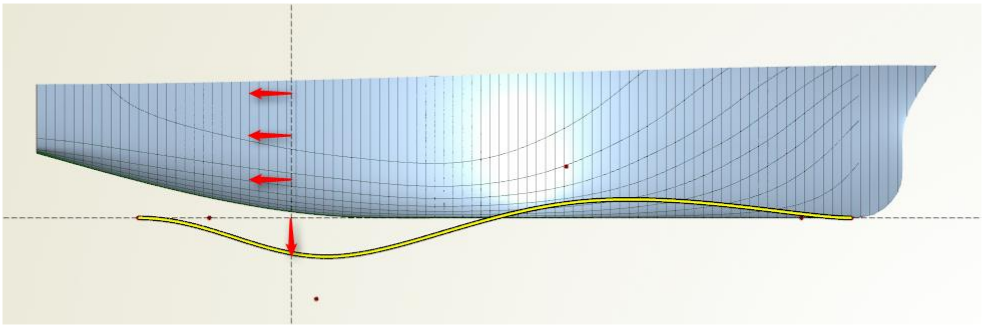
Hull Variation

In this tutorial you will learn how to vary existing hull geometries using so-called *delta shift* transformations. For demonstration purposes, an IGES file is imported and the hull shape gets varied i.e. “shifted”. This kind of modification can be applied to offset data (e.g. used by the CFD package *SHIPFLOW*) and even also to advanced parametric models created in CAESES.

Typically, the delta shift moves initial geometry in x-direction according to a given shift function (“shiftfunction” see step 2). The abscissa of the shift function is the x-axis while the ordinate is the z-axis. Geometry information at a specific x-position, say x_0, is then shifted with the corresponding z-value of the function at x_0. Negative z-values move the shape at x_0 backwards while positive values represent a forward shift.

In optimization setups including CFD, the shift function can then be automatically varied in x- and z-direction.



CAESES Project

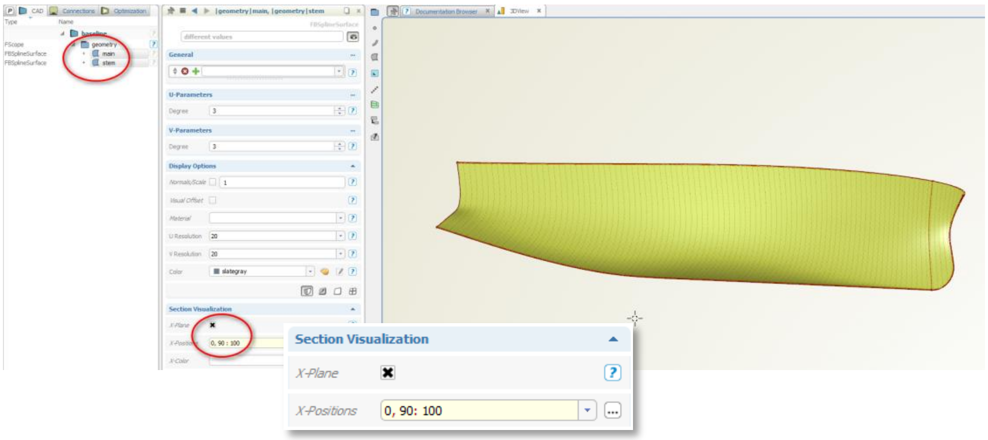
The resulting setup can also be found in the section *samples > tutorials* of the documentation browser.

1

Initial Geometry

The hull needs to be imported first. Instead of using an existing IGES geometry, the subsequent steps do also apply for any parametric model that has been created in CAESES.

- Choose *file > import > IGES*.
- In the installation path of CAESES, open the geometry file *tutorials > 06_hull_design > basicosv.igs.*
- Rename the IGES scope to “geometry”.
- Rename the two surfaces to “main” and “stem” to have more readable names.
- Select the two surfaces and visualize some sections in x-direction (i.e. click at category *display options > section visualization* of the selected surfaces). For instance, activate x-plane and set a series “0,90:100”.



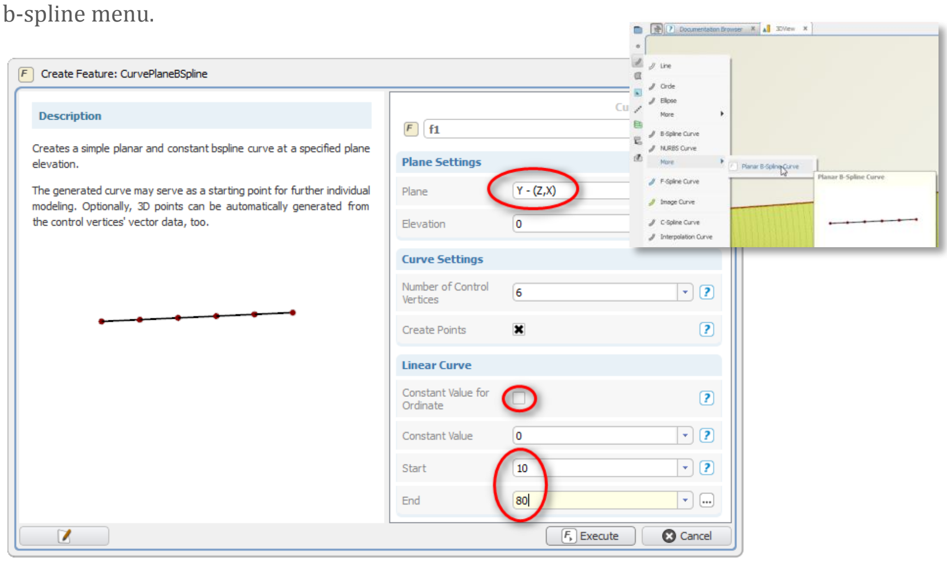
✓ For more information about series definition see type documentation of *FSeries*.

2

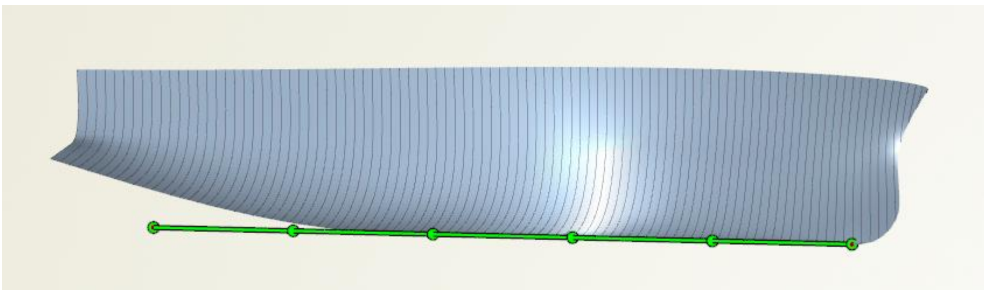
Shift Function

In this step we create a shift function. It will define the way of how the hull shape is moved in forward and backward direction. We want to shift only within the range x=10m to x=80m to leave the stem surface and the stern area untouched.

- Create an initial b-spline curve via *CAD > curves > more > planar b-spline curve* of the b-spline menu.

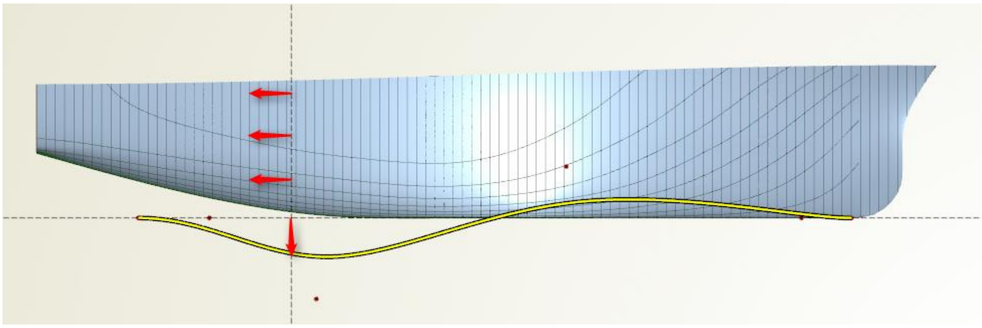


- Set the *plane* as well as the values for *start* and *end* according to the screenshot above.
- Deactivate *constant value for ordinate*.
- Press the *execute* button.
- Rename the new scope “f1” to “shiftfunction”.

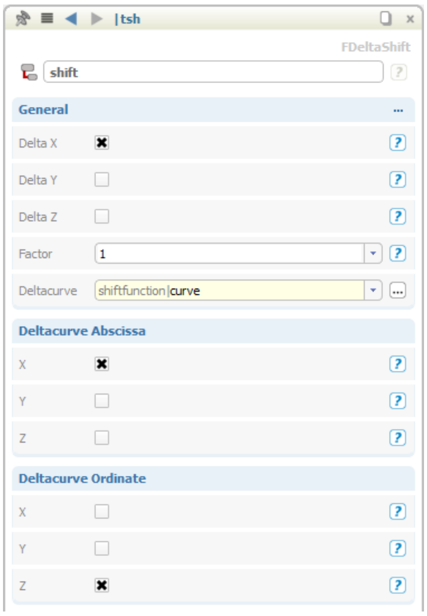


3 Delta Shift Transformation

There are different transformation entities available in CAESES. In this tutorial a so-called *delta shift* is utilized:



- Choose *CAD > transformations > shifts > delta shift* and name the new object “shift”.
- Activate *Delta X* and insert the shift function from the previous step.
- Activate x-abscissa and z-ordinate, see also the screenshot:

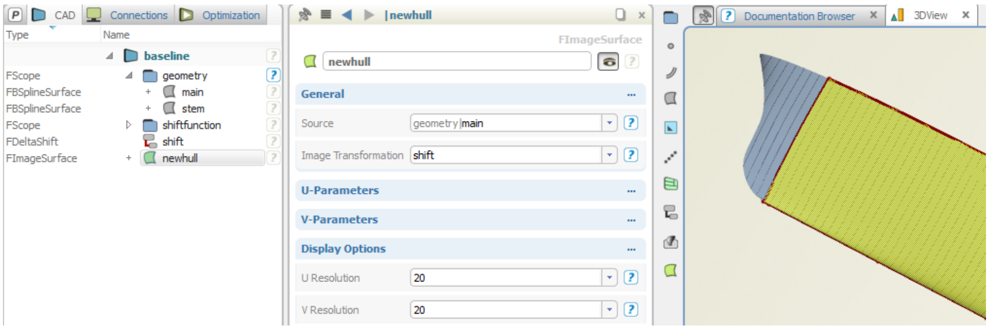


✓ The attribute *factor* scales the values of the shift functions. This is useful if the shift function provides very small values for small changes of the hull and you still want to visualize the function in a scaled, larger version in the 3D view (you would set a factor of e.g. “1/10” etc.).

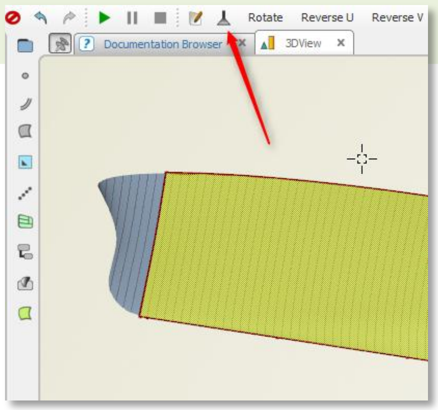
4 Image Surface

The initial surface and the shift are put together in an image surface in order to receive a transformed surface:

- Create an image via *CAD > surfaces > image surface* and name it “newhull”.
- Set the surface “main” as *source* for “newhull”.
- Set the “shift” transformation as input for *image transformation.*



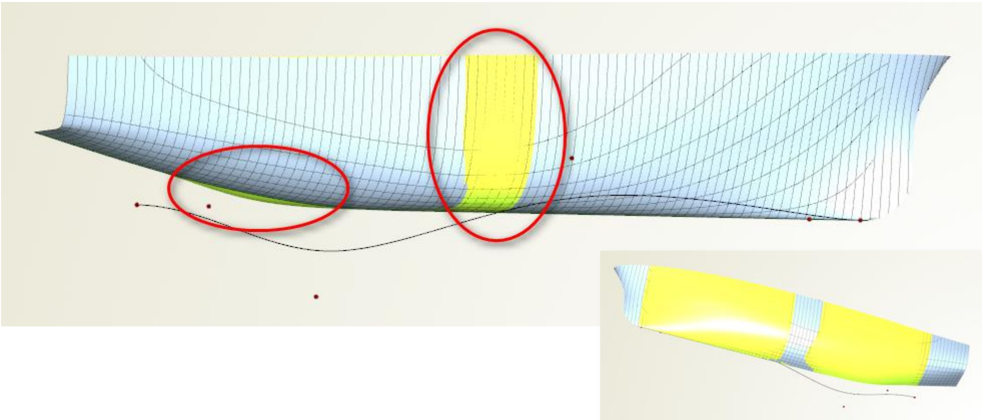
✓ If you want to have the same section visualization for “newhull” as well: Copy visualization settings from one surface to another by using the *copy format* button. Select “main”, press the *copy format* button in the toolbar and select “newhull”. The visualization attributes including color and section positions of “main” are copied to “newhull”.



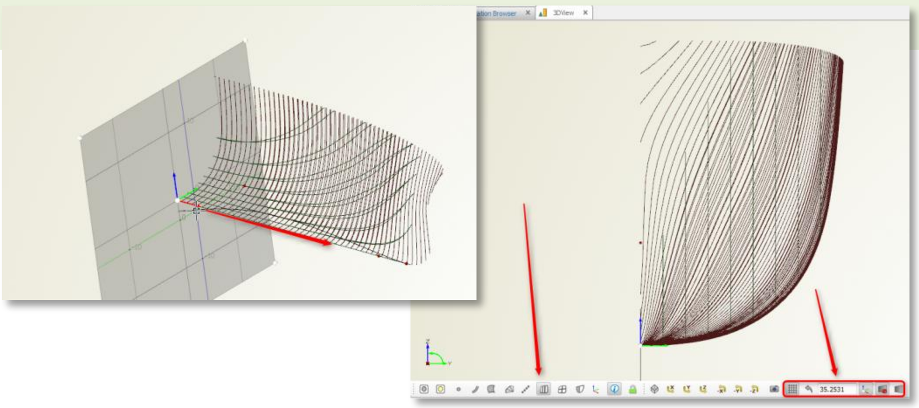
5 Varying the Initial Hull

The initial and the new surface are currently coincident since the shift function has a constant value of “0”. Let’s change it in this step:

- Select “p02” of the scope “shiftfunction|auxiliary” and move it in z-direction (remember: this is the ordinate of our shift transformation “shift”).
- Select “p03” and move it e.g. in opposite z-direction.
- Move “p01” and “p04” along the x-axis for more degrees of freedom. Keep the z-value for these two points to “0” in order to have a smooth transition to non-deformed geometry.



✓ Use the section visualization view at the 3D window in order to clearer compare changes. Set the same section positions for “newhull” as well (see step 1). Add y-sections as shown in the screenshots above. Utilize a *clipping plane* to hide for instance the aft part of the hulls (click at the principal axis of the clipping plane to activate/switch the axis and drag it). Color the sections of “newhull” differently in order to better distinguish them.

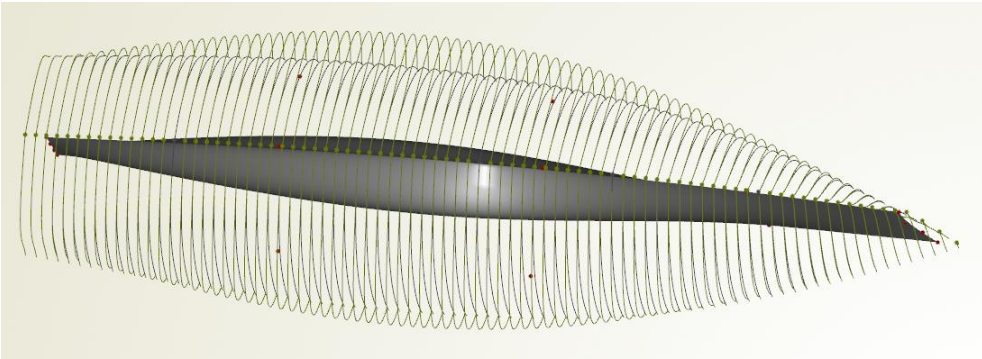


6

Conclusion

In this tutorial a simple shift deformation is applied to an existing hull. The shift is defined by means of an arbitrary user-defined curve. Typically, the x- and z-coordinates of the shift function are controlled by design variables: Design engines then automatically apply changes to the hull with regard to the chosen variation or optimization strategy.

There are other transformations available such as the *surface delta shift.* Here, a surface is defined which provides the delta values for a certain principal direction (e.g. y-axis in the screenshot below, to enlarge the hull).



In addition, the *Generalized Lackenby* is an extended version of the presented delta shift where delta functions are internally generated. The resulting functions are created in a manner that some user-defined constraints are fulfilled, for instance, change of center of buoyancy or displacement. Note that there is another tutorial available for the Lackenby.