ArchimedesMB
User Manual

Introduction

ArchimedesMB Free for Personal Use

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by John A. MacSween

We hope you like the software and we always appreciate feedback on what we can do to improve the software so please email us at info@naval-architecture.co.uk.

ArchimedesMB User Manual

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Special thanks to:

We ahve a number of people to thank for the creation of this document and the software itself.

There are various GUI components, both freeware and commercial that have been employed and these are acknowledged below:

Vit Kovalcik for his excellent EasyGraph delphi code which he has gratefully alowed me to butcher to suit my own needs.

TMS Software for their excellent grid components

STEEMA Software for theor excellent graphing components

MADSHI for their excelent exception handling and reporting code.

Martijn van Engelend for the excelent FREEShip software (www.freeship.org), many of whose models are featured in this manual and we are gratefull for the inclusion of Archimedes export to allow exchange of files between our software.

Existing users of Archimedes who acted as very gracious beta testers. This release is dedicated to you all.

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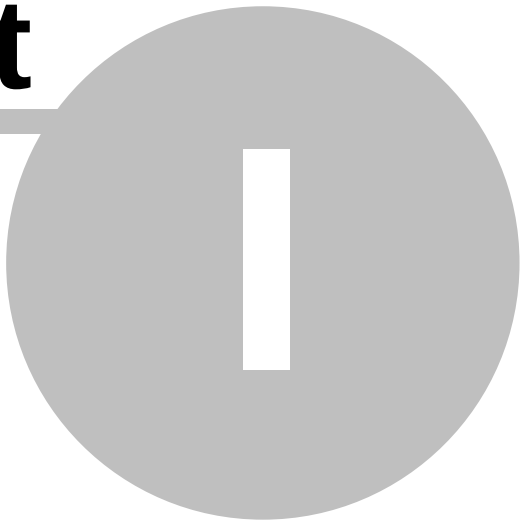


1 Introduction

1.1 Welcome topic

Archimedes has been created as a easy, low cost commercial or free personal hydrostatics editor. It can be used to import or create a model of a floating body and then interogate that model to obtain the hydrostatics of that body at various drafts and trimmed waterlines.

The results can be saved either as detailed graphs or exported as tabular data for import into a spreadhseet for further post-processing.

The software is provided as is with no warranty so please treat it accordingly. By running it on your computer, you are implicitly agreeing to the terms and conditions on the next page of this manual.

Please note that this manual is being updated as the software is being developed and as such a number of sections are marked as "WIP" or Work In Progress. Please feel free to comment on the content of the manual and provide feedback on what you would like to see added.

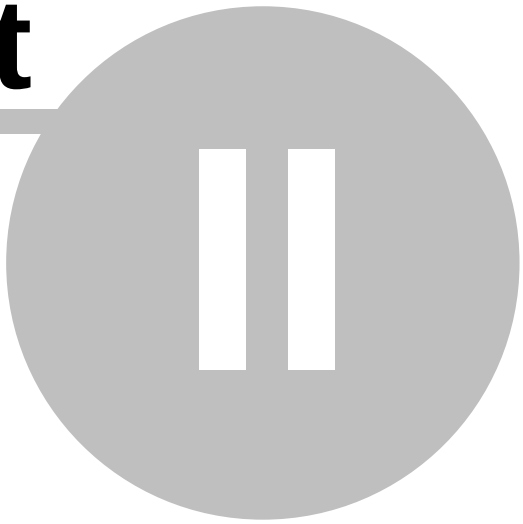
1.2 Terms and Conditions

Software has been distributed free for personal use. If used commercially, we request that it is registered at a nominal fee
of $99. This allows us to pay web server fees, commercial components and covers support for all point release versions i.e. all 2.x versions.

To register visit ShareIt or follow the links at www.naval-architecture.co.uk

Nominal upgrade fee applicable for moves from 2.x to 3.x versions etc.

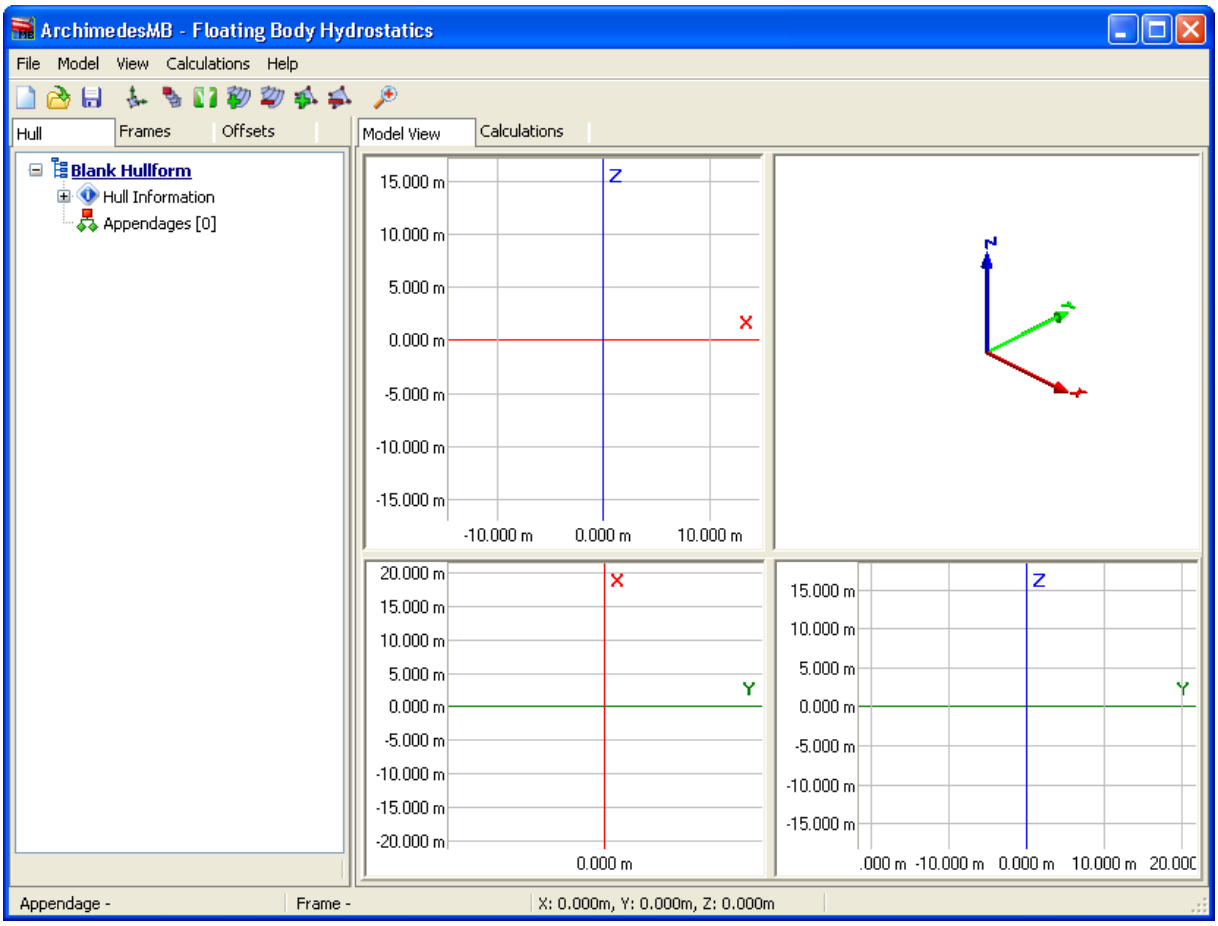
Part



2 Program Operation

2.1 Overview

When you start Archimedes you will be faced with a screen similar to the following:



This screen is divided into four main areas, namely menu and tool bar at the top, Hull tree and data entry on the left, model views and reports on the right and staus bar along the bottom.

For details of each of these, refer to the following sections of the help.

2.2 Menu and Toolbar

2.2.1 Menu and Toolbar Overview

The menu and toolbar are the main areas where you load and save new models, import and export models, activate floating tool boxes and modify the genreal model charecteristics.

Items on the menu can often be quickly accessed via tool bars. These can be identified by correponding icons both on the menu item and the tool bar. Additionaly, for greatest flexibility, tools and functions can also often be accessed in context sensitive pop up menus (for example adding and removing appendages and frames).

2.2.2 File Menu

File Menu allows access to creating and importing models, saving your work and changing application preferences.

2.2.2.1 New Model, Open and Save

The most fundemantal operation is the opening and saving of of models.

Selecting "New" clears the model data from memory and creates a new blank models with no appendages or other data.

Clicking "Open" allows you to open model data from the .hll file format. This is a txt based xml file where model data is stored in a tree like structure which mirrors the heirarchical structure of the model in memory. This file format is easily readble and open to allow users to edit directly in txt editors or write their own exporters.

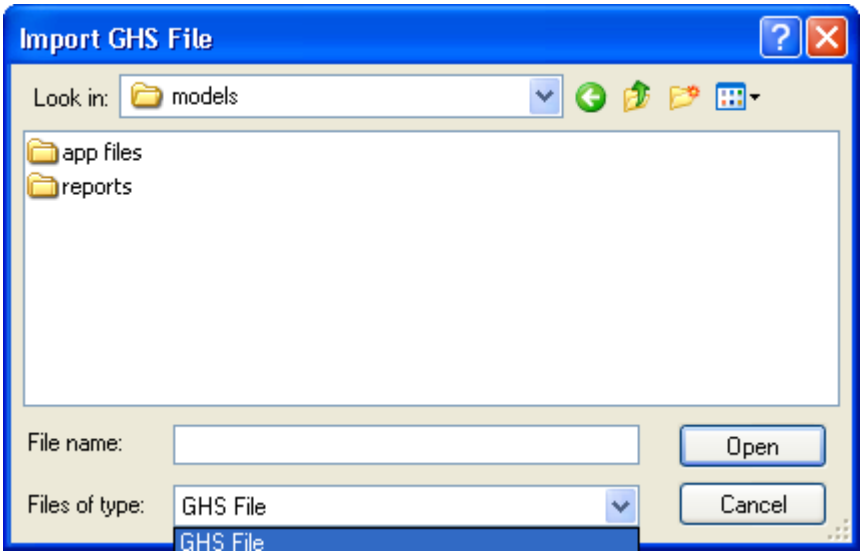
"Save", as its name suggets, saves the current models in the native xml file format ".hll".

2.2.2.2 Import and Export

Importing models
Models from other programs that can be imported along with any limitations are as follows:

Ver 1.x app Files
These files are the native appendage format used by Archimedes ver 1.x (single body models) and allow users to leverage any legacy models they may have created. There are no limitations and the model imported should be directly usable in the new version. AP and FP data have to be re-entered and associated with the new model using the model tree (see later).

External Files
On selecting this option a file import dialog box is presented. The required model format can be selected by changing the "Files of Type" combo box as highlighted below.



Files presently supported are as follows:

GHS/Autohydro Files: These files can be imported to give a representation of the original vessel. Buoyancy elements only are fully supported at present however as Archimedes develops more features of this format will be supported. See our online forum for a running commentary on the development of this feature or to provide feedback at GHS Import Forum Topic

Defcar Files: Defcar files define the floating body as a single hlf body representation. Archimedes

imports this and mirrors it to create the full appendage.

Exporting Models
Archimedes provides export to a number of general formats for extended use of models you create. These formats are as follows:

3D obj
This exports the sections as n-gons for importing and further use in 3d rendeering and modelling packages.

Current Frame to CRD File
This allows the user to export the currently selected frame to a general purpose txt file called crd. These files are useful for tranfering section data to other prgrams or spreadhseets and are described as follows:

The first figure is the number of offsets in the file and thereafter it is simply the offsets as X,Z pairs. e.g. the following represnts a square with edge length 10.00m and centered at the origin.

Code
```
4
-5 -5
 5 -5
 5  5
-5  5
```

Current Appendage to *.app file
Users can select an appendage and export to ver 1.x file. This is intended to allow users to use legacy code and routines they may have created to work with older files. New work should always be saved in the extensible hll format.

Current Appendage to FreeShip txt file
This feature allows the exporting of an appendage to a txt file that FreeShip (see FreeShip website for an excellent 3d hull modeller) can open. This allows users to use the section tracing system to transfer model data to FreeShip for creating a true 3d representation of the vessel. For example starting with a legacy low resolution ghs file, it can be exported to freeship, tidied up and accurately modelled, then brought back into Archiimedes for hydrostatics and stability checks.

GHS File
Using this option users can export a hll file to GHS file format. Due to the way that the ghs file format works (limits section count, offset count, appendage names etc) this is not complete. If you model is to be exported for use in ghs we recommend you model all parts seperately on the CL, name appendages in line with ghs recommendations and keep the section and offset count down to 256 each.

2.2.2.3 Recent Files and Directories

These submenus store the most recent files and directories accessed by the prgram and is persistent from one execution to another. It allows users to quickly navigate between recent and common files/directories in complicated storage trees and layouts.

2.2.2.4 Preferences

Application preferences are entered and stored here between program executions. This allows the user to customise their work environment to suit their tastes and workflow.

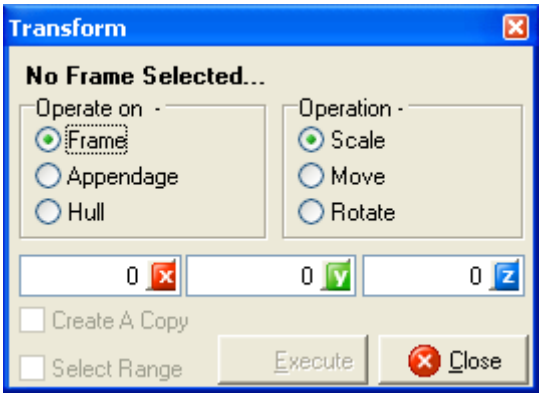
The user defined preferences are seperated into groups which define the various aspects of the software that can be customised.

2.2.3 Model Menu

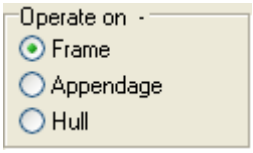
Enter topic text here.

2.2.3.1 Transform Dialog

The transform tool allows users to modify frames, appendages and the whole hull in several ways, all from within this one dialog. When activated using the tool bar, menu or shortcut Ctrl-T, you will be presented with the following:

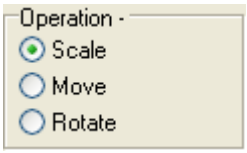


From here you can selected the geometry you wish to transform, i.e. frame (uses the current frame in the currently selected appendage), current appendage or whole hull.



The text indicator at the top will tell the you the name of the frame and appendage the operation will be carried out on.

Once the geometry you wish to transform has been identified, you then select the operation you wish to carry out on the selected geometry in the right hand radio group box shown below.



Thereafter, the scale/move/rotate values along each axis are selected in the X, Y and Z decimal number boxes below:

Selecting the coloured button drops down a simple calculator which can be used to work out movement and scale values based on other factors for example multiples of frame spacing etc.

Create a Copy
For each operation, a copy is created and scaled/moved/rotated with the original left as-is.

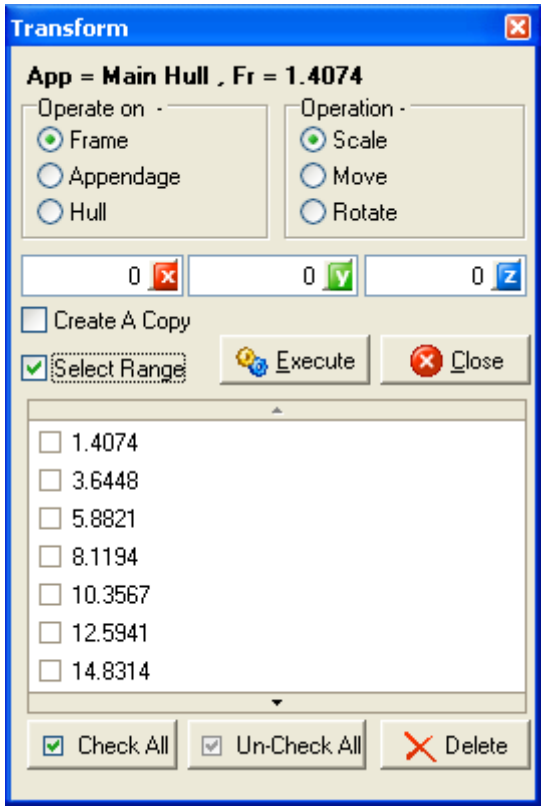
Execute
Scale: When execute is clicked, the selected geometry is scaled along the x, y and z axis by the values in the respective edit boxes. Scaling affects frames and appendages differently and can be used to move frames on the y axis, stretch frames along the x and z axis. Using negative values, frames and appendages can be mirrored about their respective axis. Scale will not accept zero values and any attempt to do so will have no effect and will be logged in the log file.
Selecting "Create a Copy" and then scaling an appendage by X=-1, Y=1, Z=1 is an effective way to quickly mirror an appendage about the vessels CL.

Move: Executing a move translates the geometry along each axis by the prescribed amount.

Rotate: Executing a rotate for sectional geometry is only valid about the y axis and is analagous to helling a vessel with no change in trim. Note that rotations are about the yaxis i.e. origin of global coordinates.

Select a Range

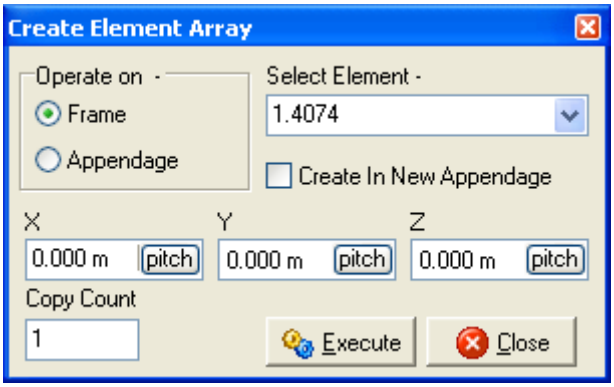
Checking this box expands the dialog box and allows the user to select a range of either frames or appendages to transform using the tools and options outlined above. The expanded dialog appears as follows: (example sown has a single body hull loaded)

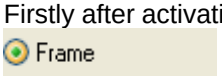
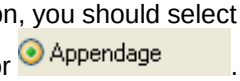


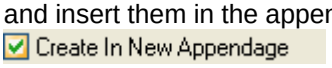
From here multiple frames (or appendages if model permits) can be selected. If required a selection of frames/appendages can be quickly deleted. This is a speedy alternative to deleting one by one using the model tree.
Check all and uncheck all quickly allows the selection of all or none of the frames in the list.

2.2.3.2 Create Element Array

The "Create Element Array" tool allows users to take a single instance of geometry such as a single frame or appendage and make multiple copies evenly spaced along any of the three axis. When activated using the tool bar, menu or shortcut Ctrl-A, you will be presented with the following:



Firstly after activation, you should select the geometry you wish to copy by slecting either  or  . The "Select Element" drop down list will change its content subject to what is selected. Once the original geometry element has been selected the spacing and number of copies along each axis can be specified in the "Copy Count" box.

If you are creating an array of frames, you are presented with the option ot create the multiple copies and insert them in the appendage of the original. Alternatively, you can check  and the program will create a new blank appendage, and feed all copies of the base frame to this new appendages. So, if you wished to take a reference frame and create a parallel midbody as a new appendage from this reference frame, which may reside, for example in a swim end, then checking this option would do just that.

Distribution of Copies

There are two ways of specifiying the distribution of copies of the reference geometry. You can either specifiy the offset between each copy as the pitch between each one and then duplicate these by the number entered in "Copy Count". Useful for creating known number of frames at regular spacings.

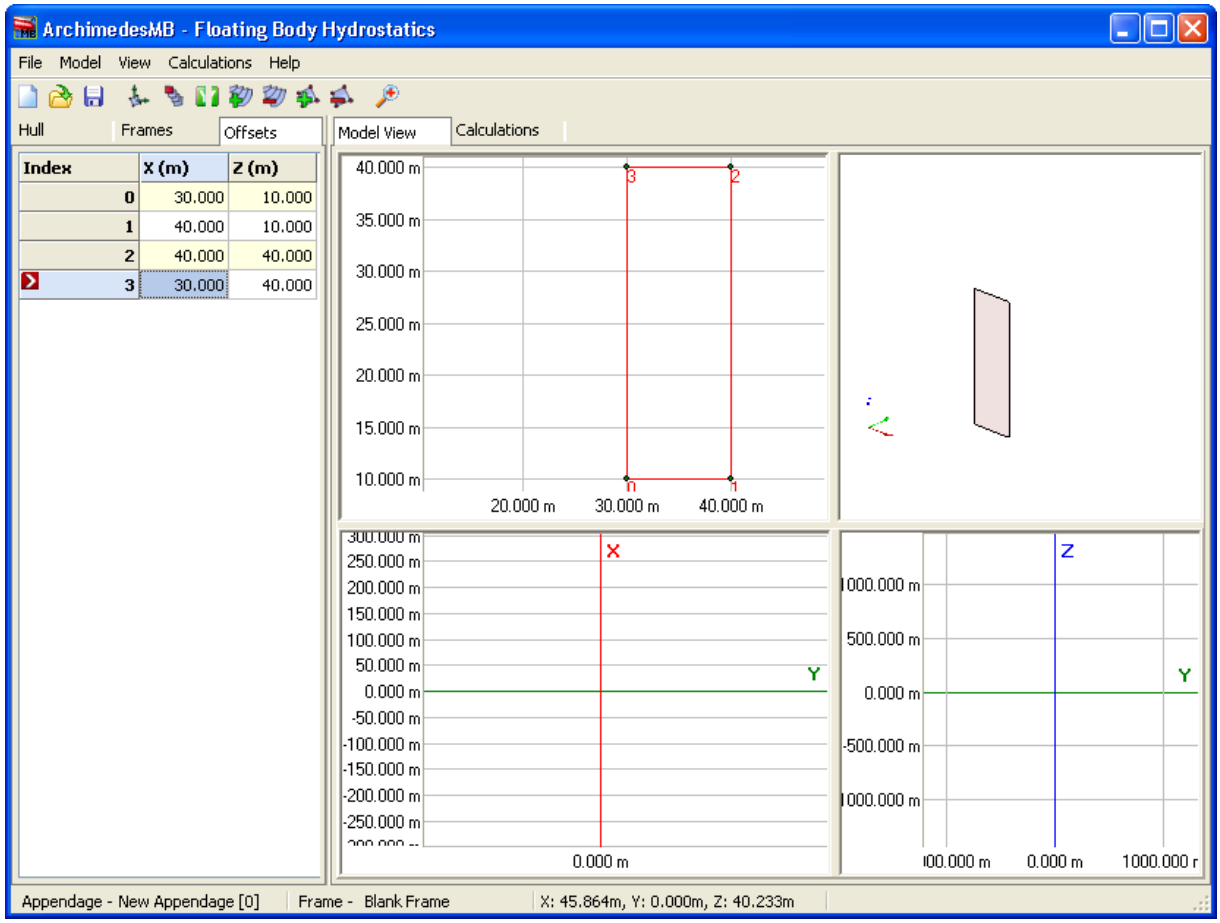
Alternatively clicking the button marked pitch toggles it to "Total" i.e.  or  .

With "Total" selected the pitch between each copy is calculated by dividing the figure entered by "Copy Count". This is usefull if the user knows the last location of a copy and can select a number of copies to populate between a start and end point.

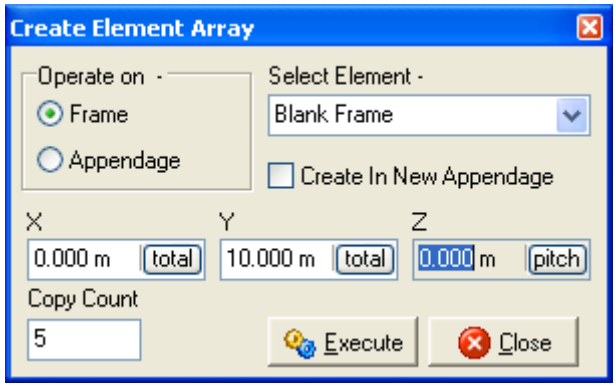
Example

Lets say you wish to create a series of columns to represent the legs os a semi submersible. The base geometry is a rectangle, 10m wide and 30m high. The top of the pontoon is 10m above the baseline (z=0.00m) and the transverse and longitudinal pitch is 30m and 30m with 3 columns posiitoned along the length of the pontoon.

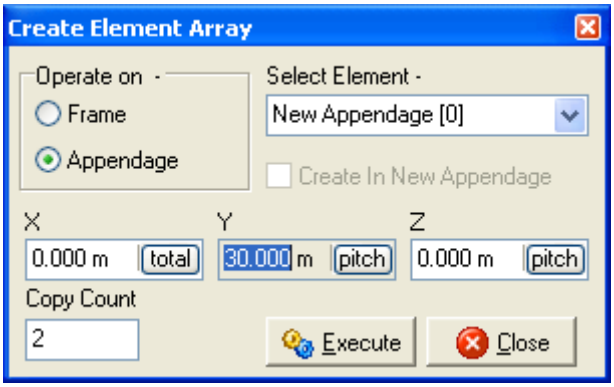
Creating the base rectangle with snaps switched on and set to 1m is simply a case of four clicks on the section view giving:



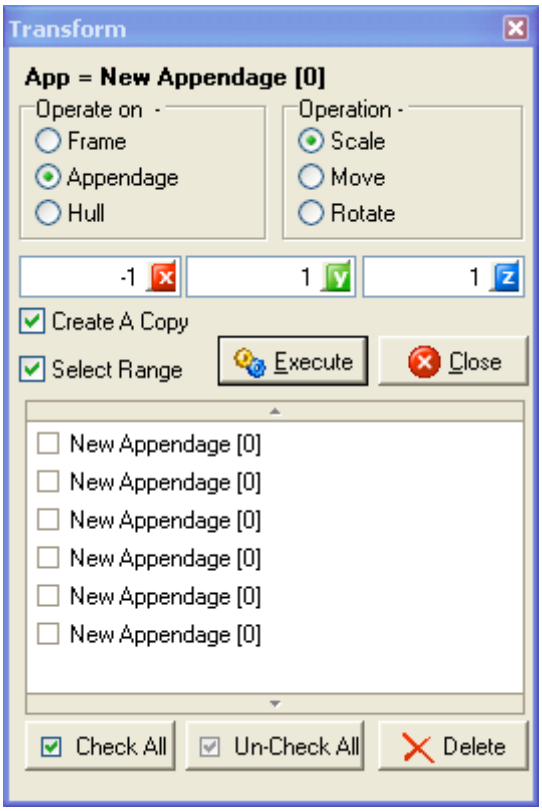
If we now open the create element array dialog and set the following values and click "Execute":



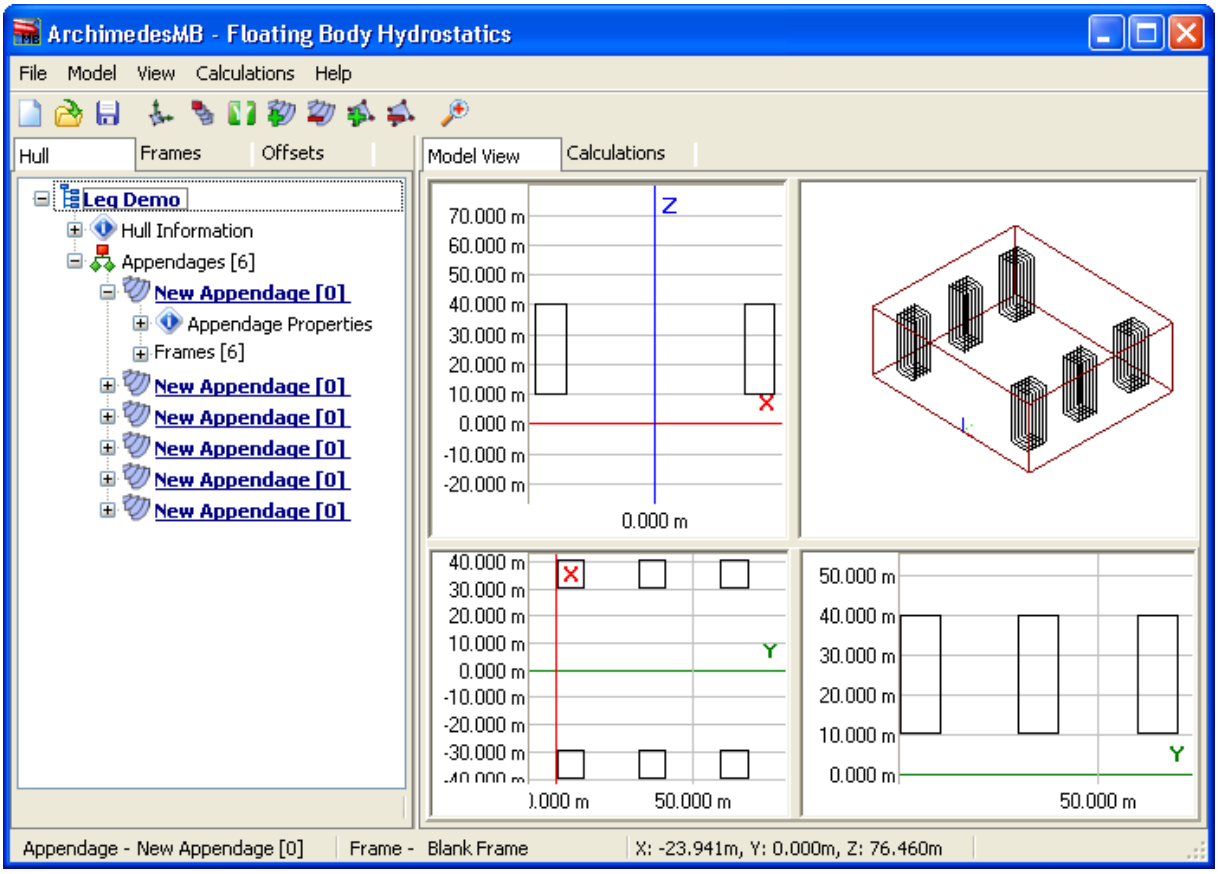
This creates a leg with 6 frames, every 2m between frame @ Y=0.00m to a frame @ Y=10.00m. Next we want to duplicate complete appendage along the y axis. Populate the array tool bax as follows and click execute again:



Finally we want to create a copy on the port side. Easiest way to do this is to mirror the 3 starboard legs using the "Transform" dialog. Scaling by -1 on the x axis and asking Archimedes to place these scaled appendages in a new appendage will mirror the legs for you. Note the use of selecting the appendages you wish to scale (all in this case).



Final model is demonstrated in the screenshot below:



2.2.4 View Menu

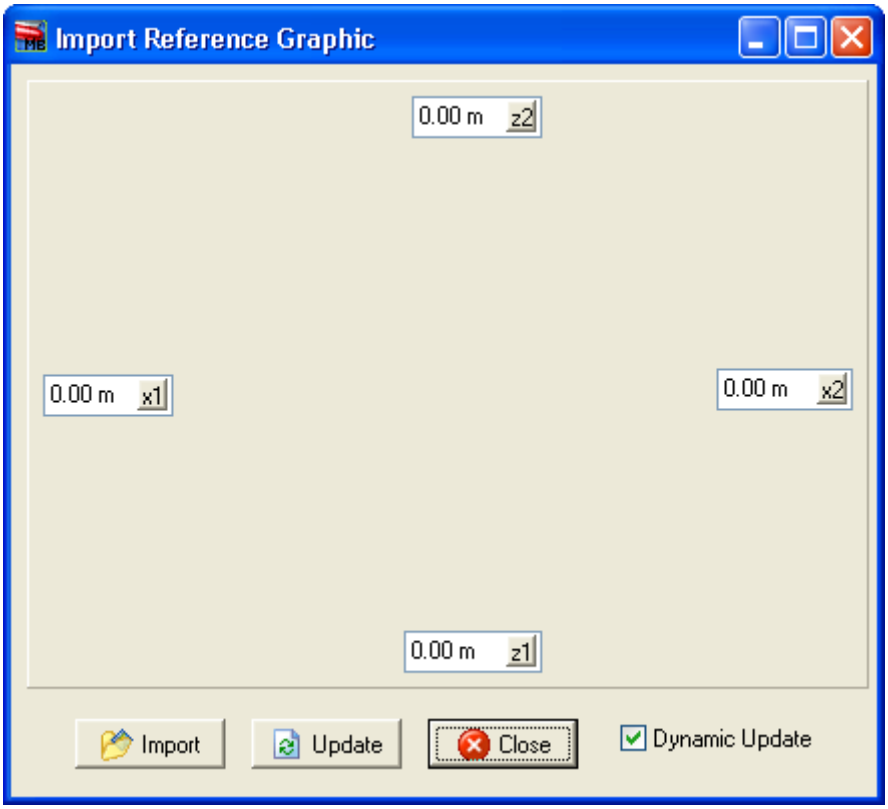
Enter topic text here.

2.2.4.1 Save View

The four sub menus allow the saving of the current view to a bitmap for use in other programs.

2.2.4.2 Import Reference Image

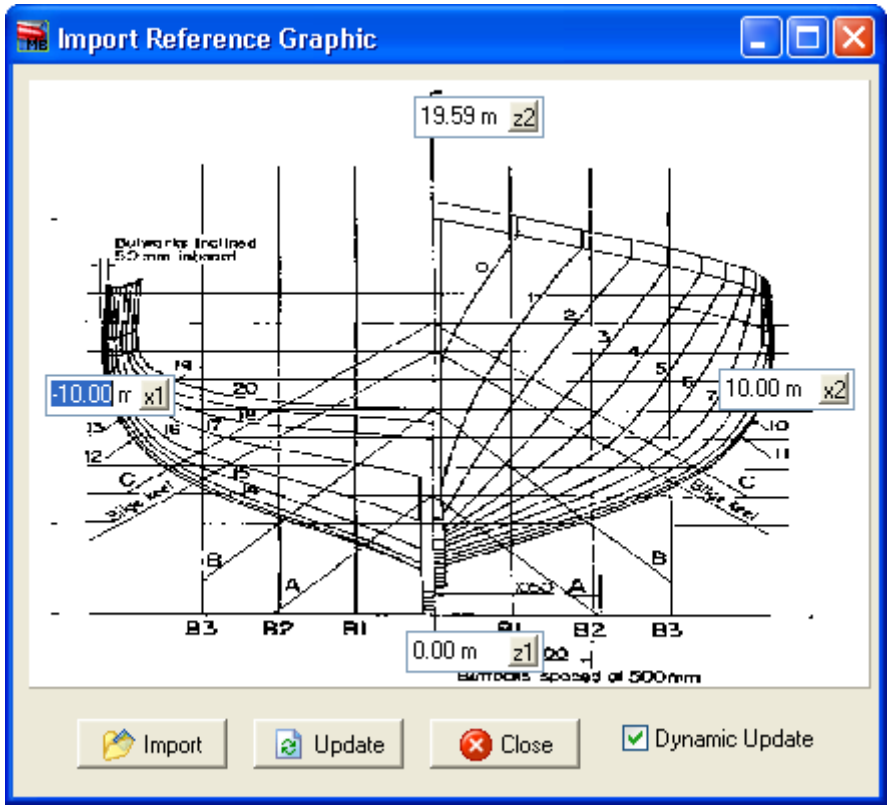
A feature that has been added to the MB version is the ability to import a reference image to act as a background in the 2D section view. Selecting the "Import Ref Image" from the menu presents the user with the following dialog:



By selecting the import button you will be presented with an import picture dialog. Selecting an appropriate image and clicking clicking OK, brings the selected image into the background of the dialog. The four edits around the perimeter are updated to accurately draw the imported body plan at a nominal 20.0m wide and height set to correctly depict the aspect ratio of the image. It is suggested that you use the defaults in the boxes on import, digitise the sections then clear the reference image and use "Transform Dialog" to set the correct scale and location.

x1,x x2, z1 and z2 represent the real world values the edges of the image are mapped to and is how both the scale and the transverse and vertical location of the mapped image is located in the section view.

The dialog loaded with a sample image (downloaded from the web here - Sample Image) is shown below:



Clicking "Update" closes the dialog and maps the reference image into the section view ready for digitising. The Dynamic Update checkbox updates the imported image as you alter the values in the x1,x2 ans z1,z2 boxes.

Clear Import Image
This menu option allows the section view reference image be cleared.

2.3 Hulltree and Data Entry

2.3.1 Hulltree and Data Entry Overview

Enter topic text here.

2.4 Model View and Reports

2.4.1 Model View and Reports Overview

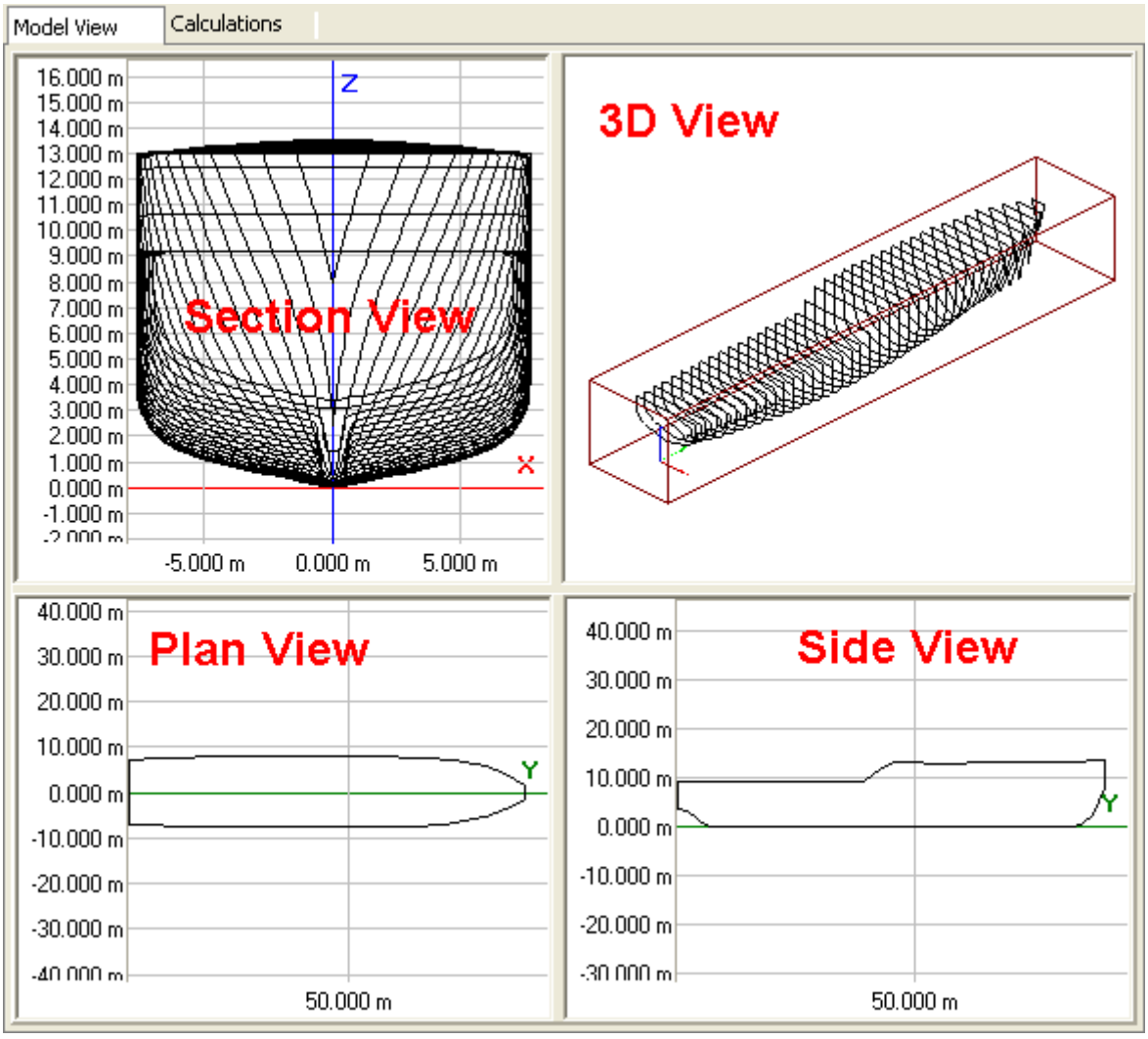
The right hand section of the application screen defaults to showing the 4 views of you model namely Section, Side, Plan and 3D.

These views allow visual feedback on the shape of your model, and also allow direct manipulation of the sections and offsets through point and clicking (see "2D Views").

The tabs at the top of this area allow you to switch from the model views to the report view. Here is where you interrogate the model and run hydrostaics, cross curves etc.

2.4.2 Model View

The "Model View" tab gives access to the 4 classic views on you model as shown below.



Clicking and dragging on the horizontal and vertical grey bars allows the resizing of the views. The program maintains user preferences and the view sizes as set-up on closing down are reloaded when the application is re-started.

2.4.2.1 2D Views

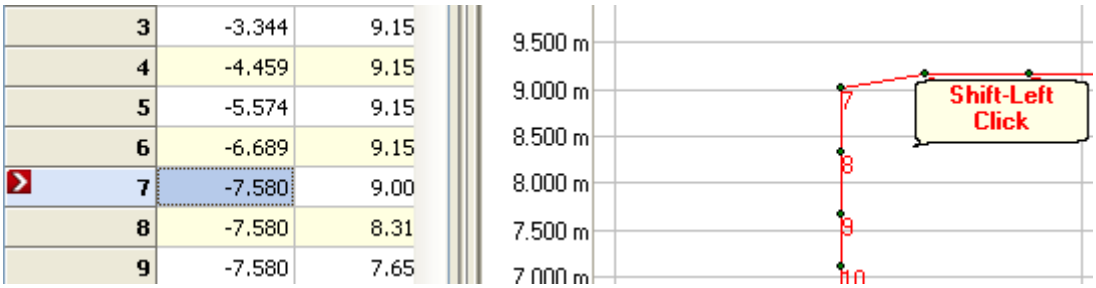
The 2D views show the three classic views on your model, namely Section View, Side Elevation and Plan View. These views are dynamic and allow you to freely scroll around the model, zoom in and zoom out and select/move/add offsets.

Basic Navigation
Each of the 2D views support four standard mouse operations namely Left Click (zoom into view), Right Click (zoom out of view), Left Click and Drag (expand defined portion of the view to expand the entire view) and Right Click and Drag (pan the view in the direction and by the amount specified between the mouse down and mouse up points).

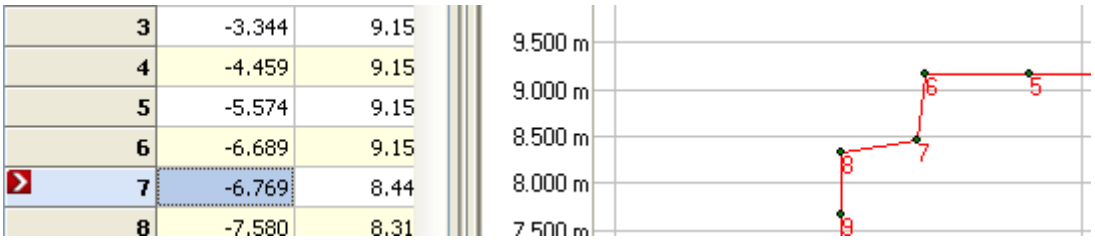
Section View Advanced Editing
The section view has also implemented some advanced features which enable additional functionality namely Ctrl-Left Click (add point after current offset), Ctrl-Right Click (select nearest offset to point clicked), Shift-Left Click (move currently selected offset to the clikced point) and Shift-Left Click (select nearest offset to point clicked).

Important: For editing the section view using point and click the Hulltree and Data Entry section must be in the offset view.

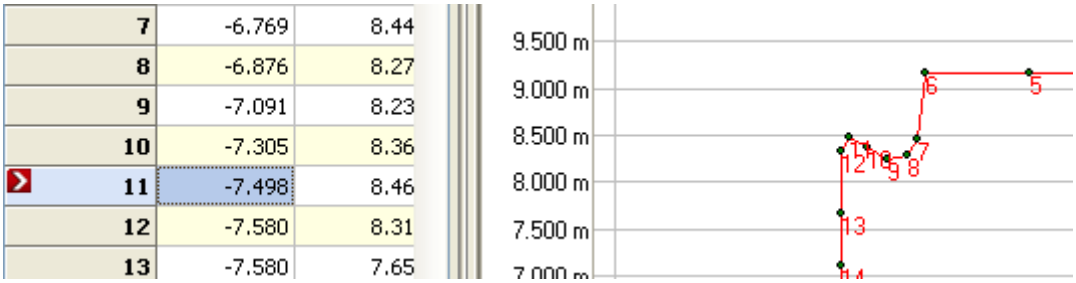
In the screenshot below we have zoomed in on the deck edge and offset 7 is active (indicated by highlight and red arrow). If we Shift-Right Click on the spot shown below then we can move the offset and the numerical editor is updated accordingly:



The view and numerical editor will be updated as follows:



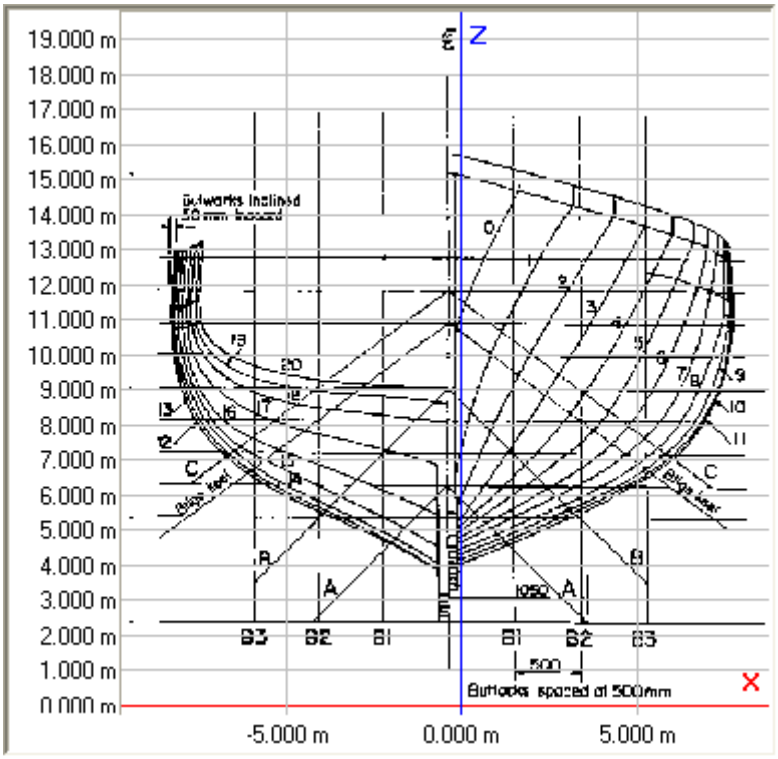
If we then Ctrl-Left Clickbetween offset 7 and 8 above we can add a radius detail between the two.



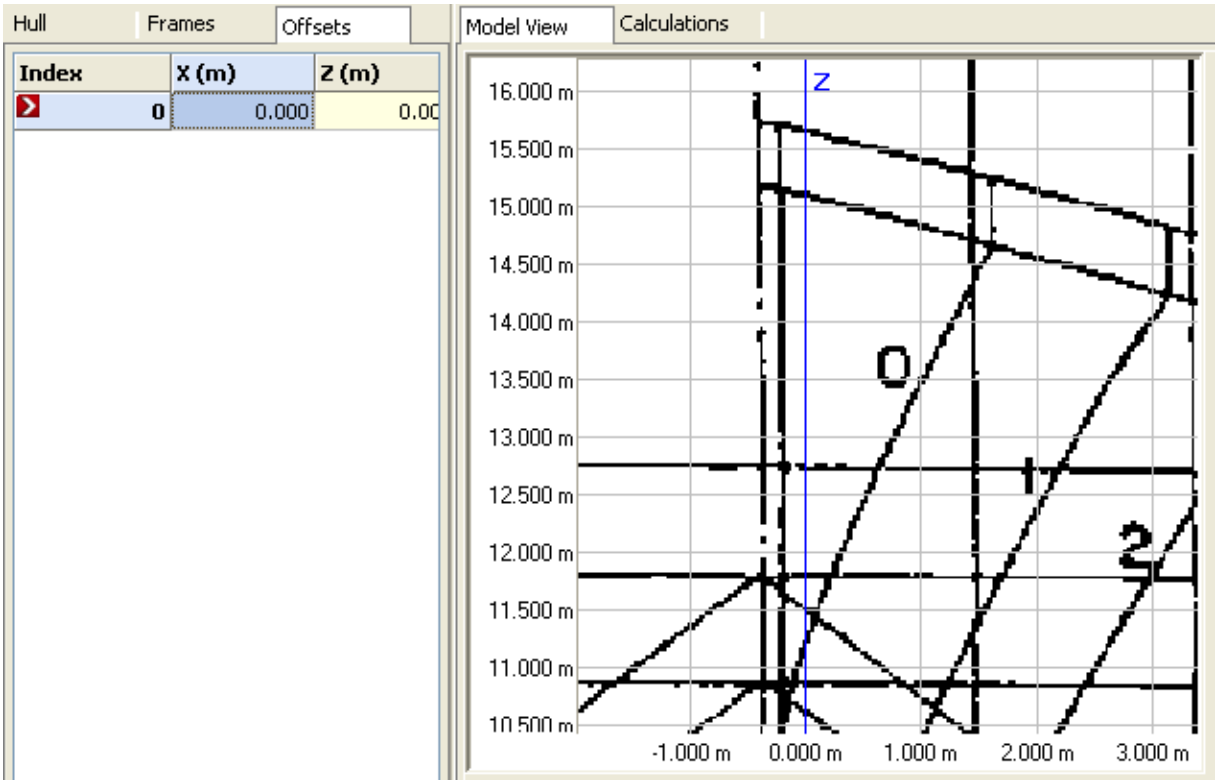
Each Ctrl-Left Click adds a point after the current point, and then automatically selects the next offset allowing an easy way to rapidly trace outlines. When used in conjunction with an imported reference image, gives you an easy way to import lines plans.

Digitising Body Plan

Start by importing a lines plan (refer to "View-Import Reference Image" for details on how to do this). You will have a view similar to the following:

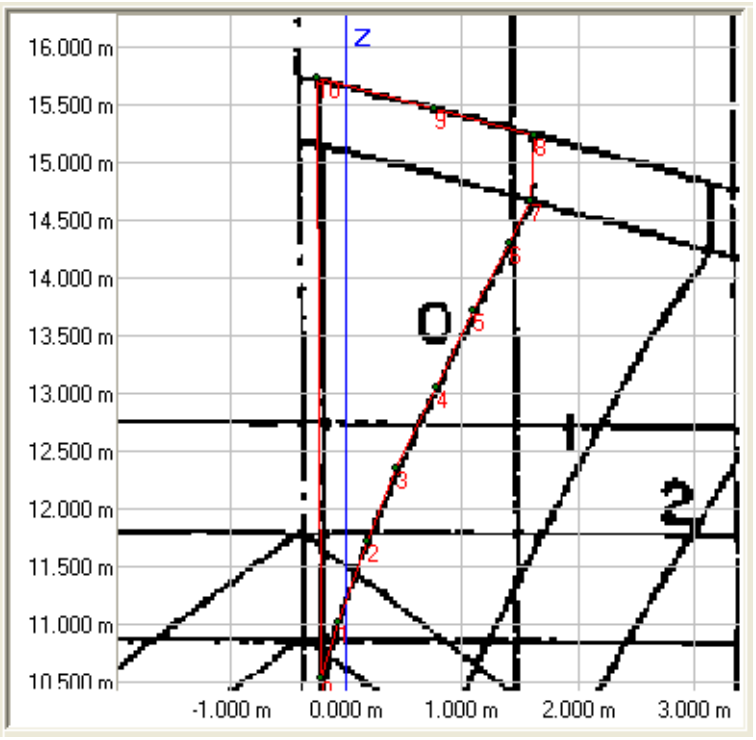


If you zoom in on the first section (section 0 in our view), you will notice that the image is offset from the CL. Dont worry about this for now. Add a new appendage and a new frame and then switch to the numerical offsets view. (you can scan a copy of the body plan used above from the sample body plan included).



You are now ready to digitise a section. Start by Shift Left clicking the intersection of section 0 with the CL on the image. This moves the default first offset ready for adding after and following the shape of the section. Repeated Ctrl-Left Clicking results in the following:

Index	X (m)	Z (m)
0	-0.233	10.52
1	-0.083	11.00
2	0.167	11.70
3	0.417	12.33
4	0.767	13.03
5	1.083	13.70
6	1.400	14.28
7	1.583	14.65
8	1.617	15.21
9	0.750	15.45
10	-0.266	15.71

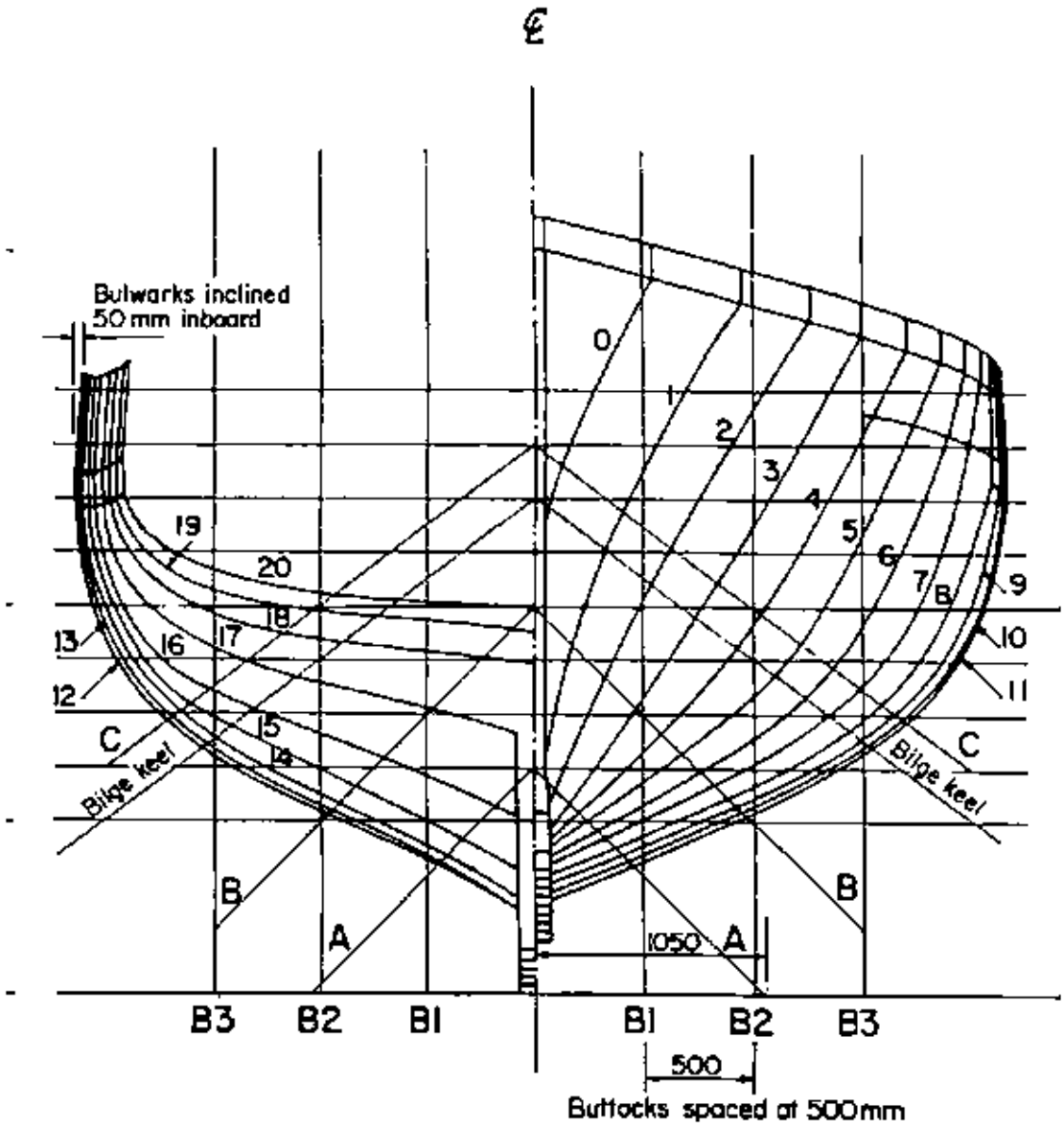


Adding a new frame and then repeating for all other sections allows the full hull to be imported.

Tips for tracing body plans
Create two sperate appendages, one for the fwd sections and one for the aft sections. These can then be mirrored seperately.
Ensure all sections are cleaned up and moved to lie on CL before mirroring. Best to tidy up each station after it has been imported.

2.4.2.2 Sample Body Plan

Sample Body plan for use in digitising a body plan:

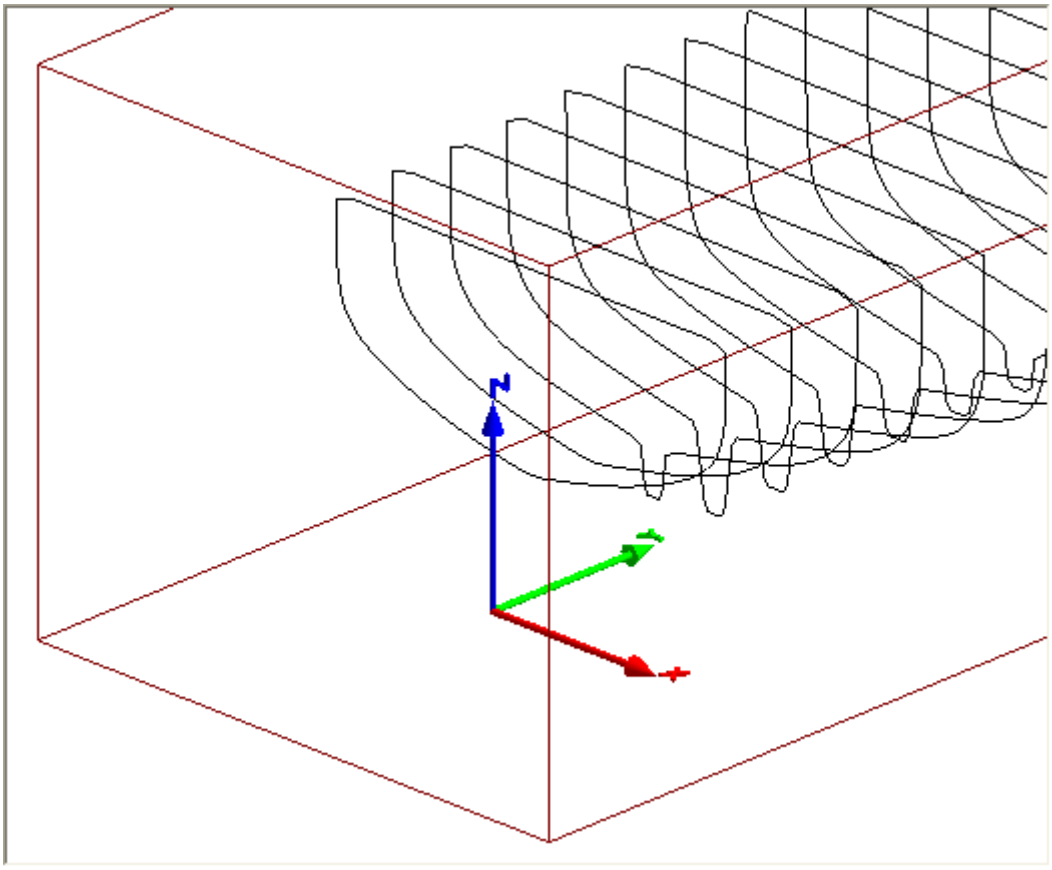


2.4.2.3 3D View

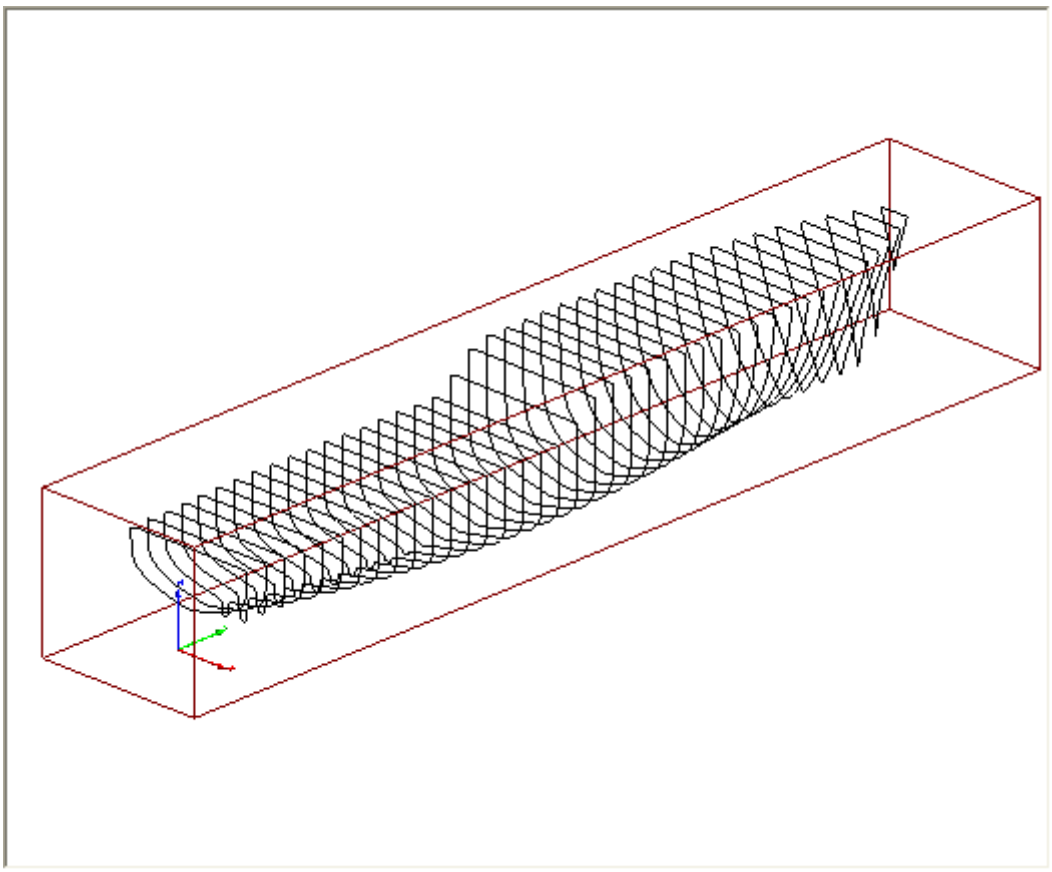
3D view allows you to view, zoom, pan and rotate the model in 3 dimensions.

To navigate in 3D, Left Click zooms in on the view and Right Click zooms out (consistent with the 2D views). Left Click and dragging rotate the view with Right Click and dragging pans the view.

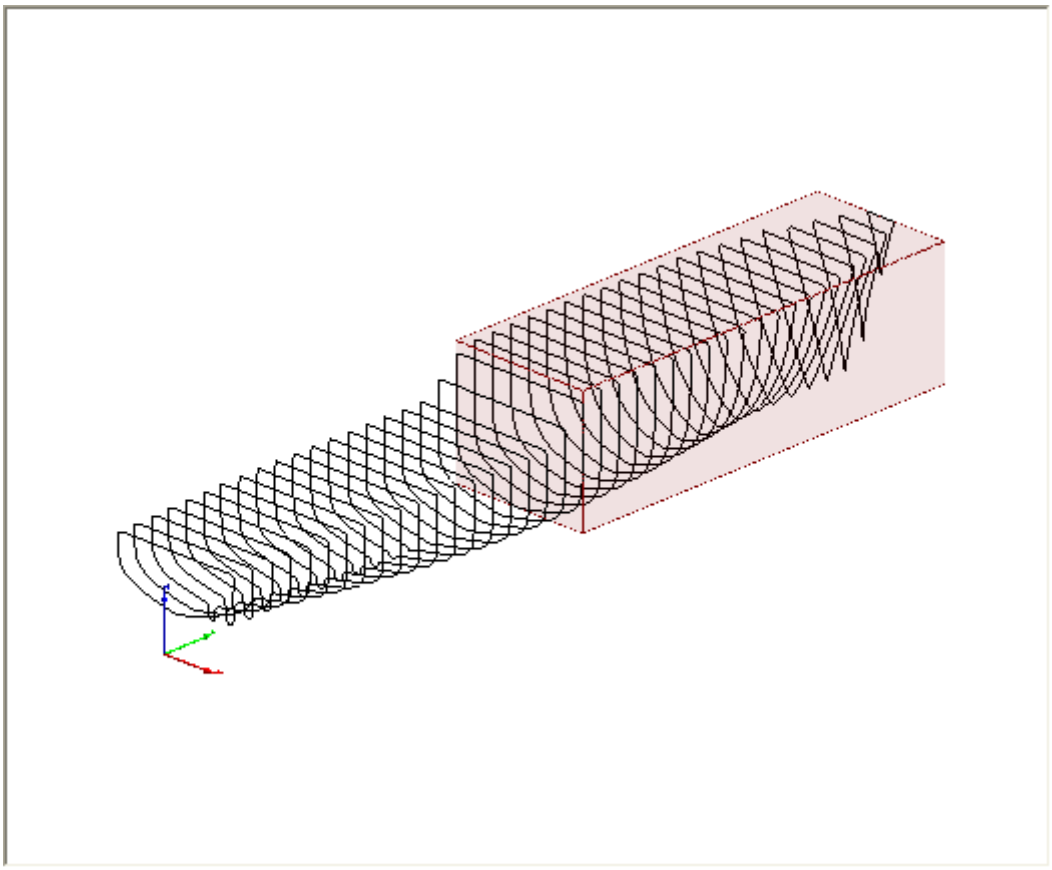
The world axis and origin location are represented by coloured arrows pointing along the x y and z axis as follows:



When the whole model is selected a wireframe bounding box is drawn to represent the model extents.



When there are multiple appendages, the current appendage is highlighted using a shaded bounding box. For example see below where the model above has been split into fwd and aft appendages and the fwd appendage has been selected in the Hulltree.



2.4.3 Reports and Analysis

All the reporting and analysis tools are grouped within this page view. The tabs along the bottom give access to the different analysis types available within Archimedes and the functions of each are described in detail in the following sections.

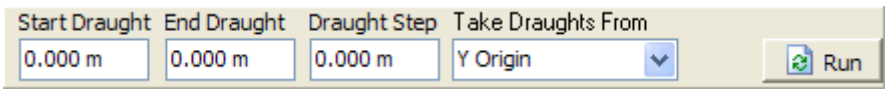
2.4.3.1 Hydrostatics

From this page you can analyse your models hydrostatic properties for different draughts and trims. The results can be viewed as either tabular data or as a graph.

The page is split into two areas, with data input at the bottom and results displayed at the top.

Data Input

The data specifying the range of draughts you wish to run for is entered in the section shown below:



Here you enter the start draught, end draught and the pitch between each set of hydrostatics. Start draught must be less than the end draught. The start draught is inclusive and the end draught will also be reported if a suitbale value is entered in the step edit box, for example start drught of 0.00m and end draught of 1.00m with a step of 0.20m will report hydrostatics at 0.00m, 0.20m, 0.40m, 0.60m 0.80m and 1.00m. Using the same values for start and end draughts but a step of 0.30m will results in

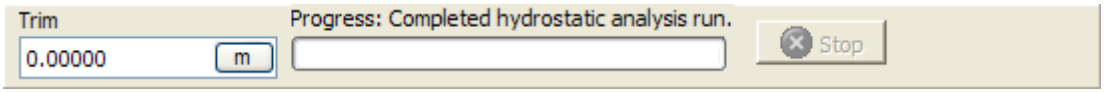
draughts reported for 0.00m, 0.30m 0.60m 0.90m.

Draught Step must have a valid figure (i.e. non zero, positive decimal figure). If an incorrect value is entered, Archimedes will throw an eror and not run. To run a hydrostatics for a single draught, for example 5.00m, setting a start draught of 5.00m, end draught of 5.20m and a step of 0.50m will only report one set of hydrostatics. Note that to correctly plot a graph, a range of values are required and so calculating for one draught only will not provide a useable plot on the graph page.

The drop down box entitled "Take Draughts From" allow you to specify where the start and end draughts are referenced to. Internally all draughts are based on the values running along the Z axis at Y=0.00m and the software defaults to this. However, you can enter the longitudinal location of draught marks and ask Archimedes to use these as the basis for reporting draughts. For example if you wished to calculate hydrostatics for draughts against readings referencing midships draught marks on your vessel, you can change the drop down box to reference the mid set of draught marks. The position of these marks on the Y axis are edited using the model inspector tree.

Standard Calculation Controls

Below these edit boxes, there are standard controls which allow you to specfiy the trim of the vessel for the current run and also a progress bar which reports on the current status of the analysis.



Clicking the "Run" button starts a new thread in the application which takes the model in its current state (allowing for any appendages that are currently turned off or on in the model inspector tree) and returns both tabular and graphical reports on these values.

You can ask Archimedes to insert the latest set of tabular values at the top of the current table by checking the appropriate item "Append Report" under the "Calculations" menu. Note that this only maintains a record of tabular data as it is run, it does not store consecutive records of graphs. These have to be saved each time a new run is initiated.

Hydrostatic Tables
Tabular hydrostatics can be produced and to view these ensure the Table tab is selected at the bottom of the upper area (see below)

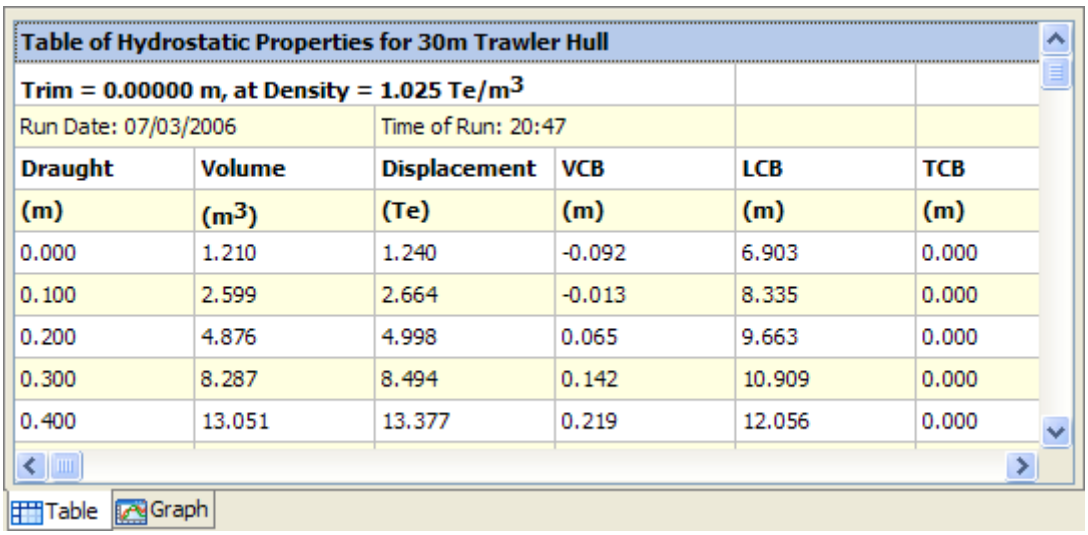


Table of Hydrostatic Properties for 30m Trawler Hull

Trim = 0.00000 m, at Density = 1.025 Te/m^3

Run Date: 07/03/2006 | Time of Run: 20:47

Draught (m)	Volume (m^3)	Displacement (Te)	VCB (m)	LCB (m)	TCB (m)
0.000	1.210	1.240	-0.092	6.903	0.000
0.100	2.599	2.664	-0.013	8.335	0.000
0.200	4.876	4.998	0.065	9.663	0.000
0.300	8.287	8.494	0.142	10.909	0.000
0.400	13.051	13.377	0.219	12.056	0.000

Table Graph

Archimedes allows the calculation and reporting of key hydrostatic properties namely:

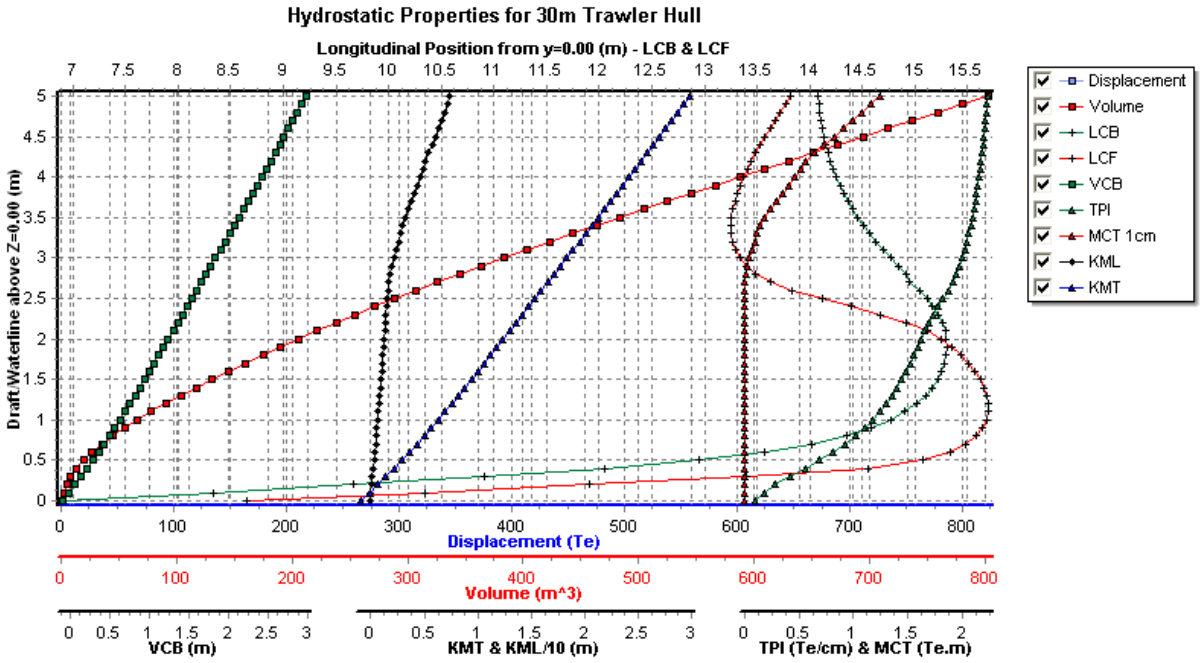
Volume (m^3)
Displacement (metric tonnes)
VCB (m along Z axis from Z=0.00m)

LCB (m along Y axis from Y=0.00m)
TCB (m along X axis from X=0.00m)
LCF (m along Y axis from Y=0.00m)
TCF (m along X axis from X=0.00m)
MCT 1cm (moment in tonne.m)
TPI (metric tonnes)
KMT (m along axis from Z=0.00m)
KML (m along axis from Z=0.00m)
WL Width (max width of water plane along X axis in m)
WL Length (max length of water plane along Y axis in m)
WPA (m^2)

For more detail on each of these variables and comments on how Archimedes calculates them please refer to the section Calculating Hydrostatic Properties

For more information on working with std tables in Archimedes see
Working with Tables in ArchimedesMB

Hydrostatic Plots
As well as tabular data, hydrostatics can be represented as graphical plots. These plots have multiple axis allowing for different scales and positions for each set of data. This allows trends to be identified and distinguished from each other. A sample plot is shown below and for more details on the std interface for editing and viewing your plots, see section on Viewing and Editing your Plots



Sample Hydrostatics Plot

2.4.3.2 Cross Curves

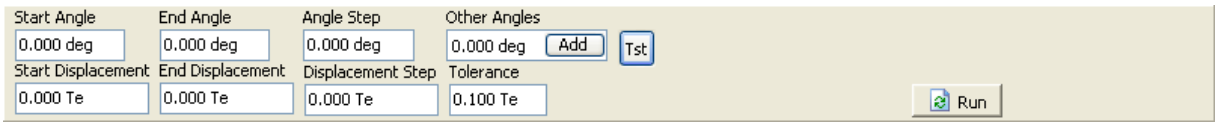
From this page you can generate a set of cross curves for your model. The results can be viewed as either tabular data or as a graph.

The page is split into two areas, with data input at the bottom and results displayed at the top.

For details of how ArchimedesMB calculates cross curves see
Calculation of Cross Curves and GZ Values.

Data Input

The data specifying the range of displacements and angles you wish to run for is entered in the section shown below:



This section allows you to specify both a range of angles of heel to report for via the "Start Angle", "End Angle" and "Angle Step" edits. In addition you can also specify key angles to report by adding them into the "Other Angles" edit and clicking the "Add" button.

The "Start Displacement", "End Displacement" and "Displacement Step" edits boxes allow you to define the range of displacements that the set of KN values over the given angle range are calculated.

"Tolerance" allows you to specify the accuracy to which the software tries to balance the specified displacement and the currently calculated one. Default is 100kg however this can be decreased and thought should be given to the size of vessel analysed. Investigation is underway and this may be changed in the future to a percentage of the currently analysed displacement.

Clicking the Run button starts a new thread in the application and the requested cross curves are calculated.

The results can be diplayed either in tabular form or as a more traditional plot.

KN Tables

Tabular KN values can be produced and to view these ensure the Table tab is selected at the bottom of the upper area (see below)

Table of Cross Curves for 30m Trawler Hull

Trim = 0.00000 m, at Density = 1.025 Te/m^3

Run Date: 26/03/2006 Time of Run: 16:21

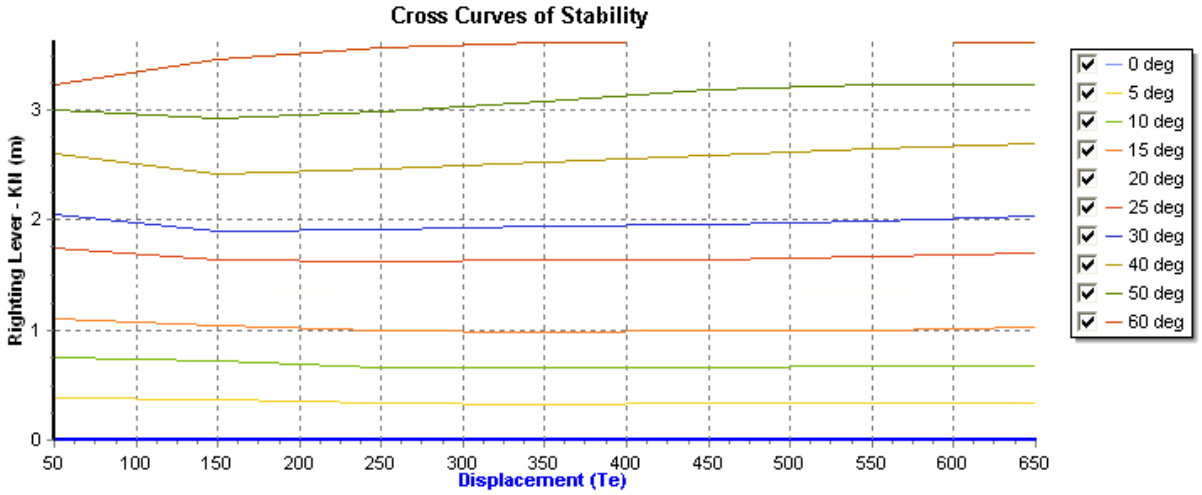
Displacement (Te)	0 deg	5 deg	10 deg	15 deg	20 deg	25 deg	30
50.000	0.000	0.389	0.754	1.099	1.427	1.741	2.0
150.000	0.000	0.361	0.712	1.044	1.351	1.634	1.9
250.000	0.000	0.333	0.665	0.992	1.313	1.622	1.9
350.000	0.000	0.328	0.656	0.985	1.311	1.630	1.9
450.000	0.000	0.330	0.659	0.987	1.315	1.640	1.9
550.000	0.000	0.334	0.667	1.000	1.331	1.662	1.9
650.000	0.000	0.340	0.680	1.019	1.357	1.695	2.0

Table Graph

Tabular Output following KN Curve Run

For more information on working with std tables in Archimedes see
Working with Tables in ArchimedesMB

KN Plots
As well as tabular data, KN values can be represented as graphical plots. A sample plot is shown below and for more details on the std interface for editing and viewing your plots, see section on
Viewing and Editing your Plots



Sample KN Curve Plot

2.4.3.3 Longitudinal Buoyancy

From this page you can generate area and buoyancy curves for your model. As with the other calculations, the results can be viewed as either tabular data or as a graph.

Again the page is split into two areas, with data input at the bottom and results displayed at the top.

Data Input

The data specifying the draught you wish to run the analysis for is entered in the section shown below:

Clicking the run button starts the analysis. Note that changing the trim in the std footer of the calculation view will change the trim used in the calculation of the longitudinal section area curve.

Longitudinal Curve Tables

Tabular curve values can be produced and to view these ensure the Table tab is selected at the bottom of the upper area (see below)

26.495	0.931	0.954				
27.198	0.777	0.797				
27.902	0.650	0.666				
28.606	0.544	0.558				
29.309	0.451	0.462				
29.661	0.405	0.415				
29.661	0.000	0.000				
29.661	0.405	0.415				
30.013	0.347	0.355				
30.716	0.190	0.195				
31.243	0.046	0.047				
31.418	0.001	0.001				
31.418	0.000	0.000				
31.420	0.000	0.000				
32.123	0.000	0.000				
32.827	0.000	0.000				

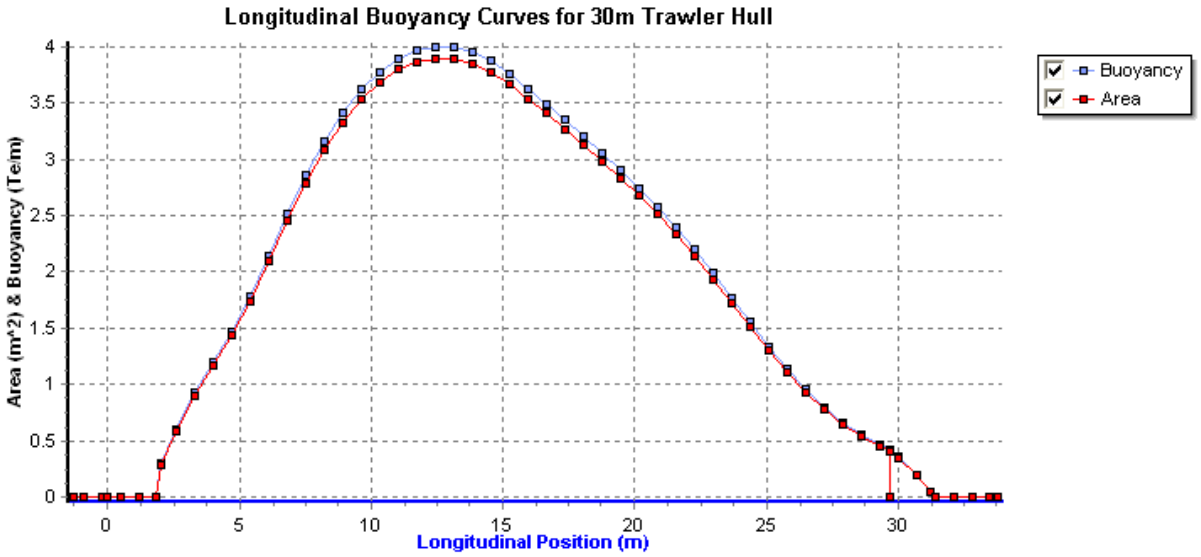
Table Graph

At present, two curves are supported and these are longitudinal section area and longitudinal buoyancy. The longitudinal buoyancy curve is simply the area curve multiplied by the density of the water in which the appendage is immersed. While redundant at this stage, it will be used later when weight curves are added allowing the shear force and bending moments to be integrated over the vessels length.

For more information on working with std tables in Archimedes see
Working with Tables in ArchimedesMB

Section Area Plots

As well as tabular data, section area and longitidinal buoyancy values can be represented as graphical plots. A sample plot is shown below and for more details on the std interface for editing and viewing your plots, see section on Viewing and Editing your Plots



Sample Section Area Plot

2.4.3.4 Viewing and Editing your Plots

The plotting of data in Archimedes MB has a consistent interface regardless of the data you are viewing.

Displayed on all the graphs available in ArchimedesMB are a legend allowing you to identify the various curves. You can also toggle the visibility of these curves by checking and unchecking the checkbox next to the title of the plot you wish to hide/view. Note that the respective axis associated with the curve you are changing also updates. This allows you to generate uncluttered smaller plots for illustration in manuals and reports as well as the flexibility of producing full sized complete plots all from the same interface especially when viewing the plotted data for all hydrostatic properties.

2.4.3.5 Working with Tables in ArchimedesMB

Tables in ArchimedesMB are a convenient way of displaying data and allowing direct export to spreadsheets for further post processing. Copying data to the clipboard from a table will also allow you to directly paste this data in both a word processor and a spreadsheet.

TODO: Notes on csv files, text files and printing from tables within Archimedes

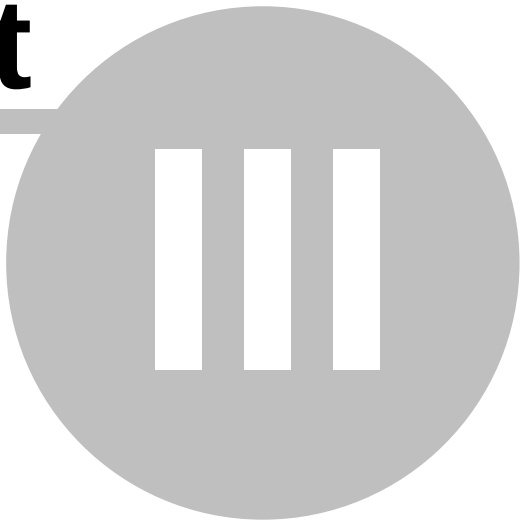
2.5 Status Bar

Enter topic text here.

2.5.1 Status Bar Overview

Enter topic text here.

Part



3 Background Theory

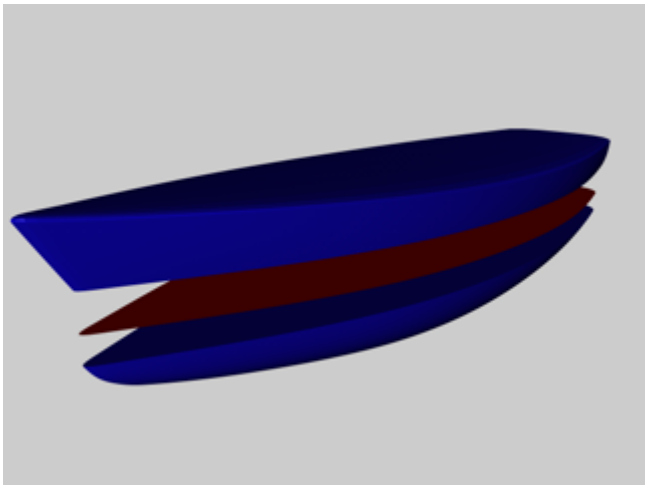
This section covers the theory of Naval Architecture and its application in the core functions of ArchimedesMB. This is to allow full transparancy to the inner workings of the code and allow the user full clarity on how the values the software spits out are obtained.

Please, if after reading this section, anything remains unclear please contact the author so we can amend and add further detail as required.

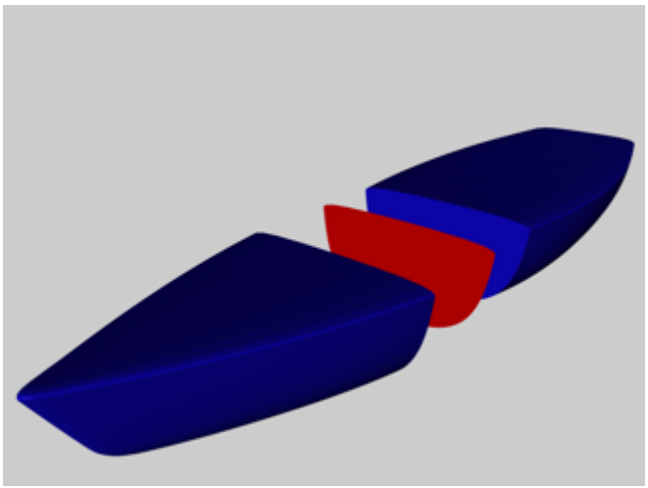
3.1 Primer on Naval Architecture Terms

To aid the user in finding their way around the software and also to give a fighting chance of understanding this capter, some of the basic terminaology used in Naval Architecture will be discussed.

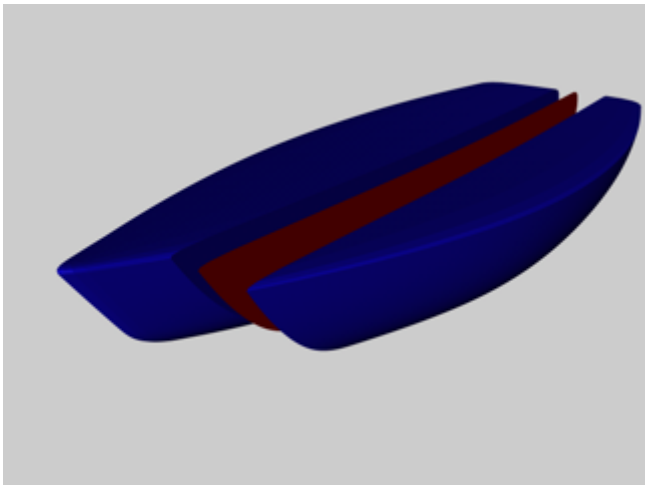
Firstly, a 3D hullform can be described or shown in 2D form using a lines plan. This lines plan shows sections through the hull in 3 different planes known as waterlines, sections and buttocks, see the three images below to see how these slices through the hull are visualised.



Waterline plane - horizontal slice through a hull normal to Archimedes Z axis.

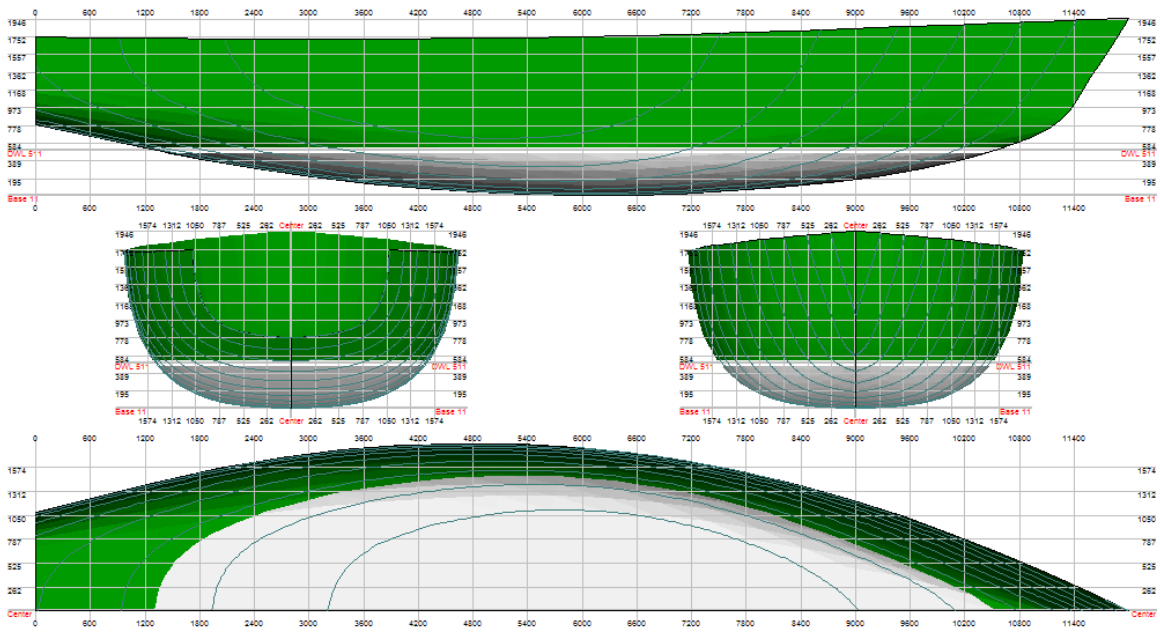


Section - vertical slice through a hull normal to Archimedes Y axis.



Buttock - Vertical slice through a hull normal to Archimedes X axis.

These sections can be formally arranged in drawing known as a lines plan. A sample lines plan from the excelent FreeSHIP software is shown below.



Sample Lines Plan generate using FreeSHIP

TODO: Add skecth showing tumble home, sheer, camber rake etc etc.

TODO: What is trim, moulded dimensions etc.

3.2 Modelling and Axis System

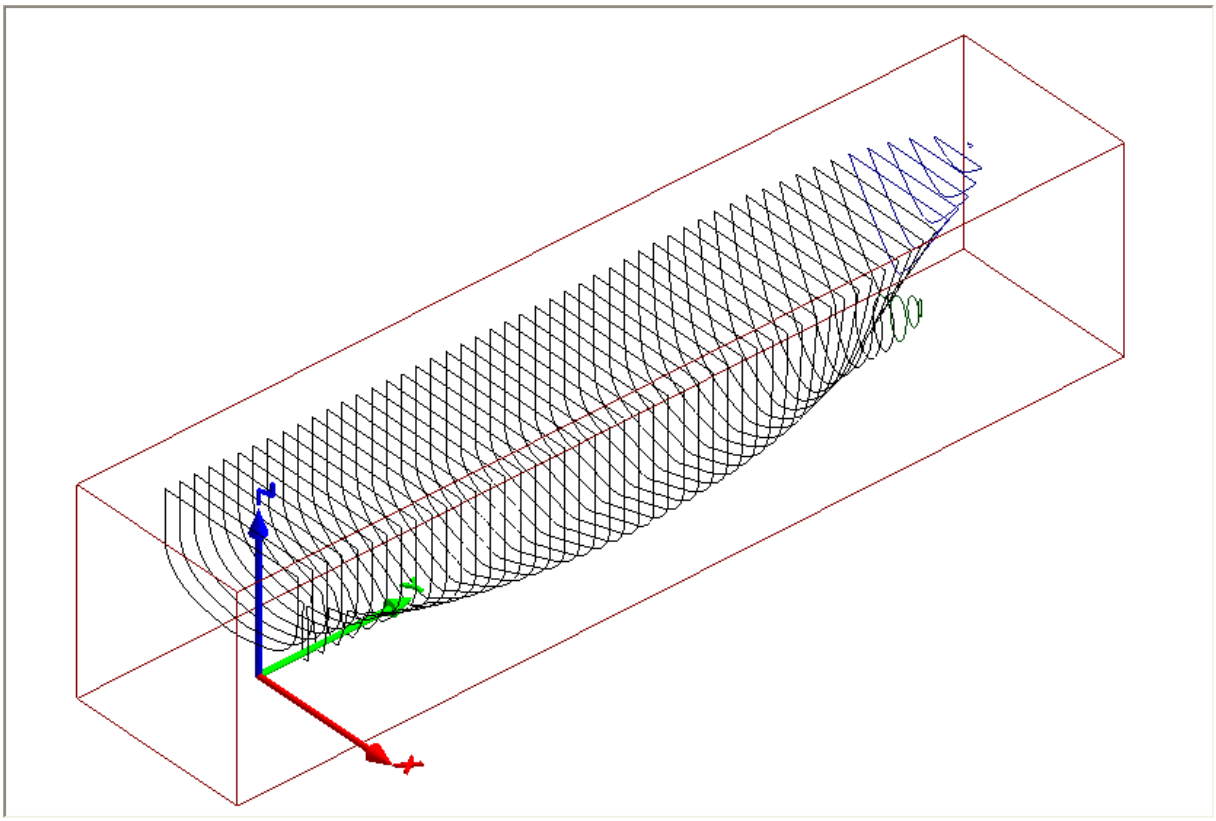
Archimedes axis system maps the traditional naval architectural vessel axis system of longitudinal, transverse and vertical as follows:

X Axis - Transverse.
Y Axis - Longitudinal.
Z Axis - Vertical.

Also note that the three primary colours are applied to the axis system to allow the user an intuitive indication to what direction or axis any particular user editable values apply. For example the numeric

edit controls in the Transform tool box.

If the fwd direction of your model is set as running along the positive y axis direction, then positive X axis points to starboard. The following image shows a typical orientation of a vessel modelled in Archimedes. Note the Z axis is typically coincident with the vessel centreline.

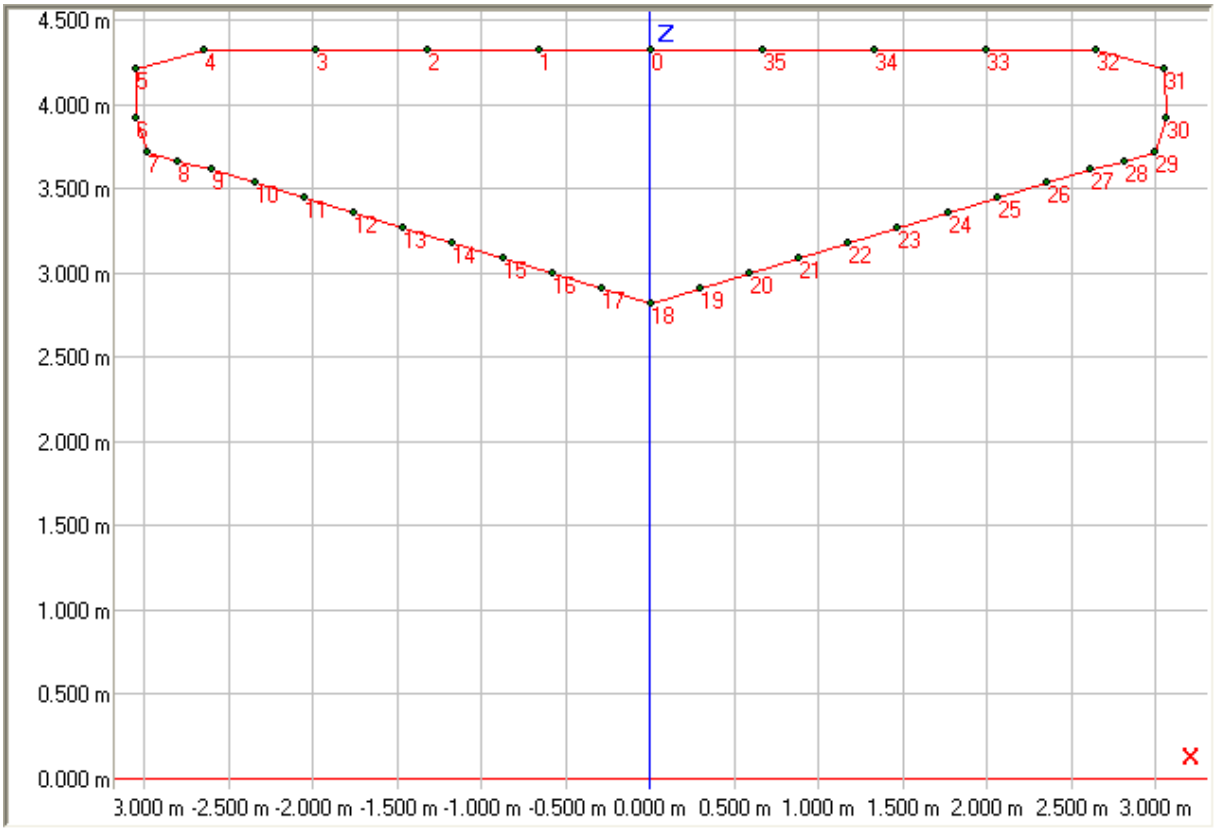


Note also that the Y axis runs along the keel. Draughts in Archimedes are measured along the Z axis above the origin, i.e. from Z=0.0m.

While this is the recommended system for setting up and running models, it is by no means required and the system is designed to analyse floating bodies in general and so a system is required that is not soley tied to a traditional vessel axis system. Where this can offer confusion to traditional analsysis we will endeavour to draw the users attention to alternative means of interpretation and clarify.

3.3 Offsets and Section Data

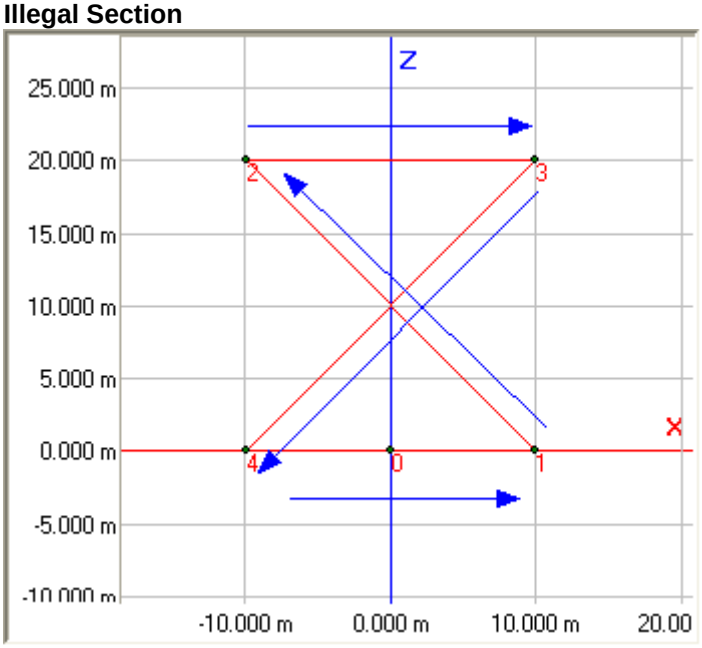
The fundemental building blocks of models in Archimedes are offsets. These are pairs of double precision floating point values which always lie on the local X-Z plane. These are grouped together in an array to allow a description of a 2D polygon called "Sections" in Archimedes. The software assumes a closed section and assumes the last offset entered is connected to the first as shown in the image below (note offset indexed @ 35 is connected to first indexed @ 0):



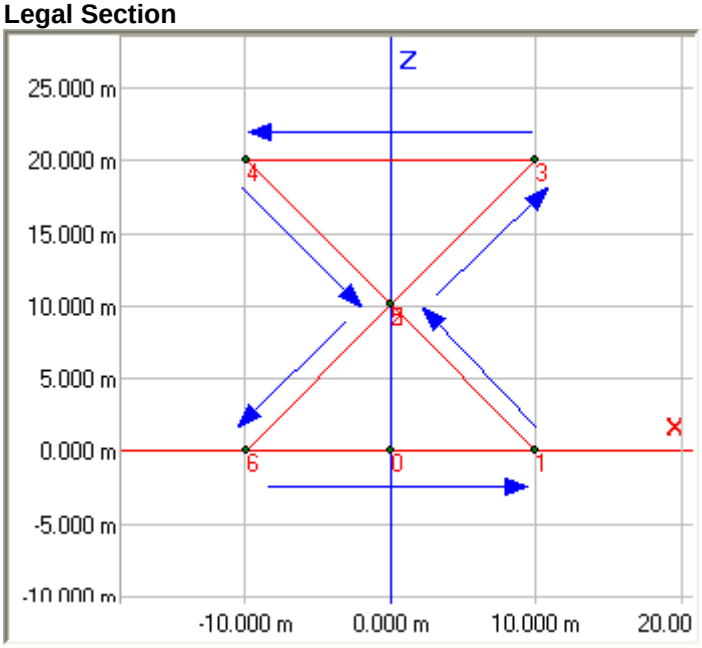
Valid Sections

Sections are analagous to frames or transverse sections in traditional naval architecture systems and are 2D polygons that are always normal to the local longitudinal Y axis. In Archimedes offsets may be entered either clockwise or anti-clockwise to create sections and may also use either system within the same model or appendage. Unlike version 1.x sections may not have outlines that cross. i.e. figures of eight. The following is an example of an illegal section and how it can be modelled legally in ArchimedesMB.

Illegal Section



Legal Section



The use of crossed sections will have an unpredictable result on your analysis and so you should be very carefull to ensure that these types of sections are not employed in your model.

Section Accuracy

The software calculates the true area of the section as a polygon bisected by a line parallel to the X axis which represents the waterline. If the waterline is greater than the maximum offset location on the Z axis then the area will be the complete area of the polygon enclosed by the offsets. The calculation of this area assumes the offsets entered describe the profile of a section as a series of discreet lines.

To assess the accuracy offered by this system, we can compare different resolutions that describe a circle as follows:

TODO: Add results of section calcs on circle crd files.

3.4 Calculation of Hydrostatic Properties

The foundation of most Naval Architectural calculations is the Hydrostatic properties of a vessel or floating body. These properties are numerical representations of the underwater form of the vessel. They tell the Naval Architect how "stiff" a body is, how buoyant it is at the current draught and if it is statically stable in the upright position.

We will give a broad overview of hydrostatics and show what the variables actually represent both in the context of a real floating body and also give some detail to the way in which Archimedes calculates them as an aid to those professionals who intend to use the values in their further work.

We will take each of the properties that Archimedes calculates and discuss their derivation in detail. For a complete list refer to section Hydrostatics in the chapter on Reports and Analysis.

Draught

Volume and Displacement

Centre of Buoyancy

VCB
LCB
TCB

Centre of Floatation

LCF
TCF

Moment to Change Trim

MCT 1cm

Static Stability and the Metacentre

KMT
KML

Waterplane Characteristics

TPI
WL Width
WL Length
WPA

3.5 Calculation of Cross Curves and GZ Values

Primer on cross curves and GZ curves and how ArchimedesMB calculates them.

3.6 Internal Data and Scientific Constant Representation

Where data and scientfic contants are discussed in this manual they are detailed as follows:

Numerical Representation and Range

Type	Size (bits)	Range	Sample applications
unsigned char	8	0 <= X <= 255	Small numbers and full PC character set
char	8	-128 <= X <= 127	Very small numbers and ASCII characters
short int	16	-32,768 <= X <= 32,767	Counting, small numbers, loop control
unsigned int	32	0 <= X <= 4,294,967,295	Large numbers and loops
int	32	-2,147,483,648 <= X <= 2,147,483,647	Counting, small numbers, loop control
unsigned long	32	0 <= X <= 4,294,967,295	Astronomical distances
enum	32	-2,147,483,648 <= X <= 2,147,483,647	Ordered sets of values
long	32	-2,147,483,648 <= X <= 2,147,483,647	Large numbers, populations
float	32	1.18 10^-38 < |X| < 3.40 10^38	Scientific (7-digit) precision)
double	64	2.23 10^-308 < |X| < 1.79 10^308	Scientific (15-digit precision)
long double	80	3.37 10^-4932 < |X| < 1.18 10^4932	Financial (18-digit precision)

Ref: [1]

Scientific Constants

Acceleration due to gravity	g	9.80665 m.s^2

3.7 References

[1] - Borland C++Builder 5 Help File
[2] -

Back Cover