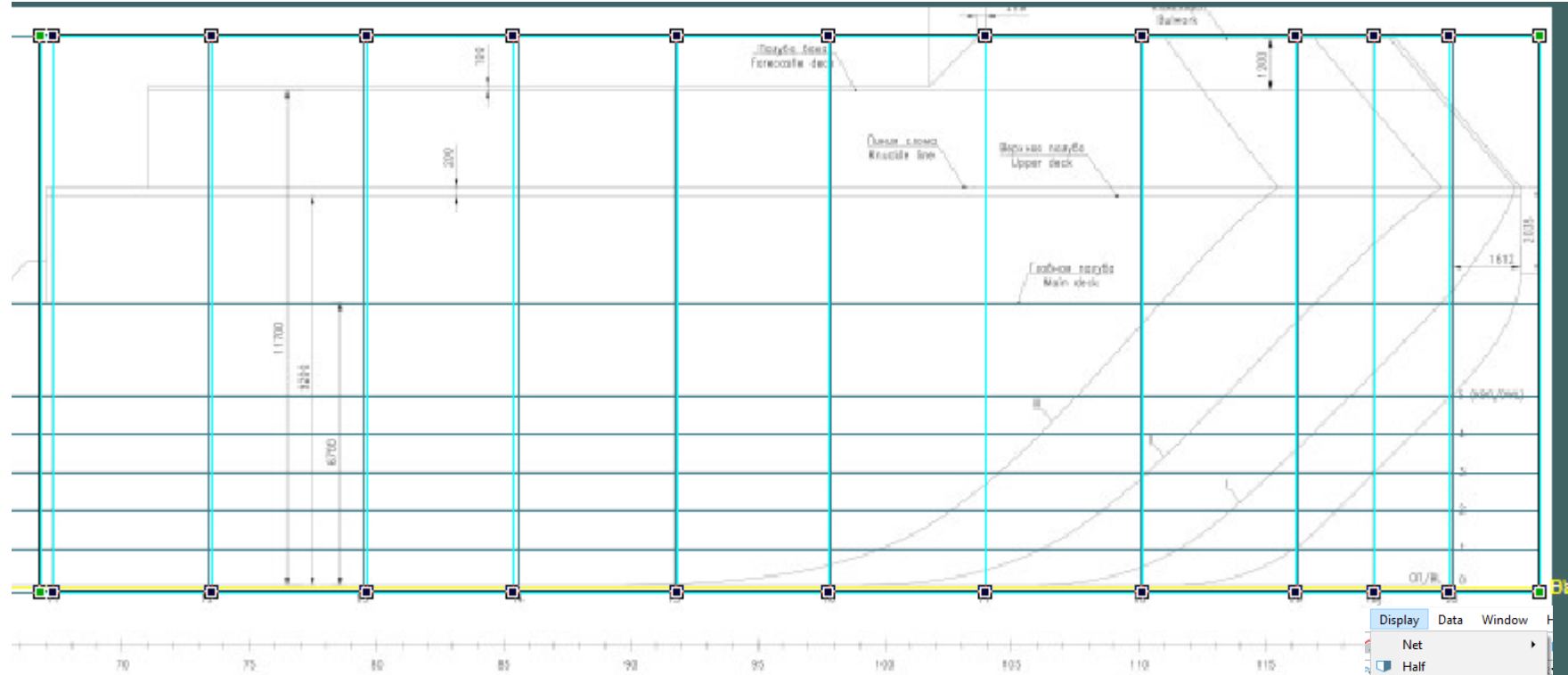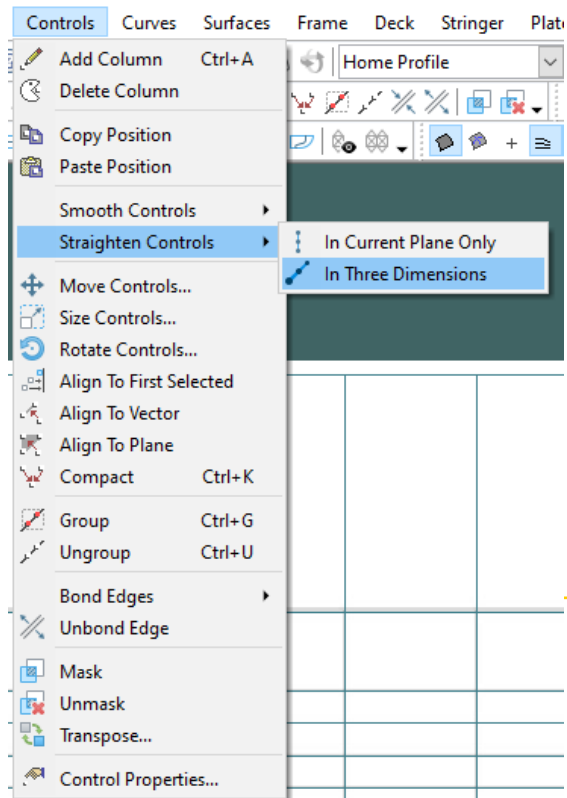
Defining Lines Plan (Surface)

- Now we need to define columns of control points to shape the buttock plane surface.

- Press (Ctrl + A) and add columns of control points at each station (press left click on the location where the column should be added).

- Near the last station (at the parallel middle body) define 2 columns of control points.

- Make sure that the "surf. Net" is active

  ✓ **Display ➤ Net ➤ Active Rows and Columns**

Surf.Net

Toggle display of the control point net for all visible and unlocked surfaces
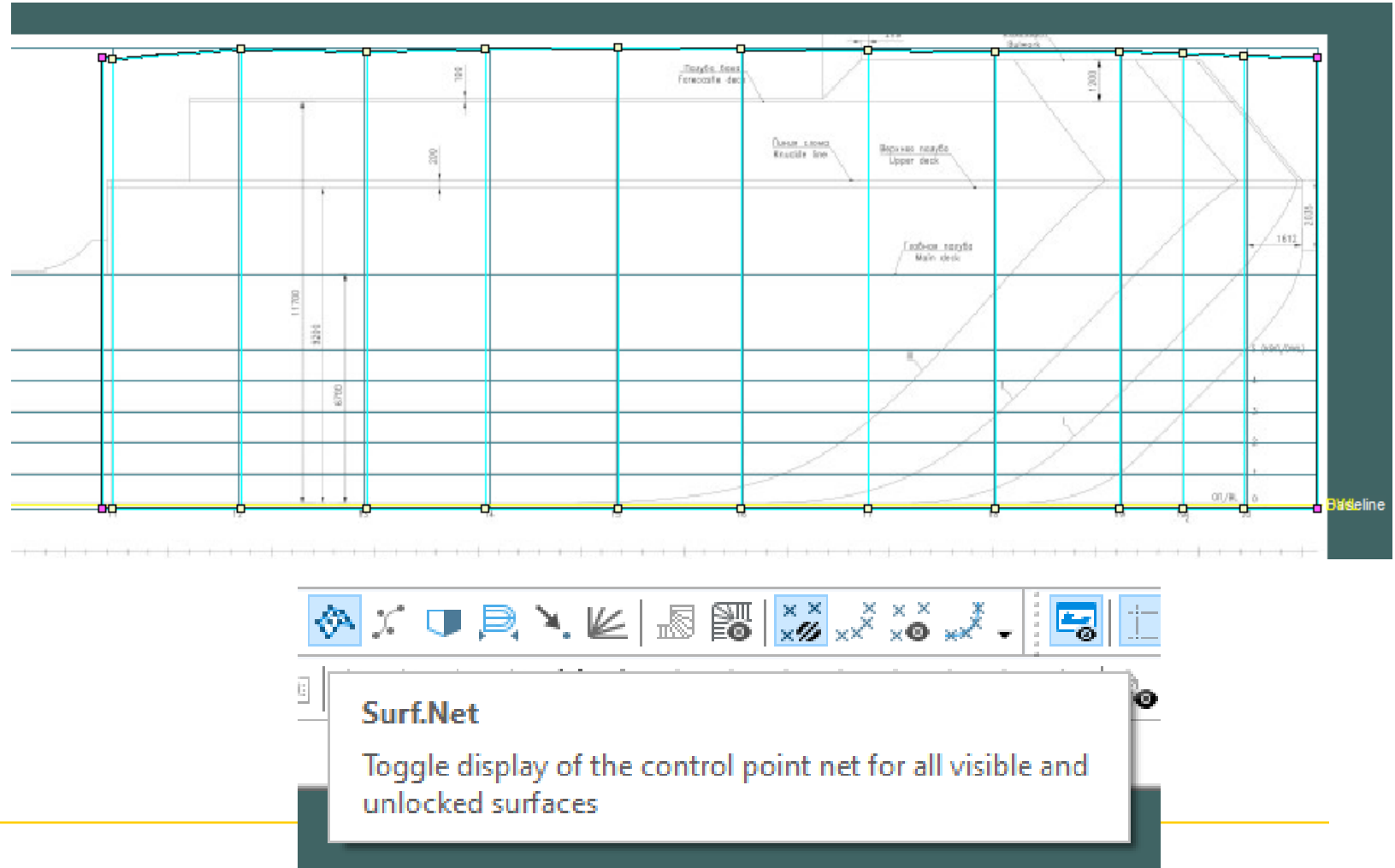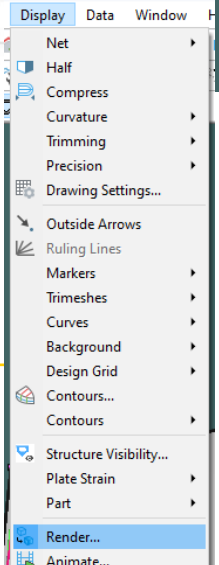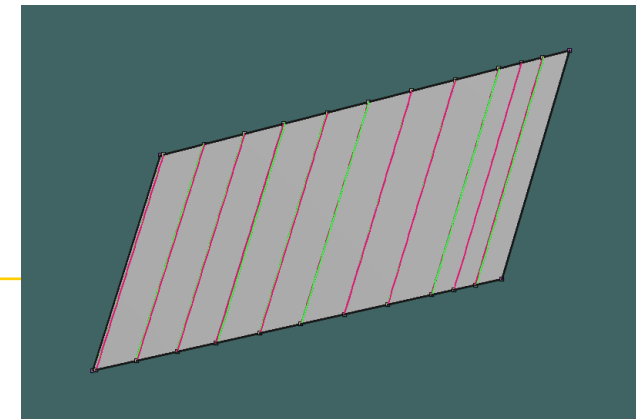
Defining Lines Plan (Surface)

- Straighten the control points (this step is important to avoid intervention in the net while adding rows in the next step)


- **Go to perspective view and active render to see the flat buttock plane surface.**
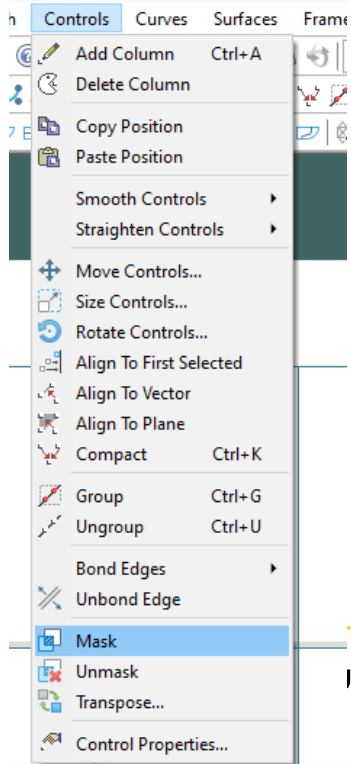
Defining Lines Plan (Surface)

- Switch to body Plan view to add rows of control points (Ctrl +A).

- In this exercise we defined 11 rows.

- You can delete rows in the body plan view by pressing "delete"

- Similarly you can delete columns in the profile view by pressing "delete".

- Return back to the Perspective view, you can see a net of Columns x Rows.

- Each of these control points can be positioned freely to change the shape of the surface.

- Double click on the surface to change its properties

  ➢ Change longitudinal stiffness to 4 and Transverse stiffness to 3 (flexible)
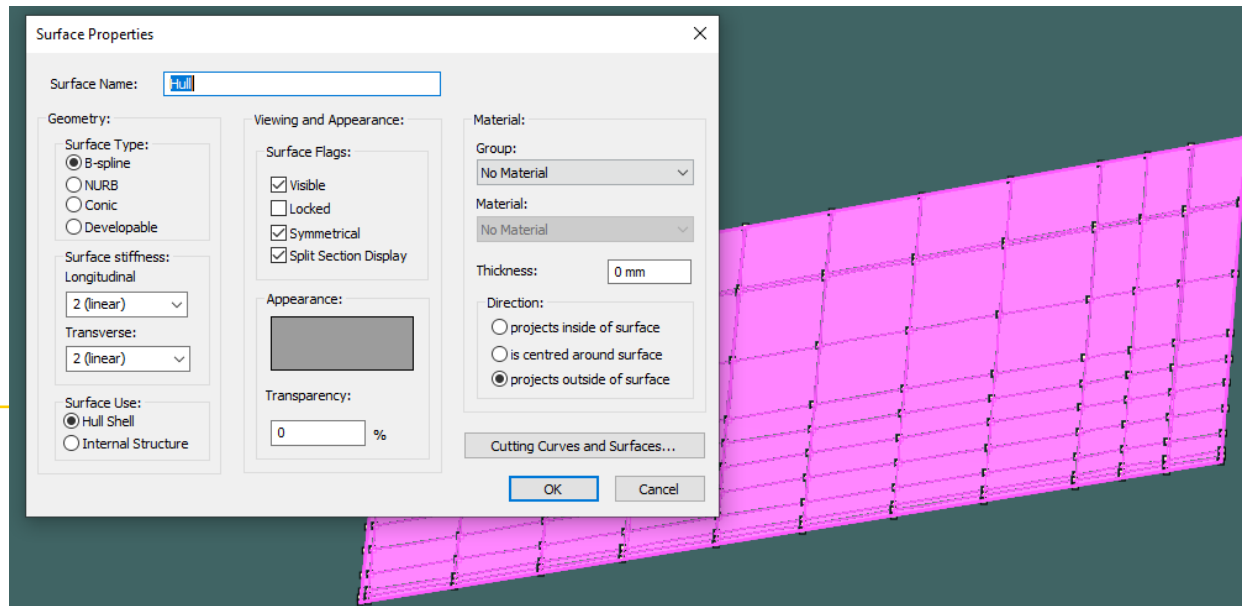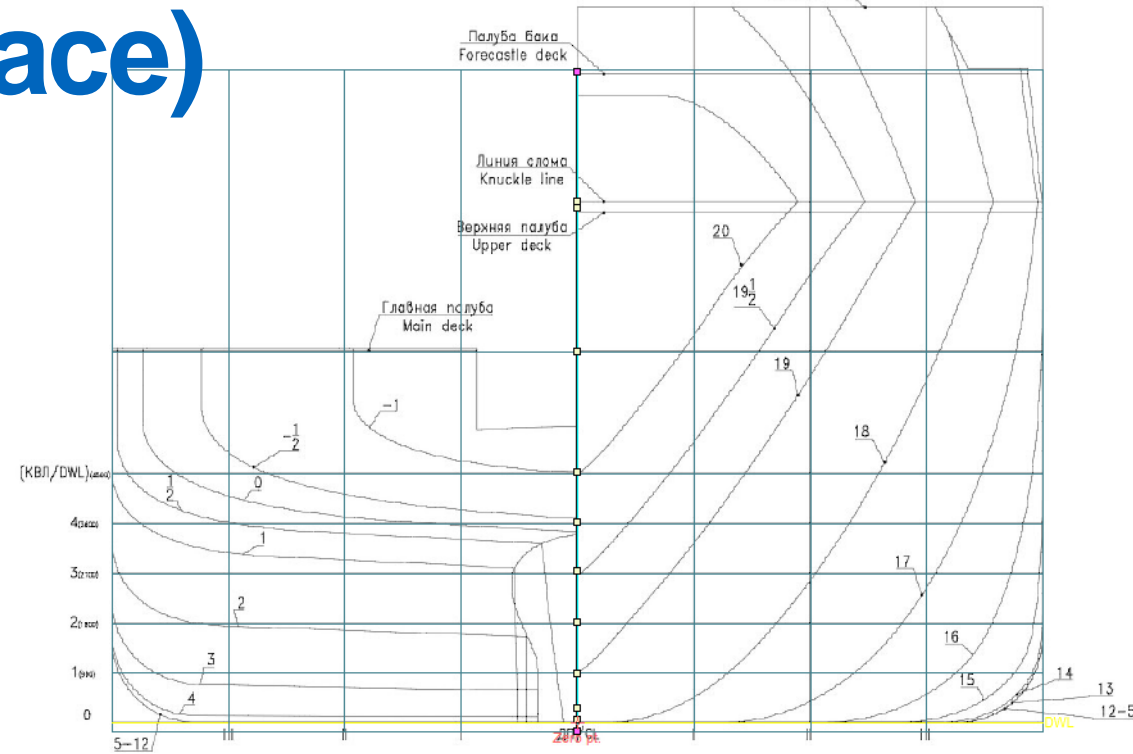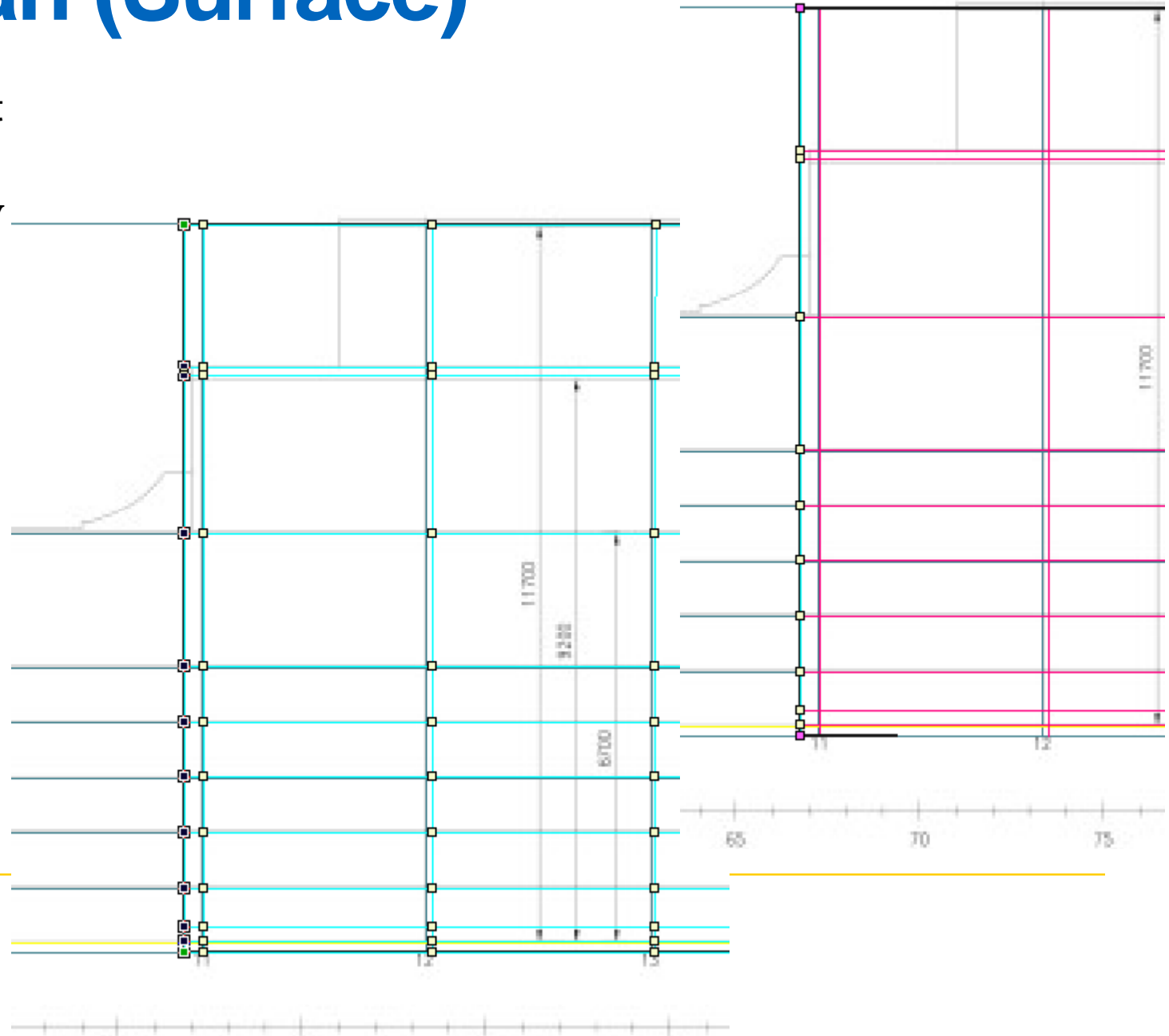
Defining Lines Plan (Surface)

- Switch to Profile view and select the first column.

 ➤ **Go to Controls ➤ Mask to show only the selected column of control point.**


University

Defining Lines Plan (Surface)

- Switch to body plan view and drag control points and align them to the corresponding station (11-12-13).

- We have here one knuckle at the Connection between side and forecastle.

- Knuckle can be defined by compacting 2 control points (transverse surface stiffness should be 3)
  - **Select two control points to be compacted and press Ctrl+ K**

- To keep the side flat (especially at the parallel middle body) you should use a number of control points with the same offset coordinate.
  - The number of these control point depends on the surface stiffness. The larger the surface stiffness the larger the number of control points required to keep it flat.

Two control points (select and press ctrl +K to compact them and create knuckle)

A? **Aalto University**
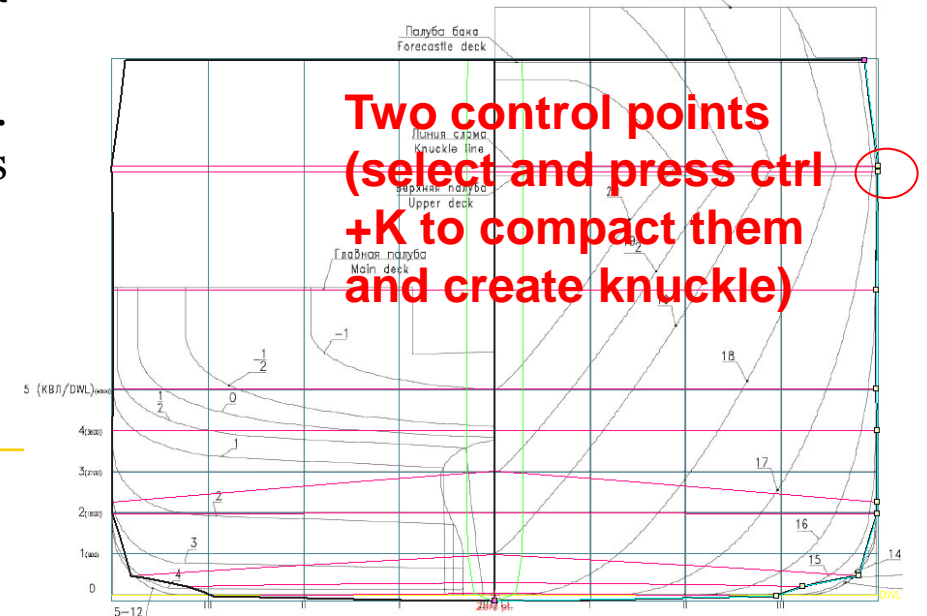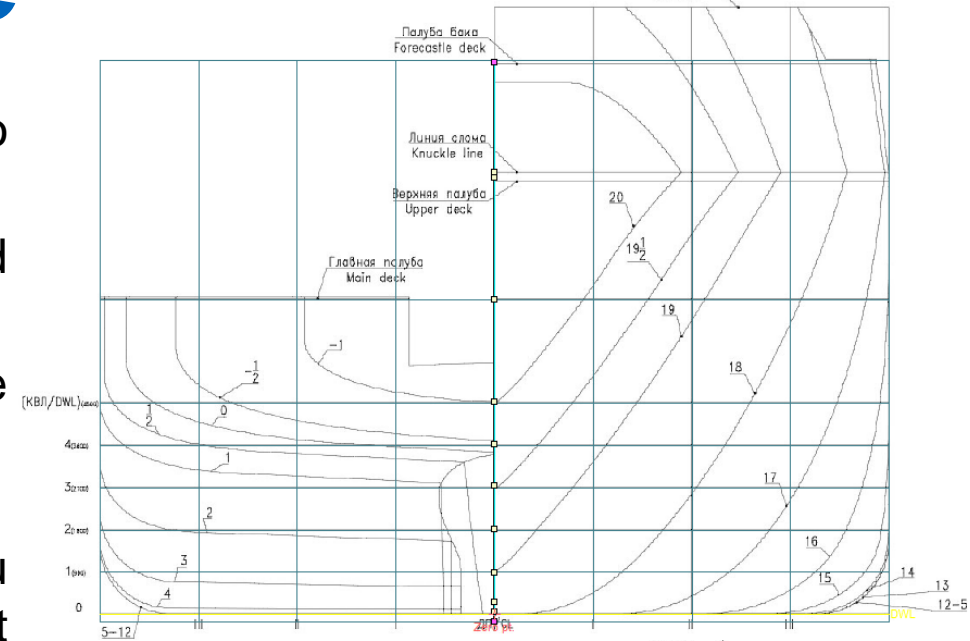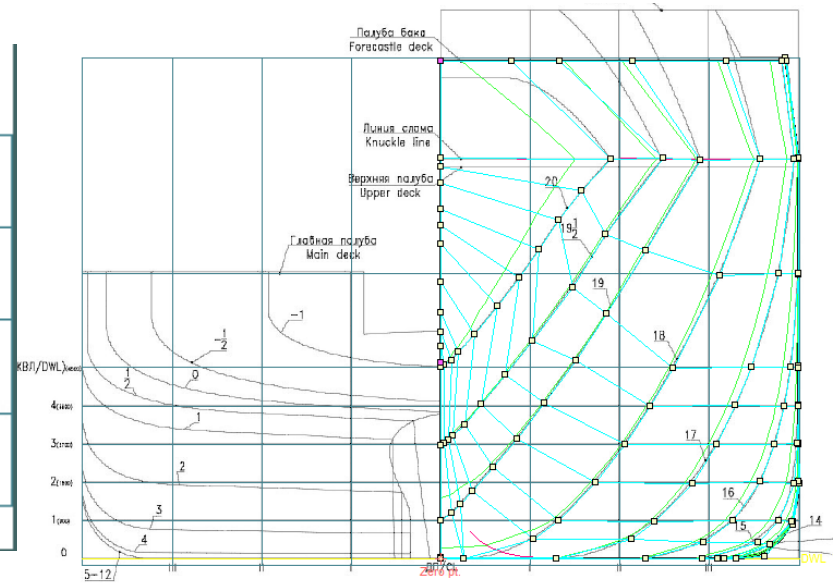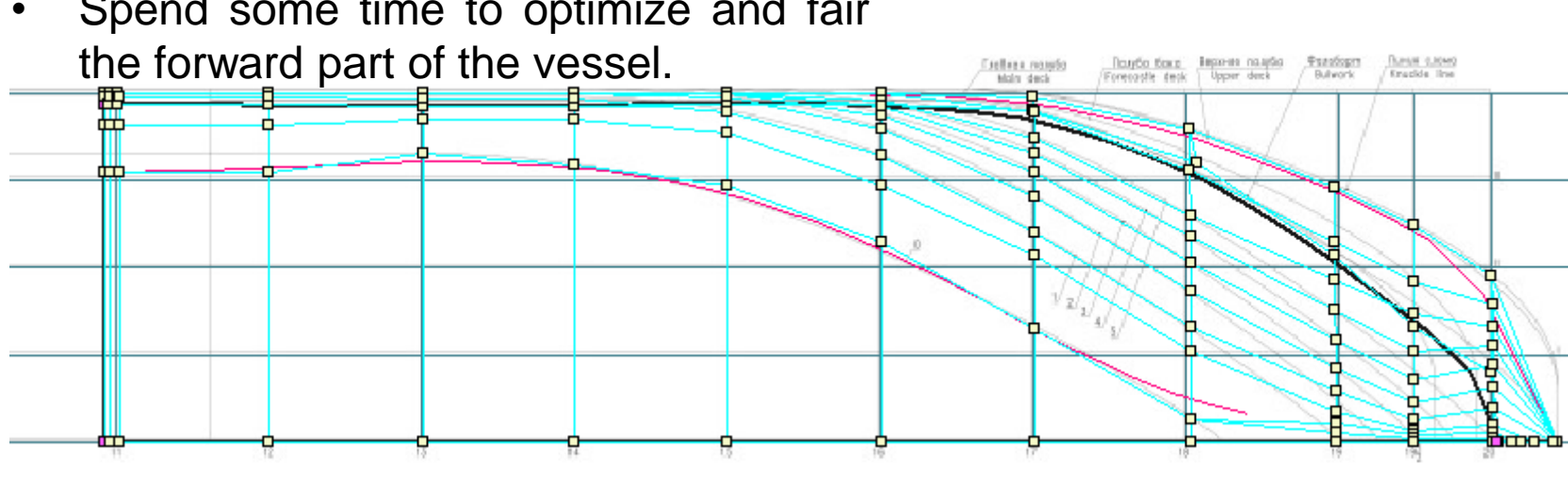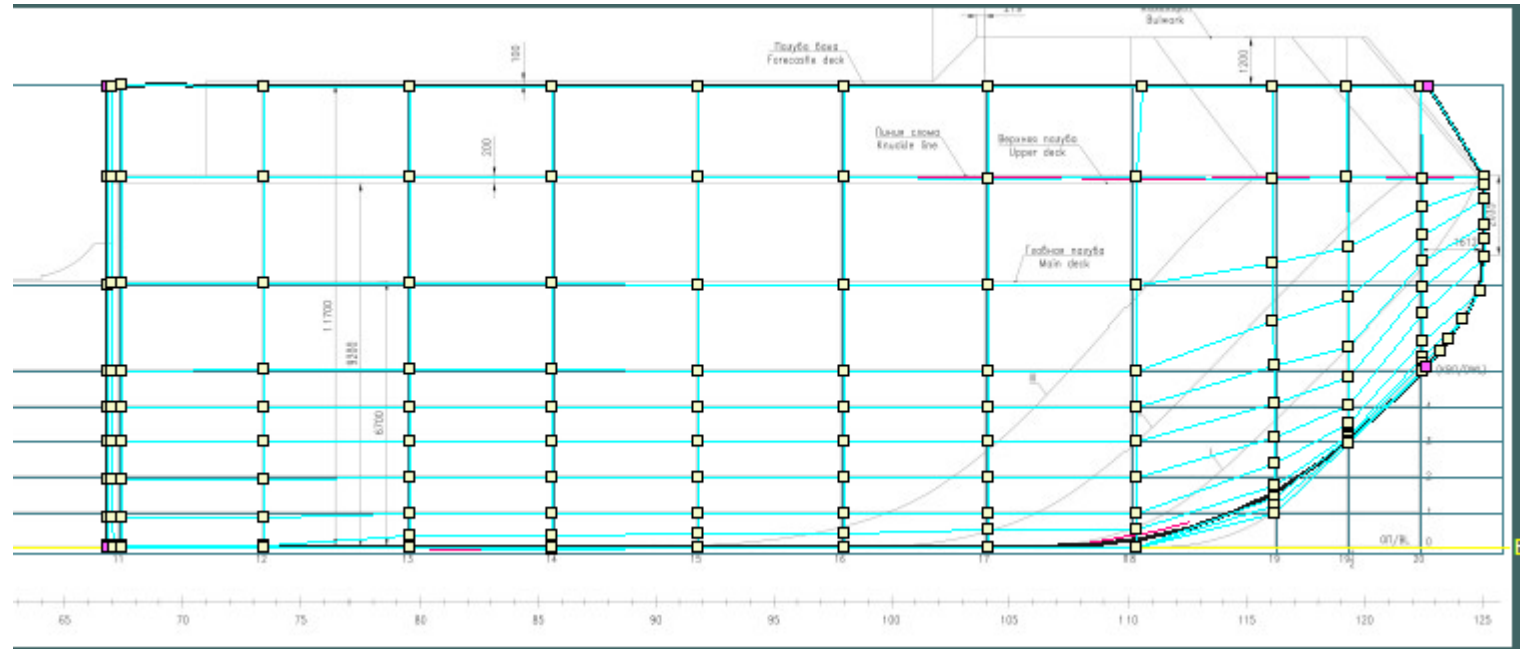
Defining Lines Plan (Surface)

- Define the Knuckle point at the connection between the forecastle and the side.
- You can change the coordinate of the control points from properties window
- Change the offset of all control points on the side to equal half Breadth (and similarly the points on the keel to equal the keel height from zero point
- (in this station height = 0 and side offset = 8.4 m)
- Go to controls and press Unmask to view all the control points.
- Repeat the same procedures with the other stations
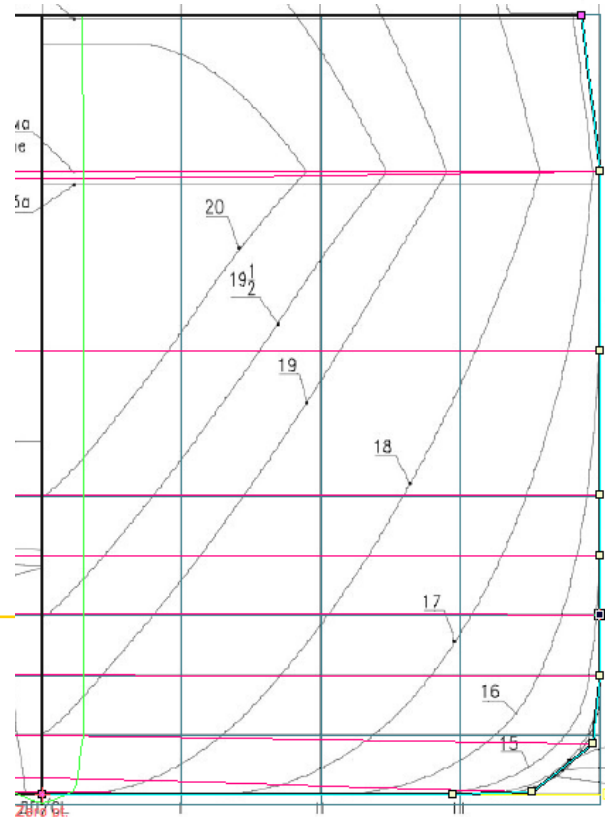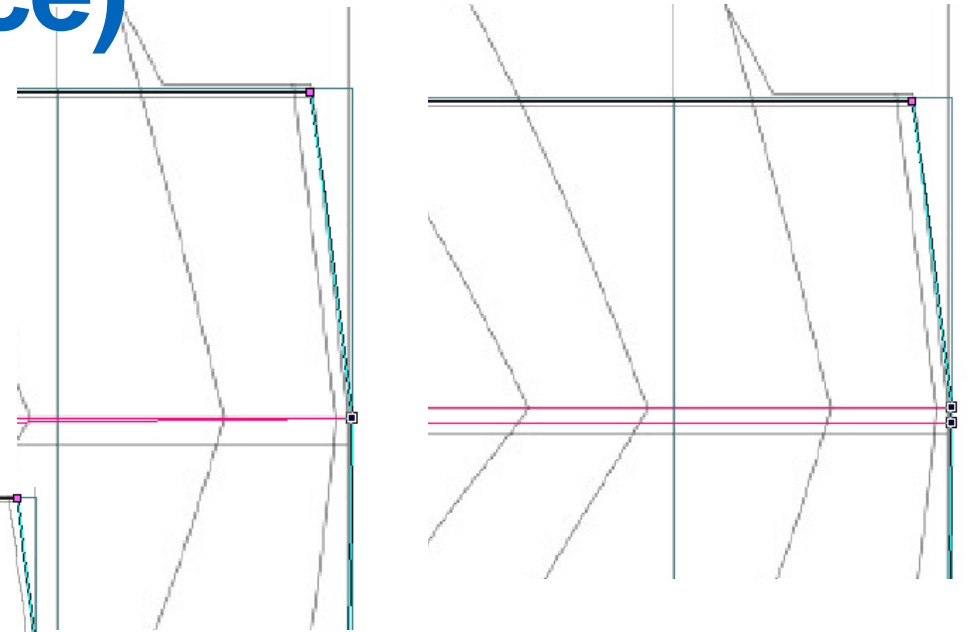
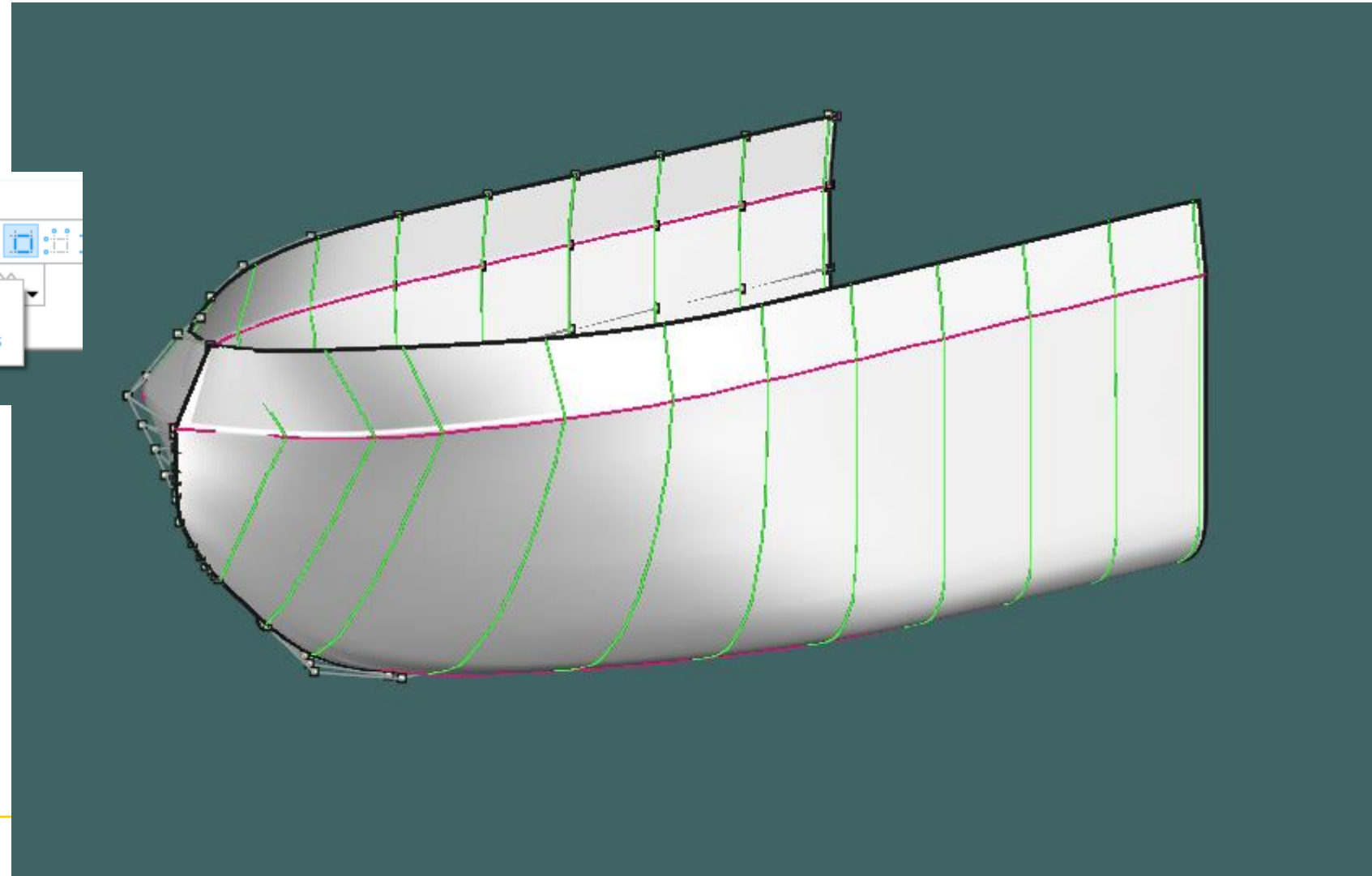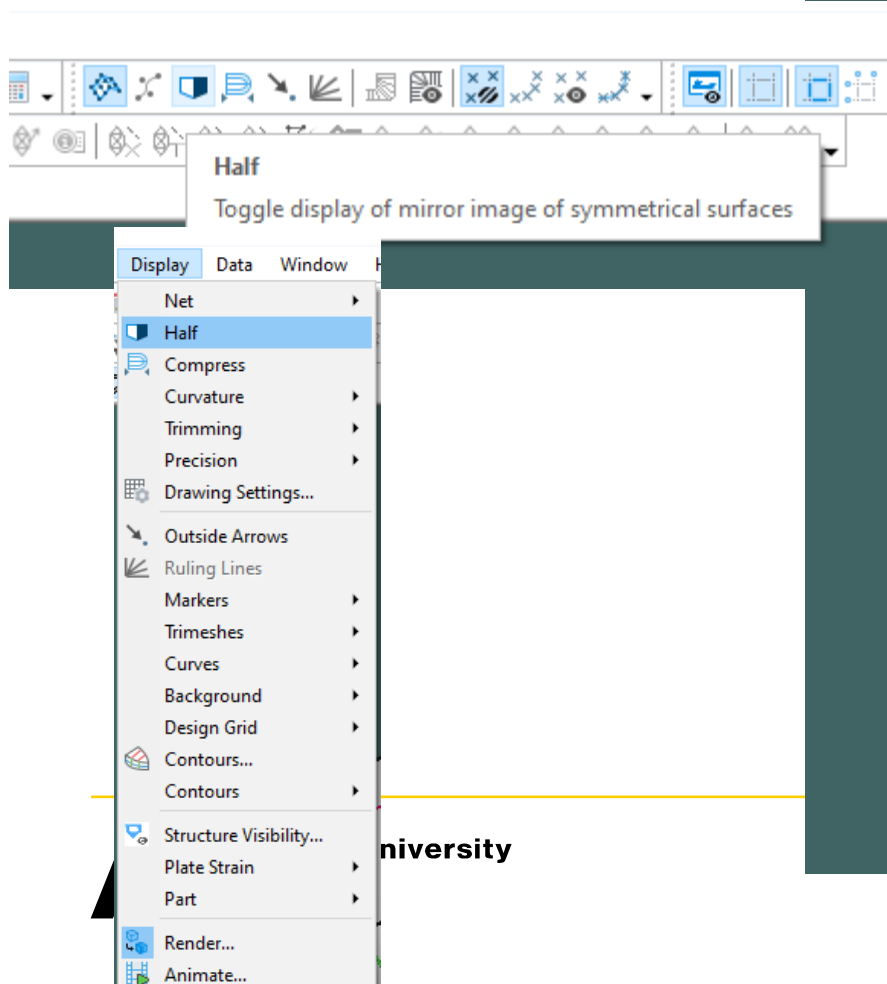| Control Points	
Surface	Hull: Multiple con
Row	
Column	0
Long. Pos. m	40.083
Offset m	8.414
Height m	9.398
Weighting	1

Defining Lines Plan (Surface)

- The last station (edge column) should define the stem (offset should equal zero).

- The Last station can be defined from the profile view.

- The first 2 columns near the parallel middle body should have same offsets as they will define the parallel middle body.

- Recheck the 3 views and make sure that the net looks tidy.

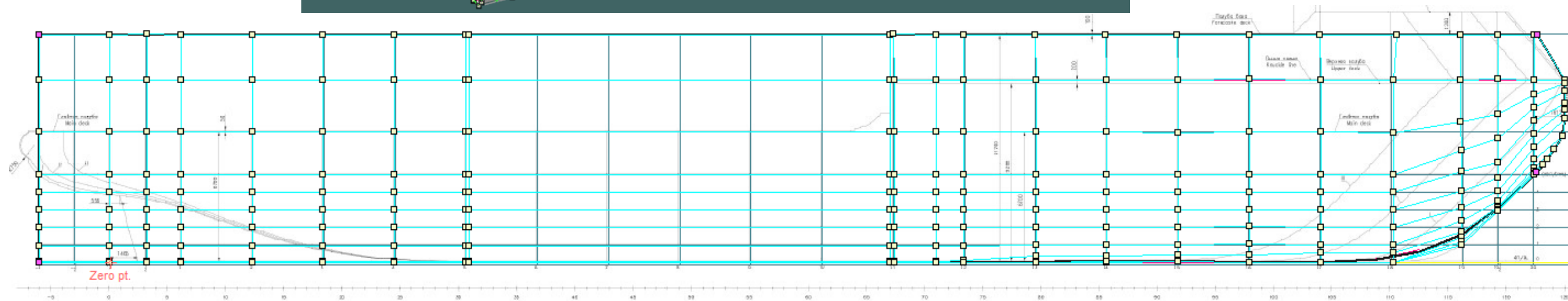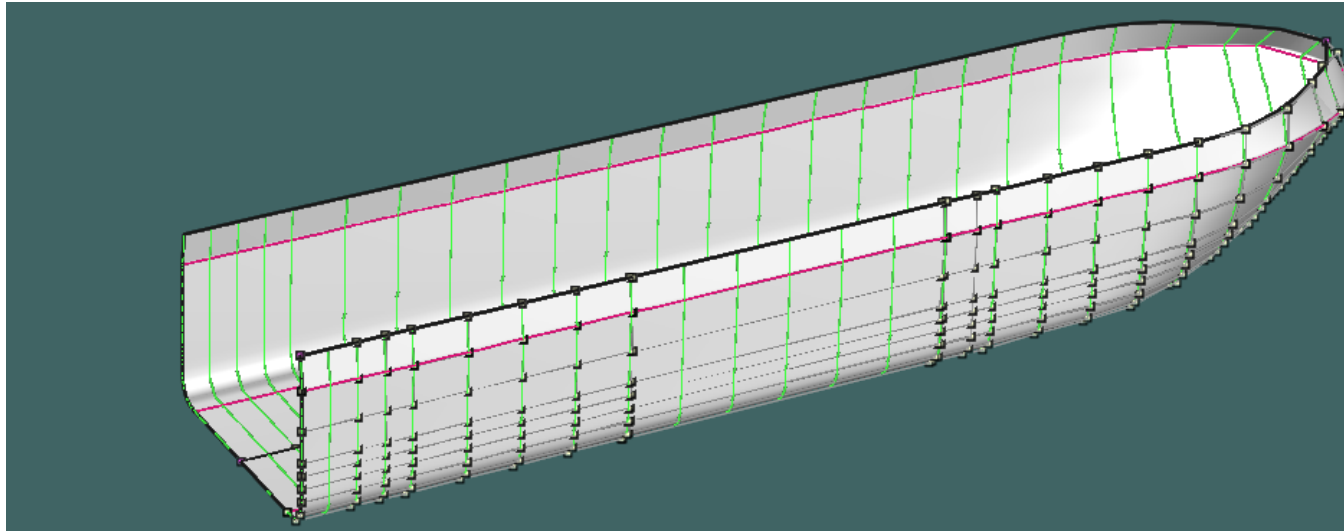- Spend some time to optimize and fair the forward part of the vessel.

Defining Lines Plan (Surface)

- Active the Half Icon to show both sides
 - ➢ **Display** ➤ **Half**

Defining Lines Plan (Surface)

- **Add columns of control points and move them to the corresponding aft and parallel middle body stations.**
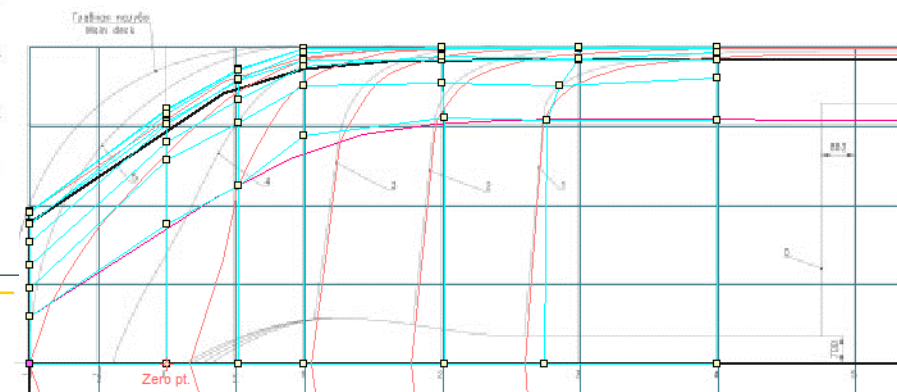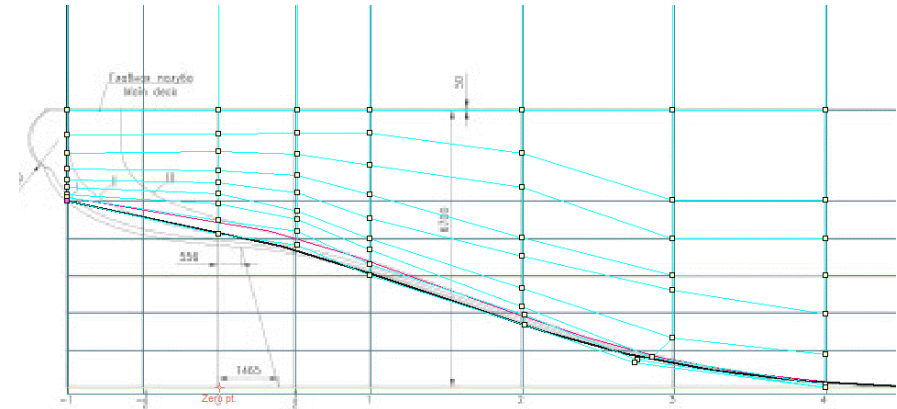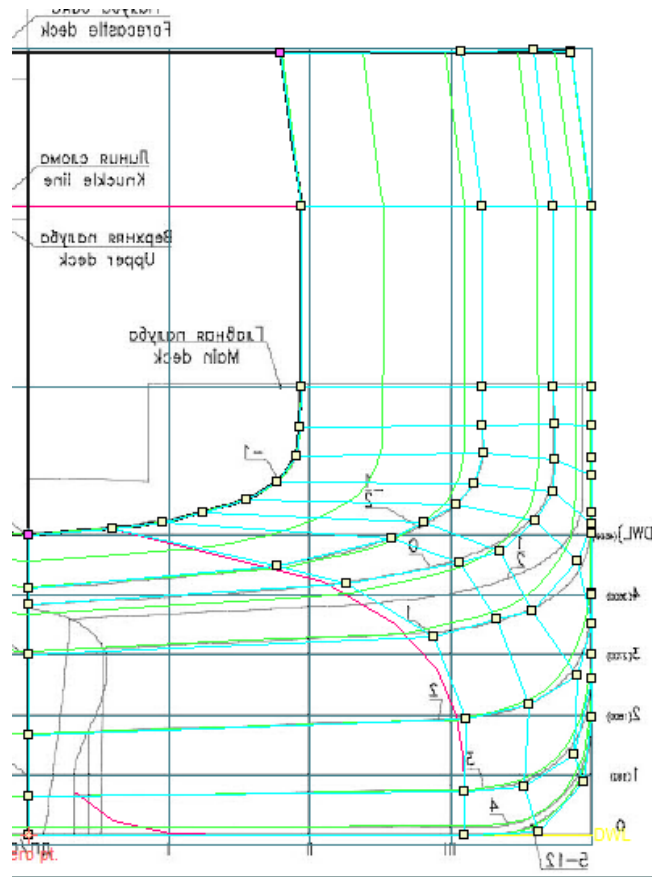
Defining Lines Plan (Surface)

- Switch to Body plan and change the background with Body plan view with aft on the right of the image.

- Then repeat the same procedures as in the Bow to define the aft part and parallel middle body.

- The Skeg can be ignored in this stage and modelled separately.
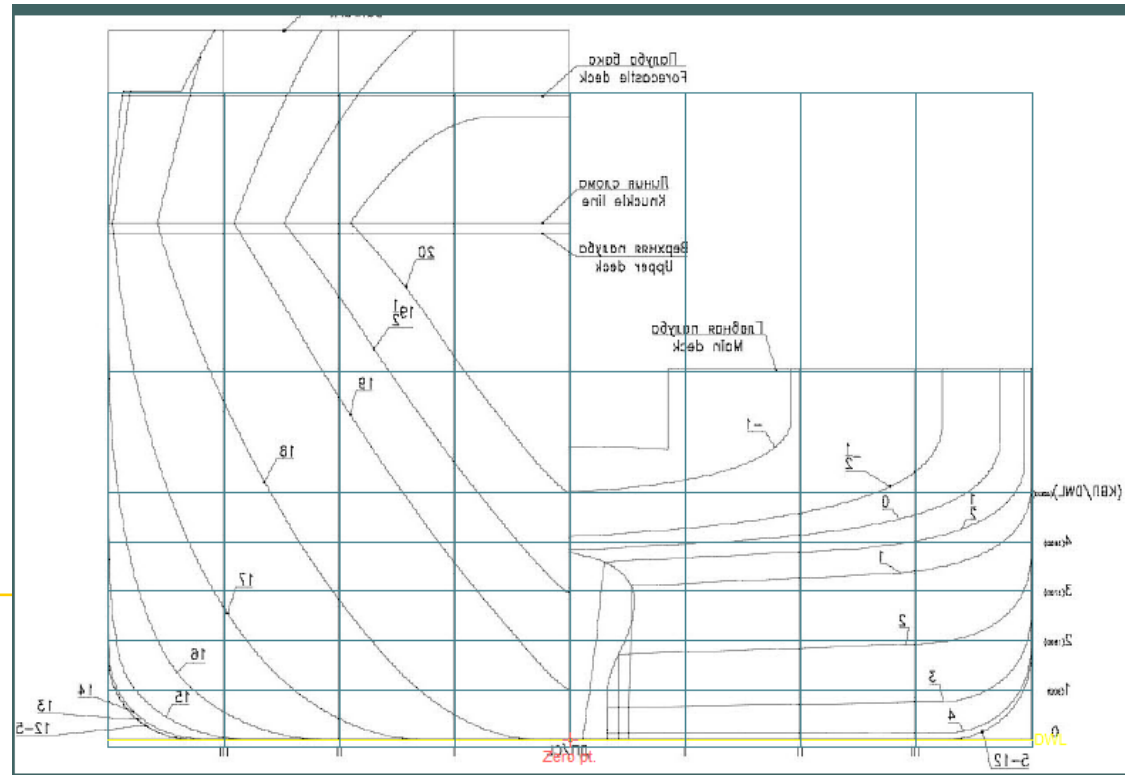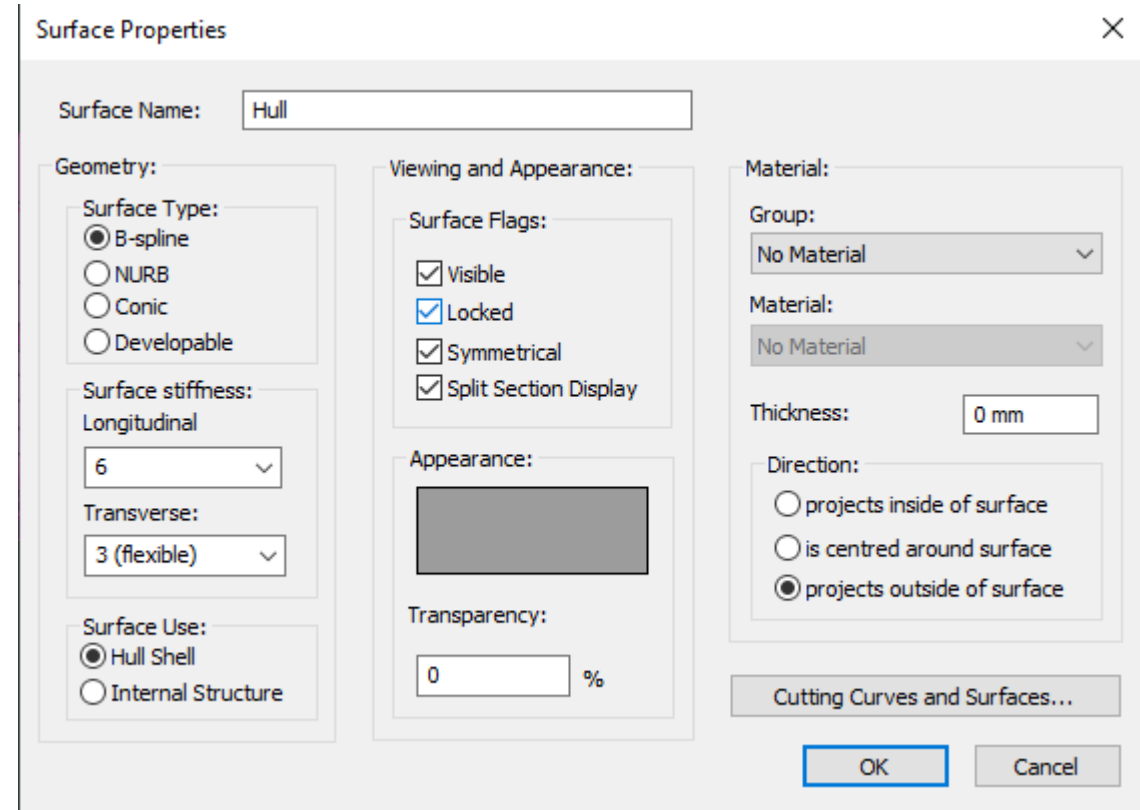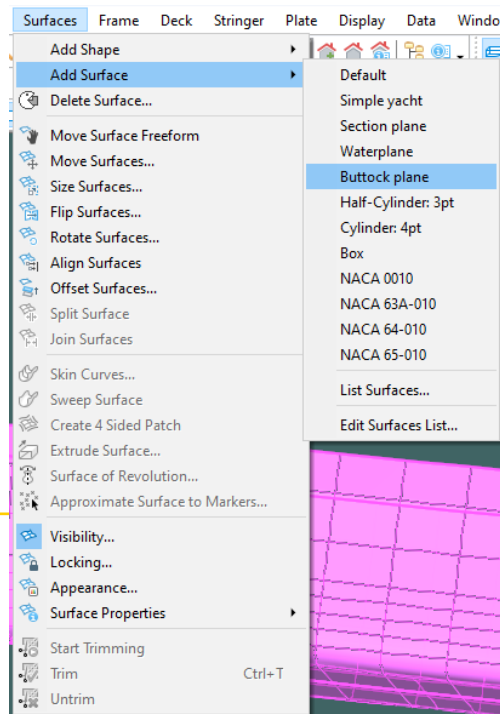
Defining Lines Plan (Surface)

- Make sure that the surface is improving while aligning control points to stations by Navigating between the Three projection views and perspective view.

- Spend more time to fair the surface by aligning the stations, wateriness and buttocks of the hull model to the corresponding ones in the images.
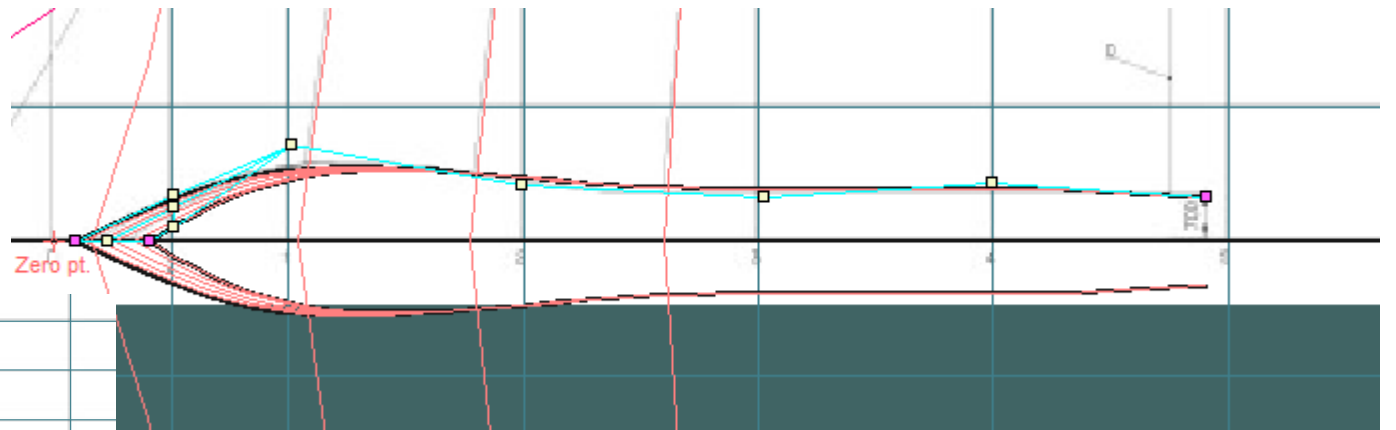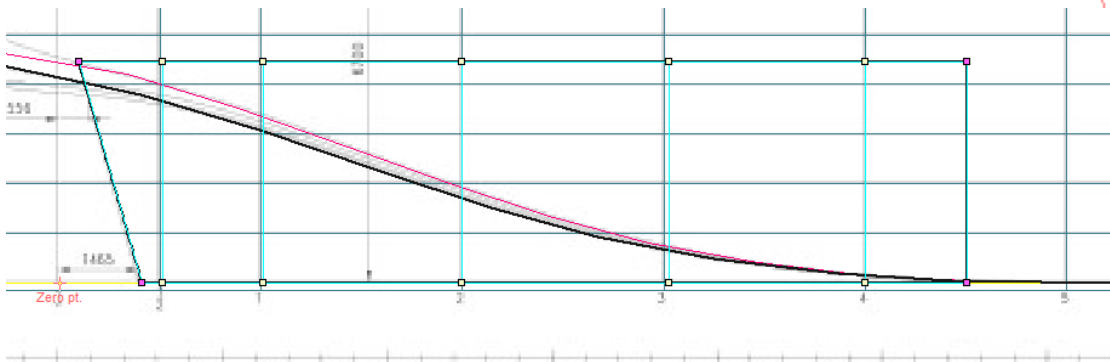
Defining Lines Plan (Surface)

- After fairing the Hull model, you can lock it by double click on it and then check locked.

- Define the skeg
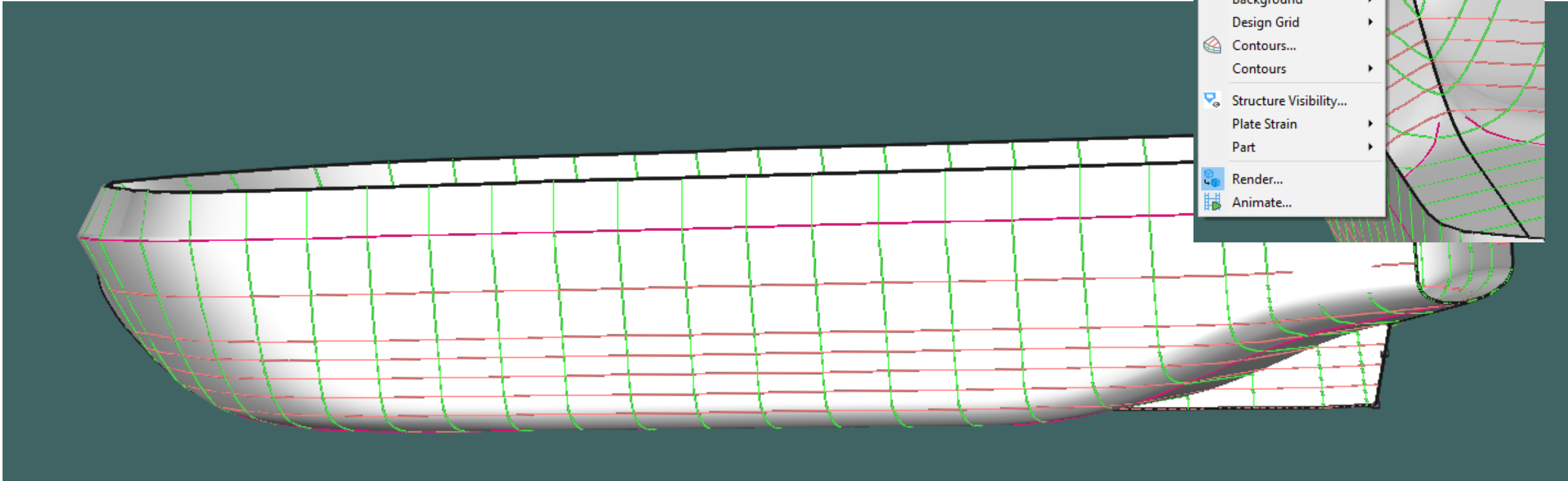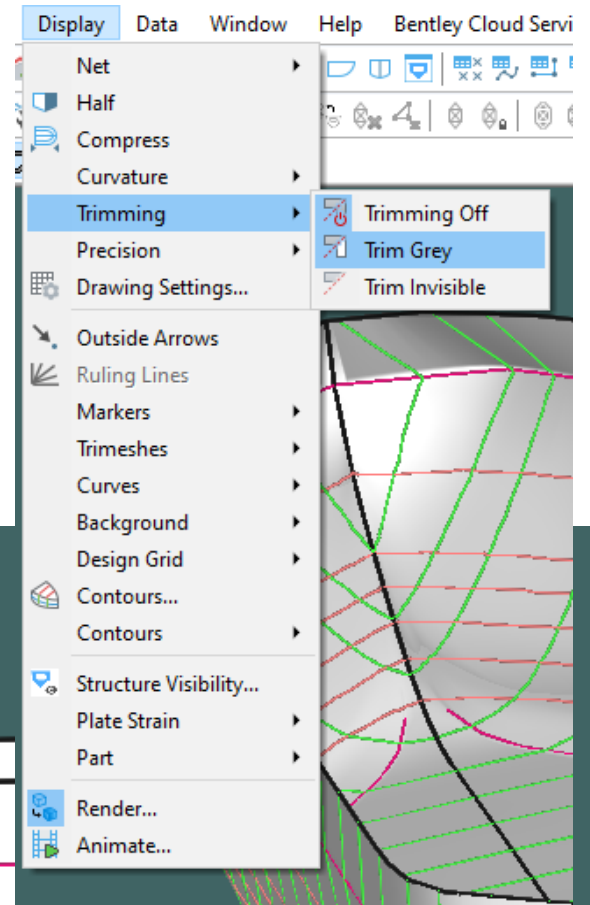 - ➢ **Go to surface ➤ Add surface ➤ Buttock plane**

Defining Lines Plan (Surface)

- Add enough columns and rows to define the skeg surface.

- Repeat the same procedures to align the control points to the corresponding projection in the images.

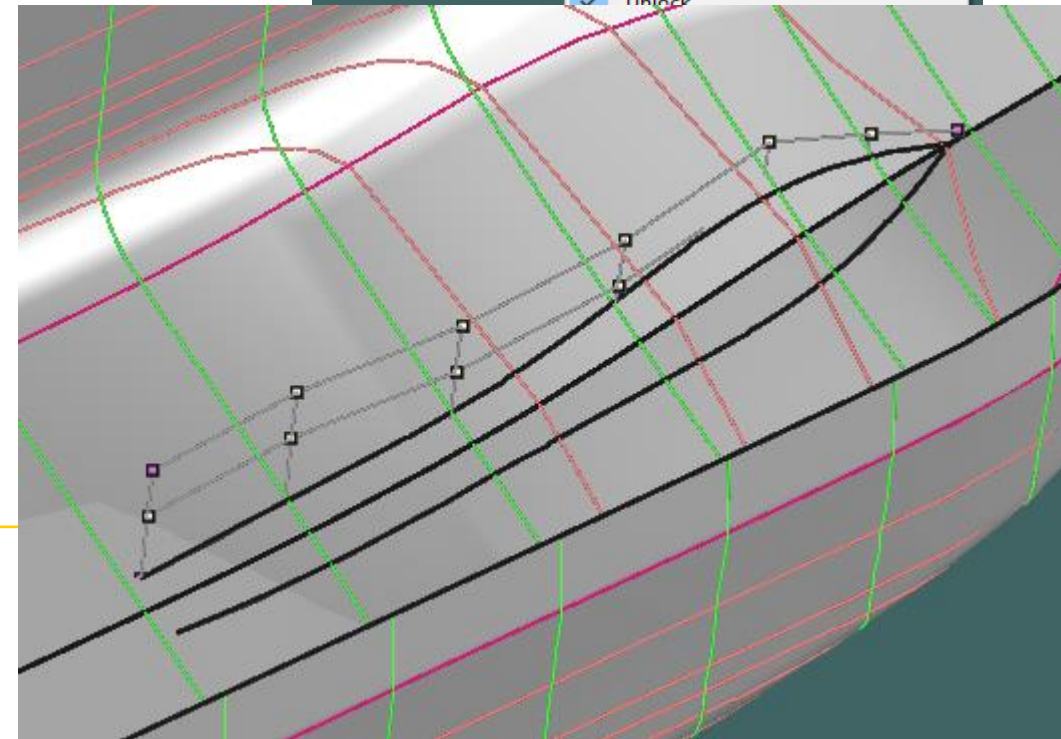- Make sure to change the stiffness of the surface to suitable value.

Defining Lines Plan (Surface)

- **Trim surfaces**
  - Go to Display ➤ trimming ➤ trim grey

Defining Lines Plan (Surface)

- **Trim surfaces**
  - Go to Surface ➤ start trimming ➤ select the surface you want to trim ➤ then select the part of the surface to be trimmed ➤ then press Ctrl + T
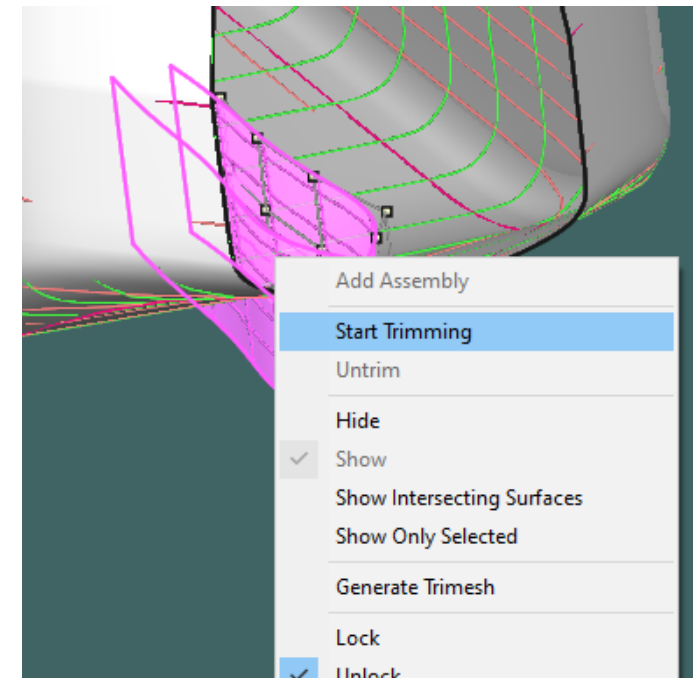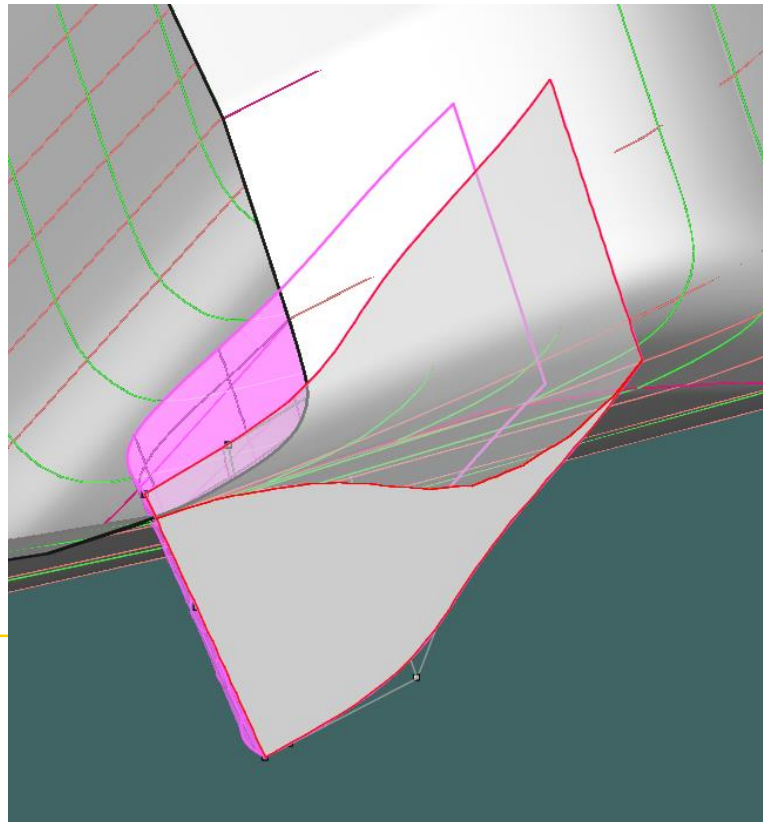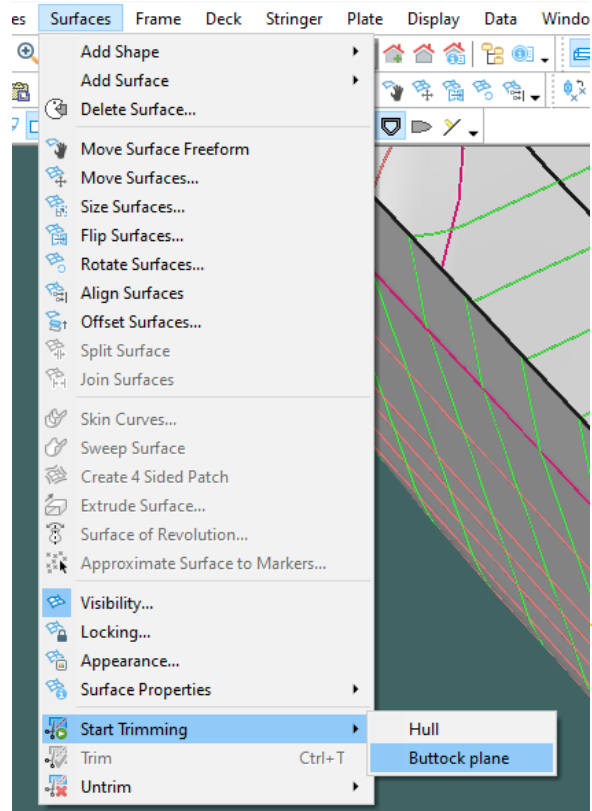
Defining Lines Plan (Surface)

- **Similarly for decks**

  - Go to Surface ➤ add surface ➤ waterline plane ➤ amend it to have the shape of the decks ➤ start trimming ➤ select the surface you want to trim ➤ then select the part of the surface to be trimmed ➤ then press Ctrl + T
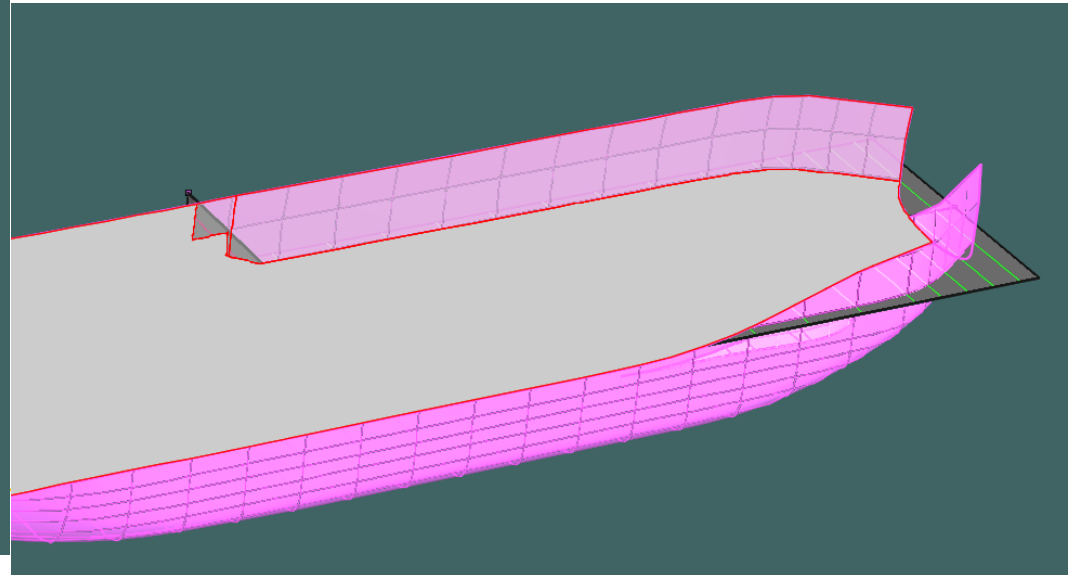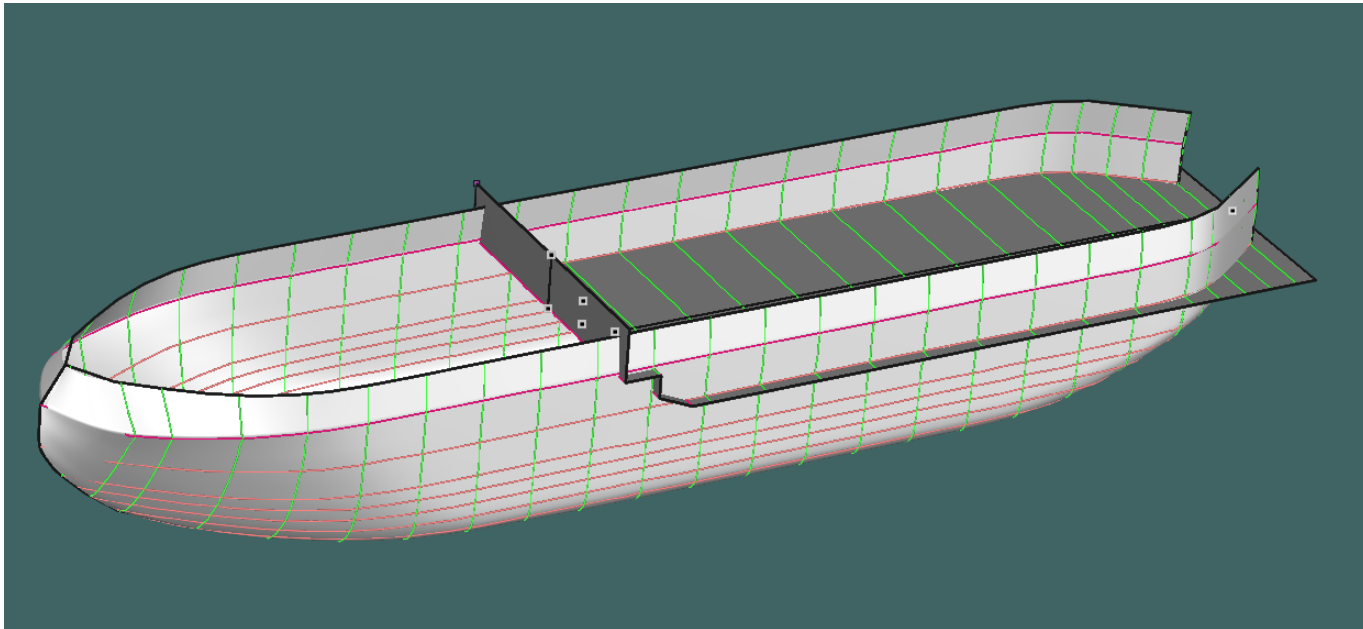
Defining Lines Plan (Lines plan)

- **To show labels and grid lines**
  - Display ➤ Design grid ➤ design grid labels
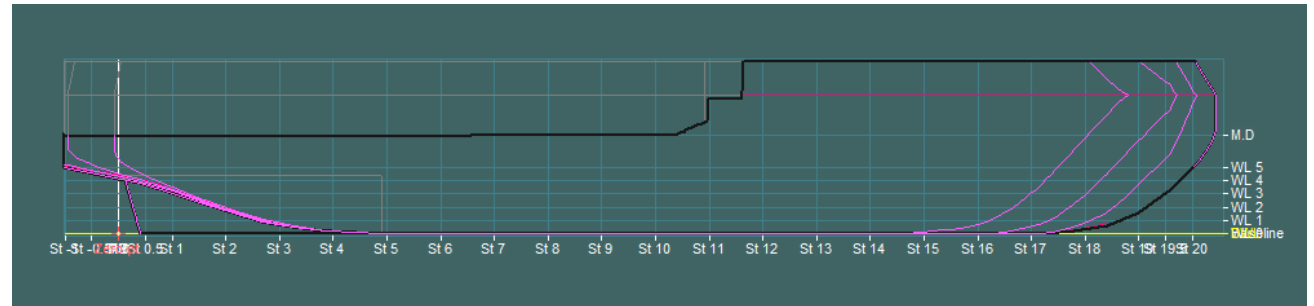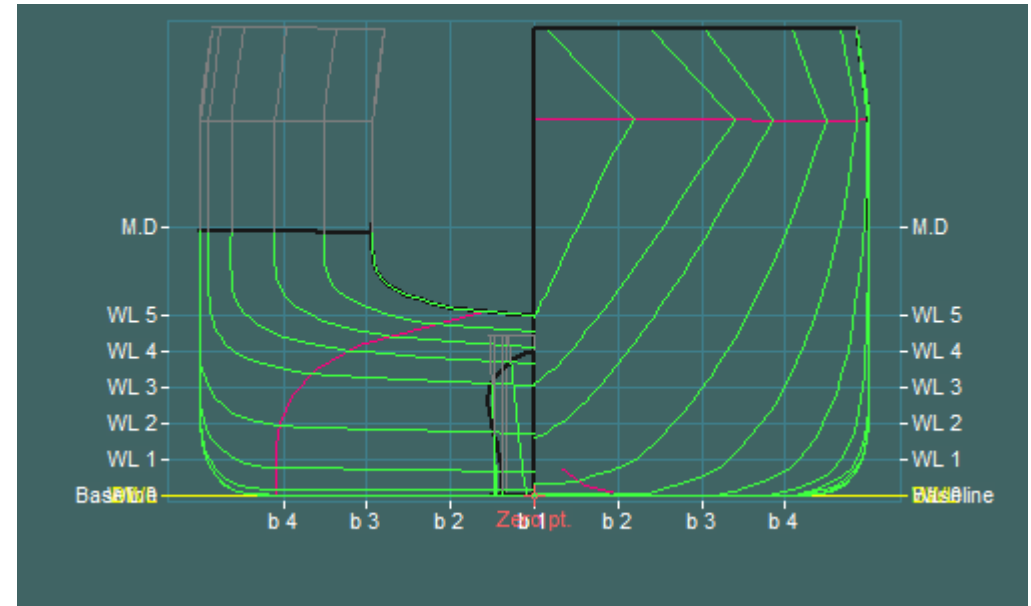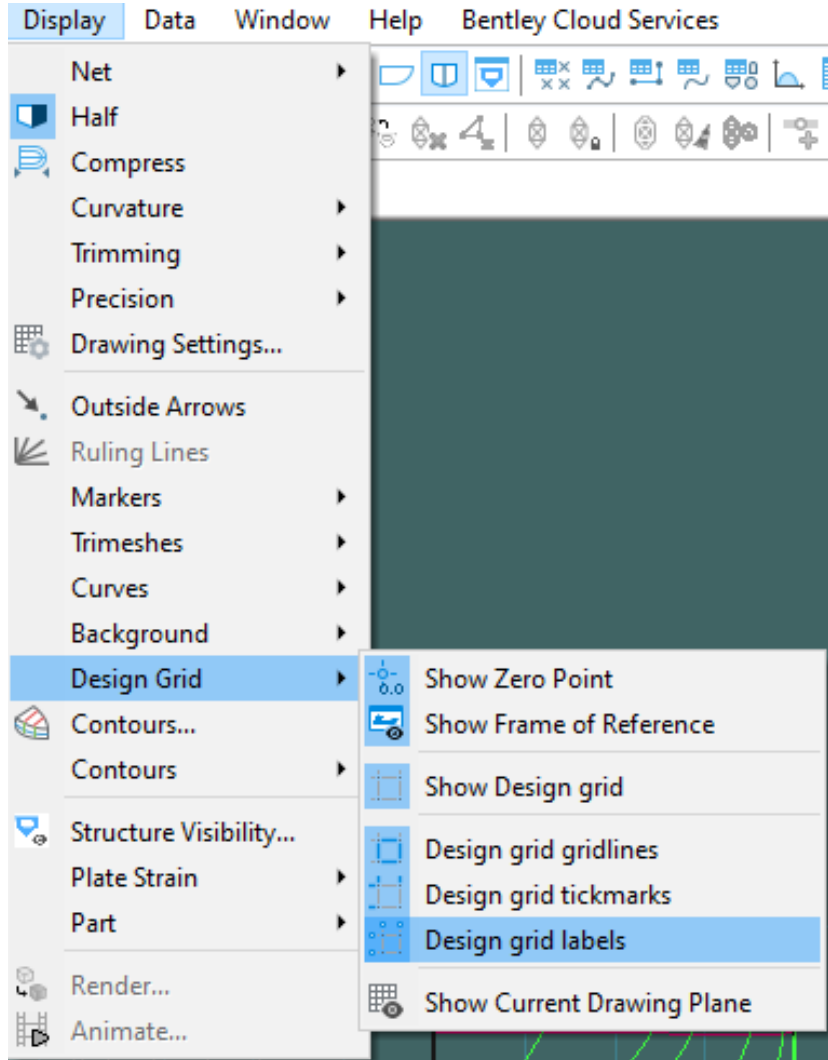
Defining Lines Plan (Lines plan)

- **To define the Aft and forward perpendicular in addition to longitudinal and transverse datum**

  - Go to **Data ➤ Frame of Reference**

  1. **Define design water line (DWL)**
  2. **Press find base**
  3. **Press (Set to DWL for Aft and Fwd perpendiculars)**
  4. **Set vertical Datum to Baseline**
  5. **Set Longitudinal Datum to Aft Perp.**
  6. **Press Ok**

Aalto University
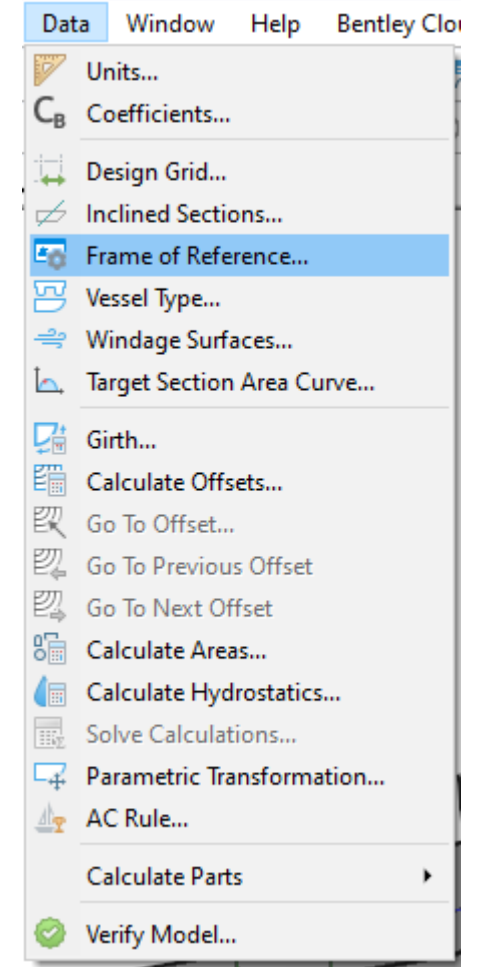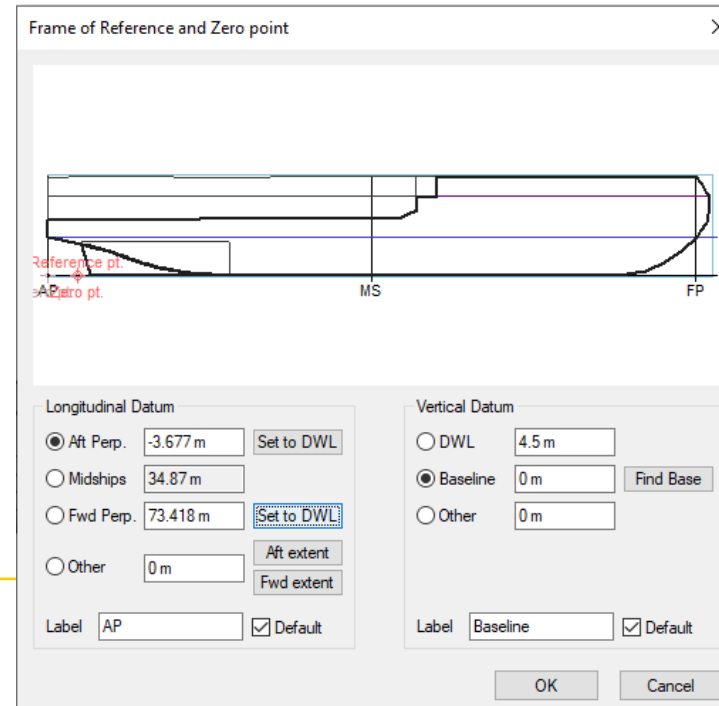
Defining Lines Plan (Lines plan)

- **The Model still can be refined and optimized as required**

- **To generate lines plan from the 3D model Go to the profile and press**

  - File ➜ Export ➜ Lines Plan
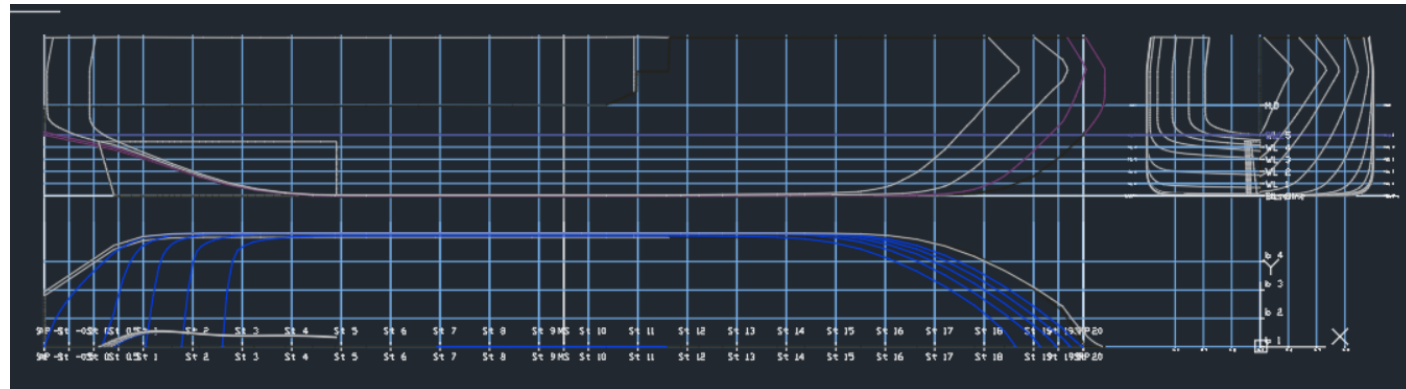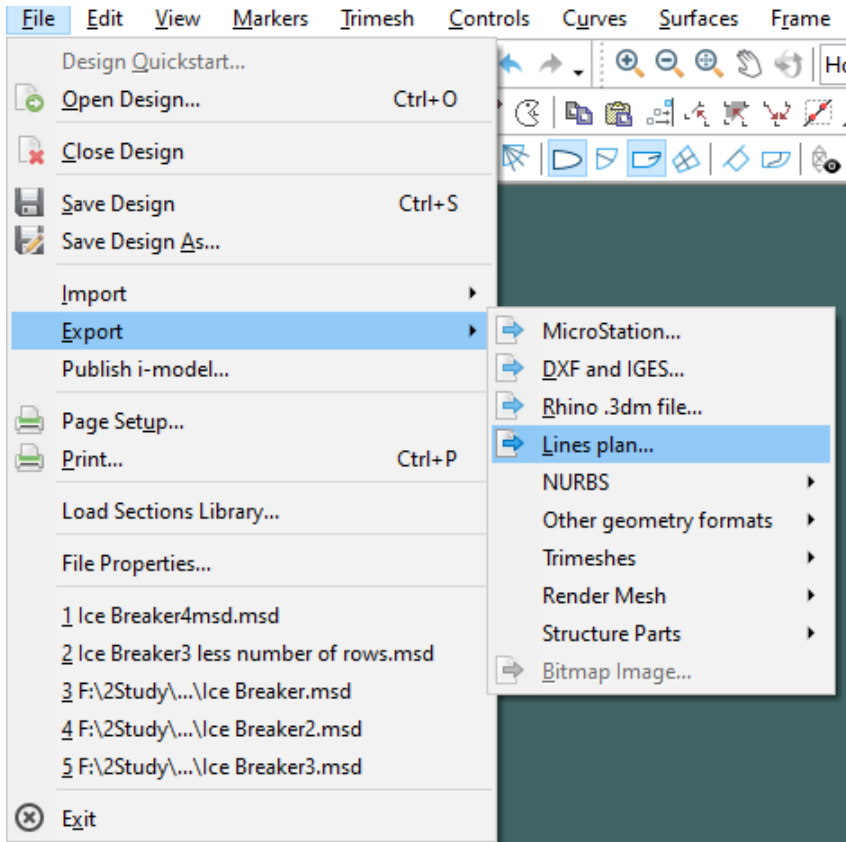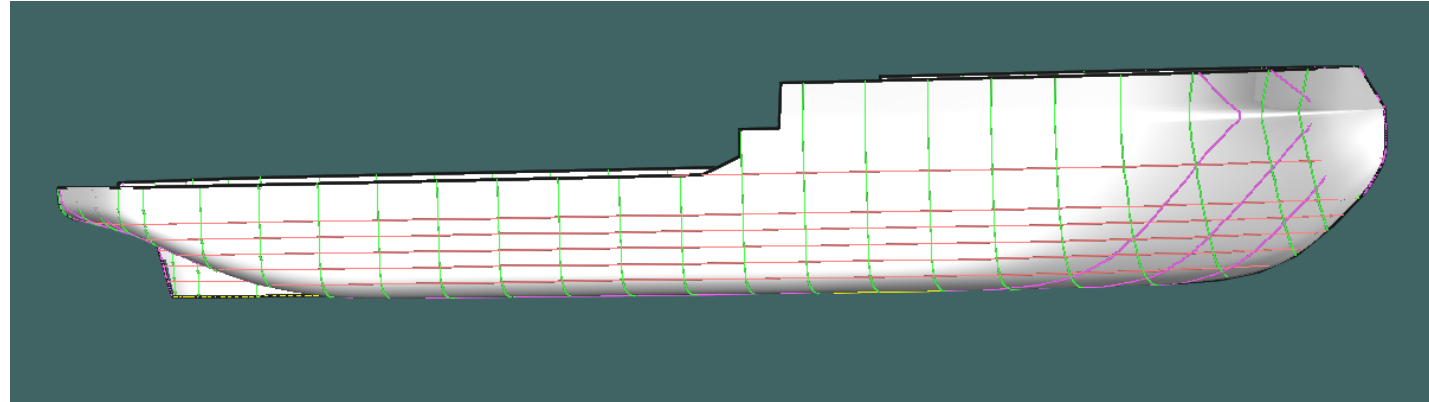
Hydrostatics

Hydrostatics

- **Maxsurf Stability can be employed, to plot hydrostatics curves.**

  - Save the model in Maxsurf modeler

  - Open Maxsurf stability

  - Go to File ➤ Open Design ➤ and open the modified model.

  - If it is the first time to open the model in Maxsurf Stability, the first option " read existing data" should not be active (Next time you can select this option to open the saved stability file)

  - From stations, select the appropriate number of stations that will be used to calculate ship hydrostatics. It depends on the ship length and the ship geometry. Increasing the number of stations will increase the required analysis time.

A? Aalto University
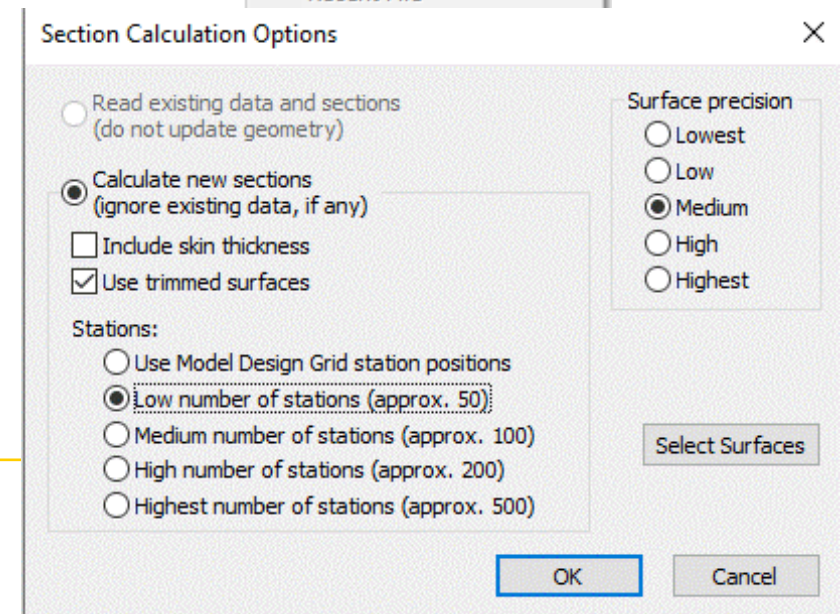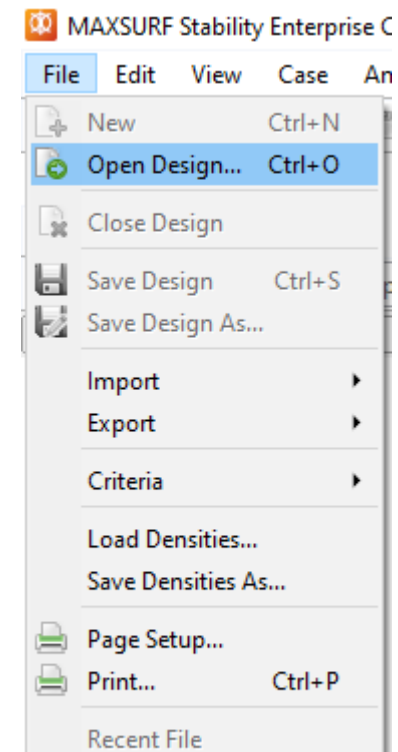
Hydrostatics

- **To show the stations that will be used in hydrostatics calculations**
  - Go to Display ➤ Visibility ➤ Sections

Aalto University
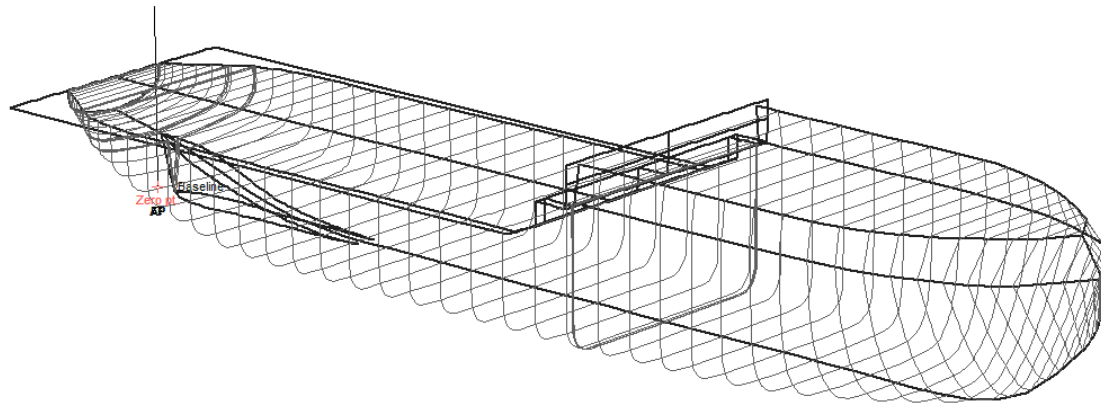
Hydrostatics

- **Now we need to define the range of draft for hydrostatics calculations:**

  - Go to window ➤ Upright Hydrostatics (Or select it from Analysis tab)

  - Go to Analysis ➤ Draft..

  - Define initial draft amidship, Final draft and draft increment or number of drafts

  - Define VCG and LCG if available unless the calculations of GM will be not accurate.

  - Press Ok

  - You can instead define range of displacement from Analysis ➤ Displacement..
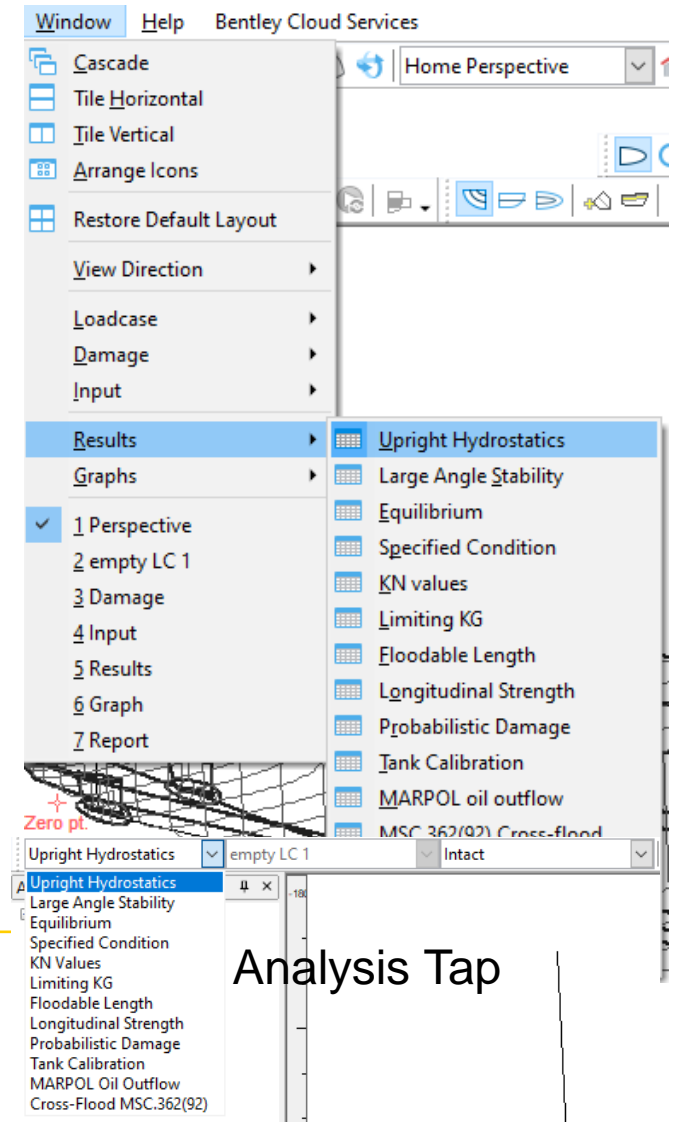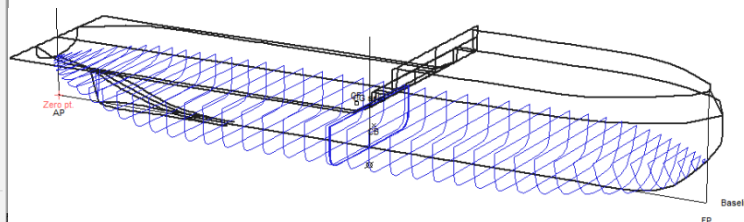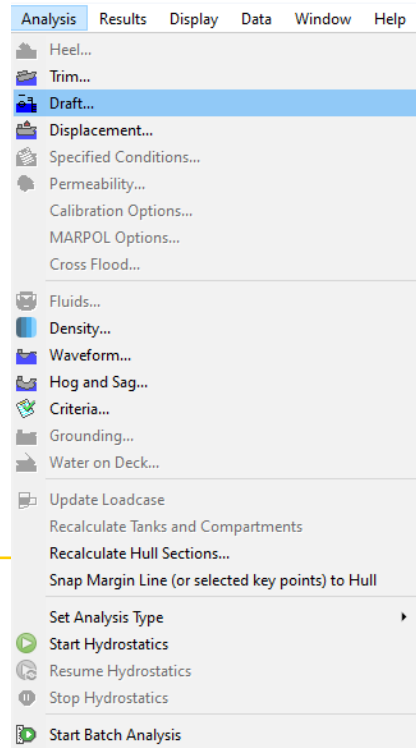
Analysis Tap

Hydrostatics (Results)

- **To Calculate the hydrostatics Go to Analysis ➤ Start Hydrostatics.**
- **To show the tabulated results at different drafts:**
  - Go to Window ➤ Results..

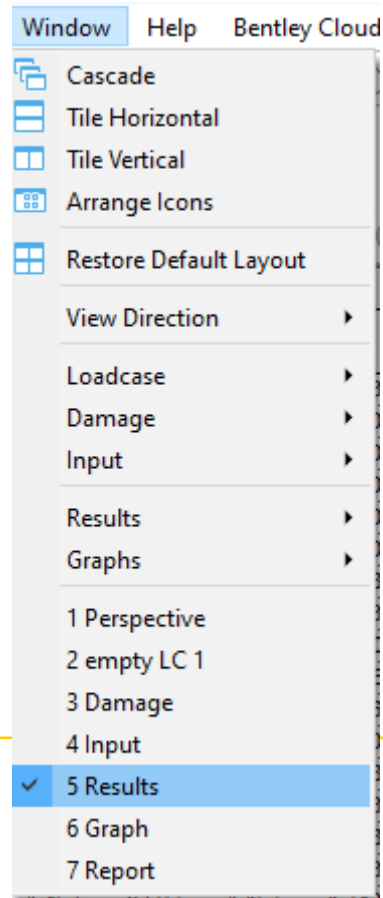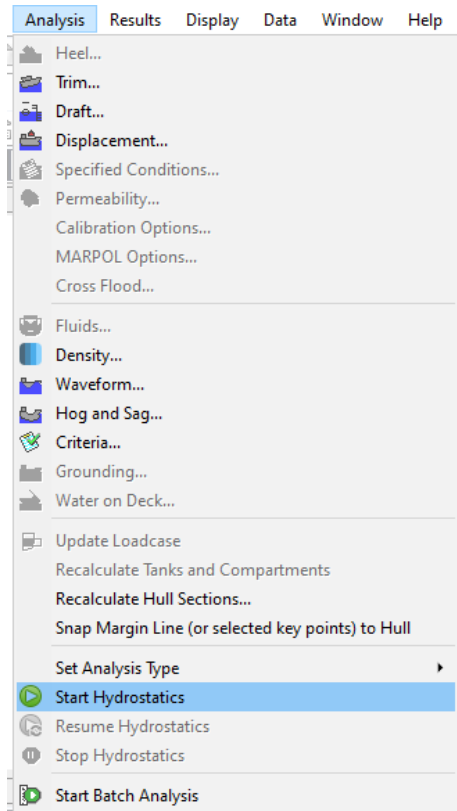|	Draft Amidships m	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
1	Displacement t	791.8	1259	1748	2256	2782	3323	3881	4458
2	Heel deg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Draft at FP m	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
4	Draft at AP m	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
5	Draft at LCF m	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
6	Trim (+ve by stern) m	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	WL Length m	67.959	69.021	69.822	70.568	71.234	71.900	74.174	77.091
8	Beam max extents on W	16.539	16.735	16.804	16.807	16.802	16.800	16.800	16.800
9	Wetted Area m^2	919.469	1011.985	1116.639	1209.030	1302.302	1387.289	1483.717	1585.119
10	Waterpl. Area m^2	877.590	926.661	979.855	1013.958	1045.433	1071.521	1107.317	1143.999
11	Prismatic coeff. (Cp)	0.723	0.740	0.753	0.764	0.774	0.782	0.773	0.758
12	Block coeff. (Cb)	0.687	0.709	0.727	0.742	0.756	0.767	0.760	0.746
13	Max Sect. area coeff. (	0.950	0.958	0.965	0.972	0.977	0.980	0.983	0.985
14	Waterpl. area coeff. (C	0.781	0.802	0.835	0.855	0.873	0.887	0.889	0.883
15	LCB from zero pt. (+ve f	40.657	40.405	40.187	39.966	39.738	39.527	39.297	39.038
16	LCF from zero pt. (+ve f	40.387	40.027	39.245	38.833	38.451	38.195	37.628	36.990
17	KB m	0.535	0.802	1.068	1.335	1.604	1.871	2.142	2.416
18	KG m	4.500	4.500	4.500	4.500	4.500	4.500	4.500	4.500
19	BMt m	23.631	16.207	12.434	9.986	8.349	7.200	6.341	5.663
20	BML m	278.636	200.775	168.842	144.472	128.196	115.352	108.950	104.715
21	GMt m	19.666	12.509	9.002	6.821	5.453	4.571	3.984	3.578
22	GML m	274.671	197.077	165.410	141.307	125.300	112.723	106.592	102.631
23	KMt m	24.166	17.009	13.502	11.321	9.953	9.071	8.484	8.078
24	KML m	279.171	201.577	169.910	145.807	129.800	117.223	111.092	107.131
25	Immersion (TPc) tonne/c	8.995	9.498	10.044	10.393	10.716	10.983	11.350	11.726
26	MTc tonne.m	28.209	32.182	37.502	41.356	45.216	48.583	53.657	59.347
27	RM at 1deg = GMt.Disp.	271.755	274.837	274.625	268.615	264.751	265.094	269.810	278.387
28	Max deck inclination deg	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Trim angle (+ve by stern	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Hydrostatics (Results)

- **The graphical representation of the results can be illustrated from:**
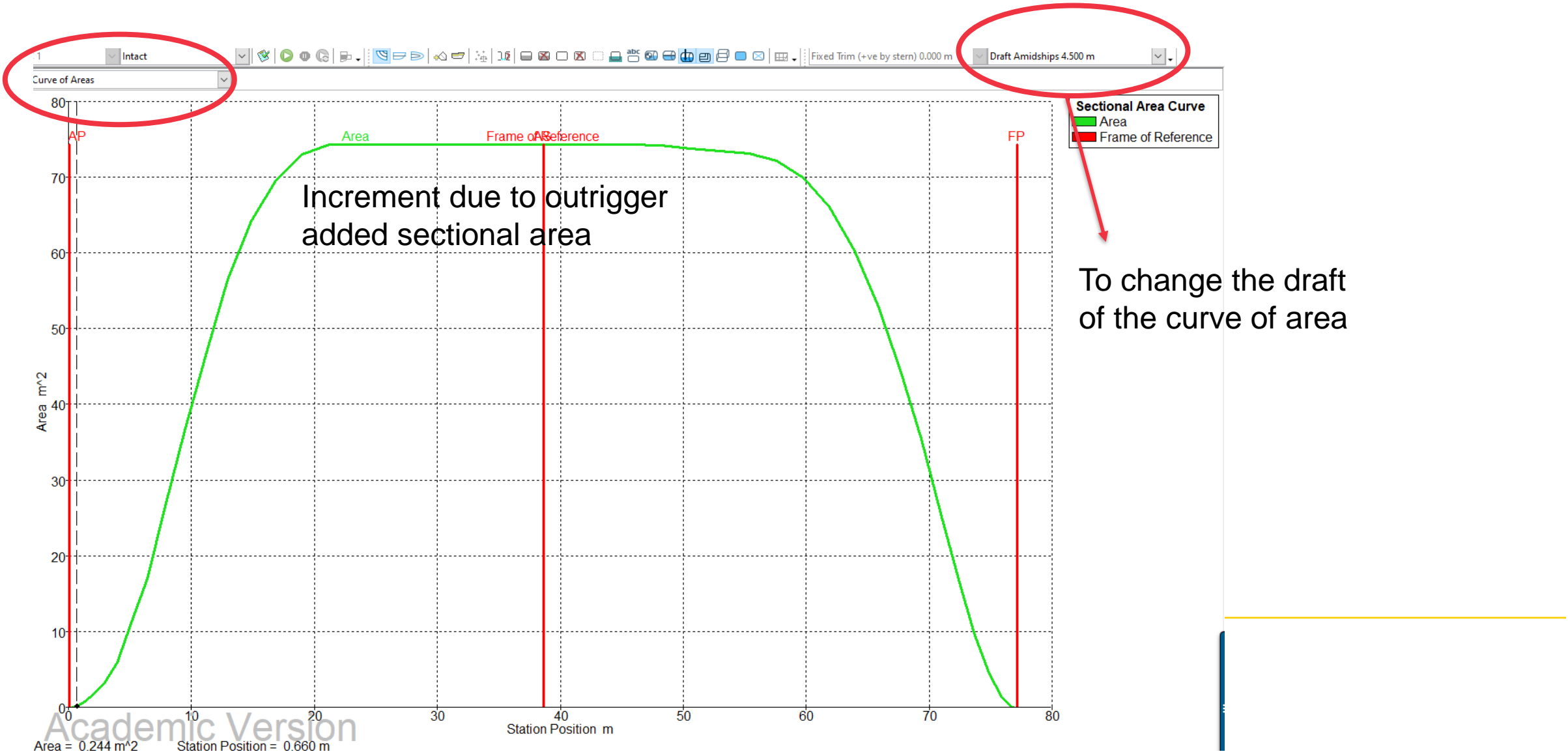 - Go to Window ➤ Graph..
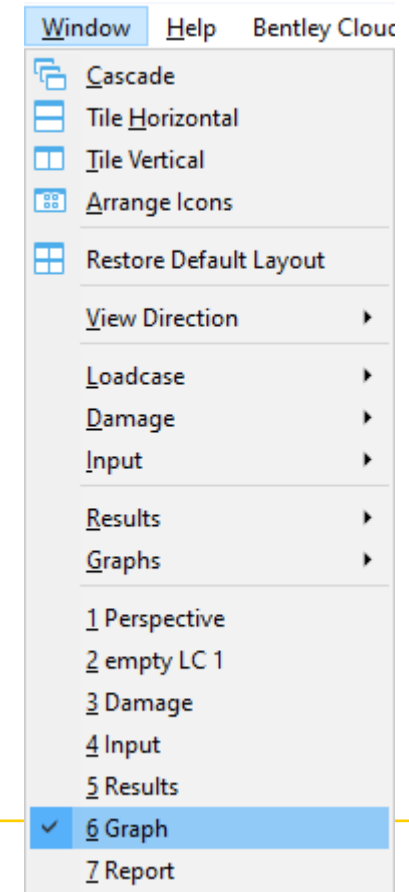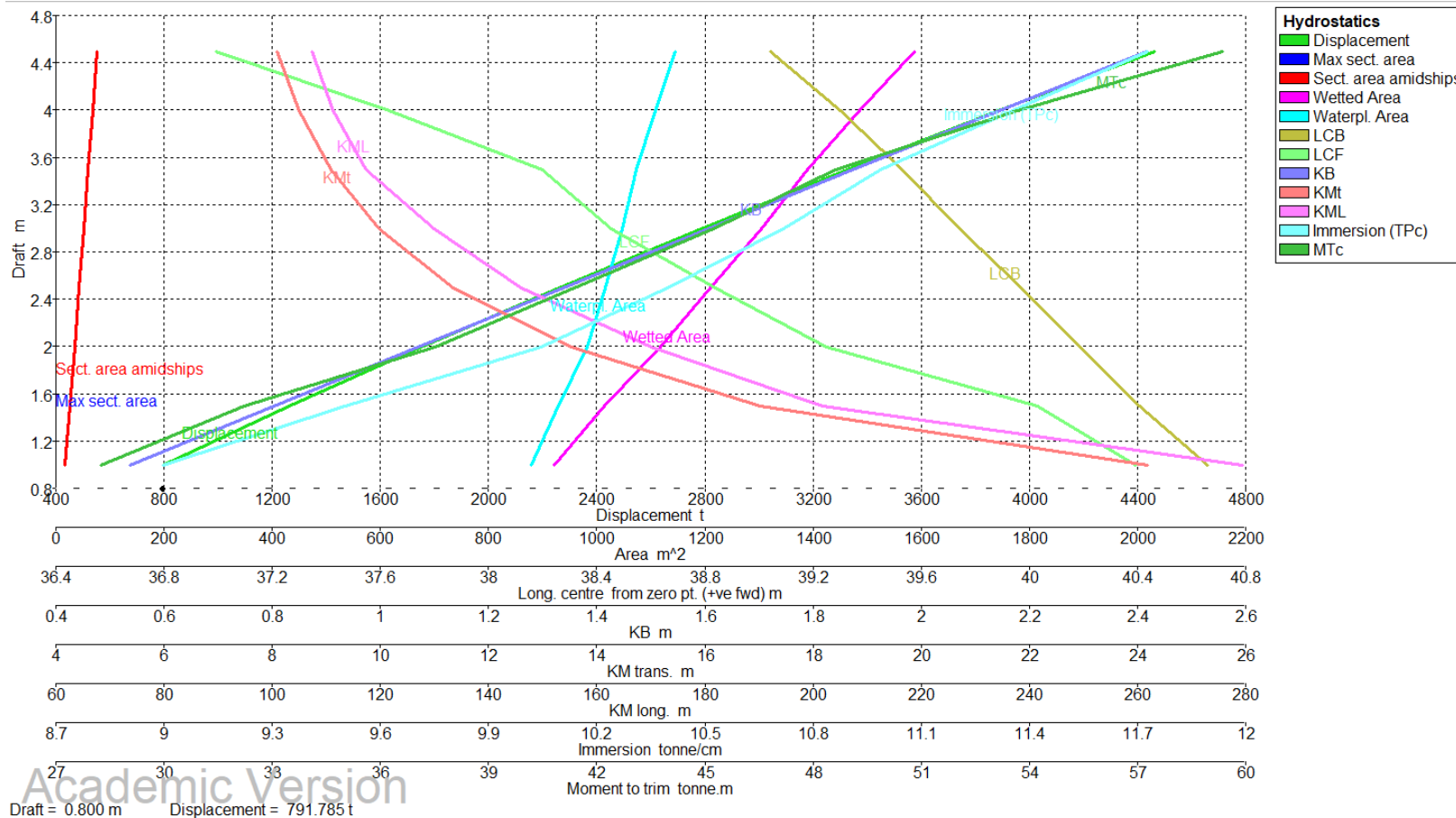
Hydrostatics (Results)

- **The show curves of form, change the type of curves from the tab above the Graph window**
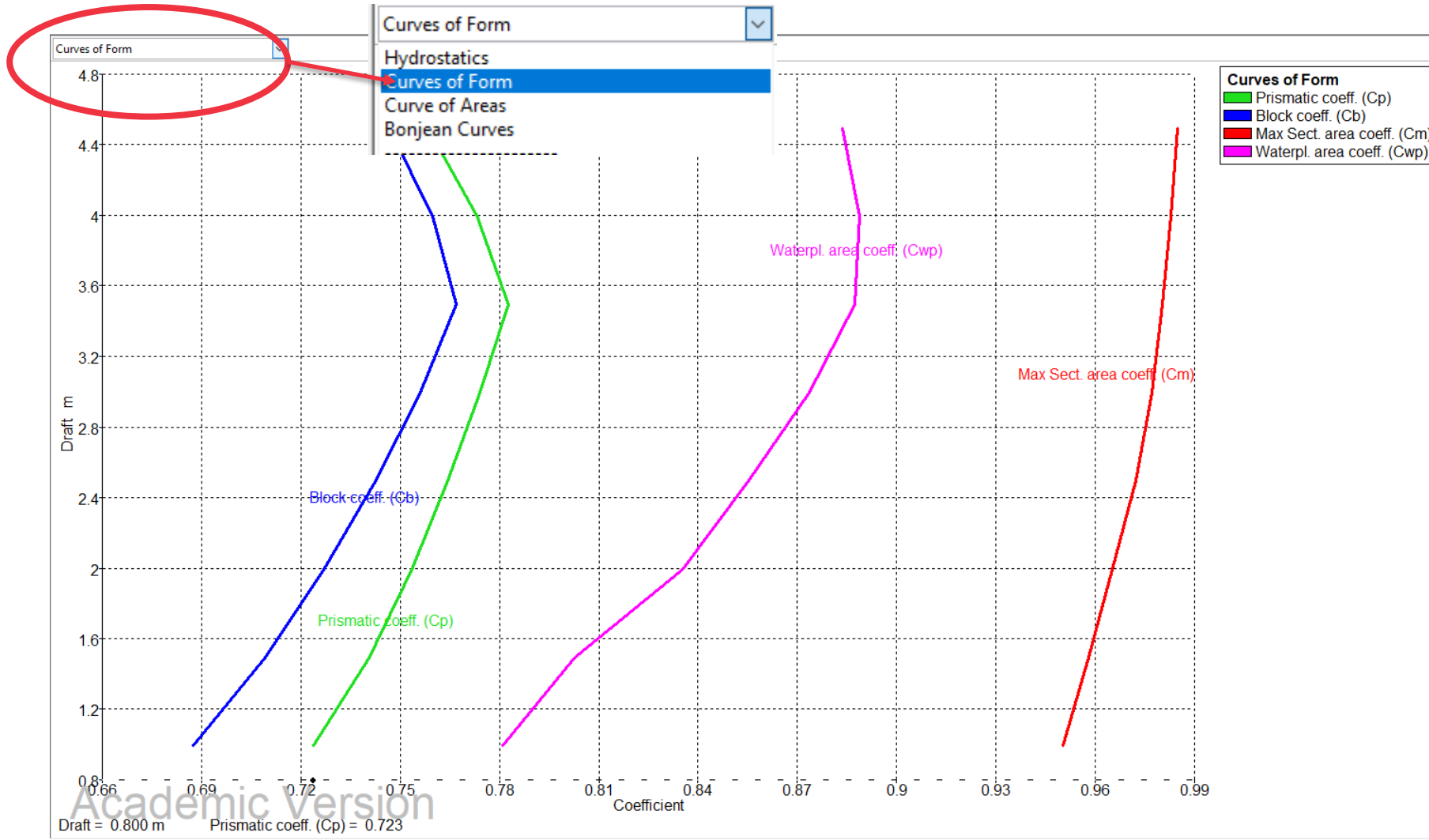
Hydrostatics (Results)

- **You can also show the curves of areas and Bonjean curves from the same tab.**

Increment due to outrigger added sectional area

To change the draft of the curve of area

Academic Version

Hydrostatics (Results)

- **Bonjean curves**