FREE!ship manual

Version 2.6

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Contents

FREE!ship.

This manual is distributed as part of the FREE!ship project.

FREE!ship is an open source surface-modeling program based on subdivision surfaces and intended for the design of ships.

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- **Stefan Probst** for his continuing support, advice, patience and developing the script used for the online database.
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- **Antoine Birckel** for translating the manual into French
- **Andrey Factor and Bruce Taylor** for repeatedly beta testing new features as well as their constructive comments.

FREE!ship and Linux.

Free!ship is originally intended for Windows, although users have reported that it runs rather well under WINE too. In some cases problems might be experienced with the window focus. In Windows the dialog that has focus always stays in front of the mainform. Under Wine the dialog windows of FREE!ship go sometimes to the background while retaining user input focus. As a result, FREE!ship seems to be crashed while it hasn't. To solve this problem, you must cycle through the windows to get the dialog window back to the foreground and close it. Unfortunately, some window managers don't allow this because not all of the open windows are listed in the window menu. The following are the results of some tests that have been done on a Ubuntu Breezy Badger.

KDE 3.5	Unusable. The menus don't stay opened so no menu item can be chosen.
Gnome	Only the main window of FREE!ship is listed in the window menu, so if you loose the focus of a dialog window, your only choice is to kill FREE!ship.
Fluxbox	OK
IceWm	OK
WindowMaker	OK
Openbox	OK
Blackbox	Not tested, but as Blackbox is quite close to Fluxbox it is probably ok.

1. Introduction.

FREE!ship uses a technique called surface modeling to define the shape of a ship. This technique involves "sculpting" the hull as if it were a very thin and flexible piece of cloth by pulling and shifting points. It is however not limited to the hull alone as we will see later. Decks, superstructures, masts, keels and rudders can be modeled this way too. Unlike other programs, FREE!ship uses subdivision surfaces to completely model the ship. Subdivision surfaces give the designer more flexibility in designing any desired shape. But when you want to get the most of this technique it is important to have a basic understanding of some of its underlying principles. An example of the hull a simple demo yacht can be seen on Illustration 1. The actual surface is a mesh consisting of the following 3 objects:

- Faces
- Edges
- Points
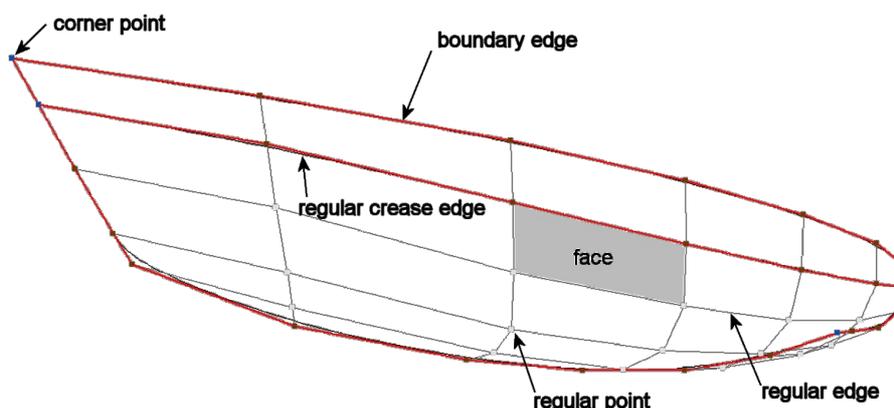
Illustration 1

1.2 Faces.

A face is a little piece of the entire surface (sometimes also called a patch) and is usually defined with 4 points.
In some areas it is desirable to have less (or even more) points, but generally the best results are obtained when most of the faces consist of 4 points.

1.3 Edges.

All successive points of the face are connected by lines. These lines are called edges and can be divided into two different kinds of edges.

- *Boundary edges*. These are edges which form, as the name suggests, the boundary of the surface. A boundary edge is characterized by the fact that it has **always** only **1** face attached to it. Examples of boundary-edges are the sheer line (when the ship is not fitted with a deck) or the centerline of the ship. The centerline, or profile, is in fact a special case. When defining the hull only its portside is created. So all edges on the center plane are boundary-edges as they have only one face connected to it. In reality the ship is symmetric, and when performing calculations FREE!ship creates a virtual symmetric ship by mirroring the model in the center plane.

- *Regular edges*. These are all other edges away from the boundary of the surface, and must **always** be shared by **2** adjacent faces. Regular edges are drawn as dark-gray lines. The two faces connected to an edge are joined smoothly along their shared edge. It is possible however to mark an edge as a crease-edge. When doing so, the two faces are joined in a tangent-discontinuous way. In other words, crease-edges are used to define knuckle lines. A boundary-edge is in fact a specific case of a crease edge since there is no second face to make a smooth transition.

FREE!ship uses the presence of boundary-edges in its calculations. By doing so it is able to determine when the ship is making water when for example the deck line is submerged. The downside to this is that it is critical for any regular edge to be connected to two faces, at least when not submerged. Having two different edges which are located precisely on top of each other is not sufficient. Faces have to be physically connected to the **same** edge. There is also another reason for this which will be explained in 1.6 Guidelines to subdivision modeling. Boundary-edges from which both the startpoint and endpoint are located on the center plane are excluded from this test. In reality these edges are connected to both the portside and the starboard side of the ship and are therefore not truly a boundary-edge.

1.4 Points.

Points form the basis of the surface. Most of the editing is done on a point-level by moving points to different locations, inserting new points or removing existing points. Basically there are two different types of points of interest to the user. These are:

- *Regular points*. These are all points other then cornerpoints. It is important to realize that these points have a certain offset to the resulting surface. This deviation to the surface is bigger in surface areas with high curvature. It becomes less when more points and edges are inserted.
- *Cornerpoints*. Cornerpoints are specific points, usually connected to 2 or more crease-edges. Just like a crease-edge can be used to specify that two faces have to be connected in a discontinuous way, cornerpoints may be used to do so with two adjacent edges. Cornerpoints are the only type of points actually located on the hull surface. Points where 3 or more crease-edges meet are automatically set to cornerpoints by the program.

1.5 Subdivision surfaces.

A subdivision surface is a special type of spline-surface. Normally modeling programs work with parametric spline surfaces like B-Spline surfaces or NURB surfaces. These surfaces are completely described by a set of controlpoints. Controlpoints are the points which the user can modify to control the shape of the surface. Any point on the surface can be calculated from these controlpoints using a set of parametric formulas. The drawback of these parametric surfaces is that they always require a "rectangular" grid of controlpoints. These controlpoints in reality might follow the shape of a hull, so they do not look like a true rectangular grid. But they always have say **N** points in the longitudinal direction and **M** points in the vertical direction where both *N* and *M* might be any number equal to or larger than 2. In the figure left **N**=4 and **M**=4 and the number of controlpoints equals 4*4=16. With parametric spline surfaces it is not possible to insert a single new point on an edge. Instead an entire
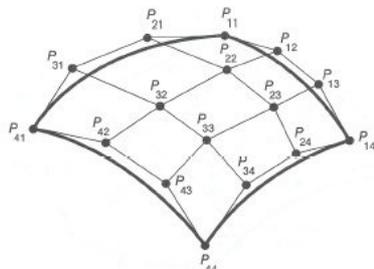
Illustration 2

row of points have to be inserted as demonstrated in the figure to the right. This results in having more controlpoints than actually needed or desired, and more controlpoints mean more work to the designer. Also very complex shapes cannot be modeled using only one surface. When using multiple surfaces the designer is challenged with the difficult task of aligning these surfaces at their boundaries. It is often desirable to maintain a smooth transition along these boundaries. Each time one of these surfaces is modified, the other surface has to be modified by the user to maintain this smooth transition.
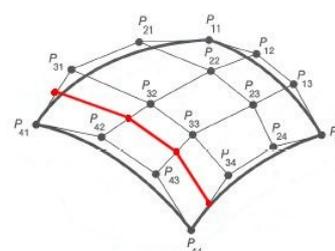
Illustration 3

To overcome these problems FREE!ship makes use of subdivision surfaces. Subdivision surfaces also use controlpoints as a modeling handle, just like NURBS or B-Splines. With subdivision surfaces the grid of controlpoints does not need to be rectangular, but calculating a point on the surface is more difficult since the surface is not parametric. Instead the controlmesh is refined and smoothed in a number of steps. Each step is called a "subdivision step", hence the name subdivision surfaces. This process is clarified in Illustration 4:
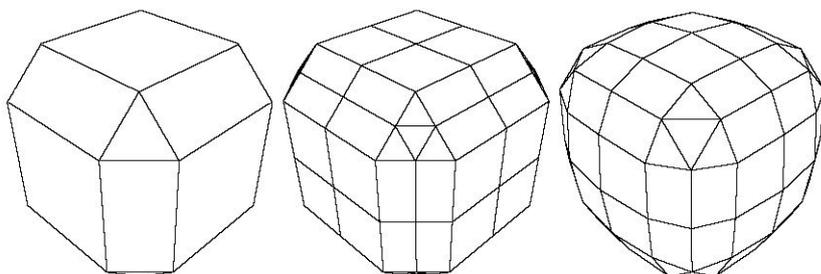
Illustration 4

To the left the controlmesh of a beveled cube is visible. The first step in the subdivision process is refining the mesh. This is done by inserting a new point on each edge (called an edge-point). Whenever a new edge-point is calculated, information from both adjacent faces is retrieved. This is another reason why edges always must be shared by two faces. For each face which has four points or more a point is also inserted at the center of each face (called a face-point). For faces with three points each new edge-point is connected with the new point of the previous edge, thus creating 4 new triangles. All other faces are subdivided by connecting each edge-point to the face-point. This way a refined mesh is created which still has the same shape as the original. This is shown in the middle. Finally all the points in the surface are shifted to a new location in such a way that the surface appears smooth. This is called *averaging* in subdivision terms (right side). If this process is repeated a number of times a very fine and smooth
mesh is the result. FREE!ship shows a dropdown box in the toolbar showing the precision of the model. This is actually a measure for how many subsequent subdivision steps the program performs.
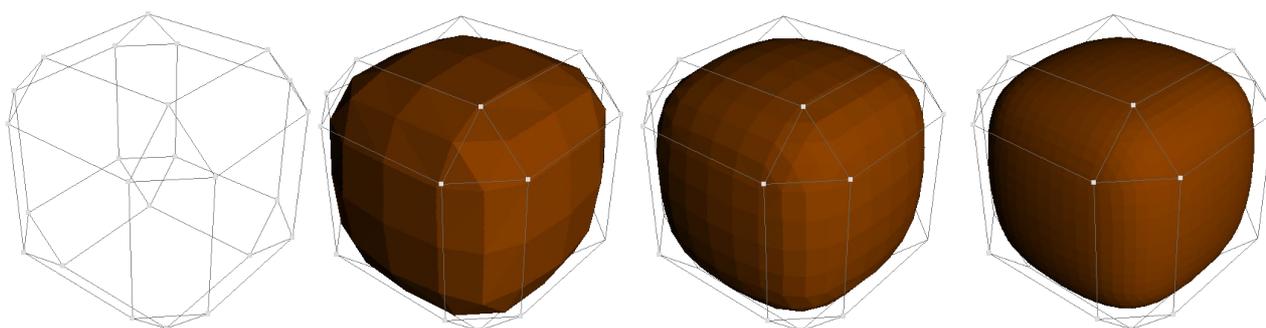
Illustration 5

Illustration 6 shows the controlmesh of the same beveled cube and the resulting surface after 1, 2 and 3 subdivision steps is shown.
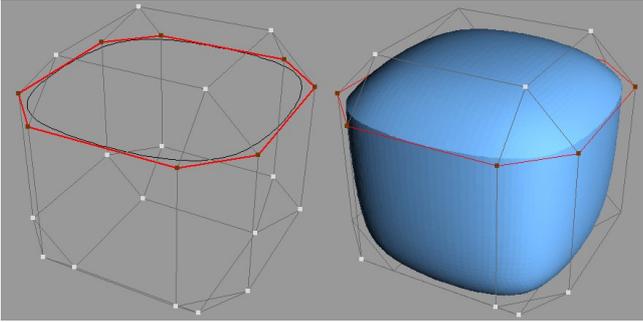
Illustration 6

This is the same cube, but a number of edges have been marked as crease-edges (red lines). The result is a sharp knuckle line going around the cube. It is clearly visible that faces adjacent to the crease-edges are no longer joined in a smooth manner.

1.6 Guidelines to subdivision modeling.

In this paragraph some guidelines are given to obtain the best results.

● Use a regular grid whenever possible. A grid is considered regular if all faces consist of four points, and all points are connected to four edges and faces. A point on the boundary is considered regular if it has 3 edges and two faces connected to it. Off course this is not always possible. Triangular faces may be used as a means to reduce the number of points in an area. 5-sided faces, or 5 4-sided faces can be used to increase the number of points. A truly regular grid would look exactly as the B-spline surface in the previous paragraph.

a point on the boundary is considered regular if it is connected to 2 faces and 3 edges.

an interior point is considered regular if connected to 4 faces and 4 edges.
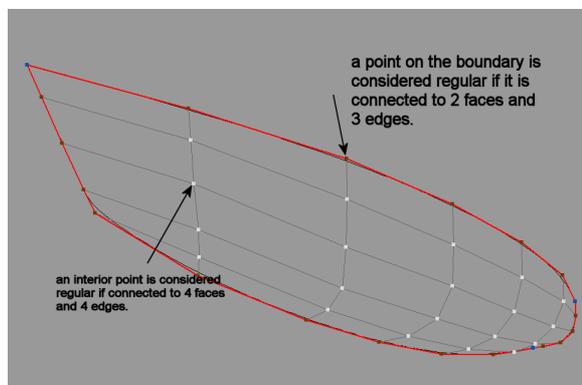
Illustration 7

● Whenever possible always have two faces connected to all edges other than boundary-edges. If more than two edges are connected to an edge, that specific edge will be drawn thicker and in a light green color. This must be avoided at all cost as it messes up hydrostatic calculations. Boundary-edges are allowed, but as soon as they become submerged hydrostatics will not be calculated anymore. See also 13.1 Check model.

● Make sure that the normals of all the faces point outward (in the direction of the water). This is of uttermost importance since FREE!ship calculates hydrostatics by integrating the enclosed volume **at the back** of the faces. If the normal of a face points inward, the volume **outside** the hull would be calculated and might even become negative. By using the actual surface for hydrostatic calculations instead of a number of stations, a higher accuracy is obtained. This is especially true when the model has a heeling angle and/or trim, or is fitted with a superstructure. FREE!ship can also check the direction of normals automatically, but correctness is only guaranteed if the model is totally closed, meaning that no other boundary-edges are present except the edges lying on the center plane. Automatic checking can be disabled in the project settings dialog as explained in 4.1 Project settings.

2. Viewports.

2.1 Zooming and panning.

When a new model is opened or started the program by default adds 4 windows. Each window has a different view on the 3D hull. The area of the window on which the model is drawn is called a viewport. Zooming in or out on the viewport is done by pressing the left mouse button and moving the mouse up or down while keeping the left button pressed. Users having a mouse wheel may find it convenient to zoom in or out using their mouse wheel. Panning the viewport is done in a similar manner, only with the right mouse button must be pressed. Only when the viewport displays a perspective view, as in the image to the right, two scrollbars are visible. These can be used to rotate and tilt the model. Another way to rotate the model is keeping the middle mouse button (or mouse wheel) pressed while dragging the mouse, also only in a in a perspective view. Additional options for

Illustration 8

each viewport are accessible from the popup-menu which shows after the right button of the mouse has been pressed.
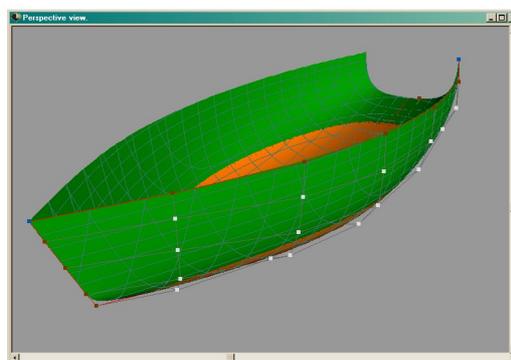
2.2 Selecting items.

Only items visible in the viewport can be selected and only if the viewport is in wireframe mode (shading is turned off). In order to select points or edges the controlnet has to be turned on. Faces can only be selected when the interior edges are turned on. For more information concerning visibility options the reader is referred to 11. Visibility options. It is important to keep in mind that selected faces, edges or points **remain** selected even when they are not visible in the viewport due to a change in the visibility options. To select an item, simply click on it with the mouse. Selected items can be recognized because they are drawn in yellow. If a point is selected, and the user clicks on a different point, this new point will be selected and the previous point will be deselected. Selecting multiple points however is possible by keeping the CTRL-key pressed while clicking on a new point.
If the CTRL key is pressed while an edge is being selected, the program tries to trace the edge until a irregular point is encountered or an edge with a different crease-property. This way it is easy to select an entire row of edges (edgeloop) such as for example the sheerline or a hard chine.
Faces also can be CTRL-selected. In that case all the faces belonging to the same layer and connected to the selected one are also selected or deselected. Faces that are isolated from the selected face because they are totally surrounded by crease edges are not included.

2.3 Dragging control points.

One of the most important options when it comes to modeling the hull is dragging points. In order to do this the controlnet must be turned on. Although it is possible to select points in a perspective view, the actual dragging of the point can only be done in the bodyplan view, profile view or plan view. When dragging a controlpoint all information is updated realtime. This includes stations, buttocks, waterlines and diagonals. Especially when the precision of the model is set to a high value this updating might become slow since each intersection with the hull must be recalculated. If it becomes too slow, try using a lower precision. If it is still too slow, switch off some of these intersection curves since only visible items are recalculated, or try using less intersection curves.

2.4 Modifying controlpoints manually.

If a point is selected, the form displayed to the right is shown, and the position of the point in 3D-space is displayed in it. These values can be altered manually by typing the new location in the appropriate fields. In addition to that the values can also be altered relatively to the current location by typing the character @ in front of the numerical part. If for example the string @-0.2 is entered in the field for the y-coordinate, then all the y-coordinates of **all** selected points will be decreased by 0.20. So the y-coordinate for the displayed point becomes 2.10-0.20=1.90. This is a convenient way to shift a number of selected points. If the project uses imperial units then it is also possible to enter a feet-inch/8 value as follows: 3-2-1, meaning 3ft 2 1/8 inch.

Another way of moving points is by pressing the arrow keys in the bodyplan, profile or plan view. The active point moves a certain distance in the direction of the arrow key that was pressed. This distance, called "incremental distance" is visible at the statusbar of the program, next to the amount of undo memory that is in use. If clicked on the text displaying the incremental distance a dialog appears in which a new value for the incremental distance can be specified. Another and faster way is to press either the + or – key. The incremental distance is then changed by 10%.

The black arrows displayed next to each input field on the controlpoint form can be used to increment the values with the same incremental distance as mentioned above.

2.5 Different drawing modes.

FREE!ship has three different drawing modes which are accessible from the popup-menu under the right mouse button.

- Wireframe (Ctrl-W). Only the points, lines and edges are drawn.
- Shade (Ctrl-F). The surfaces are drawn in a solid color, lines are drawn on top of it. The submerged part of the surface can optionally be shown in a different color.
- Developability check (Ctrl-D). The surfaces are shaded again, only this time parts that are developable are shaded green and parts that are not developable are shaded red. More about developable surfaces can be found in 10.8 Layer properties dialog and 13.4 Develop plates
- Gaussian curvature (Ctrl-G), used to check the fairness of a surface. The model is shaded in colors, based on the discrete Gaussian curvature in each point. Most hulls are curved in two directions, called the principal curvatures. Gaussian curvature is the product of these two principal curvatures. Now there are 3 possibilities here:

  - **Negative Gaussian curvature**. These areas are shaded blue and have the shape of a saddle, since the curvature in one direction is positive while the curvature in the other must be negative.
  - **Zero Gaussian curvature**. At least one of the two principal curvatures is zero, so the surface is either flat or curved in only one direction. In both cases the surface is developable (This is in fact a very important property of developable surfaces). These areas are shaded green.
  - **Positive Gaussian curvature**. The curvature in both directions can be positive or negative, but must have the same sign. These areas are convex or concave and shaded red.
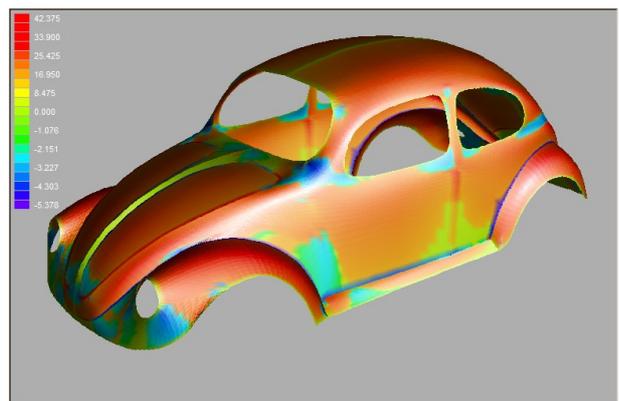
- Zebra shading (Ctrl-E). Another option to check the model for fairness. Regions with a constant light-reflection intensity are shaded in bands. This is similar to the way the human eye detects unfair spots on a surface since the shininess and shadows vary in those areas. If the edges of the zebra stripes are curved smoothly then the surface is smooth in these areas. At knuckle lines they vary abrubtly.

2.6 Printing.

Viewports can be printed, but only if they are in wireframe mode. Regardless of the zoom state of the viewport, the entire model will be send to the printer. If the current view is a perspective view then the scale of the print will be such that the model fits the paper. Other views may be printed to scale.

2.7 Save as bitmap image.

The image as shown in the viewport can also be saved to disk. The following dialog appears in which the desired width or height might be specified. It is also possible to enter the filename and the file location.
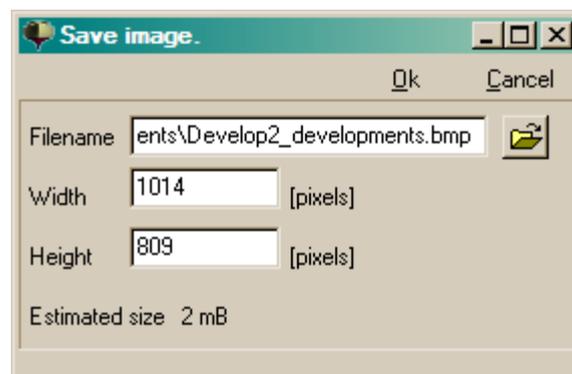
3. File menu.

From the file menu various options are available.

3.1 New.

This starts a new model. The following dialog is shown:

The number of points in longitudinal direction means how many "columns" of points are desired. Points on these columns are roughly in the ordinate plane. The number of points in vertical direction means the number of points on each "column" from the bottom up. The desired number of points depends on (and

Illustration 9

increases with) the complexity of the final hull. But it is easier to obtain a fair surface when the number of points is kept as low as possible. Also the amount of work is reduced, since fewer points have to be faired. Extra points might always be inserted later on in the process, especially in surface areas with high curvature (such as the bilge or bulb). The input values for length and draft speak for itself. With beam is meant the total moulded beam. The last option enables to user to switch between metric units (meters) or imperial units (feet and inches).

3.2 Open.

Use the open option to read an existing FREE!ship model from file. Starting with version 1.90 FREE!ship saves files to a new binary format with the .fbm extension. The old files with the .free extension can still be imported, but saving of this format is no longer supported. Files can still be transferred to older version of the program by using the .fef import/export. To open a .free file, click the open command in the mainmenu. When the opendialog appears, select "Old freeship files (*.free)" from the dropdownbox at the bottom of the dialog.

3.3 Save.

This option saves the current model to file. If a file is saved and a file with that name already exists, it is renamed by changing the extension from *.fbm* to *.bak* This way a backup file is created*.

3.4 Save as.

Save the model while prompting for a filename.

3.5 Import.

FREE!Ship imports the following file formats:

3.5.1 Part.

You can import a part file and add it to the present geometry. How to create part files is discussed in 3.6.1 Part.. FREE!ship automatically detects if the part file uses imperial or metric units and scales the imported geometry to suit the type of units used for the current project.

3.5.2 Carlson .hul file

Import files created with Carlson Hulls shareware program, which is available from http://www.carlsondesign.com/hulls.zip. Information about the rig will not be imported. When importing a file, the user may specify if the intermediate bulkheads, as specified in Hulls, should also be imported. If not then only 5 points on each subsequent chine are imported. From version

1.90 and up a new spline is fitted through the points defined in the Hulls program. Although the actual points in FREE!ship are still outside the hull the points as read from th .hul file are exactly on the hull. This can be easily checked because the original chines from the file are imported and added to the model as markers. Controlcurves are added to the crease edges corresponding to each chine which should coincide with the markers.
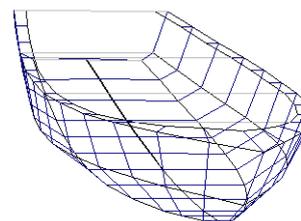
Illustration 10

3.5.3 Import .fef file.

The Fef file format (**F**REE!ship **E**xchange **F**ormat) is of no interest to most users since it is mainly supported by other programs from the same developer.

3.5.4 Surface.

Import a textfile containing a number of 3D curves. This option can best be used when the offsets of a round bottomed hull need to be imported. These curves may have any number of points which may differ from curve to curve. Usually the curves run from the bottom of the hull upwards, however longitudinal curves are allowed too, just as long as all the curves have the same orientation and run in the same direction. It is important that the curves are **not** crossing each other.
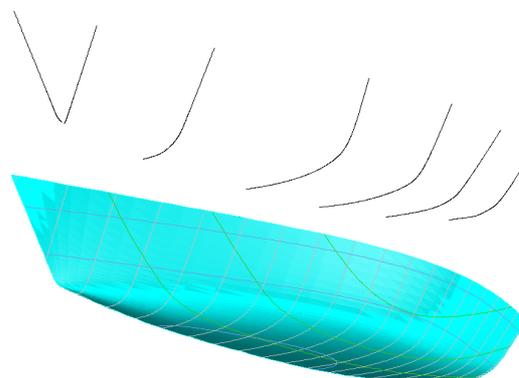
The user will be prompted how many points in longitudinal direction (number of columns) and in vertical direction (number of rows) the imported hull must have. Then the program fits a B-Spline surface through these points such that the new surface interpolates these points.
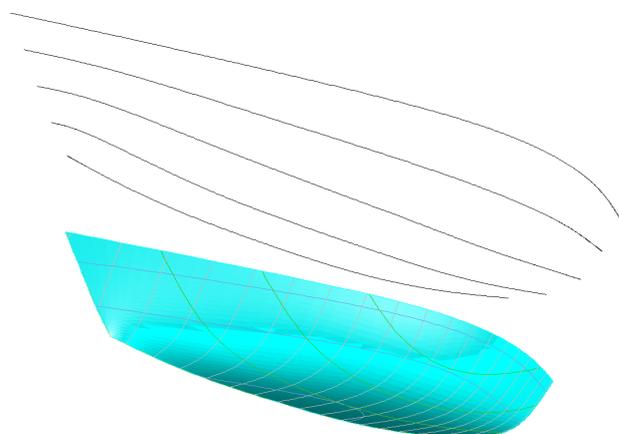
The first line of the file must either be a 0 (zero) or a 1. A zero indicates that all coordinates are in meters while a one indicates that the coordinates are in feet. Each curve is defined by a sequence of X,Y and Z coordinates separated by at least 1 space. The end of a curve is indicated by an empty line after the last coordinate. The last line in the file should be 'EOF'. The following is an example of a file containing 3 stations.

```
                                      0
                          10.62990          0.00000          1.75504
                          10.62990          0.15186          1.87085
                          10.62990          0.36387          2.07768
                          10.62990          0.51880          2.25144
                          10.62990          0.71454          2.51209
                          10.62990          0.91032          2.83897
                          10.62990          1.03680          3.13278
                          10.62990          1.10212          3.33143
                          10.62990          1.18380          3.65010

                          11.81100          0.00000          2.26416
                          11.81100          0.20519          2.48343
                          11.81100          0.36424          2.71927
                          11.81100          0.55190          3.09169
                          11.81100          0.68655          3.41447
                          11.81100          0.80491          3.75381

                          12.99210          0.00000          3.01751
                          12.99210          0.09559          3.19544
                          12.99210          0.18538          3.43133
                          12.99210          0.25068          3.62583
                          12.99210          0.33232          3.86172

                                     EOF
```

A more extensive sample file can be found in the FREE!ship \ships subdirectory and is called *Round hull import demo.txt*. When importing such a text file FREE!ship assumes the following:

- X-coordinates are longitudinal. Positive Y coordinates correspond with the portside of the ship. The base lies at z=0.0 and the aft perpendicular at x=0.0

- All curves have multiplicity of 1. Having 2 curves at the same location leads to errors. Whenever 2 curves exist at the same location these 2 curves must be combined into one by connecting the two segments with a line lying on the center plane. These segments can later be removed.

- The curves must be sorted from aft to front (or bottom up in case of longitudinal curves), and the coordinates of these curves must be sorted from the bottom to the top (or aft to front in case of longitudinal curves).

3.5.5 Importing chines.

If you want to import a hard chined hull then this is the best option. The file has the same format as described in the previous paragraph, only the curves have to run in longitudinal direction this time since they represent chines.
Again the number of points may differ from chine to chine, each chine is ended with an empty line while the last line of the file should contain the EOF identifier.

The curves are imported and the chines are fitted to the datapoints of each imported curve in such a way that the chines from the FREE!ship hull match these curves. The imported curves are also added to the model as markers. The file *chines import demo.txt* contains a more elaborate demo. It is located in the FREE!ship \ships subdirectory. The chines must be ordered from the bottom up with coordinates going from aft to front. At least three curves must be in the file: The keel line, at least one chine and finally the deck- or sheerline. Controlcurves are added to the crease edges corresponding to each chine.

```
      1
    0.000           0.000            0.150
    0.856           0.000            0.048
    1.884           0.000           -0.046
    3.939           0.000           -0.158
    4.966           0.000           -0.184
    5.994           0.000           -0.195
    8.049           0.000           -0.192
    9.590           0.000           -0.163
   10.618           0.000           -0.122
   11.645           0.000           -0.059
   13.700           0.000            0.150

   -0.771           0.000            1.056
    0.685           0.662            0.844
    2.398           1.219            0.666
    4.110           1.536            0.565
    5.822           1.664            0.524
    7.535           1.672            0.522
    9.248           1.575            0.553
   10.960           1.300            0.640
   12.672           0.795            0.802
   14.471           0.000            1.056

   -0.053           0.000            1.683
    0.856           0.421            1.498
    2.911           1.071            1.211
    4.966           1.375            1.077
    7.021           1.436            1.050
    9.076           1.344            1.090
   11.131           0.989            1.247
   13.186           0.272            1.563
   13.753           0.000            1.683

                    EOF
```
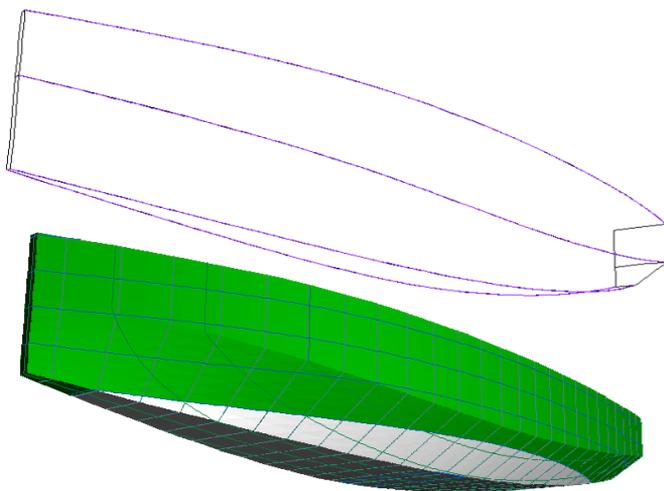
3.5.6 Import Carene XYZ file.

This option is to open a textfile generated by the Carene program, which is available from http://www.epoxy-resins.co.uk/Carene/carene.htm . The textfile contains the coordinates of the chines describing the hull. These chines will be imported into FREE!ship and a spline is fitted such that the chine in FREE!ship lies exactly on that of Carene. The original chine as defined in the XYZ file is added as a marker so that it can be checked visually if the models are the same. Controlcurves are added to the crease edges corresponding to each chine.

3.5.7 VRML.

Import a mesh from VRML 1.0 files. For information regarding the VRML format see :
http://www.bergen.org/ATC/Course/InfoTech/VRML_FAQ.html
http://trap.mtview.ca.us/~tom/tech/languages/vrml10c.html
When a VRML file is imported only the boundary-edges are set as crease-edges. All other crease-edges must be manually set. The only information imported from a VRML file are indexed face sets.

3.5.8 PolyCad files.

Used to import .geo files generated with PolyCad by Marcus Bole. PolyCad can be downloaded for free from http://www.polycad.co.uk/downloads.htm Information currently imported from the file includes either generalized Bspline surfaces or surfaces generated with the Shiplines or Yachtlines option. Contours are also imported.

3.5.9 Michlet waves.

If wave elevations have been calculated using Michlet (see 3.6.11 Michlet), the results can be saved to a file. FREE!ship is able to import this information back into the program. It is important not to use too many panels. A resolution of 50 x 50=2500 panels gives generally a good result as can be seen below. Using more panels really slows the program down. Results of both the rectangular plot and the sectorial plot can be imported into the program.
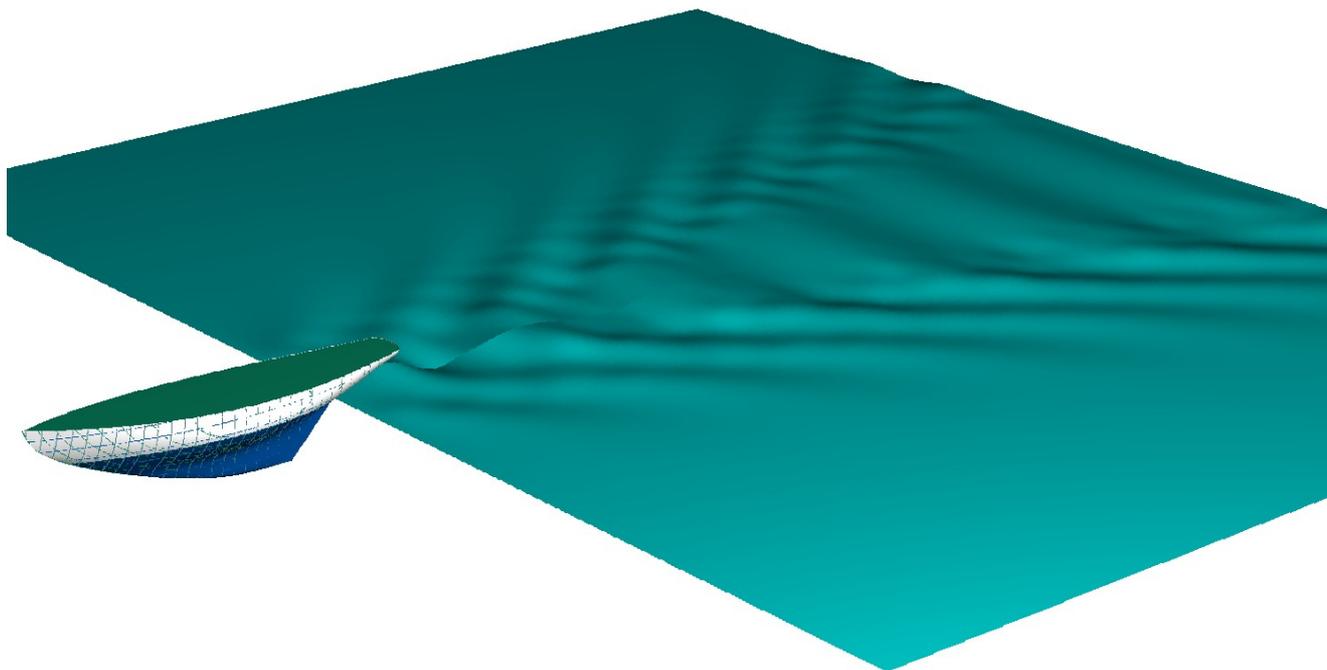
3.6 Export.

FREE!ship currently exports the following file formats:

3.6.1 Part.

It is possible to save a selection of the model as a part to a so called part file. You can do this by selecting the desired faces yourself, or by selecting layers in the layer selection dialog that appears if no faces were selected manually. Apart from the points, edges, faces and controlcurves also layer information is saved. This way for example a keel can be saved to a file and imported in another design.

3.6.2 IGES.

Subdivision surfaces can be used to model very complex shapes with only one mathematical surface, which cannot be done with one single NURB surface. Because of this it can be difficult to translate the subdivision surface into NURB surfaces. Normally one NURB surface is created for each face with 4 points. Faces with more or less points are subdivided in as much NURB patches as there are points in the face. So a three sided face is converted to 3 NURB patches. This can lead to an enormous amount of patches in the IGES file. This is not necessarily a problem, unless you want to modify the surfaces in another CAD program. Therefore FREE!ship uses an algorithm that assembles as much 4 sided faces as possible to form larger NURB surfaces. This reduces the amount of exported surfaces significantly. In some cases it can even be reduced to a single NURB surface. Only surfaces are exported to the IGES file. They are exported as NURB surfaces (IGES entity 128).

3.6.3 DXF 3D mesh.

The same algorithm as described above is used to form polygonal meshes. These meshes are exported as DXF polymeshes. Faces that cannot be converted to meshes are exported as 3D faces. 3D faces are small three or four sided surfaces used in AutoCad. The information send is equal to what is visible in the viewport. Only visible layers are sent. If the viewport shows both halves of the ship then both halves are exported.

3.6.4 DXF 2D polylines.

The intersection curves (except diagonals) can be exported to a 2D DXF file. A dialog appears in which you can specify the directory where the files should be saved and the units in which they are saved (meters, centimeters, millimeters, feet or inches). Each curve can be exported to a different file, or curves can be grouped and saved to 3 files (stations, buttocks and waterlines). Because of

the fact that the curves are exported as polylines, curved sections are approximated by straight line segments. The max. length of such a straight line segment is adjustable which makes this kind of export ideal for CNC data.

3.6.5 DXF 3D polylines.

All intersection curves such as stations, buttocks, waterlines, diagonals and crease edges are exported to an AutoCad DXF file as 3D polylines. Controlcurves are exported also. Again information is exported as visible in the viewports.

3.6.6 Wavefront file (.obj).

Visible parts of the surface are sent to an .obj file as specified at http://www.fileformat.info/format/wavefrontobj/. Color information is not included at this point.

3.6.7 STL file.

The STL format is mainly used for manufacturing purposes, but sometimes also for exchanging data with other CAD programs. All visible parts of the surfaces are send to the file as a large collection of small triangles.

3.6.8 Export .fef file.

See:3.5.3 Import .fef file

3.6.9 Offsets.

Offsets of intersection curves and controlcurves are exported to a text file. Regardless of the visibility settings all available lines are exported. Of each line only the portside is send to the file.

3.6.10 Coordinates.

This option saves the coordinates of all the controlpoints from the model to a textfile. This textfile can be read directly into Rhino.

3.6.11 Michlet.

Michlet is an excellent free CFD program which can be downloaded from http://www.cyberiad.net/michlet.htm. The program can be used to give a more accurate prediction of frictional and residual resistance. It is based in Mitchell's theory and is best suited for ships with a large length/beam ratio (7 or higher) and low blockcoefficient. However Leo Lazauskas, the author of Michlet, reported that even ships with a L/B ratio of 5 and up may be used, although this reduces accuracy. Michlet also predicts the wave elevations of the far field (the waves behind the vessel). For more information regarding the use of Michlet and its input values the user is referred to to Michlet manual. One important aspect which I believe is not mentioned in that manual is that the speed used for prediction wave elevations cannot be higher than the maximum speed specified for the resistance calculations. So make sure that this is high enough.
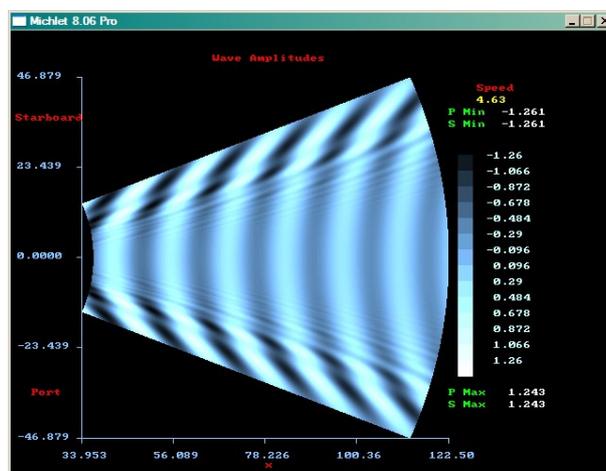
There are currently 3 ways of exporting a hull to Michlet:
- **Monohull**. This is the default option for sending monohulls.

- **Monohull as catamaran**. This option is intended for designing catamarans. The usual way to do this is first design the hull as a monohull, with it's centerplane still on the XZ plane through the origin. You can send the hull to Michlet as a multihull with a specified distance between the two center planes of each individual hull. Michlet can be used to optimize this distance by varying it as the interference of the two hulls shows up in the wave pattern (and in the resistance curves).
- **Catamaran**. If you have a design consisting of two hulls, again the distance must be specified. however in this case it **must** be the actual distance between the center planes of the hulls otherwise FREE!ship cannot calculate the proper offsets of the hulls.

If you want to use Michlet it is important to realize that each individual hull in Michlet must be symmetrical with respect to its own centerplane. In other words, it cannot handle asymmetrical hulls. The results of the wave elevation calculation can be imported back into the program. More information about this topic is given in 3.5.9 Michlet waves.

3.6.12 Archimedes.

FREE!ship exports all stations in the model either to Archimedes single body (.app file) or to ArchimedesMB, which is the multi body version of Archimedes (.hll file). Both versions of Archimedes can be used to perform additional hydrostatic and stability calculations. Archimedes is low-cost software and is available from http://www.naval-architecture.co.uk. This option is only enabled if stations are added to the model.

3.6.13 GHS.

Export all available stations to a GHS file. GHS files can be imported by most hydrostatic programs that perform calculations based on a bodyplan and is a widely accepted format.

3.7 Exit.

Shuts down the program.

3.8 Preferences.

The following dialog in Illustration 11 shows in which program preferences may be altered. These modified preferences are stored in the file *freeship.dta* located in the same directory as the program. To restore the preferences to the default settings it suffices to delete this file and restart the program. You can restore modifications to color settings by pressing the reset button.

You can also modify the language used by FREE!ship. More about the language support can be found in Chapter 17.
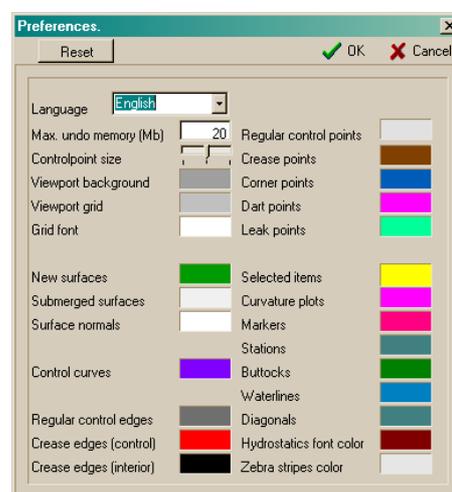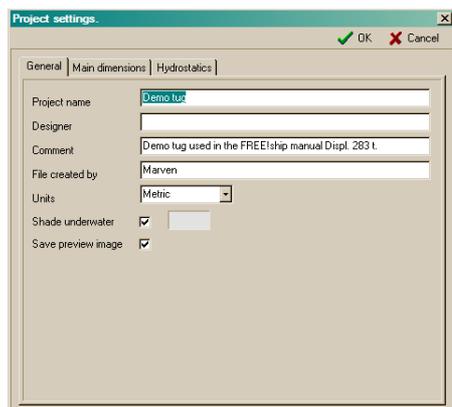

Illustration 11

4. Project options.

4.1 Project settings.

The project settings dialog will let you specify various project settings. It has a number of tab pages.

The first tab page is used for general information about the project, such as the project name, name of the designer, some comment, the name of the person who created the file and the type of units used for this project. This can either be imperial or metric units.

It is also possible to turn shading of the submerged hull in a different color on or off, and to specify the color to be used for the submerged body.

There's also a switch to enable or disable the storage of a preview image in the project file.
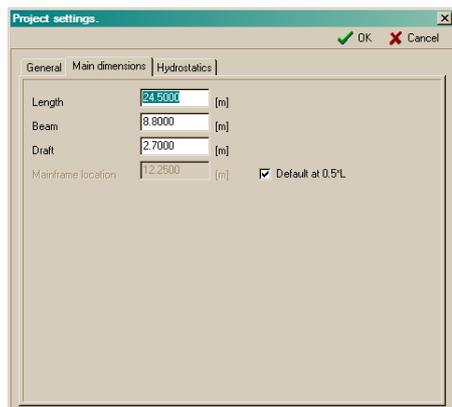
The second tab page is used to define the main particulars of the model, and the location of the midship section. By default this is at half the defined project length but this can be modified.
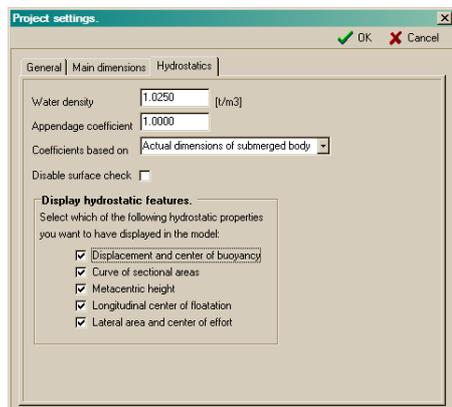
The last tab page is used for all hydrostatics related settings, such as the density of the water and appendage coefficient. This is a factor normally used to incorporate shell thickness and appendages such as the rudder in the displacement calculation, usually in the range 1.005 - 1.010. There's also a dropdownbox which can be used to specify how hydrostatic coefficients, such as for example the blockcoefficient and prismatic coefficient should be calculated. This can be done using either the dimensions specified in this project dialog (customary when designing larger ships) or the actual dimensions of the submerged body(customary when designing yachts and small boats) .

Each time hydrostatics are calculated, the program checks the direction of all facenormals. If the normals point in the wrong direction after this check, it is best to disable the automatic check and manually flip the normals (9.2 Flip) to the correct side.

FREE!ship can also show some hydrostatic features in the 3D model in wireframe mode (see 11.10 Hydrostatic features). You can also specify here which features should or should not be plotted.

4.2 Linesplan.

FREEship! enables the user to view the complete formatted linesplan of the ship. This can be done in two different modes, wireframe mode (to the left) and the filled mode (to the right). The linesplan shows only the present intersection curves, regardless of the visibility setting of the corresponding intersection curves. So stations are always shown in the linesplan, even if they are switched off in the hullform views. Currently this linesplan can be saved as a bitmap, to a dxf file, or sent directly to the printer/plotter. The linesplan can also be drawn in black & white by clicking on the appropriate button in the toolbar. Using fill colors is not possible in black & white mode. Only if the model contains no diagonals, the plan view might optionally be mirrored so that both sides are visible.

Some layers can be hidden from the linesplan. How this is done is described in 10.8 Layer properties dialog.
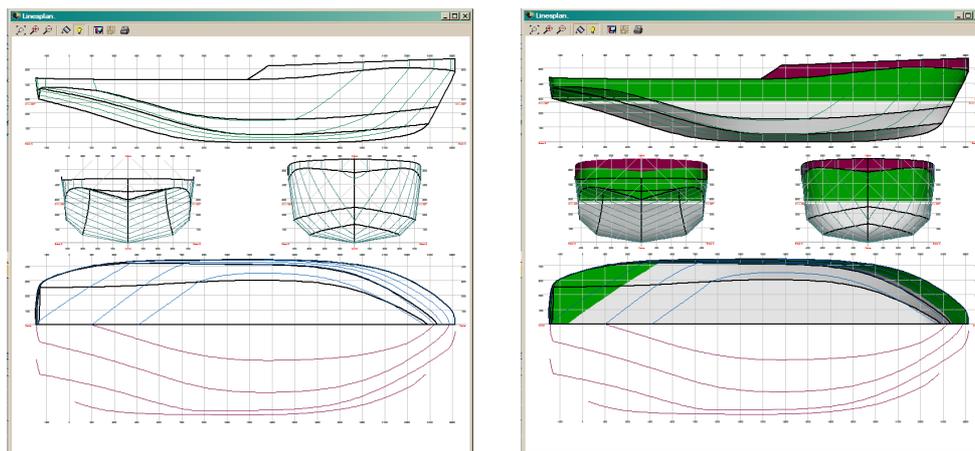
Illustration 12

5. Edit menu.

5.1 Undo.

Undo previous editing actions. FREE!ship stores all actions. When a new file is read into memory, the previous undo data will not be destroyed.

5.2 Delete.

Use this if you want to delete selected items. The program first deletes all selected faces, then the edges and finally the selected points. Any points or edges that appear to be unused after this process are deleted also. Note that when a point is deleted all attached faces and edges are deleted too. If an edge is deleted, any attached faces will also be deleted. See also point collapse and edge collapse.

6. Point operations.

6.1 Add.

Adds a new point in 3D space. The new point is by default located at the origin (0.0, 0.0, 0.0). Adding new points is only enabled if the controlnet is visible.

6.2 Align.

If more than two points are selected it is possible to align them so that they form a straight line. This is done by projecting all the selected points on the line segment through the first and last selected point. They are projected to that line rather than uniformly distributed to keep the displacement of the points minimal.

6.3 Collapse.

This removes a selected point without deleting the surrounding geometry. A point can only be collapsed if it is attached to exactly two edges. The point is then removed, and the two edges are combined into a single edge. If a point is attached to more than 2 edges, the other edges might be removed first by collapsing these edges. The example below shows a point before and after collapsing it.
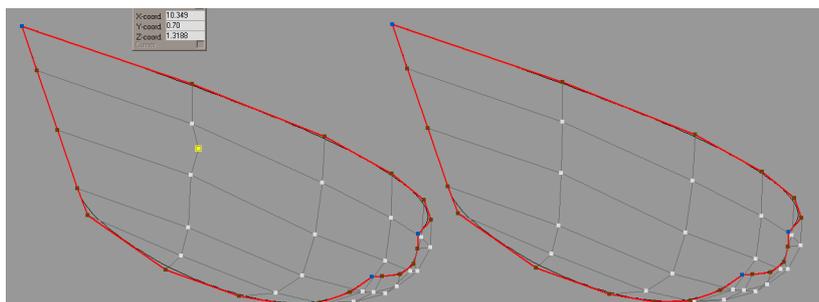

Illustration 13

6.4 Insert.

For inserting a new point on an existing edge the reader is referred to the edge-split operation.

6.5 Insert plane.

This operation intersects all edges that are **visible** with a plane. If such an intersection point exists, it will be inserted on the edge. After this, faces that have multiple newly inserted points will be split by inserting a new edge. This is a convenient way to insert for example a while range of points at a certain ordinate location. There is also an option to add a controlcurve to the newly created edges. The type of plane (vertical, horizontal or transverse) can be specified as well as the location by entering the desired distance into the dialog that appears.

6.6 Intersect layers.

This option is used for finding the intersection curve of two layers, so it is only enabled if more than one layer exists. If two layers are selected than all the edges of the first layer are check for an intersection with all the faces of the second layer. If such an intersection exists than the point is inserted in the edge. After the intersection test all inserted points are connected with new edges which form the intersection curve of the two layers. Remember that only the first layer is affected by

this operation, the second layer is left undisturbed. Another important issue is that points are only inserted in edges, **not** in faces. This option can be used for example to find the intersection of the hull with a keel or rudder.

6.7 Lock points.

All selected unlocked points will be locked. Locked points appear dark gray on screen and cannot be moved. None of the available editing operations has any effect on locked points. This option is only enabled when more than 1 unlocked point is selected.

6.8 Unlock points.

This unlocks selected points that are locked, so that they can be modified again. Only enabled if at least 1 of the currently selected points has previously been locked.

6.9 Unlock all points.

This unlocks all points in the model, whether they are selected or not.

7. Edge operations.

7.1 Extrude.

Extruding edges is a convenient way to create new surfaces. Since an edge may only have a maximum of two faces attached, only boundary-edges are allowed to be extruded. Illustration 14 shows how a deck is easily added by extruding the sheerline. The three stages of the process are:

🍷 Select the boundary edges that must be extruded. Select the edge-extrude option from the menu. A dialog appears in which the direction of the extrusion is specified. In this case the extrusion direction is 0.0 in longitudinal direction, -2.25 in transverse direction and 0.02 upwards.

🍷 The edges are extruded in the specified direction. New faces are created and added to the currently active layer. (See 10.1 General information about layers)

🍷 The newly created points are moved to the centerline, and the deck is finished.
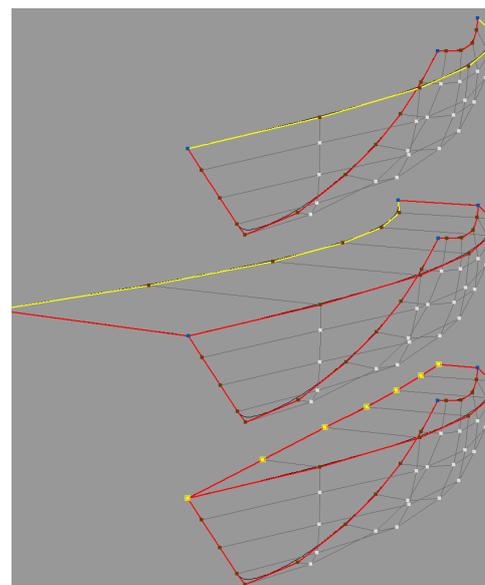

Illustration 14

7.2 Split.

Selected edges are split in two by inserting a new point in the middle. After the operation all newly created points are selected. This is convenient if new edges should be inserted. In that case multiple edges can be selected and split in two. All selected points belonging to the same face may then be split by inserting a new edge. (see 7.4 Insert). The image to the right shows two selected edges before and after the split. Note that this way a face consisting of 6 points is created. The two selected points should preferably be connected, thus splitting the face in two regular faces. This ensures a more regular grid and a smoother surface. (see also 1.6 Guidelines to subdivision modeling).

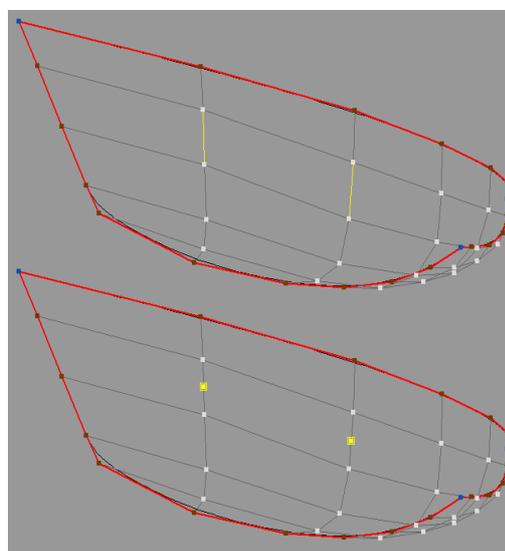*Illustration 15*

7.3 Collapse.

Collapsing an edge removes the edge and combines the two attached faces into one new face. Edge collapsing only makes sense if the selected edge is not a boundary-edge. The example to the right shows how multiple edges are collapsed in one pass. Only two points on the boundary-edges remain. These can be collapsed using the point-collapse option from the menu.

7.4 Insert.

A face can be split into two new faces by inserting an edge. To do this at least two points have to be selected. Both points must share the same face, and no edge is allowed to already exist between these two points. To ensure a fair surface it is recommended to extend inserted edges (as those seen to the right) to a crease or boundary-edge if possible.
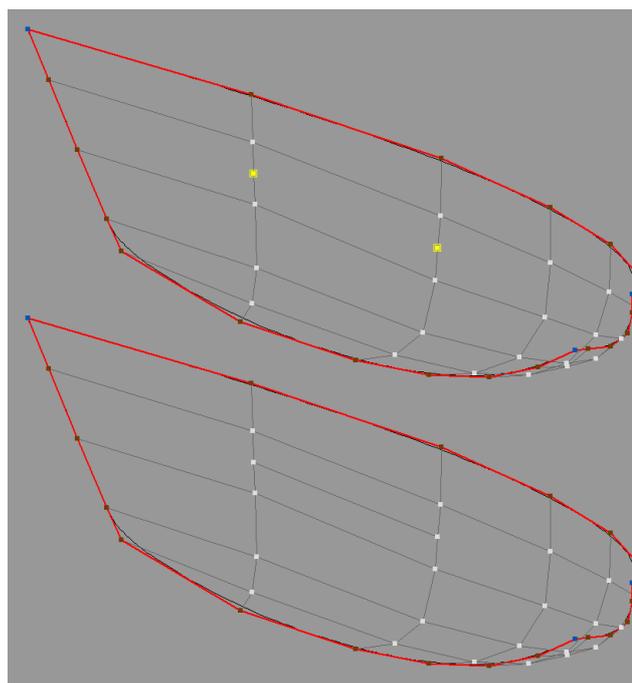
Illustration 16

7.5 Crease.

Setting selected edges as crease-edges allows the user to add knuckle lines to the hull. The crease-property of boundary-edges cannot be changed. FREE!ship treats all boundary edges by default as crease-edges. The image below shows how a hard chine is created. To the left the model without the chine is visible. To the right the yacht with the new knuckle line is displayed. In this specific example the knuckle line runs over the full length of the hull. This is not absolutely necessary. Knuckle lines may run freely over the surface.

Illustration 17

8. Curve operations.

8.1 Controlcurves and fairing.

To have a better control over the shape of the surface, controlcurves can be added to the model. These controlcurves are assigned to edges, and after each subdivision step the new edge-points are not only inserted into the surface but also into the curve. This ensures that the controlcurves are always exactly embedded in the surface, regardless of the precision setting of FREE!ship. If the curvature visibility i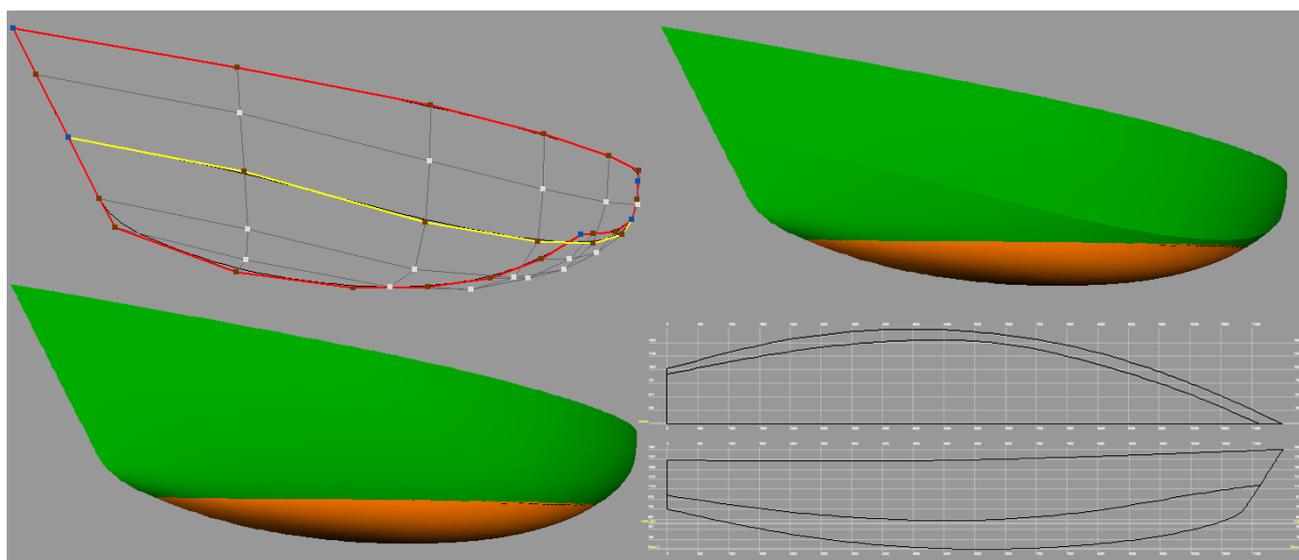s switched on, then the curvature plot of the selected controlcurves is shown also. This curvature plot is updated in realtime if one of the points is moved. If the curvature plot is interpreted and used correctly it is possible to produce a perfectly fair surface. Bumps or dents in the surface that are too small to be seen on screen with the naked eye are easily identified.

So what is curvature anyway? Curvature can be defined as follows:

the rate of change (at a point) of the angle between a curve and a tangent to the curve
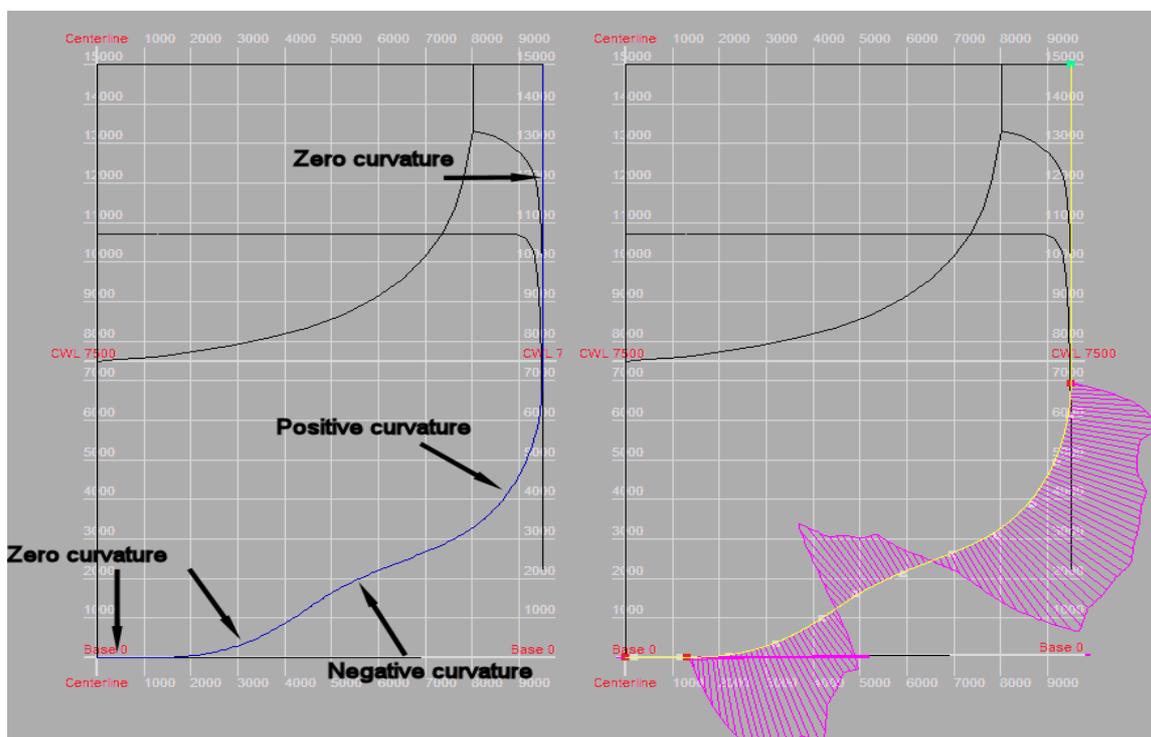
The image above shows a controlcurve in the aft part of a container ship. To the left the controlcurve is shown in blue, while to the right the controlcurve is show in a selected state (yellow) together with it's curvature plot (fuchsia). The straight parts of the curve have zero curvature. If you travel along the curve from the bottom to the direction of the deck, first the curve starts bending to the left. In this area the curvature is positive. At a height of about 2.5 meters the curve starts bending to the right, here the curvature becomes negative. A little bit further along the curve it bends to the left again, so the curvature becomes positive. How is this translated into the curvature plot? At a number of points on the curve the curvature is calculated and drawn as a line, perpendicular to the curve. The larger the line, the larger the curvature. If the curvature is positive the line is drawn on the opposite site of the curve. So while the absolute value of the curvature in a point is not that interesting, the way it changes along the curve is. This is a measure of the fairness of the curve. You don't want abrupt changes in the curvature, it should vary as smoothly as

possible. And very often, especially with small boats and yachts, a change of the sign of the curvature as seen in the image above is highly undesirable. Below is an example of a controlcurve from a sailing yacht. The upper part of the image shows a poorly faired curve. We see a change of the curvature sign in an area where it should be positive, followed shortly after that by a sudden increase in the size of the curvature. After that the curvature size rapidly drops, just to increase again at the bow. The lower half of the image shows the same controlcurve after being faired. It is obvious that the curvature changes gradually now and the curve is very smooth.
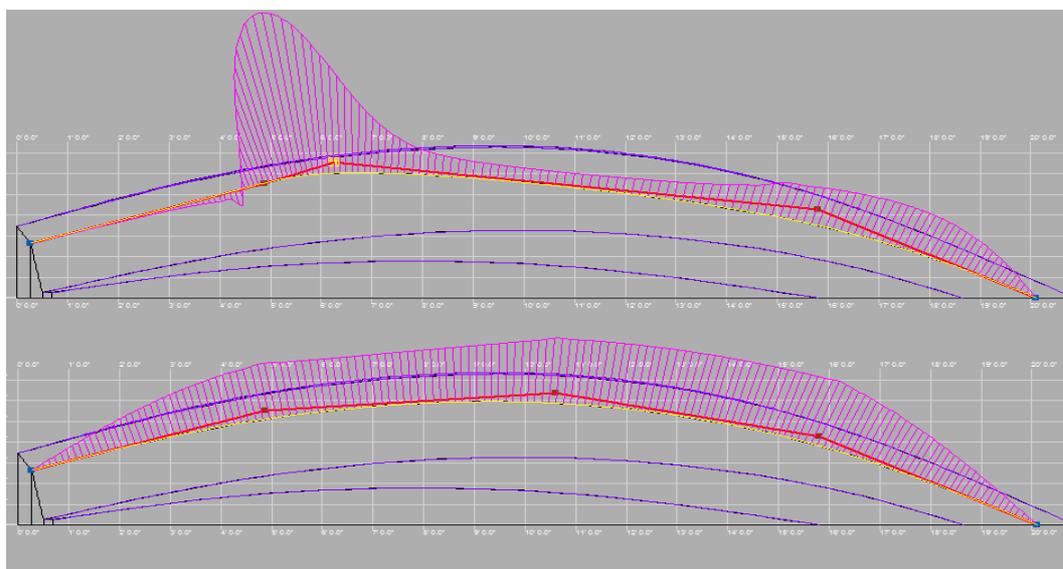
One thing to bear in mind is that the curvature at the first and the last point of the curve is always zero. This is due to the way the curve is being drawn, and it has nothing to do with the actual curvature of the surface at that point. Controlcurves are easier to fair when the controlpoints are spaced more or less evenly along the curve and are regular whenever possible. The less controlpoints a curve has, the easier it is to produce a good running smooth curve.

8.2 New

First select a number of edges that are connected by their start and endpoints. (This is easier when you hold the control key on your keyboard pressed down when selecting an edge) After that it is possible to create and assign a controlcurve to these edges. Only one controlcurve can be assigned to each edge. If the new curve is not shown on the screen, make sure that the visibility of controlcurves is turned on.

9. Face operations.

9.1 New.

Add a new face using previously selected points. These points have to be selected in the correct order. If looked in the direction of the new face as seen from the water, the normal of the new face points outward if the points are sorted in counterclockwise order. If selected in clockwise order, the normal points inward. All normals **must** point outward in the direction of the water (see 1.6 Guidelines to subdivision modeling). The direction of facenormals is automatically checked and corrected (if possible) if this option is not disabled in the project dialog. This check is performed each time hydrostatics are calculated or when the check model option is chosen from the menu.

9.2 Flip.

This option can be used to manually flip the normals of selected faces to the other side. The normals of a face can be visualized by selecting the specific face. Make sure that both interior edges and visibility of normals are turned on. When displaying normals, each normal is calculated as the average normal in a point of the refined subdivision mesh. This average is calculated from all faces surrounding that point. Along the boundary of an edge sharing two faces with opposite normal directions, this may seem a bit strange as can be seen on the left side of the image below. The normals along these boundaries look as if projected to the surface.
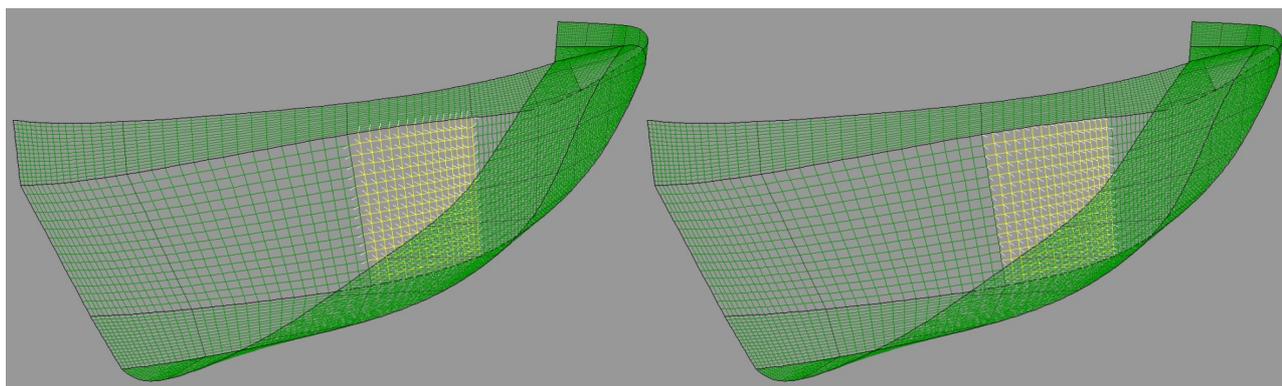

Illustration 18

10. Layer operations.

10.1 General information about layers.

The hull created with FREE!ship consists of only 1 surface, even if multiple separate surfaces appear on the screen that are not connected to each other. When modeling complex models the information on the screen may sometimes be overwhelming. Therefore layers are implemented. Each face is assigned to a layer. These layers have certain properties such as for example color and visibility. This way it is possible to group faces into a layer and assign those properties to all faces. The visibility property of these layers makes it possible to hide them from the user. If all faces attached to an edge or point are invisible, the edge or point in question will also not be shown. This ensures an optimal view on the model when selecting items or dragging points. Faces assigned to a layer all share the properties of that layer.

10.2 Active layer.

At all times an active layer is present in the model. If **no faces are selected**, the dropdown box in the toolbar displays which layer is currently active. If one or more faces are selected belonging to the **same** layer, this dropdown box shows which layer this is. This might be a different layer then the active layer. When multiple faces are selected which are assigned to **different** layers, the

Illustration 19

dropdown box turns blank. All newly created faces created by extruding edges or manually adding faces, are assigned to the layer which is currently active.
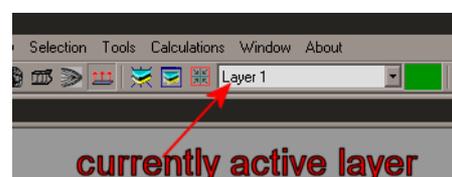
10.3 Assigning faces to a different layer.

Assigning faces to a different layer is done as follows:
- Select the faces in question
- Pull down the dropdown box and click on the new layer.
- Deselect the faces.

All faces should now be assigned to the new layer.
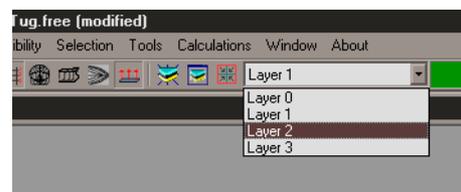
Illustration 20

10.4 Active layer color.

Modify the color of the active layer. This color is also visible in the toolbar, right next to the dropdown box.

10.5 Auto group.

This option extracts groups of faces which are totally surrounded by crease edges. Then each group of faces is assigned to a new layer. If no faces are selected, all faces of the model will be used. Otherwise only the selected faces will be grouped. FREE!ship tries to save as much of the present information as possible. If a set of faces is extracted, and they already belong to the same layer then this layer is left undisturbed. Auto grouping is only enabled when interior edges are turned on.

10.6 New.

Adds a new empty layer to the model
and makes it the active layer.
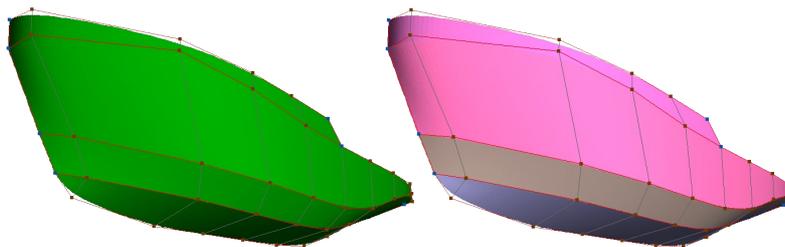
10.7 Delete empty.

Only enabled when the model contains at least one empty layer and when more than 1 layer is
present. When selected, all empty layers are removed from the model. This also includes the active
layer if it is empty. At least one layer remains as the active layer.

10.8 Layer properties dialog.

A window is displayed showing all layers and
their properties. The left half of the window shows
a list containing all available layers in the model.
By clicking on the name of a layer, this layer is
selected. The properties of this selected layer are
then displayed to the right. Double clicking on a
layer in the list on the left side makes it the active
layer. From within this dialog it is possible to turn
layers on or off or to modify the following layer
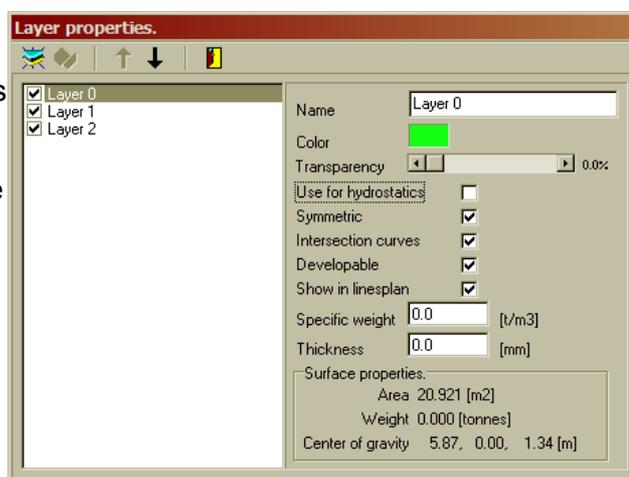properties:

Visibility.

> The checkboxes on the left side indicate
> whether the corresponding layer is visible
> or not. Click on the checkbox to turn the layer on or off. Points or edges from the controlnet
> belonging to invisible layers are also hidden, which makes modeling of complex models
> easier.

Name.

> The layer name is displayed in the list at the left, but it can only be modified at the right side
> of the window. FREE!ship does not require the layer name to be a unique name, since all
> layers are identified by an internal unique identification number. Some CAD programs
> however, such as Autocad, do not allow spaces in the name of a layer or duplicate names.

Color.

> The layer color is used for shading the model. It is also used in the linesplan and for
> developed panels. The color of a layer can be modified by clicking the colored square to the
> right. A dialog then appears in which a new color can be chosen.

Transparency.

> Sometimes it is nice to shade certain surfaces (partially)
> transparent, such as windows for example. The amount
> of transparency can be modified by moving the slidebar.
> The amount of transparency can range from 0% (totally
> solid) to 100% (invisible).   Note though that transparent
> shading might consume a lot of memory and
> significantly slow down the shading process. Since
> normal Z-buffer shading or plain alpha blending
> produces strange artifacts, the only way to do this
> properly is by keeping track of all surfaces covering a particular pixel on the screen and then
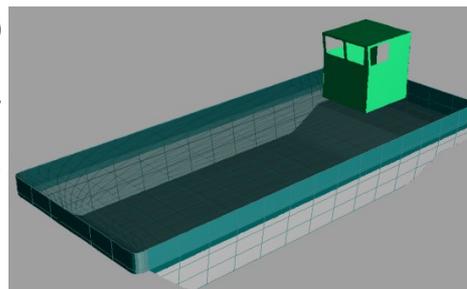
drawing all these surfaces from the back to the front. This costs extra memory and CPU time, but apart from being a bit slower it should not pose any real problems.

Symmetric.

Only if a layer does **not** contribute the hydrostatics it can be a non-symmetrical layer. So generally it can not be used to create asymmetrical hulls. It can be used however to add asymmetrical deckhouses or other objects on the hull, such as sails, people etc.

Use for hydrostatics.

FREE!ship uses the faces of the subdivision mesh for hydrostatic calculations (see 15.2 Design hydrostatics). It calculates the volume enclosed by these faces. Sometime however there are surfaces present in the model that should not be included in the hydrostatic calculations. This is particularly the case if the faces of a layer do **not** form an enclosed volume, but only a surface, such as a sail for example. If a sail were to be included in the calculations, FREE!ship would calculate the volume aft of the sail (if it is submerged) as a volume. Since this volume extends to infinity (there is no backside surface present) it would introduce an error. So specific layers can be excluded from the calculations by removing the check from the checkbox. See also 13.1 Check model for more information concerning leak points.

intersection curves.

By clicking this checkbox, the intersection curves property of a layer can be enabled or disabled. If the checkbox is not checked then the faces of this layer will not be included when the intersection curves are calculated. For complex models it is often convenient to display stations, buttocks, waterlines and diagonals of the hull only, and not for the deck, superstructure etc. This setting has **no** influence on the hydrostatics.

Developable.

Developable hulls can be build from flat plates which are only bend in one direction. Most hulls are not developable since the surface is curved in two directions. Layers from which the developable property is checked are shaded differently. Developable areas of these layers are shaded with a light green color. Areas that are not developable are shaded red. This is a convenient way to check if a hull is indeed developable. Illustration 22 shows an example of a multi-chine motorboat. It can immediately be seen by the green color that almost the entire hull is

Illustration 22

developable. Just a few very small spots in the topside and bow, and a larger area in front at the bottom are colored red. Those very small spots are mostly numeric errors (FREE!ship uses a very small tolerance). The larger bottom area however is not developable from a mathematical point of view. Developable hulls are often made of plywood, which is far easier to bend than metal as a result of different material properties. In reality "almost" developable hulls can perfectly be build using plywood, whereas the same hull build of metal requires "torturing" the metal to get it into shape. If one or more layers are marked as developable, the program can unfold (or develop) this 3D surface onto a flat plane as explained in *13.4 Develop plates.*
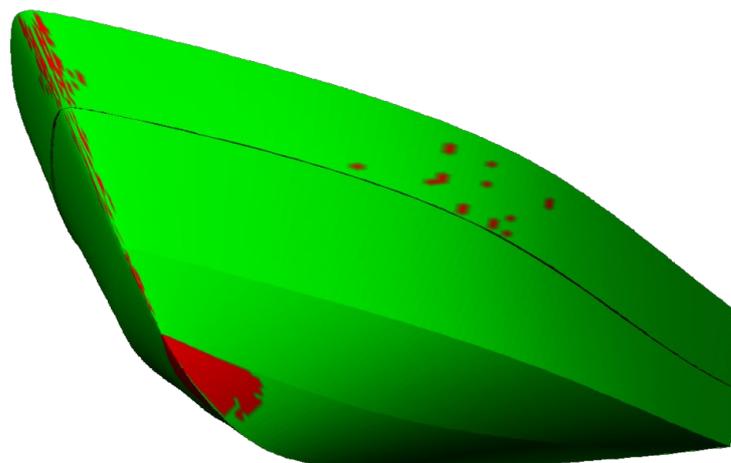
Show in linesplan.

Sometimes a layer contains items you don't want to be seen in the linesplan. An example of this could be a mast and sails. These are relatively high compared to the rest of the boat. Showing these in the linesplan view would cause the hull to appear very small. Therefore some layers may be hidden. Be aware though that the scale of items in the linesplan is also determined by the intersection curves. If a layer would contain a sail, and the intersection

curves property is checked, intersection curves of this sail would still be calculated and seen in the linesplan. Therefore it is best if you want to hide layers from this view to also disable calculating intersection curves from those layers.

Material properties.

There are two input fields at the bottom that can be used for a weight estimation of a layer. In the "specific weight" field the density of the used material can be entered, for example 7.8 tons/m3 in the case of steel. In the field below that the average thickness can be specified. These two properties combined with the total area of the surface assigned to this layer result in a weight estimate and corresponding center of gravity. This is shown when the design hydrostatics are calculated.

Below the material properties the surface area, weight and center of gravity of the selected layer are displayed. The black up and down arrows in the toolbar can be used to move a selected layer up or down in the list. Developable layers will appear in the same order in the window with developed panels.

11. Visibility options.

11.1 Control net.

The controlnet is the combination of points and edges that form the initial subdivision mesh. These are the entities that can be manipulated by the user to shape the surface. If all the faces attached to a certain point or edge belong to layers which are turned off, it will not be drawn to the viewports. That way only the points or edges of interest will be shown.
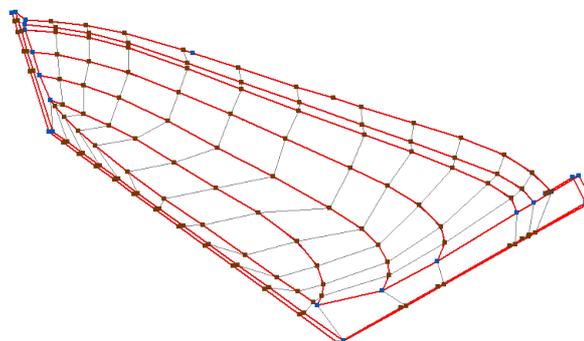

Illustration 23

11.2 Controlcurves.

Controlcurves are curves that are assigned to edges of the controlnet and are used to fair the surface. The visibility of these control curves is not depending on the visibility of the controlnet. In fact, selecting and manipulating controlcurves is often easier when the control net is not visible. Points and edges assigned to a controlcurve automatically become visible whenever a controlcurve is selected.
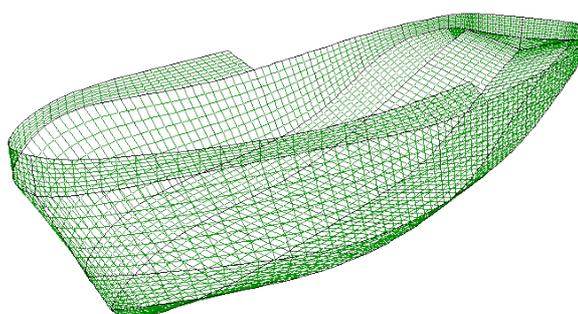
11.3 Interior edges.

The interior edges are in fact the edges of the subdivided surface. The higher the precision is set, the more edges are shown. The interior edges are drawn in the color of the layer they are assigned to.

Illustration 24

11.4 Show both sides.

Since almost any ship is symmetrical in respect to the centerplane, only the portside of the hull is modeled. If less information is shown it is easier to select a point, edge or face. Both sides can be shown however so that the designer has a good impression of what the entire hull looks like. Not only the surface is drawn symmetrical, also the intersection curves. Showing both sides of the hull is possible in both wireframe view and shaded view.
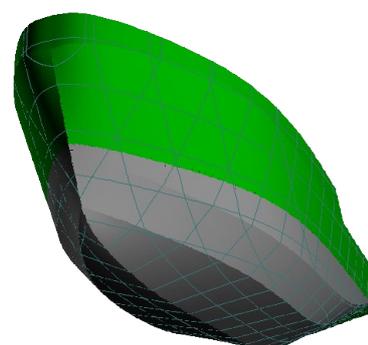
11.5 Grid.

If intersection curves are added it is also possible to have a grid displayed. This grid marks the location of these intersection curves. It is visible in wireframe and shaded mode and next to each line its distance is printed. In addition the baseline, centerline and dwl are also indicated. The grid is visible in all views except for the perspective view. This grid is shown, regardless of the visibility setting of the intersection curves.
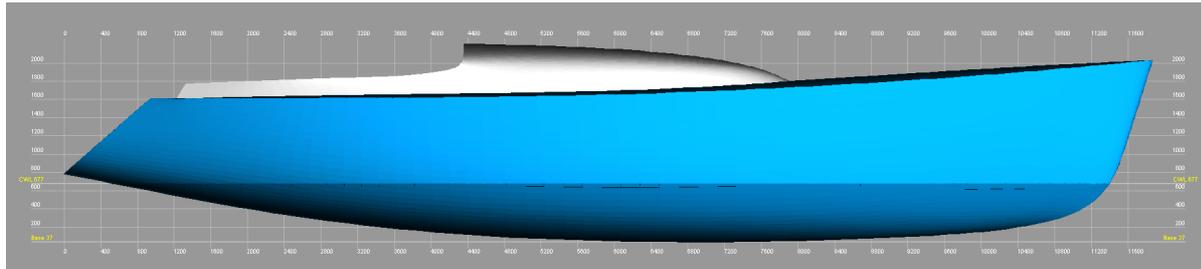
Illustration 25

Illustration 26

11.6 Stations.

Draws all present stations to the viewport. This option is only enabled if stations are added to the model.

11.7 Buttocks.

Draws all present buttocks to the viewport. This option is only enabled if buttocks are added to the model.

11.8 Waterlines.

Draws all present waterlines to the viewport. This option is only enabled if waterlines are added to the model.

11.9 Diagonals.

Draws all present diagonals to the viewport. This option is only enabled if diagonals are added to the model.

11.10 Hydrostatic features.

FREEship also provides the option to plot some key hydrostatic values in the model. These are:

• Center of buoyancy
• Displacement
• Center of floatation
• Lateral center and area
• Metacentric height
• Curve of sectional areas. Contrary to the other values this curve is only plotted in the profile view of the hull. Of course these values can only be shown if the model is consistent enough to calculate the hydrostatics at the design draft (so no leaks below the waterline). The values are updated in realtime when the model is being modified. You can specify which data you want the program to show in the project settings dialog (see 4.1 Project settings).
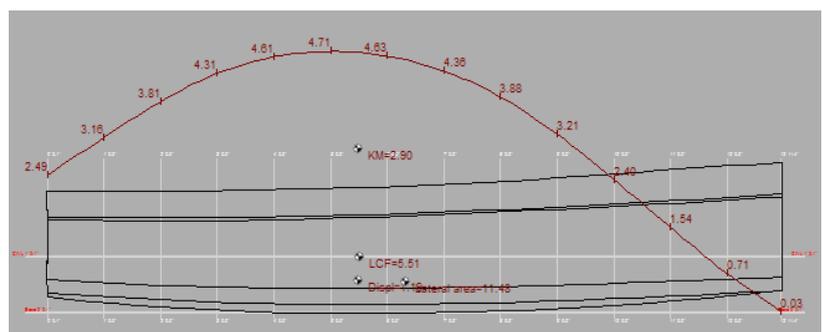
11.11 Flowlines.

Show or hide flowlines. The flowlines that are displayed by FREE!ship are calculated through analysis of the surface geometry only and have <u>nothing</u> to do with CFD. This is a huge simplification as speed, pressure and waves are excluded from the calculation. Despite this simplification the flowlines show a resemblance with those calculated wit CFD programs, but they only are added to give the designer an impression of how the water will approximately flow. Real CFD calculations are of course much more accurate and reliable. You can add a flowline by keeping the alt-button pressed and clicking with the mouse on a point below the waterline surface (profile, plan or bodyplan view only). This point is used as the origin of the flowline. From there the flow is traced as far as possible to the stern or until it penetrates the design waterline. Flowlines are only traced along surfaces that belong to a layer that is also used for hydrostatic calculations (generally the shell of the hull). The image above shows some flowlines at the bow of a hull with a bulb. The background image shows the results from a CFD calculation. The small black lines represent the direction of the flow as calculated with CFD, the blue curves are the flowlines calculated by FREE!ship. Flowlines can be selected and deleted like any other geometry in FREE!ship.
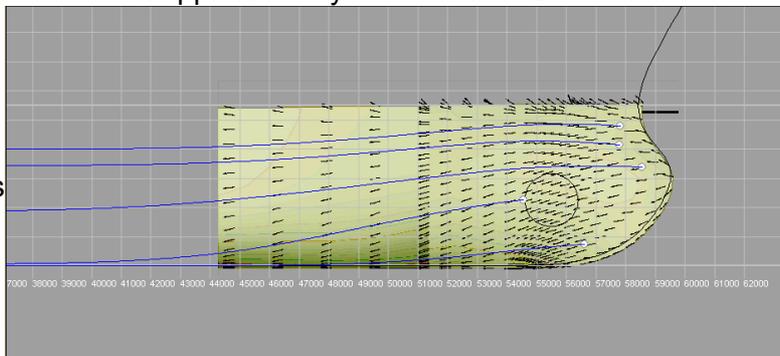
11.12 Normals.

If this option is switched on, normals of **selected** faces are drawn. The normals appear as thin white lines, pointing either inward or outward the hull. This option is only enabled if the interior edges are visible. A normal is drawn at each interior point of the subdivision surface. The higher the precision is set, the more normals are drawn.
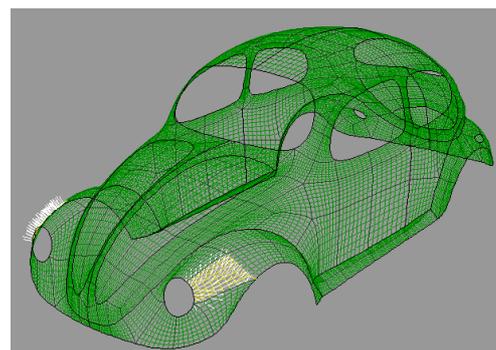
Illustration 27

11.13 Curvature.

This option enables or disables the drawing of the curvature plot of certain intersection curves. Only of intersection curves which appear checked in the intersection dialog will the curvature be plotted.

11.14 Markers.

Markers are lines and/or curves added to the model as a reference. For example the bodyplan of an existing design could be imported as markers. Stations could then be added to the FREE!ship model at the same location as the markers. Finally the points can be dragged until the stations and the markers are exactly on top of each other. In that case the FREE!ship hull matches the hull from the existing design.

Markers can be selected with the mouse and deleted like any other geometry used in your model.

11.15 Curvature scale.

The curvature scale can be decreased by pressing the F9 key, so that curves with high curvature can be evaluated. The scale can be increased with the F10 key for low curvature areas.

12. Selection.

12.1 Select all.

With this command (also available by pressing the shortcut Ctrl-A) all visible geometry can be selected in one pass. This includes markers and flowlines.

12.2 Deselect all

Use this option to deselect all currently selected items simultaneously. Pressing the Esc-key has the same result.

13 Tools.

13.1 Check model.

FREE!ship can check the model for any inconsistencies, and corrects most of them automatically. This check is also performed each time hydrostatics are calculated, unless this automatic checking is disabled in the project settings. First of all the surface is checked for any disjoint segments. Then each segment is checked if all the face normals point in the same direction. If not, it adapts those faces. Then the lowest point of each segment is identified. This usually is the bottom. If this is indeed a point on the bottom then the average normal of this point should point down. Assuming this, all faces are adapted such that the direction of their normal corresponds to the direction of the normal of this particular point. In some rare cases this might cause the normals to point in the wrong direction. In that case it is recommended to manually flip the normals to the right direction and to disable automatic checking of the surface. This test also identifies edges with more than two faces attached. Secondly a list of points is provided where the hull is considered leak. A point is considered "leak" if:

- It is not situated on the centerplane, meaning that the y-coordinate of the point >0.0001.
- The point is attached to an edge with only 1 face attached. Note that this is also the case if 2 faces are attached, but 1 of these faces belongs to a layer from which the "Include in hydrostatics" property is switched off. This could for example be the case for a ship with a closed deck, from which the deck is put in a separate layer that is not included in the hydrostatics calculations. FREE!ship keeps calculating until the deckline is submerged. Also windows or any other none watertight surfaces could be treated this way.

It is important to realize that these points are not actually always leak, they only become leak when they are submerged. So the presence of leak points does not always have to be a problem, just as long as they are not submerged. If more then 10 leak points are found, only the first 10 are shown. The points are shown sorted in increasing height above the base plane.

Finally, if the test is called from the menu, an overview of corrected items and possible remaining errors is shown.

13.2 Remove negative.

Sometimes, when a hull is imported, the geometry of both sides of the ship is present. FREE!ship only needs the port side. This option removes all faces from the model that are completely on the starboard side.

13.3 Remove unused points.

This can be used to remove all unused points from the model.

13.4 Develop plates.

All layers which are marked as developable in the layer properties dialog are unfolded onto flat plates (a process also called developing). If the model contains no developable layers then this option appears disabled. Both sides of the ship are unfolded. A window then appears showing the unfolded plates. It is best to assign each strake or part of the hull to a different layer. Then each layer will have its own unfolding. If a layer consists of multiple separate parts, each part again will have its own unfolding. The unfolded panels can be moved by dragging them with the mouse. Buttons on the toolbar at the top of the window can be used to rotate the currently selected item. The rotation angle of each panel may also be entered manually. Zooming and panning can be done exactly as in the viewports used for modeling the ship. Interior edges and any present intersection

curves are also drawn on the unfolded panels, and can be switched on or off as desired. The initial settings for these options are the same as those for the entire model. So if the stations are turned off in the hullform-viewports, they will not show in the developed surfaces window either, until they are turned on again. The viewport be can saved as a bitmap, but the visible parts can also be exported to a .dxf file or sent directly to the printer/plotter. The coordinates forming the boundary of each part can be exported to n ASCII text file.
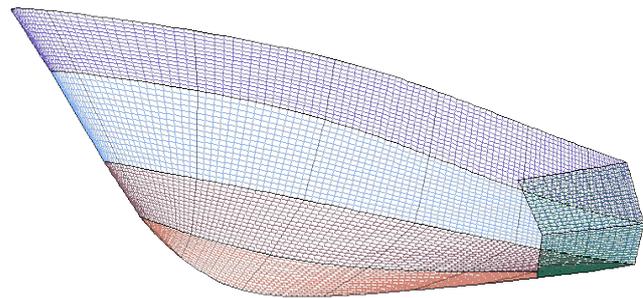

Illustration 28

On the right of the window a list is visible, showing all unfolded parts. By clicking on the checkboxes each part can be made visible or invisible. At the top some crucial information about the developments is shown. After the plates have been unfolded to 2D, FREE!ship compares the length of the unfolded interior edges to the length of these edges in 3D. If this length is smaller then the edges were compressed (drawn in blue). If the unfolded edges are longer then these edges were stretched (drawn in red). The min. error shown at the top is the largest compression error that occurred (in world space dimensions, so meters or feet). The max. error is the largest amount of stress of an edge. Compressed or stretched edges may be visualized by turning both the visibility of interior edges and highlighting of compressed edges on. The difference in area between the 3D surface and the unfolded surface is also shown. Below the displayed edges the number of iterations it took to unfold the selected panel is shown. FREE!ship makes up to 25 developments of each panel and uses the one with the smallest overall error as the final one. Generally surfaces that are truly developable are unfolded in 1 iteration, and have min. and max. errors of 0.0. Surfaces that are not exactly developable can in most cases still be unfolded but might have significant errors due to the fact that the surface is curved in two directions. Think of it as the top half of a sphere, you can not press this surface down to a flat surface without stretching or compressing certain areas, unless you make some cuts of course.

So it's **very important** to check these errors when you actually want to use the unfolded plates for construction purposes!

There are also two input fields to adapt the grid spacing. The grid can be turned on and off from the toolbar. Each intersection of a grid line and an unfolded panel has a number next to it indicating the coordinate of that intersection.

The two panels that are created from layers that border the centerplane of the hull and are completely flat, such as for example a flat transom or bottom, are merged into 1 unfolded panel.
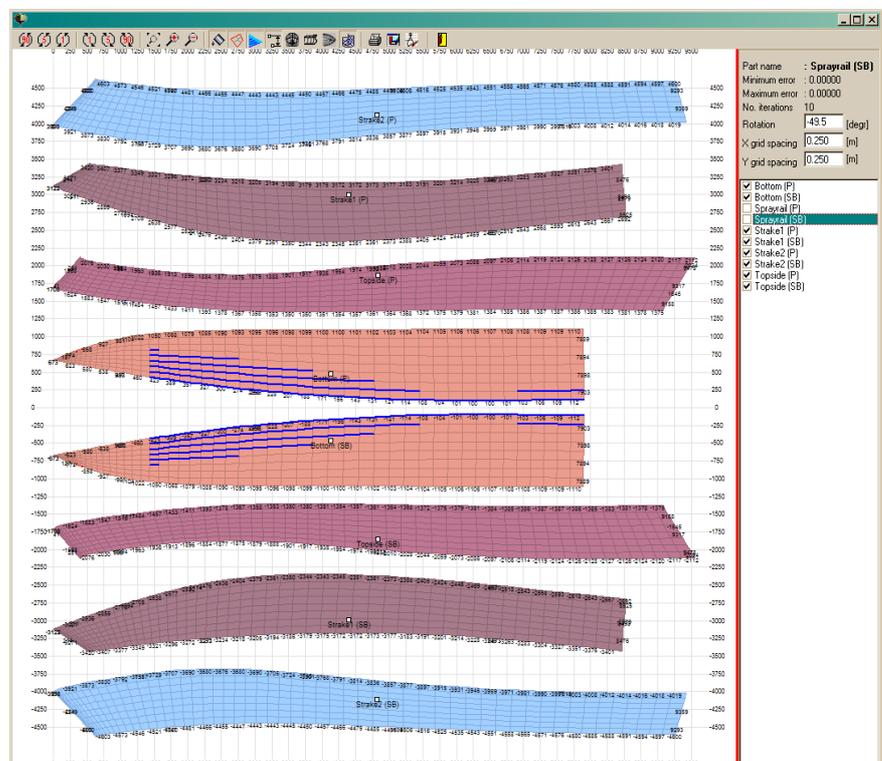

Illustration 29

13.5 Keel and rudder wizard.

The keel and rudder wizard enables you to quickly define a keel or rudder with a predefined planform. You can select the desired wingsection from a list of standard NACA sections. The keel or rudder is show in 3D along with it basic properties such as aspect ratio, volume, center of buoyancy etc. Once the keel or rudder is complete it can be exported in two ways. Using the "send" button it is inserted at the current FREE!ship model at the origin. Using the "save as part" button it can be saved to disc as a FREE!ship part which can be imported in other designs. The lift/drag tab shows an estimation for the lift and drag curves.
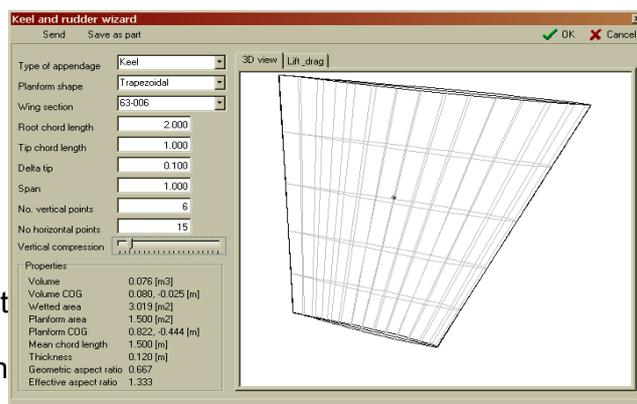
13.6 Import markers.

Markers are curves that can be added to the model as a reference. For example the offsets of another design can be imported as markers. Then intersection curves can be specified at the same locations in FREE!ship. If the intersection curves coincide with the markers both hulls are exactly the same. At the moment the only way to add markers is by importing them from a textfile. The file format of this file is exactly the same as as described in 3.5.4 Surface and 3.5.5 Importing chines. The only difference is that the integer value on the first line of the file that indicates the units used in the file (imperial or metric) is discarded here.

13.7 Delete markers.

This deletes all markers from the model. It speaks for itself that this option is disabled if there are no markers added to the model. (see also 11.14 Markers).

13.8 Add cylinder.

This option lets you add a cylinder. You can specify the startpoint, endpoint, radius and number of points in the dialog that appears. The points are calculated in such a way that the resulting surface has the required properties, even though the points are located outside the cylinder. The minimum number of points that can be used to form the cylindrical shape is 4, however 6 or more is recommended. You can use the cylinder for example to add a bow thruster to your model.

14 Transform.

The first following 4 transformation operations described in this chapter are intended to be used on a selection. There are two different ways to create such a selection.

1. Select the items yourself with the mouse
2. Select nothing. As soon as one of the commands below is chosen, and there is no selection yet, the program shows a dialog from which you can select entire layers. Then the operation is performed on the layers that you have selected.

14.1 Scale.

Scales (part of) the model. For this operation the program assembles all selected points, but also all the points that belong to edges and faces that are selected. If nothing is selected, a dialog is presented to the user from which entire layers can be selected. If the checkbox at the bottom of the dialog is checked (the one saying: "include points that are shared with unselected layers") then a point is selected automatically if _at least_ one attached face belongs to a selected layer. If the checkbox is not checked, then a point is selected automatically when _all_ the faces around it belong to selected layer(s). If everything is selected, then not only is the hull scaled, but mainparticulars, stations, buttocks and waterlines too.

14.2 Move.

Moves (part of) the model. Works on points extracted from a selection, as described in 14.1 Scale.

14.3 Rotate.

Rotates (part of) the model. Works on points extracted from a selection, as described in 14.1 Scale.

14.4 Mirror.

In contrast to the previous transformation commands is this one based on selected faces, not points. First select all the faces you want to mirror (see the chapter about viewports for special selecting options). Then use the mirror option to create a mirrored copy of the selected faces. The mirror plane can be either transverse (YZ plane), horizontal (XY plane) or vertical (XZ plane). The distance of the mirror plane to the origin must be specified in the distance field. The checkbox at the bottom of the form tells the program if the mirrored points should be connected to already existing points or not.
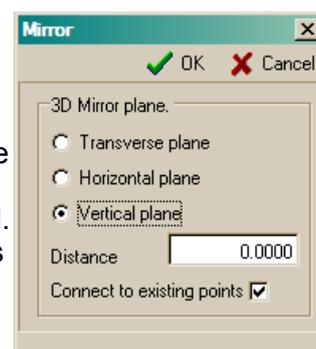
As an example the image to the right shows the process of creating a catamaran. The catamaran at first is modeled as a symmetrical monohull (top left). To convert it to a proper catamaran the mirror option is used. All faces of the (at this stage still a) monohull are selected and mirrored in the centerplane of the hull (vertical plane, distance = 0.0). This way a symmetrical monohull is obtained (top right). This is finally moved in the positive y-direction with the *move* command as described in the paragraph above. If the visibility setting of the program is set to show both sides of the design (in this case both hulls) the final shape of the catamaran appears (bottom left and bottom right)
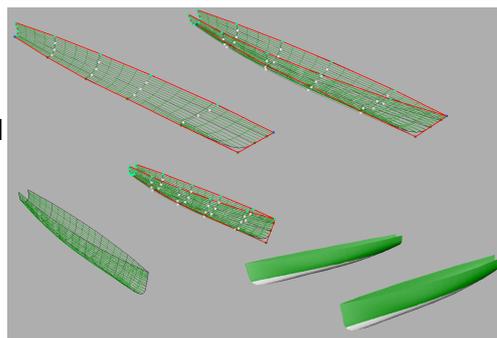
14.5 Lackenby.

The hullform method developed by Lackenby is used to transform the hull to match a desired displacement or longitudinal center of buoyancy while maintaining fairness of your design. This is done by shifting controlpoints in the longitudinal direction. So the overall length of the design will be different after the transformation. The dialog looks as follows:
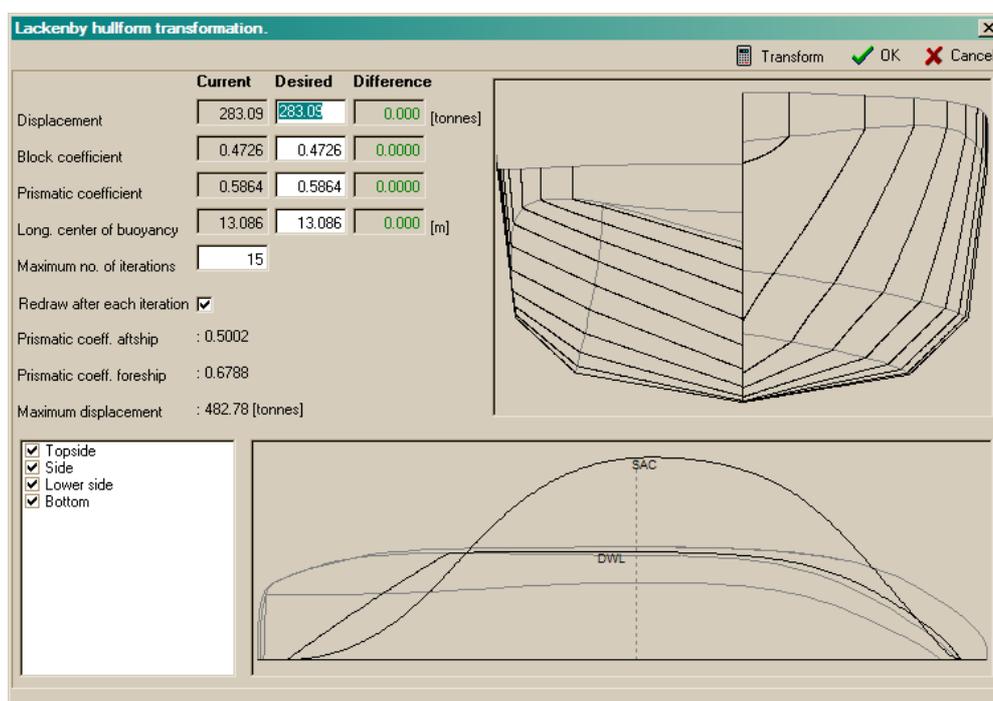
The input fields to the left are divided in 3 columns. The left column shows the current values as calculated from the model. The middle column shows the desired values which can be modified by the user. The right column shows the difference between the current and desired values. The left and right column are updated after each iteration so the progress can be monitored.

Below these 3 columns the maximum number of iterations that may be performed can be modified. The default is 15, but sometimes more iterations are needed to obtain the desired result. This is specially true when a design has a high prismatic coefficient in the aftship, such as planing motorcraft, or when the midship location is far from the usual place at 0.5*Length.

The checkbox below that ensures that all windows of the program are updated after each iteration, so the progress can be monitored in 3D.

To the right the bodyplan of the original hull is displayed in black. If the transformation was successful then the new bodyplan is displayed in red dashed lines on top of the original bodyplan.

At the bottom of the dialog the original sectional area curve and design waterline are displayed, also in black. Again the new sectional area curve and design waterline are displayed on top of these if the transformation was successful. The dark gray dashed line is the location of the midship section as defined by the user in the project settings. Important to know is that in contrast to the hydrostatics calculated elsewhere in the program here it is calculated using ordinates, and not surface panels. This can cause a slight difference between the displacement shown here and calculated elsewhere. A total of 82 ordinates is used to calculate the sectional area curve and hydrostatics, 41 for the aftship and 41 for the foreship.

Finally at the bottom-left corner all layers of the model are shown. The transformation is <u>only</u> applied to the layers that have a checkmark next to them. As stated previously the transformation consists of shifting controlpoints longitudinally, so the location of for example a keel, centerboard or cabin is also likely to change. By removing the checkmark layers containing such items remain unchanged, but it may result in a distorted or unfair model if the model was excessively changed.
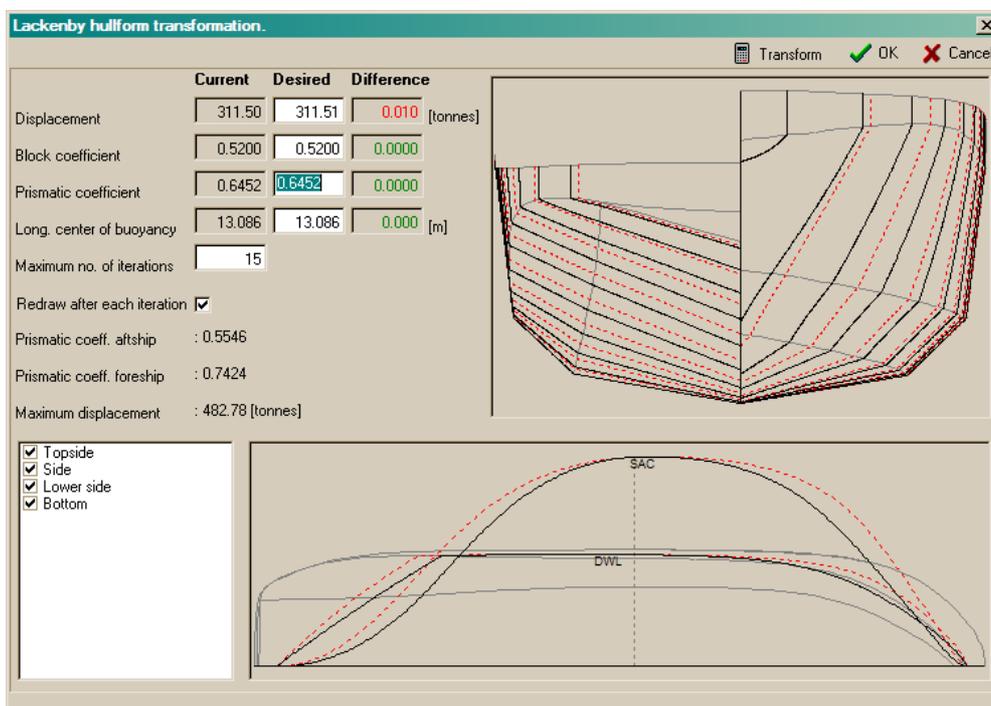

Here the result is shown after transforming the blockcoefficient from 0.4726 to 0.5200. The new lines and sectional area curve are displayed on top of the original lines.

15 Calculations.

15.1 intersection curves.

intersection curves such as stations, buttocks, waterlines and diagonals are calculated from the model. Only their location needs to be specified. Diagonals are always at an angle of 45 degrees to the center plane. Each time the model is changed, the calculated intersection curves are destroyed. They are rebuild as soon as they need to be exported or drawn to the screen. The buttons on the toolbar let you switch to which type of intersection you want to add or delete. You can add one intersection at a time by selecting the +1 option in the menu. A dialog is displayed asking for the location of the intersection. It is also possible to add a whole range at once by selecting the +N option. Only the spacing between successive intersection curves needs to be specified. The program starts at the origin (x=0, y=0 or z=0, depending on the type of intersection) and keeps adding intersection curves in positive and negative direction until the extents of the model is reached. The intersection curves appear in an increasing order of their distance. To delete an intersection, just select it and press the *delete* key on your keyboard.
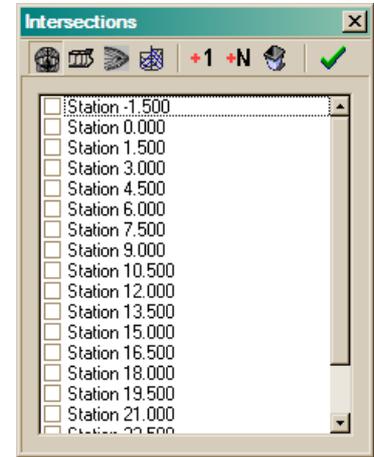
The checkbox displayed to the left of each intersection indicates if the curvature plot of that specific intersection curve must be plotted. (see curvature visibility). Due to the scale and nature of the computer screen it is in almost any case impossible to determine if a curve is fair. To overcome this
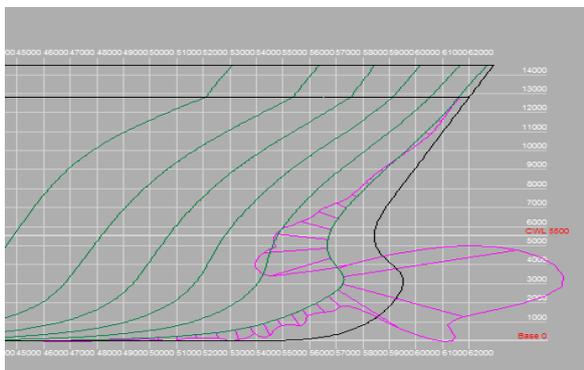
Illustration 30

a curvature plot is often drawn. A curvature plot means that in a large number of points of a curve the curvature is calculated and plotted perpendicular to the curve (the purple line). Since the curvature can be positive as well as negative, the plot can swap from one side of the curve to the other (see the image left). Where the plot intersects the curve the curvature is zero. So in areas of a curve where the curvature is zero (straight line segments), both curves are on top of each other. At a knuckle point on the other hand the curvature is very high and can go to infinity. So the higher the absolute value of the curvature, the further the curvature plot is drawn away from the curve. Smooth curves are characterized by curvature plots with no unexpected humps or hollows, the curvature must change gradually as is the case with the waterline below. The scale of the curvature plot can be decreased by pressing the F9 key and increased by pressing the F10 key. Make sure that the curvature visibility is also turned on!
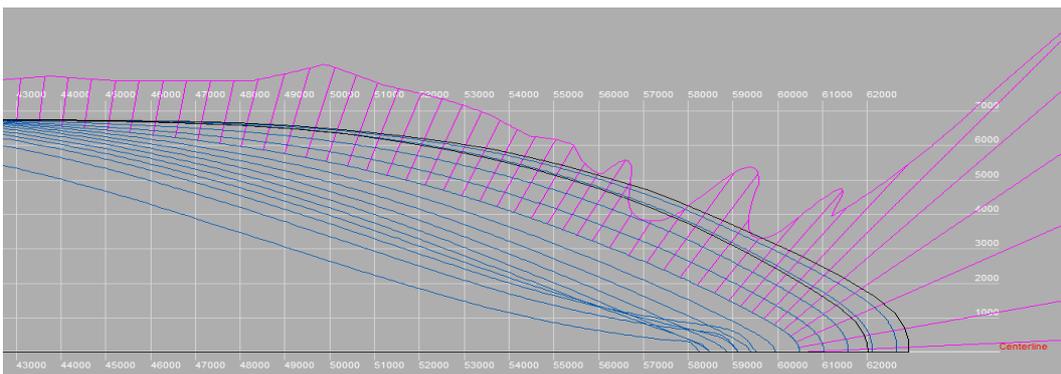
15.2 Design hydrostatics.

A simple hydrostatic calculation is performed of the ship at the design draft, as specified in the project settings. Some important coefficients, such as blockcoefficient, are calculated twice. Once using the length and beam as specified in the project settings, and once using the actual length and beam at the waterline. Finally the surface area and center of gravity of each layer is shown. These properties are calculated for both sides of the ship and may be used for example to estimate the weight of the hull.

If imperial units are used, the displacement is given in longtons (1 longton equals 2240 lbs).

15.3 Hydrostatics.

This option is used to perform hydrostatic calculations at a range of drafts. A trim may also be specified. The results can be saved to a textfile.

Print   Save   Close

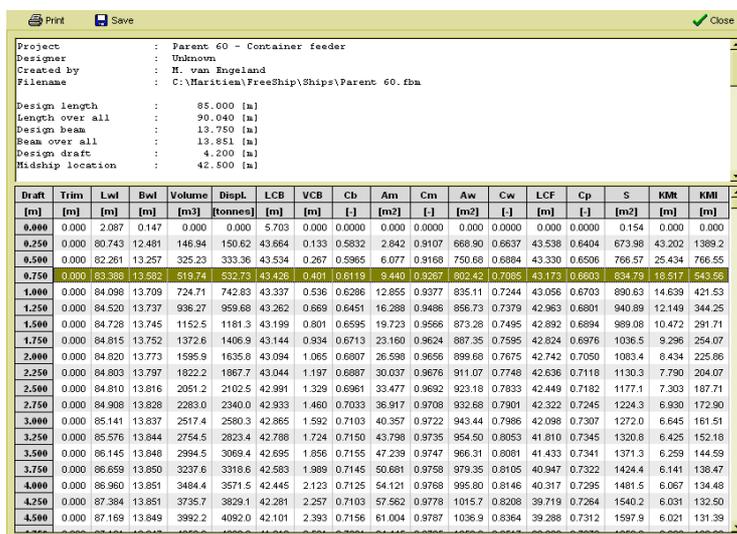| Project | : | Parent 60 - Container feeder |
Designer	:	Unknown
Created by	:	M. van Engeland
Filename	:	C:\Maritiem\FreeShip\Ships\Parent 60.fbm
Design length	:	85.000 [m]
Length over all	:	90.040 [m]
Design beam	:	13.750 [m]
Beam over all	:	13.851 [m]
Design draft	:	4.200 [m]
Midship location	:	42.500 [m]

Draft	Trim	Lwl	Bwl	Volume	Displ.	LCB	VCB	Cb	Am	Cm	Aw	Cw	LCF	Cp	S	KMt	KMl
[m]	[m]	[m]	[m]	[m3]	[tonnes]	[m]	[m]	[-]	[m2]	[-]	[m2]	[-]	[m]	[-]	[m2]	[m]	[m]
0.000	0.000	2.087	0.147	0.000	0.000	5.703	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.000	0.0000	0.154	0.000	0.000
0.250	0.000	80.743	12.481	146.94	150.62	43.664	0.133	0.5832	2.842	0.9107	668.90	0.6637	43.538	0.6404	673.98	43.202	1389.2
0.500	0.000	82.261	13.257	325.23	333.36	43.534	0.267	0.5965	6.077	0.9168	750.68	0.6884	43.330	0.6506	766.57	25.434	766.55
0.750	0.000	83.388	13.582	519.74	532.73	43.426	0.401	0.6119	9.440	0.9267	802.42	0.7085	43.173	0.6603	834.79	18.517	543.56
1.000	0.000	84.098	13.709	724.71	742.83	43.337	0.536	0.6286	12.855	0.9377	835.11	0.7244	43.056	0.6703	890.63	14.639	421.53
1.250	0.000	84.520	13.737	936.27	959.68	43.262	0.669	0.6451	16.288	0.9486	856.73	0.7379	42.963	0.6801	940.89	12.149	344.25
1.500	0.000	84.728	13.745	1152.5	1181.3	43.199	0.801	0.6595	19.723	0.9566	873.28	0.7495	42.892	0.6894	989.08	10.472	291.71
1.750	0.000	84.815	13.752	1372.6	1406.9	43.144	0.934	0.6713	23.160	0.9624	887.35	0.7595	42.824	0.6976	1036.5	9.296	254.07
2.000	0.000	84.820	13.773	1595.9	1635.8	43.094	1.065	0.6807	26.598	0.9656	899.68	0.7675	42.742	0.7050	1083.4	8.434	225.86
2.250	0.000	84.803	13.797	1822.2	1867.7	43.044	1.197	0.6887	30.037	0.9676	911.07	0.7748	42.636	0.7118	1130.3	7.790	204.07
2.500	0.000	84.810	13.816	2051.2	2102.5	42.991	1.329	0.6961	33.477	0.9692	923.18	0.7833	42.449	0.7182	1177.1	7.303	187.71
2.750	0.000	84.908	13.828	2283.0	2340.0	42.933	1.460	0.7033	36.917	0.9708	932.68	0.7901	42.322	0.7245	1224.3	6.930	172.90
3.000	0.000	85.141	13.837	2517.4	2580.3	42.865	1.592	0.7103	40.357	0.9722	943.44	0.7986	42.098	0.7307	1272.0	6.645	161.51
3.250	0.000	85.576	13.844	2754.5	2823.4	42.788	1.724	0.7150	43.798	0.9735	954.50	0.8053	41.810	0.7345	1320.8	6.425	152.18
3.500	0.000	86.145	13.848	2994.5	3069.4	42.695	1.856	0.7155	47.239	0.9747	966.31	0.8081	41.433	0.7341	1371.3	6.259	144.59
3.750	0.000	86.659	13.850	3237.6	3318.6	42.583	1.989	0.7145	50.681	0.9758	979.35	0.8105	40.947	0.7322	1424.4	6.141	138.47
4.000	0.000	86.960	13.851	3484.4	3571.5	42.445	2.123	0.7125	54.121	0.9768	995.80	0.8146	40.317	0.7295	1481.5	6.067	134.48
4.250	0.000	87.384	13.851	3735.7	3829.1	42.281	2.257	0.7103	57.562	0.9778	1015.7	0.8208	39.719	0.7264	1540.2	6.031	132.50
4.500	0.000	87.169	13.849	3992.2	4092.0	42.101	2.393	0.7156	61.004	0.9787	1036.9	0.8364	39.288	0.7312	1597.9	6.021	131.39

15.4 Cross curves.

Stability calculations are provided in the form of cross curves. For a number of heeling angles and displacements KN sin(ø) is calculated and presented in a graph and table. If only one displacement is provided the KN sin(ø) curve is displayed. If multiple displacements are provided the graph shows the standard cross curves. The calculated data can be printed or saved to a textfile.
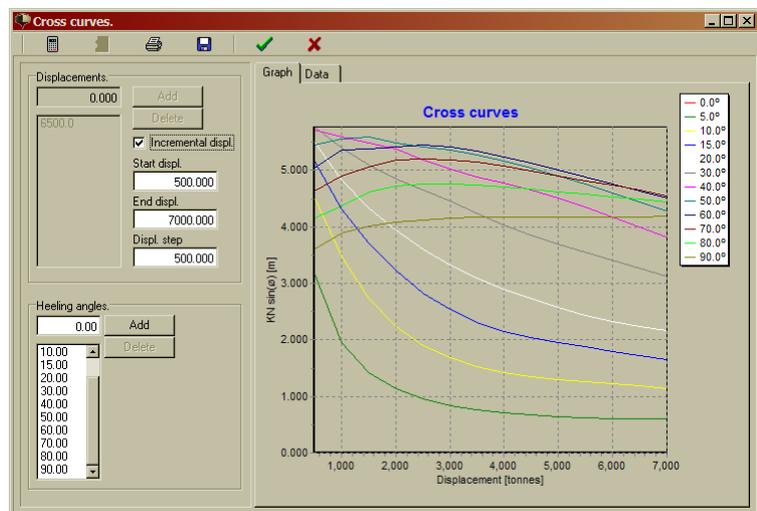
15.5 Resistance calculations.

15.5.1 Delft series.

The Delft series resistance calculation is a method that is intended for fin-keeled yachts. It's a statistical method based upon a whole series of models that are tested over the years in the towing tank of the Delft University of Technology. The calculation is restricted to run only if the parameters of the model are in the same range as those of the tested models.

These ranges are:

✔ Lwl/Bwl   : [2.76 - 5.00]
✔ Bwl/Thull   : [2.46 - 19.32]
✔ Lwl/Displ^0.333   : [4.34 – 8.50]
✔ LCB (in % of Lwl) : [-6.0 – 0.0]
✔ Cp   : [0.52 – 0.60]
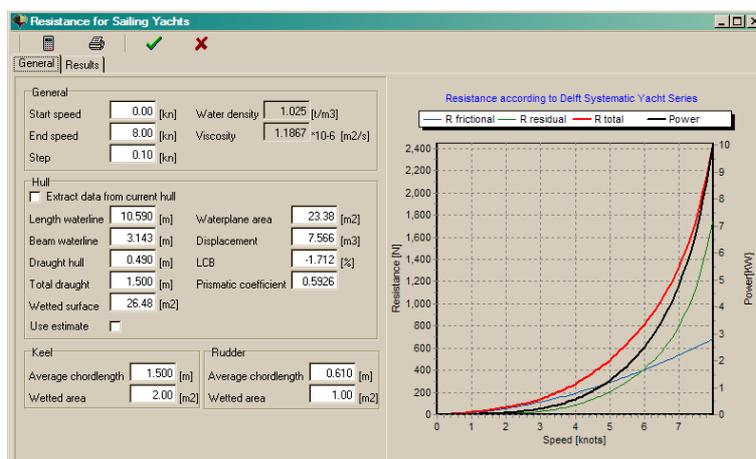
If there are no lines displayed in the graph to the right, then it's safe to assume that at least one of the parameters is out of range. You can switch to the results tab to check the details.

There are two different ways to use the module:
• Fill in all the data manually. You don't even need a hull to do this. Each time a modification is made everything is recalculated and updated.
• Let the program calculate the hydrostatic values that are needed by clicking on the checkbox that says: "Extract data from current hull". Only two input fields concerning the hull data are enabled in this mode. One is for the draft of the hull alone, the other for the total draft of the hull including the keel. This last draft is used when the hydrostatic values are calculated, assuming you have indeed attached a keel at the bottom of the hull. If this is not the case, then fill in the draft of the hull alone as if it was the total draft including the keel. As all data has been calculated by the program then disable the "extract from hull" checkbox, and set the correct drafts in the two edit fields and continue as normal.

All data used for the resistance calculation is stored with the model.

15.5.2 KAPER.

The KAPER resistance method is intended for canoes and kayaks. It was originally developed by John Winters, a naval architect now specializing in designing canoes and kayaks. (See http://www.greenval.com/jwinters.html) It is based on statistical data obtained by model tests. His method is later extended by Matt Broze to higher speed/length ratios and to incorporate more variables into the equations. This extended version is available in the form of an Excel spreadsheet from http://www.marinerkayaks.com/mkhtml/downloads.htm. However while implementing this method in FREE!ship two serious discontinuities showed up in the curve of residual resistance. These consist of a sudden drop in resistance of about 10% at speed/length ratios of 1.4 and 1.6 and are the result of a correction implemented by Matt. After careful consideration the decision was made to only allow calculations up to a speed/length ratio of 1.4 in order not to give the user a false sense of security. It also restricts the method to stay within the range of parameters of the actually tested hulls.

Basically there are two ways to use the KAPER resistance method. The easiest way is to open it with a design in memory. In that case the checkbox saying "extract data from the current hull" is enabled and may be checked. If it is checked all input fields, except those for the draft and

submerged transom ratio, are disabled. When the draft is changed the program calculates the appropriate hydrostatics corresponding to that draft and the resistance data is updated. The other way is by removing the check from the checkbox. In that case you can specify (or modify after most values have been automatically calculated) all input values manually.

After each modification the resistance is recalculated. You can see the data either graphically on the first tab page or numerically on the second tab page. When no data is visible the input data is out of range. The range of valid parameters is:

- Prismatic coefficient 0.48-0.64
- Submerged transom ratio 0.0-0.04
- None of the other variables other than the waterline entrance angle me be zero.

The graph displays 4 resistance curves. The first three are for frictional resistance, residual resistance and the total resistance. The fourth line is showing the total resistance according to Spilman. The residual resistance in this case is a very simple formula based only upon the speed/length ratio of the design and is included to give the user a point of reference.

All data entered in the input fields of this resistance method is also stored in the FREE!ship file.
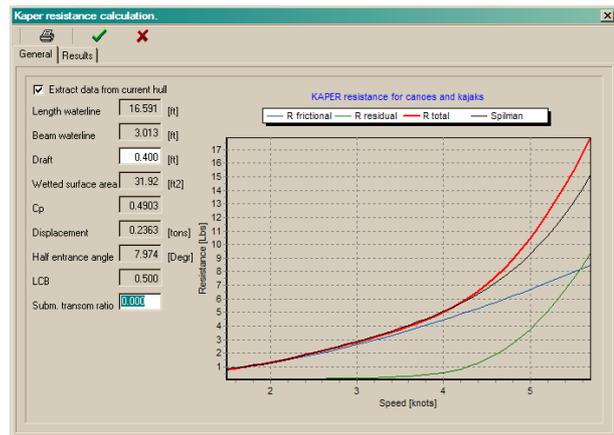
16 Background images.

FREE!ship has the ability to show images on the background of your model. This functionality is particularly convenient if you have an existing linesplan on paper and want to recreate the lines in FREE!ship. You can load a maximum of three images. Each of these images is assigned to a view (profile, plan or bodyplan view). You can not assign an image to the perspective view. All options related to background images are located in the popup-menu that appears when you press the right mouse button in a viewport. When using background images pay special attention to make sure that all horizontal and vertical lines on the images are truly horizontal or vertical.
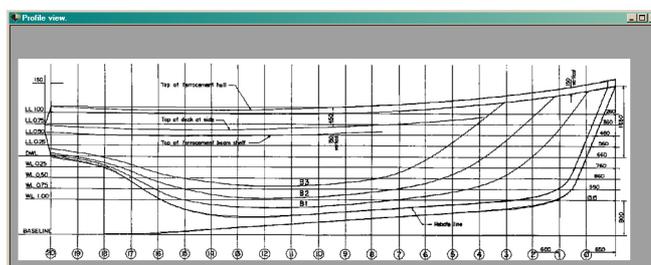
16.1 Visible.

Once you have assigned an image to for example the profile view, it will be shown in all viewports showing the profile view on the model. By changing the *visible* property you can hide the image from a particular viewport.

16.2 Clear.

Using the clear command removes the image not only from the current viewport but also from all other viewport. It is entirely removed from the FREE!ship model.

16.3 Load.

Imports a background image. FREE!ship only reads *bmp* and *jpg* images. For performance reasons make sure that the images you are going to use are not too big. After having imported an image you must set the origin to make sure it is displayed at the right location. You also have to set the scale of the image to math the size of your model.

16.4 Save.

Exports the background image to a file.

16.5 Origin.

If you use this option a special cursor appears. Once you click on a spot in the active viewport that part of the image will be moved to the origin of the current viewport. It does not necessarily have to be a point within the actual background image, it may also be located outside the image.

16.6 Set scale.

Make sure you set the scale of an imported image before opening another image. FREE!ship assigns the same scale of the previously imported image to the freshly imported one. This is particularly useful if you have multiple images imported from the same linesplan. When executing this option the user is required to click on a point within the actual image of which the location is known. The program uses the same scale for both the horizontal and vertical direction.

16.7 Transparent color.

Often background images are in black and white. Having a huge white area on your viewport can sometimes be distracting. By setting white as the transparent color the program does not draw the white areas. So only the black lines are draw on your screen. You can select the transparent color by clicking on an area of the background image that has the color you want to hide. If you click on a point that lies outside the area of the background image transparency is disabled again.
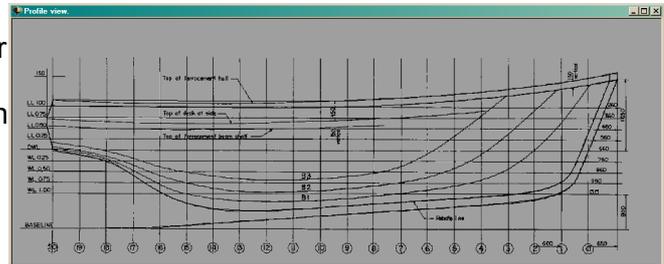
16.8 Tolerance.

Sometimes images that look black and white have a lot of colors in between. This is particularly the case where some quality has been lost due to compression, as is the case with *jpg* images. When white is the designated transparent color and is filtered out, a lot of "almost white" pixels remain. By increasing the tolerance these pixels can be filtered out by the program too.
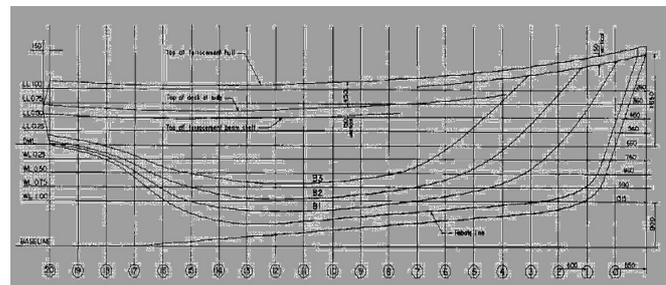
16.9 Blending.

If even after all the measures above the background image is till too dominant, it can be blended with the viewport color. This way it dissolves in the background and the geometry of you FREE!ship model is still clearly visible.

17 Language support.

Current translations include:
- English
- Dutch
- German
- French
- Castellano
- Suomi

Due to the fact that FREE!ship is still in development (new features keep being added) and that the translations are created and maintained by FREE!ship users, it is likely that the translation files are not completely in sync with the most recent English.ini file. After each official release the translation files have to be updated again. These update files are then included in the next release of FREE!ship.

17.1 Creating translations.

All the text strings used on the forms are placed into a single .ini file. The original file is called *English.ini* and can be found in the *Languages* subdirectory. This is a simple textfile containing the information of all forms where each form has it own section that begins with the name of the form enclose by two square brackets, for example: *[TMainform]*. Each line after that has the following syntax: `TMainForm.LoadFile.Hint=Open a new file`. This line can be split into two parts. The part left of the = sign tells the program where the text should be placed, in this case it is the hint that appears when the mouse hovers above the toolbar button used to open a file. The part to the right of the = sign is the actual text. When modifying the file make sure the = sign is not removed. You can translate the file either with a ASCII text editor such as notepad or use the special tool that can be downloaded from the FREE!ship homepage. If you decide to make a translation, make sure you give the file the name of the language you are translating into, as this is the text that is displayed in the list with available languages in the preferences dialog. New language files can be sent to info@freeship.org so they can be included in the next release of FREE!ship.

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