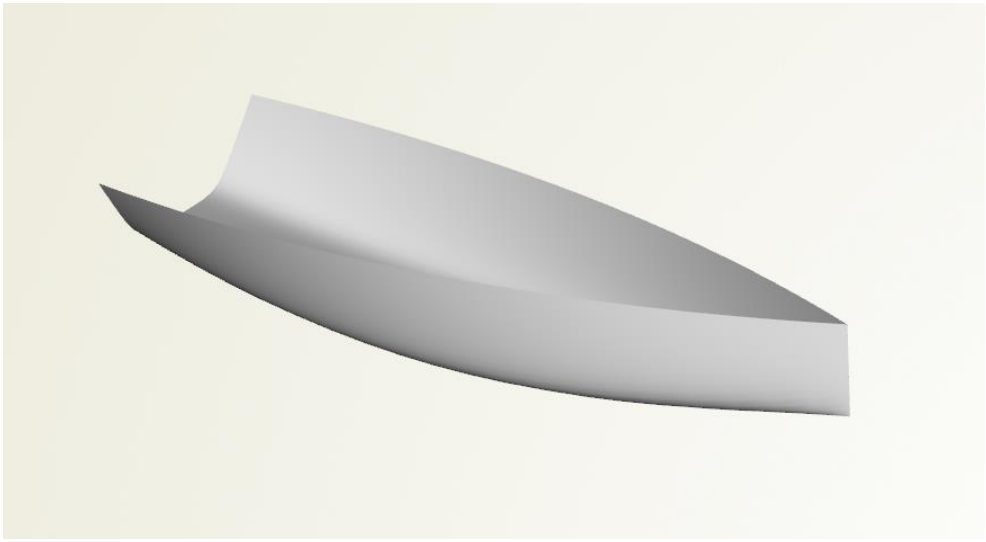
Yacht Hull

This tutorial will guide you through the creation of a simple parametric yacht hull consisting of only a single *meta surface*. It is recommended to complete the introductory tutorials as well as the feature tutorials beforehand.

First, a sectional curve of the hull is defined as a *NURBS curve* within a feature definition. This curve will mathematically describe the surface at each longitudinal position (i.e. x-direction) and is defined in the yz-plane.

Then, functional curves are created which describe the section's input parameters in a certain range (along the length of the hull). These functions are linked to the section via a *curve engine* which finally allows the creation of a *meta surface*.



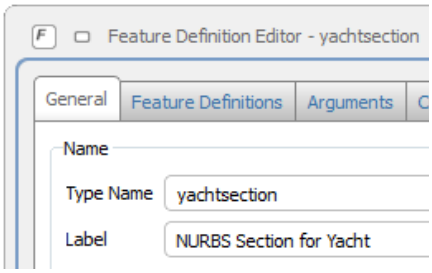
CAESES Project

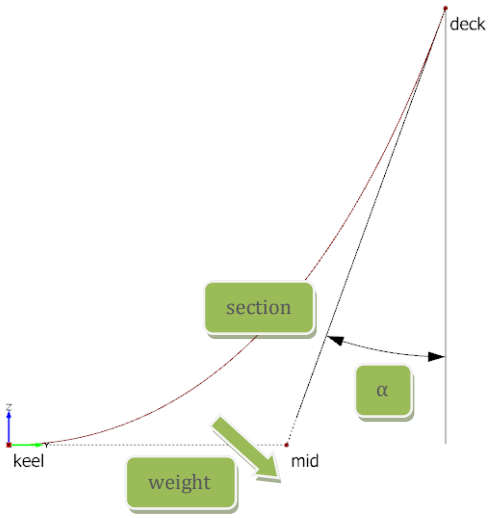
The resulting model can be found in the section *samples > tutorials* of the documentation browser.

1 New Feature Definition

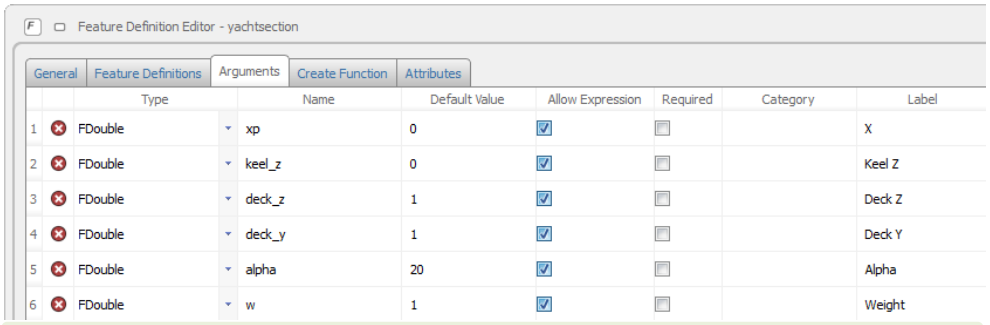
The section curve will be defined within a feature definition. It is controlled by three points (keel, mid, deck), an angle value (α) and a "weight" that drags the section in the direction of the mid-position, see the figure.

- Save the project (CTRL + S).
- Create a new feature definition via *menu > features > new definition*.
- Set the *type name* of the definition to "yachtsection", for instance, and choose a meaningful label such as "NURBS Section for Yacht".

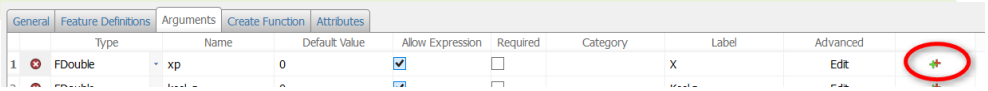




- Define input arguments for the section parameters according to the screenshot below. Set the default values of "keel_z" and "xp" to "0", "deck_z" and "deck_y" as well as the weight "w" to "1", while the value for "alpha" can be set to "20" degrees.



✓ You can createa a copy of an argument by clicking on the "++" button on the rigtht side of the feature dialog.

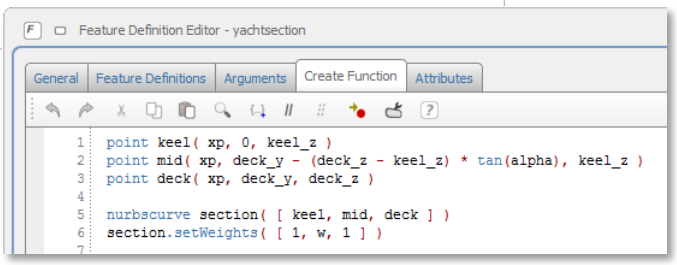


2 Create Function

Three points will be defined as well as a NURBS curve which is based on these three points. Finally, the weight controls the influence of the inner vertex ("mid") of the NURBS curve. Increasing the weight will result in a sharper section shape – more like a hard chine boat – while decreasing the weight will do the opposite.

- Go to the tab *create function* and type in the following (you can also copy & paste the text):

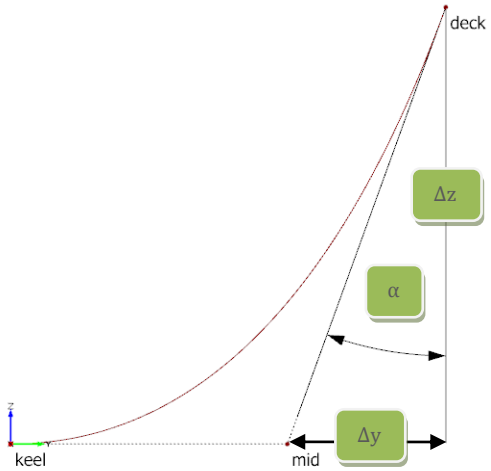
```
point keel( xp, 0, keel_z )
point mid( xp, deck_y - (deck_z - keel_z) * tan(alpha), keel_z )
point deck( xp, deck_y, deck_z )

nurbscurve section( [ keel, mid, deck ] )
section.setWeights( [ 1, w, 1 ] )
```



- Press *evaluate* to check the definition.
- Press *apply*.
- Close the dialog.

✓ The y-value of the point "mid" results from the trigonometric relationship

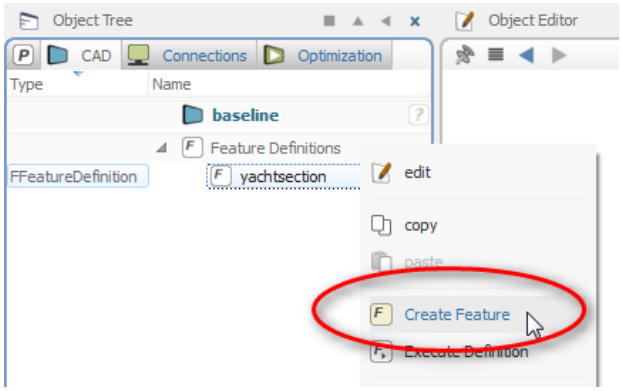
tan(alpha) = Δy / Δz (see the screenshot below again).



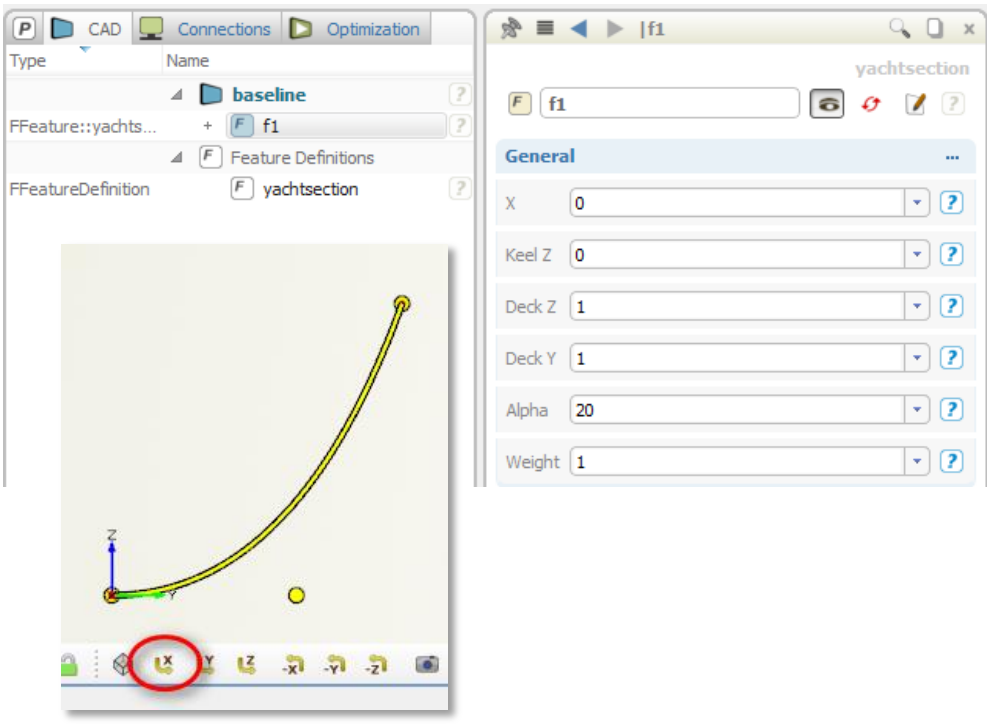
3 Section Test

Since the curve definition is complete, we can now test it by creating a feature from it. This step is optional.

- Choose *create feature* from the context menu (right mouse button) of "yachtsection".



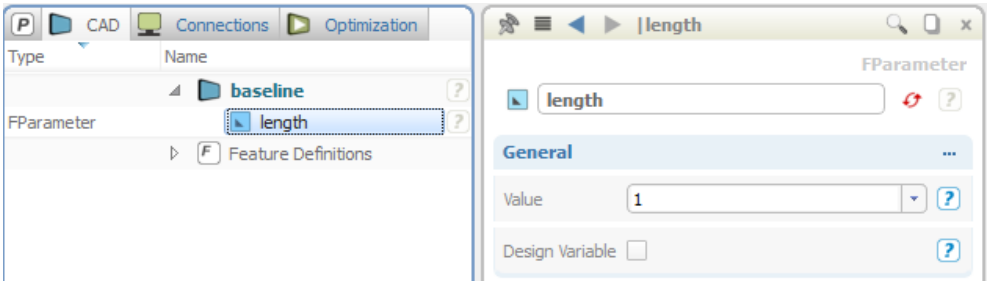
- Since the section is modeled in the yz-plane, we switch into the x-view by clicking on the x-button of the 3D view.
- Select the feature "f1" and try out different input values in order to see how the section behaves. (You can delete "f1" because it will not be used for surface generation.)



4 Length Parameter

In order to have a parametric model whose length can be changed, we introduce a parameter. This parameter will be involved in step 6.

- Choose *CAD > parameters > parameter.*
- Set the name to "length" and the value to "1".

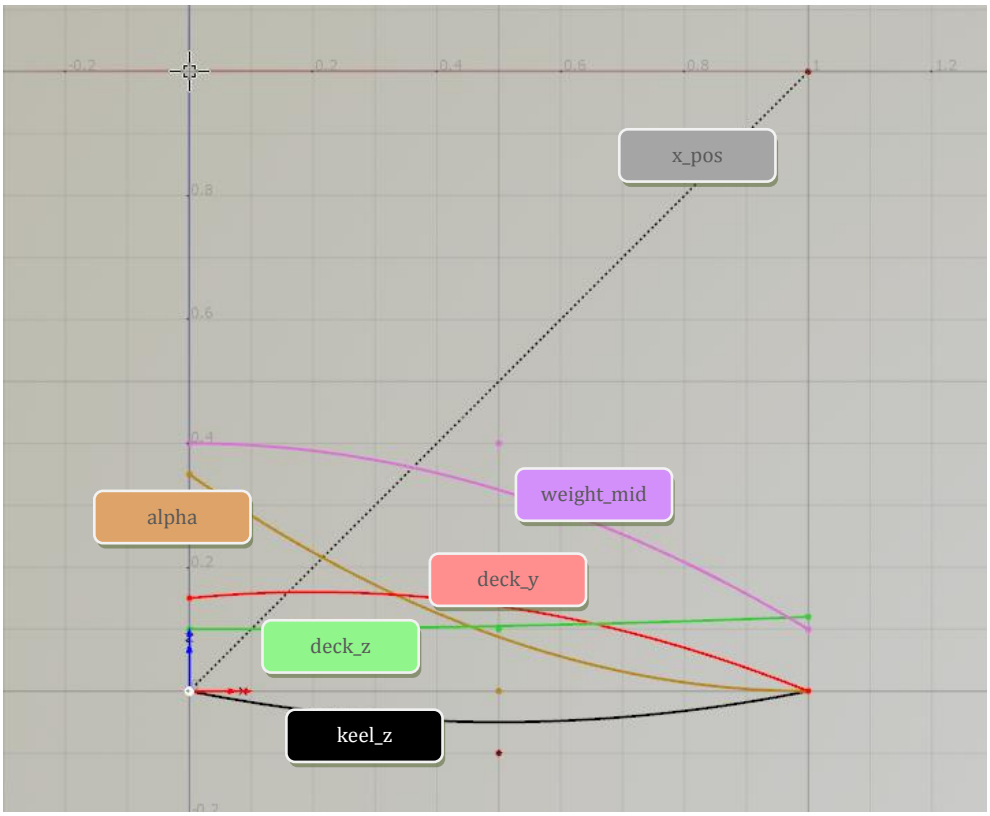


- Remove the object "f1" – we do not need it anymore (it was created before only for testing).

5

Functions

The arguments of the feature definition (see step 1) shall be given not by fixed values but by functional distributions. Therefore, arbitrary functions in the zx-plane for each argument (*keel_z*, *deck_z*, *deck_y*, *alpha*, *weight_mid* and *x_pos*) are required, as shown in the screenshot below.



✓ These curves can be created for example as b-splines (*CAD > curves > b-spline curve*) with three control points each (*CAD > points > 3D point*). Defining the functions in the domain $x = 0$ (start) to x = length (end) will make it easy to change the entire shape afterwards by altering the length parameter. Hence it is important to include the length parameter in the distribution curves.

The following steps describe how to create such basic curves.

6 Functions: keel_z

We will create a function for the argument *keel_z* and describe this process in more detail:

- Since the functions are modeled in the xz-plane, we switch into the y-view by clicking on the y-button of the 3D view.

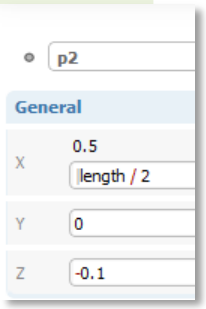
This is the first point:

- Choose *CAD > points > 3D point* and set x, y and z of the new point "p1" to "0" (note that they are "0" by default).

Now, the second point:

- Press *F12* (execute last command again) so that "p2" gets created.
- Set the x-coordinate of the new point "p2" to "length/2".

✓ Use drag & drop for setting the parameter "length" at "p2". Alternatively, use the ALT-key, see the GUI introduction tutorial for more information about keyboard shortcuts.



- Set the z-coordinate of "p2" to "-0.1".

And, the last point:

- Press *F12* again and set the x-coordinate of the new point "p3" to "length".
- Set the z-coordinate of "p3" to "0".

Let's create a curve based on these points and put everything into a new scope:

- Select "p1", "p2" and "p3" (in this order!) and choose *CAD > curves > b-spline curve*.
- Select "p1", "p2", "p3" and the new curve "c1" and choose *CAD > scope*.
- Set the name of the new scope to "keel_z".

7 Functions: Copy & Paste

For all other functions, we can copy & paste the scope “keel_z” and modify the three control points. See the screenshot in order to adjust your own functions (compare the ordinate values). As an example, we create “weight_mid”:

- Copy & paste the scope “keel_z”.
- Set the name of the new scope to “weight_mid”.
- Set the z-coordinate of “weight_mid|p1” to “0.4”.
- Set the z-coordinate of “weight_mid|p2” to “0.4”.
- Set the z-coordinate of “weight_mid|p3” to “0.1”.

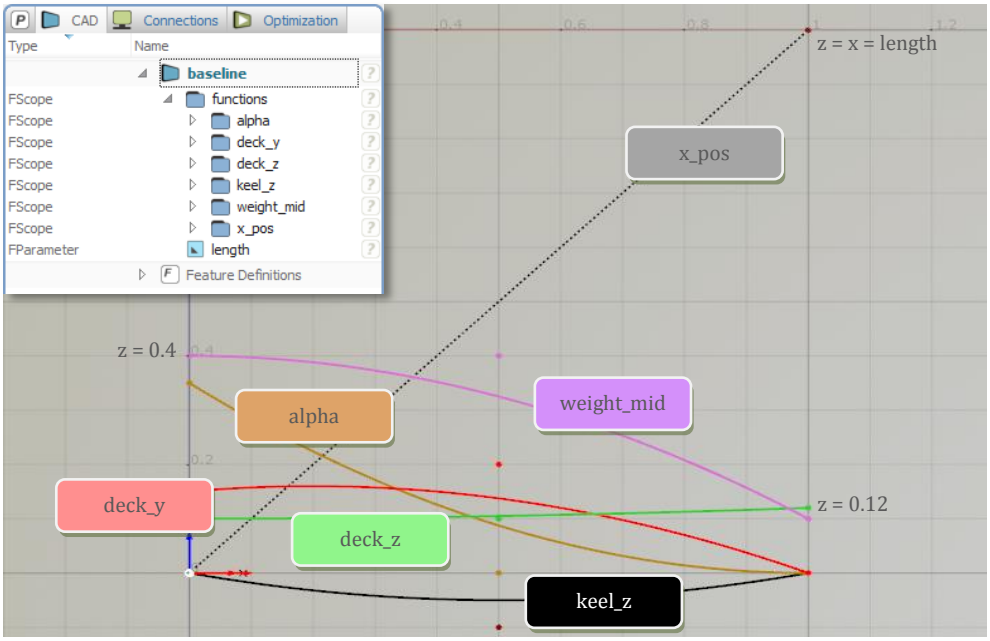
Proceed in the same manner with the remaining curves for “alpha”, “deck_z”, “deck_y”.

- For the x-position “x_pos”, we create a linear curve. Just make sure that the end point coordinates x and z of this linear curve are set to “length”.

Put all functions together into a single scope:

- Select all function scopes and choose *CAD > scopes* and set the scope name to “functions”.

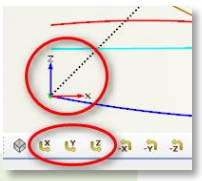
✓ Optional: Change the colors of each scope (e.g. “alpha”) and switch on the 3D view grid.



8 Curve Engine

We can link the functions to the feature definition, in order to prepare the surface generation:

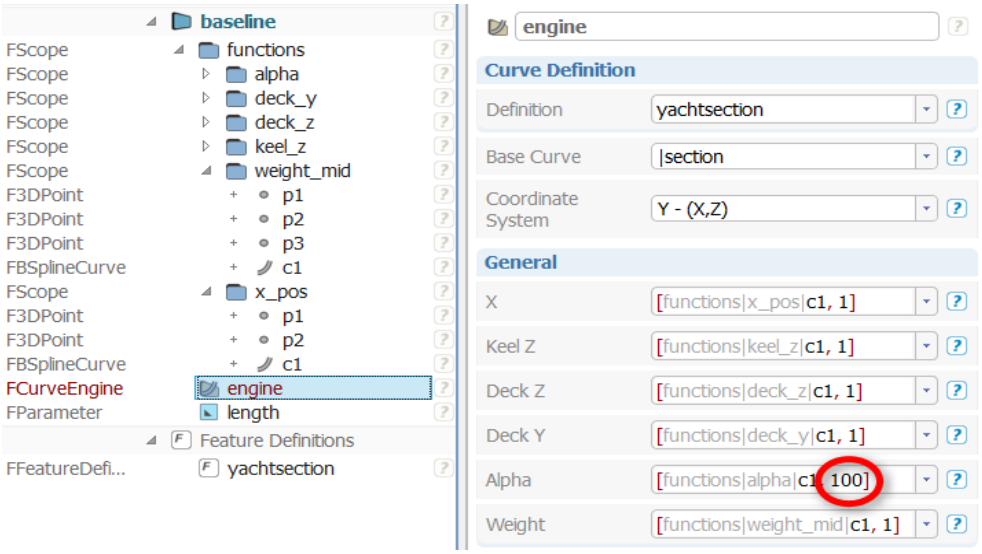
- Choose *CAD > curves > curve engine* and set the name to “engine”.
- Set “yachtsection” for the attribute *definition*.
- Set “section” as *base curve* (is done automatically if there is only one curve).
- Set “Y – (X,Z)” as *coordinate system*.



✓ ”Y – (X,Z)” corresponds to the abscissa and ordinate of our functions. Important setting! If you are not sure, you can use the x-, y- and z-buttons of the 3D view in order to find out which view needs to be set for the curve engine (observe the coordinate system in the 3D view).

- Drag & drop the curves “c1” of each scope into the corresponding editors (or use ALT-key or use the drop down menu).
- Enter a factor of “100” for the function “alpha”, see below.

✓ ”alpha” is given in a normalized manner so we multiply the ordinate values by “100”. For instance, an ordinate value of “0.4” will then result in an angle of “40°”.



9

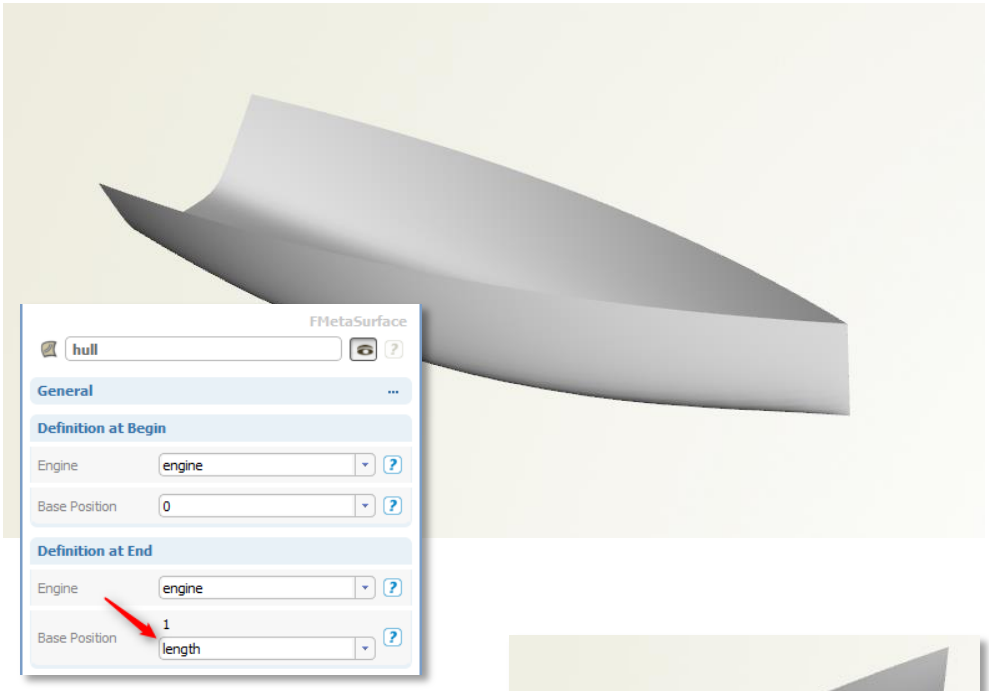
Surface Generation

Finally, the surface can be created by means of the configured curve engine from the last step.

- Select “engine” and choose *CAD > surfaces > meta surface*.
- Set the name of the new surface to “hull”.
- Set the base position of the end definition to “length”.

Now, let’s play around with the parametric model:

- Change the length to “2”, for instance, to enlarge the yacht hull.
- Change the functions in order to modify the shape (z-coordinates of the curve points).
- Change the factor of the weight function “W” in the curve engine to “10”, for instance (similar to the alpha function in step 8), to increase the influence of the point “mid”.



✓ Switch on the 3D mirror in order to have a look at the complete hull (this y-mirror is only for displaying purposes and does not create a second surface e.g. in the tree).