WOLFSON UNIT
FOR MARINE TECHNOLOGY &
INDUSTRIAL AERODYNAMICS

SHIPSHAPE USER MANUAL

Version 19/7/99

University of Southampton, Highfield, Southampton, SO17 1BJ, U.K.
Tel: +44 (0)23 8058 5044 Fax: +44 (0)23 8067 1532
wumtia@soton.ac.uk http:\\www.soton.ac.uk\~shipsci\wumtia

TABLE OF CONTENTS

PACKAGE CONTENTS

In addition to the manual there is one 3½" disc supplied with this package. New users will be provided with a hardware key or **Dongle** for software protection.

Instructions for installing the programs onto the hard disc are given in the section entitled **Configuring The System**. For additional protection, it is advisable to perform configuration using a copy of the original disc supplied in this package. Always ensure that the write protect tab is in place on the original master discs.

PROTECTION SYSTEM

Single user option

This program utilises a hardware key or **DONGLE** which fits into the **Printer** port of the computer, the printer lead then plugs into the back of the key. The individual programs check for the presence of this key. If it is not found, a warning is given, place the **DONGLE** in the port before continuing.

Network option

The Wolfson Unit's Network Protection System allows for a single **Dongle** to be placed either on the file server (for Networks which allow access to the DOS Segment) or on a suitable Workstation (with rights to save files on the \HYDRO directory), rather than on the workstations which will run the software. This allows any workstation on the network to operate the Wolfson programs.

On the installation disc is the file **NETDOM.EXE**. This file should reside on the file server and must be run either by the file server each day, if the Network system allows, or by a logged workstation with rights to the appropriate subdirectory on the file server. **NETDOM** creates the file **WOLFSON.SYS**, which is in turn interrogated by the Wolfson Unit programs to ensure that the Dongle has been read.

The syntax for running **NETDOM** is: **NETDOM** <Path>

Path is a valid MS-DOS name to the subdirectory on which the Wolfson Unit files reside, e.g. **NETDOM F:\PUBLIC\WOLFSON**

Separate commands should be made for each subdirectory containing Wolfson files, thus a network running **Hydrostatics**, **Ship Motions**, **Resistance & Propulsion**, and **ShipShape** in separate subdirectories would require four calls to **NETDOM**.

CONFIGURING THE SYSTEM

Configuration of the system is performed by a file on the program disc entitled SHIPSHAP.EXE. Before undertaking the configuration however, take a backup copy of the disc supplied, and then follow this procedure with the backup copy :-

This procedure assumes that the supplied program disc will use drive A, and that the program will be installed onto drive C in a subdirectory but any valid drive letters and subdirectory path may be specified.

1. Place the program disc in drive **A**.

2. From the File Manager run **SETUP** from the floppy.

3. Follow the installation prompts. The sub-directory onto which the program will be installed defaults to **C:\Progarm Files\Wolfson\ShipShape**, and the Windows group file defaults to **Wolfson**. These may be changed if required.

4. The installation will automatically add device driver **MNXX.386** to **SYSTEM.INI**, in the **386Enh** section This driver is required for correct operation of the protection system. Windows will need to be restarted in order for it to take effect.

The program may then be run from the program manager as normal.

The main **ShipShape** manual can be found in the **ShipShape** help file by activating the context sensitive help by pressing the F1 key or via the help menu during the program execution. Particular pages from this manual can be printed if paper references are required. A tutorial is available with the **ShipShape** help system and is also supplied in the following section.

SHIPSHAPE HELP SYSTEM

ShipShape has a comprehensive on line help system. It describes the functionality of all commands, windows and dialogs together with all the information supplied in this help manual. The on line system can be activated using the help menu on the main ShipShape window. Context sensitive help can be also activated by pressing F1 at any time. This will start the help system and display any pertinent information about the current window or dialog that is active.

INTRODUCTION

ShipShape is a program designed to assist the naval architect in defining, fairing and drawing a set of ship's lines. The program uses cubic splines through specified sets of points to describe a set of three-dimensional curves, which are defined to be sections or longitudinals. These curves do not have to be true sections nor specific longitudinal curves from a lines plan; however sections are assumed to run primarily girthwise and longitudinals are assumed to run primarily fore-and-aft. These curves are linked to each other at specific nodes to create a network of curves. Each curve can be edited by moving the points defining the curve or editing the curvatures at those points. Finally, when the curves have been faired, a lines plan can be generated by interpolating sections, waterlines and buttocks, through the three-dimensional curve network. In addition, the intact hydrostatics at specified waterlines can be computed.

The cubic spline approach used in this package is very flexible, allowing a wide variety of hull features to be defined, including flats of side and bottom, chines and multiple hull elements. The method is also intuitive for the naval architect, since a cubic spline through a series of points mathematically models a flexible batten held by spline weights. Since the points defining a curve are on the curve, this approach also facilitates the transfer of existing drawings and allows the curve to be precisely located at known points.

ShipShape allows initial entry and editing of the curves. To define a new curve the user enters its description, its type (Section or Longitudinal) and the number of points defining the curve. The points can then be entered numerically, in a spreadsheet-like numerical table, or by using the computer screen as a sketch pad, or by digitising an existing sketch or lines plan. The numerical editing mode is also used to edit the end conditions of the curve, which can be defined as being free (no curvature), or with specified slope, or specified curvature.

Once curves have been entered, linking them defines where each curve lies on the network. The network is a schematic representation of the ship, consisting of a grid of longitudinal and transverse lines. Each longitudinal and section curve must lie along one of these grid lines, although each network grid line may be composed of several individual curves. The user specifies on which network grid line, and where along that line, the curve lies. If the curve crosses a network node where another curve has already been set (e.g. a longitudinal crosses a previously linked section), the existing data for that node are transferred to the new curve. Thus the order in which curves are linked defines which curves are forced in to compatibility with other curves.

Once a curve has been initially entered, it can be edited by selecting a point on the displayed curve and moving it to its new location. If the curve has been linked to other curves in the network, the corresponding points in the other curves will also be moved. The curvature and slope for the curve are constantly displayed while it is being edited, to show subtle unfairness invisible in the curve display itself. The curvature values themselves can also be edited, giving fine control over the fairness of the curve.

When the sections and longitudinals are faired to the user's satisfaction, the data output can be used to generate true sections, waterlines and buttocks at specified planar locations. These can then be output directly to a printer, .DXF file, an offset table file or a file for conversion to another format such as Wolfson Unit Hydrostatics and Stability program format. This module also computes the basic hydrostatics for the ship, including displacement, form parameters, metacentres and centres of buoyancy and flotation.

PROCESS DESCRIPTION

Basic Surface Definition

Within the ShipShape program suite, a surface is defined by a network of connected 3-dimensional cubic spline curves. Subject to certain minimal rules, a network of curves appropriate to the desired form may be defined.

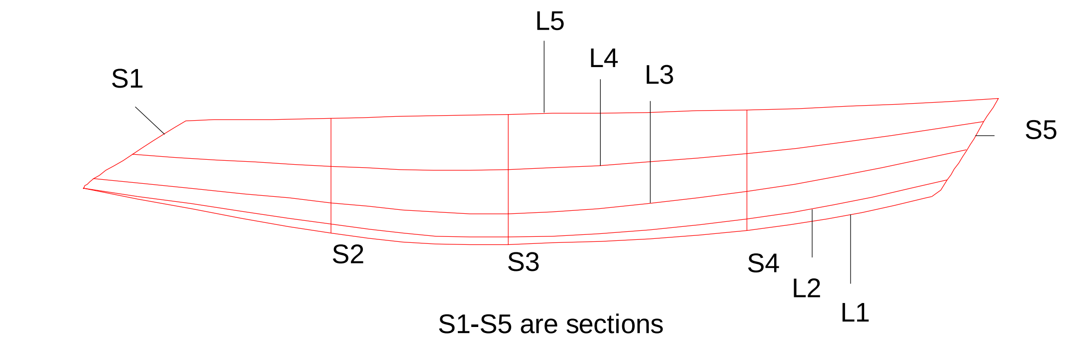
Two types of curves are recognised within the network, classified as:

1. *Longitudinals* running basically lengthwise along the hull.

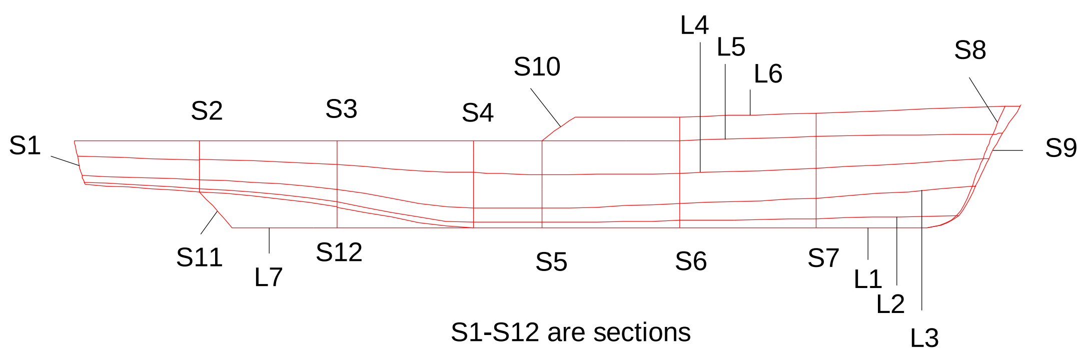
2. *Sections* running basically girthwise around the hull.

It must be emphasised that none of the network curves need to be plane curves. In particular, longitudinals need not be conventional waterplanes nor need sections be conventional plane transverse sections. In practice, it is desirable to keep the sections planar for the major part of the network, if only because the designer will have a feel for the shape of the sections on the final interpolated body plan. As a contrast, longitudinals will almost certainly not be conventional waterlines.

Certain natural hull features (e.g. sheer lines, knuckle lines, flat of bottom lines etc.) will need to be network longitudinals. Between these natural features, the spacing of the longitudinals is governed by the need to provide reasonably smoothly spaced data around each section, consistent with the variation of curvature around the section.



S1-S5 are sections
L1-L5 are longitudinals

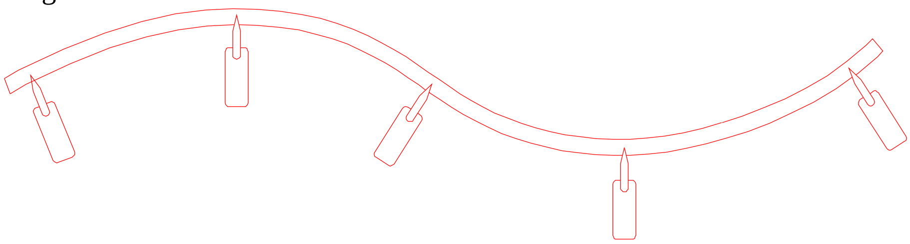


S1-S12 are sections
L1-L7 are longitudinals

Each network curve is defined by (x,y,z) co-ordinate data given only at the nodes where network curves cross or join one another, together with end slope or curvature information as appropriate. Thus the number of longitudinals chosen is governed by the number of data points required to define the section shape adequately. In terms of the work content and the quality of the result, the advantage lies with keeping the network as sparse as possible.

Mathematical Formulation Of Network Curves

All curves forming the network are parametric cubic spline curves in which each of the space co-ordinates (x,y,z) are cubic spline functions of a parameter (u) which varies continuously along the curve length. The cubic spline curve is precisely the curve obtained by deflecting a uniform elastic beam by means of point loads applied at the same points as the nodes of the curve, when calculating the deflection curve according to simple beam theory. The analogy with a draughtsman's batten and weights is clear.



Mathematically, the advantage of the spline curve lies in its optimum smoothness property (minimum RMS curvature) analogous to the minimum strain energy property of an elastic structure. Thus a spline curve is the smoothest curve that can be drawn through any given set of nodal points. The parametric form permits both horizontal and vertical tangents and also the formation of closed loops. Neither of these features are possible with non-parametric curves. Just as the deflection curve adopted by an elastic beam depends on its 'end fixity', so a mathematical spline curve needs end condition data, in the form of slope or curvature values to complete the curve definition.

A detailed explanation of the cubic spline mathematics is given in the Appendix.

Choice of End Conditions

At each endpoint of a curve, the first and second derivatives (slope and curvature) of each co-ordinate (x,y,z) with respect to u may be specified. This feature is used to apply specific local characteristics to the curve at the ends.

For the majority of curves, the appropriate end condition will be either zero curvature or a curvature chosen to produce the fairest curve form. Alternatively, if the slope conditions at the end are known the end slopes can be set to the known values.

The best choice of end curvature is not usually known initially. It may conveniently be set to zero when the curve is set up and subsequently adjusted whilst fairing the curve. The initial choice of zero curvature at the ends is the default option on curve input.

The tangent vector at the curve end is defined by the three slope components dx/du, dy/du and dz/du. Note that the slope vector has a length as well as direction.

Altering slope components while leaving the relationships between them constant alters the amount of fullness in the curve near the end, while retaining the slope tangent at the end.

Curve Fairing

The two choices available for fairing the curve are to move points directly or to manipulate their curvature values. Direct movement of points is useful for making large changes to a curve. Curvature manipulation is used for the final fairing process. At points other than those at the ends of the curve, the program calculates an adjustment to the selected co-ordinate at the point concerned, to obtain the new curvature value. This provides a sensitive method of adjusting point position to improve curve fairness. At either end point, the adjustment is to the curve end condition (slope or curvature).

Moving a point on a curve, or changing end conditions, alters all curvature values along the curve. In practical terms only two points either side of the change are significantly affected. The change of curvature at the adjacent points to the change is about $^{2}/_{3}$rds of that at the change itself and in the opposite direction. This must be allowed for in selecting the new curvature value at the point of change.

The aim of the fairing process is to achieve a smoothly varying set of curvature plots along the curve for all 3 co-ordinates (x, y and z).

Care must be taken to avoid removing regions of high curvature that are desired features of the curve. For instance, the fillet region between a skeg and the upper portion of the section is a valid region of high curvature which shows as a spike on the curvature plots, but is not an unfairness to remove. Some experience is required to gain a sense of direction when curve fairing and only general guidance can be given. The general principles are as follows:

1. Try to adjust end conditions first.

2. Move the smallest possible number of points, avoiding regions of authentic high curvature.

3. Work from the points of worst unfairness first and be prepared to make two or three changes to produce the final result.

4. Keep in mind the shape of curvature plots for adjacent curves and try to preserve a progressive variation across the hull surface.

Connecting Network Curves

The network consists of an array of points that will accommodate all of the curves to be connected into the network. The display is a schematic representation of how the curves relate to each other.

A curve is entered into the network by selecting it from the curve list and defining the location of its start point on the grid. The network is scanned to locate points at which the new curve crosses or joins existing curves currently in the network. Where a connection is detected, co-ordinate data are transferred from the existing curve to the new curve to ensure common co-ordinate data at the connection.

Note that neither longitudinals nor sections need extend the full width or depth of the network. A change of section above and below a knuckle line, for example, allows a slope discontinuity to be obtained.

At points in the network where linked curves require slope continuity across the joint, slopes can be matched at the common end point. One curve is designated as the master curve and the other designated the slave curve. The master curve is itself unaffected by the slope matching, and can be edited as normal. The end slope on the slave curve is set to maintain slope compatibility with the master curve.

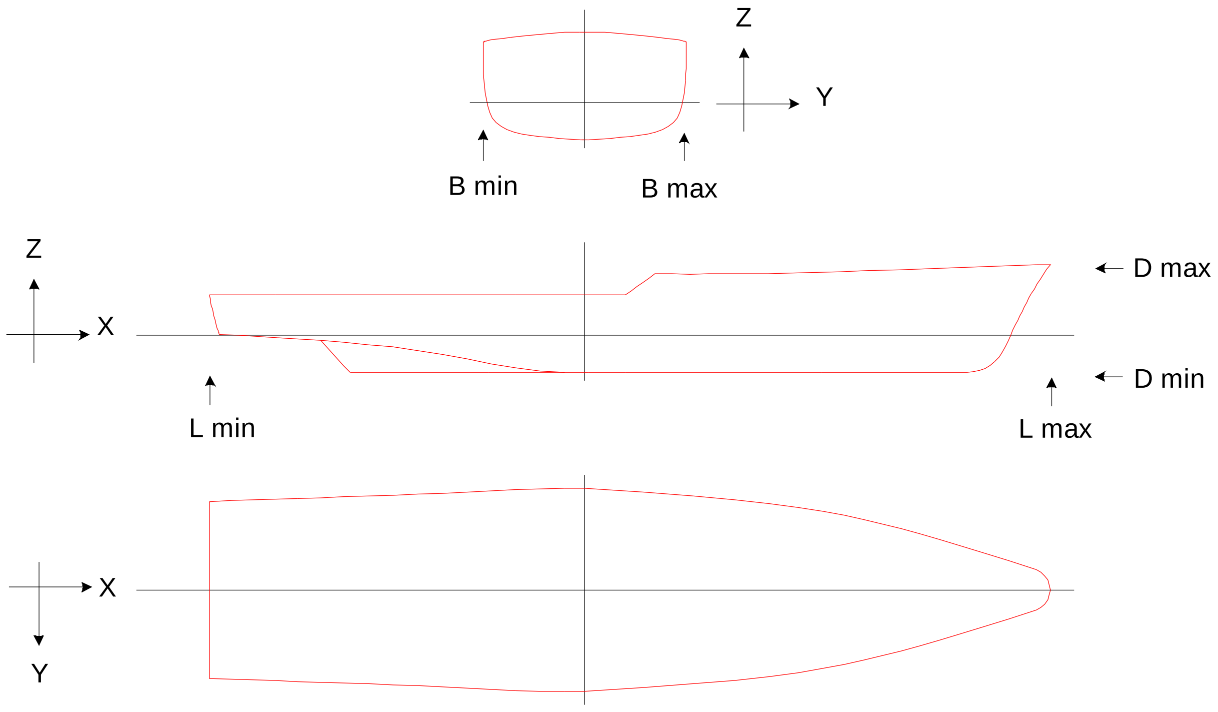
Point Numbering Convention

The convention adopted throughout the program suite is that section curves should be entered starting from the lowest point on the centreline and working towards the deck edge and the longitudinals entered from the stern working towards the bow.

If interpolated sections are to be written to a file for use in the Wolfson Unit Hydrostatics and Stability program suite, then the sections must be defined as described above.

Co-ordinate System

The co-ordinate system is a Cartesian (x,y,z) system. The axis system is placed with its origin on the centreline, at a convenient longitudinal datum (e.g. midships) and a convenient vertical datum (e.g. baseline or design waterline). Longitudinal or x-values are positive forward, vertical or z-values are positive up and transverse or y-values are positive to starboard.



SHIPSHAPE TUTORIAL

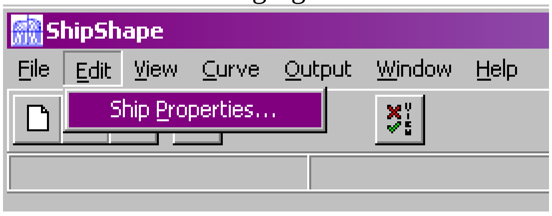
Step 1 - Creating Curves

Run ShipShape from the Start Menu in the Programs, Wolfson Folder.

This will display a start up screen, indicating the version of ShipShape you are using. Click anywhere within this window to close it and start ShipShape.

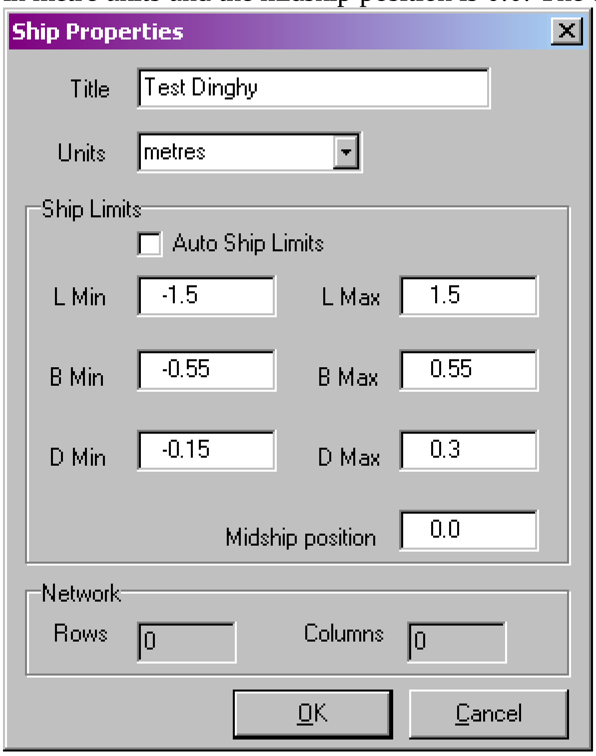
If a message appears that a software dongle is not found ensure the dongle is positioned correctly in the parallel printer port.

ShipShape will now start with a blank ship. Start by clicking ***Ship Properties*** on the ***Edit*** Menu as shown in the following figure. This will activate the Ship Properties Dialog.



Clicking on Menu items will be referenced as the following ***Edit, Ship Properties*** with each menu level indicated by a comma.

Enter the following ship parameters. The title is 'Test Case'. The length dimensions range from -1.500 to 1.500, the breadth dimensions from -0.550 to 0.550 and the depth from -0.150 to 0.300. The hull is in metre units and the midship position is 0.0. The dialog is shown in the following figure.



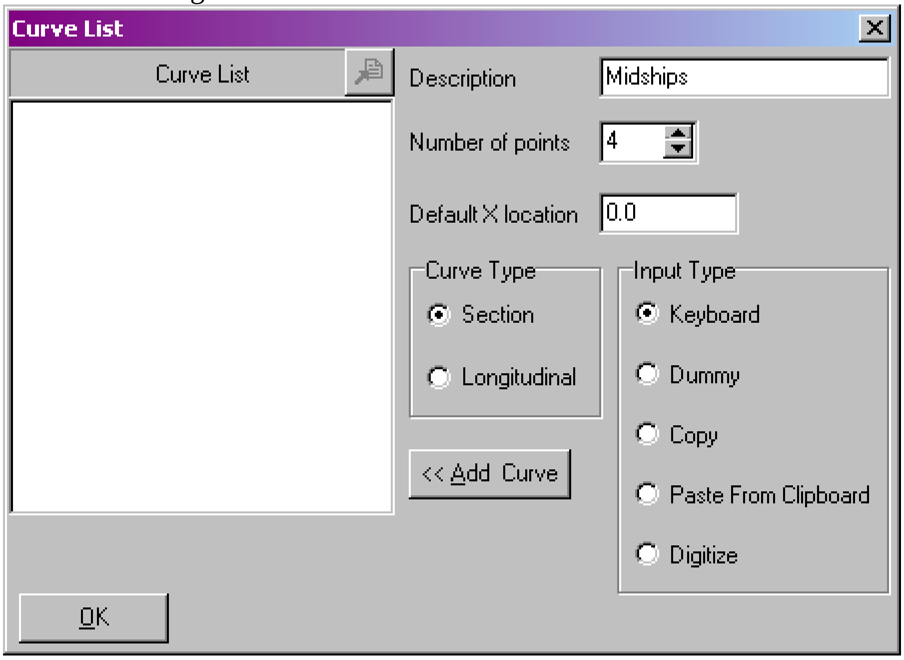
Tip: Clicking on the **auto ship limits** check box so a check appears will set the ship limits automatically using all defined curves.

Click on the **OK** button to close the dialog and effect the changes.

Now begin to enter curve data as follows:

a) Click on the ***Curve, Add*** menu item and enter the following data into the Curve List Dialog.

b) Type the description as ‘Midships’, the number of points should be 4 and the default location should be 0.0. The curve type should be section and the input type should be keyboard. The dialog should look like the following.



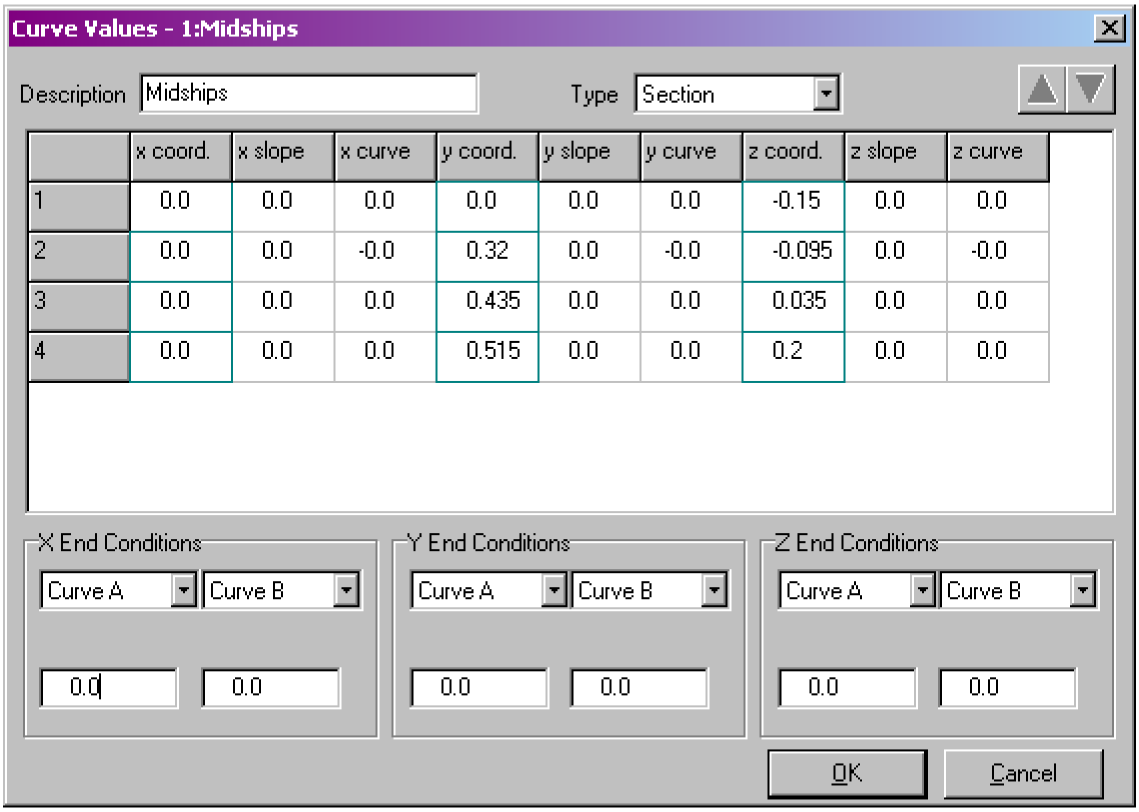
Note that in this example, for this curve, the values of the X co-ordinates will be obtained from the default value (0.0000 in this case) and those of the Y and Z co-ordinates will be typed into the Curve Values Dialog.

b) Press the **Add Curve** button and the Curve Values should activate.

c) Now enter the following points on the curve by moving the cursor with the mouse or the arrow keys.

Point No	X	Y	Z
1	0.0	0.000	-0.150
2	0.0	0.320	-0.095
3	0.0	0.435	0.035
4	0.0	0.515	0.200

The dialog should look like the following:



d) Click on the **OK** button to effect the changes and the curve name and details should appear in the Curve List.

Repeat steps (b) to (d) to enter the 2 following curves:

Tip: If extra curves are added by mistake do not worry these can be deleted later using the ***Curve, Delete*** menu item. This will activate the Curve List dialog. Highlight the curves to be deleted and press the **OK** button. A confirmation message will appear and ask you if you are sure. Click on the **OK** button to delete the curve.

Curve No. 2

Type	Description	Default Location	No. Points	Input Type
Section	Transom	-1.50	4	Keyboard

with the following co-ordinates:

Point No	X	Y	Z
1	-1.500	0.000	-0.035
2	-1.500	0.220	-0.020
3	-1.500	0.400	0.080
4	-1.500	0.435	0.250

and

Curve No. 3

Type	Description	Default Location	No. Points	Input Type
Section	Stem	1.500	4	Keyboard

with the following co-ordinates:

Point No	X	Y	Z
1	1.500	0.000	-0.090
2	1.500	0.010	0.040
3	1.500	0.020	0.170
4	1.500	0.035	0.300

Note that in both these cases, as with the 1st curve, 'Midships', the X coordinate values have been obtained from the default value and the Y and Z coordinate values from typed values.

Tip: Curves do not have to be inserted into the curve list in any particular order. If an error is made such as a curve is inserted as a section rather than a longitudinal just continue by inserting the correct curve in and delete the wrong curve later using the ***Curve, Delete*** menu item.

The next set of curves are not going to be assigned a set of values as their values will be assigned by the curves already created by linking them in Step 2. These curves will therefore be entered as dummy curves.

Now enter the Deck as follows:

e) The description should be 'Deck', the number of points should be 3 and the default location should be 0.0. The curve type should be longitudinal and the input type should be dummy.

f) Press the **Add Curve** button and the curve name and details should appear in the Curve List.

Repeat steps (e) and (f) to enter the next set of dummy curves with the following details.

Curve No. 5

Type	Description	Default Location	No. Points	Input Type
Longitudinal	Keel	0.00	3	Dummy

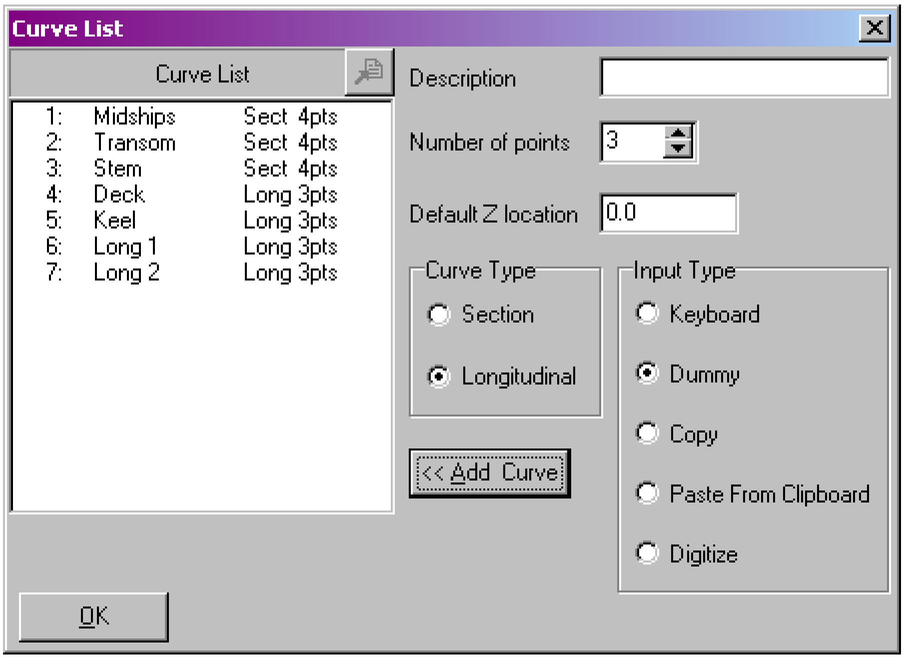
Curve No. 6

Type	Description	Default Location	No. Points	Input Type
Longitudinal	Long 1	0.00	3	Dummy

Curve No. 7

Type	Description	Default Location	No. Points	Input Type
Longitudinal	Long 2	0.00	3	Dummy

The final dialog should look like the following with the list of curves



Click on the **OK** button to close the dialog.

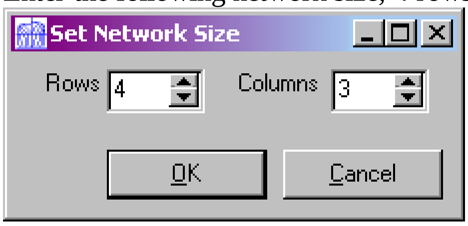
Tip: It is advisable to save your ship at regular intervals. Choose save by clicking the ***File, Save*** menu item, type a name in the Save dialog box and click on the **OK** button. Another option ShipShape has is to Save Automatically. Click on the ***File, Auto Save*** menu item and click on the **Auto Save On** check box so a check appears. Select the desired time interval for Auto Save and click on the **OK** button. For more information refer to the Auto Save dialog.

Step 2- Linking Curves

After the Curves have been defined in Step 1 curves have to be linked together to create a network of curves. Linking curves define where each curve lies on the network. The network is a schematic representation of the ship, consisting of a grid of longitudinal and transverse lines. Each longitudinal and section curve must lie along one of these grid lines, although each network grid line may be composed of several individual curves. The user specifies on which network grid line, and where along that line, the curve lies. If the curve crosses a network node where another curve has already been set (e.g. a longitudinal crosses a previously linked section), the existing data for that node are transferred to the new curve. Thus the order in which curves are linked defines which curves are forced in to compatibility with other curves.

Start by clicking on the ***Window, Network*** menu item to display the Network Size dialog. This dialog is activated if no network has defined.

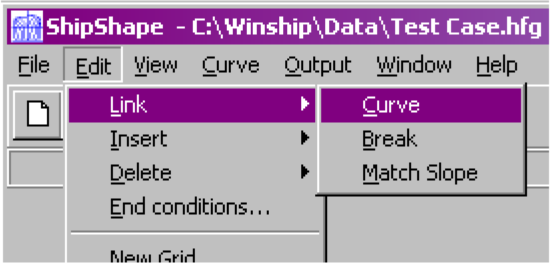
Enter the following network size; 4 rows and 3 columns. The dialog should look like the following.



Click on the **OK** button and the Network window should appear.

The next task is to link the defined curves together to form the basis hull definition. The squares displayed in the window represent the possible positions of the curve points.

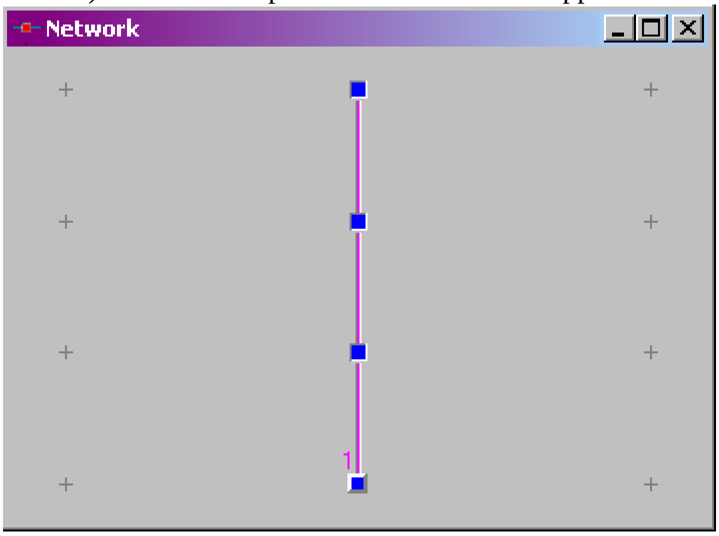
a) The first curve to link into the network will be the Midships. Click on ***Edit, Link Curve*** menu item.



b) The Curve List dialog should activate, select the Midships curve from the list so that it is highlighted and then click on the **OK** button.

As the cursor is moved on the window a highlighted square will appear and also the location i and j will be displayed in the top left of the Main window. i is number of points up and j is number of points along.

c) Move the cursor until it the i and j display reads i: 1, j: 2 (i.e. first or bottom row and second column). Click on this point and the curve will appear as a vertical straight line as follows:



A curve is always linked by it's first point and therefore, in this network, cannot be linked at any higher rows than the first one as there are four points on the curve and four rows. If a warning message has appeared saying incompatible connection then an attempt has been made to try and link the curve in the wrong place. Repeat steps (a) to (c) to link the curve in the correct location in the network.

The curve number is shown at the first point of the curve and by locating the cursor of the square representing the first point the curve name will appear in a hint box.

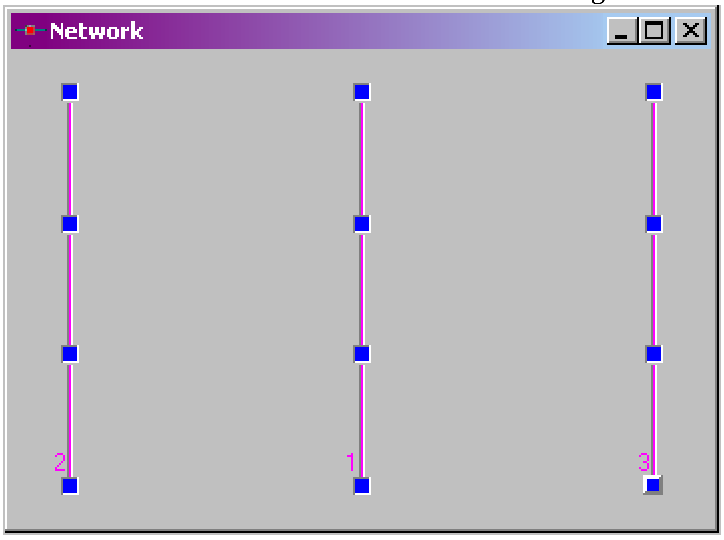
Tip: If, at any point in this process, a mistake is made, and for example the curve is linked into the wrong column use the ***Edit, Link, Break*** menu item. This will activate the Curve List dialog. Highlight the curve that has been wrongly linked and click on the **OK** button. Repeat steps (a) to (c) to re-link the curve in the correct location.

Now repeat steps (a) to (c) but linking the following curves in the specified locations:

Curve	**i location (column)**	**j location (row)**
Transom	1	1
Stem	1	3

Tip: Some menu items such as linking can be accessed via the Toolbars. For toolbar options click on the ***View, Toolbars*** menu item to activate the Toolbar Options dialog. Hovering over the toolbar buttons with the cursor will activate a hint to indicate the button function. Select which toolbars are to be shown by clicking on the appropriate check box by the toolbar such that a check appears, then click on the **OK** button to close the dialog.

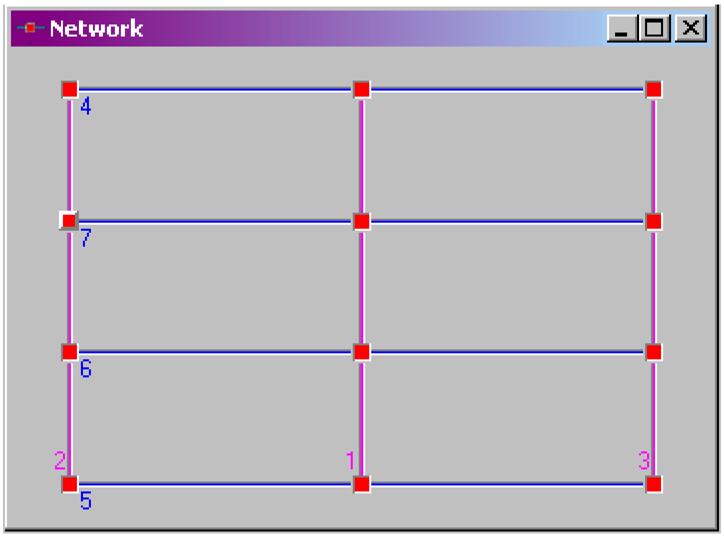
The Network window should look like the following:



Now the defined curves have been linked, the dummy curves can be cross-linked. This will transfer the values from the already linked curve points into the corresponding point on the dummy curves. Now repeat steps (a) to (c) but linking the following curves in the specified locations:

Curve	**i location (column)**	**j location (row)**
Deck	4	1
Keel	1	1
Long 1	2	1
Long 2	3	1

The Network window should look like the following:



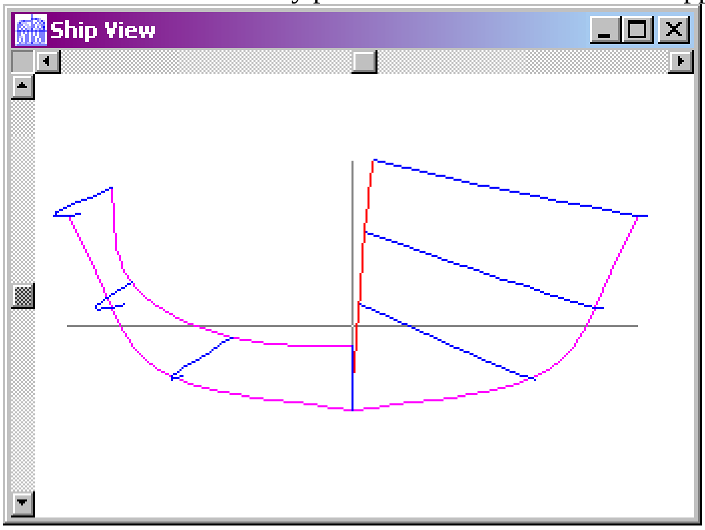
The network nodes change from blue to red where linked curves cross. (i.e. when a point has been connected to another point in the network).

The order of linking is important, If a point on a curve is linked in a place where a point already exists the second points co-ordinates will be assigned to the first curves co-ordinates. For dummy curves their co-ordinates are all zero. For this example when the dummy curves are linked into the network, the coordinate data from `Transom', `Midships' and `Stem' are transferred to 'Deck', 'Keel', 'Long A' and 'Long B'.

Curves can be add into the network at any time in ShipShape and do not have to be done prior to linking.

<u>Step 3- Displaying Curves</u>

The ship can be viewed at any time using the Ship View window. Click on ***Window, Ship View*** menu item to activate it. A body plan of the defined curves will appear as follows.



Tip: You will now have two views within the ShipShape Main window. As a window is selected the menus will change to suit that particular window. It is therefore essential that when selecting a menu item for a specific window the window must be activated and highlighted. Windows can be made accessible and visible by selecting the window title in the ***Window*** menu or by using the ***Tile, Cascade***, or ***User Arrange*** menu items if already activated.

This view can be rotated using the scroll bars at the top and left hand sides of the window. Orthogonal views can also be displayed by using the ***Body Plan, Plan and Profile*** menu items in the ***View*** menu.

To zoom in on the view click on the ***View, Zoom , Window*** menu item. The cursor in the Ship View window will change to a magnifying glass with a cross. Click on the first corner of the window you wish to zoom and keep the mouse button down while dragging to the opposite corner. The zoom window will be indicated while dragging. Scrollbars will appear in the right and the bottom of the window for scrolling around the view.

To zoom back out click on the ***View, Zoom, Extents*** menu item. This will zoom to the extents of the ship in the current view. Clicking on the ***View, Zoom, Limits*** menu item will zoom to the limits set in the Ship Properties Dialog.

To set view options in the Ship View window use the ***View, Options*** menu item. This will activate the View Options Dialog. There are many filters for displaying network curves, interpolated curves and intermediate curves. There are also options for plot density, viewing limits, viewing full breadth plan, line settings and display fonts.

The settings in view options can be used to set the view the ship in the Ship View window. For example turn longitudinals off by clicking on the **Longitudinals** check box to clear it. Click on the **OK** button to close the dialog and the network will be redrawn in the Ship View window with only the Sections displayed.

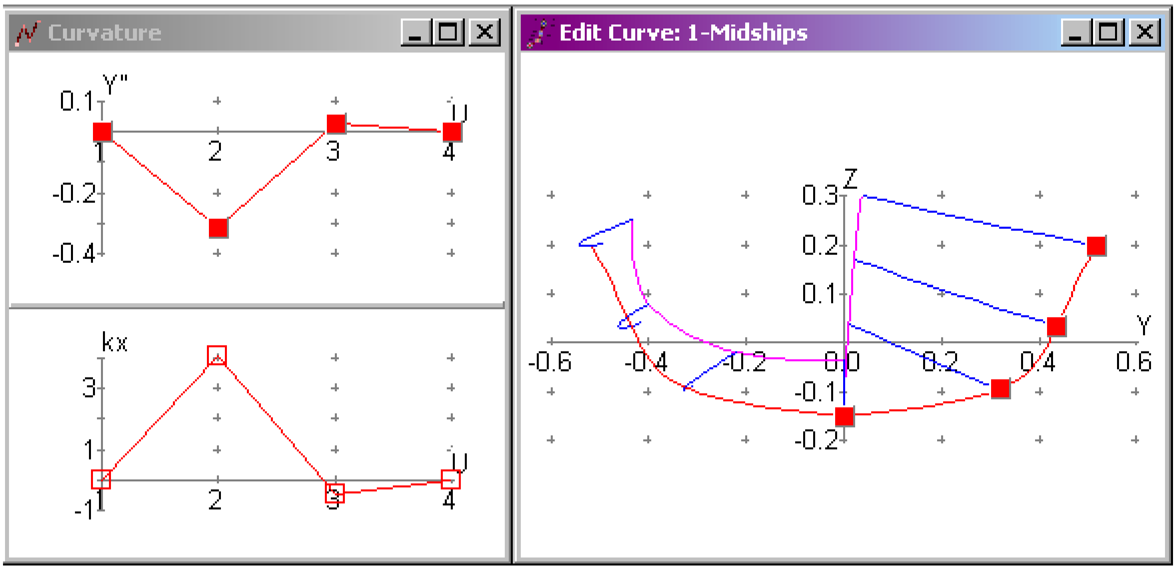
Select ***View, Options*** again and change the Plot Density value to 2. Click on the **OK** button. The curves will be much less smooth. Select ***View, Options*** again and return the plot density back to 10 and click on the **Longitudinals** check box so that a check appears. Press **OK** to close the dialog and the Ship View window display should return to how it was before the changes.

Step 4- Editing Curves

Once a curve has been created in ShipShape it can then be edited and faired using the mouse or by direct input of it's values.

Click on the ***Curve, Edit*** menu item to activate the Curve List Dialog. Click on the 'Midships' curve to highlight it and click on the **OK** button to close the dialog.

The Edit Curve window will activate together with the Curvature window the windows should look like the following (if they are not visible use the ***Tile*** or ***Cascade*** or ***User Arrange*** items in the ***Window*** menu):



The first action is to modify the y-curvature in point no. 3. Move the cursor to point No. 3 (counting from the left) in the Curvature window and click the mouse button down on this point. Now move the cursor with the mouse button down to Y'' = -0.150 and release the mouse button. This action is referred to as dragging. Moving the curvature resets the extents of the axes and therefore It may be necessary to move the point twice to get the axes to the correct magnitude of Y"= -0.500. Values for curvature are shown in the top left information panel in the Main window. (shown top right). The new curvature values are calculated and the effect of the change to point No. 3 is shown in the Edit Curve window.

Tip: The values attained when moving the cursor, points on the curve or changing the curvature are dependent upon window size and screen resolution. When moving the cursor and moving curve and curvature points a higher resolution is obtained by making the window larger.

Now select the Edit Curve window. Move to point No. 3 and drag it with the mouse button to,

Y: 0.480, Z: 0.040

and register this new position by releasing the mouse button.

Tip: When a move is made in the Edit Curve window it can be undone by using the ***Edit, Undo Move*** menu item. If at any time the curve is to be reverted to the original curve before any editing occurred this can be done by using the ***Edit, Undo to Stored*** menu item.

Now click on the ***Edit, Snap, To Y*** menu item. This will limit movement of the cursor to only the Z direction in the body plan view. Move the point to,

Y: 0.480, Z: 0.020

The original curve (before the current changes) is shown by the dotted line.

Curve values may be edited directly by clicking on the ***Edit, Curve Values*** menu item. This will activate the Curve Values Dialog.

Tip: Double clicking on a point in the Edit Curve window will activate the Curve Values Dialog with the selected point's x position highlighted.

Now edit the 'Stem', in the profile view, to produce a straight stem as follows:

Click on the ***Curve, Edit*** menu item and the Curve List Dialog will activate. Now select the curve labelled 'Stem' by clicking on it in the **Curve List** and clicking on the **OK** button.

Affirm the changes on the midships curve by clicking on the **YES** button when the dialog appears with 'Do you want to store changes to curve?'. The Stem curve will then be highlighted with its points in the body plan view.

To display the profile view click on the ***View, Profile*** menu item.

Now click on the ***Edit, Snap, To Z*** menu item. This will limit movement of the cursor to only the X direction in the body plan view.

Now select the 1st point and move it to,

X = 1.4000, Z = -0.090

Now select the 2nd point and move it to,

X = 1.440, Z = 0.040

Now select the 3rd point and move it to,

X = 1.470, Z = 0.170

Now click on the ***Edit, Store Current Curve*** menu item. This will make the changes permanent.

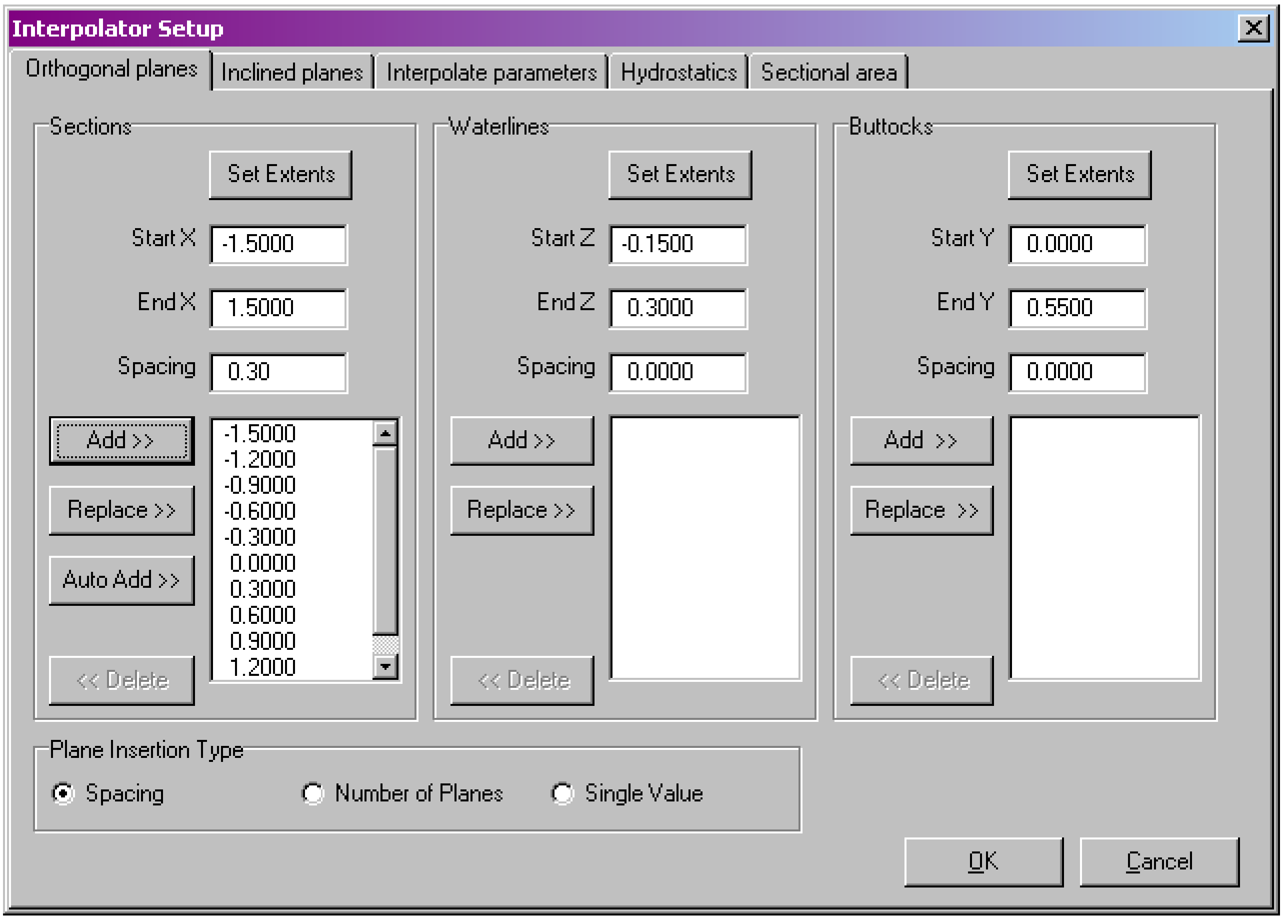
Step 5- Interpolating and Hydrostatics

Activate the Interpolator Setup dialog by clicking on the ***Output, Interpolator Setup*** menu item.

To interpolate curves on the ship's surface a set of planar curves need to be defined. This is done using the **Orthogonal Planes** page.

a)To create a set of sections first set the **Start X** and **End X** to -1.5 and 1.5 respectively then enter a **spacing interval** of 0.300 in the Spacing edit box.

b) Ensure the **plane insertion type** radio button is set to Spacing. Then click on the **Add >>** button in the Sections part of the page. The dialog should look like the following:



Tip: The same sections can be produced by selecting the **Number of Planes** radio button in the Plane Insertion Type, setting the **No. of planes** edit box to 11 and clicking on the **Add** >> button. This will create 11 sections evenly distributed between -1.5 and 1.5 (i.e. a spacing of 0.300).

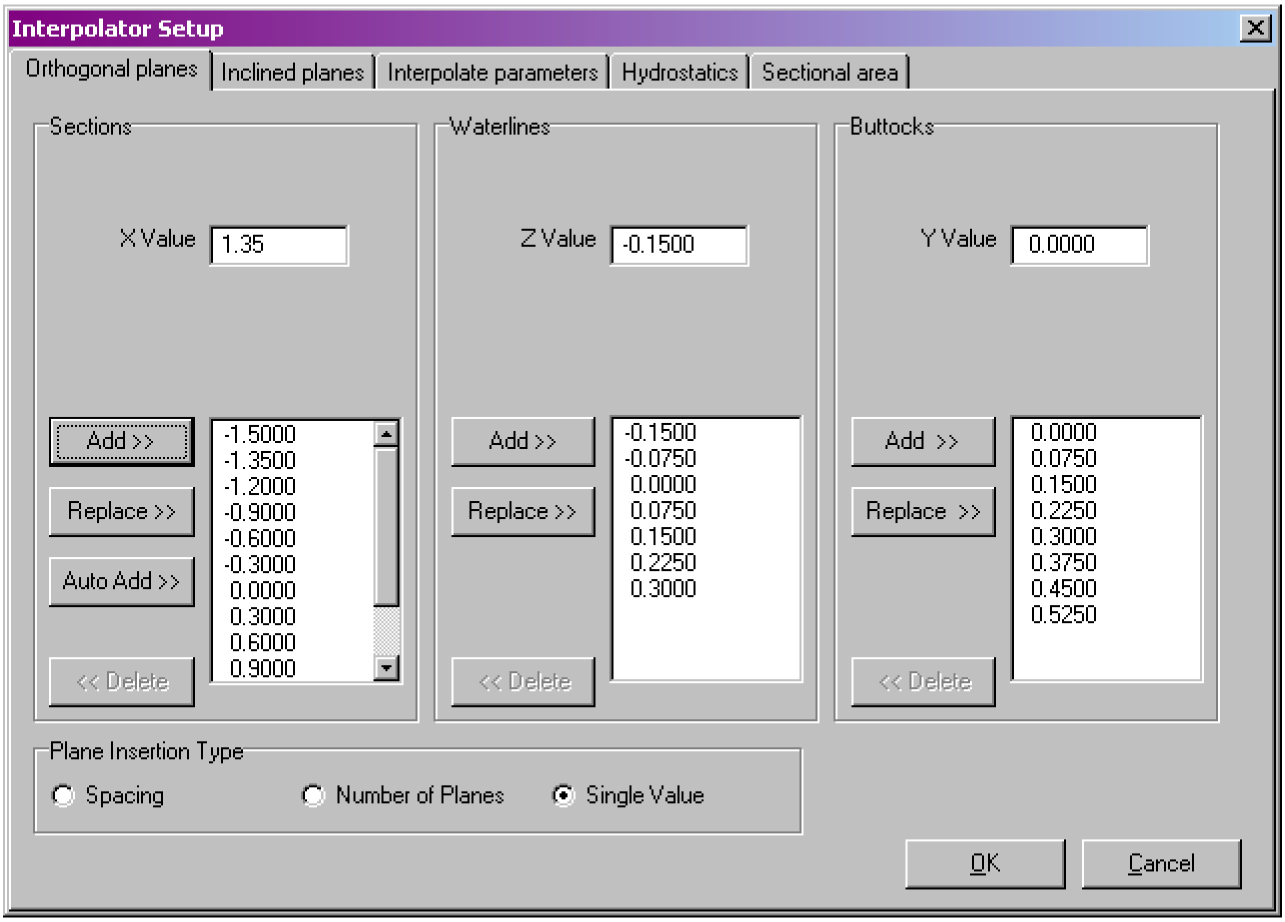
Now add some Waterlines and Buttocks with the following values repeating steps (a) and (b) with the following values and in the corresponding part of the page.

Type	Start Value	End Value	Spacing
Waterlines	-0.150	0.300	0.075
Buttocks	0.000	0.550	0.075

Click on the respective **Add** >> button to add the values to the list.

Finally add two more values to the Sections by selecting the **Single Value** radio button of the Plane Insertion type and typing -1.350 in the **X Value** edit box and pressing the **Add** >> button in the Sections part of the page. For the second value type 1.350 in the **X Value** edit box and click on the **Add** >> button again.

The dialog should look like the following:

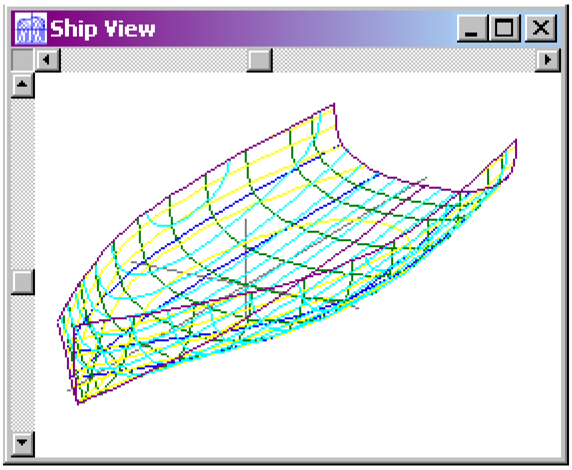


Now click on the **Hydrostatics tab** of the Interpolator Setup dialog to activate the Hydrostatics page. This will show a report of the current Hydrostatic properties of the defined ship. Set the **Weight Units** drop down list to kgs and press click on the **Calculate** button. The current Moulded Displacement will be close to 177 kgs. Try increasing the draught by changing the **Waterline, Z** edit box to 0.050 and click on the **Calculate** button. The new value of the Moulded Displacement will be around 287 kgs. The values of displacement shown here may vary from actual results as slight differences in curve points positions may occur during the fairing of the ship.

Tip: The hydrostatics of the ship are calculated using the sections set in the **Orthogonal planes** page. Increasing the number of sections distributed over the hull will increase the accuracy of the results. Although more calculation is required for each result.

Now click on the **Sectional area** tab there will be a plot of the sectional area at the sections set in the **Orthogonal Planes** page. Move the cursor along this plot, the X location and value of sectional area at each section will be displayed.

Click on the **OK** button to close the dialog. The Ship View window should show the sections, waterlines and buttocks as well as the defined curves:



Step 6- Plots and Printing

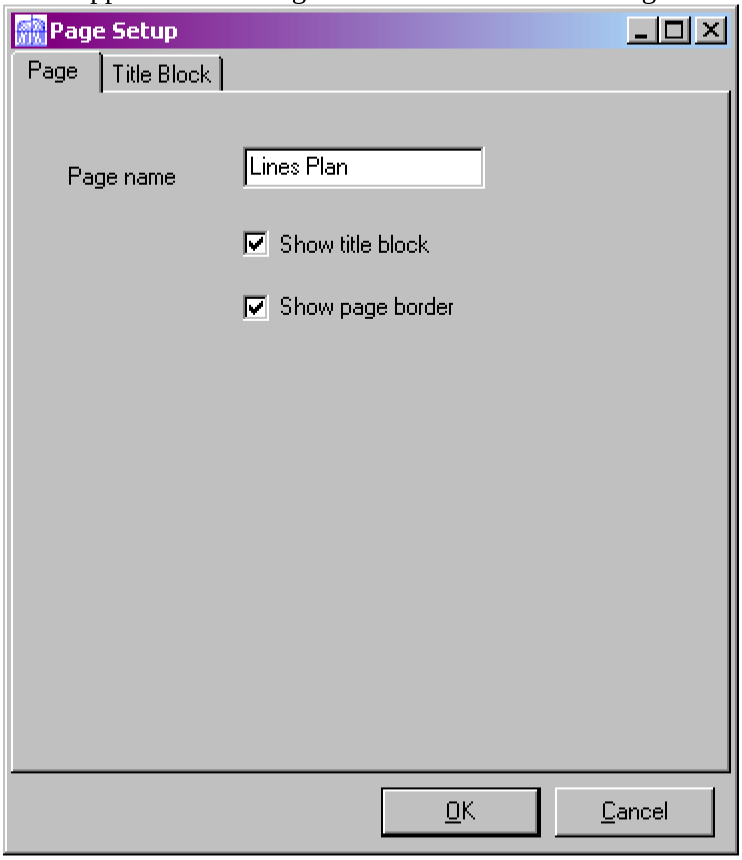
It is important a printer is installed as the Plot Setup window uses the currently set up page of the selected printer. This can be accessed by clicking on the ***File, Printer Setup*** menu item.

Click on the ***Window, Plot Setup*** menu item, this will activate the Plot Setup Window. The example in this tutorial uses an A4 landscape page (Height: 210 mm, Width: 297 mm). Any other type of page can be used but the scales and positions indicated in this example may need to change.

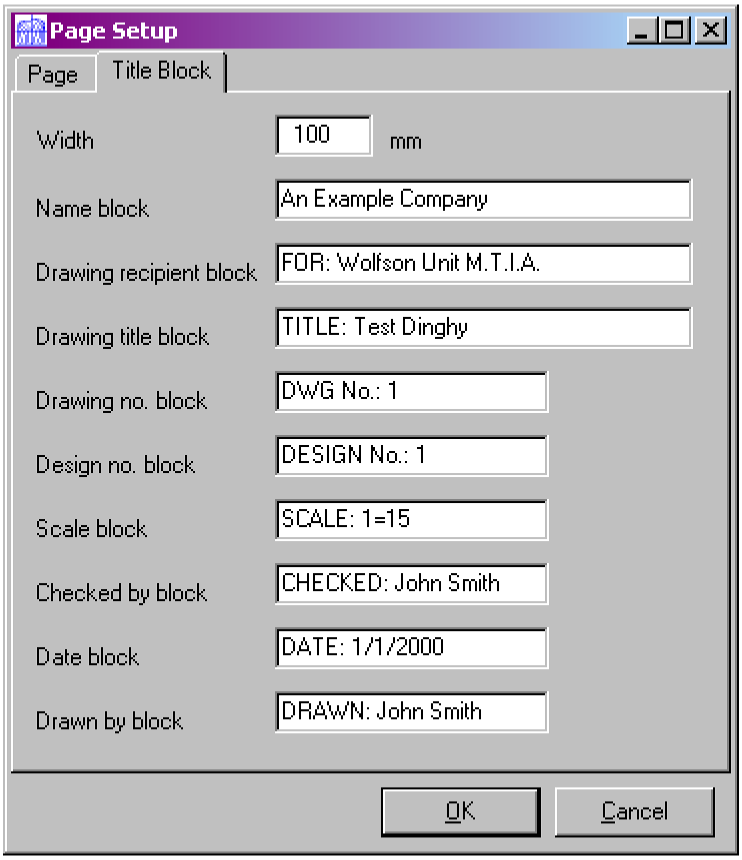
Setting up the Page

Click on the ***Edit, Page, Setup*** menu item to activate the Page Setup dialog.

Edit the **Page Name** and change it to 'Lines Plan' and click on the **Show Title Block** check box so a check appears. The dialog should look like the following:



Now click on the **Title Block** tab to activate the Title Block page and set the title block **Width** box to 100 mm. Next fill in the Edit boxes with pertinent details. The following figure shows an example of the dialog:

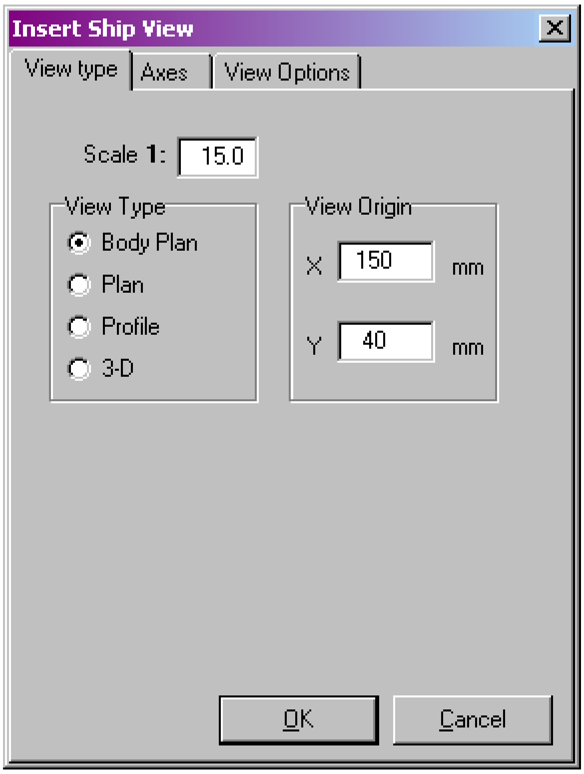


Click on the **OK** button and a title block should appear in the bottom right of the page.

Adding Ship Views

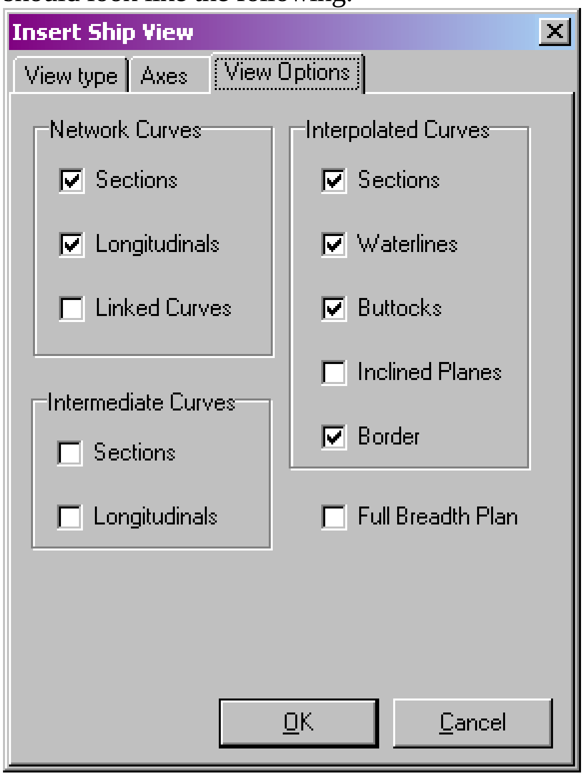
a) Click on the ***Edit, Insert, Ship View*** menu item to activate the Insert Ship View dialog.

b) On the **View type** page set the **Scale** edit box to 15.0 to get a Scale of 1:15.0, set the **View Type** radio button to Body Plan and set the View Origin X to 150 mm and Y to 40 mm. The view origin specifies the location at which ship units, x=0,y=0 and z=0 appears on the page. The dialog should look like the following:



Tip: It should be noted that the origin X=0, Y=0 is located at the top left hand side of the printed page.

c) Now click on the **View Options** tab at the top of the Dialog to show the View Options page. Now turn all Network Curves off by clicking on the **Network Sections** and **Network longitudinals** check box so that there are no checks in the boxes. Then turn all interpolated curves on by clicking on the Interpolated **Sections, Waterlines, Buttocks and Border** check boxes so a check appears. The dialog should look like the following:



d) Click on the **OK** button and a body plan should appear on the page of the Plot Setup window.

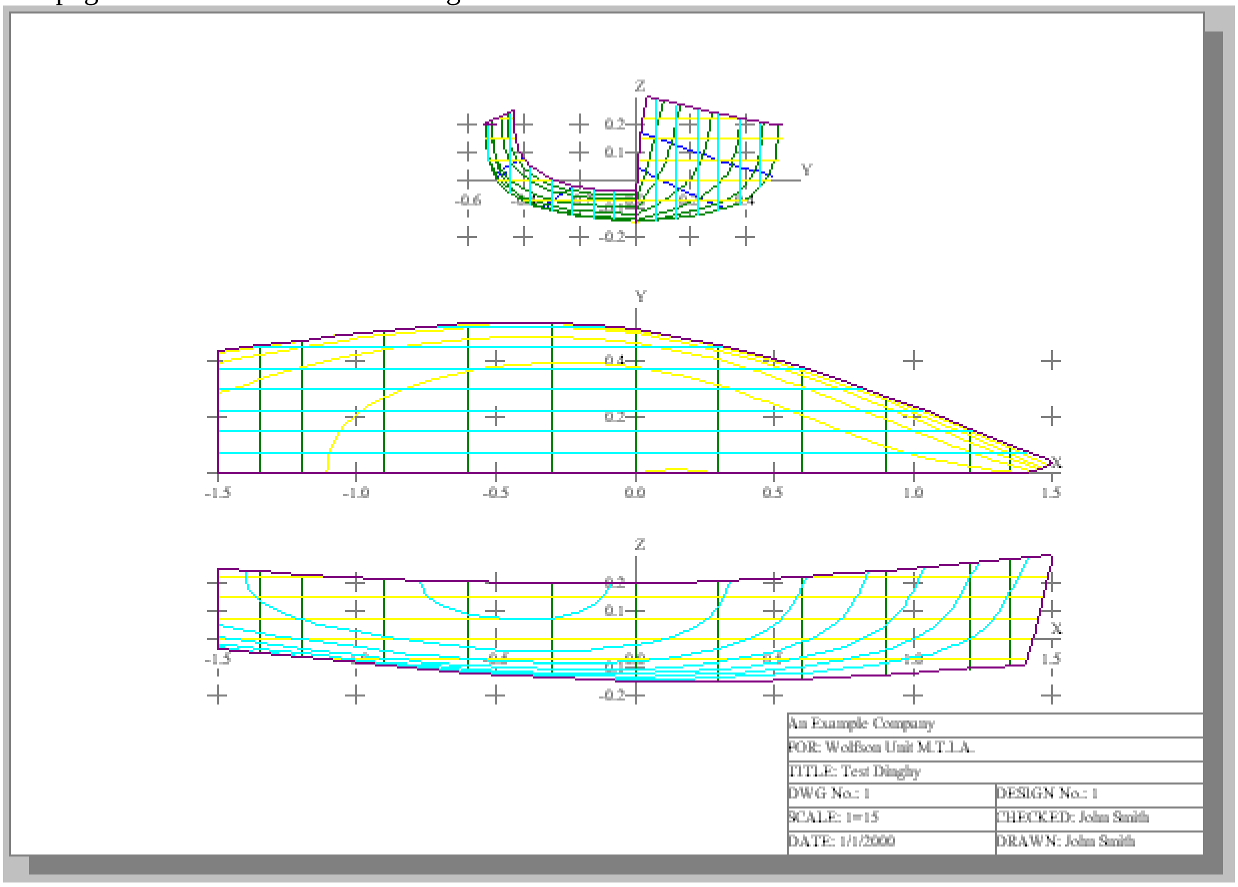
Now add another two views by repeating steps (a) to (d) with the following settings:

Scale	View Type	View Origin X	View Origin Y
1:15.0	Plan	150 mm	110 mm
1:15.0	Profile	150 mm	150 mm

The view options for each view should be exactly the same as described in section (c).

Tip: Ship views can also be moved by clicking on them and dragging them to a different location.

The page should look like the following:

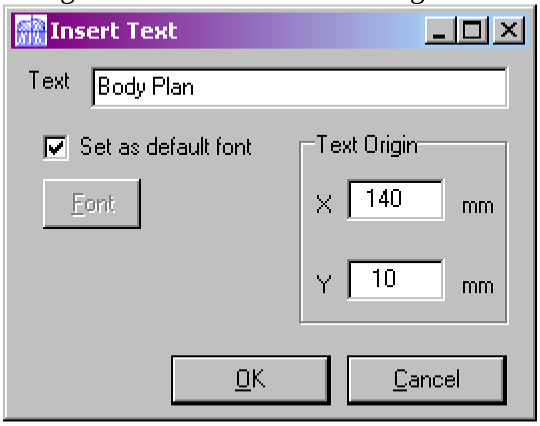


Tip: If the settings of a view needs to be altered at any time click on the view you wish to alter so a box appears around it and use the ***Edit, Selected Ship View*** menu item to activate the Insert Ship View dialog. Double clicking on the ship view will also allow the settings to be altered in the same manner. If text is selected with a box around it the menu item will appear as ***Edit, Selected Text***, text can be edited in the same way as view. Views and Text can also be copied and deleted using the appropriate ***Copy*** or ***Delete*** menu item on the ***Edit*** menu.

Adding Text

a) Click on the ***Edit, Insert, Text*** menu item to activate the Insert Text dialog.

b) Now enter ‘Body Plan’ in the **Text** edit box and set the text origin X to 140 and the Y to 10. The dialog should look like the following:



Tip: The text font can be changed by clicking on the **Set as default font** check box so no check appears and then click on the **Font** button to activate the Font dialog to set the required font.

c) Click on the **OK** button to close the dialog. The text: ‘Body Plan’ should appear above the body plan ship view.

Now repeat steps (a) to (c) with the following values.

Text	Text Origin X	Text Origin Y
Plan	147 mm	60 mm
Profile	147 mm	120 mm

Titles should appear above the respective view.

Tip: Text as with Ship views can also be moved by clicking on them and dragging them to a different location.

Further pages can be add, deleted and duplicated in the Plot Setup window using the appropriate ***Edit, Page,*** menu item.

If a printer or plotter is installed plots can be printed using the Print menu item of the File menu.

TIPS AND HINTS

Every regular user of the ShipShape package will find their own working methods and the software allows freedom to work in the most comfortable mode. Included in this section are some tips and hints on working methods.

There are several tips to allow ShipShape users to understand and obtain the maximum from the program.

Order Of Working

The process of creating curves, fairing and building the curve network can be carried out in many ways, each of which may be best suited to a particular application. A suitable fairing sequence might be:

1. Digitise all the section curves and create dummy longitudinal curves.

2. Fair the stem profile, transom and midship sections and enter them into the network.

3. Enter the keel, deckline and bilge/knuckle longitudinals into the network and connect them to the faired sections from stage (a).

4. Fair this set of longitudinals.

5. Insert the remaining set of sections into the network and fair them.

6. Insert the remaining longitudinals into the network. At this stage, the only fairing option which preserves the coordinate data of each curve is the adjustment of curve end conditions. The end conditions should now be faired.

7. It may be that minor changes need to be made to the actual points on the curves. Bear in mind that any change to a section point will be reflected in the intersecting longitudinal point. Any further fairing is a repetition of the process to date but should be confined to movement of a small number of carefully selected points on the network, chosen near areas of residual unfairness.

8. When the hull is considered to be sufficiently fair, the network must be complete prior to generating interpolated curves for a lines plan or generating hydrostatic data.

9. It is worthwhile to check the hydrostatics early on, so that necessary adjustments to displacement, LCB etc. may be made before too much effort is made in the fairing process.

Half Sidings

Half sidings of keel, stem and stern profiles should be built in from the start. As digitised values of half sidings will be inaccurate, use the editor to overwrite these values by the exact figures before proceeding with the fairing or connection of curves into the network. Plan the order of entering curves into the network so as to preserve half siding values.

Placing of Longitudinals

In planning the number and placement of longitudinals, the following factors need taking into account:

1. Decklines, knuckle lines and keel lines form natural longitudinals.

2. Between these features, additional longitudinals are required to define sections properly. The nodes on each section should be placed at a smoothly varying spacing. They should be closest for regions of high section curvature and furthest apart on straighter portions.

3. It is a good idea to place a longitudinal along the line of the bilge corner or similar curvature feature on the hull.

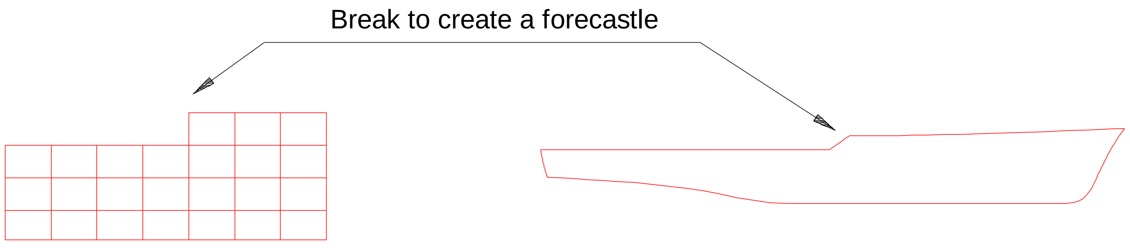
4. On nearly vertical sided parts of the hull topsides, the longitudinals will naturally take on the appearance of waterlines, whilst on nearly horizontal lower surfaces, they will resemble buttock lines. No attempt should be made to force the longitudinals to conform to either waterlines or buttocks.

5. The final placing of longitudinals will be determined by the fairing process. It is not necessary to place a great effort on getting them correct at the input stage.

6. Regions of exceptionally high curvature may best be treated as a 2 point circular arc segment joining longer curves on either side. Typical examples include bilge corners, fillets between hull and skegs and bow rounds.

Breaks Of Longitudinal Continuity

The program suite treats longitudinals and sections in analogous ways, so that longitudinals may join at a section part the way across the net of curves, as well as vice versa. There may be a requirement for a step in a deckline or a mild slope discontinuity at the leading edge of a propeller tunnel, or some other feature. This is accomplished by using the same general principles as described for forming knuckles and chines in sections.



As shown in the figure above, all of the network grid points do not have to have sections or longitudinals connected to them. Such 'holes' in the network can be useful for defining discontinuities such as steps in the deckline and multiple hull entities (e.g. multihulls).

Knuckle Line Features

Knuckle lines are formed by defining separate sections above and below the knuckle. Two special features of knuckles are worthy of comment:

1. Fading a knuckle line can be accomplished by extending a section across the longitudinal forming the knuckle. The result is a knuckle which fades out between the last pair of sections ending on the knuckle line and the first continuous section which crosses the line. Thus, knuckles do not need to run the full length of the hull.

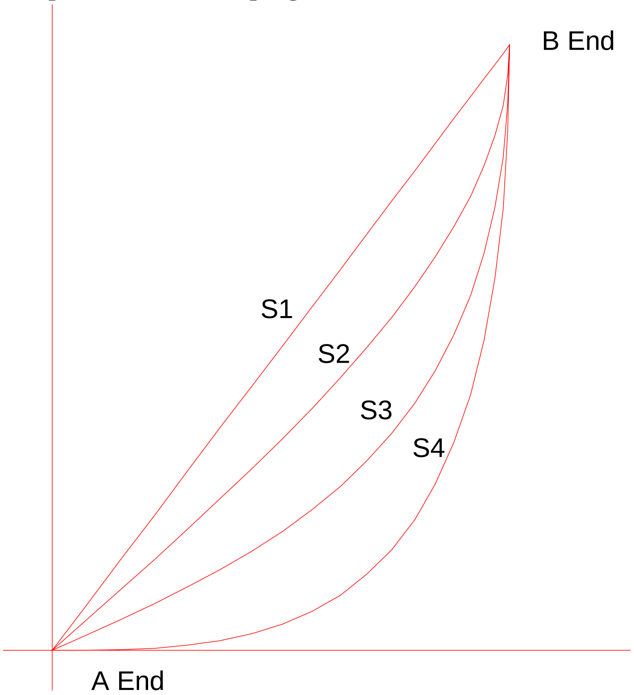
2. It is possible to create a chine with a spray rail. This is achieved by defining a rail by two longitudinals representing the inner and outer chines, with the inner chine forming the upper edge of the hull lower surface and the outer chine forming the lower edge of the topsides. The best method of defining such a rail is to create and fair one chine (e.g. the inner one) and subsequently form the other chine by making a copy of the first and editing the (y,z) data to obtain the desired rail dimensions.

Straight Sections

Straight lines can most easily be defined as two-point curves, defined only by their end points. For example, a chine hull with straight sections between the chines can be developed by, first, defining the longitudinals for the keel, chines and deck edge, putting points at the same x values on all curves. Secondly, define a set of dummy sections with two points each, sufficient to define all of the straight-line section segments on the hull. Link all of the longitudinals into the network, to fix their positions, and then link the dummy sections between the longitudinals. The sections will then take on the co-ordinates of the longitudinals at their end points and, if their end curvatures are zero, define straight sections between those points.

End Slopes

The slope at the end of a curve is a vector with x,y and z components equal to dx/du, dy/du and dz/du. Thus it has both a magnitude and a direction. Altering the direction of the vector by changing the relationships between dx/du, dy/du and dz/du modifies the direction of the end of the curve. This is analogous to holding the end of a batten at a fixed angle. Altering the magnitude of the vector without changing the relationships between the components is analogous to changing the length of a batten thus varying the fullness of the curve. The following figure illustrates the effect of varying one slope vector component whilst keeping the other fixed.

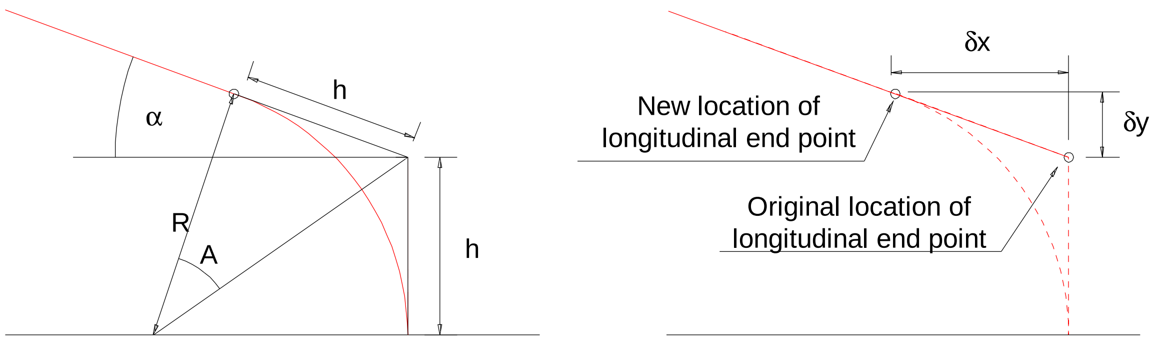


A end: y = 0.0, z = 0.0
B end: y = 1.5, z = 2.0

	YE	Curve A	Slope B	ZE	Curve A	Slope B
S1	2	0.000	0.000	2	0.000	0.000
S2	2	0.000	0.000	2	0.000	2.000
S3	2	0.000	0.000	2	0.000	4.000
S4	2	0.000	0.000	2	0.000	6.000

In this illustration, the A end is free (zero curvature), the y-slope at the B end is set to 0 and the z-slope at the B end gradually increased from 0 to 6. When the z-slope assumes a positive value, the B end of the curve has a vertical tangent. As the z-slope is progressively increased, fullness is induced into the curve and the B end tangent remains vertical.

Bow Round Theory



Exact Circular Arc

α = half angle of entrance from longitudinal end slope data
1
Required arc radius 2

Single Segment approximation

End tangent vector length 3

Method of Constructing Bow Round

1. Fair main fore body with longitudinals squared off to true stem profile.

2. On main longitudinal, change end point x and y-co-ordinates using the Edit Values route and calculated $\delta x = -h \cos \alpha$, $\delta y = h \sin \alpha$.

3. For end rounding segment, calculate tangent vector length T and set segment end conditions via Edit Values such that

$dx/du = T \cos \alpha$, $dy/du = -T \sin \alpha$ at tangent with main longitudinal
and
$dx/du = 0$, $dy/du = -T$ on centreline at stem profile.

Increasing Speed

ShipShape can be reasonably computationally intensive and thus on some slower computers can seem to run slowly. Most of the operations are quite repetitive so if the user can reduce the number of repetitions ShipShape can run quicker. Refreshing and drawing can also slow ShipShape down so there are options associated with this that can help to resolve any speed issues.

Speed is quite strongly related to the number of interpolated points that ShipShape has to calculate so some of the tips in Reducing Memory Overhead also apply here.

i) There are numerous options associated with each view of the ship (i.e. Ship View window and Edit Curve window). Turning off some of the curves that are non-essential to the users operation in the View Options dialog can rapidly increase the refresh rate of the views.

ii) Turn off the Auto Interpolate option on the Interpolate Parameters Tab of the Interpolator Setup dialog. This will prevent ShipShape from re-interpolating the ship every time the construction curves are altered in any way. If you need to recalculate the interpolated curves on the ship at any time you can use the Recalculate command.

ii) Reduce the plot density in the View Options dialog. This has the effect of reducing the number of interpolated points to draw and also the number of derived points to calculate.

iii) Lower the plot density of Sections, Longitudinals, Buttocks, Inclined Planes and the Intermediate Spacing on the Interpolate Parameters Tab of the Interpolator Setup dialog. This has the effect of reducing the number of interpolated points to draw on each interpolated curve and also the number of derived points to calculate.

All these options are aimed at reducing the number of interpolated points over a ship. In general if these options are used wisely then there should be no speed problems associated with ShipShape.

Reducing Memory Overhead

ShipShape is written to be as memory ‘friendly’ and non-aggressive as possible such that it does not require a large memory overhead to run. To give an insight into ShipShape and its use of the computer’s memory it is best to describe the breakdown of allocation of memory, at what point is allocated and what affects the memory overhead.

ShipShape first of all has memory associated with the executable program and the static data within that program. Examples of this are toolbars, permanent dialogs, windows and internal settings. All other memory is allocated dynamically when needed and thus deallocated when not needed. For example most dialogs and their associated memory are created when needed and when the user closes the dialog, the memory for that dialog is destroyed leaving more memory space for other dialogs and objects.

A large amount of the dynamically allocated memory is associated with construction curves and the derived interpolated curves from the ship. All of these require memory and the more points associated with these curves the larger the memory overhead. Once curves are created, including derived interpolated curves they are generally stored in memory until the user changes the memory requirement (i.e. adds more points or curves). These are stored in memory for viewing and calculating data such as hydrostatics. This allows ShipShape to rapidly recalculate derived data without the need to calculate the fundamental ship’s surface again and again.

The user can easily increase the number of curves and points in ShipShape and thus rapidly increase the memory requirement. If you do not have much memory left on the machine this can create problems such that ShipShape cannot dynamically create curves, dialogs, or any other objects that require memory additional to that already used. There are several ways of resolving this. The first and foremost is to close any other programs that are running on the machine. If this is not possible then the next step is to reduce the amount of memory ShipShape is using, this can be done by several means:

1. Reduce the plot density in the View Options dialog. This has the effect of reducing the number of interpolated point to reduce the total memory required to spline curves.

2. Lower the plot density of Sections, Longitudinals, Buttocks, Inclined Planes and the Intermediate Spacing on the Interpolate Parameters Page of the Interpolator Setup dialog. This has the effect of reducing the number of interpolated points on each interpolated curve.

3. Lower the number of interpolated sections, longitudinals, buttocks or inclined planes in the Orthogonal Planes and Inclined Planes Page of the Interpolator Setup dialog.

4. Turn off the interpolated sections, longitudinals, buttock, inclined planes, intermediate sections or intermediate longitudinals on the Interpolate Parameters Page of the Interpolator Setup dialog.

5. Turn off the offset table on the Interpolate Parameters Page of the Interpolator Setup dialog.

6. Remove any construction curves that are not required using the Curve Delete command.

All the above tips are aimed at reducing the number of interpolated points over a ship. In general if the options available to the user are used wisely then there should be no memory problems associated with ShipShape.

Digitizer Setup and Configuration

ShipShape uses its own drivers via the COM ports on your machine to communicate with digitizer tablets. It does not require WinTab or any other similar drivers and these should not be loaded.

Digitizer settings are accessed via the Digitizer Setup dialog this has various options to match the settings on the digitizer tablet.

As ShipShape expects a constant stream of information from the digitizer tablet the information from the digitizer should be setup to be streaming constantly rather then when a digitizer pointer button is pressed.

Importing and Using DXF Files

1. The DXF Translator will only load sections if they are planar in the x-direction (i.e. have a constant x value) within a tolerance defined by the user on the Import DXF Options Dialog. When the LFH file is saved it will specify only one x value being the x value of the first point of the section. The Import DXF Options Dialog has several filter options that can aid the accurate import of a DXF file.

2. The Wolfson Unit packages are sensitive to the spacing defined in the LFH file and it is useful to consider this when using another package to create the DXF file. Refer to the other manuals for more details on section spacing, numbers and intervals.

3. It is best to keep the DXF file simple with ideally sections just defined. This will lower the chances of any spurious lines being read and translated as sections.

4. The maximum number of points per curve or line is 255 and the maximum number of curves or lines are 255. The DXF translator will notify the user if the DXF file exceeds this.

5. The co-ordinate system is a Cartesian (x,y,z) system. The axis system is placed with its origin on the centreline, at a convenient longitudinal datum (e.g. amidships) and a convenient vertical datum (e.g. baseline or design waterline). Longitudinal or x-values are positive forward, vertical or z-values are positive up and transverse or y-values are positive to starboard.

6. Sections defined in a DXF file must be a continuos line with no breaks, for example a the line above and below a chine must be part of the same polyline.

7. The resolution of the definition of the hull created in the DXF is directly related to the resolution of the resolution exported in the DXF file. It is therefore important to have enough points on a section such that straight lines between the points will adequately model the shape of the hull.

8. DXF files must be in ASCII and 3-D format for further information see File Types and Formats.

Printer and Page Setup for Plotting

To use the Plot Setup window a printer must be setup under Windows as the page created accesses the current printers page settings. Therefore even if the computer you are working on does not have a printer it is necessary to install a dummy printer to enable the Plot Setup window to work.

Auto Saving and File Backup

The auto save facility allows the current ship file to be saved at regular intervals. The purpose being if a problem occurs either on the computer or within ShipShape a backup file, saved at the last auto save interval, will be available on your computer. When ,in normal operation, ShipShape closes, the auto save file will be deleted as the user will have the latest wanted version of the ship saved to the normal .HFG file. Should an auto save file need to be loaded the user should select all files in the Open dialog file type and search for the name of the file with the **.**AH~ extension instead of the normal .HFG extension.

A backup of a file is also created when a file is saved. This file is created and is the version of the file before the current saved one. This way a copy of the file before the one saved is always available. Should a backup file need to be loaded the user should select all files in the Open dialog file type and search for the name of the file with the .HF~ extension.

GLOSSARY

B Min, B Max, the minimum and maximum Y co-ordinates of the hull, B Max - B Min equals the total beam of the hull.

buttock, a derived curve that has a constant y value.

CAD, Computer Aided Design.

CB, block coefficient = (submerged moulded volume) / (reference length * reference beam * (waterline - keel position)).

CM, midship section coefficient = (area of reference section) / (reference beam * (waterline - keel position)).

CP, prismatic coefficient = (submerged volume) / (area of reference section * reference length).

CW, waterplane coefficient = (area of waterplane at waterline) / (reference length * reference beam).

construction curve, a curve defined by the user to produce the shape of a ship.

curvature, second derivative with respect to U. e.g. d^2X/dU^2,. d^2Y/dU^2,. d^2Z/dU^2

derived curve, a curve derived from construction curves by interpolating a defined orthogonal plane, inclined plane or intermediate curve.

dialog, a window with input and output.

full displacement, the displacement of the ship including the shell thickness in weight units. It is the enclosed volume plus the shell thickness multiplied by the specific gravity of water.

girth, the full distance around a transverse section travelling on the surface to the waterline.

GZ, righting lever, the transverse distance between the centre of buoyancy and the centre of ravity.

heel, the rotation angle of the ship in degrees around the X axis of the ship.

immersion, the amount of displacement increment per unit increase in draught at the particular displacement waterline.

inclined plane, a plane that is defined with a constant x-value, y-value or z-value to derive a section, buttock or waterline respectively.

intermediate curve, a derived curve that is iso-parametric over the ships surface. In the girthwise or longitudinal direction.

interpolated curve, a derived curve.

keel position, the position used to calculate the minimum point of the draught (i.e. draught = waterline - keel position).

KMl, longitudinal metacentric height, relative to the keel position.

KMt, transverse metacentric height, relative to the keel position.

LCB, longitudinal centre of buoyancy, relative to X=0.

LCF, longitudinal centre of flotation, relative to X=0.

link, fix a curve to its location in the network, This defines the relationships between the three-dimensional network curves. Co-ordinate data are transferred at points where the curves are already linked into the network, ensuring geometric compatibility at all curve crossings.

L Min, L Max, the minimum and maximum X co-ordinates of the hull, L Max - L Min equals the total length of the hull.

longitudinal, a construction curve that can be linked into the network adjacent to a section in the longitudinal or horizontal direction.

MCT, the moment to change trim.

midship position, the longitudinal, X position that defines the mid point of the ship and where the lines in the body plan are reflected to indicate that they are aft of this position.

moulded displacement, the displacement of the ship NOT including the shell thickness in weight units. It is the enclosed volume multiplied by the specific gravity of water.

network curve, a construction curve that has been linked into the network to define the surface of a ship.

orthogonal plane, a plane that is defined with a constant x-value, y-value or z-value to derive a section, buttock or waterline respectively.

pitch, the rotation angle in degrees of the ship around the Y-axis. If the ship is defined with the bow having a greater X value than the stern a positive pitch angle will result in a bow down attitude.

plot density, the number of points derived between each defined point for plotting to the screen or printer. For example a three point construction curve with a plot density of 10 will have 30 segments.

reference section, This section is used as the basis for the calculation of CP and CM.

section, 1. a construction curve that can be linked into the network adjacent to a longitudinal in the transverse or vertical direction. 2. a derived curve that has a constant x value.

shell thickness, the thickness of the shell used to calculate the full displacement from moulded displacement and wetted surface area.

slope, first derivative with respect to U. e.g. dX/dU, dY/dU or dZ/dU.

specific gravity, specific gravity of water in which the ship is assumed to float, 1.0 being fresh water.

VCB, vertical centre of buoyancy, relative to the vertical datum.

view, three standard views are available, body plan, plan and profile each being a different angle projection. A 3-D projection is also available.

waterline,. 1. the vertical, Z position at which the ship floats. 2. a derived curve that has a constant z value.

weight units,. units of measurement for displacement. Can be tonnes, Kg, Tons or Lbs.

wetted surface area (WSA),. the integration of all underwater girth contributions. The value does not include transoms.

X,. the longitudinal position of defined points, relative to the longitudinal datum.

Y,. the horizontal position of defined points, relative to the horizontal datum. Y=0 is generally assumed to be at centreline of the hull.

yaw,. the rotation angle of the ship in degrees around the Y axis of the ship.

Z,. the vertical position of defined points, relative to the vertical datum. Z=0 is generally assumed to be the baseline or the design waterline.

APPENDIX A TECHNICAL REFERENCE

Spline Algorithm

The spline algorithm is an interpolating function, fitting a space curve defined by 3 equations,
x = X(u), y = Y(u) and z = Z(u),
through a set of n data points (or nodes) specified by the nodal values (u_i, x_i, y_i, z_i)
of each of the nodes i = 1, 2 ... n.

The construction of each function is of identical form, the construction of X(u) is given as follows. For simplicity write

$$4\, s = \frac{dx}{du} \qquad \text{and} \qquad m = \frac{d^2x}{du^2}\, 5$$

$$u = u - u_i\, 6 \qquad \text{and} \qquad l_i = u_{i+1} - u_i$$

Each segment of the curve (between consecutive nodes) is a cubic polynomial defined by the nodal values of **x**, **m** to be chosen to give continuous variation of **s** across the nodes.

Thus for the segment $u_i < u < u_{i+1}$ write:

$$x = x_i + s_i u + \tfrac{1}{2} m_i u^2 + a \;\; u^3\, 7 \qquad (1)$$

where the subscript i denotes nodal values.

On differentiating twice it is found that

$$a = \frac{m_{i+1} - m_i}{6\, l_i}\;\; 8 \qquad (2)$$

where

$$s_i = \frac{x_{i+1} - x_i}{l_i} - \frac{l_i}{6}\left[m_{i+1} + m_i\right] 9 \qquad (3)$$

which becomes

$$s_{i+1} = s_i - \frac{l_i}{2}\left[m_{i+1} + m_i\right] 10 \qquad (4)$$

or

$$s_{i+1} = \frac{x_{i+1} - x_i}{l_i} + \frac{l_i}{6}\left[2m_{i+1} + m_i\right] 11 \qquad (5)$$

Corresponding to equation (5) the slope of the previous segment at the ith node is

$$s_i = \frac{x_i - x_{i-1}}{l_{i-1}} + \frac{l_{i-1}}{6}\left[2m_i + m_{i-1}\right] 12 \qquad (6)$$

Combining (3) and (6) yields the slope compatibility at the ith node as:

$$l_i\, m_{i+1} + 2\left[l_i + l_{i-1}\right] m_i + l_{i-1}\, m_{i-1} = 6\left[\frac{x_{i+1} - x_i}{l_i} - \frac{x_i - x_{i-1}}{l_{i-1}}\right] 13 \quad (7)$$

There is one such equation at each of the (n-2) internal nodes and two further equations are needed to completely determine the nodal curvature values. These can be simply to specify either m, or s, and either m_n or s_n, noting that equation (3) can be used to relate m_1 to s_1 and equation (5) to relate m_n to s_n without requiring data beyond the curve ends.

A stable direct solution to the slope compatibility equations can be obtained by defining auxiliary arrays E_i and G_i in such a way that

$$m_{i-1} = E_i \cdot m_i + G_i \quad 14 \qquad (8)$$

Substituting into (7) and rearranging gives:

$$E_{i+1} = \frac{l_i}{\left[E_i \, l_{i-1} + 2l_i + 2l_{i-1}\right]} \quad 15 \qquad (9)$$

and

$$G_{i+1} = \frac{E_{i+1}}{l_i}\left[l_{i-1}\, G_i - 6\frac{x_{i+1} - x_i}{l_i} + 6\frac{x_i - x_{i-1}}{l_{i-1}}\right] \quad 16 \qquad (10)$$

With starting values $E_2 = 0$, $G_2 = m_1$ 17

or $E_2 = -\tfrac{1}{2}$, $G_2 = \frac{3}{l_1}\left[\frac{x_2 - x_1}{l_1} - s_1\right]$ 18

depending on whether m_1 or s_1 is specified.

If s_n is specified, the process of back substitution using (8) must be preceded by determining m_n from:

$$m_n = \frac{1}{E_n + 2}\left[\frac{6}{l_{n-1}}\left(s_n - \frac{x_n - x_{n-1}}{l_{n-1}}\right) - G_n\right] \quad 19 \qquad (11)$$

<u>Curvature Influence Function</u>

Fairing at the ith internal node is made using a curvature influence array formed by fitting a spline function to a curve such that $x_i = 1$ and $x_j = 0$ for $j \neq i$. The end conditions being chosen as s=0 or m=0 to match the specification of slope or curvature values in the end conditions of the curve being faired.

The co-ordinate adjustment δx_i to achieve a given change of curvature value δm_i is given simply by:

$$d\, x_i = \frac{d\, m_i}{M_i} \quad 20$$

where M_i is the curvature influence value at the ith node.

The spline curve formed by interpolation through the new coordinate values differs from the original along the entire length of the curve, but the differences rapidly diminish with distance from the altered node.

The effect can simply be assessed by considering the case where parameter values are integer, and by considering a unit displacement at the point i = 0 on a doubly infinite spline function.

In this case, the compatibility equation has the solution

$$M_o = 6\left(1 - \sqrt{3}\right)$$

$$M_i = -6\sqrt{3}\left(-2 + \sqrt{3}\right)^i \qquad (i \geq 1) \quad 21$$

Looking at the ith segment of the curve, the slope is zero at

$$u = u_i + \frac{1 - \sqrt{2} - \sqrt{3}}{\sqrt{3}\left(\sqrt{3} - 1\right)} \approx u_i + 0.380 \quad 22$$

at this point $\frac{x}{M_i} \approx -0.0491$ 23

Now $2-\sqrt{3} \approx 0.268 \approx ¼$, thus from one node either side of the correction M_i decays by a factor of about 4 per node and the maximum curve deviation from zero decays by the same factor. The results can be tabulated to assess how far along a curve, the effect of change of coordinate is propagated:

Node i	**1**		**2**		**3**		**4**
M_i / M_0	-0.63		+0.17		-0.05		+0.01
max $\lvert x \rvert / x_0$		-0.14		+0.04		-0.01	

It can be seen that for practical purposes, that the curve change is restricted to three segments either side of the alteration. The relatively large curvature influence value at the nodes either side of the altered point should be noted and taken into account in selecting a new curvature value for the point being faired.

APPENDIX B FILE TYPES AND FORMATS

HFG Files

The ASCII HFG file stores the general information about the ship, the curves and the network. Backup files ~HF and ~AH also posses the same format.

The format of the HFG file is as follows:

Ship Title
Number of curves
For each curve:
  Curve Type ('S' for Section or 'L' for Longitudinal).
  Curve Description.
  Curve Status ('Complete', 'Faired' or 'Altered') N.B. Not used in Windows Version.
  Link Flag (1 if linked into network, 0 otherwise).
  Number of points on the curve.
  End Condition Type for X,Y,Z.
  End Condition at A end for X, Y, Z.
  End Condition at B end for X, Y, Z.
  i and j location in network where first point on the curve is located
  for each point on the curve:
    X, Y, Z, X Slope, Y Slope, Z Slope, X Curvature, Y Curvature, Z Curvature, Protected Flag (1 if point linked to another curve, otherwise 0)
Link Index (List of curve numbers in the order in which they were linked into the network)
INET, JNET.
L Min, L Max, B Min, B Max, D Min, D Max (all 0 if auto ship limits is on).
Length units.

PLO Files

The ASCII PLO file stores the general information about the interpolated curves and settings from the Interpolator Setup dialog and all the plot settings in the Plot Setup window. Backup files ~PL and ~AP also posses the same format.

The format of the file can vary depending on many parameters and is therefore too extensive to describe in the context of this manual and should never be edited manually.

INI Files

The ASCII INI file stores all user information and preferences such as line settings, font settings, previously used files, digitizer setup and window setup.

The format of the file can vary depending on many parameters and is therefore too extensive to describe in the context of this manual and should never be edited manually.

DXF Files

ASCII Drawing interchange format files (DXF) are used for exchanging drawings. The format consist of primarily the following:

POINT : individual points.
LINE : A line defined by two points.
POLYLINE : A line or curve defined by n points where n>2.

There are many other options and objects that can be set in a DXF file. These are not recognised by the DXF to LFH Translator as it is only concerned with the lines and polylines to describe the sections of a ship or yacht.

DXF files read by the translator must be in ASCII format and defined in 3-D as the DXF cannot assign a longitudinal location of the sections if it is only in 2-D.

As the LFH file only describes half of the ship any half sections with a negative y-value will be assumed to be reflections of a positive y-value section and will therefore be ignored by the DXF to LFH Translator.

More information about how to create DXF files can be seen in Tips and Hints.

LFH Files

LFH files are an ASCII format file specified by the Wolfson Unit for Marine Technology and Industrial Aerodynamics. The format is used to describe a set of orthogonal sections that describe the surface of a ship or yacht.

Only one half of the ship is defined in the LFH file format with the sections defined from most aft to most forward and the X and Y values of the sections are defined from bottom to top.

The LFH format is described with the following example:

Example Yacht	*Title of Ship or Yacht*
21	*Number of Sections in the File*
-5.000000	*Longitudinal or X Position of 1st Section*
5	*Number of Points on 1st Section*
0.008000 0.000000	*1st Point of 1st Section (Z,Y separated by space(s) or tab)*
0.008802 0.106723	*2nd Point of 1st Section (Z,Y separated by space(s) or tab)*
0.011716 0.203514	....
0.015711 0.271432	
0.015711 0.000000	
-4.500000	*Longitudinal or X Position of 2nd Section*
24	*Number of Points on 2nd Section*
-0.039002 0.000000	*1st Point of 2nd Section (Z,Y separated by space(s) or tab)*
-0.032259 0.113125	*2nd Point of 2nd Section (Z,Y separated by space(s) or tab)*
-0.023557 0.216692	....
-0.012308 0.311496	
0.002052 0.398296	
0.006741 0.421438	
0.020062 0.477814	
0.042235 0.550735	
0.069052 0.617706	
0.100956 0.679338	
0.138336 0.736216	

0.181526	0.788911
0.220151	0.828182
0.262015	0.864823
0.306349	0.898429
0.352359	0.928595
0.399230	0.954907
0.446122	0.976945
0.457779	0.981749
0.492176	0.994285
0.536517	1.006499
0.578278	1.013166
0.616626	1.013877
0.616626	0.000000

Longitudinal or X Position of 3rd Section
Number of Points on 3rd Section
1st Point of 3rd Section (Z,Y separated by space(s) or tab)
2nd Point of 3rd Section (Z,Y separated by space(s) or tab)
.... Continue with definition until all 21 Sections have been defined.

IMS Files

The IMS file is used to generate IMS ratings and outputs from some lines fairing software. IMS is generally used as the hull definition for yacht Velocity Prediction Programs (VPP).

GHS Files

The General Hydrostatics System (GHS) file is an ASCII file for use with hydrostatics software written by Creative Systems.

Offset Files

Offset files are an ASCII offset file with an offset table.

VRML Files

Virtual Reality Modelling Language (VRML) ASCII files are used to describe a 3-D geometry. ShipShape exports a 3-D surface file of the hull. The file format is an unstructured grid format describing a set of nodes and the connectivity between them to create a set of quadrilateral panels.

AVS UCD Files

AVS UCD files are ASCII Unstructured Cell Data (UCD) files used with the Advanced Visual Systems Inc. (AVS) programs. The file format is an unstructured grid format describing a set of nodes and the connectivity between them to create a set of quadrilateral panels.

Bitmap Files

Bitmap files are binary graphic files. The file format is pixelated rather than vector or raster.