HULLFORM

Professional

Version 9

Blue Peter Marine Systems
92 Dyson St, Kensington,
West Australia 6151
Phone +61 8 9367 6949
E-mail support@hullform.com

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INTRODUCTION

History

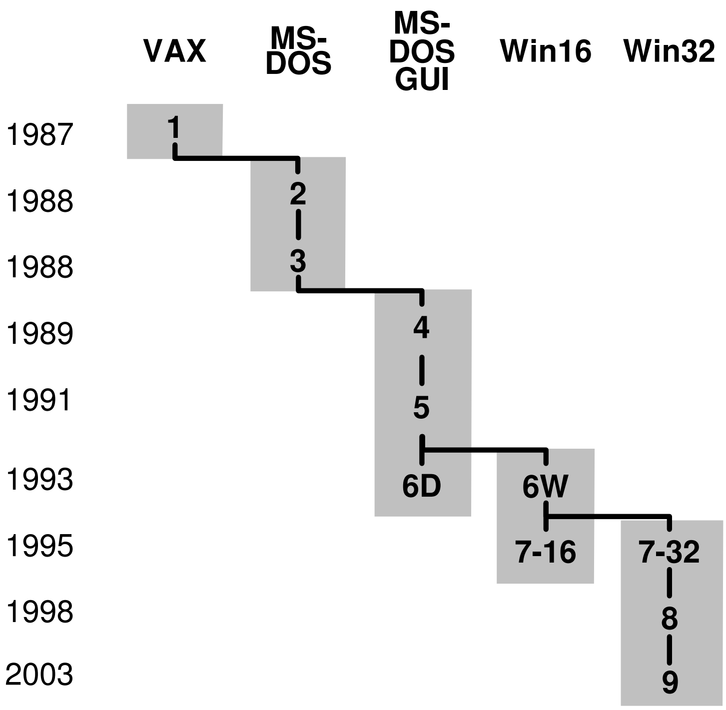
Hullform is the name assigned to a family of programs specifically designed to help the process of designing a boat hull. It was originally developed to provide access to computer-based hull design by users possessing only limited computer facilities.

Versions 1 and 2 were low-distribution demonstration exercises. The initial commercial release, Version 3 was conceived as a simple hull design program, which would provide entry-level design capability to the hull designer with only minimal resources. Version 4 extended the concept, adding a graphical user interface, and using the PC hardware base to much greater advantage. It provided a rich set of tools, which would only be fully useable by a designer with a degree of experience in naval architecture. Hullform 5 followed, adding further design capabilities, and with interface refinements which moved closer to the model provided by Microsoft Windows® 3.

With Windows 3 came a viable, standardised graphical user environment for the IBM-compatible PC family, which provided an ideal basis for CAD programs. Hullform 6 for Windows and DOS, the next stage in the development path, presented a growth upgrade of the design tools of the DOS Version 5, but now available both in the original MS-DOS and Windows environments.

Following from Hullform 6, version 7 added features making better use of the Windows operating environment. Version 7 also marked the end of the DOS version, but offered both 16-bit and 32-bit Windows versions, the latter making much better use of system memory, and offering much faster computational performance. Stringer design and enhanced tank hydrostatics were also first introduced in Hullform 7.

Hullform 8 marked the "levelling" of the Hullform field, being available only as a 32-bit application. Compatible with operating systems ranging from Windows 95 onward, its architecture formed the basis of subsequent versions. Version 9 continues this trend, using the same memory archicture and adding features only feasible with 32-bit and larger memory models.



The major stages of Hullform's development

About This Manual

The most difficult task in developing any item of software is the creation of the manual. The only practical source of manual details is the author of the program - but in many ways, the author is the worst person to write the manual. To the author, the way the program operates is the most logical and obvious way - but this is rarely the case for all other users, worldwide.

The presentation and style of the Hullform manual reflects some years of refinement, and the result is probably still imperfect. Crucial items have been emphasised by several means - including repetition, to ensure readers have the greatest probability of seeing them, and "information boxes" at the side of the text. The latter correspond to points important to the use of the program, which users often miss, and ask support questions about.

Much of the content of this manual also can be found in the Hullform help file. In fact, the content of help file can change more quickly in response to user problems than a manual can, so you may find it more useful in some cases.

Look for "information boxes" like this one - they carry information crucial to your use of Hullform.

THE MATHEMATICAL MODEL

Any hull design program uses a mathematical representation of the hull which has two main aims:

- to permit ease of construction of the final product
- to allow easy manipulation of the shape of the hull, to a fair or non-fair form as preferred

In addition, Hullform adds two further aims:

- to permit ready entry of the offsets of an existing design
- to permit the program to perform further calculations, such as plate development, stringer design and drag estimation, quickly and accurately.

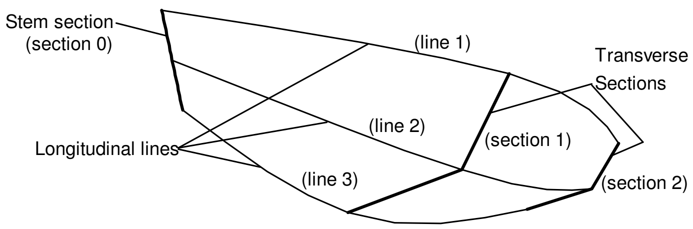
The retention of first two aims means that the Hullform model has much in common with those used by other CAD systems. The addition of two extra ones means that the model has remained less complicated than other hull models. For some users, the simpler model is preferable, being easier to handle; for others, it is a small price to pay for the extra features which it makes possible.

One of Hullform's first-up design objectives was to allow entry of the offsets of an existing design.

Basics

The hull is constructed across transverse sections (which may be equated to frame positions in some cases), each at user-specified locations along the hull axis. Up to 100 sections may be defined. Sections are generally assumed symmetrical, so only half of each section needs to be specified.

The sole exception to this rule is section zero, which corresponds to the stem. This is aligned fore-and-aft, rather than transversely.



Between the sections run longitudinal hull lines, whose coordinates at the section positions coincide with the section boundary. These lines are indexed from 1 upward, the program assuming the highest-number line to correspond to the keel (although this may be of finite width).

Hullform's design model is based on transverse hull sections - plus "section zero", a longitudinal section of the stem.

The program allows a maximum of 400 lines. They may be located at any point around the hull surface, from centreline to sheerline. They may correspond to sheerline, keel or chines, or even to waterlines, diagonals or buttock lines.

Curvature is permitted in both longitudinal lines, and transverse section outlines. Longitudinal lines are faired to curves used a natural cubic spline scheme, while transverse curved are defined by quadratic Bezier curves. The natural spline is used because it matches closely the behaviour of the traditional batten "spline" used to generate a fair curve on the lofting floor. The quadratic Bezier is used because it requires only one line of control points on each surface - and is therefore easier to manage - and because its mathematical simplicity has allowed inclusion of many additional features in the program.

Between the hull lines, at each section, form control variables determine the curvature (or non-curvature) of the hull surface.

The hull sections, lines and control variables may be separately edited, to generate the required hull shape.

In some cases, hull lines will coincide (e.g., when a fin keel is added, the keel may be of zero size over most of the length of the hull). The program recognises this, and when any line is moved, all higher-index lines coincident with it are altered to match.

The positions of the hull line points of each section are specified within the program in terms of the vertical and lateral (horizontal) offsets a boatbuilder might use, when constructing a hull in an inverted position. Thus, vertical offsets are normally greatest for the keel or skeg, least for the sheerline.

However, larger craft are generally built upright, and this convention may be reversed by selecting the upward Z-positive direction under the Configuration menu. As a result, you may never need to consider the inverted convention used within the program.

Master and Slave Sections

You do not need to edit all hull sections. While you can elect to edit each section individually, it is often more useful to control explicitly the hull shape at only a few points along its length. These are called “master sections”, the rest “slave sections”.

The “master section” approach allows you to edit a hull with dozens of sections, using only a few main ones to control the rest.

Hullform provides two primary editing modes - line smoothing, and section editing. When you smooth any line, the master sections will remain fixed as you left them, and only slave sections will be faired into a smooth curve. Line fairing may be performed only on a user’s command, or may be done automatically whenever a master section is changed. The former might be a good idea for a complicated design on a relatively slow computer, but for most designs on most modern computers, the auto-fairing option is recommended.

You can enable automatic fairing using menu item Edit, Line Properties

In editing sections, you can explicitly move any offset or control point only for a master section; if you try to change a slave section’s offset or control point, you will be asked whether you want that section to be a master section.

When you first create a hull, only the stem and stern, and mid sections are defined to be master sections. You can add others, or remove any other you have added, at any time later.

NOTE: these features were new in Hullform 8. Users of previous versions may find adjusting their editing techniques takes time. If so, a configuration item allows pre-Hullform 8 editing - see menu item Edit, Edit mode.

Longitudinal Lines - Fairing

In Hullform, longitudinal lines are faired using a natural cubic spline. In fairing, the line is held fixed at a small set of sections, and it is allowed to reach the shape of minimum overall curvature in between. The natural spline scheme generates a curve whose second derivative varies linearly between the fixed sections.

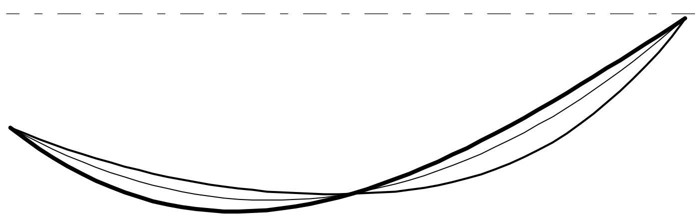
For line fairing, a weighted natural cubic spline scheme is used.

By comparison, the curvature of a thin batten held between fixed points varies linearly between them. For slender hulls, the value of second derivative is proportional to the value of the curvature of the batten, so the natural spline gives almost the same result as obtained on the lofting room floor - but much more reliably and easily.

In traditional lofting, it was sometimes necessary to apply a load to the extremities of the batten, to generate extra curvature near its ends. Hullform provides an equivalent facility, in its “end curve factors”. These express the effect of this load.

When an end curve factor of zero is set, the curvature of the line will go to zero at its end. This equates to an unloaded batten. When the factor is set non-zero, some curvature of the line is maintained at its end - equating to a loaded batten. A value of 1 will keep curvature constant from the last fixed section to the end of the hull, and values greater than one will increase it.

In the view below, three lines of varying width are shown. The thinnest corresponds to the plan view of a sheerline, with end curve factors of 1 for stem and stern ends. The next widest corresponds to a factor of 5 at the stem and 1 at the stern, and widest to a factor of 0 at the stem and 2 at the stern. The changes of curvature due to the “loading” effect are clearly seen.

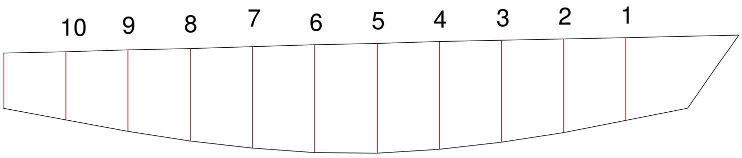


Line Flexibility

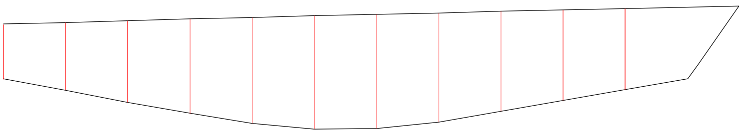
While it is common for the fairing process to presume constant flexibility of the numerical equivalent of the spline “batten”, this is not essential in Hullform. In the old approach to lofting you can thin a batten used to fair a hull, to give a higher curvature. In Hullform, you can adjust the flexibility of the numerical spline used within the program.

You can specify flexibility for the curve between each pair of section points. The default is 1 for all pairs, but can be large (allowing free flexing) or zero (preventing all flexing, if the neighbouring stiffness values are not of the same magnitude)

There are many combinations of effects from changes in line flexibility. For illustration, consider a simple hull initialised with uniform flexibility along its keel line:



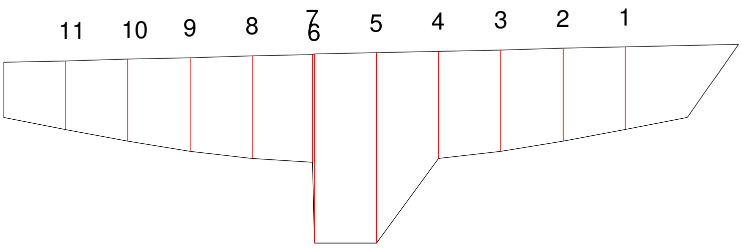
then with extreme flexibility imposed on its central sections - in this case, from section 4 to 8. Below is the result when the line is faired - notice that all the curvature has moved to the central sections.



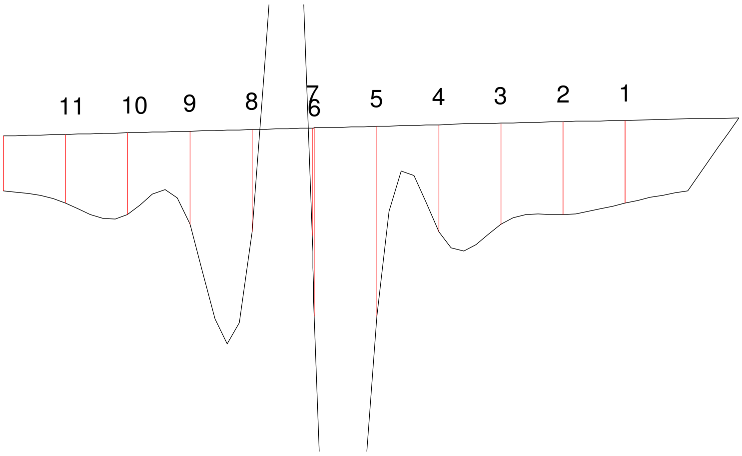
(You may see that the curvature has not been distributed evenly from section 4 to 8 - this is because, in this case, the central master section, about which the curvature is distributed, is section 5. Since it is not centrally placed in the region of high flexibility, the curvatures become asymmetrical)

A “step” in a hull line can be generated, using a large flexibility between two sections bounding the step

A more useful example arises when we introduce near-discontinuities in a hull line. In the example below, an extra section has been added just aft of section 6, and a rudimentary keel profile generated by moving the offsets for sections 5 and 6 downwards. In Hullform, you can elect to plot the hull lines from section to section only, without interpolating a curve between; when plotted this way, all looks OK:

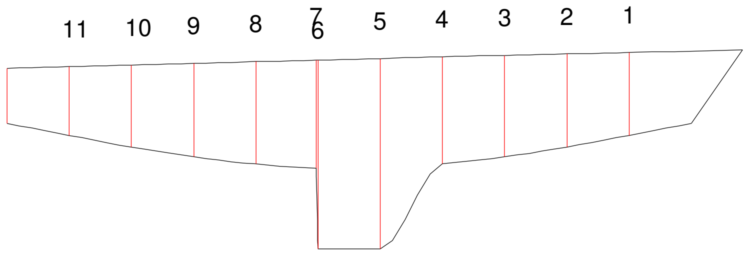


But when a curve is drawn between, the effect of the discontinuity becomes dramatically apparent:

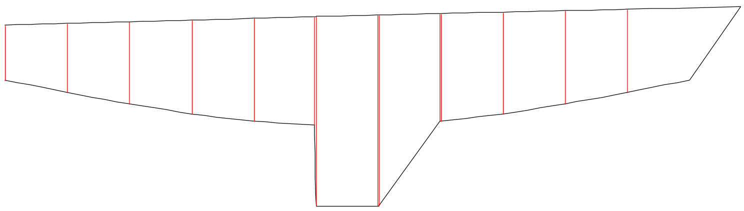


The solution is to assign high flexibility to those segments of the line where most of the curvature can safely be retained. In the example below, high flexibility (a numeric value of 100000000) was assigned to the segments between sections 4 and 5, and between sections 6 and 7:

You can force a straight hull line, by assigning flexibility values of zero.



Notice that these segments are not straight, since the alignment of the hull line is still fair through all sections. To generate - for example - a straight leading edge to the keel, we need to define extra sections near sections 4 and 5. One we have assigned high flexibility to these short segments of the line, the rest of the line behaves as we would prefer:



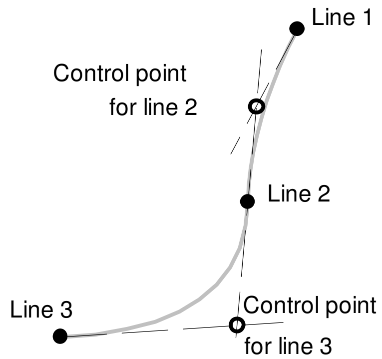
Transverse Curvature

The hull curvature between lines follows a quadratic form, allowing arbitrary alignment at either end. The curvature model is essentially that of a quadratic Bezier curve. The form of the curve between adjacent offset points on a hull section is defined by a single “control point”. Lines from the control point to neighbouring offset points are tangential to the curve at that end.

Hullform permits a single point between each pair of lines, controlling curvature.

The example shown here illustrates this principle. Notice also that the curvature of the section is maintained fair through offset line 2. Hullform provides for specification of “relative” or “absolute” control point positions, the former automatically maintaining this fairness.

Therefore, a perfectly “hard-chine” surface can be generated by setting the vertical control point exactly on the straight line between a pair of neighbouring offset points. The easiest way to do this is to set it coincident with one of the lines - normally the lower-indexed of the pair. A smooth curve (“soft chine”) can be produced by using relative lateral control point offsets (See below), and setting a zero value for lateral control point offset.



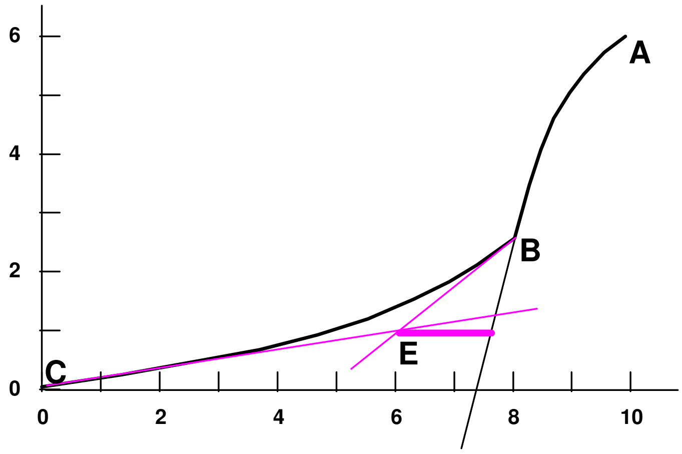
Similarly, a rounded bottom can be generated by using a vertical offset for the control point equal to the vertical offset of the hull bottom, and ensuring the lateral offset of the control point is outboard of the line marking the hull bottom.

Absolute and Relative Control Points

The vertical location of a control point is always specified as a simple vertical measurement. However, its horizontal location can be a simple horizontal measurement, or a displacement inward or outward relative to the location which would maintain fairness with an adjacent section curve. The first is referred to as an “absolute” position, the second as a “relative” position.

In the example below, the offset point A has coordinates (10,6), B is at (8,2.5) and C is at (0,0). The control point at E has coordinates (6,1). If the control point is absolute, these will be the values retained by the program. If the control point is relative, however, the value used for the horizontal control point will correspond to the wide shaded line, and be negative since the control point, E, is inboard of the “fair continuation” of the previous curve, between A and B (shown by the thin black line) - that is, about -1.5.

You can keep the outside surface of your hull fair using relative control points.



Partial Lines

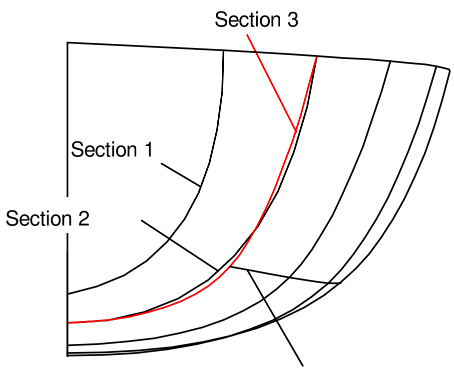
A normal hull line extends from stem to stern. However, it is possible to create a line which commences and terminates at any section.

This feature mainly intended for use in the program's tank-definition scheme, and should not be used directly by a designer without some care. Where a line terminates, one offset point and one control point is lost from the hull definition, and this means that it may not be possible to maintain fairness through the termination.

Partial lines should only be used with care.

For example, in the following case, a section has been inserted adjacent to and just aft of section 2, and line 2 has been made “partial", commencing at the new section, 3. With sections 2 and 3 adjacent, they should coincide if fairness is to be maintained.

But forward of the end of line 2, only lines 1 and 3, and one control point between them, are available. The form of section 3 is more complex than the section curvature model can handle using lines 1 and 3 and their control point only, so section 2 can not be made to match section 3 exactly.



With care, the consequences of such effect can often be overcome (e.g., by altering section 3), and there are circumstances, such as merging chines, where a partial hull line is a useful facility.

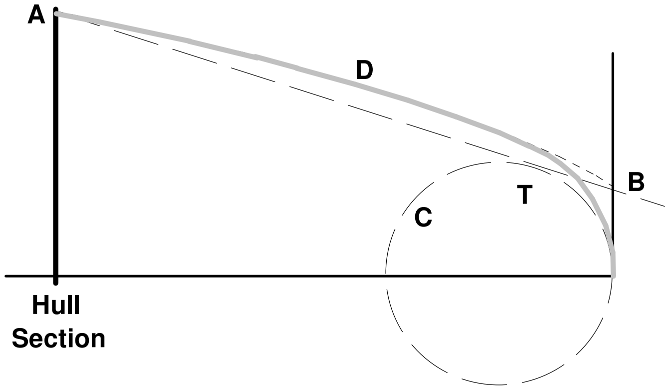
When a line does not extend to a given section, the program will normally presume that the curve parameters for the next line below refer to the last higher-indexed line which did extend to the section. This will normally result in discontinuity of the hull form at the line end.

If a partial line is used, the “tank” analogy for the termination of a partial line should be remembered.

Stem Radius

Hullform allows definition of a finite radius at the forward end of any line - normally the stem.

The effect of the stem radius on stem form is shown in the following diagram. Inside the forward end of the line concerned, a circle C of the requested radius is drawn. A line AB is then drawn from the intersection of the hull line with next section aft, tangential to the circle. The point B where the tangent line intersects the perpendicular at the line end defines a "virtual end" to the hull line. When the curved line D is faired using Hullform's spline curve, this is the point where the line is taken to end.



The resulting faired curve is normally displaced slightly outward from the circle (as shown above, in exaggerated form). The hull line is drawn coincident with this curve aft of the tangent point (T). Forwards of this point, it diverges from it curve, by an amount equal to the transverse distance from the tangent line AB to the drawn circle. Since the spline curve (following points ADB) meets the tangent line at the stem end, so the drawn hull line meets the hull axis.

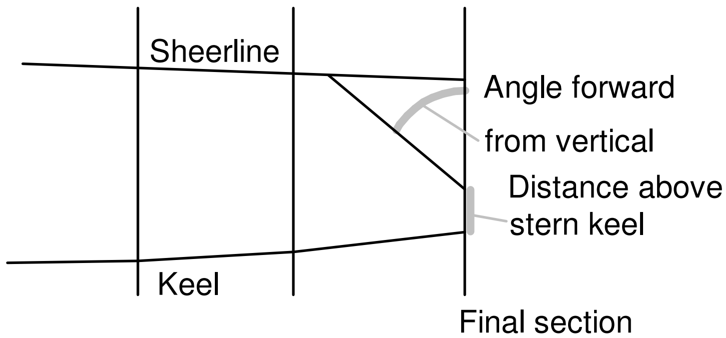
If you create a new section forward of tangent point T, above, the program will not draw the curve correctly.

PARTIAL LINES: If a line starts aft of the stem and is allocated a non-zero radius, the line will be attached at its start section to the hull line which runs into the base of the stem (the "stem line"). All lines between this line and the stem line will also be attached to the stem line, out of necessity.

Transom

Hullform permits a sloped and rounded transom. The slope may be forward or backward, and the transom may intersect the final section at any height. The radius may also take any value - although radii too small for the transverse size of the transom will cause the logical problems.

The meaning of these two parameters is illustrated below:



NOTE: The transom radius is measured perpendicular to the transom surface - not in the horizontal plane.

The effects of the transom are included in the program's hydrostatic calculations. This is implemented by interpolating transverse sections within the transom. The number of sections depends on the drawing detail implemented using menu item Configure, Extra drawing points – the number of points used to draw curves between hull lines defines the number of transverse sections interpolated between the intersections of each hull line with the transom. In the program's default configuration, this means that even for a minimal hull, there will be about 10 interpolated sections used to estimate the transom's hydrostatics effect.

Effects of the transom are included in hydrostatic calculations.

Hydrostatics

Once the hull has been defined, the program can perform a number of calculations relevant to its dynamic and static properties (e.g., displacement, righting moment). These are calculated by trapezoidal integration between bow and stern.

This technique is less accurate than schemes employed by other such programs. It is used because discontinuities between sections (e.g., transoms) are often used in small craft design, and these generate gross errors when higher-order schemes are employed. As a general guide, errors are about 1% for a hull specified using about 15 sections.

For greater accuracy, more sections can be used, errors decreasing in proportion to the square of the number of sections. The program allows ready addition of sections. However, you must beware the same errors as arise unseen in other programs - irregularities, near locations on the hull where discontinuities occur. Use of the program's graphics capacity will provide an easy check.

INSTALLATION

Installation of Hullform is simple, and differs mainly from most other installation procedures in that it makes no changes to your operating system without your knowledge. It is also relatively unusual, in that it involves only a single diskette.

If your software has come on a diskette or compact disk, open the window for the distribution medium; otherwise, for software delivered via the Internet, open the folder to which you have saved the installation file. Click on the "Setup" program icon – this will normally possess a name like "Setup-9P" to show that you have received the version you ordered.

Hullform's installation does not alter your operating system in any way.

Hullform's installation set is generated using the freeware "Inno Setup Compiler", which, apart from being free, produces an extremely simple interface and a very fast installation. We strongly recommend it to anyone who has need of such an application.

There are only two installation choices you need to make. The destination directory name is one, and the defailt of "C:\Program Files\Hullform 9P" should be satisfactory for most users. The other is whether you would like a "Hullform 9P" icon on your desktop. Accepting the latter is a good idea, since you can subsequently move the icon to whatever folder you like.

The installation also associates Hullform's data files (the ones with the "hud" extension) with your copy of Hullform, and adds an entry to the "Add-Remove Programs" list of your Control Panel, making removal easy should you ever need to do so.

A pint of general significance: when you "uninstall" a program like Hullform, the files installed will be removed from the program folder, and then Windows will attempt to remove the folder itself. However, if you have generated any files in the folder after installation, the folder removal will fail. You may need to delete this folder yourself.

Configuring the Program

You set up the program using the Configuration menu, once Hullform is installed.

An initial configuration is copied during the installation, but the program configuration includes many items, some of you are bound to want to change - for example:

- If you are likely to require graphical output to a file, check whether the required format is listed under the "Plotter" item of the program's Configuration menu. If so, select it, and enter a destination (Normally a file. Windows usually takes control of all available parallel and serial ports).
- Under the "File directory" item, enter the directory – i.e., folder – where your design files will be stored. The typical format is "C:\HULLDATA" (without quotes). DO NOT INCLUDE A TRAILING BACKSLASH ("\") - this gives Windows problems. NOTE that Hullform will manage this entry itself, making it match the last directory from which you loaded, or to which you saved, a hull design, so you can omit this stage if you want.
- Select the direction in which you prefer the hull drawings to point (stem left or stem right), and whether you prefer the vertical coordinate to increase upward or downward, using the "X-positive direction" and "Z-positive direction" items.
- Decide whether you want to use Windows' standard "GDI" graphics, or the smoother and slower OpenGL graphics model. If in doubt, use GDI – the main benefit of OpenGL is in three-dimensional visualisation, which may not worry you till later.
- Choose line colours and styles to suit your preference, using the "line colours" and "line styles" items. (Remember, your line style choices will only have effect in screen, printer, Windows metafile and clipboard output)
- Select screen and printer fonts to suit the size of your screen, and your personal preferences.

  NOTE: the default printer font may not match one installed on your system. If you see weird characters on printer output, the cause will be a failure to follow this step.
- Define the amount of drawing detail you prefer, using the "Extra drawing points" item.
- You can choose to display any view of the hull (or none) when you open its file, using the "View on open" menu item.
- "Edit mode" may be used to set editing tools to pre-version 8 style - without automatic line smoothing or the "master section" approach. If you have upgraded from an earlier version, you might like to set this to "7-", for a while.

- Where do you like the toolbar? At the top, like most word processors? At the left or right, like many drawing programs? At the bottom, like some spreadsheets? You can use menu item Toolbar, Locate toolbar to place it wherever you like. Just one word of caution - you will need to close, and restart, the program for some toolbar operations to work properly.
- You can also add to, delete from and rearrange to toolbar contents to suit you own taste. But it is recommended that you find out for yourself which items you will like in the toolbar, and where, before doing too much here.
- The "Lines, text-edit" item allows you to customise the size of the dialog box you see when you operate directly on the numerical values of the hull offsets. It is recommended you leave this unaltered until you have some experience with the program.

When you have completed customising the program, select “Write configuration” to preserve your selection for access next time.

Alternately, just exit from the program. Your configuration is saved automatically.

PROGRAM OUTLINE

Screen Layout

Hullform follows normal Windows conventions on menu and dialog box usage. In addition, it provides a toolbar which can be customised so that all common tasks are initiated by a single mouse button click.

Keyboard Usage

The program accepts many forms of textual input, and also makes special use of the escape (“Esc”) and cursor keys.

Character case: Input may be in lower case or upper case. Lower-case input is converted internally to upper case before processing, so that inputs are case insensitive - e.g., the strings “all” and “ALL” are equivalent.

The length of input which may be entered is generally 128 characters. Input spaces are always smaller than this, but the text being input will scroll horizontally if required.

Escape key: The escape key aborts from any option currently selected.

Function keys: At many stages when the program is awaiting input, pressing either of those below will access a corresponding item:

F1 is the on-line help key. By pressing this key at any time when a dialog box is not present, you obtain information on the highlighted, or otherwise the most recently selected, menu item.
Windows dialog boxes usually include a help push-button, performing the equivalent task for the current dialog box.

F2 is the quick-save key. By pressing F2 at any time when a dialog box is not present, you may save the current design. This facility is identical to the normal Save option, except that on completion you remain in the part of the program previously in use.

When you press F2, the design is saved - so quickly, you may not notice it.

F10 Is the Windows' main menu key. When this key is pressed, you are returned to the “main menu” level of program operation.

The three separate orthogonal views, plus the three perspective views, may be also adjusted using keyboard:

Cursor keys: these rotate the perspective views, moving the stem in the sense of the arrow – e.g., the left-arrow key rotates the stem to the left.

Shift-cursor keys: when the cursor keys are used in while a shift key is depressed, the image moves in the direction of the key. This is most useful when a centre of a zoomed view is not where it is required.

Page keys: the page-up key shortens the viewing distance, increasing the perspective effect, while the page-down key has the opposite effect

Mouse Usage

The program uses the left and right buttons of your mouse. In general usage, the left-hand button is the positive key: it means “select this option” (see below, “Menu Access”), “select this item” (e.g., a hull file) or “yes”.

The right-hand button is used at a few stages as the “Properties” button. This particularly applies to line properties, in the section-edit window.

The mouse may also be used to “drag” (with the left key down) hull-defining points in the “Edit", “Edit sections” graphic edit facility and in line smoothing section (“Edit", “Smooth a line”), to select items from displayed lists at various program stages, and to move the corners of the Zoom rectangle (see page 15).

It is also used to adjust the perpective views. You can use it to drag the scroll bar sliders, rotating the stem in the perspective image in the direction the slider is dragged. If you have a mouse wheel, rolling it upward zooms in on the view, while rolling it downward zooms out. If you keep the Shift key pressed, rolling the mouse wheel upward shortens the viewing distance, increasing the perspective effect, while rolling it downward has the opposite effect.

Menu Access

The main menu, and all sub-menus, may be accessed in three ways:

1. By pressing the Alt key in combination with the underscored uppercase character in the menu item's description.
2. By moving down a menu to the required option, using the mouse with left button pressed to "drag" the menu bar, followed by release of the button.
3. a click of the left mouse button on the required item.

In some cases, where no ambiguity can arise, you can access a menu without pressing the Alt key

Toolbar

The toolbar provides "single-click" access to any item of the program's menus. It fully customisable, both in what it contains, and where each iconic button is placed. Typical toolbar functions are available:

Re-open last design used	Port perspective view
Open a hull data file	Starboard perspective view
Print current screen	Run Windows calculator
Write DXF file	Plot development rulings
Alter statics setting	Start new hull
Edit sections	Save current hull design
Statics cross-plot	Plot current screen
Triple orthogonal view	Copy current screen to clipboard
Body plan (end view)	Balance hull
Full hull perspective view	Smooth hull lines
Zoom	Drag plot
Run File Manager	Plan (top) view
Run Notepad editor	Profile (elevation) view

Hullform's toolbar is easily customised to your own preferences

Remember, the selection, placement, ordering and meaning of each iconic button is your own choice. Refer to the Configure, Toolbar section (page 107) for details of how to configure the toolbar to your own preferences.

Dialog Boxes

Hullform uses, for most of its dialog box operations, a standard dialog box controller which supports

- edit boxes, which are used for entry of numeric values or text
- radio buttons, used for selection of one item from a limited set of options,
- check boxes which can be set on or off.
- the normal "Ok", "Cancel" and "Help" push buttons. The primary exception are those functions which involve file input or output (discussed at the end of this section) and more complicated selection processes.
- other push buttons, which normally spawn a further dialog box related to options within its parent.

- list boxes or "combo boxes", which allow you to select items from a larger set of choices than radio buttons.

An edit box input may be a character string, one or a set of integers, or a real number.

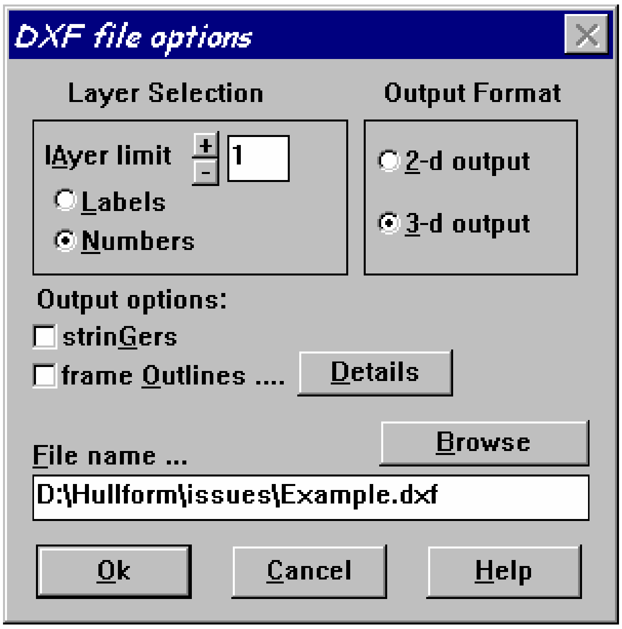
In many cases where an integer is required, two extra small push buttons are placed next to the edit box, marked by a "+" and a "-". Clicking the "+" button with the mouse increments the number in the edit box, while clicking the "-" decrements it.

In cases where a set of integers is to be provided (for example, when specifying a set of transverse section numbers), these should be entered with commas separating them, with the following provisos:

- A contiguous range may be defined by its end values, connected by a colon.
- The complete set may be specified using the word "ALL" (or "all").
- An empty set may be selected using the word "NONE" (or "none").

Common valid inputs are typified by "1,2,4:7,13" and "1:6,9:12".

A typical Hullform dialog box, for DXF output, is shown below:



Radio buttons are used to select a parameter from a small set of mutually-exclusive options.

When a push button is present (apart from the Ok, Cancel and Help buttons), it commonly means that further options are available. If you press the button, a further dialog box providing these options then appears. While this dialog box is present, the one from which it was spawned remains inactive.

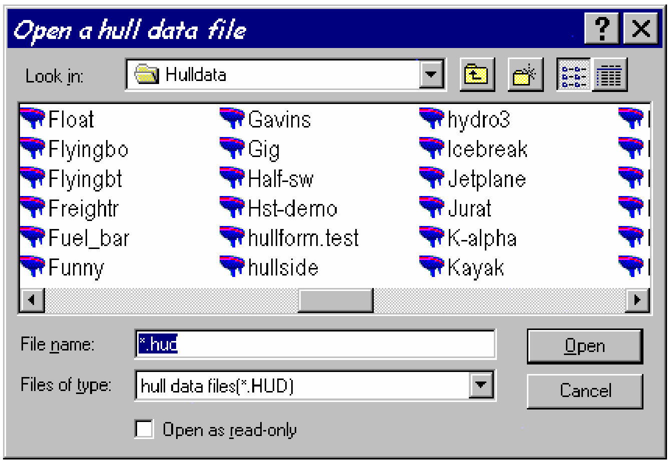
Check boxes are like radio buttons, except that multiple selections may be made from a group of check boxes. In the above example, you may choose to include or omit stringers from your DXF output. Separately, you may also choose to include or omit frame outlines with thickness corrections.

The "Ok" and "Cancel" options are used to close the dialog box. Only when "Ok" is selected are the modified input parameters returned to the program.

When the dialog box is entered, the first input edit box (if present) is automatically selected for entry. Movement between items is achieved by:

- using the Tab key (→|), which moves the selected item to the next in sequence,
- using the Back Tab (|←) key, which moves the selected item to the last in sequence.
- pressing the Alt key in combination with the highlighted letter in the text adjoining the edit box,
- Selecting the edit box or adjoining text using the left mouse button.

File Dialog Box: Hullform for Windows calls on the Windows standard dialog box for most file operations. This dialog box is identical to the one you will see in many other Windows programs. Is has form:



Using a mouse, you can double-click on a file to select it, or click the down-arrowheads on the "Look in" and "Files of type" drop-down list boxes to select another file directory (folder) or file type.

Using the keyboard, the Tab key will move the input focus cyclically through all dialog box items. When one of the drop-down list boxes has focus, you can use the down-arrow key, then the down- and up-arrow and page-up and page-down keys to move through the list of options.

For hull data file input and output, the "Files of Type" section will be irrelevant, showing only the "*.hud" option when selected. Other file operations provide for a range of extensions.

As normal with a Windows dialog box, you can cancel a file operation by selecting the "Cancel" button, let it proceed by using the "Ok" button (or pressing the Enter key).

The Windows file dialog box provides file-management features, such as creating new folders, and file deletion.

The file dialog box provides many other services, such as file renaming and deletion. To delete a file, simply highlight it and press the Del key. To rename it, highlight it, then click once within the highlighted text. The file name will then appear as an edit box, allowing you to type a new name into it.

You will often find that, when the dialog box is displayed, there is a default file extension, and that the displayed files correspond to those with this extension. However, a problem arises because Windows does not limit file names to have to a single extension - for example, file.doc.txt is a legitimate name.

By default, Windows always adds an extension to the name you give - so, for example, if you nominate file name data.doc when the default extension is "txt", the file generated will have name data.doc.txt. The standard method to overcome this problem is to place the name within double quotes - e.g., "data.doc".

Hullform attempts to overcome Windows' habit of adding the default filename extension, even when you have specified your own.

However, users generally do not want double file extensions, so Hullform adds an additional control on file names. When there are two "."s in a file name, the second extension (after the second ".") is tested. If it matches the default extension used in the file dialog box, it is presumed to have been added by Windows, and is removed from the file name. In most cases, this step removes the need for double quotes around file names.

Zooming Graphical Views

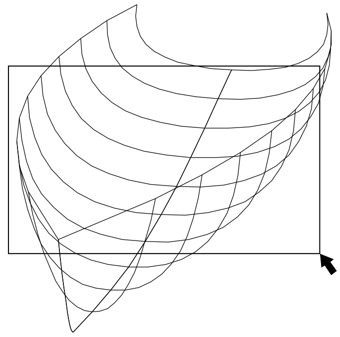
In viewing perspective and orthogonal hull drawings, perspective views of, or "rolled out" developed surfaces, and in editing a hull section by section, you may "zoom" into any selected part of the screen, using the Zoom menu option. This feature operates as follows:

Zoom Rectangle

When "Zoom rectangle" is selected, a rectangle occupying the central portion of the screen appears. This marks the region which will subsequently be expanded to fill the normal window.

The edges of the rectangle may be moved using the mouse or cursor keys. Initially, the right- and left-arrow keys move the left edge, and the down- and up-arrow keys move the top edge. Movement of the other edges is selected by pressing of the "Tab" key (a second press of this key "toggles" back to the first possibility).

Alternately, the mouse may be used to move the corners. When the mouse pointer is placed in the program window, close to a corner of the rectangle, and the left button is pressed, it jumps to the nearest corner (as above). While the key is kept pressed, you may "drag" that corner to the desired position. This action may be repeated until the rectangle is in the desired location.



When the area to be "zoomed" is defined, you must press the "Enter" key. The smallest rectangle of the window's aspect ratio which can be drawn about the chosen rectangle is then expanded to fill the full screen.

The original field of view may be restored by selecting the Zoom option, and pressing the "Esc" key, instead of "Enter".

Zoom In

After you select this item (or, equivalently, the toolbar button showing a plus sign in a magnifier), you place the mouse pointer anywhere on the display window, and press the left mouse key once. The display size increases, keeping the point on the hull where the mouse pointer was in the same location.

Zoom Out

This menu item (or, equivalently, the toolbar button showing a minus sign in a magnifier) decreases the size of the image, keeping the point on the hull in the center of the window in the same position.

On-Line Help

Function key F1, at any stage where a dialog box is not present, and the Help push button in most cases when one is present, will access the Windows help system for the program.

For this feature to work, you must have file hullform.hlp accessible to the program - e.g., in the program's startup directory, or in your current file search path.

Error Messages

The program can report several error messages related to the availability of memory, all due to low memory in various memory areas. In normal use such events should be rare. Occasionally, however, Windows memory allocation becomes too fragmented, and then "Out of memory" messages start to appear.

An "out of memory" condition can occur when Windows itself suffers memory fragmentation.

Should this ever happen, all you need to do is close all applications you have running, allowing Windows to clear all allocated memory blocks. You can then normally restart the applications, and memory allocation messages should not recur.

Error Reports

Should you receive any error message, **please** report the error, giving full details of:

- the command sequence giving rise to the error
- the exact point in program execution where the error occurred
- your configuration file, "hullform.cfg" - preferably on a diskette, or as an e-mail attachment.
- the design in which it occurs (If it can be produced using one of the sample designs, the name will do. Otherwise, please send a copy of the hull data file on diskette or as an e-mail attachment)
- the hardware and software configuration of your machine, including the program configuration parameters and the Windows video driver you are using (e.g., Standard VGA), and printer driver if relevant.
- Do not send a copy of any memory dump which Windows generates under the "Details" button of the error message box. This information is not useable in analysing your problem.

If you provide the above details, the problem will be inspected promptly, and in usually a replacement copy of the program with the error removed can be sent with two weeks. If you do not, it is probable that no checking of the problem will be possible.

Software support via the Internet is the easiest for customer and supplier alike.

If you have access to Internet, you will find this the easiest way to contact Blue Peter Marine Systems. The e-mail address is

support@hullform.com

GETTING STARTED

Once you have installed Hullform for Windows, it is a good idea to run through some simple exercises, to explore what the program can do.

First Steps - Design of a Simple Hull

In this exercise, you will design a simple hull, characteristic of a small displacement keel yacht. It is intended to guide you through the main elements of the program. Note that all numbers are suggestions only, and you may select your own dimensions.

Run the program, by double-clicking its program icon in whatever group you have chosen. You will see a screen view much like the one at right.

You may have altered the toolbar during the initial configuration process (See page 10). So, to ensure some standardisation, all commands are specified in menu item terms.

Starting a New Hull

Firstly, you will need to choose the measurement units you are going to use. Lengths may be in metres or feet, masses in kilograms, tonnes, pounds or tons. Select the Units option from the Configuration menu, and pick the set of units you prefer. Select "Ok" to confirm your selection.

Following this, select the Configure menu's item "Z-positive direction". This allows you to choose the direction in which you want your vertical measurements to increase. Make your selection between options "Upward" or "Downward" by pressing key Alt-U or Alt-D (or using the mouse pointer). After making your selection, press "Enter" to confirm it. Your selection is not crucial to the shape you generate, but will make your own interpretation of numeric values easier.

You have probably set up these values to your liking already - but it is important that they are done before you start this exercise.

Finally - because if you don't, things might get confusing later - select the Configure menu's "Extra drawing points" item, and enter 0 for the "number of points to plot between sections".

Now you have the program configured sufficiently to allow you to design a hull, on your own customary terms.

You start a hull in the same way you start a document in your favourite word processor program - select the "New" menu item from the "File" menu. The dialog box you see allows you to initialise the basic details of any new hull design you desire.

You now provide a sequence of inputs, in the input areas of the dialog box. You can ignore (for now) the message "Now in normal hull mode", and the push-button entitled "Change to surface mode". These are used in designing a hull using multiple surfaces, and not needed here.

The first edit box is where you provide the required number of hull lines.

For the simplest possible hull, the number must be 2 (the suggested default value), one for the sheerline and one for the keel. Note the "+" and "-" buttons here - you can increment the adjacent edit box value by 1 for each click of the "+", and decrement it using the "-".

> *Accept the value of 2 by pressing the tab key only, to move on to the next item.*

The next edit box allows you to specify the number of sections to use. This corresponds to the number of transverse (frame-like) sections, plus the stem. The default of 12 will be sufficient for this first try.

> *Accept the value of 12 by pressing the tab key only, to move on to the next item.*

At the next edit box, you provide the length. The default is either 15 metres or 50 feet. Let's presume you want a 10-metre of 30-foot hull.

> *Enter the desired numeric value, and you will see it replace the default.*

Then you must input the beam. The default is 30% of the default length.

If you do not like it, you may alter the value by entering your own.

The following input accepts the transom beam, for which the default will be 18% of the default maximum.

Again, you may accept this, or substitute your own value.

The program next requires the rake of the stem, which it takes to be the fore-and-aft distance between the forward extremity of the sheerline, and the effective forward end point of the keel. (See page 32) The default is 5% of the default overall length of the hull.

Accept this value.

The maximum draft of the hull is next required. The default is 5% of the default overall length. This will generally be too large for sailing craft, and too small for displacement power craft, so you will probably substitute your own value.

Either accept this value, or enter whatever you prefer. It is not important in this exercise.

The final numeric inputs are the freeboard at the stem and stern.

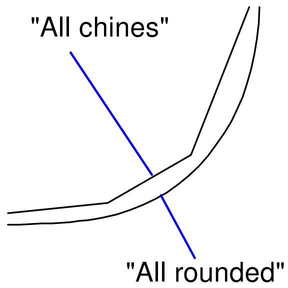
The next choice you have is of the “hull type” - yacht, workboat or planing. This choice gives you a start in creating the shape of the hull, and works by customising the end-curve factors for your design (See page 4). The “yacht” has fine ends, generated by end curve factors of zero, “workboat” has full ends, due to the us of large end curve factors, while “planing” has enhanced curvature forward, and much less towards the stern.

The “hull type” feature gives you a start towards the particular type of design you want, by initialising the factors which define the fullness of the hull at its ends.

Naturally, there are many other combinations possible. Even the three examples here are only approximations to the shape you may be after. This item is mainly provided because the end-curve aspect of the program is a significant element of the program’s design tools, and is easily missed if not provided to beginning users “up front”.

The initial section curvatures are the next requirement. These correspond to the form of each transverse section, between the hull lines. Examples are shown following.

A pair of radio buttons allows you to choose between these. The simple options “all chines” and “all rounded” generate respectively a chine hull, or one with a fair curve from sheerline to keel.

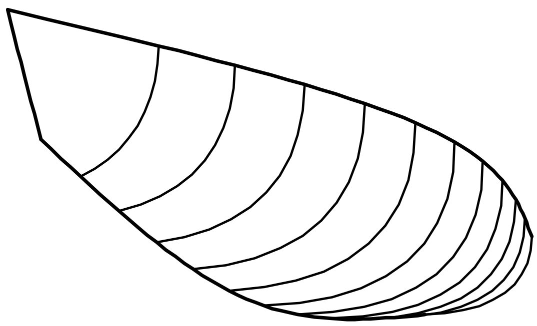


For the two lines you are using, you must select “all rounded” to generate a useful hull shape.

The baseline selection may be left as shown. It affects only the zero reference level for vertical measurements, not the shape of the hull. (It is common to use the keel as the hull baseline)

When all values have been confirmed or entered, select “Ok”. The “New hull” option is now complete.

To verify this, press keys Alt-V and P or S, to access the View, Port or Starboard perspective menu item. You will see that the hull has a stem, and eleven transverse sections. If you have not made some gross error on data input, it will correspond roughly to your intents (as below).



Notice in this case that the sheerline is close to straight at both the stem and stern. This is characteristic of the “yacht” hull type, which was used for this demonstration.

Improving the Design

While you design will look like a hull, it is unlikely to match your needs closely. Hullform provides two editing facilities, named “Edit sections” and “Smooth a line”.

(These names are a little misleading - when you smooth a line, you automatically alter hull sections, and since the release of Hullform 8, line smoothing has been the default mode of operation when editing sections. However, the view you see in line smoothing is of a hull line only, so there is a big difference in usage)

When you select “Edit sections”, your design will appear in a new window. It will be oriented at approximately the same angle as the last perspective view you used (only approximately, because the view is an oblique projection, rather than perspective)

To avoid errors due to poor projection angles, you will not be allowed to edit any section if it is angled less than 10^{o} from edge-on.

The view you see can include all hull sections and all hull lines. If you do not see all lines and sections, press key combination Alt-S, enter ALL into both edit boxes of the resulting dialog box, then click the Ok button.

You should normally also see a plot at the right, showing a vertical line and a curve representing the curvature of the hull’s surfaces at the selected section. If you do not see one, it may be because the selected section is of zero size (as the stem often is), or because all parts of the section outline are of zero curvature.

When you can see the lines and sections, drag the scroll bars on the bottom and side of the view, to rotate the design so you can conveniently see all lines and sections. For most hulls, this is best done by dragging the vertical scroll bar button upward, to raise the bow a little, and the horizontal scroll bar button to the left.

You can move between the master sections using the Tab and Shift-Tab keys.

The first action you should take is to see which hull sections are masters, and which are slaves. By default, the stem, stern and the midships sections are masters. They will be drawn in different colours, but you can check this by pressing the Tab key, which moves between master sections. As you press the Tab key, the highlighted section will move from the stem, to midships, then the stern. (Press the Shift-Tab key combination to move back over the set).

Initially, you should stick with three master sections, because it makes editing easier. With auto-fairing of lines, and direct control of their end curvature, you may not need more. If you find you do, extra master sections can be added - but the later you can add them, the easier the editing will be.

To add master sections, click on the “Master” edit menu item, or press key combination Alt-M.

Alternately, you can place the mouse cursor on any section, and press the left mouse button. This action selects the section - something you can not do unless it is a master section. The program therefore asks “You have tried to select a point on a non-master section. Do you want this section to be a master section?”

If you answer by pressing the “Yes” button, the new master section will be defined.

Now you can start editing. Firstly, let’s edit the stem section to make its shape more useful. We will start by getting a good look at it - as follows.

Press key E, and enter only number 0 in the resulting edit box (then press Enter, or click the Ok button). Then press key S, enter NONE in both edit boxes of the resulting dialog box and press Enter again.

See that the transverse sections disappear.

Now drag the scroll button at the bottom of the screen fully to the right. The view you then have is of the stem section, in profile.

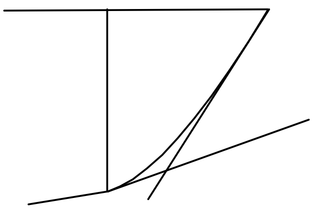
The profile isn't too bad, but a little curvature near the stem base might not go amiss. In order to take charge of the curvature, you need to move the curvature control point between lines 1 and 2, so press key C.

You will see some extra lines appear. These pass through the control points. However, with the sole control point for your two-line design lying at the top of the stem, you may not see much of these lines - yet.

Accurate movements of offset and control points are best done using the cursor keys.

Next, press key 2 to select the curve between lines 1 and 2, then press the down-arrow key. You will see the stem develop a curve, of maximum curvature near the upper end.

A normal stem has the curvature maximum near the base. To generate this, press the D key a few times, and note that the number in the top left corner doubles each time. Now when you press the down-arrow key, the curvature control point (located at the intersection of the two tangent lines) will move further.



Using the cursor keys, you will be able to move the control point near to the lower end of the stem (as at left). The size of the movement step of the control point will need to be reduced for any fine changes; use the “H” (“half”) key for this purpose.

Mouse Support: Alternately, after pressing press C, move the mouse pointer close to the upper end of the line. Now depress - and keep depressed - the left-hand mouse button. You will find the pointer jumps to the top end of the stem.

If you now “drag” the mouse pointer downward, keeping the button depressed, you will see the control point follow it.

You can drag offsets and control points in a “quick and rough” manner using the mouse

Whether you use the cursor keys or the mouse, you should see that the curvature plot - at the right-hand edge of the edit window - shows the peak curvature moving to the base of the stem, as the control point descends. As peak curvature changes, an occasional press of the R key may be needed to return the curvature scale to a sensible value.

When you are happy with the stem form, press key E, and enter the word ALL. Then press key S, and enter ALL into both edit boxes. You will see little of value, of course, because you are looking at transverse hull sections side-on. Press key N to centre the image, and look at them end-on.

Observe that the transverse sections of the hull have a rounded bottoms, and topsides vertical at the sheerline. We can make a few changes, to match better a common form of yacht hull - to add some “vee” at the keel, and a little tumblehome. To do this, press the Tab key to move to the midships section (the next master section), then press keys C and 2. Now, move the control point up, and out a little, using the cursor keys - using the same techniques as you used for the stem.

You will see the line corresponding to your control points changing, to maintain fairness between the master sections. Hull sections will not be re-drawn until you press key “R”. (This is for reasons of operational speed) What you see here is the “auto-fairing” feature of Hullform at work. You can change this, if you ever want to, by placing the mouse cursor on any line, and pressing the right mouse key.

Line properties can be accessed at any time by “right-clicking” a hull line.

We can also move the hull lines. For example, to increase the draft of the hull, press key O (for Offset) and key 2 (for line 2), then the down arrow key. Observe that the keel moves downward.

You can repeat the exercise to give the stern section a reasonable form. Press the Tab key to move to it.

To exit, press key combination Alt-Q, or the Esc (escape) key.

Working on Hull Lines

You can also use the Edit sections window to work on hull lines, if automatic fairing is enabled. To do this, place the mouse pointer on any line, and press the right mouse key.

The “Line properties” dialog box will appear, for the selected line. You can set the “Automatic fairing” checkbox, to ensure that this line is faired automatically whenever you change an offset on a master section.

Having enabled automatic fairing for this line, you can try dragging an offset on it, at a master section. You will see that, not only does the section change, but the line also, in a fair manner. Other sections will not be redrawn, to avoid wasting computer (and your!) time, until you press key “R” or combination “alt-R”.

Adding More Detail

You may be happy with the amount of detail in your design, but the default of twelve sections is usually not enough at the final design stage. To increase the count, select the Edit menu's “Alter sectioning” item.

You will first receive a warning, to save the hull. It is a good idea to do this - simply press the Enter key to clear the warning, then press function key F2, and you will be prompted for the name to use for the hull. Choose any you like (e.g., “TEST”), and press key “Enter", once. (You may use the “F2” save option whenever you are not using a dialog box)

Keep the default option, “Retain stem”. This ensures that when you create new sections, the stem form you have created will be retained.

Now you need to decide on the amount of detail you need. This will often be a compromise - the greater the number of sections, the slower the program's calculations. On modern computers, any number up to the program's limit should cause few problems.

When you have entered your required number of sections (e.g., 20), the section positions will be shown to you. If you are happy with them, select “Ok” in the query dialog box, otherwise you may quit without changes using the “Cancel' option.

The new sections will be generated quickly. If you choose the View menu's “General orthogonal” item again, you will see a much more detailed design. The program has performed a smooth interpolation, generating a set of sections which should approximate your intended design.

The new design will have master sections located as near as possible to those you had previously defined, and will have a form matching what you had previously created, but with more detail.

Floating the Hull

Now that you have some sort of hull, it is worthwhile seeing how it floats. Press Alt-S to get to the statics menu, and key S to input some necessary hull statics parameters.

If you have designed an approximately 10-metre long hull, try a displacement of 3000 kg, and set the centre of mass (LCG) position to a rough midships location by entering a value of 5 at the appropriate edit box. You need not enter other values, so simply select “Ok” (or press the Enter key).

Now select the Statics menu's “Balance hull” item, and observe the decreasing changes of waterline offset shown on-screen, as the hull reaches equilibrium. After a short pause, a screen of information, showing the hull's current state, is displayed.

If the program reports any problems during balancing, check the displacement, LCG and measurement units you have nominated.

The screen you see first is one of three, which represent a fairly complete summary of the hull's hydrostatic and stability characteristics. If you are not familiar with the terminology, you should consult any basic Naval Architecture text (or the glossary at the end of the manual).

At zero heel, the righting moment is zero, so this place is occupied by a small-angle stability estimate. It is expressed as “kg m per deg", or equivalent depending on the units you are using. This corresponds to the initial increase of righting moment as a hull heels away from the upright position.

When you have digested the information, select the Statics menu's “Settings” item again, choose a heel angle of 20°, then select the “Balance hull” item again. This time, the display will show a righting moment, due to the heel, expressed in “kg m” (or equivalent).

These tests demonstrate the program's capacity to handle free-floating hydrostatics at any heel value.

Improving the Hull Lines

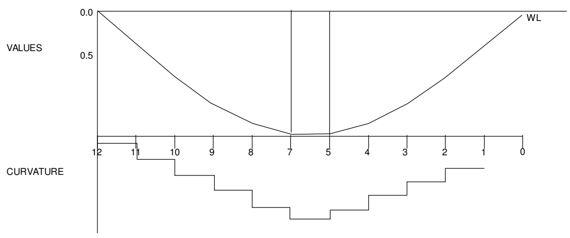
We will now go through a simple design exercise, fixing the keel line a little below the water level at the bow, and at the waterline at the stern. This time we will use the Edit menu's “Smooth a line” item.

When you select Edit, Smooth a line, you will see a dialog box with many options. These represent the collection of user requirements over the years - organised as well as possible, given their number.

Firstly, in the edit box, enter line number 2 - or left-click on the “+” button next to it to give the same result. This value corresponds, of course, to the keel of your design.

Choose to smooth the vertical offset, by pressing key combination Alt-V, or by clicking the “Vertical offset” push button using the mouse.

You now see a window, with a representation of the selected view of the selected line in its upper half, and a graph of the curvature of that line in its lower half. In this case, the keel offset is shown, along with the waterline (denoted “WL”) and the stem profile. You will also see vertical lines drawn to the curve from the zero axis; these correspond to master sections:



You can edit the offsets for the line using either the keyboard or the mouse. To use the keyboard, press key “P", and enter “0” at the prompt. Now if you press the up-arrow key, the point corresponding to section 0 (the stem base) will move upward. You can quit the Pull option using the Esc or Q key.

As for “Edit sections”, you can move points using either the keyboard or the mouse.

Alternately, you can drag the point using the mouse. But remember that the resolution of mouse movement is one pixel, which is a few centimetres on most designs. The “drag” mode is really only useful in initial coarse design work.

Using this technique, move section 0 a little below the waterline, and section 9 (the stern section) to the waterline. You can modify values for both of these sections, but not for any slave section - you can, however, change any slave section to a master section.

If you try to move a point on slave section, you will be given the option of making it a master section.

Next, press key “S", and enter “ALL” (or ”all”) at the prompt. You will see a smooth curve drawn through points on the slave sections. Since you have used the “yacht” hull type, curvature shown on the lower will taper off to zero at each end.

You now have before you, on the screen, two lines, the old one and the (possible) new one. You may choose to retain the old one, to use the new one, or anything between.

You will be prompted, by a dialog box, for the fraction of the difference between old and new you require. If you like the result, indicate that you want all of the result, by entering “1” as the fraction of the new hull line to be used.

But perhaps you don't. If not, you can retain the old curve by entering “0” instead. Or you can take the average of old and new, by typing “0.5” ... and so on.

One clear matter which will probably make the design look unacceptable is the shallowness of the hull forward, due to the taper of curvature to both the bow and stern. You can reduce this taper by the “Curve” menu options.

The “Smooth a line” item is the most efficient way to manage curvatures in your hull lines.

You access this menu item by pressing key C, or Alt-C. Enter “1” when asked for the bow curvature factor, and “0” for the stern value.

Now, press key “S” again and the “Enter” key, smoothing the same sections as before. You will see that the line near the bow end is lower, and curvature is maintained out to the bow, from the midships hull section. This is the point of the “Curve” option: it allows control of the loading of the mathematical spline “batten", giving more or less curvature at its ends.

Adding a Keel or Skeg

Two lines is the minimum number to allow definition of a viable hull, but is not enough to allow any complexities in the design. A keel is a good example of the extra detail you will want to add.

To add a line for the keel, return to the Edit menu, and chose “Insert a line”. Enter “2” in the “Insert before line number” edit box, and leave the “first section” and “last section” values untouched.

In the “Interpolate at” edit box, you will need to specify a value which ranges from 0 at line 2, to 0 at line 1 (See page 50 for details). The correct value to add a new line at line 2 is 0.

This extra line will be used to form the new keel.

Remember: the interpolation term is zero at the nominated line

To allow a normal-looking keel, you will need a sharp step at its trailing edge. To do this, you must create a new section, very close to an existing one, with more forward section containing the tip of the keel, the other its base.

Enter the “New section” option, pressing keys Alt-E N from the top-menu level. Request a position slightly greater than that of section 5 - say, by 0.001 metres (The position of section 5 is shown as one of the entries in the list box), and press the “Enter” key. Ignore for now the message about using the “Edit a section” facility.

You can also define a position by left-clicking a point in the profile view. This is not accurate enough for present needs, however.

Now re-enter the “Smooth a line” facility, and choose line 2. Press keys Alt-L and Enter to edit the lateral offset. Observe that the new section, of index 6, is not labelled (it is too close to number 5) and that all offsets are zero, as befits a line on the centre line of the hull.

We want to open out line 2, to form the plan view of the top of a rudimentary keel. We have to be careful here, however - the automatic fairing option, which is set by default, will make the points on every slave section with the point you move. To avoid this problem, select the “properties” menu item, and remove the check mark in the “fair automatically” check box.

If a line is to have non-fair elements, you must disable automatic fairing for the line.

In opening out the line, we want to follow the existing curve of the hull. This is the role of the smoothing menu’s “Follow” option. Thus, press “F" for “follow”, press key “4” to select section 4, and move it out by pressing the down-arrow key.

(You will receive a prompt, asking whether you want this section to be a master section. Obviously, you have to answer "Yes")

Use "Follow" whenever you want to move a line to another position on the existing surface of the hull.

The line will move off-screen, so press R (for "redraw"), and you will see a more reasonable result. Press key F again, to re-enter the "Follow" mode.

You will see the numerical offset value for the point at the top of the edit window. Move the point using the up- and down-cursor keys until a reasonable width (e.g., about 0.1 m) is achieved.

You will see that the "Follow" option does not generate an exact lateral or vertical distance of motion per cursor keystroke, since the motion is following a curve. However, by use of the "D" and "H" keys, and a few up- and down-keystrokes, the required value is quickly generated. When this has been done, press Esc or Alt-Q to leave this smoothing option.

Now use the smoothing menu again, and choose the new hull line, line 3. This time, select its vertical offset (keys Alt-V and Enter).

The simplest way to add a keel is to use the "Value" option. Set the values for sections 4 and 5 to -1.8 metres, or -6 feet (or, if you are using the downwards-positive convention, use 1.8 or 6). To do this, press key "V" (or click on "Value" using the mouse pointer), then enter characters in format such as "4 -1.8". Note the large curvature at the 5-6 junction. Press "R" to redraw the screen on a better scale.

You will find that the curvatures due to the keel's sharp changes will be so large as to make other values insignificant. This problem has a first solution in the program, which is worth demonstrating, so press key Alt-I (for "Ignore"), and enter at the prompt "4,5".

Here, you have requested that points 4 and 5, and the curvatures affected by them, should be ignored, both in hull fairing and in plotting. If you press key R, the keel will disappear from the plot, and the curvatures from the fair portions of line 3 will reappear.

Before you exit - reset the "Ignore" sections, by pressing Alt-I and entering the word "none", then pressing the Enter key.

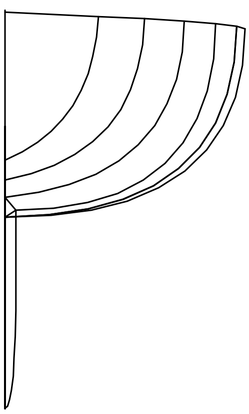
When you exit from the line smoothing screen, and re-plot the hull, you maybe dismayed at the result. A large "bulb" shape will have been generated, rather than a keel.

This occurs because curvature fairness at the junction of the hull and keel has not been eliminated. To make the view look better, use "Edit sections" again, this time operating on section 4.

When you open the "Edit sections" window, firstly right-click line 3 (the bottom of the keel). In the Line Properties dialog box which appears, at the "Lateral control point location" item, check the "absolute" radiobutton. This will ensure that any changes you make to the hull above do not affect the shape of the keel in future. Also, remove the check mark on the "fair automatically" check box (You don't want the control point at section 4 affecting other control points)

If you want the curvature of a hull surface to be unaffected by changes to surfaces above, be sure to use the absolute control point setting.

Now, press C to enter curvature control point mode, and drag the control point between lines 2 and 3 - or press key 3, and then use the arrow keys - until the control point is close to the base of the keel.



At left is a part-view of the result to this stage. The small deflection of the hull line at the top of the keel, and the curvature of the keel's outline, were the objectives of this exercise.

Before you view the hull again, use menu item "Configure", "Drawing detail" to set the number of points drawn between hull sections to a value greater than zero (3 is typical). When you plot the hull again, you will see large variations, as the spline fitting scheme tries to draw a smooth curve through the line discontinuities at the keel. This is an example where application of the program's "line stiffness" feature - see page 5 to see how to do this.

Smoothing a Complicated Hull Section

When entering an existing hull design, the amount of attention to detail will depend on the purpose intended. A moderately-rough approximation will probably be adequate if the general hydrostatic characteristics of the existing hull are all that is sought. If a design is to be revised, however, it may be advisable to get the hull section curve as accurate as possible. This is where the curvature plot at the right of the section-edit graphic screen becomes of greatest use.

We explore this issue using an arbitrary fair curve - a cubic. In the example below, a hull section obeying the rule

$$(\text{vertical offset}) = (\text{lateral offset})^3$$

is constructed. After entry of the initial three sections (stem, midships and stern), using the “New hull” option (Alt-F N), individual offsets may be entered using the direct-edit capacity available under the “Edit a section” menu. In this example, the offsets entered were:

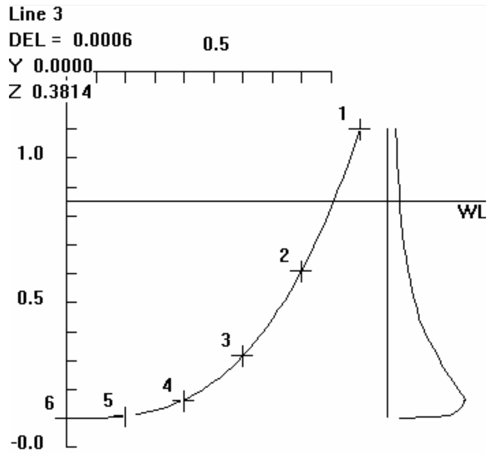
lateral: 0.0, 0.2, 0.4, 0.6, 0.8, 1.0

vertical: 0.0,0.008,0.064,0.216,0.512,1.000

The hull is this case is initialised using the “New hull” item from the edit menu (see tutorial example 1). Six lines should be selected, and default values accepted for other parameters.

To enter the values above, press keys Alt-E E, and select section number one. But this time, press keys Alt-T and Enter, to enter text-edit mode.

Line number 1 has intercept values of 1 for both its y- and z-position. Once the direct edit screen has appeared, press key “1”.



You will see that the top-left value disappears from the screen, and is replaced by your “1”. You may overtype any lateral or vertical offset or control value in this edit mode, simply by moving to its location and typing the new value. Movement may be produced using the Tab and Shift-Tab keys, or by “clicking” the required point with the mouse.

Next, move down to the next line (four tabs will be needed, if you don't want to use the mouse to select an edit box). Key in “0.8”. Again, the value will replace the old. Repeat this process for all the lateral and vertical offsets values shown above; do not alter the control values.

Once finished, press the Esc key, then from the top menu level enter key sequence “Alt-E E Alt-G Enter” to enter graphic edit mode. You will see that, while the offsets are correct, the interpolation between the points is imperfect.

This arises because there is no hull curve above the point corresponding to line 1, and the position of the hull control point between lines 1 and 2 depends on the form of such a curve. As a result, an arbitrary assignment must be made, and that made here corresponds to a vertical surface. For a lateral control offset of zero, the topsides under line 1 will be consequently be vertical.

The correction of this error, through moving the control point inwards, eliminates most of the error in the fitted curve. Since each curve below remains constrained to fit smoothly into the curve above it, the other curves respond, and a smooth curve closely resembling a cubic results.

The curvature plot at the right of the screen shows that maximum curvature occurs at the fourth line down (line 4), which is about right (In theory, it should be at a lateral offset of 0.44, and line 4 is set at 0.40). But the curvature is not perfect, with a sudden drop, then a rise, between line 4 and the hull bottom, and a discontinuity at line 3.

With attention to the curvature plot, it is possible after a few minutes experiment to improve the curvatures to a point such as shown.

To achieve such a result, note that, with the exception of line 2, only the vertical control offsets may be changed. (See page 6) Also useful is to bear in mind that the curvature peaks in the vicinity of the control point. So, if you desire to move a curvature peak upward, you must move the control point upward.

Obviously, the repetition of such an exercise for a large number of sections would be tedious. However, if it is performed at the initial (3-section) stage, the subsequent re-sectioning process will result in the transfer of the information from the first sections into the rest of the hull in a smooth manner. The result would mean much less work on the newly-interpolated sections.

Hull Detail - Adding a Longitudinal Strake

Hullform can handle up to 400 hull lines, allowing all sorts of fine detail on the hull surface to be represented. In this exercise, you will design a simple chine hull, but will include a longitudinal strake at the chine, protruding down at an angle to the horizontal.

Use key sequence Alt-C U to select metric units - the values used below are relatively important, and will be quoted only in metric units. Using the “New hull” option (Alt-F N), request a hull of 6 lines, 12 sections, length 6 metres, beam 2 metres at midsection and stern and stem rake 0.5 metres. Accept the default draft, waterline offset and freeboard values. Select chine form for all hull lines.

Next, enter the “Edit sections” menu item, and select section 0. Select “Text-edit” from the menu. Enter values of zero for the lateral and vertical offsets of all lines, except for line 1 (which should be left as it is). This will make all hull lines converge on the base of the stem, generating a simple stem profile about which we shall not worry again in this exercise.

Now return to the “Edit sections” graphical screen, by pressing the Esc key, or clicking the “Ok” button. You will now edit the designs master sections (6 and 11) to create the initial form of the strake. Doing this involves dragging offsets, using the “Offset” option and the mouse or the cursor keys.

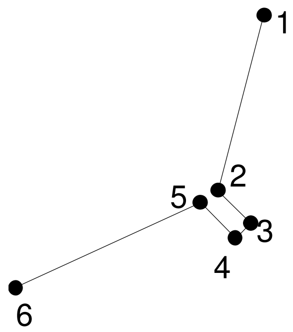
Press the Tab key to move to section 6. Line 1 should be left where it is, but you should move line 2 to a typical position (i.e., slightly in from the sheerline, at the waterline or below). Move line 3 to be close to 2, but a little out and down, to form the upper surface of the strake. (We do not need quantitative accuracy yet) Move line 4 to be below and inside line 3, to form lower outside edge, and line 5 inside and above 4, to form its lower surface.

The Zoom facility may be useful here - press key “Z", use the cursor and Tab keys or the mouse to move the zoom rectangle over the strake position, then press the “Enter” key.

Repeat this exercise for both sections 6 and 11, using the Tab and Shift-Tab keys to move between them.

Next, edit from the “Edit sections” window by pressing Q (or Alt-Q). Then enter the line smoothing part of the program, using keys Alt-E S.

Hullform provides specific design tools to help the addition of such the detail needed in this exercise. We require a strake of specific size, and of some fixed angle - say, 45°.



So, firstly select line 3 (the upper line of the two marking the outer edge of the strake, as at left), and press key “P", to design the angle from it to line 2, where it attaches to the hull.

A fixed angle can be easily selected. Press key V, (“value”), and enter “0 135", setting an angle of 135° at the stem. Press V again, and enter “11 135” to do the same at the stern. Then press key S, and enter range “1:10”.

This tells the program to fair a line between only two end points, so that it will be straight. Since the end values are the same, the line will be horizontal on screen. Accept this line, by entering “1” in response to the following prompt.

Now press Esc or Q. You are presented an “exit menu", by which you may decide what to do with your faired angles.

You can move the points on either line 2 or 3, in a vertical or horizontal direction, or circularly (at constant radius) about the points on the other line. Choose “circularly” for the movement direction, and “this line” for the line to move. (Remember, you are nominally editing line 3 - so line 3 is “this line”)

When you press the Ok button, the changes will be made.

If you press key sequence Alt-V N, you may be able to see the changes - the angles to the top of the strake will all be the same.

To set the width of the strake, use the smoothing option “Distance to prev line”. You have already selected line 3, so the width of the top of the strake (between lines 2 and 3) will be shown. Set values for section 5 and 11, using the key V, to 0.05 m (i.e., enter keystrokes “V5 .05” and “V11 .05”).

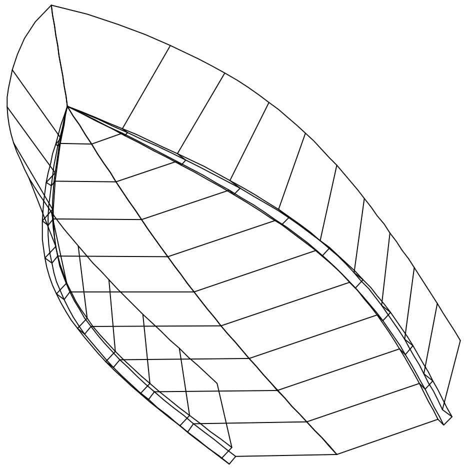
In order to set uniform values in between, we do as for the angles - but the process must not be affected by values for sections 0 to 4. Thus, press key I, and tell the program to ignore range “0:4”. Then you may smooth sections “6:10", and generate the fair line.

To fair values for sections 1 to 4 into this line, press key I, and enter “NONE”. Then smooth sections “1:4”. (Press key R to redraw the screen after this, to confirm that the curvatures are well-behaved)

On completing the edit, and pressing “Esc", a similar exit menu will be presented. Again, you need to change line 3, and move it at the constant angle you have already generated - this is what “radially” implies. The default options will now be as required. Thus, simply press the Ok button, to perform the changes needed.

The top of the strake has now been "perfected". By selecting line 4, and repeating the above exercise using an angle of +45° and width of (say) 0.02, and then selecting line 5, and using an angle of -45° and width of 0.05 again, a complete strake can be faired onto the hull.

At right is an example of such a design exercise.



Tanks and Damaged Stability

The purpose of this exercise is to show the basics of the use of Hullform's internal tank feature.

Tank Definition: We start by using a simple basis design. Open the PLANING design, included in the sample hull set, but alter its displacement to 10000 kg (using the Statics, Settings menu item). The increased displacement locates the waterline, at hydrostatic balance, higher up the hull. This renders the effects of internal tanks easier to demonstrate. Select the Statics menu's "Balance hull" item to locate the hull at its correct waterline.

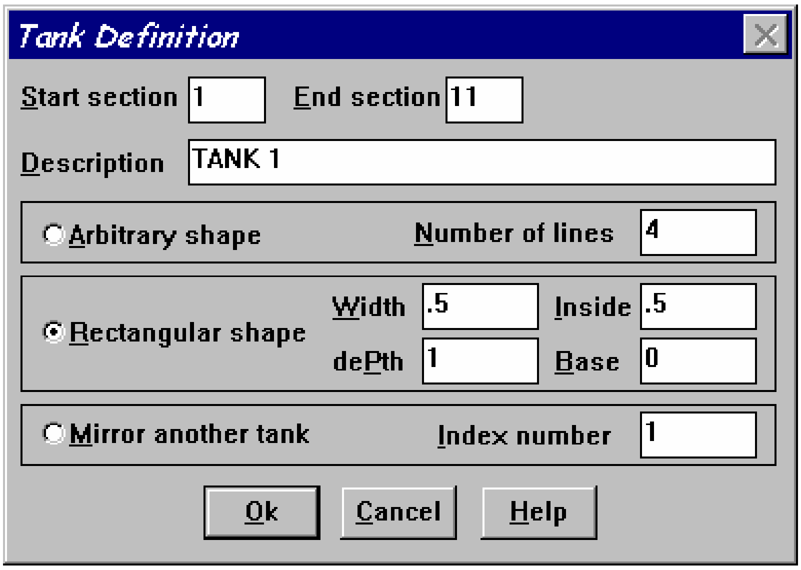
Now select the Tank menu, and choose the Add tank item from the ensuing menu. Specify start section 8, end section 15, and leave the default description ("TANK 1") untouched.

You will see you have two choices for initial tank shaping - an "arbitrary shape", which provides for use of any number of lines, and a "rectangular shape", which uses four lines to create a tank of rectangular form. Whichever you choose, you can edit the shape and add and remove lines later - the main point of the second option is to simplify the design of rectangular tanks, which are the commonest.

For the "arbitrary shape" option, the hull lines will be arranged in a circular form, with diameter about half of the hull depth. This form does not relate to any normal tank shape, simply locating the lines in a convenient place for further editing.

When you specify rectangular shape, you must specify exactly where the tank is to go. This is easy, because the tank shape (in end view) is entriely defined by its width, depth, and its location within the hull. In Hullform, the location is defined by the offset of the inside face of the tank from the hull centreline, and the offset of its base upwards from the zero plane.

For this exercise, use "rectangular shape", and specify a width of 0.5 m, depth of 1 m, inside position of 0.5 m and base position of 0 m. The Tank Definition dialog box should then look like:



When you have completed this operation, use the View menu, select the "Options" menu item, and set the "Tanks" checkbox. Then use the "General orthogonal" menu item to see the form of the tank. You will see it located approximately equally above and below the waterline, on the starboard side.

Tank Statics Effect: To see one effect of this tank, choose again the Tank menu, select Fill/position, nominate tank 1 and click the "edit" button with the mouse. Note that it is set "Starboard". Then check the Filling status items in the same dialog box. The entries should read “% full", with a fill of 100%, and a specific gravity of 1 (i.e., fresh water). Exit from this dialog box using the Cancel button, and the tank-selection dialog box using the Quit button.

Now select Balance hull in the Static menu. The result will be similar, but with a small change in pitch (-4.170 to -4.948^{O} when this chapter was tested) and an increase in sinkage (from 0.7392 to 0.8847 m). But you will also see a finite righting moment at zero heel (1117 kg m under test).

Next, use the Tank menu to select a tank status of Leaky, and repeat the “Balance hull” item. The righting moment will decrease (to 696 kg m under test), since the external water level is too low to completely fill the tank.

Here you have seen two functions of Hullform's internal tank feature. Firstly, the program has found the heeling moment of fluid in an internal tank. The, the effect of holing the hull, with the tank flooded to the waterline, was evaluated.

What is required frequently is not the heeling moment, but the equilibrium heel of the hull. This is the role of “balance All” in the Statics menu. To test this, set the tank to 100 % full again, and select the “balance All” menu item. The hull will be balanced in heel and pitch, ending at a zero-righting moment state. In the tested case, the quoted heel angle was 19.6^{O}.

Tank Editing: The tank is formed from a set of partial lines, which may be edited using the Edit menu's “Edit sections” and “Smooth a line” options. The lines which form the tank have the exact functionality of all other hull lines, with one addition - in sectional views, the last and first lines are joined by a straight line, closing the tank.

There is a control point between each other pair of tank lines, so you can generate curvature as you would for any other hull section. But should you require curvature in the surface which joins the first and last tank lines, you will have to define an extra tank line, and make the first and last tank lines coincident. (The “Insert a line” menu item will handle the line insertion - just be sure you define the new line as a partial line, with start and end sections matching those of the tank within which it is placed)

HULLFORM MENU ITEMS

On the following pages are detailed descriptions of each of the menu entries provided by Hullform.

The menu structure used by the program follows as closely as possible the standard established by word processing, and similar, programs. The first three top menu items - File, Edit, View - are identical to those provided by normal office software. Of course, the object you are editing and viewing is three-dimensional, so there are differences underneath these levels.

However, you will find items like New, Open, Save, Save As, Exit, Print, Copy, plus the file history list, exactly where they normally occur. “Normal” does not mean sensible - for example, “New” is an edit function, not a file function, and Copy in Hullform is not an edit function - but standardisation is a crucial point of Windows (for better or worse).

FILE

This component of the program's menu system allows you to save and retrieve hull data files, to manage the data file directory, and to write output in several formats useful to other programs.

File Management

Hull data files are held in a directory (i.e, folder) controlled by the user. Files are read from, and written to, this directory using the “Open” and “Save” (including “Save As ...”) menu items.

Versions of Hullform prior to 8 also provided menu items for renaming and deletion of hull data files. However, since the advent of Windows 95, the normal Windows “common file dialog box” provides these functions, plus a few more. If this point is new to you, try a “right click” while the mouse pointer is in the file name window, to see what is possible.

In particular, it is strongly recommended that you make good use of the directory-creation function. You should keep your files in subdirectories within the “Hulldata” directory, a separate one for each design project, or at least class of project. You may ultimately have several hundred designs (and versions of designs) on your system, and the hierarchial directory / folder structure available under Windows will help you keep track of them.

Hull Data File Format

As a matter of deliberate policy, all input and output files are of text format, which may be edited external to the program by an experienced user. (They are also easily transmitted to other users via Internet)

The hull file format is typified by the following table. This presents the contents of the hull data file generated in the “Tanks and Damaged Stability” tutorial exercise, with some figures removed to fit the lines within a manual page.

The first line of the file shows the displacement (10000.000), horizontal and vertical positions of the centre of mass (3.800,-1.100), the units code (1), number of hull lines (7), stem line (3), distance of base of transom above lowest hull line at stern (0.000), and transom angle forward of vertical (0.000), Version 8-9 format flag (8) and number of points to plot on lines between sections (0). These features are discussed at their respective stages, later in this manual.

Subsequent lines show, for each section, the fore-and-aft position (the first being -0.50), then groups of four numbers specifying the lateral and vertical offsets (first pair 0.00,-1.400), and the values of the two curvature control offsets (first pair 0.000, -1.400). One set of four such values occurs for each hull line - so in this case, there are seven groups of four.

The number of sections for the hull is determined when the program detects an end to the data, at the line containing words “line ends”.

```
10000.000    3.800  -1.100    1    7    3     0.000     0.000 8 0
-0.5000 0.000 -1.400 0.000 -1.400 0.000 -1.400  0.000 -1.400
        0.000 -1.400 0.000 -1.400 0.000  0.000  0.000  0.000
        0.000  0.000 0.000  0.000 0.000  0.000  0.000  0.000
        0.000  0.000 0.000  0.000
```

... data continues ...

```
8.0000 1.430 -1.0900  0.000  0.000 1.330 -0.100 1.376 -0.539
       0.000  0.0300  0.707  0.030 0.000  0.000 0.000  0.000
       0.000  0.0000  0.000  0.000 0.000  0.000 0.000  0.000
       0.000  0.0000  0.000  0.000
0.0000 3.000  1.0000  0.000  0.000 5.000  4.000 5.000  3.000
       0.000  2.0000 20.000 20.000 0.000  0.000 0.000  0.000
       0.000  0.0000  0.000  0.000 0.000  0.000 0.000  0.000
       0.000  0.0000  0.000  0.000
0.0000 0.000  1.0000  0.000  0.000 0.000  0.000 0.000  0.000
       0.000  0.0000  0.000  0.000 0.000  0.000 0.000  0.000
       0.000  0.0000  0.000  0.000 0.000  0.000 0.000  0.000
       0.000  0.0000  0.000  0.000
line ends
```

Before “line ends” are two dummy sections, which contain not offsets, but the end curve factors for each line of offsets and control points. Separate horizontal and vertical curve factors are kept, in the entries which would have corresponded to horizontal and vertical offsets.

The "line ends" line marks the start of partial line information, which in this case includes the start and end sections of the single internal tank:

```
 0 20
 1 20
 0 20
 8 15
 8 15
 8 15
 8 15
```

These lines - one for each defined hull line - are followed by one line specifying the number of defined tanks, and then the tank statics information, one line for each defined tank plus one containing only the end line index of the hull. For each tank, the line specifies the starting line index (less 1), an index specifying the tank position (0 = port, 1 = starboard), a second index specifying the nature of the tank's contents (0 = leaky, 1 = fixed volume, 2 = percent comume), then three values corresponding to the amount held by the tank (in volume or percentage), the specific gravity of its contents, and the permeability of the tank.

```
1
3 1 2 100.0000 1.0000 1.0000 |TANK 1
7 0 0 0.0000 0.0000 0.0000 |
```

The next three lines hold the stem radii, for each of the three non-tank hull lines in the design. Following is the transom radius parameter (the zero in this case indicating a flat transom):

```
0.000
0.000
0.000
      0.00
```

Following this line are the stringer details, comprising the index (less 1) or the higher-indexed hull line (less 1) of the surface bounding the stringers, followed by the stringer width, thickness, and an integer specifying the direction (up or down the surface) in which the stringers are created. These are followed by parameters specifying the stringer interval and the interval to the first stringer, and then an integer indicating whether the stringer interval or stringer count is constant.

The list is terminated by a "-1" hull line index. In this case, there are no stringers, so a "-1" only is present.

```
-1
```

The next is a single line of integers, specifying for each hull line, whether its horizontal control point positions are absolute or relative.

Following this line is a set of lines, one for each hull section ,specifying the section names. In this case, we have not altered any from their defaults, so the section names match the section indices.

```
 0 0 1 0 0 0 0
0
1
2
.
.
17
18
```

The next line shows a set of integers, specifying whether each section is a master section or not. The set of 1's below indicates that all sections of the design are defined to be master sections.

```
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

The following lines each contain one integer, then a number of values equal to the number of hull sections. There is one line in the file for each line of the design. The integer specifies whether the line is to be faired automatically, and the following values are the inter-section flexibilities - written with one superfluous value on the end, to maintain consistency of output data counts. (The lines below are truncated after the sixth flexibility value)

```
0 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 ...
0 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 ...
0 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 ...
0 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 ...
0 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 ...
0 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 ...
0 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 ...
```

New

This provides a simple means of starting a new design from scratch. It generates a rudimentary hull, with a stem, midships section and stern section. This may subsequently be edited, re-sectioned and faired to generate a desired hull form quickly.

If the program already has a design in memory when New is selected, you is firstly asked whether it is intended to delete the old file. If confirmation is received, the program then prompts for details of several parameters of the new design:

Number of hull lines	(default 2)
Number of sections	(default 12)
Overall length	(default 15 metres or 50 feet)
Maximum beam	(default 30% of overall length)
Transom beam	(default 60% of maximum beam)
Rake of stem	(default 5% of overall length)
Draft	(default 5% of overall length)
Stem freeboard	(default 10% of overall length)
Stern freeboard	(default 80% of stem freeboard)

One pushbutton, at the top of the dialog box, switches the design from normal hull mode and "surface" mode. The latter allows creation of a hull surface, which may later be merged with a normal hull to create a more complex design (See Surfaces, page 95).

Two sets of radio buttons are also presented, for each of the following groups of options:

Initial section curvatures:

⦿ all chines

⦿ all rounded

⦿ specify individually

Of these, the terms "all chine" and "all rounded" refer to the form of the hull surfaces above and below each line of the hull design, corresponding respectively to hard chines with a flat surface above, and a smooth curve around the full section form of the hull.

For line 1, the "rounded" and "chine" options determine whether the section outline will follow a curve directed initially vertically downward, or towards the next hull line, respectively.

If you select "specify individually", you will (after confirming "Ok" in the dialog box) be asked, in sequence, whether the inter-line curvature between each pair of requested lines corresponds to a rounded or a curved surface.

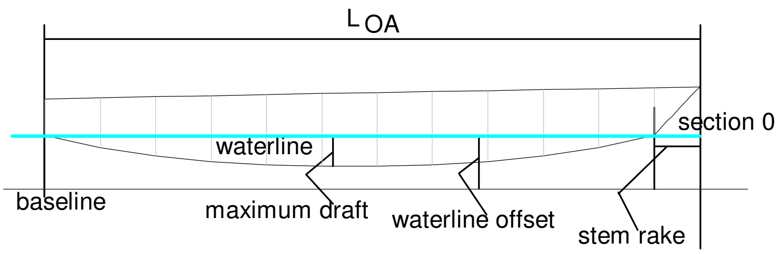
Baseline Position

⦿ waterline

⦿ keel

The level which corresponds to a vertical offset is the "baseline". This may be set to match the initial waterline, and to align with the lowest point of the hull (i.e., the keel).

Following is a representation of the parameters defined by inputs to the "new hull" queries, when you use only three hull sections:



Open

When this option is selected, the program provides a Windows standard dialog file box, which lists files in the hull data directory, and a list of alternate directories, and prompts for the required filename. The use of the Windows file dialog box is covered in detail on page 14.

Hull data files are written to, and read from, the default hull data file directory. The default may be specified under the Configure, File directories menu item, but it is otherwise the last directory from/to which the previous hull data file was read or written.

Success will be confirmed by appearance of the name of the opened hull file in the title bar.

If a read failure occurs, the data read are presumed incorrect. All input is cleared, with the hull name reverting to “(undef)”. The only possible causes of this error are

- incorrect manual editing of the hull data (“HUD”) file requested
- corruption of the file, due to a disk error.

Save / Save As ...

The current file may be saved to the hull data file from which it was read using the “Save” menu item. The “Save as ..” form allows the current hull design to be saved with a new file name.

The “Save as ...” feature is functionally similar to the “Open” option. Note that you are warned, and asked for confirmation, if an attempt is made to overwrite an existing file.

The hull data file format is upwards-compatible with that for files produced by earlier Hullform versions. In some cases, earlier versions may be able to read Hullform 9 files - but these cases are not predictable, and in general the file format is not downwards-compatible. Note in particular, that, even when files are successfully read by a lower version,

- due to the lack of transom support by Version 3, the transom is “lost” when a hull data file is overwritten by this program.
- Version 3 reads the final two “sections” of a Version 4+ file as if they were true hull sections. These must be deleted manually, after the file has been read in.
- in overwriting a Version 5+ file using Version 4 or earlier, you will lose any tank definition and “partial line” details of the hull.
- Editions before 5D.04 do not support the stem-radius feature. Those before version 6 do not support the transom radius.
- Versions earlier than 7 will not read the tank names, although they should handle other details in a reasonable way (bearing in mind that tanks were symmetrical in earlier versions, and are not now).

Read Waterline

Stability, wetted surface, and other such factors change when the motion of the hull distorts the water level about it. This effect can be included, by creating a file containing a set of pairs of numbers in sequence, the first being position along the hull (specified exactly as for the section positions), and the second a water-level height, positive upward.

In operation, the program simply prompts for the name of the file from which data should be read. Data in the file should be sequential pairs of x-values (in the co-ordinate system you have already defined for the hull) and waterline z-values (POSITIVE UPWARD), in ASCII form. For example, the following set shows (for operation in metric units) water level displaced 20 cm upward at the bow (position -4 metres), -10 cm at the mid-section (position 0 metres), and 25 cm upward at the stern:

```
-4 0.20
0 -0.10
4 0.25
```

The data format in the file, as long as the proper ordering (as above) is maintained, is unimportant. Pairs may also, for example, be placed on a single line, two pairs to a line, or each pair may be entered over two lines.

Up to 60 heights may be entered, but need not be - the program will take any number up to this limit, and interpolate the data to the existing section positions of the hull in use.

Note: When hull sections are added, removed or shifted, or a new hull is input, the dynamic waterline data must be re-read.

Read Overlay

You can load any other hull design, for use as a reference while designing a new hull. This is the “overlay hull”, and is shown (as required) on all hull views, and the window used under the Edit, Edit sections menu item. This hull may not itself be edited.

These is an entry under the “Configure”, “Graphics”, “Colours” menu item, which allows you to define the (single) colour used to display the overlay hull.

Import, text file

Hullform can read in the offsets for a design from a wide range of text files. These may be formatted as:

- **Sections down the page:** Each section position (including the stem), followed by lateral and vertical coordinate pairs for each hull line. The arrangement of entries on lines of the import file is unimportant, as long as the proper sequence is followed, but conventionally the first few lines of the file might look something like:

Section positions — Lateral offsets

```
0.000  1.291 8.602  0.740 6.000  0.560 5.500  0.080 5.000
0.001  0.854 8.260  0.486 6.000  0.372 5.500  0.200 5.000
1.000  1.589 8.010  1.179 6.000  1.025 5.500  0.749 5.000
```

Vertical offsets

- **Buttocks, sections across the page:** All section positions are shown firstly across the top of the document "page", with the lateral offset for each hull line starting each line of the document. After each lateral offset, the vertical offsets for each section follow.
- **Waterlines, sections across the page:** This format is similar to that above, but each line starts with the vertical offset of the waterline, and lateral offsets follow.
- **Buttocks, sections down the page:** Here, the first line holds the lateral offsets of the buttock lines, and following lines hold the section positions and the vertical offsets for each buttock line in turn.
- **Waterlines, sections down the page:** The first line holds the vertical offsets of the waterlines, and following lines hold the section positions and the lateral offsets for each waterline in turn.

In specifying the input format, you must also provide the count of lines and sections in the file, indicate whether the data rows or columns start with the sheerline (line 1) or the highest-indexed line, and indicate whether the sequence of sections in the file is from stem to stern (The "first section is stem" checkbox) or stern to stem.

You can also choose whether to assign flat surfaces between lines of offset points (shown by the "Chines" radiobutton), or to attempt to maintain fairness between them (shown as "Rounded"). The "Chines" option is the best when the input hull lines correspond to actual chines, or when the hull sections are of very complex form and many offset points are available for each section. "Rounded" is obviously best for rounded hulls, but may give poor results when curvatures change sharply. In either case, some editing of the control points will usually be required.

Only the section positions and offsets are fully initialised during file import. All lines are presumed to extend from stem to stern.

Since you are likely to want to perform final editing on all sections, all sections are set to be master sections, and automatic line fairing is disabled for all lines. Line smoothing stiffness terms are all set to one.

Hydrostatic terms like the centre of gravity are not modified.

Import, DXF file

You can import DXF files using a subset of DXF entities, and convert them to Hullform format.

You can import DXF files using a subset of DXF entities, and convert them to Hullform format.

Only designs based POLYLINE, LWPOLYLINE and polygon mesh entities can be converted. Support for other entities may be added in future, but many are incompatible with the need to be able to discern a structure which relates to the shape of a hull, so will never be accepted.

Line entities are presumed to be frame / section outlines if their linear extent is less than 1% of the length of the hull. The program otherwise attempts to treat them as longitudinal lines. Section outlines are used to define the longitudinal positions where horizontal and vertical offsets are interpolated for each such line, and their shape between these offsets may be used to estimate a curvature.

Note that there are many options available in importing a design, and only one combination will give the best results. A few tries with various options enabled may be necessary before a good result is obtained.

After reading your DXF file, the program will attempt to check that the details of your design are consistent with the shape of a hull. Some suggestions may be made, on which you may choose to act, or which you may choose to ignore.

The aspects of the design which you can control are as follows:

Highest X at stem

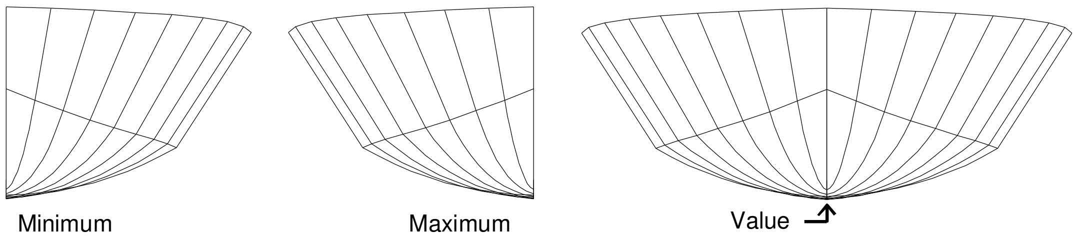
The imported design can have its for-and-aft dimension increasing towards the stern or stem. Check this box if the high co-ordinates values correspond to the stem end of the hull.

Allow curvature

You can allow the program to create curvature between lines, based on the shape of the section outlines. If this is unsuccessful, you can leave this box unchecked, and section outlines will be straight between lines.

Y-coordinate at zero plane

Your design may be symmetrical about a central axis, or may be presented as a half hull. The correct choice for this term is, in principle, obvious – for the cases below (presuming the coordinate values increases to the right), the zero plane is at the minimum offset, the maximum offset, and at the hull centre.



The main difficulty in the third case may lie in knowing the correct numerical value of the lateral offset marking the zero plane in your DXF design. Most drawing packages have an option to read out coordinate values, and it recommended that you use this to provide the numerical value you enter here.

If you select the “maximum” option, you should also set the “reverse Y offsets” check box, so that the offsets read in are accepted as valid (positive) values.

Invert Z offsets

If your hull dimensions are designed for construction in the inverted position, you should check this box to ensure the design is imported "right side up".

1x, 2x, 3x items represent

Three-dimensional entities in a DXF file have "tags" on their dimensions, like 10, 11, 12 or 13 for the nominal "x" co-ordinate, 20, 21 (etc) for the "y" co-ordinate, and 30 and following for the "z" co-ordinate. If your design has been laid out with the CAD system's "x" co-ordinate not matching the along-hull direction, you can manage this by selecting the correct combination from the radio button set.

The program will check which dimension of your design is the longest, and suggest the corresponding option here, if you have not chosen it correctly.

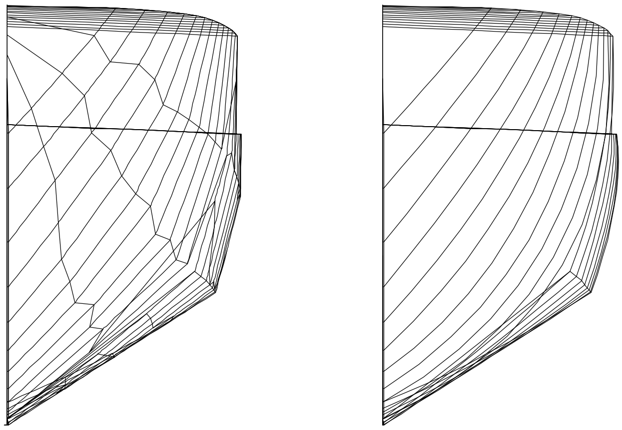
Allow Curvature
Points between chines
Minimum angle at chine

Your DXF design may include sections having clear chines with curvature between. These three options give you the chance to generate a design with these chines as lines, and rounded surfaces corresponding to that curvature.

If you check the “Allow curvature” box, the “Minimum angle at chine” will be used to identify where chines occur on each hull frame. The default of 30 degrees will probably be adequate for your needs; in a chine hull, the angle between line segments defining a hull frame will usually be less than 5 degrees, except at chines, and at chines the angle will usually be 45 degrees or more.

If you leave “Allow curvature” unchecked, the program will attempt to use the number of “Points between chines” you have requested, between each chine. If the number of points available is less, some coincident lines will be generated. If there are more available than required, the ones chosen will be at as uniform a spacing as possible.

The advantages and disadvantages of these options are seen in the cases below. In the case at left, curvature has not been allowed, and three points left between each chine. The result is a faithful copy of the input, but a little “ragged”. The case on the right resulted from allowing curvature. Notice that a much smoother design has resulted, but that detail has been lost near the stem, where the chine which softens there is no longer resolved.



Edit section positions

The program will suggest section positions based on the sections which appear to be present in the design, but you can choose to delete or add sections before proceeding. If you check this box, you will be presented a list of positions in a list box, each of which you can delete, and you will also be able to add sections of your own choice.

Note that there will be no curvature information available at section positions you add yourself, so the section outlines here will be straight.

File name

The file name shown must correspond to an existing file. If it does not have a full path name (like "C:\Program Files\Hullform 9P\DXF Files") it must be located in your default DXF output directory.

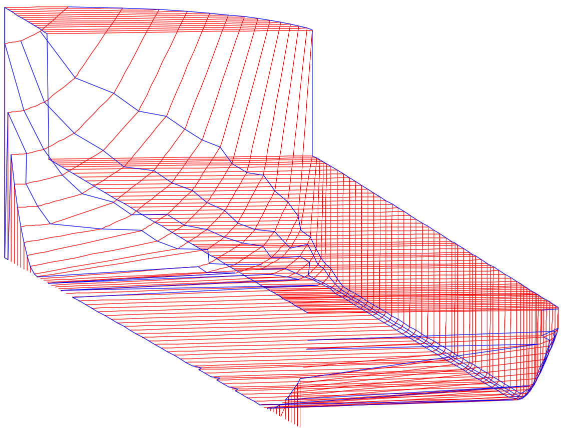
Show DXF lines on hull views

If you leave this box checked, your DXF design will be shown on all hull views as an "overlay", for reference. You can remove it

Import, GHS file

The "General Hydrostatic File" format is a common one used for static analyses, and being well-documented, these files are easily imported.

The dialog box provides no options beyond the identification of the file required. As can be seen from the example below, the limitations of the GHS format carry through to the Hullform version. However, the issues evident – lack of a stem, continuation of the hull baseline forward and sternward to form a "web", and lack of curvature between hull lines – can easily be removed manually. Often, however, these are not needed, since the commonest application of the import is comparative analysis of the GHS analysis and that provided by Hullform.



Import, DXF Overlay

This feature allows you to import POLYLINE entities from a 3-dimensional DXF file for drawing with your hull view as a reference. There is currently a limit of 50,000 imported points.

The import dialog box allows you to reverse the x (lengthwise) coordinate, and to invert the z (vertical) coordinate, to ensure that the imported hull is drawn correctly.

Once read, the DXF view will be drawn with your selected overlay colour on all hull views, as well as on the edit display (Edit, Edit sections).

Export, Waterlines

This facility was created mainly to provide the information needed for use by the dynamic waterline input option, based on approaches centred in thin-ship theory. A few other users have also found it of value, too. If you can find a use of your own, you're welcome.

The dialog box provides for input of the initial waterline value required, the height interval between waterlines, and the sections along the hull for which values are to be written found. The defaults are the current waterline value, 0.1 measurement units, and all sections.

When these parameters are confirmed, the program requests a filename, using the standard Windows file dialog box. Only when a valid filename is entered, and “Ok” is selected or the Enter key pressed, is output actually performed.

Calculation commences at the current waterline, and proceeds downward until a waterline height is found at which no waterline intersection occurs. Data are output using the current measurement units.

Export, Frame Outlines

This allows you to output hull data in a form useable by a boat builder. It will write out a set of measurements, which will allow each section to be laid out with the same mathematical precision as used in the program - that is, a set of horizontal and vertical offsets for the inside or outside of each section, sufficiently close to allow accurate reconstruction of your design.

Data are written out one section at a time, each line showing the index of the immediately preceding hull line, and the lateral and vertical offset of each point. Values are written in metres, or in feet and inches, depending on the units used for the design. Where a hull outline is straight between hull lines, only the end points are written, but where the outline is curved, an arbitrary number of points along the curve may be written.

The dialog box provides for input of the interval between written offsets (the default is 0.1), number of decimal places to be used (default 4), sections to be output (default “all”), and skin thickness.

Interval on curves

This is the distance, along the curved outline of the section, between points output to the file. The best value depends on the width of the broadest surface of the hull. In general, at least 10 points should be written, allowing the outline to be marked accurately.

Decimal places

Four decimal places is the default output resolution, because this is the resolution used in writing hull offsets to a hull data file. Higher accuracy is probably not needed. But for use by builders who may prefer measurements in units such as millimetres (i.e., 3 decimal places), lower accuracy can be requested.

Sections to write

Output may include any subset of hull sections, from “ALL” down to 1. The standard range syntax is permitted (e.g., “1,3,5:12”).

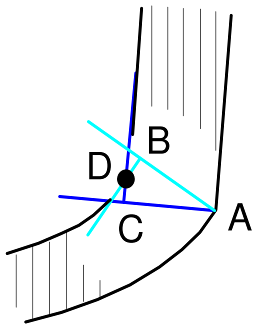
Stringers

If you mark this check box, stringer notches will be included on the calculated outlines. The extra coordinates will comprise the lower and upper corners of the rectangular notches (as shown on hull views).

Frame Outlines

If you check this box, thickness corrections and any stringer details will be written, as well as the external outline of each hull section (“frame”). If you press the “details” button, you will be presented a dialog box in which you may edit the details to be applied, namely

- thickness - the skin thickness correction to be used for all frames and surfaces
- hole radius - the radius of “mouseholes” to be cut into the angles where hull surfaces meet.
- notch width - the size across the hull surface of angled notches where stringers meet the frame outline
- notch height - the size along the stringer surface of angled notches where stringers meet the frame outline



The skin thickness correction allows for the thickness of the hull material, from the outside formed by the hull surfaces you have defined, to the inside where structure's frames join. The points output are located on the inward normals to the section outline, except at the meeting of two curves at a hull line.

As shown in the figure, the point whose coordinates are output, D, is the intersection of perpendiculars drawn from the two points, B and C, which are on the two normals to the outlines just each side of the hull line. While this location is slightly off the exact location, the difference will be negligible for almost all designs and realistic hull thicknesses.

If you have created a set of stringers for any surface of the hull (See page 91), their further effect on the section outline will be included. A representative case is at right.

The actual hull outline is shown by the lighter line. A non-zero skin thickness has been used, so the written outline (the dark line) is displaced inward. Stringers make further indentations in the outline, at their calculated positions, and a “mousehole” has been added at the chine.

When these parameters are confirmed, the program requests a filename, using the filename dialog box. Only when a valid filename is entered, and “Ok” is selected or the Enter key pressed, is output actually performed.

Export, DXF file

The program can write data to a file in AutoCAD® “DXF” format, for reading by that program or any other which accepts the format. Output of “DXF” graphic images is also possible from any graphical component of the program (See the Plotter section, starting on page 102), but this program section provides the most detailed form of DXF output. Many features have been included to help you match the program's DXF output to the needs and capabilities of the particular CAD program in use.

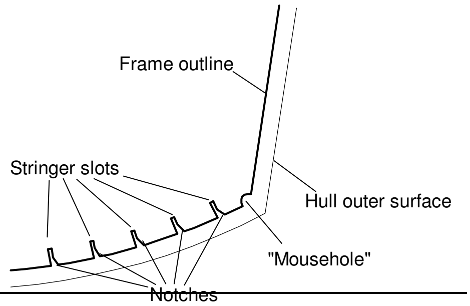
- Two output file structures may be generated, one using numeric labels and the other mnemonic text labels.
- Two output formats are possible, one generating a two-dimensional plan, elevation and end elevation combination, one giving a three-dimensional view.
- Skin thickness corrections and stringer indentations may be added to the frames output.

Your selections in this dialog box are saved by the Configure, Write configuration menu item, and also at the time you exit from the program. They become the defaults when you next run the program.

HINT: Most CAD programs accept Hullform's DXF output without problems, but some versions of AutoCAD, at least, had odd requirements in addition to what defines a valid DXF file. Fortunately, this situation has improved marked in recent years.

In case you have one of the “odd” programs, you may customise Hullform’s output to suit its needs. In the absence of other information, Hullform will generate a DXF file including an empty HEADER section, a TABLES section including definitions of all LAYERS required, and the ENTITIES section. If your CAD program indicates that this is inadequate, customised TABLES and HEADER sections can be included in the output DXF file.

Hullform is provided with standard versions of the TABLES and HEADER sections in files TABLES.DXF and HEADER.DXF. If your CAD system rejects a DXF file due to missing TABLES or HEADER information, check firstly whether Hullform has access to these files. They must be in the program’s working directory, or somewhere in the file system search path, for the program to be able to find them. (Use the MS-DOS command “path” to show what directories / folders this path includes)



Should these be inadequate in for your CAD package, it will be necessary to find out yourself what extra is required. The best trick is to generate a minimal DXF file from a simple drawing, and extract the contents of the HEADER section and of the TABLES section (excluding LAYER definitions). The contents of the HEADER section (excluding the "0", "SECTION", "2", "HEADER" and "0", "ENDSEC" lines) should be placed in file HEADER.DXF, and the extra TABLES lines (excluding the "0", "SECTION", "2", "TABLES" and "0", "ENDSEC" lines) should be placed in file TABLES.DXF.

These files must be placed in your working directory, or somewhere in the file search path (The same directory as HULLFORM.EXE is recommended).

Selecting DXF Output

The dialog box initially produced contains two sections, defining the layer selection and required output format:

Layer selection

The DXF file specification makes no restriction on the names which may be used for drawing layers, but various CAD programs make their own. In this facility, you can chose either of:

⦿ Labels

Mnemonic labels, commencing with an initial letter (“S” if the layer includes a section, “L” if it includes a line, and “T” if it includes a sloping transom), suffixed with the index number of the item - e.g., layer “S14” holds section number 14, “L2” holds line number 2. (“T” is always suffixed 0).

⦿ Numbers

numeric layer names (in sequence “1", “2", “3” etc.); if this is specified, a limit to the number of labels should be entered also.

Stringers

If you mark this check box, stringer lines will be drawn on the hull surface, and, if you request frame outlines (See below) stringer notches will be drawn on the frames

Frame Outlines

When this check box is marked, not only the outside hull surface, but also an outline corresponding to the outline of interior frames in output.

Details

If you request frame outlines, the form of the written outlines will depend on information you provide in the dialog box this button generates.

Thickness: this is the thickness of the hull surfaces (See the section "Builders Output", page 34, for usage details)

Hole radius: the radius of the “mousehole” to be cut into the outline where each pair of hull surfaces join (i.e., at each hull line)

Notch width and notch height: the size of the angled notches cut into the frame, outboard of each stringer. These are usually included to allow drainage of water, so minimising corrosion.

The same information set is accessible under “File”, “Builder's Output” (see page 34 for a detailed review) and “View”, “View options” sections. It affects DXF output through reduction of the size of frames written out. (See the examples below)

File Name

When you press the “Ok” button, you next see a dialog box prompting you for a file name. The default extension is “dxf”, so you need only enter the name without the extension.

The destination subdirectory may be specified under the “Configure”, “File directories” menu item, where the DXF output directory is the third you may nominate. More simply, it remains the same as the directory to which you last wrote a DXF file.

Output format

Lines are generally drawn as “POLYLINE”s, which are piecewise linear between defining points. You have control of the number of output points per hull surface and per pair of sections, through the Conf, Extra drawing points, Line detail and Section detail menu items.

Users should beware that AutoCAD can apply a set of POLYLINE points as the meeting points of a set of tangents to the line, or as points through which the line actually passes. Hullform output requires the latter presumption.

⦿ 2-d output

In two-dimensional output, the program writes data as a three-view orthogonal projection, comparable to that obtainable using DXF hardcopy output from the View, General orthogonal facility, but for

- use of a half-plan view,

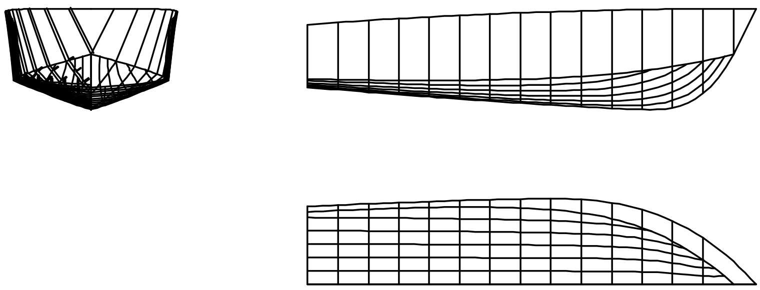
- separation of each hull line and hull section into an individual drawing layer,
- inclusion of intersections between any hull-development ruling line and any section.
- drawing of interior frame outlines and well as exterior surface outlines.

In two-dimensional output, the hull half-plan view is drawn at the lower edge of the drawing region, the side elevation above it, and the end-elevation to its left. The stem is drawn pointing left or right, as selected using the Configure, X-positive direction menu item. All co-ordinates written are in your measurement units. Since many CAD programs can not accept negative co-ordinates, measurements are offset if necessary to ensure that their numeric values remain positive.

The sections and lines are drawn using the same rules as for on-screen views. This means that the “Configure, Extra drawing points” menu items (extra points per line and section - see page 106) affect the detail in a DXF drawing also.

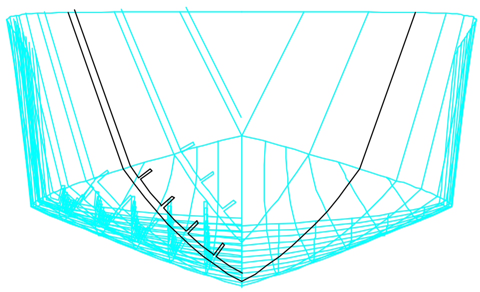
The example following illustrates the capacities of this form of DXF output from Hullform. Stringers have been added to the hull bottom of the design used, and are shown on all views. The drawing has been created using three extra drawing points between sections, giving a fair curve at all points.

The view can not show the layer separations provided. These are normally displayed in a CAD program using a range of colours.



Visible on the drawing are frame cutouts for the stringers. The end elevation view (expanded below) shows the external outline of each hull section on both sides. On the left side, frame outlines are also drawn, including recesses for insertion of stringers. These outlines equate to the written outline generated by the File, Builder's offsets menu item (page 34), and full details of their derivation are found under that section of the manual.

In the interests of clarity, details for only one section are highlighted on the following view. Finer details, in the form of mouseholes and stringer notches, have also been omitted.



⦿ 3-d output

Hull lines and sections, plus the transom, stringer details (as described above) and any internal tanks, are written out as three-dimensional coordinates. All co-ordinates written are in your measurement units. Since many CAD programs can not accept negative co-ordinates, measurements are offset if necessary to ensure that their numeric values remain positive.

The details written are sufficient to recreate the full three-dimensional form of the hull.

Export, DXF Plates (File Menu)

This menu item simplifies the output of developed surfaces generated using the program's Plate menu. To use it, you first must generate sets of ruling lines for all relevant surfaces of the hull (using the Plate menu). Then, when you select this menu item, you are provided dialog box requesting a "file name pattern", that will be used in generating the DXF files for each of the surfaces.

The pattern represents the names of the files to be generated, with a format entry defining where and how the indices of the bounding lines are written. The format entry includes an index specifier taking the form "%nn", where "nn" is an integer. The value of the integer is the number of digits to be output for the index. For example, if the file name in the pattern is "plate-%03d-%03d.dxf", a surface between lines 1 and two will have name "plate-001-002.dxf".

Although the program is set up to generate a file name using two indices, you can use only one if preferred. As a corresponding example, a pattern including file name "surf-%02d.dxf" will generate (for a surface between lines 1 and 2) the name "surf-01.dxf".

As for the DXF frames output, the leading zero in the file pattern ensures a constant number of digits in the file name.

Export, DXF Frames (File Menu)

A common application in DXF output is to generate a set of frame outlines. Rather than going through the process of breaking apart the entities in a full DXF view of the hull, you can generate the frames as a set of individual files, one per frame. The dialog box items you must provide are as follows:

Sections to write

You may write all sections, or a subset. The field is entered in the standard ~~range~~ format.

Plot both sides

You may write frames for one side of the hull, or both sides. Note that, if you write both sides, the frames are written as two separate curves, meeting at the hull axis.

Frame outlines ..

You can write, as well as the outline of the frame, and inner outline including the effects of thickness corrections. The output effects are identical to those generated by the same option under the ~~Frame offsets~~ menu item.

Stringers

If you write out frame outlines including thickness corrections, you can include stringer notches. As for frame outlines, the output effects are identical to those generated by the same option under the ~~Frame offsets~~ menu item.

Details ...

This button brings up the skin thickness correction dialog box, allowing you to edit the skin thicknesses used in the program's calculations.

File name pattern

The program will generate a set of file names, each including a numerical index corresponding to that of the section written. The contents of the edit box represent the names of the files to be generated, with a format entry defining where and how the index is written.

The format entry takes the form "%nn", where "nn" is an integer. The value of the integer is the number of digits to be output for the index – e.g., "frame-%03d.dxf" will generate names like "frame-024.dxf".

The leading 0 on the integer is necessary to ensure that your files are viewable with the correct sorting order in their folder. Without this, there will be a variable number of digits in each index, so your will see files for a hull of 12 sections listed in a manner like:

frame-0.dxf
frame-1.dxf
frame-10.dxf
frame-11.dxf
frame-12.dxf
frame-2.dxf
frame-3.dxf
…

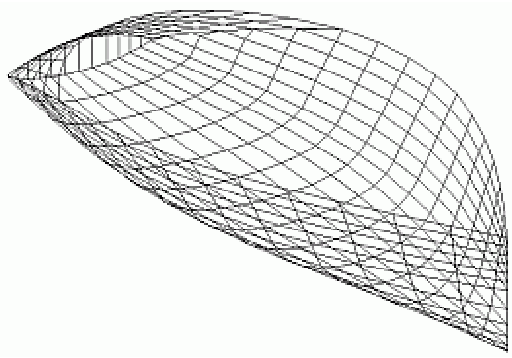
With the leading zero, you will see:

frame-00.dxf
frame-01.dxf
frame-02.dxf
frame-03.dxf
frame-04.dxf
frame-05.dxf
frame-06.dxf
…

Export, DXF Mesh

Hullform's standard DXF export item outputs a close representation of its own model of the hull. For some applications, a representation that shows its three-dimensional surfaces more explicitly is preferable.

This export format generates the DXF file as a set of DXF meshes, one each per pair of hull lines, one for the sloping transom (if used) and one for the vertical section of the transom.



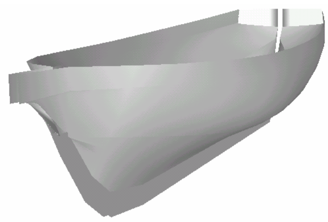
The simple example at right illustrates the form of the output. The mesh is formed from the hull sections, with lines drawn at the user's specified number of points between each line ("Configure" menu, "Extra drawing points"). The transom is output using a mesh using the "points between each line" controlling the detail in longitudinal and transverse directions (as is a rounded stem, if defined), while the mesh on the vertical transom surface matches that on the hull bottom.

Export, VRML

The VRML ("Virtual Reality Modelling Language") file format is a common means of distributing three-dimensional models via the Internet, and is readable by many programs which run under Windows 95/98 and NT.

The file written by Hullform is a rendered surface representation - with the added advantage that VRML viewing software can be used to rotate and position the view in any way.

Below is a copy of a view presented by one freeware VRML viewer available in the Internet. See the Blue Peter Marine Systems web site for links to this and other viewers.



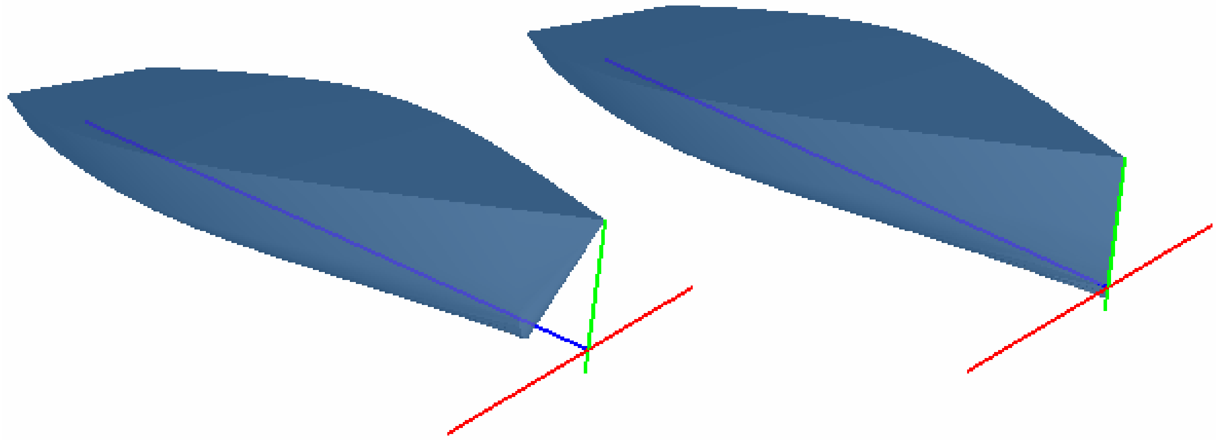
Export, GHS

The GHS ("General Hydrostatics") file format is widely used by other hull design systems for analysis of hulls, and is relatively simple to generate.

The GHS data format comprises outlines of the hull and other objects such as internal tanks, at specified transverse section positions. Hullform generates a GHS file by writing outlines at each of its own section positions, using the specified number of drawing points between hull lines to control the resolution.

The GHS specification does not provide for any stem definition, so the Hullform output only generates a single zero-sized section at the stemhead. If this is insufficient for your needs, the solution is to interpolate new sections within the stem (See “Alter Sectioning” under the Edit menu).

For illustration, the view at left below is of the exported sample design “Dinghy”. This design has a plumb stem, so the raked stem represents loss of the stem information. The view of right is of the exported version of the “Dinghy” design with an additional section interpolated 0.001 m back from the stem – now correctly representing th hull shape.



Internal tanks are output with details of the density of their contents and their permeability, but there appears no facility to specify their fractional filling. Names allocated are simply “TANK1”, “TANK2” (etc), because of the limitation of their allowed length. A content descriptor is allowed by GHS, and is written as “SEA WATER” if the density exceeds 1.02, “FRESH WATER” if it exceeds 0.99, otherwise is written as “OIL”.

The file written has default extension “gft”. The only input required for generation of a GHS file is the name for this file.

Export, ORC Offsets (File menu)

Hullform can export a design to a file acceptable by the Offshore Racing Congress "ORC Manager" software system, for assessment of a yacht's potential rating. The export file is a standard text file, but for terminating by Control-Z characters required by the target software.

The dialog box you use to generate this export format includes the following:

Measurer

This is the registered number of the measurer responsible for the data in the file. Since the design has not been measured, but created using Hullform, there is no measurer in any formal sense, so this entry may be left as zero.

Series date

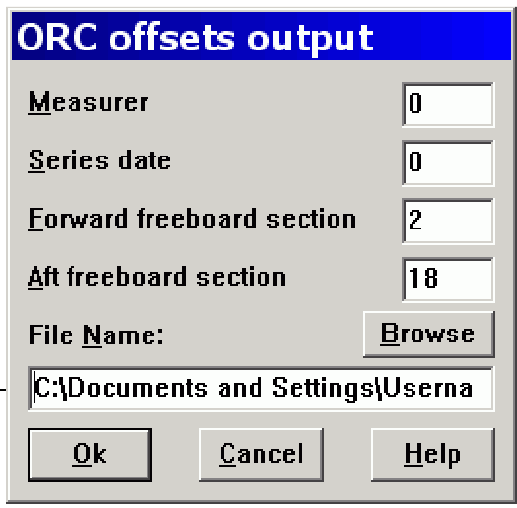
This is the date to be assigned to the design. if used, it should be entered as a four-digit year and month, "YYMM" format. Alternately, it can simply be left as zero.

Forward freeboard section

This is the hull section ("station" in the language of the oRC software) at which forward freeboard is to be assessed. The default is, arbitrarily, hull section 2, and should be set to the actual section number preferred.

Aft freeboard section

This is the hull section ("station" in the language of the oRC software) at which aft freeboard is to be assessed. The default is, arbitrarily, the second hull section forward of the stern, and should be set to the actual section number preferred.



File name

This is the output name required. Hullform permits it to be any legitimate Windows file name, but the ORC software requires a limit of eight characters. The file extension should be "off".

If you do not use the "Browse" button (See below) to locate the file, the exported file will be written to the program's "General File Output" directory.

Browse

This allows you to place the exported file in any selected directory. To do this, you navigate to the required directory, and select an existing file, or type the name of a new file.

Print

When text or a graphical view is present on-screen, it is possible to send a permanent copy to a text or graphics destination, as appropriate.

Hullform provides three ways to copy a screen to another program or file. Text and graphics may be sent either to your Windows printer or to the Windows Clipboard (See page 46). Graphics may also be sent either to a “plotter” device, output generally being directed to file, or to an output port not used by Windows. (See “Plot", below)

Almost all printers supported by Windows provide some level of graphics capacity. Hullform uses this capacity, providing truly device - independent hardcopy output. Normally, views are formatted to fill the width of a printer's page, although scaling above and below this size is possible.

If your printer supports landscape print mode, a view may be drawn “along the page” rather than across. The resulting graphic will usually be larger in size.

Text may also be sent to a file. For file output to be more useful, the “Generic/Text Only” printer should be installed, with output to a file. To do this, activate the Windows' Control Panel, and select Printers. Install the “Generic/Text Only” printer, and press the Connect push button. Scroll the list box of output ports until “FILE:” comes into view, and select this item.

When you attempt to “print” using this device, output will not go to any printer. Instead, you will be prompted to provide the name of the file to which print output will be sent. The print file generated will be straight ASCII, which can be input by any editor program, word processor or spreadsheet.

(Remember that you can perform the same function using the program’s “Copy to clipboard” menu item - see page 46)

Plot

Any graphical view can be “plotted” as well as “printed”. However, the term “plot” is of largely historical origin, and the normal use for this menu item is to generate an output file for input by other software.

The default “plot” device type and output destination are set in the Configure menu (see page 102). Whichever destination is selected, the output port or file selected under the Configure menu remains the default. Any alteration of the output destination persists only for the immediate period of output.

Details of supported plot protocols are given on page 102.

Of the supported formats, the Hewlett-Packard output may not be able to drive a HPGL-compatible plotter directly. Many modifications to the file output format have been made, in order to permit input of HPGL files by a range of software which do not all comply properly with the HPGL format. If you encounter such a problem, the simple solution is to install an HPGL plotter as a Windows printer, and write the output to the plotter port, or a file. (Drivers for many HPGL plotters are provided in the standard Windows distribution set)

Exit

This is the usual way to exit from the program.

Remember that under Windows, you can switch to other tasks using the Alt-Tab, Control-Escape and Alt-Escape key combinations, without unloading Hullform. Alternately, under both versions, you should install commonly-used tasks under the Run menu (See Run, Add Program, page 100).

When exiting from a program, you should always make sure you have saved your work results. Even if you feel t he hull you have generated is not good, the output file only occupies only a few thousand bytes of storage, and you may change your mind later about its value. You might, for example, keep one filename for your current work file - e.g., “WORKFILE” or “INTERIM”.

EDIT

This is the entry point through which all changes to the hull are specified.

You may edit a hull section by section or line by line. Also alterable through the Edit menu are the position of the stem, the overall dimensions of the hull, the number and positions of transverse sections, the stem radius and the radius, location and slope of a transom.

Copy To Clipboard

This is not a true edit function, being located here by convention. It may be used whenever a copy of a screen display is to be transferred to another Windows application program - for example, the statics screen, or a drag calculation. The result may then be copied back into any suitable program using that program's Edit, Paste menu option.

Hullform does not provide an Edit, Paste option, because it is not relevant to the program's operation. If some modification of the screen text display is required, you should paste the copied screen text into an editor program (e.g., the Windows Notepad editor, which you may make readily available using the Run menu).

New Section

This allows you to add a transverse section to an existing hull, at any point within it. To start a hull from scratch, use the “File”, “New hull” menu item.

The dialog box accepts two inputs, the first, Position, being the position of the required new section. You must specify it in terms of the longitudinal system of co-ordinates used to define other section positions. A list of existing sections is provided, for information only.

The other input, Ignore sections, allows you to use a subset of the hull sections, as a basis for interpolating the new one. You may tell the program which are to be ignored, by entering a standard range string.

You can also specify the position of your required section by clicking the mouse pointer on the profile view shown with the dialog box. The location will then be shown in the “position” edit box. Since the view is small, you will probably want to edit this value, to make it match your exact needs.

The section position you request should be aft of the location of the stem section. While Hullform provides some support for positions within the stem, such sections are intended only for internal use by the program. For this reason, if you use sections within the stem, you must beware the following caveat:

> *While a section may be created within the stem, there are limitations which arise from the overlap of the stem form and such a section. Provided that the stem section is not altered, there may be no problem encountered, but no guarantees are given. A warning to this effect is posted by the program, when such a section is created.*

The cubic spline option is the default means of calculating offsets in the new section.

Should you wish to create a section using linear interpolation between a pair of sections, all but these two sections should be nominated in the “Ignore sections” edit box before selecting “Ok”.

For example, if a hull possesses 11 sections, numbered 0 to 10, and you wish to linearly interpolate a section between existing sections 5 and 6, the string input in the Ignore sections edit box should be “0:4,7:10”.

Delete A Section

Here, you are shown the section positions, and may then specify which to remove. Current sections and their positions are shown in a list box. You can specify the section by selecting the section in the list box, or pressing the left mouse button when its pointer is on the required section, in the provided profile view.

Upon entry of the required number, a confirmation is requested - e.g., for station 4, in format:

`Do you mean station 4, at 4.0 m from the stem end?`

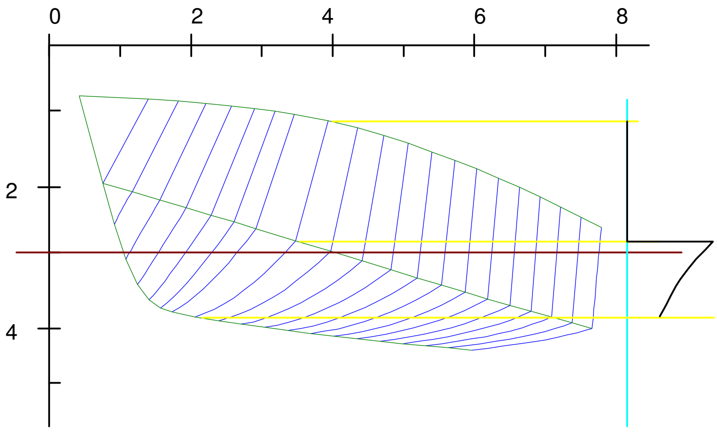
Selection of answer “Yes” will lead to removal of that section.

This option is also a convenient way of checking section positions - you can press the “Esc” key to quit without deleting any section.

Edit Sections

Any hull section may be edited, using on-screen graphics or numeric inputs in text mode. This menu item provides both forms of editing.

When you select this menu item, you will see, initially, an end view of the hull. This view may be rotated in azimuth and elevation (“trim”) angle using scroll bars at the bottom and side of the edit window. The view below typifies the form of the edit screen.



The edit menu, at the top of the window, provides access to the following features:

Offset

This selects the edit mode in which the points on the hull lines (rather than curvature control points) may be moved. You can move a point by two means

- locating the head of the arrow-shaped mouse pointer near the desired point, at the intersection of any hull line and section. Then press (and keep pressed) the left mouse button. The arrow will move to the nearest point. While the left mouse button remains pressed, you can “drag” the section point to a desired position.
- keying in the line number (which will be shown at the top left of the screen, for confirmation), then pressing the Tab and Back Tab (shift-Tab) keys to move the selected section to the one required. If you make a mistake keying the number, press a non-numeric key such as the Delete or Escape key, and start again.

When the line and section have been identified, you can use the cursor keys to move the chosen point in the required direction.

Control

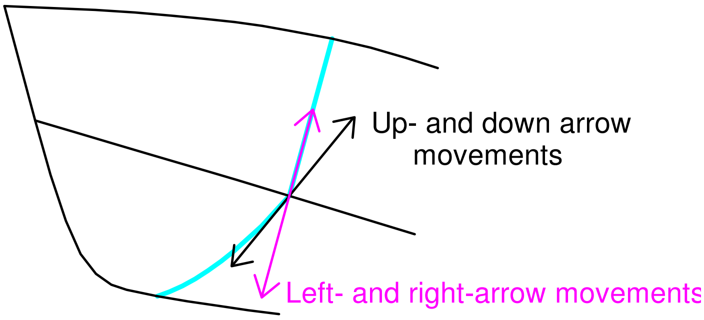
This selects the edit mode in which the curvature control points (rather than points on the hull lines) may be moved.

When “Control” mode is selected, lines are drawn from each point on the selected hull section, tangential to the section outline, so that they intersect at the curvature control points. Also drawn are the lines of control points, defining curvature between each adjacent pair of hull lines.

Use is identical to “Offset” mode, except that control points may be moved, rather than offsets on the section outlines. Remember that, when keying in line numbers, the relevant control point is the one between the specified line, and the next lower-indexed.

Follow

Select a mode related to “Offset", with one difference: when the left- or right-arrow cursor keys are used to move a point, it will follow the curve of the section between the selected line and the next lower-indexed one. When the up- or down-arrow cursor keys are used, the point will follow the curve of the section between the selected line and the next higher-indexed line (See below)



Double

When this is selected, the increment made when a cursor key is pressed is doubled.

Half

When this is selected, the increment made when a cursor key is pressed is halved.

Redraw

This causes the edit screen to be redrawn.

Edit

On occasions, you may want to change only a subset of the hull sections. This option effectively protects other sections from inadvertent changes. You may find its use essential if two sections are so close that the “nearest point” method of selecting a point to be dragged (using the mouse) does not work.

You will be provided a dialog box, to which you enter the range required. Sections are nominated using the program's standard range format (See page 14). The default is “ALL”.

Show

If you do not want to see all lines, sections or internal tanks on-screen, you may select the required subset using this menu item.

You will be provided a dialog box, with edit boxes to enter the ranges of sections and lines required, and a checkbox by which you can select or de-select display of internal tanks. Sections and lines are nominated using the program's standard range format (See page 14). The default for both is “ALL”.

To see the full hull, you can use “ALL” for both lines and sections. At the other extreme, you can view and edit a single section at a time by setting both to “NONE”. Then, all you will see is the currently-selected edit section.

Undo

When you select this item, the effect of the previous alteration is removed. Up to 100 edit actions, for the current session in the Edit menu option, are retained by the program.

An edit action is movement of any offset or control point. One movement corresponds to one complete “drag” action (from mouse key press to key release), or one cursor keystroke.

Zoom

The use of the “Zoom” option has been covered under the “Program Outline” section, earlier in this manual (page 15). Note that there is no change of relative position of any part of the view in response - unless explicitly included, both the curvature plot and axis scales may be “zoomed” off the workspace region.

Text-edit

When this item is selected, the text-mode editing dialog box appears. See page 49 for use details.

Quit

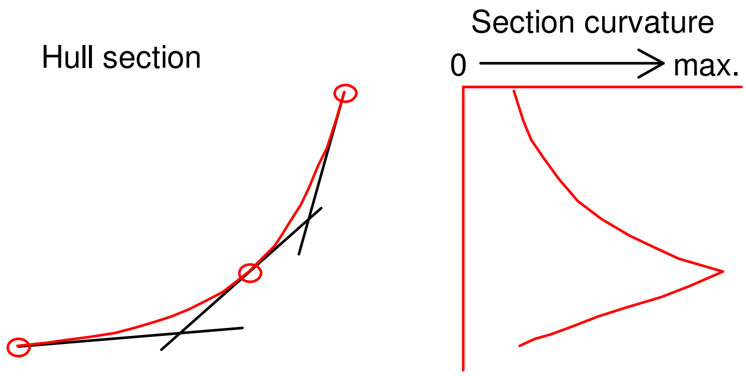
This is the way to finish, and return to the main menu

The actual hull parameter values are displayed as any hull line or control point is moved. When a control point is involved, the parameters shown are the lateral control offset and vertical control factor (Refer to "The Mathematical Model", earlier in this manual). Otherwise, they are the actual horizontal and vertical positions of the line.

DESIGN NOTES

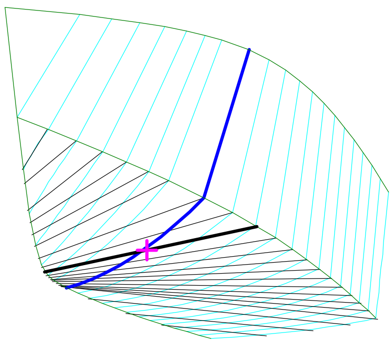
Using the curvature plot: The curvature plot may be used to maintain a high order of smoothness of the hull. A lateral control offset of zero only keeps the tangents above and below a line parallel, but by manual adjustment of offsets or control points, the curvatures on either side of a hull line can also be matched. This can make construction of a hull slightly easier.

In the example below, the control point between hull lines 1 and 2 has been moved so that the curvature, although peaked, is continuous through line 2. To produce such a result, you can move the control point for either line 2 or line 3. Such operations are simple, but familiarisation is best gained by experimentation, since a wide range of effects - good and bad - can be produced.



The curvature plot can also be used to ensure the curvature trend of a surface matches your general intents. For example, by keeping the curvature peak in the central region of the hull surface (as above), you can reduce the load required to mould any rigid or semi-rigid construction material to shape.

Matching a Section Outline to Plate Development Marks: When plate development has been performed for any hull surface, the intersection of the ruling lines with the currently-selected hull section will be shown on screen.



This is illustrated at left. Several ruling lines (shown block) intersect the section drawn by the heavy line. Where the one such line (shown using a heavy line) intersects the plane of the section, a cross is drawn. One such cross is drawn for each intersection.

Rarely will there be a perfect match between these intersections and the hull outline. Because of the limited degree of freedom allowed by the program's transverse curve model, it will also be impossible to create a perfect match by adjusting the curve. But for many surfaces, a close match is possible. The intersection marks are provided to allow this to be done - and also to show the magnitude of the final error.

TEXT-MODE EDITING

The Text option allows entry of offsets where values are known already. Operations are conducted using a dialog box with the following elements:

- section number, section position (both editable) and Help button,
- "Back" and "For." buttons (possibly disabled), with up to 10 section indices arranged between,
- Four columns, two headed "OFFSETS", two headed "CONTROL PARAMETERS", both sub-headed "lateral" and "vertical".
- Static text items "Abs" and "Rel", which are reminders of whether the lateral control point positions are specified in absolute or relative terms.
- a set of (normally) 40 edit boxes, containing up to 10 sets of offset and control parameter values. (The maximum number of lines to display can be altered – see the section "Configuration, Lines, text-edit").
- "Ok", "Cancel" and "Undo" buttons.

You can change the index of the section being edited by altering the “Section” edit box. When you do this, the design values in the dialog box will be used to update the hull in memory, so be sure they are as required.

The “Position” edit box permits the longitudinal position of the section to be changed, within the limits allowed by neighbouring sections.

To edit any value in the offset or control value table, you may:

- use the “Back” or “Forw.” buttons to scroll through the hull lines. You will only need to use these if there are more lines used than may be displayed, and the desired line is off-screen.
- point to the desired number using the mouse, and click the left button.
- use the tab key to move the selection highlight to the desired number.

New values may be entered into the edit boxes using Windows' normal editing procedures. At any stage, the original set of offsets for the current section may be reinstated using the “Undo” key.

NOTE: A little-known, but useful feature, of Windows' edit boxes is that data can be copied, cut and pasted within them. You copy by selecting the text required, and pressing ^C. ^X cuts the text, while ^V pastes it into an edit box. This is a particularly valuable when you are entering identical values - e.g., when creating a plumb stem, setting lateral offsets all to zero.

All parameters in edit boxes may be changed, but the section position may not be moved beyond the range defined by neighbouring sections.

The meanings of the “offsets” and “control” variables were described earlier in this manual (Refer to the “Mathematical Model” section entitled “Transverse Curvature”, on page 6).

You should also see that, in cases where a line is coincident with another of higher index, changes to its position will be matched by changes to the others. A coincident line will only remain separated from a lower-indexed line once it has been moved explicitly.

When the hull has a defined partial line or an internal tanks, and the section edited is located forward of its start section or aft of its end section, the relevant lines will not be shown. Instead, a gap will be displayed, which will be skipped when the cursor is moved down or up through it.

Note that the lateral control offsets must remain zero if a fair curve is to be maintained, with the sole exception of that for the second line. The control values for the first line have no effect, referring as they do to a non-existent curve, above line 1.

Insert a Line

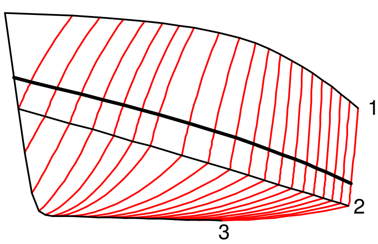
This allows an additional hull line to be interpolated at one of a range of positions on the hull surface. It is useful when you find you need extra detail which the inter-line curvature model cannot support.

The position of the new line is specified by a line index and an interpolation parameter. The line index required is the high-indexed of the pair of lines which bound the surface where the new line is to be added. The interpolation parameter ranges from zero at the specified (higher-indexed) line to one at the lower-indexed line.

The correct value for the “Interpolate at” entry depends on the position of the curvature control points for the surface affected. If the control points are closer to the high-indexed line, a parameter value of 0.5 will locate the new line closer to that line.

To simplify the choice, you can specify the location of the line graphically. A body plan (end view) of the hull is also shown in the dialog box. You can place the mouse cursor at a point on any section of the body plan through which you want the line to run, and press the left mouse key. The corresponding line number and interpolation value will replace any values in the edit boxes.

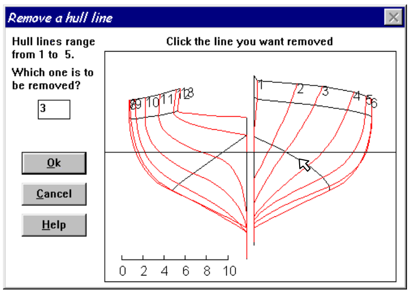
In the example at right, a new line - shown as a broad black line - has been inserted, close to the original hull line 2. The values provided in the dialog box were “2” for the line index, and 0.25 for the “Interpolate at” value. In the new design, line 1 remains untouched, line 2 becomes line 3, and line 3 becomes line 4.



You may make the new hull line a "partial line", not extending between the stem and stern, but between sections within the hull. You do this by altering the defaults provided in the **Start section** and **End section** edit boxes.

Remove a Line

When you select this menu option, you will see a dialog box which requests the index of the line to be removed. On nomination of a valid line number, and selection of “Ok", the line is immediately removed.



You can also specify the line by placing the mouse cursor over any point on it in the accompanying body plan - as at left - and pressing the left mouse key. The index number of the line will appear in the edit box.

You will normally need to adjust the curvature of the hull where the line used to be. The new curvature will have to correspond to some combination of the curves adjacent to the line removed, but the exact combination is purely your own choice.

Smooth a Line

Whatever method used to design a hull, once approximate sections have been defined, it is normal to fair the resulting hull lines. Hullform provides a wide range of tools for this task, which you access from the first dialog box you see. The procedure is to input a line index, then press the pushbutton selected from the range of twelve offered.

Details of the meaning and usage of each follow:

Lateral offset
Vertical offset

These are the actual lateral and vertical offsets of each of your hull lines - for example, when you select lateral offset for line 1, you will see a plan view of your design's sheerline, and if you select its vertical offset, you will see a profile view of the sheerline.

Lateral control offset
Vertical control offset

These define the curvature of the hull's surface between defined hull lines. The former may, and the latter always does, represent the lateral and vertical offsets of the hull curvature control points.

The exception occurs when you make the set of control points for any line relative, rather than absolute. Greater detail on this point, and on the definition of Hullform’s control points are given on page 6 of this manual.

Angle to prev. line
Angle to next line

This feature was added to permit users to explicitly set the “vee” of a hard chine hull. Using the “Value” command (see below) you can enter from the keyboard the exact deadrise angle required.

For example, if you are designing a simple planing hull, with a sheerline, chine and keel, you can directly edit the vee of the hull bottom by specifying line 3 (the keel), and using “angle to prev. line”. Equivalently, you could use line 2, and specify “angle to next line” - the difference is primarily one of a user’s perspective, not of the program’s mathematics.

Angle to prev. control
Angle to next control

This pair of options allows the alignment of the hull surface at any hull line to be faired (or otherwise adjusted). Features such as tumblehome and keel vee angle for a round-bilged craft can be altered using these options.

Distance to prev. Line
Distance to next line

The final option allows you to set the width of a hull “plank”. It was added at the request of an early Version 4 user, and has proved useful in particular for editing the shape of small surfaces running along the hull.

Distance to prev. cont.

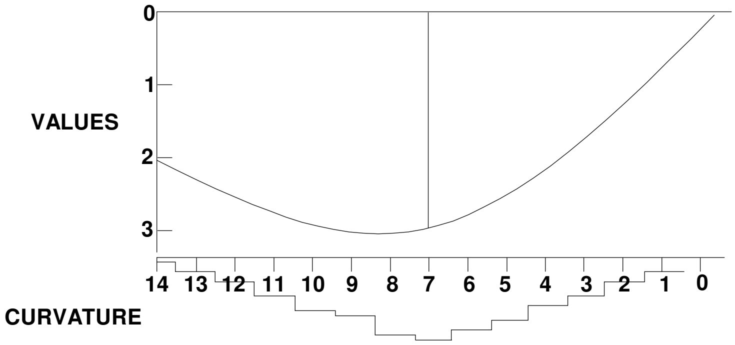
Distance to next cont.

These two complete the set. Their most common application has been to permit straightening the surface of a hull, by moving the control point between a pair of lines to either line (There is an easier way now - see "Straighten curve", under "Line Properties", starting on page 57)

USAGE

Clearly, operations involving pairs of lines can not be performed unless a pair of lines is available. This means that when line 1 is selected, only the options not involving the previous line or control point are available. When the highest-indexed line (normally the keel) is selected, only the options not involving the next line or control point are available.

Once a smoothing option has been selected, the line and its curvature are presented on a graphical window:



This window shows

- in its upper half, a scaled form of the longitudinal profile of the selected parameter, with both the zero-offset line (unlabelled) and the waterline if appropriate (labelled "WL"), and a scale to the left. Master sections (Section 7 only, here - see page 54) are shown by lines from the zero-offset line to the hull line
- in its lower half, a plot representing the curvature of this line.
- in between, a set of numbers showing the positions of each of the sections in use.

The aim of smoothing is generally to minimise curvature, so both halves of the plot should be considered.

When the smoothing window opens, and as a default state subsequently, the program is in "Pull" mode. In this state, when you depress the left mouse button, the cursor moves to the nearest offset point on the displayed line. Moving the point vertically will move the offset in that direction.

Alternately, in "Follow" mode (See below), the same thing happens, but the vertical offset is also adjusted so that the offset point on the section affected follows the section's curvature.

The top menu indicates that fifteen command options are provided. In sequence:

Smooth

Entry of an S will produce a dialog box prompting "Enter sections to smooth". You may enter the sequence numbers of the desired sections, separated by commas, or enter a range in "n:n" format, or a combination of both (See page 14). For example, the input "2:5,7,9:14" would allow freeing of the hull line at points 2, 3, 4, 5, 7, 9, 10, 11, 12, 13 and 14.

A curve will be fitted through the offsets for the remainder of the sections, generating a new curve seen on-screen.

The curve-fitting scheme used is a weighted cubic spline, the mathematical equivalent of fixing a batten to the corresponding points on hull frames, while still permitting its fore-and-aft motion. Thus, the process represented is the freeing of the batten at selected frames, and seeing what happens. Naturally, it generates a fairer curve.

After overdrawing of the proposed new curve (and curvature) you are then prompted for the "Fraction of the relaxed offsets to include". This is an extension of the usual "accept / reject" type of option. You can enter any numeric response, nominally in the range 0 ("reject") to 1 ("accept").

Entry of 0 will hold the old curve, while 1 will select the new one. Any input value is valid, not only decimal values between 0 and 1, but any others - with consequent "unrelaxing" (for values less than 0) and "over-relaxing" (for values greater than 1) effects.

Pull

When the necessary change is obvious, it may be more efficient to move the point manually - i.e., “pull” it outward or inward. The “P” option leads to a prompt for the section number of the point to be altered, which you will see as text in the upper left of the window. As you key in the number, you will see it echoed (If you make an error, use the Backspace key to clear the index).

then you may move it up or down using the up- and down-cursor keys, the H and D keys to halve and double the motion increment, and the “Esc” key to exit to the previous menu.

As a hull line or offset is changed, the relevant value - transverse and vertical position of a line, or the lateral control offset and vertical control factor - will be displayed.

You can also “Pull” any point on the line by dragging it, using the mouse. This is quicker, but limited in accuracy by the step between raster lines on the screen.

Follow

The “follow” option allows the hull line to be moved without distorting the hull surface, either above or below the line selected. This may be desirable in cases such as opening out a line near the keel, to accommodate a skeg or fin keel. It is functionally equivalent to the same option in graphical section editing (See page 47).

With use of the up- and down-arrow keys, when editing a vertical offset, the selected point will be moved vertically on the screen (as for Pull), but the other coordinate and control points will also be changed so that the curve to the next-highest indexed line (generally below) changes in length, but not in shape.

When editing a lateral offset, the line will be moved to follow the hull curve between the selected line, and the next lower-indexed (generally above). When editing a vertical offset, the line will be moved to follow the curve between the selected line and the next higher-indexed.

While this facility equates to that available in section-edit mode, it can only support the “follow” movement in one direction at a time:

- When editing a line's lateral offsets, the altered point follows the form of the hull curve between it and the prior hull line.
- When editing a line's vertical offsets, the altered point follows the form of the hull curve between it and the next hull line.

As an offset is changed, the transverse and vertical positions are displayed on-screen.

Redraw

This option clears the screen completely, and redraws only the curves for the current state. When redrawn, the curves are rescaled, a feature which is useful when smoothing has reduced the curvature of the hull line.

Value

This is perhaps the most obvious facility, allowing you to enter a new value directly. When it is provided, the line and curvature are redrawn using the new value.

The syntax of the data to be entered is “section value” - e.g., to set the offset at section 14 to 2.3, enter “14 2.3”.

Curve

In fairing a hull line, it may be desired to maintain curvature to the end of the hull, or to reduce it to zero. This feature provides the choice.

When Curve is selected, you are prompted, in a dialog box, for the “bow factor” and “stern factor”. The numbers you input are the ratio of assumed curvature at the end concerned, to that at the adjacent section.

The program initially assumes a ratio of zero at both ends. To permit straight end lines, enter zero. To produce a steady curve, enter 1.

Any numeric value is allowed, the range 0 to 1 being the normal range, but by no means the limit. To allow high curvature to develop near the stem or stern, values as high as 10 or 20 may be required.

The parameters entered this way are retained when the hull-smoothing facility is exited. The original default values of zero must be restored explicitly if they are required.

You can also modify the line’s end curve factors using the “Properties” menu item. The duplication is provided to make access to these parameters easier, since they are closely involved in the line smoothing process, and to make adaptation to the program easier for users of earlier versions of Hullform.

Ignore

In many applications, you may desire to use only a subset of the hull's section offsets to fair a line. For example,

- a sudden change in a line's offsets (e.g., a step in a planing surface) can generate a very large curvature. As a result of the program's automatic scaling, other values may then be drawn close to the zero line.
- the hull line may be required to be straight over part of its length. This can be achieved, by specifying that sections outside the required range be ignored, setting the values at the end of the straight part (see “Value", above), and smoothing those section offsets between.
- a hull line may run through a fin keel with sudden changes at the keel's start and end, as often happens for a chine on a multiple-chine hull. The curvatures where the line joins the keel will be very large. It is normal to “ignore” such sections, to allow study of the meaningful points only.

The “Ignore” option allows you to specify, in normal range format (See page 14), which sections should be ignored in line smoothing.

As for the “Curve” option, the values input are retained between uses of the smoothing facility. The sections specified here are also ignored in creation of a new section, and re-sectioning a hull (see New section and Alter sectioning, both also under the Edit main-menu section).

To ensure that all sections are used, enter the word “NONE”.

Also

When redesigning a line or an offset, it is often useful to be able to refer to related hull lines (e.g., the sheerline lateral offset, while working on the chine lateral offset). The program can plot any set of other hull lines, obtaining the data it needs from your response to the dialog box prompting “Also plot which lines:”.

When vertical measurements are being smoothed, the vertical offsets of the specified lines are shown, and when lateral measurements are smoothed, lateral line offsets are shown.

This facility is only available when editing the lateral or vertical line or control point offsets. It would be meaningless when editing the lateral control displacement or vertical control factor.

The selection of “Also” lines is not retained between separate uses of the line smoothing facility.

Undo

This allows you to restore a hull line to the condition it was in when this section of the program was entered.

Master

This item permits you to alter the master sections of the design. You will see the sections which are currently master sections marked with lines from the zero axis to the offset line, in the offset plot in the upper part of the line smoothing window. See page 4 for details on the purpose and application of master sections.

Remember that your choice of master sections affects all hull lines, not just the one you are working on.

Flexibility

This item allows you to alter the inter-section flexibility for the line being smoothed. The program has a standard dialog box for this function - see page 57 for more details on the full “line properties” facility, of which this is part.

You may notice that you can also access the line’s flexibility through the “Properties” menu item. It is provided as a separate item here to provide a more convenient (and more obvious) pathway, since it is closely associated with the line smoothing process.

Half

Use this menu item to halve the amount by which any offset is changed when the up-arrow or down-arrow key is pressed.

Double

Use this menu item to double the amount by which any offset is changed when the up-arrow or down-arrow key is pressed.

Properties

You can use this item to gain access to the full set of properties for this line, via the program’s “Line Properties” dialog box. See page 57 for more details.

Quit

You may exit using key Q, combination Alt-Q, or the right mouse button.

Normally, the program returns to the main menu stage, but for the angle and distance options, you have a choice of the manner in which the changes are applied.

The choice is provided in an exit dialog box, which provides two sets of radio buttons:

Movement direction

⦿ **vertically**

⦿ **horizontally**

⦿ **circularly** or ⦿ **radially**

The program permits line offset points to be moved in one of three directions. (Control point offsets may only be moved horizontally or vertically) “Circularly” is applicable only when angles are being edited, and implies movement of one of a pair of points in an arc about the other. “Radially” is applicable when the distance between a pair of hull lines is edited, and implies movement along the line joining the pair of points.

Line to be moved

⦿ **this line**

⦿ **previous line**

Of the pair of lines involved, you may elect to move the line nominated - the higher-indexed of the pair - or the other line. The indices of the lines concerned are shown in the dialog box.

Lines At Stem

The manner in which the longitudinal lines of the hull join onto Hullform's stem (“section zero”) may include consideration of

- which line forms the keel, and so joins contiguously with the stem (and, within the program's own logic, defines the transverse offset of the stem for hulls such as catamarans)
- whether the keel line joins the stem in a fair curve
- whether any line is rounded at the stem, forming a “cone stem” or “soft nose”.

Details of these features follow:

Stem Line

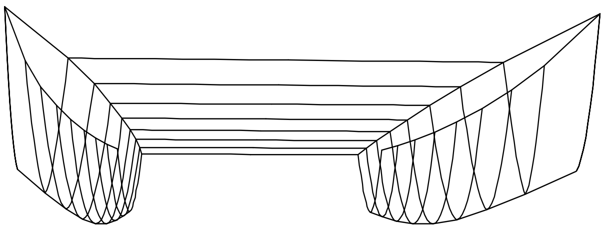
This is the means of altering the line to which the stem section attaches. By default, the stem is taken to form a continuous curve with the highest-index hull line. For catamarans, this is not the correct choice, however.

For example, a catamaran design might use hull line 1 for the outboard sheerline, line 2 for the outboard chine, line 3 for the keel, line 4 for the inboard chine and line 5 for the inboard sheerline. In this case, the stem would tie to line 3, not the default of line 5. Below is a case where the appropriate line is number 2.

On selection of this option, you are asked for the index of the line desired. This index is maintained by the program, being incremented, for example, when a new hull line of lower index is added.

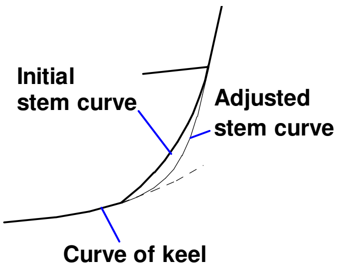
Trimaran designs may be developed, but the program only allows for one stem line on each side. If the central stem is aft of the outer hull stems, additional sections may be added to generate its profile. Otherwise, a single central stem must be defined, with the detail in the stems of the outer hulls formed by extra sections.

Following is an example, of a catamaran using three hull lines per side, with the stem line being line 2.



Fair stem to stem line

On selection of this menu item, the stem curve is automatically adjusted so that it makes a fair join to the selected stem line. This is done by deriving an estimate of the slope of the stem line at its forward end using the program's cubic spline - fit algorithm, and using this to move the control point for the curve of the stem immediately above the stem line (as shown below).



In performing the spline fit, any "end Curve" factors which may have been entered during smoothing of the stem line (see page 53) will be used, with consequent effect on the calculated stem shape.

For multihull designs, in which the stem section may extend down to the stem base and back up to the sheerline, the curve for the return part of the stem is not altered. This may be done manually once the above function has been completed.

Radius of line at stem

This permits you to define a rounded stem - i.e., a "soft nose". The radius is specified in terms of the current measurement units.

The default radius for all lines is zero, until altered. The radius must be separately specified for each line at the stem.

Statics, viewing, hull smoothing and hull editing respond to this feature. About the only limitation is that in shaded views, the stem is presumed to have only a conical curve between defined radii. This does not, however, prevent the inclusion of a more curve in the design of the stem section.

The algorithm used is a fairly accurate - but not perfectly accurate - rendering of a circular planform for the line at the stem, as follows:

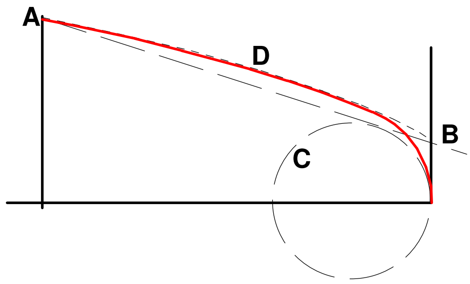
Any hull line may have a nominal stem radius. In constructing the stem form, a straight line is firstly projected from the line's intersection with section 1, tangential to a circle drawn so that its forward end is the forward end of the line. The point where it cuts the perpendicular to the stem end is a "virtual end" of the line; you will see this end when you use the "Lateral offset" item in the "Smooth a line" menu.

When such a hull line is drawn without extra points between sections, it is shown coincident with the above straight line until the circle is met, then coincident with the circle until the centreline is met.

When a line is drawn with extra points, it is firstly faired to the "virtual end" point. Then, forward of the point where the tangential straight line meets the circle, the distance from the circle to the straight line is subtracted, giving a final curved line which meets the centreline at the forward end of the stem.

The effect of the stem radius on stem form is as follows (See the following diagram for reference). Inside the forward end of the line concerned, a circle **C** of the requested radius is drawn. A line **AB** is then drawn from the intersection of the line concerned with section 1 (the first transverse section), tangential to the circle. The point **B** where the tangent line intersects the perpendicular at the line end defines a "virtual end" to the hull line. When the curved line **D** is faired using Hullform's spline curve, this is the point where the line is taken to end.

The drawn hull line is coincident with the line faired to the virtual end, up to one radius back from the line end. At that point, it diverges from the spline-faired curve, by an amount equal to the transverse distance from the tangent line to the drawn circle. Since the spline curve meets the tangent line at the stem end, so the drawn hull line meets the hull axis.



Line Properties

Each longitudinal line in Hullform has many properties, each affecting the way it behaves when edited.

Start section

End section

A hull line will normally extend between the first section (stem) and the stern section. You may, however, start a line later and end it earlier along the hull. It is then termed a "partial line".

There are a number of traps in the use of partial lines - see page 7 for details. In many operations, the "Ignore" menu option is a simpler way of effectively terminating a line, without the potential complications which you will find in the use of partial lines.

Lateral control point position

You can locate the lateral position of a control point by specifying its actual offset from the hull centreline, or its offset from a position which would generate a fair curve where the surface it affects meets the surface above. The former is the "absolute" option, the latter "relative". More details are given on page 6.

Fair automatically

If you check this box, the line you are currently editing will be maintained fair as you edit the master sections of the design. This makes the results of your editing more obvious, but slows operations on older computers. More details are given under "Master sections, slave sections and auto-fairing", starting on page 4.

Inter-section flexibility

This item allows you to alter the inter-section flexibility for the line being smoothed. There is a standard dialog box for this function, which is also accessed from other parts of the program.

The dialog box includes a list box showing all pairs of hull sections (starting as "0-1", then "1-2", and so on) with the flexibility allocated to each. These are the ones to which any change is applied.

You can highlight any pair of sections by placing the mouse cursor on their entry and pressing the left mouse key. You can also highlight any combination of pairs of sections by keeping the control ("Ctrl") key on the keyboard pressed as you make your selections.

The "New value" edit box is where you enter the new flexibility value. This value is applied to all selected pairs of sections when you press the "Change" button.

The "Undo" button resets all flexibilities to the values they had when the dialog box appeared.

Master sections

This edit box holds a list (in the program's standard range format) of the design's master sections. As noted on the dialog box, this list applies to all hull lines. Details on the purpose and use of master sections are given on page 4.

End curve factors

These are explained in greater detail on page 4, but in simple terms the two values control the continuation of curvature to the ends of each faired hull line (offsets or control points). A value of zero means that curvature tends to zero at the end, a value of one maintains curvature to the ends, and anything greater results in increasing curvature at the ends.

Values near zero are most appropriate to hulls with slender ends, such as many yacht designs. Larger values give fuller ends, typical of many commercial craft.

Multiply / Add

This facility is useful when using one hull design as a basis for another of different size.

The dialog box allows for a range of rescaling / shifting operations:

⦿ multiply vertical dimensions

⦿ multiply horizontal dimensions

⦿ multiply longitudinal dimensions

These permit rescaling of any of the three dimensions of the hull. The factor used is obtained by dividing the value in the adjacent “Multiply by” edit box by the value in the “Divide by” edit box.

The two terms are used because a common application of this feature is to change the length of a hull. It is easier and quicker to change a 15 metre hull to 13 metres by entering 15 in the first edit box and 13 in the second, than hunting for a calculator.

⦿ shift lines forwards/backwards

⦿ shift lines up/down

These allow the design to be shifted longitudinally or vertically within the co-ordinate system you have defined for it. The adjoining edit box is used to define the required shift distance.

For vertical shifts, positive values shift the hull upward in its reference frame, only if the chosen “z-positive” direction is upward.

The positive convention for the longitudinal shift is sternwards.

Select lines

By using other than the default “ALL", you can choose the hull lines to which the changes will be applied. The range may include only one line, or up to the full set.

The hull rescaling facility has proven to have a number of uses. For example, if a hull's offsets are inadvertently entered using the wrong vertical offsets convention (upward versus downward), a multiplying factor of -1 applied to the vertical offsets will solve the problem, in conjunction with selection of the correct convention using the Configure, Z-positive direction menu item. In addition, section dimensions can be entered in inches or millimetres, then modified to feet or metres by multiplying by 0.08333333 or 0.001 respectively.

Units Conversion

This allows conversion of the dimensions in which a hull has been developed between the two groups of units permitted.. Length units are converted between feet and metres, and between either kilograms and pounds, or tonnes and tons. The exact combination to which the design will be converted is shown in the confirmation dialog box - e.g., a query such as “Perform conversion to ft and lb?”.

The displacement, and most recently computed waterline, are also converted.

This menu item does not perform conversion of a displacement between pounds and tons, or kilograms and tonnes. Conversion in these cases is simply a matter of dividing or multiplying the displacement by 2240 or 1000 respectively. Alternately, you can balance the hull using Statics, Balance hull, change the units as required using the Configure, Units menu item (see page 104), then use Statics, Evaluate to find the displacement in terms of the new units.

Alter Sectioning

This facility allows alteration of section positions, for a hull whose shape has been defined already. For example, a few critical sections may have been set, and a greater number then required for accurate calculations.

The initial screen display is a warning, to ensure that the old design is not accidentally lost due to an error in specifying a re-sectioning parameter. (The new section data will overwrite the old) When the warning has been cleared, the hull can be quickly saved using function key F2.

The program allows definition of new section positions in three ways, with input also of those sections which are to be excluded from the interpolation base, and the number of sections required in the revised design.

⦿ retain stem

The first retains the existing stem as section 0, and interpolates new sections uniformly from there sternwards.

⦿ interpolate stem

The second permits you to add sections in the longitudinal space between the base of the stem, and the stem head, setting the stem section size to zero and locating it exactly on the bow. The remainder of the requested sections are interpolated uniformly towards the stern.

⦿ specify positions

The third allows explicit input of new section positions.

Ignore sections

If the pre-existing hull design includes any significant discontinuity, these should be eliminated, to avoid the errors induced in the spline curves at the discontinuity. Here you enter the indices of the sections concerned, in the program's standard range format.

Number of sections

The number may be any value from 2 to 100.

The detailed consequences of each form of interpolation request are as follows:

Retain stem

In this option, the stem section (index 0) is retained unchanged. New sections are interpolated at an interval given by

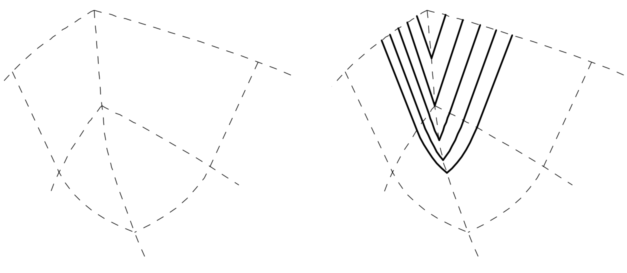
$$\frac{\text{distance from base of stem section to stern section}}{\text{number of sections - 1}}$$

The stem and stern sections remain unaltered, and the rest are calculated by a cubic-spline fit to the existing hull data.

When definition is completed, the chosen section positions will be shown, preparatory to the actual interpolation (see below)

Interpolate stem

When “interpolate stem” is used, a sequence of small dialog boxes is presented, one per pair of hull lines. In this interpolation mode, one new section will always be located at the forward end of each line (as shown by the solid lines in the following figure), but to represent detail between, you may request more within the stem. This number of extra sections is the sole entry required by each dialog box.



Before interpolation of stem After interpolation of stem

In the example shown above, one extra section has been specified between lines 1 and 2, and two between lines 2 and 3. Section numbered 0 has become of zero size, at the stemhead, section 1 is between the ends of lines 1 and 2, section 2 is at the end of line 2, sections 3 and 4 are between the ends of lines 2 and 3, and section 5 is at the end of line 3 (the base of the stem).

In this example, stem definition has used six of the requested sections. Had you requested 20 sections total, the remaining 14 would be set at intervals equal to 1/13 of the distance from the base of the stem to the stern.

Specify positions

To this option, you provide inputs in response to a sequence of prompts in a single dialog box, for the location of each section. Sections may be inserted anywhere between the foremost point of the stem, and the stern.

At each prompt, the program will propose a default, based on a uniform interpolation from the previous section to the stern. This value may be accepted by pressing the “Enter” key, or altered as required. Alternately, all subsequent defaults (i.e., a uniform interpolation for the remainder) can be accepted by selecting the “Accept all” dialog box button.

When definition is completed, the chosen section positions will be shown, preparatory to the actual interpolation.

You may still, at the display stage, chose whether to proceed with the sections shown, to define a new set, or to abandon resectioning completely. No change to the hull's internal representation has yet occurred.

When the new section positions have been defined, the set is displayed in a further dialog box.

The “Ok” option should then be selected to regenerate the hull using these positions.

Orientate Lines

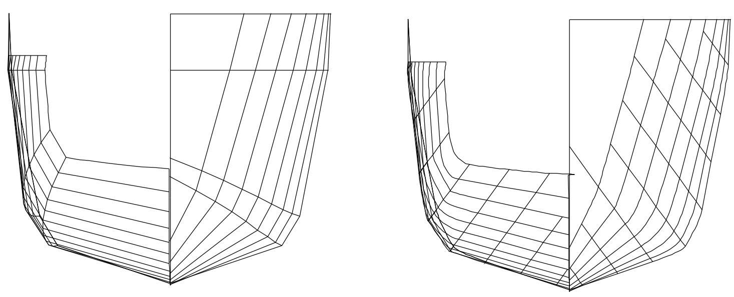
This feature permits you to redefine the hull lines “en masse” to a set of waterlines, diagonals or buttock lines.

When selected, you are firstly reminded to save the existing design (as for the “Alter sectioning” menu item). The program provides for selection of the form of line required, the interval between lines, and, relevant to diagonals only, the angle to be used (measured downward from horizontal). The conversion is performed immediately parameters have been entered.

The shapes of the all sections are maintained as closely as possible. Where new lines are located between two previous lines, the shape is maintained exactly. Where an old line lies between two new lines, the alignment of the section outline is maintained where the new lines are placed, and a fair curve is drawn between.

The previous lowest- and highest-indexed lines (the sheerline and keel) are retained. The new lines will normally meet these lines, but not at a hull section. As a result, the new lines will normally be created as partial lines, extending only between those sections they intersect.

The scheme used has been found highly reliable, but success can not be guaranteed for multihulls (where one waterline would generate two or more hull lines) or unusual hulls (e.g., where a buttock line is interrupted mid-hull due to a narrowed waist section).



BEFORE **AFTER**

A before-and-after example of use of this menu item is shown above. The original sheerline and keel have been retained, but the three lines between have been replaced by eight diagonals. While the sections of the original design used a “hard chine” form between hull lines, the modified design has curves between. However, the curves have been chosen by the program to give a shape closely matching the original form.

Transom

NOTE: No effect of the transom is included in hydrostatic calculations. It is presumed to remain clear of the waterline at all times.

The program permits inclusion of a curved transom which may slope either forwards or backwards. This menu item allows you to turn the transom on or off, and adjust the radius, angle and height of the transom surface.

Distance above stern keel

The distance is specified as the distance separating the keel and transom, at the stern. The value may be negative, in which case, for positive transom angles, the transom plane passes entirely inside (forward of) the final section. Negative angle with a negative height would normally result in no transom intersections.

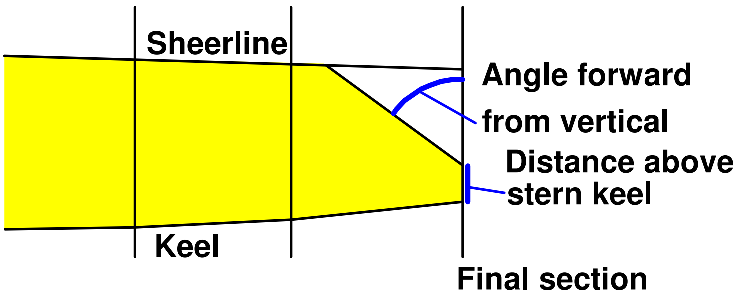
Angle forward from vertical

The transom angle is positive for a transom which slopes forward (so that the sheerline terminates ahead of the keel). Meaningful values may range from -90° to 90°.

Radius

The transom radius is measured perpendicular to the axis of the curve - i.e., not in the horizontal plane. Enter of value of zero if you want a flat transom (In Hullform, zero equates to an infinite radius!).

The meaning of the first two parameters is illustrated below:



Transom active

You may uncheck this checkbox to temporarily disable the transom, allowing you to view sections above the transom level - for example, in section editing. This button must be checked again to re-activate the transom.

Catamaran Conversions

Stem Line

This item is identical to the item of the same name under “Lines at stem” (See page 56). It is placed here because this location is possibly more logical. It is also placed under “Lines at stem” because Hullform 4, 5 and 6 users expect to find it there.

Convert Monohull to Catamaran

This menu item allows you to design a symmetrical-hulled catamaran in two stages. You can firstly create a single hull of the shape required, and later allow the program to generate a double-hulled form from it.

You need only nominate the offset of the keel from the hull centreline. The program then moves all hull lines outward by this amount, “mirrors” these lines, and locates the mirrored lines inboard of the new keel.

The program can have problems, attributed to rounding errors, when your design includes a perfectly horizontal line in any hull section. Should you see any wild curves for a section, check the curve parameters using Hullform's Edit, Edit sections, Text edit mode. Look for numbers almost zero or almost one, and make them match exactly zero or one.

Move Hulls In or Out

This allows you to change the beam of any catamaran design. You may nominate any change, positive values increasing the beam, negative values decreasing it.

NACA Profile

You can generate automatically a hull surface matching as closely as possible (within the limitation of the Hullform hull model) to a NACA “00xx” profile. The foil generated extends vertically downward, and may have a straight taper.

You must firstly identify a starting line for the operation, into the “first line of range” edit box. The default index one greater than the index of line which defines the keel of your hull, but can be any value. It may be the first line of the design, if you want the whole design to take NACA form.

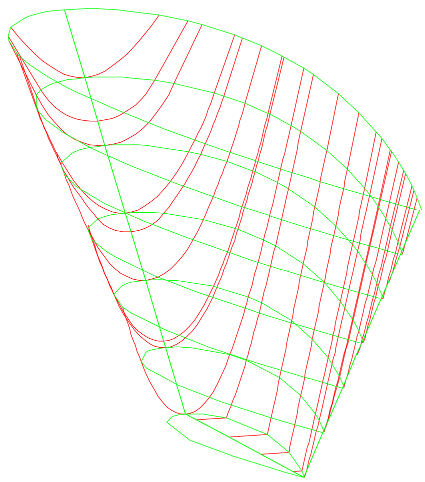
This line does not need to exist before you use the NACA facility. If it does not, the program will use a copy of the highest-indexed hull line. The vertical offset of this line where the profile commences is used for the “base” of the foil section.

You also need to specify what will be the last line of the set used to create the profiles (in the “Last line of range” edit box. As a minimum, you will need one hull line to form the profile at the top of the surface, one to form the profile at the bottom, and one to use for the outline of the surface - that is, a minimum of three lines. More lines will allow better resolution of the shape. This line does not need to exist prior to the foil calculation - if it does not not, the program will add the lines automatically.

You also must specify the longitudinal coordinates defining the start and end of the profile at its first and last lines, and the “span” of the surface. The program will interpolate between the start and end values, generating a straight tapered form. The “span” is the transverse width of the shape, equating to the span of a half-wing section. The first line will be located at the start of this span, the last and second last at its end, and any others located uniformly between.

The final numerical value required is the NACA profile number. These are written “00xx”, the “00” signifying zero camber (as is normal for hull foils), and the “xx” indicating the maximum thickness, as a percentage of distance from leading to trailing edge (i.e., the chord). As indicated by the “00” preceding the edit box, you should only enter the “xx” value.

The check box labelled “Add sections at leading and trailing edges” is set by default, ensuring that the intersection of each hull line with the edges of the foil will be identified as accurately as possible. You should leave this checked, unless you have a clear reason to do otherwise.



The view at right shows a NACA foil generated using this feature, in the professional version (with some sections removed, or partly removed). Observe the use of stem radii to generate a good approximation to the rounded nose of the NACA section, and the parabolic form of the foremost section curve. The latter is not an exact representation of the actual section shape, but is the best the program can do using its own section model.

Since versions 8S and 8E do not support partial lines and rounded stems, the accuracy of the result at the leading edge is lower than for the professional versions. To ensure that irregular oscillations of the hull line do not intrude, the NACA process also cancels plotting of points on hull lines between sections, in version 8E.

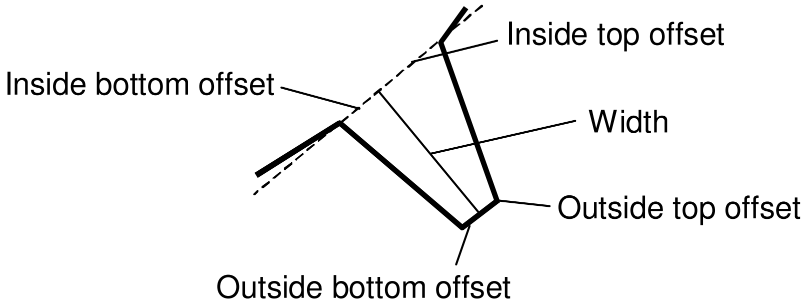
NOTE: Do not attempt to fair the offsets or control points of a NACA surface. They have been precisely located to ensure a match to the NACA form. This particularly applies to control points, whose locations may not appear to correspond to fairness near the leading edge of the foil, but which have been mathematically calculated to give the best possible shape.

Strake

You can add a strake to any surface of the hull, by forming a line on the surface, then converting the line to a strake.

Overview

The strake has a width, being the distance from the hull surface to its outer edge, and four dimensions defining its profile shape, as shown below. The four strake offsets can have any values, even negative.



The strake can also have an orientation fixed relative to the hull – so that, if the surface twists, so does the strake – or a fixed angle to the horizontal.

Note that, while the strake has a trapezoidal profile, each line of the strake is a normal hull line. This means you can delete either of the outside lines, giving the strake a triangular profile. You can also add lines later, to give a more complex profile to the strake.

Using the Dialog Box

Index of line to replace

This identifies the line whose alignment will be used to define the path of the strake along the hull surface. When the strake operation is completed, this line will be lost, and replaced by the four lines which form the strake.

Width

This is the (constant) distance of the strake's outer edge from the hull surface.

Note that, while the width must be a constant in this facility of the program, you can edit the strake's shape later to vary it along the length of the hull.

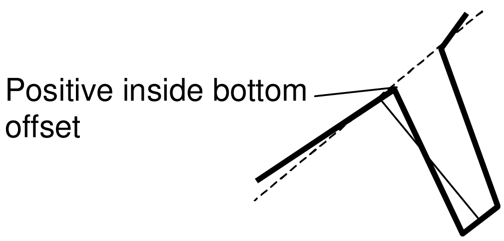
Inside top offset
Outside top offset
Inside bottom offset
Outside bottom offset

These numbers represent the outward-directed displacement of the corners of the strake from the nominal plane of the strake. Note that they are signed numbers – normally the "top" offsets (which, for a normal hull shape, could also be called outside offsets) are positive, while the "bottom" offsets are negative.

Orientation

The strake can be set at a fixed angle to the horizontal, or can be allowed to follow the alignment of the hull.

While the only shape-following option is "perpendicular", note that, by use of small or opposite-signed offset values, non-perpendicular shapes can be generated: for example,



VIEW

This set of options allows you to review quickly the shape of the hull, using orthogonal or perspective views. It also permits the designer to display the design in shaded “hidden surface” form, which will give its prospective user a better impression of its final three-dimensional form.

The orthogonal viewing options, in by-passing the perspective transformation routines, function significantly faster. As a result, the orthogonal views are the best way of performing an initial check of the lines of a new design.

In both orthogonal or perspective wire-frame views, calculated waterlines, diagonals or buttock lines may also be shown.

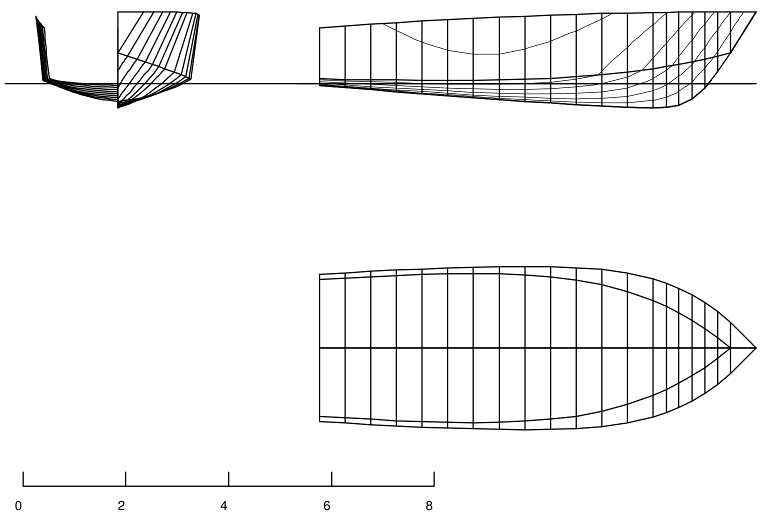
No editing of the hull is possible within this part of the program. However, a full oblique view may be edited using the Edit, Edit sections menu item.

Orthogonal Views

General Orthogonal
Top View
Elevation
End Elevation

These correspond to the three possible orthogonal views of the designed hull, with the first showing all three in combination, using a more-or-less conventional layout. The three other options allow checking of each view at its largest possible magnification.

Following is an orthogonal triple view for a simple hull design. The view shown includes buttock lines on the profile (elevation) view - these have been removed from other views for clarity.



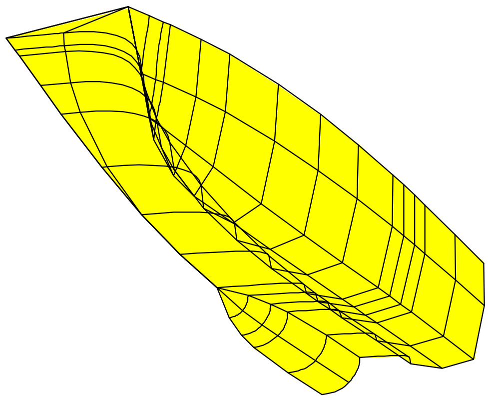
Perspective Views

Full Perspective
Port Perspective
Starboard Perspective

Each of these menu options generates a perspective view, of all or half of the hull. Often one part of the hull image obscures another part, so it may be advantageous to select only half. Also, plotting half a hull takes only half as long, whatever graphics hardware is used - for a quick look, half is often better.

When a perspective view is shown on-screen, it may be rotated using the scroll bars at the right and bottom of the window. Moving the lower scroll box - which locates the small "button" in the scroll bar - to the left rotates the stem clockwise, when viewed from above. Moving the right scroll box upward lifts the stem, giving positive pitch.

The example at right is of a port perspective view. Since the outline views are do not use a hidden-line scheme, half views are the most useful for presentation purposes.



Viewing Position

This option permits the hull to be oriented whichever way required, in a perspective view. The three input parameters cover all possible relative positions of a viewing point and the hull.

This is largely a carryover from early Hullform versions, since the scrollbars are a much easier way to rotate the view. But this item is still the only way the distance from viewer to hull - i.e., the amount of perspective effect - can be changed.

Azimuth

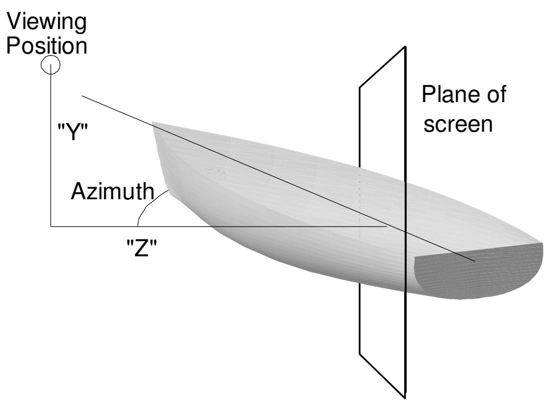
Hull azimuth may take any angular value (positive or negative). A value of 0° implies the bow (lowest section number) towards the viewer, with increasing azimuth corresponding to rotation of the bow to starboard.

Y-position
Z-position

The other input parameters are positions specified relative to a picture plane on the screen, with the first (y-) co- ordinate upward, and the second (z-) co-ordinate out of the screen.

If a z value within the fore-and-aft extent of the hull is specified, only those sections in front of the viewing position will be plotted. In all cases, the plot is scaled to fit comfortably within the graphics screen.

Hull diagonals may be drawn at any fixed angle, on the hull surface between sheerline and keel. The upper line of this two-line pair allows the user to specify the number of diagonals required (in format as shown above) these will be drawn at uniform intervals.



Remember that you can adjust the perspective viewing angle (but not the distance) using the scroll bars on the perspective view.

View Options

This item provides for display of subsets of sections and lines, and also of calculated stringers, waterlines, buttock lines and diagonals.

Lines to plot
Sections to plot

You may elect to display almost any subset of hull sections or hull lines, in either orthogonal or perspective views. The only exception is that the stem section (indexed zero) may not be omitted.

Values must be entered in the program's standard range format (see page 14).

Tanks

If you select this item, any internal tanks will be displayed on all outline views.

Stringers

When this item is checked, lines corresponding to the location of any calculated stringers will be drawn on all outline views. It is turned on automatically whenever you generate a set of stringers for a hull surface.

Frame outlines

Selection of item results in the plotting of frame outlines, as well as exterior section outlines, on all outline views. When you use this option, you should also ensure that the **Skin thickness** edit box contains the correct value.

Skin Thickness

The value shown here is the same as that provided under the File, Builder's offsets (page 34) and File, DXF output (page 38), and may already be correct if these items have been previously used.

Section numbers

In elevation and plan views, you may choose to display the section number beside each transverse section. When you elect to display section numbers, it is a good idea to use a relatively small screen font.

Centres

The positions of hydrostatic centres M (metacentre), CG (centre of gravity) and CF (centre of flotation) will be shown if this checkbox is set.

On each view, only those centres whose position bears useful information are shown. For example, the centre of flotation is not shown in the end elevation (body plan) view.

Overlay

This controls whether an overlay design imported (using the File, Overlay hull menu item) is shown along with each hull view. It is set automatically whenever a design is read in, but can be disabled or enabled using this checkbox.

DXF lines

A design imported using the File, Import, DXF file menu item is converted to Hullform format internally, but can also be viewed after import to check how well the conversion worked. Viewing of the imported design as an overlay is automatically enabled when a file is imported, but can be disabled using this check box.

⦿ Waterlines

⦿ Buttocks

⦿ Diagonals

⦿ Exclude all of the above

Waterlines, buttock lines and diagonals may all be drawn on any hull view, either orthogonal or perspective. For waterlines and buttock lines, only the perpendicular interval between lines need be specified (as at right), using the **interval** edit box.

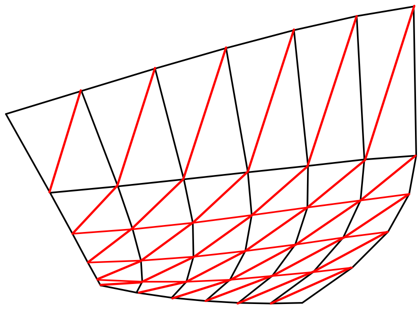
Diagonals are drawn at a fixed inclination across the hull. For this option, the perpendicular interval and angle must be provided, at the **angle** edit box.

In all three cases, drawing of lines is cancelled by entry of a zero separation value, as well as by checking the “exclude all of the above” radio button.

Shaded Surfaces

This allows viewing of the hull as a “solid surface", with brightness determined by the angle of incidence of light from a distant source. You can set the highlight and shadow colours using the colours option of the configuration menu (see Configure, Colours, page 105).

For shading, the hull surface is subdivided into triangular facets, whose vertices lie on the hull sections.



The triangles are arranged in pairs, with each triangle extending between a pair of hull sections, and each pair of triangles forming a roughly-rectangular surface on the hull.

The number of pairs between each hull line is determined by the drawing detail you select between hull lines. Use the “Configure”, “Extra drawing points”, menu item (See page 106), and set the “number of points between hull lines” to the value you want.

For example, in the case shown, the presence of three extra longitudinal lines, between hull lines 1 and 2, reveals that this value was set to 3.

Surface shading starts with those between furthest pair of sections, and progresses to those closest. For each pair of sections, facets are sorted by distance from the viewer only, the furthest way being shaded first.

The scheme used is therefore not a true hidden-surface algorithm, and for some hulls the odd error occurs. The return for this limitation is a considerable speed increase, allowing fine resolution of the hull's surface on any PC. Routinely, several thousand facets may be used in surface drawing.

The hull is assumed to be illuminated by an infinitely-distant light source. If a facet faces away from the source, it is shaded using the darkest possible shade or pattern. Otherwise, it is assumed to be a diffuse reflector, with intensity proportional to the cosine of the angle between its surface normal and the line to the light source. This intensity of reflection is converted to a grey-scale value, over the range from shadow to highlight colour. Shadows which might be cast by one part of the hull surface on another are not shown.

A NOTE ON SHADING TECHNIQUES: The shading method used depends on the display driver used. Normally, Windows uses fair-quality dither patterns. 8-bit and better displays can generate better results. If the default for your display is dithered shading, you can try setting the “Solid shades” check box in the Configure, Colours dialog box (See page 105).

When shaded views are transmitted to printer devices, a dithered pattern is generated. The pattern produced on laser printers is of high quality. However, it may be too fine for reliable reproduction - if so, you may be able to select a lower printer resolution, giving a more useable dither pattern.

Beware: if you have installed a Hewlett-Packard plotter as a Windows printer, shading is performed using a myriad of fine cross patterns. Generating a shaded image this way is very expensive on time and pens, and is not recommended.

Remember that you can also produce shaded hull views by writing a VRML file, and viewing it using suitable software.

Illumination angles:
Azimuth

Light coming from directly out of the screen is from azimuth zero, light from the right as you view the scene is from azimuth 90, and light from the left is from azimuth -90)

Elevation

Light coming horizontally is from elevation zero, light from directly above is from elevation 90, and light from directly below is from elevation -90.

Viewing mode:

Outline

Select this option to draw “wire-frame” outline views.

Shaded

Select this option to draw shaded- surface views.

Both Modes

This results in the display of the “wire-frame” view over the shaded view. The “wire-frame” view does not remove hidden lines, so it works best for a single-side view of the near side of the hull. In drawing the wire frame, the number of extra points drawn on each line, per section, is temporarily zeroed, to ensure drawn lines match the triangulated surfaces of the shaded view.

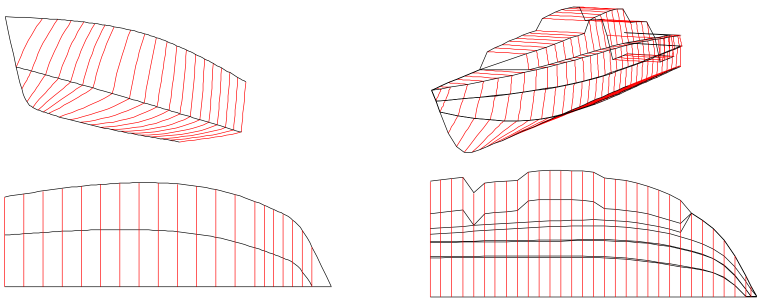
Shell Expansion

This feature permits viewing of the opened-out shell of a hull. It works best for monohulls, and can give results which at times may look unrealistic.

In most such cases, the problem is due to a difference between the program’s own “perception” of the design, and your own. In some cases, however, there can be discontinuities where the program attempts to interpret the transverse form of the stem region. These are in general unavoidable, but have been minimised as far as possible.

In other cases, you may see large excursions of the drawn lines from a fair curve. If this occurs, use menu item “Configure”, “Extra drawing points”, and set the number of points drawn between sections to zero.

Below are two examples, each showing a view of the hull, and its expansion below. A minor case of an unexpected difference is apparent in the right-hand view - the sides of the rear deck appear as “fins”.



Zoom

Any view except “General orthogonal” may be zoomed, in the standard manner (See page 15 for an explanation).

STATICS

Most applications require this facility. It allows calculation of the displacement of any hull form, or alternately allows calculation of the waterline for a hull form of known displacement. Also generated in the process are estimates of other hydrostatic parameters like righting moment, offset to buoyant metacentre, waterplane area, wetted surface, centre of buoyancy position and prismatic co-efficient.

The on-screen displays shown using this component of the program's menus may be written to a printer or a file, using the File menu's Print and Plot items, and also transmitted to other programs via the Windows' clipboard.

Settings

Heel

Values should be entered in units of degrees, positive for a heel to starboard. Heel may be set at any value, including those greater than 90°. Displacement and righting moment calculations allow fully for the effects of water over the deck.

Heel is only modified through this edit item, and in the balance All item. It is not altered permanently in any statics calculation.

Pitch

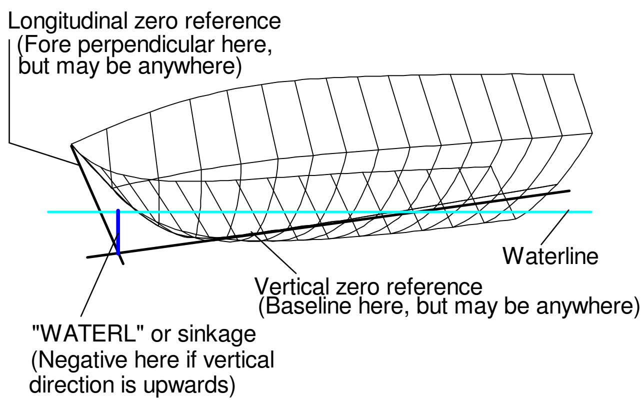
Pitch may be set to any value within the range -90° to 90°, although some calculations are only accurate for small pitch angles (say, less than 10°).

Pitch is also changed when the Balance hull and balance all menu options are selected (See below).

Sinkage

Also referred to as "waterline" in some contexts, this measures the distance from the user-defined baseline of the hull, at the longitudinal zero position, to the waterline. If this baseline is the intended waterline, and the Z-positive direction is downward, it is the true sinkage of the hull below its design waterline.

The direction of sinkage reflects your chosen z-positive direction. If your z co-ordinate increases downwards, the positive sinkage direction is upwards. In the example below, the sinkage value for an upward z-positive direction is a negative number:



Sinkage is also altered when the Balance hull option is selected, since it is one of the two parameters adjusted to achieve balance (the other being pitch).

Displacement

Displacement is unrestricted. If it is set too large, the hull will "sink" (with non-catastrophic results) when an attempt to determine its waterline is made. The value is measured in the current mass units (see Configure, Units, page 104).

Displacement is also altered when the Evaluate statics option is selected (see page 72).

X-Centre Of Mass (LCG)

Conventionally referred to as “LCG", the centre of mass position is measured relative to the currently-selected coordinate system. It is therefore not a distance from the stem or stern, or a percentage of any hull dimension - but it is consistent with the rest of the program's longitudinal measurements.

A correct centre of mass location is required, in order that the hull may be balanced against pitching moments as well as heeling moments. A common problem is balancing a new hull arises because the default position is zero, in the stem of a hull created using the File, New facility. Not surprisingly, this causes the model hull to pitch stem-down in a rather dramatic (but, to the program, non-catastrophic) manner.

The x-centre of mass position is also altered when the Evaluate statics option is selected (see page 72).

Z-Centre Of Mass (VCG)

This is the vertical position of the centre of mass of the hull, conventionally termed “VCG”. It is measured from the selected base plane of the hull, upward or downward according to the your choice of positive-vertical direction (See menu option Configure, Z-positive direction)

Balance Hull

When this option is selected, the program the hull balances in sinkage and pitch, according to the following algorithm:

- the difference between displaced water mass and hull mass is calculated,
- the waterplane area, and hence the displacement change per unit sinkage, is found
- the ratio of these gives the needed change of waterline level.

... and ...

- the pitching moment is calculated
- the moment to change trim a unit of distance is calculated
- the ratio of these gives the change of pitch.

If an asymmetrical floodable tank is operational, a heeling moment will be generated, but the hull will not heel in response. The equilibrium heel when a tank is flooded may be determined using the “Balance all” menu option.

The display monitors the equilibrium of the hull, showing the change of vertical position of stem and stern at each iteration. Calculation proceeds until these are less than 0.01% of the waterline length (i.e., 1 mm per 10 metres of hull length). Due to the usual rapid convergence of the scheme, this generates a waterline accuracy better than 0.001%.

(If the initial value of sinkage is such that the hull is completely clear of the water, or completely immersed, the first changes will be reported as “99.999", and the hull forced to a level where the waterline is at a mid-hull position. The balancing process will then proceed)

The program then presents the first of three possible screen displays, summarising the hull's state, of typical format

```
At a heel angle of                   0.000 deg
Pitch angle is                       0.215 deg
Volume displaced is                  2.626 cu m
Displacement is                   2690.375 kg
Righting moment is                  76.571 kg m  per deg.
Mass per unit immersion          1.546e+04 kg/m
Moment to change trim (MCT)         71.215 kg m  per cm
Waterplane area                     15.086 sq m
Wetted surface                      11.626 sq m
Overall length (Loa)                10.680 m
Waterline length (Lwl)               9.721 m
Maximum beam (Bmax)                  3.118 m
Waterline beam (Bwl)                 2.247 m
Draught (T)                          0.321 m
Midsection freeboard (Fm)            1.006 m
```

The two other displays are obtained using a small dialog box using three push buttons. The second display is of hull shape coefficients, as follows:

```
Midsection coefficient (Cm)              0.699
Prismatic coefficient (Cp)               0.535
Block coefficient (Cb)                   0.374
Waterplane area coefficient              0.687
Forward prismatic coefficient            0.497
Stern prismatic coefficient              0.571
```

The third screen shows the positions of hull centres, in a range of terminologies:

```
X-centre of mass (LCG)                   0.270 m
- distance forward of midships          -0.133 m
Centre of buoyancy (LCB)                51.367 %
- at                                     0.270 m
- distance forward of midships          -0.133 m
Centre of flotation (LCF)               54.438 %
- at                                     0.569 m
- distance forward of midships          -0.432 m
Waterline entry point at                -4.725 m
Z-centre of mass (VCG)                   0.000 m
Vertical centre of buoyancy              0.129 m
Metacentre above waterline               1.648 m
Metacentre above baseline (KM)           1.629 m
Metacentre height (GM)                   1.629 m
```

The percentage positions express values as fractions of the distance from waterline entry point to waterline exit. “Midships” in these terms is at the 50% position.

The multi-screen format has been included to provide flexibility in additions to the statics display. If you are interested in further items, you are encouraged to contact Blue Peter Marine Systems.

Users unfamiliar with the terminology used should refer to the Glossary, at the end of this manual. Of these, relevant points are:

- The pitch angle comes to equilibrium, as well as the waterline position. The final hull state is its true equilibrium value, for the given heel value and centre of mass position.
- The percent centre of buoyancy position (LCB) is measured towards the stern, quoted as a fraction of the waterline. The position is presented to provide a value in terms of the hull coordinates.
- The centre of flotation (LCF) is measured in the same units as LCB.
- When the righting moment is zero, the righting moment shown is incremental, quoted in (for example) “tonne m per deg”. When the heel is set nonzero, the value is absolute - e.g., in “tonne m”.

  A zero righting moment will correspond to zero heel, but only if no asymmetrical floodable tank is operational.
- The righting moment arm (GM) is the standard design parameter, being a stability measure. The height of the metacentre above the waterline is provided as a supplementary reference.
- The mass per unit immersion is presented in consistent units. In metric units, it is quoted “per cm", and for measurements in feet, it quoted “per inch”.
- The waterplane area is simply a “by-product” of the calculations used in evaluating the mass per unit immersion and thus waterline position.
- The wetted surface includes all underwater surfaces. The program uses a detailed triangulation of the hull surface, and so is not subject to the approximations such as are involved in the “bilge factor” correction, or other empirical approaches.
- The overall length is simply the distance between the first and last sections (including the stem), included to provide a reference when considering the waterline length.
- The maximum beam is the greatest width across the any pair of hull lines. Thus, for hulls with tumblehome, the beam will be underestimated. (Unlike other parameters, it is not affected by the heel chosen)
- The waterline beam is the actual maximum, including the effects of hull asymmetry when heeled.
- The draught also represents the true maximum, including the possibility that the lowest point of the hull is part of the hull's curved sections.
- The midsection freeboard, for a hull with “n” sections, is evaluated at the section of number “n/2", or the next greatest integer. It is the lesser of port and starboard freeboards, when the hull is heeled.
- The midsection coefficient is evaluated as the ratio of maximum immersed hull section area, to the product of maximum beam (Bwl) and draught (Tc).

- The prismatic coefficient is the ratio of displaced volume, to the product of waterline length (Lwl) and maximum immersed hull section area.
- The block coefficient is the ratio of displaced volume, to the product of waterline length (Lwl), waterline beam (Bwl) and draught (Tc).
- The forward prismatic coefficient is evaluated for the part of the hull forward of the transverse section of greatest area. The stern prismatic coefficient is evaluated for the part of the hull aft of the transverse section of greatest area.
- The percent values for the centres of buoyancy and flotation represent the position relative to the waterline entry - i.e., they represent “percent back”.

For all coefficients above, if a keel is included in the design, artificially low values will be produced.

Balance All

This is only relevant for hulls incorporating asymmetrical floodable tanks. The designed hull is balanced in sinkage, pitch and heel, the criteria for the first two being detailed under “Balance hull", above, and that for heel being a maximum change of 0.05°.

The result will show the complete equilibrium state of the hull, for the current condition (full, empty or leaky) of its tanks.

Evaluate Statics

This option produces the same result as the previous one, but does not pursue the iteration. It is used to find the displacement for a specified hull of known waterline and for given heel and pitch.

Before you use it, you should firstly use the “Settings” menu item to set the pitch and sinkage.

Once “Evaluate” is completed, the hull's displacement is set equal to that calculated, and the centre of mass of the hull is moved to match the position of the centre of buoyancy. This option may therefore be used to find the correct displacement or centre of mass for a specified shape of hull (or, equivalently, to find whether a trial hull form is of its intended displacement).

Write Variables

Hullform can perform a wide range of calculations itself, but it is recognised that some specialised ones may require calculation externally, by a user-supplied program. This option is intended to assist the process, by writing a summary of the hull's state (as determined by the Balance hull and Evaluate statics options) to a file.

The functional difference between using the Write variables option when the statics display is on-screen, rather than the Edit, Copy to clipboard or File, Print options, is the presence of formal variable names and values and units in fixed columnar format. This is intended to make assimilation into another program easier. The variable name is in columns 1-6, its value in columns 7-18.

The variables output correspond to the program's DDE parameters, of which there are over 50. See page 112 for a listing of their names and meanings.

Variables Plot

In analysis and optimisation of a design, it is normal to plot interrelationships between design parameters. Commonly, this is limited to factors such as stability curves, but many more are possible - and of benefit to the serious designer.

Hullform provides a wide range of plotting options, through this option. When selected, a dialog box having three “combo” boxes appears.

X-axis variable
Y-axis variable
Determining variable

In each list box appear the same variables as those which may be written using the Write variables option. Any one may be plotted against any other, the principal restriction being that only the first five (WATERL, HEEL, DISPLA, PITCH and XCOFM) may be used to (as the “determining variable”) to determine the state of the hull. Thus, for example, to obtain a plot of DRAFT as a function of WETSUR (wetted surface), you would probably use DISPLA (displacement) or WATERL (sinkage / waterline) as the “determining variable”.

Names may be specified by keyboard entry in the edit box at the top of each list, movement of a selection bar in a list box using the cursor keys and pressing “Enter” (commencing with the down- or right-arrow key), or by clicking the left-hand mouse key while the mouse pointer is on the required name.

The “Y-variable” is plotted on the vertical axis and the “X-variable” on horizontal axis. When the program is first used, there are no defaults for the variable names, but the first selections become the default. These default are saved in the configuration file when the program exits.

Start
End
Incr.

The increment used must be positive, and the start value should be less than the end. A maximum of 100 values may be plotted.

If the determining variable is HEEL or DISPLA, the hull will be balanced at each state for which values are to be calculated. However, since WATERL and PITCH are altered in the balancing process, no balancing is attempted for plots for which these are the determining variables.

The FREEBD (freeboard) option allows you to plot the freeboard of

- the intersection of any hull line with any transverse section, or
- the lowest point on any hull line, as a function of heel.

If you request variable FREEBD, you are provided a dialog box for definition of the freeboard point, with inputs

⦿ Minimum

If this is checked, the program will find the minimum for the full length of the hull line nominated at the **Line** edit box (See below)

⦿ At ...

If this is checked, the freeboard will be evaluate at a specific point on the hull, marked by the intersection of a nominated hull line and section.

Section

To this edit box is provided the section number, if the **Minimum** radio button is checked. The allowed range is 1 to the final section index; if zero is entered, the program will find the minimum freeboard.

Line

The line specified may be any one defined.

Since a section may be interpolated at any point within the hull, and a line also formed at any position - both without distorting the existing hull shape - it is possible to find the freeboard curve for any hull point.

The hull will be balanced for each heel used, so the freeboard calculated will be the true equilibrium value, including the effects of pitch changes with heel.

Tabular Output

For use in quantitative reporting, the program can write a tabular summaries of the hull's hydrostatics to file.

Dialog box items are as follows:

PARAMETER TO VARY

This may be displacement or draft. If the parameter used is displacement, the hull is balanced in sinkage and pitch before values are found. If draft is used, this and the current value of pitch is used to define the hull's position on the water.

Start Value, End Value, Increment

Required inputs are the range of displacement or draft, and for the stability table also the range of heel, all entered as start, end and increment values.

TABLE FORM

You may generate either of

- a stability table, showing righting moment as a function of heel, and of either displacement or draft. For this, you will also have to provide a range of heel angles.

- a hydrostatic table, showing selected hydrostatic variables as functions of displacement or draft.

Stability Variable

You may write estimates of righting levers GZ or KN, or the righting moment itself, as the stability variable. When you press this push button, a dialog box appears, providing these options.

Hydrostatic Table Variables

When you press this push button, a further dialog box appears, showing two list boxes.

- The left-hand one lists names of those of the program's hydrostatic variables which have not been selected for output.
- The right hand one shows the names of the variables which have been selected for output, in the order in which they will be written across each line of the output file.

You can add a variable from the left-hand list to the right-hand list by highlighting its name, and pressing the button with the “>“ sign. It will then appear at the end of the list in the right-hand list box.

You can remove a variable from the right-hand list by highlighting its name in the list box, and pressing the button with the “<“ sign. Its name will disappear from the right-hand list, and appear in the left-hand list.

To change the output order of an item in the right-hand list box, highlight its name, and press the “Up” or “Down” buttons.

Any number of the entries from the left-hand listbox can be selected for output. However, there will be a practical limit to the width of the output line you can use, depending on the medium to which the output is ultimately to go (e.g., printer, word processor file).

Value Separator

This section allows you to choose whether to write output with spaces, tab characters or commas. If the output file is simply to be printed, spaces may be the preferred option. If it is to be inserted into a word processor document or a spreadsheet, tab or comma separators will give better results.

Examples of the output produced by each are shown below. In generating these tables, additional decimal places on the displacement (“DISPL”) and mass per unit immersion (“MPI”) columns were removed. The LCB values are shown as a percentage from waterline entry to exit (“% back).

Stability versus displacement table output, for displacements from 1000 kg to 4000 kg, in 1000 kg steps, and heels from 0° to 60° in steps of 15°:

```
Righting moments, units of kg m

 DISPL      HEEL (degrees) ...
           0.0        15.0        30.0        45.0        60.0
1000.000   0.00       437.17      695.19      832.81      901.16
2000.000   0.00       811.93     1335.11     1638.41     1742.64
3000.000   0.00      1153.78     1940.62     2423.52     2512.83
4000.000   0.00      1474.26     2522.46     3163.05     3232.04
```

Hydrostatic table output, for displacements from 500 kg to 2000 kg in steps of 500 kg:

```
DISPLA DRAFT  MPI   MCT   ZMETA  LCB     LCF
500    0.194  5658  0.146 1.610  59.253  57.877
1000   0.274  7890  0.202 2.215  59.986  59.068
1500   0.338  8967  0.225 2.141  60.523  58.289
2000   0.403  9341  0.239 1.810  60.924  57.604
```

In stability table output, the draft used is the maximum of the keel. For fixed draft, displacement changes markedly with heel. A stability table dependent on draft is therefore of limited value.

The formatting of such tables is simplified by the use of Tab characters between columns. This also makes entry of the data into word processor tables and spreadsheet programs simpler.

Tabular output of tank hydrostatic information is also available under the Tanks menu - see page 91.

DRAG

Minimising drag is an important element of the hull design process, and so figures in Hullform's design tools. The program not only calculates drag and powering estimates for specific speeds in detail, and plots drag curves, but also can plot out the curves of section areas along the hull - useful in deciding how to distribute the hull's displacement when minimising wave drag.

When the Drag menu item is selected, the program firstly balances the hull, and pre-calculates a range of terms needed by all drag estimation schemes provided. While the drag estimates are strictly valid only for an upright hull, no check is made that the heel of the hull is zero. You may elect to study the implications for a heeled hull, if desired. Naturally, no real confidence should be vested in such estimates.

In all cases where skin friction coefficient estimates are required, the I.T.T.C. formula is used:

$$C_f = 0.075 / (\log_{10}(Rn) - 2)$$

(where Rn is the Reynolds number)

Two of the schemes estimate actual power needed, as well as effective power. To obtain this estimate, some propellor information is needed. The program inputs propellor diameter and pitch / diameter ratio, and estimates an optimum efficiency (based on Harvald, “Resistance and Propulsion of Ships", Wiley Interscience, New York, 1983, figure 6.3.10), and the advance ratio and rotation rate to which this optimum corresponds. The estimates were fitted to Harvald's full range of pitch / diameter ratios, from 0.5 to 1.4.

If you specify an inappropriate input parameter, the program will generate an inappropriate advance ratio and rotation rate. Since it does not take propellor design into consideration (Hullform is a hull design program, not a propellor design program), it has no way of verifying user inputs. You must therefore retain a critical “mistrust” of this part of the program's calculations.

The drag and power estimation schemes used by the program are described below.

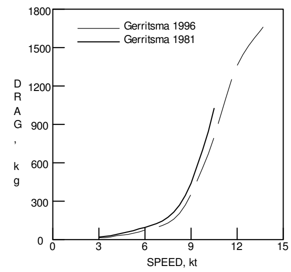
Please note that, while all care has been taken to ensure the schemes are as well implemented as possible, it is not always possible to prevent quirks of a design rendering any scheme inappropriate. Nor can responsibility be taken for the accuracy of the schemes on which the algorithms used have been based, or any unidentified ambiguities in the publications used. The program's calculations should always be checked carefully, to ensure accuracy of any estimates used in a commercial environment.

Overview Of Drag Schemes

Gerritsma et al. 1981

This scheme is the commonest used to estimate the drag of sailing craft, and is based on the “Standfast series” of model hulls (e.g., Gerritsma, J., Onnink, R. and Versuis A., 7th HISWA Symposium on Yacht Architecture, 1981, pp 46-106) It is intended to be applicable to shapes and displacements typical of racing yachts, and will not be reliable either for light-displacement hulls which plane readily, or for bulkier craft such as fishing vessels. (However, experience shows it to give broadly representative results for some of the latter cases) It only provides valid estimates for hull Froude numbers less than 0.45.

The algorithm uses a combination of skin friction and residual resistance estimates. Skin friction is derived assuming a flow speed equal to the hull speed - not an exact estimator, but recognising that areas of the hull's surface will have flow speeds both above and below the hull speed, probably a fair estimator of the mean. Residual resistance estimates are found using a cubic-spline interpolation between the table entries provide in the Gerritsma et al. article.



Gerritsma et al. 1996

This is an update of the earlier work. The scheme generally gives slightly lower drag estimates, but extends to a higher limiting speed, corresponding to a Froude number of 0.6. The plotted comparison at right - for a 17 tonne, 16 metre hull - is typical of these differences.

Holtrop And Mennen

This estimation scheme is based on "A Statistical Analysis of Performance Test Results" (J. Holtrop, International Shipbuilding Progress, Vol. 24, 1977, pp. 23-28) and "A Statistical Power Prediction Method" (J. Holtrop and G.G.J. Mennen, International Shipbuilding Progress, Vol. 25, 1978, pp. 253-256). Additional input parameters needed are propellor diameter, pitch / diameter ratio and whether the vessel is a single- or twin-screw type. The effects of a bulbous bow, described in the paper, are not included, primarily because of an apparent error in the paper's description.

Van Oortmerssen

This scheme was described in "A Power Prediction Method and Its Application to Small Ships" (G. van Oortmerssen, International Shipbuilding Progress, Vol. 18, 1971, pp. 397-415). The implementation in the program follows this description, except for the use of the form factor estimate suggested in Holtrop's paper. The scheme requires input of propellor diameter and pitch / diameter ratio.

Savitsky

Based on "Hydrodynamic Design of Planing Hulls", by D. Savitsky (Marine Technology, Vol. 1, No. 1, Oct. 1964, pp. 71-95), this is the commonest scheme used for estimating the drag of planing craft. The program implements the complete algorithm, and requires input of the propellor shaft inclination (relative to the hull baseline) and offset down from the base of the transom, in addition to the stored hull details.

In order to handle oddities of hull bottom forms, a somewhat arbitrary algorithm has been adopted to define the width of the planing surface. This width is taken to be the average, over all sections, of the lesser of either -

- the static waterline beam, or
- the beam to the outermost underwater points where the slope of the hull surface is 45°.

For some hulls of non-traditional form, this might give spurious results.

The program also implements the increased effective angle of trim, where the bottom deadrise is not constant. The angle between the keel and chine is estimated over the rearward portion of the hull, from the centre of mass to the stern - this being taken to approximate the wetted portion of the hull while planing. (Note that this angle should not normally increase in any significant manner, forward of the centre of mass, so the effects of the approximation should be minimal)

Savitsky And Brown

This uses the scheme described in "Procedures for Hydrodynamic Evaluation of Planing Hulls in Smooth and Rough Water", by D. Savitsky and P. W. Brown (Marine Technology, Vol. 13, No. 4, Oct. 1976, pp. 381-400). It is based on empirical parameters, and only applies for beam-based Froude numbers from 1 to 2.

It has been found to give results normally within about 20% of the Savitsky formulation, with excellent agreement often achieved by altering the position of the hull's centre of mass. It seems that the Savitsky and Brown formulation is derived for craft of "normal" centre of mass positions, and may be unreliable for extreme cases. (Even when their estimates differ, the trends shown by the two schemes are usually closely matched)

Drag Menu Items

Speed

The dialog box allows selection of a nominal speed and its units. The speed specified here is the value used in “drag for one speed” calculations, and used as the maximum in plotting drag curves.

One unit is always knots, the other (described as “measurement units”) being metres per second or feet per second, depending on the measurement unit selected for the design.

Area Plot

When selected, this results in the plotting on the screen of a curve of relative areas, with each section (where practical) labelled with the percentage of maximum area.

The plot is presented “stem left” or “stem right", depending on your selection under the Configure, X-positive direction menu item.

Drag For One Speed

This allows selection of any of the five drag calculation schemes.

Examples of output from each scheme follow. In all cases, a full set of parameters is shown, to permit checking of any estimate manually.

Gerritsma et al. (1981 or 1996)

```
Using I.T.T.C. formula:

For wetted surface of         497.148 sq ft
Reynolds number of              4.533e+07
Friction coefficient of         2.344e-03
Skin friction is                0.095 ton
For ...
Froude number                   0.364
Prismatic co-efficient          0.499   (optimum, 0.570)
Centre of buoyancy at          54.669 % (optimum, 53.543)
Waterline beam                 10.852 ft
Draught                         8.948 ft
Waterline length               43.016 ft
Displaced volume              561.297 cu ft
Length/displacement ratio       5.215
Residual resistance is          0.197 ton
So total resistance is          0.292 ton
```

Note that the theoretical optimum values for prismatic coefficient and centre of buoyancy are included. These are derived using only the residual friction terms, and ignore the contribution from skin friction.

Holtrop and Mennen

This display (and that for the Oortmerssen scheme, below) includes the propellor rotation speed and advance number, giving the optimum efficiency shown. The issue of whether this value is achievable is left to the user of the program.

```
For speed                                    13.511 ft/s
Waterline length (LWL)                       43.016 ft
Wetted surface                              497.125 sq ft
Skin friction coefficient (I.T.T.C)           2.694e-03
Prismatic coefficient (CP)                    0.499
Form factor                                   0.294
Centre of buoyancy (LCB)                     -1.338 %
Half-entrance angle                          16.478 deg
Beam                                         10.852 ft
Draught                                       8.949 ft
Reynolds number (Rn)                          4.533e+07
Froude number (Fn)                            0.364
Thrust deduction factor (t)                   0.019
Wake fraction (WT)                            0.016
Open water prop eff.(eta 0) @ 206 rpm,Ja 3.0  0.297
Hull efficiency (eta H)                       0.997
Relative rotative efficiency (eta R)          0.843
Drag force: friction        0.109
          + form drag       0.032
          + wave drag       0.310 =           0.452 ton
Effective power needed is                    24.855 HP
Thus total power needed is                   99.644 HP
```

Oortmerssen

The calculation summarised here used data identical to that used for the Holtrop and Mennen example. You should observe the difference between the power estimates: inconsistencies such as these routinely occur, and should demonstrate clearly that the reliability of the powering estimates rarely matches that claimed by the responsible author. The similarity of the skin friction and form drag terms should also be noted - this is due to the close similarity of the estimation schemes used.

```
For speed                                    13.511 ft/s
Displacement length (LD)                     44.449 ft
Wetted surface                              497.141 sq ft
Skin friction coefficient (I.T.T.C.)          2.682e-03
Prismatic coefficient (CP)                    0.499
Form factor                                   0.294
Centre of buoyancy (LCB)                     -1.334 %
Half-entrance angle                          16.476 deg.
Beam                                         10.852 ft
Draught                                       8.949 ft
Reynolds number (Rn)                          4.684e+07
Froude number (Fn)                            0.358
Thrust deduction factor (t)                   0.137
Wake fraction (WT)                            0.264
Open water prop eff.(eta 0) @ 154 rpm,Ja 3.0  0.297
Hull efficiency (eta H)                       1.173
Relative rotative efficiency (eta R)          0.930
Drag force: friction        0.109
          + form drag       0.032
          + wave drag       0.083 =           0.224 ton
Effective power needed is                    12.323 HP
Thus total power needed is                   38.049 HP
```

Savitsky

For the Savitsky calculations (here and in the plot case, below) you must input values for the slope and position of the propellor shaft. The slope must be positive for the case of a shaft which rises as it enters the hull, and the offset must be positive for a shaft whose alignment is below the keel line at the stern.

Following is a typical Savitsky drag calculation:

```
Values used:  LCG       6.071 ft
             Beam       5.964 ft
             LP/B       1.018 ft
   Deadrise angle      13.116 deg. (ratio 0.233)
Values found:  Cv       1.467
              CL0       0.198
         CL(beta)       0.166
           Lambda       1.656
       Trim angle       6.728 deg.
        Trim drag                      291.781 lb
    Lambda.Beam^2      58.899 sq ft
               Vm      19.603 ft/s
               Rn       1.510e+07
               Cf       3.154e-03
    Skin friction                       72.842 lb
       Total drag                      364.617 lb
Effective power required                13.436 HP
```

This example, and that below, were derived at a Froude number of 1.956, at the stage where the two schemes could be hoped to meet. The 20% difference can be reduced (as discussed already), but should be used as an illustrative warning.

Savitsky and Brown

```
Based on the empirical formulation of Savitsky and Brown
(Mar. Tech. 13, 1976, p. 381-400), for ...
Displaced volume^1/3 / Length ratio    0.234
Displaced volume / Beam^3 ratio        0.158
Half-entry angle                      54.621 deg.
Transom / Maximum immersed area ratio  0.432
Froude Number                          1.956
Calculated drag force is             450.703 lb
Corresponding effective power is      16.608 HP
```

Part of the cause for the discrepancy of the schemes might be the use of half-entry angle for the above calculation. A hull with small deadrise can have a large value (as shown), but still a small initial angle of incidence to the flow.

The “displaced volume” ratios, above, are both dimensionless numbers.

Plot Drag Curves

You may also plot on-screen, and transmit to the selected hardcopy device, calculations of the hull drag as a function of speed. Any combination of Hullform's five drag schemes may be used chosen, by setting any of five checkboxes.

The speed range over which drag curves will be plotted varies. The Gerritsma 1981 scheme is shown only to length-based Froude numbers of 0.45 (the documented limit of application), while the 1996 scheme extends to 0.6, and the Holtrop and Mennen and the Oortmerssen schemes are plotted to a Froude number of 0.5. The stated range for the Savitsky and Brown scheme is a beam-based Froude number from 1 to 2, and for consistency the full planing Savitsky scheme is shown from a beam-based Froude number of 1, upward.

Plots can be made simply for the existing state of the hull, for a range of displacements or a range of centre-of-mass positions. This choice is made when the program presents a dialog box, with options

Speeds to ...

The speed shown here is the limiting speed to be used in drag evaluation. Drag calculations will cover the range from zero up to this value.

The speed unit may be knots or measurement units - i.e., metres per second or feet per second, as appropriate.

Single Plot ...

⦿ Existing state

Here, no further inputs are required.

Multiple Plots for Range of ...

⦿ Displacement

⦿ X-centre of mass (LCG)

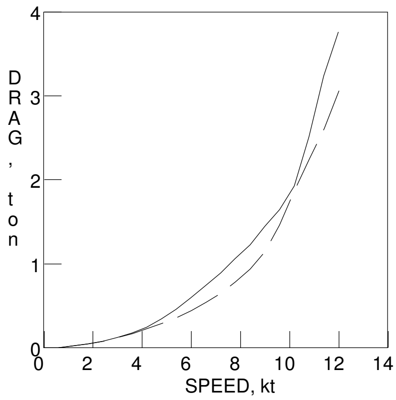
If you select either of these, you must provide inputs of the **Start value**, **End value** and **Increment**, to define the range used.

Then, starting at the largest value input, and working downward, the hull is re-balanced for the new value, and a new set of drag calculations performed.

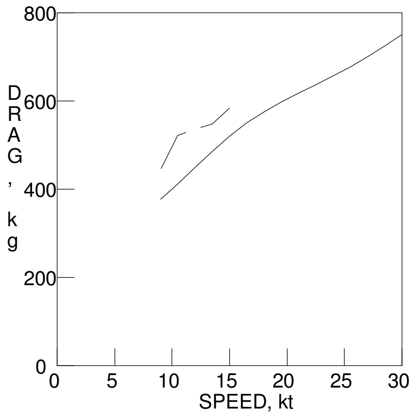
The vertical axis range is determined from the range of the first set of estimates. It is therefore possible for the second (text-colour) line to pass out the top of the plotting box.

When drag curves are found for a range of displacements or centres of gravity, the number of lines on the plot quickly becomes excessive. It is recommended that drag curves for no more than three conditions of the hull be simultaneously shown.

At right is an example of a plot showing Holtrop and Mennen, and Oortmerssen estimates. Agreement between the two schemes is well short of perfect.

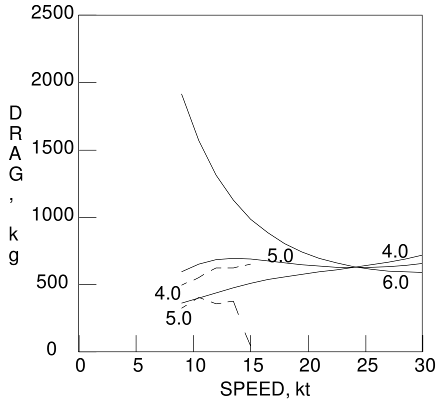


The second example shown is of a Savitsky, and Savitsky and Brown plot. Observe the generally similar trend for their common range of application, but also the differences. Commonly, the Savitsky and Brown curve (shown as a broken line) may be moved above or below the Savitsky curve, by a shift of LCG of about 10% of the overall length.



The final example, below right, illustrates an important point. It is for an 8-metre planing hull, with a normal LCG at 4.6 metres from the stem head. The plot is for LCG values of 4, 5 and 6 metres. The Savitsky curves are labelled with their LCG values on the right. The Savitsky and Brown curves are labelled on the left.

The general trend of the Savitsky curves looks valid, with the sternmost LCG giving highest drag at low speeds, lowest drag at high speeds. The Savitsky & Brown scheme gives higher estimates (within its range of application) for an LCG of 4 metres, and lower estimates at 5 metres. The best agreement clearly would occur around the “normal” LCG value (4.6 metres). It is not surprising that the latter scheme, being derived from real hulls with “normal” LCG's, appears to fail when abnormal LCG values are introduced.



PLATE

The comparison between a computer and a human was once summarised by describing a human as a slow genius, and a computer as a high-speed moron. This point is an important start to any review of Hullform's plate development section.

Plate development in Hullform presumes some intelligent intervention by the user.

The basic principles of developable hull surfaces are essentially simple, requiring fairly elementary vector algebra in their application. The “high-speed moron” is well adapted to this task.

However, the creation of a practical hull using such surfaces is less simple, requiring judgments which may be objective or subjective. At this stage, the “slow genius” is called in to assist.

The basis of the program's developable-surface algorithm is Kilgore's method. A surface is developable if non-overlapping lines can be drawn, such that at the edges limiting each line, the lines perpendicular to that line and the edges are parallel.

The program calculates, as far as possible, a set of ruling lines defining the developable surface, bounded by any adjacent pair of fore-and-aft hull lines, the transom and the stem. These rulings may be viewed, to assist the program resolve ambiguities, form judgements about the developability of the surface, and decide whether any change to either line would improve the result. The final results may then be used to modify the hull design, and to define transverse sections consistent with the developed surface(s) or the shape of the flat sheet which may be formed into the developed surface.

One simplification is used, to speed the calculation of ruling lines. Those lines intersecting the transom are presumed to originate from the next-higher-indexed (lower) curve. This means that, should the opposite be the case, some rulings will be missed.

The plate development information - that is, the set of calculated rulings - is retained, until you employ the Edit main menu option. On exit from the Edit menu, the program assumes that all rulings may have been invalidated, and cancels them.

Lines

This allows selection of the pair of hull lines between which a developed surface is desired. The value entered should be the higher of the index numbers of the two lines involved.

When a partial line is used, the program will only test that line over the longitudinal range for which it has been defined. If the two lines considered do not extend over identical ranges of hull sections, the “surface” being developed will be ill-defined, and odd ruling lines may originate from the extra length of the longer hull line.

Ignore Sections

Hullform is capable of representing hulls with discontinuous curves, as used for designs with cut-out transoms and planing designs with stepped hull bottoms. In such cases, the discontinuity can render plate development meaningless. Using this option, you can ignore those sections beyond the step (on either side).

For example, let's assume you have a hull surface which has 20 sections (numbered 0 to 19), with a step between sections 8 and 9. You could ignore sections 9 to 19 (entered as “9:19”), and calculate the form of the developed surface ahead of the step, then ignore sections 0 to 8 (“0:8”), and calculate the form of the developed surface behind the step.

Transom/Stem Lines

The curved forms of the transom and stem are defined independently of the design's longitudinal lines. This requires them to be treated a little differently in setting up the origins of the ruling lines. While the density of points along a line is set using the Configure, Extra drawing points, Line detail menu item, the number of lines attempted from the transom and stem curves must be set separately.

The appropriate number of lines to be drawn from the transom depends on the angle forward which the calculated ruling lines will take (e.g., for a 45° angle, the separation should be the same along both the transom and hull line). Before the calculation, this estimate is unavailable, so it must be entered manually.

The program will always draw one line forward from both the inner and outer ends of the transom. The default for this parameter, 5, allows three extra from the central region of the transom curve. For more detail in the area covered by rulings from the transom, this value should be increased.

Evaluate

On selection of this option, the program calculates the ruled lines which are possible. For the benefit of users on slower machines, progress is tracked, firstly by a report “INTERPOLATING", then followed by “DEVELOPING”. The former refers to the process of interpolating the requested number of points per pair of hull section, using a cubic spline algorithm, the latter to the search for ruling lines. (On newer machines, these messages will be shown so quickly that only the last may be seen)

The latter takes much longer, and it progress is monitored by a decrementing on-screen counter, which starts at the attempted ruling count, and decrements about once per second.

The program calculates all rulings possible. There may be more than one per point on each edge - such ambiguities are resolved later.

Viewing Position

For viewing the calculated lines, the program uses the same perspective drawing routines as are described under the View menu - see page 65.

Plot Rulings

Selection of this option leads to the plotting out of all rulings calculated, for all hull surfaces to which the algorithm has been applied. Rulings are plotted for all currently-developed surfaces; these may be displayed for any required hull orientation and viewing position.

When a set is first plotted, the program resolves the ambiguities mentioned above. When a sequential pair of ruling lines shares the same origin, both are plotted, and you are presented a small query dialog box. By pressing key combinations “Alt-1", “Alt-2” or “Alt-N” (or use of the mouse or cursor keys, as normal), you can select the means of removal of the ambiguity: n note the pair of lines originating near the stern in the above figure the “first” is the one nearer the stern, the second the one nearer the bow.

Sometimes, the program may calculate a ruling line which extends over a very long section of the surface - even from transom to stem. Such cases can not be removed automatically, since they are theoretically possible, on rare occasions correct, and only inconsistent with conventional hull forms. Manual removal is possible using the “Undo rulings” option (See below).

At other times, the two rulings may nearly coincide, so that only one is seen. Obviously, in such cases, either selection will do.

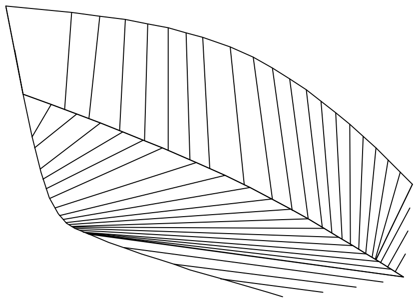
With the plotted rulings presented, you may then decide whether the end result is a valid ruled surface. There are essentially two criteria:

- no pair of rulings may intersect
- there must be a ruled line from every start point (i.e., the number of rulings per pair of sections must match the nominated ruling density).

If either rule is broken, the perspective view of hull may be rotated and “zoomed", allowing you to choose an optimum view of the problem area, and decide which hull line needs modification.

The example following shows a view of rulings evaluated for the design “PLANING” included in the Hullform distribution set. Rulings have been evaluated between both lines 1 and 2, and lines 2 and 3.

If you repeat this exercise, you will find that one spurious ruling is generated when evaluating rulings between lines 1 and 2 (adjacent to the stem), and several ambiguities arise when operating on the line 2 and 3 pair, due to interpolation at the line discontinuity where the chine meets the stem. Removal of the former requires use of the “Undo a ruling” menu option, but the latter issues are resolved at the first “Plot rulings” stage, by selection of the first ruling each time a the query dialog box is displayed.

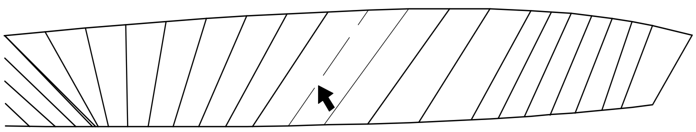


Undo Rulings

When a ruling line is (or lines are) generated contrary to the intent of the designer, removal is possible using this option.

Once this option is selected, the program waits for user input from the keyboard or mouse. A ruling is nominated either by

- locating the mouse pointer on the desired line, and pressing the left-hand key. The line will change to a broken form with a contrasting colour, indicating it's selection:



- pressing the up-arrow and down-arrow key, to move the selected line (again, shown broken and in a contrasting colour) to the one required. The initial position shown for the selected line is at the stern. When the required line is reached, you must press the “Enter” key.

When the required line has been identified by either means, the program prompts with a minimal dialog box, asking “Remove the highlighted line?”. This dialog box may cover the line; if so, it may be moved by dragging it to another screen position. The line is only removed if you select the “Yes” button in the dialog box.

The “Undo” option may be repeated as often as required, if more than one line is to be removed. For accurate location of rulings, the “Zoom” option may be used to expand the hull region of interest before using “Undo”.

Rollout

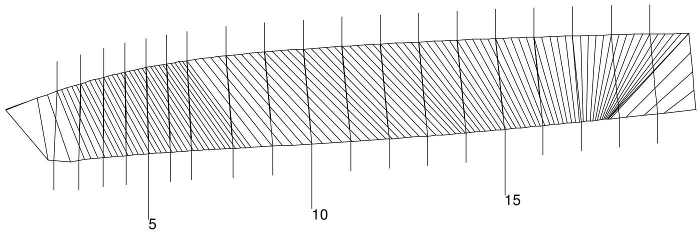
It is a simple step to convert the set of three-dimensional end points which define a ruled surface, to the flat sheet which may be formed into it. This option shows the outline of the flattened surface, for checking.

You may roll out the surface between the current line pair, or the transom. Since the transom is defined on a surface of fixed radius, it is readily developable, and does not require use of the “Evaluate” item beforehand. One half of the transom surface is shown, with the effect of any transom radius included.

If the surface is not fully developable, the calculated outline will not match the full hull surface.

The calculated surface area is also shown, on-screen.

The program rotates the image so that the major axis of the outline is horizontal. Also shown are section positions along each side of the rolled-out surface, and the total surface area of the developed plate.



The example above is of the surface of the “PLANING” hull design between lines 1 and 2. For this view, three extra points between each section were selected using the Configure, Extra drawing points, Line detail menu item, and nine transom lines were selected using the Plate, Transom/stem lines menu item.

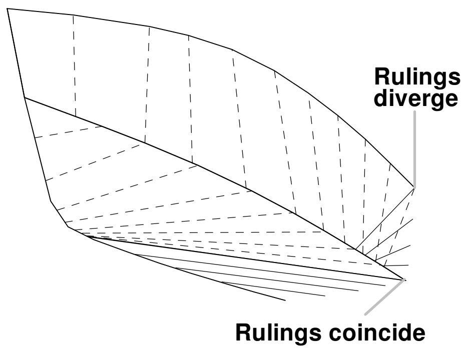
In some cases, one or more ruling lines may be missing from an area of the surface. These indicate that the program has been unable to find a development line in the area. In some cases, this is simply due to the limitations of the program's estimation scheme - where ruling lines which should originate from the transom or stem are missing, a useful test is to increase the number of transom/stem rulings, since more detail at the ends of the lines is then generated.

Users of AutoCAD® and comparable CAD programs may note that the rolled-out shape may be written directly to a “DXF” file, using the program's DXF “graphics driver", and the File, Plot menu item. The units output give the actual dimensions of the surface.

Fix Transom Curve

The processes by which the transverse hull sections and fore-and-aft lines are designed are totally independent. This means that ruling lines drawn from the transom section and from the upper of the pair of lines selected will generally be inconsistent. This will be most evident at the outer end of the transom, from which the program draws two lines - one determined by the transom curve, one by the form of the hull line it meets.

This problem is demonstrated by the example below. Rulings drawn from the hull's longitudinal lines are shown dotted, while those from the transom are shown solid. The two rulings drawn from the meeting point of the transom and chine are coincident, but those drawn from the meeting point of the transom and sheerline are not coincident.



For the surface to be developable, there must be a unique line drawn from each point on its border, so this disparity must be removed.

This menu option attempts to shift the lateral control point for the transom curve, either inward or outward, to make the two lines from the outer transom end match. In general, the algorithm used succeeds, as long as:

- You have already used the Evaluate sub-option to determine the ruling lines of the hull surface.
- The evaluation has found a valid ruling line from the end of the transom - although this may be inconsistent with that from the adjacent point on the end of the hull line.

Should either requirement not be met, no changes will be made.

The main exception occurs when the z-control factor for the curve concerned is 1, in which case the control point remains at the same level as the outer end of the transom. This prevents the program from making the necessary adjustments.

Write Sections

The developed surface is unlikely to match exactly the hull surface curve defined previously. The difference can be minimised by manual editing of the affected hull sections, but it is more efficient to write out the hull section outlines which exactly match the ruled lines.

When this option is selected, the program evaluates, for each section, the intersections of all ruling lines with its plane. It writes out the hull line points, with these intersections between.

You are prompted for the required file name, using the Windows 3.1's standard file dialog box.

The number of intersections will be variable, depending on the angle made by the ruling lines to the hull axis. If they are close to perpendicular, there may be no intersections. This corresponds to a current limitation of the program. (In such cases, the outline would be close to straight between the hull line points)

Note that output of calculated section intersections for each ruling line also occurs when “DXF” file output is used (See File, DXF output).

Write Outline

The outline shown by the “Rollout” option may be written to the currently-selected text device, using this feature. The data are written as two pairs of co-ordinates on a plane surface, these being the ends of each ruled line. The set formed by the first of each pair marks one edge of the rolled-out surface, that formed by the second pair marks the other edge.

This option writes to the selected text device (see Configure, Text output port/file), the hull line points, with these intersections between. It may be used to provide input to a CAD program not accepting DXF file input.

TANKS

Hullform allows definition of a number of compartments ("tanks") within the hull, which may be located on either side of the hull, and treated as filled to any extent between empty and full, or fillable to the external waterline.

The program can evaluate the equilibrium state of the hull for any condition of these tanks, as well as many other hydrostatic parameters. In the partly filled ("fixed volume") state, the surface of the liquid contained remains level, and functions as a physically free surface - so "free surface corrections" are not required for the program's hydrostatic calculations. A tank fillable to the waterline (termed "leaky" within Hullform) functions as a normal, but interior, surface of the hull.

A tank is defined by a set of partial hull lines and sections, as shown at right. The first tank uses hull lines commencing one beyond the last line of the exterior hull surface (3, at right), the second tank commences after its lines (4 to 7), and so on.

Any number of sections and lines may be assigned to a tank, with the constraints that tank sections are the same as hull sections, and the total of hull plus tank lines must not exceed the program's line limit. (Since sections may be located anywhere along the hull, the former is no real constraint).

The tank line indices are ordered in the reverse sense to those on the exterior surface of the hull. In a normal end-elevation view, Exterior surface line indices increase in a clockwise sense around the hull, while tank line indices increase in an anticlockwise sense. This is required because the displaced volume of the hull must remain on the same side of the hull/tank outline. Do not reverse the sense of lines during editing - the tank will have negative volume.

A tank is normally inside the hull, but there is no actual requirement for this in the program's calculation scheme. You can, for example, move the lines of a tank outside the hull and edit them to form a keel, and then nominate any density for its contents. The program will handle the stability effects of this keel without problems.

The tanks may be edited along with any other part of a hull section, and displayed within the hull viewing options.

The principal menu item is the first "Edit tanks". This allows you to add a tank, delete any tank and edit the bulk properties of any tank.

Add

When selected, this provides for input of three basic tank parameters - the start and end section, and the number of lines required. When inputs are completed, the new tank is added to the set for the hull with default properties which may later be altered using the "Edit" button.

Start section
End section

The start and end sections may range from 1 (i.e., they may not commence at the stem section), to the highest section number in the hull. If the desired end position does not correspond to an end of the tank, the Edit, Create a section option should be used to locate a hull section at the required position.

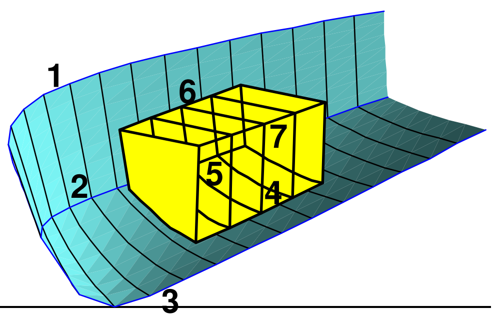
Description

You may enter a text string here, of up to 128 characters, describing the tank - for example, "Port water tank".

Specifying the Shape and Size

Arbitrary Shape

If you use this option, you will need to design the tank yourself. You specify the number of lines (for example, three for a triangular tank), and the program automatically locates them within the hull. You must use the program's line and section editing capacities to generate the shape required.



Remember that, if you want total control over all surfaces of the tank, you will need to use one extra line. If a square tank is required, four lines will be all that are needed. However, four lines means only three pairs of lines, and curvature is only definable between pairs of lines - so only three of the surfaces of the tank may possess any curvature. If you require curvature on each surface, one additional line should be defined for the tank, and the first and last line made coincident, using the Edit, Edit a section menu item, in “text” mode.

Rectangular Shape

Here, the program can automatically generate the shape of the tank for you. You specify the width, depth, the lateral offset of the inside, and the vertical offset of the base, and the program will produce a tank to those specifications extending over the nominated range of sections.

Mirror Another Tank

In this case, you need specify only the index number of the tank to be mirrored. The new tank will have identical offsets, density and so on, but will be allocated to the opposite side of the hull (starboard for a port tank, port for a starboard tank). Since most designs have a symmetrical or near-symmetrical tank layout, this feature can halve the work required in the tank definition process.

Fit inside hull

Commonly, a tank is formed partly by the outer surface of the hull, with only a thickness correction to be applied in calculating its shape where it meets the hull. This option attempts to fit an otherwise rectangular tank to the hull surface, where its nominated dimensions would see it extending outside the hull.

The options appropriate here are:

Port / Starboard / Both sides
These radiobuttons have the logical effect, allowing the hull to be located on one side of the hull, or to extend across its full width. The "both sides" option generates a symmetrical tank.

Top / Base / Inside / Outside
These values correspond to the vertical and horizontal limiting offsets of the tank surfaces, measured in the coordinate system used to define the hull. The "inside" value is ignored for a tank extending across both sides of the hull, and you can ensure that the tank extends out to the hull surface through its full depth by entering a very large value (e.g., 1000) for the outside offset.

Skin Thickness
This is the thickness subtracted from the shape of the outer hull, in calculating the tank shape – noting that the shape of the tank corresponds to its inside surface.

Delete

This permits you to remove a tank permanently from the inventory. To delete a tank, highlight its entry in the tank list box, and press the “Delete” key.

NOTE that, in order to remove a tank temporarily, this option should not be used. The “Status/position” option (See below) allows a tank to be declared of “fixed volume”. By setting the “% full” value to zero, you can effectively remove it from calculations.

Edit

This item allows the configuration of each tank to be individually defined. To edit the properties of any tank, highlight its entry in the tank list box, and press the “Edit” button. You can then modify the following:

Tank Position

⦿ Port

⦿ Starboard

A tank may be located on port or starboard sides of the hull. In Hullform 5 and earlier versions of Hullform 6 (which did not possess the extended tank-definition capacities of your copy), a tank could be located on both sides of the hull. With the need to allow for separate filling levels and liquid densities, this option is now not available - but you can still define two tanks of identical dimensions, separately located on each side of the hull.

Filling status

⦿ Leaky

⦿ Fixed volume ...

⦿ % volume ...

A leaky tank is always filled to the external water level, while “fixed volume” and “% volume” tanks hold a nominated volume of fluid. The only difference between the latter two is the manner in which you specify their contents - as a volume, using your chosen measurement units, or as a percentage of the full tank volume.

... Contents

If you have nominated “fixed volume", you must enter the volume of fluid, in terms of your chosen measurement units, cubic metres or cubic feet. (While litres and gallons are commoner measurement units for fluid volume, the cubic metre volume is simply 1/1000th of the litre volume, and a gallon differs in size from country to country - the first is too easy to bother adding a conversion, the second too hard)

Any value from 0, to either 100 or the full tank volume may be entered here. Values less than zero are converted to zero, and a limit of 100 or the full tank volume is also imposed.

Specific Gravity

The fluid in a tank may be fuel, oil, fresh water or salt water. The density of the fluid in a tank is determined by its specific gravity - typically about 0.8 for fuels, 1.0 for fresh water, 1.025 for sea water. The value entered here may be any of these, or any other - no checks are applied (so a “keel” defined as a tank - see page 88 - may contain a solid of any density)

Permeability

This corresponds to the fraction (ranging from 0 to 1) of the tank which is actually occupied, when it is filled to any level. In damaged stability analysis, a tank may, for example, correspond to an engine room, and some of the volume would be occupied by motors or other equipment.

The calculated free surface moments are not affected by this factor, since the program includes no information on the location of the occupied space, relative to the water surface. Should this ever be an issue, the solution involves designing a tank within the tank concerned, but with its line sequence in reverse order. This will have negative volume and negative free surface moment, producing the required compensating effect.

Calibrations

This menu item provides calibrations for an instrument measuring a tank's contents (be it a dipstick, or a remote-reading device).You may calculate a set of volumes, given a set of fluid levels at regular intervals, or a set of fluid levels given a set of volumes (actual or percentage) at regular intervals.

The dialog box requires input of a valid tank index number (from 1 upward), and an interval. If you check (or leave checked) the “**level from volume**” radio button, the interval is a cubic volume, in terms of your chosen measurement units. The “**level from % full**” button implies that you interval is a percentage of the full tank volume, while the “**volume from level**” radio button implies that the interval is of depth in the tank.

A further set of dialog box options allows calculations to be displayed on-screen, plotted on a graph or written to a disk file.

During on-screen display, calibration details are written to the program's display screen. You can copy the screen contents to the Windows clipboard for use in other programs. You may also print the screen contents.

The “write to disk file” option provides another way to transfer calibration data to other programs. Data are written in three columns, in sequence volume, percent volume and liquid level down from the full state. The columns are separated by single “tab” characters, allowing simple formatting when read into a spreadsheet or word processing program.

When results are plotted, the vertical axis is the volume contained, the horizontal axis is the distance of liquid surface down from the full level. The resulting graph may be plotted on your Windows printer, or plotted using the program's own drivers, if required.

The calculation proceeds from the full state downward, and volume, percent volume and the distance down from the full state of the liquid surface are shown. Calculations continue until (in “show on-screen” mode) the screen is filled, 100 set of values are displayed or volume becomes less than zero.

Statics Summary

You can write to disk a detailed summary of the hydrostatic effects of your defined tanks. When you use this menu item, you are only asked to provide a file name to receive the information.

The summary written to disk includes, the filling fraction, mass contained, VCG, vertical moment, LCG, LCF, longitudinal moment, transverse and longitudinal free surface moments and heeling moment. By way of example, the brief table below shows a summary for two tanks located at position 5.0 metres, both 50% full. (Some abbreviations have been made to fit the table on the page)

Tank	Frac	Mass	VCG	Ver.Mom	LCG	LCF	Lon.Mom	Tr.FSM	Lo.FSM	moment
1	50.0	1000	0.47	-471	5.00	5.00	5000	662.5	1885.6	308.9
2	50.0	2000	0.25	-500	5.00	5.00	10000	1166.7	2666.6	-750.0

The format is intended to allow easy insertion into stability books. Additional columns may be added to the output file, as users request other details.

STRINGERS

Stringer design is not directly related to designing a good hull shape. However, there are usually strict regulations governing the placement of stringers within an approved hull. Since the spacing of stringers on any hull frame (i.e., section) is tightly linked to its shape, and since the shape model is an explicit property of the program, it is useful to have stringer design within Hullform.

Add Stringers

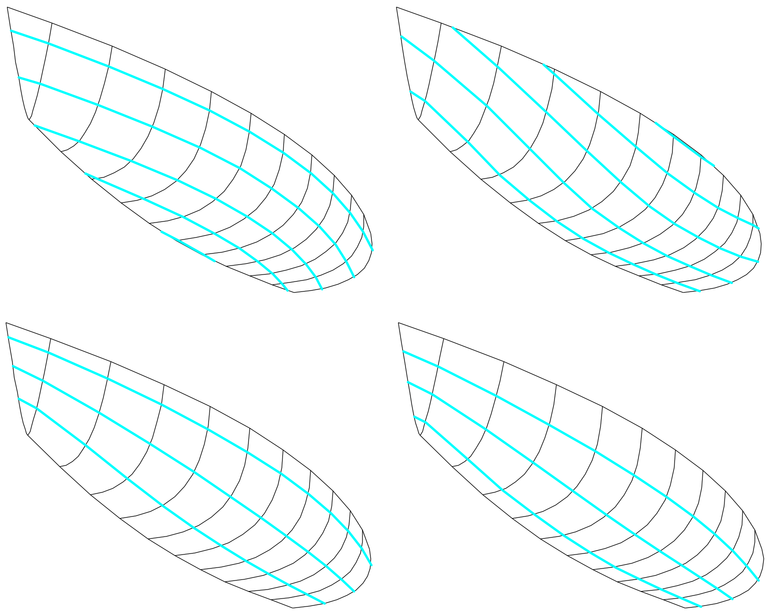
You may define the arrangement of stringers between any set of pairs of adjacent hull lines. The stringer details are retained within the program's memory, but not written to a file on exit. (Stringer generation is a quick and simple process, not justifying saving to disk)

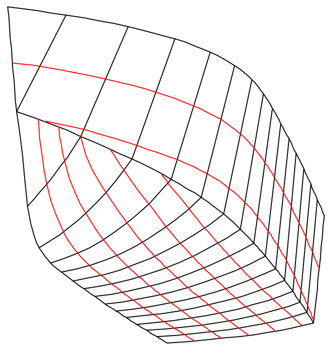
The program finds a set of stringers which may be either:

- set at uniform intervals across the surface, with the number of stringers found varying from section to section, or
- spaced uniformly between each bounding hull line, with the stringer separation varying from section to section.

The number of stringers or stringer separation, and the distance to the first stringer, are required inputs for the stringer scheme used by the program. You must also specify whether the first stringer is adjacent to the lower-indexed (normally higher) hull line, or adjacent to the higher-index line

Below are examples of the resulting four alternatives. Stringers (shown shaded) have been calculated for the surface of a simple hull. The start of the calculation of stringer locations may be either the lower-indexed (as on the left, below) or higher-indexed (as at right) of the pair of hull lines bounding the surface. Cases for a uniform stringer spacing, with initial spacing half the inter-stringer spacing, are shown at the top. The lower examples are of a fixed number of stringers.





You may calculate, display and write out stringers for all surfaces of the hull, with different spacing and different directions used for distance calculation. The example at right shows a hull for which stringers have been calculated at a coarse interval, starting at line 1 and continuing downward, and at a finer interval starting at line 3 and continuing upward.

In calculations of stringers, the program works one surface at a time. You must provide the following information to the program:

Number of the higher-indexed line

This defines the pair of lines to be used. Remember that it is not necessarily the line from which distances are calculated - this point is identified at a separate location in the dialog box.

Interval

This value defines the distance between stringers (in your chosen measurement units). The distance is measured along the curve of each hull section, and the stringer separation is therefore an exact constant along the hull.

Width

This value is used when menu items File, Builder's offsets (page 34), File, DXF Output (page 38) or View, End elevation (page 64) are invoked. It represents the width of the plates used to form the stringers, presumed to be uniform along their full length and across the hull surface.

Thickness

As for “Width", this value is used when menu items File, Builder's offsets (page 34), File, DXF Output (page 38) or View, End elevation (page 64) are invoked. It represents the thickness of the plates used to form the stringers.

Both the width and thickness are retained until either the program run is terminated, or they are altered during re-definition of the stringers for the hull surface.

Back (up) from higher-indexed
Forward (down) from the lower-indexed

Here you define whether the first stringer is closest to the lower (higher indexed) line, and the upper (lower indexed) one.

The stringers may start and end between hull sections (as in the examples above), and the program will do its best to estimate the locations of the start and end points. But if the end location does not appear accurate enough, it is recommended that an additional section be added to the hull, just aft of the start or forward of the end. This will help the program make a more accurate estimate.

Uniform stringer interval
Fixed number of stringers

These options control the stringer separation - the first gives a variable number of stringers at uniform separation, the second a fixed number of stringers at a separation which is constant across one section, but varies from section to section. Examples of the results of using these options were depicted earlier. You MUST select one or other of these options.

When you select the first, you are prompted (by a small dialog box) to provide the interval between stringers, and the interval to the first. If you select the second, you must provide the number of stringers required, and the fraction of the stringer interval (a constant for each section) to the first stringer.

Delete Stringers

Here you must provide the higher-indexed line of the bounding line pair.

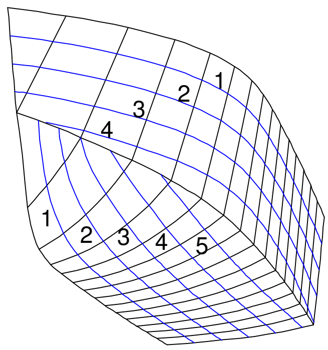
For example, if you have created a set of stringers between lines 2 and 3, the correct number to enter is 3.

Plate Development

You may calculate the outline of the rolled-out form of any previously-calculated stringer **(one at a time)** using this menu item. You must tell the program the stringer to use, by

- nominating the **number of the higher-indexed line** of the pair of lines bounding the surface on which the stringer lies.
- specifying the **index number** (starting at 1) of the stringer.

For example, in the view at right, there are four stringers indexed 1 to 4, running down from line 1 to line 2, and five stringers indexed 1 to 5, running up from line 3 to line 2. To find the developed form of the highest stringer between lines 1 and 2, you specify hull line 2, index number 1.



True and False Development

There are two development options available, termed "**False**" and "**True**". In "True" development, the program treats the bounding edges of the stringer as it does two adjacent hull lines, using the Kilgore scheme in an attempt to create a true developed surface. But, due to the narrow width of the stringer and its usually-large twist, this attempt usually fails.

In "False" development, the program presumes sufficiently-accurate Kilgore-style ruling lines can be drawn at right angles to the hull axis, and uses these for plate development. The resulting rolled-out surface appears a fair representation of the form the stringer must have, and reported experience so far suggests that the scheme is accurate for normal stringer widths.

Once you have calculated the developed form of the stringer, you can plot it (including to a DXF file) or write its outline to a file, using the File, Plot and Plate, Write 2d outline menu options respectively.

Plot Stringer Rulings

This is actually a separate entry to the Plate, Plot rulings menu item, the two edges of the stringer being treated exactly as two hull lines. See page 84 for a full explanation.

Undo Stringer Ruling

This is actually a separate entry to the Plate, Undo Rulings menu item, the two edges of the stringer being treated exactly as two hull lines. See page 85 for a full explanation.

Rollout Stringer

This is actually a separate entry to the Plate, Rollout, Current Line Pair menu item, the two edges of the stringer being treated exactly as two hull lines. See page 85 for a full explanation.

Write to File

This menu item allows you to output, in sequence, the offsets of each stringer defined for the hull. If you have already defined one or more sets of stringers using the menu item Edit, Stringers (See page 91), you will be prompted for the name of a file to receive the output, and all stringer positions will be written out.

Output is stringer-by-stringer. Values for each line are headed by a line of form “LINE n, STRINGER m", where “n” is the hull line index, and “m” is a sequence number for the stringer. Following are a set of x-, y- and z-offsets, and associated section numbers. For most section numbers, the x-offset matches the x-position of the section. But for the first or last section, it may not - where this occurs, the section number is followed by a “*” character.

SURFACES

You can use this facility to construct a hull from a number of separate surfaces.

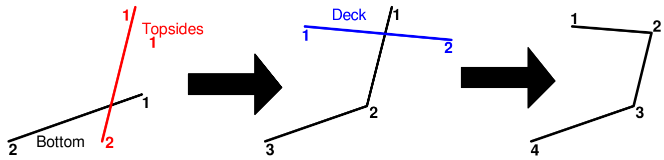
Overview

When you design a hull, particularly one constructed from sheets of metal or timber, you often commence with preconceived ideas about the separate form of each sheet, when added to the hull. Alternately, having completed the hull body, you may want to add a deck or superstructure. Filling these requirements becomes much easier when you can design the hull surfaces separately, and merge them later.

Hullform allows you to perform this function. For each final hull, you design a main hull surface (usually the hull bottom), plus a number of surfaces which intersect with it.

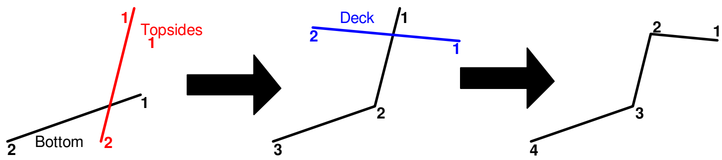
You must be careful in defining your “surface set” to remember that the final product of the intersection of surfaces depends on the ordering of hull lines in each surface, and the order in which they are merged. The following general rules apply:

1. The first merged surface in your list is merged with the main hull surface, the second is merged with this, and so on. The diagram below illustrates the process



The significance of the order in which the merging occurs should be clear in this example. If an attempt were made to merge the deck with the bottom surface, the attempt would fail completely, because the two surfaces do not meet.

Note also the importance of the sequencing of hull lines in the merged surface. If the lines of the deck were reversed, the results would have been:



2. The end result of each merging step is formed from the lines of the merged surface, up to the line before the merged surface, then the line formed by the intersection of the two merged surfaces, then the lines of the hull from the merged surface onward.

Dialog Box Items

When you select the “Surfaces” menu item, a dialog box covering all surface functions appears:

New

This item clears any previous surface set from the program’s memory. This is the program’s default state, so you need only use it if you have been working with one surface set, and want to commence a new one.

Open

Use this item to open a saved Hullform surface set file. The program will check for all files with a “hss” extension, in the current hull data directory.

Save
Save As …

The current surface set will be saved in the current hull data directory, with a name supplied by yourself and a “hss” extension.

Move Selection: Up / Down

These buttons may be user to arrange surfaces into the required order in the set definition. To use it, highlight one file name in the central list box (normally you would use the mouse for this), then use the “up” or “down’ button to move it in the required direction.

Add a Surface File

Use this button to add a file to the surface set. You will be presented a dialog box, and when you “open” the file you require, it will be added to the list.

You may need to use the “Move selection” buttons to put the file into its proper position in the sequence of surface.

Merging Parameters

This button generates a dialog box by which you control the mechanics of the surface intersection, for the surface currently highlighted in the central list box.

The indices referred to are those defining which surface of the merged design and which of the hull are to be used in the merging calculations. In both cases, the indices refer to the higher-indexed of the pair of lines bounding the surface.

The “Include merged surface sections” item allows you to control whether sections from the merged surface are to be added to the sections of the resulting hull. In general terms, if the merged surface has fore-and-aft detail - as is the case for a superstructure - you should check this box. If it is simply a fair deck or side surface, you may be best advised to leave it unchecked.

Remove Selection

When you press this button, the highlighted file in the central list box will be removed.

The file itself will remain in the hull data file directory, and can be added again if you later decide it should not have been removed.

Edit Selection

When you press this button, the highlighted file in the central list box will be opened for editing.

The surface set dialog box will be closed when you do this. You gain access to the surface set interface again simply by selecting the “surfaces” menu item.

Merge

When you press this button, all surfaces will be merged, and the result will remain loaded in Hullform. You should check that the result is as intended, before saving it.

Quit

This closes the Surfaces dialog box.

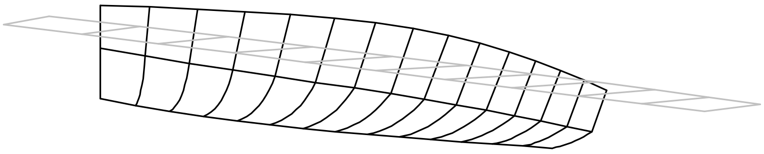
Help

This button generates help information.

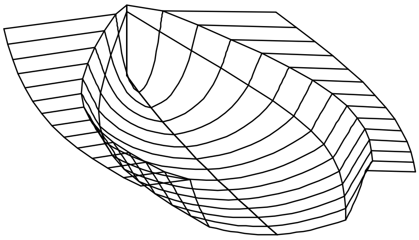
Merging Hulls - Examples

Some Simple Usage Errors

The first example shows how small usage errors - and perhaps unreasonable expectations - can lead to unexpected results. The merging involves a dinghy hull and a flat deck. When previewed using the deck as the overlay hull, you can see that the program's default choices of the surfaces between lines 1 and 2 for the intersection, for both the hull and the deck, are correct.



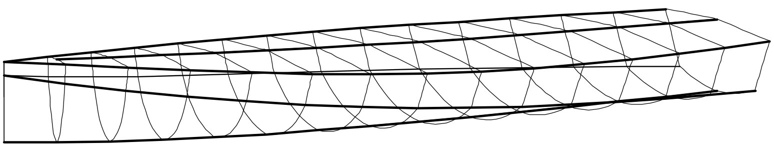
When the merging has been conducted, however, there are some effects which might be unexpected:



Notice that:

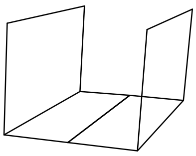
1. The deck has extended outward from the sheerline rather than inward. This is, in fact, correct behaviour, because the deck was designed with line 1 on the outside, and line 2 on the axis - the wrong way around for most applications (except, perhaps, aircraft carriers) Remember always that the lines from the merged surface which remain after the merging operation are the low-indexed ones. If you want the deck inside, the low-indexed lines must be inside too.
2. The sheerline has dropped at the stem. This is a result of the same error. The program presumes that line 1 of the merged surface is the best to use to define the height of the stem, after merging. Because the deck slopes downwards from the centreline, the stem intersection is lower than expected.
3. The deck does not extend right to the bow. This occurs simply because transverse detail, as occurs in the deck, can not be handled as part of the fore-and-aft structure of the stem profile.

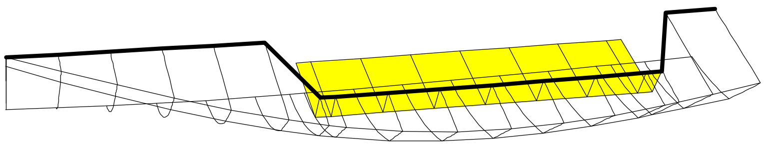
With these matters addressed, the result becomes much closer to what you would expect - as in the full perspective view below:



Another typical problem occurs when merging surfaces with discontinuities. This example involves merging a simple cockpit form with the above decked hull.

The sharp change occurs at the ends of the cockpit (shown at right). When merging has been done with the hull we have been using so far, the sharp transition has been lost. Although we can see the ends of the cockpit (floor area shown shaded), there is an angled line running from its ends to the hull centreline.



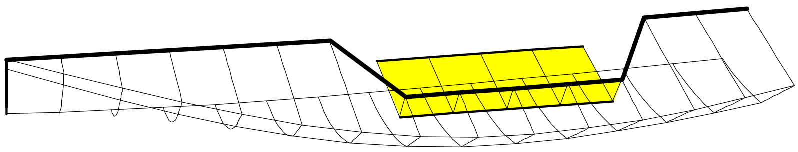


There are two ways this can happen:

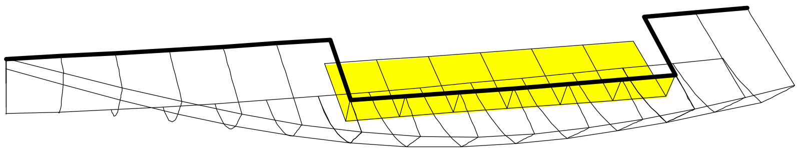
1. The foremost (and sternmost) sections of the cockpit are not close to the next section forward and the next section aft, of the hull into which the cockpit is being merged. To generate a sharp step, you need two sections close to each other. For example, if the next section of the hull forward of the cockpit is at 2 m, you should have the first section of the cockpit at a position like 2.0001 m. Similarly, if the next section of the hull aft of the cockpit is at 3.5 m, the last section of the cockpit should be at a position like 3.4999 m.
2. You have not ensured that the checkbox "Include overlay sections" in the "Merging parameters" dialog box is set. If you do not do this, the crucial end cockpit sections will not be included.

The view above corresponds to the first error. All hull and cockpit sections are present, and Hullform has simply drawn a straight line between the available sections.

The following view corresponds to the second error. It shows the cockpit added correctly, but since its sections have been omitted, the details of its ends have been lost.



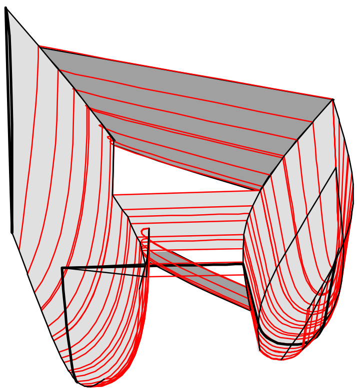
The final view, below, shows the effect of correcting both errors:



Limitations

Several conditions can arise which are the result of program limitations. As the merging algorithm matures, these will become less common, but there will probably always be "unforeseen circumstances".

A good illustration of issues at the time of program release is shown at right. It represents merging of a catamaran form with a central hull, to form a trimaran. The overall form of the "perfect" result is shown by the pale shaded region. This is by far the easiest way to generate a trimaran, but highlights a few secondary issues. Notice that:



1. There is a "doubling" of the line marking the stem - shown by a wide line. This is due to the program's presumption that the sheerline - line 1 - extends to the stem. In this case, line 1 only extends to the forward end of the outrigger hull. The simple solution is the edit the stem manually, to draw the two lines into coincidence.
2. The error towards the stern, shown by the second wide line, generating a negative excursion of one hull line. This occurred due to truncation errors in the merging code, and was due in this case to the near-coincidence of two hull sections. There are many code components handling such exceptions in Hullform, and these cases are now relatively rare, and becoming rarer. The solution in this case is simple - the section is superfluous, being close to another, and may be deleted.
3. The continuance of the surface corresponding to the bridge deck, forward and aft of the central region where the two surfaces intersect - shown by the darker shaded regions. The issue here is a difficulty within the program in handling some configurations of partial lines. There are a range of solutions which can be applied after the merging operation, but these will generally be only a part of the subsequent editing needed - for example, in replacing the lost part of the central hull's sheerline.

Handling Surfaces

When a design is merged, Hullform always removes any stem before the merging process. The reason for this is simple - Hullform can only handle a single stem.

The simplify the process of creating and editing a surface for merging, a “surface” hull design subtype is defined. When you initialise a new hull, you can invoke “normal” or “surface” mode. In surface mode, there is no stem available, and the program’s statics menu is unavailable.

A surface is simply a normal hull design with a negative displacement

You can convert a normal design to a surface very simply. The identifier of a “surface” design is a negative displacement. To perform the conversion, select menu item “Statics, Settings”, enter a negative displacement (The program’s convention is -1, but any will do), and save the design with a suitable name. When you open this design again, it will appear in the title bar with a “(surface)” entry after its name, showing it is now a hull surface.

Converting a surface to a normal hull design is less simple, and probably wisely so, because the stem is undefined. You can do it, however, by opening the hull data file using a text editor, and altering the “-1” on the top line, to change the displacement to a positive value.

Remember also that you can merge a normal hull design with a normal hull design, with the sole qualification that its stem detail will be ignored.

RUN

Hullform includes the capacity to launch other applications from the program's menu. Windows offers many ways to multi-task applications, but putting them in a menu makes accessing them much faster. And in either case, there is provided a means of communicating the current hull design from Hullform to the launched program, which no other task switching technique supports.

The Run menu, in its basic form, only provides the “Add program” and “Delete program” options. As extra items are added, these appear above the “Add program” line.

Add Program

The dialog box presented when you select this item requests a title for the menu entry, the name of the program to run, whether you wish to add the hull data file name as a command-line argument and whether you wish to re-open the hull data file on return.

The first is the text you will see when the Run menu next appears. You can include the “&” character, which makes the following character the one which invokes the menu item when keyboard commands are used (i.e., the one with the underline). There is a limit of 16 characters permitted (including the “&”).

The second item to be provided is the program name. If it is accessible in your computer's directory search path, you need only enter its name (e.g, “SKETCH.EXE”). Otherwise, you will have to enter the full path name for the program (e.g., “C:\SK\SKETCH.EXE”).

The program nominated may be any MS-DOS program or batch file, a Windows program or a Windows program information (“PIF”) file.

The third item specifies whether you wish the current hull design to be made available to the requested program as a “command argument”. Many programs will accept a file name as command argument, opening the file when invoked without the use of the “File", “Open” menu sequence. To ensure that the file provided is up to date, it will be saved automatically before the program is run.

The fourth allows automatic re-loading of the hull design file when you exit and return to Hullform. This will be necessary if the file is altered by the program you run.

To make the alteration permanent, select menu items “Configure", “Write configuration”. The updated list will be written to file HULLFORM.CFG. Alternately, your full program configuration - including the Run menu - will be saved when you next exit the program.

Suggested additions include:

Windows calculator which provides basic or extended scientific/engineering functions. When you want to perform some checks of, or minor calculations based on, Hullform's own calculations, it is a handy alternative to searching through the mess on your desk for your old calculator.

Menu entry:	&Calculator
Program to run:	CALC.EXE
Add ... argument:	leave unchecked
Re-open hull file:	leave unchecked

Windows notepad editor is a simple text editor following the normal Windows keystroke and mouse conventions. For simple tasks involving small files, it is a very useful tool.

You could provide for editing of the text of your current hull design file using the following:

Menu entry:	&Edit hull file
Program to run:	NOTEPAD.EXE
Add ... argument:	checked
Re-open hull file:	checked

Delete Program

You will be shown a dialog box containing a list of menu items which may be deleted. Select the one to be removed, and click “OK” (or press the enter key).

To make the alteration permanent, select menu items “Configure", “Write configuration”. The updated list will be written to current configuration file. Alternately, your full program configuration - including the Run menu - will be saved when you next exit the program.

CONFIGURATION

This section of the program allows you to customise of many of the program's facilities to your personal preferences. All items discussed may be changed at any stage of program operation.

Remember that you can save most of the program’s configuration items using the “Write configuration” item at the bottom of the Configuration menu. They are also saved when you exit Hullform.

Plotter

Windows provides extensive support for both textual and graphical most printer and plotter devices. But printer drivers are not available for some graphical formats. In addition, while many Hewlett-Packard plotters are listed, the wide use of the HPGL protocol by word processor, desktop publishing and CAD programs, for import of graphics files, means that it is useful to have a quick-and-simple HGPL output facility as well.

The “plotter” formats supported are None, HPGL, Tektronix, ReGIS, DXF and Windows metafile.

Normally, Windows identifies and allocates all available serial and parallel ports. This means that, while Hullform permits plotter output to go to any such port, Windows will prevent access. The normal destination for plotter output is therefore a file.

Port/File to be Used

This edit box is where you nominate the normal destination for plotter output. Whenever you select the “File”, “Plot” menu item, you will be able to alter this name, but it is useful to be able to direct your output to a standard destination - e.g., a file of name “hullform.dxf” in your normal working CAD directory.

Supported Graphics Formats

NONE:

The first option, NONE, is primarily a “safety net", used only when you have no plotter device available, and do not want to risk locking up his computer when a graphics driver sends data to an unused port.

HPGL: The program uses the pen-move, line-draw, label, text direction and colour pen facilities of the Hewlett-Packard Graphic Language, only pens 1, 2 and 3 being used. The output is of ASCII format, allowing later editing of file output.

Editing of two elements of the header line of the output file may be of value. The letters “SC” on this line lead four numbers indicating the range of plot values which correspond to the lowest and highest x- and y- values for the plotted page, and letter “SR” precede values specifying the size of text characters.

Tektronix: Some graphics devices still support this format, which uses the 40xx protocol. It is a very simple format, providing no shading, line style control, font control or character scaling.

DXF File: This is a special driver, for generation of DXF output from any part of the program giving graphical output. The output co-ordinates are in the units of the designed hull (altered only by addition of a constant, to ensure co-ordinates remain positive). Character size is fixed at 2% of the length of the hull.

Windows Metafile: The Windows Metafile format is a standard graphical format which may readily be displayed using a built-in Windows service. The file is written is in “placeable” format, so that it can be exported to software like Corel Draw or Word for Windows.

Windows metafile format is the best for import of graphics into Windows’ documents, because of its supports for aspects like font definitions, shading and line styles. However, to some degree this format is no longer needed, since any graphical view can be transferred to another Windows program via the Windows clipboard (See menu item Edit, Copy to Clipboard, on page 46). The format used for this task is also that of the Windows metafile. The main residual purpose to allow transmission of Hullform’s graphics to other computers.

Customising Plotter Output

When a plot is produced, the program also automatically produces a header, comprising the hull name, displacement, centre of buoyancy position, date and time. This is for your reference, when a sequence of hulls is being output. The sole exception to this rule is the Windows metafile format, because it is intended to duplicate the on-screen view.

For some applications it may be useful to delete the header. HPGL, DXF, Textronix and ReGIS “Plot” output, directed to a file, may be edited to remove the header lines, which are always located near the top of the file listing.

In DXF file output, files “header.dxf” and “tables.dxf” will also be included, if they can be found by the program (See page 38 for details). These files permit you to add extra information, such as line style definitions, which may be required by your CAD system.

Scale

You can change the size of your graphical output - via the Windows printer interface, or Hullform’s own plotter drivers - using this option. You may wish to do this to take advantage of a large plot surface, or to establish an exact scale for a drawing. Dialog box options are as follows:

Scale

This item only has meaning when you have displayed a view on-screen. The value shown in the “scale” edit box is the default, which will result in a comfortable fit of the drawing onto a printed or plotted page. You can set an explicit drawing scale by using the Scale factors dialog box after showing a view, and prior to print or plot output.

To set scale of a view on your printed page, display your required view on-screen before setting the “scale” value.

The scale value is the ratio of the actual size of the view (in metres or feet) to the size of the view on the page. If you do not like the default, any larger scale value will produce a smaller view on the page, with the required scale ratio. A smaller value will produce a view too large for the page.

Width of page

This is the width of the plot region on the page. While all devices supported by Windows have a nominal size, scanning or tracking imperfections in any printer can easily generate a measurable error.

For example, Windows sets the printable width for a Laserjet operating at 300 dots per inch as 2331 dots - i.e., 7.77 inches. But on one such printer, the actual print width was only 7.7 inches. The 1% error was easily detected, since a scaled plot was 1% small. Entry of a value 7.7, and checking the “Inch” radio button, adjusted for the error.

The actual page width rarely matches exactly the value presumed by the printer driver.

The units radio buttons (**Mm** and **Inch**) define the units for the page width only. You can nominate a page width in mm and hull dimensions in feet, or a page width in inches and hull dimensions in metres, without problems.

X-stretch factor
Y-stretch factor

These are further scale control terms, with a different (although overlapping) purpose. You may have an unsupported printer which emulates another, supported one, but distorts graphical output due to a different ratio of vertical to horizontal dot spacing. Or you might have a device which provides an enlarged plot surface compared to the standard model. Both issues are rectified by use of these two inputs.

The numbers you enter are the factors by which you wish the width and height of the plot to be scaled.

The success of this form of scaling depends on the nature of your printer or plotter device. Some pen plotters may draw out-of-bounds lines erratically.

You can widen a plot either by increasing the X-stretch factor, or reducing the nominal page width. It is recommended that, for simplicity, the X-stretch factor be left at 1 unless you have a clear case of an enlarged plot area.

The page width, page width unit, and x- and y-stretch factors are saved in the configuration file when menu item “Write configuration” is selected.

Printer Font

You can select the font used to display text using this menu item. Under Windows, all normal fonts are available, but bear in mind that fonts of abnormal sizes may not be located properly on the page.

When an image is output to a “plotter” device, the character size is set to match the requested size as closely as possible. The program assumes the width of the plot surface to correspond to 80, 12 point characters, and character sizes are based on this presumption.

The chosen font and or size selection are saved when the “Write Configuration” menu item is selected, and when you exit the program.

File Directories

This menu item provides for three inputs, of directories to receive:

- hull data files
- general file output (e.g., hydrostatic tables)
- DXF files

The strings entered may be up to 128 characters; the input text scrolling horizontally if needed. You may specify a disk (e.g., “B:”), a directory path (e.g., “\hullform\yachts”) or both.

Windows has problems in handling a trailing backslash on a directory name. Hullform will therefore strip this wherever possible, but it is best not to include it when you specify a directory path.

In all three cases, the program remembers the last directories used to write these files, and saves them on exit. This means that you will rarely need to alter the directories using this menu item.

Units

The program accepts both metric and British units, and masses may be (for the former case) kilograms or tonnes or (for the latter case) pounds or tons. Your choice may be selected from the four radio buttons in the dialog box presented.

When the program configuration is saved, using the “Configure”, “Write configuration” menu option, the currently-selected units become the program default.

This menu item only changes the units presumed for the design. If you wish to convert a design between metric and British units, use menu item Edit, Units conversion.

Density Of Water

Sea water has a typical density 1.025 times that of pure water. This factor is termed “specific gravity”. To accommodate accurately the effects of varying water density, you may change the value used.

The program simply prompts for the desired numeric specific gravity (with the default being the existing value).

X-Positive Direction

In viewing options (including DXF output), the hull may be displayed with stem to left or right. You may select which is required using this item.

Z-Positive Direction

In the program's default state, the vertical co-ordinate increases downwards, consistent with the practice of building many small craft in an inverted position, and using floor level as a reference. The upwards-positive convention may be chosen, however, to coincide with upright construction used for larger craft.

This feature only affects the mode of display of the hull offset data. In order to invert the offsets themselves, the Edit, Multiply/add option should be used, applying a multiplying factor of -1 to the vertical offsets.

Graphics ▸ Mode

Hullform 9 supports two modes of display graphics, namely the original Windows “GDI”, and the newer OpenGL mode. In general terms, GDI is simpler and faster, while OpenGL is smoother but slower.

In use, you will see that OpenGL generates broader, and on some systems smoother, lines. Its surface shading scheme is far superior to that provided by the GDI model. Overall, if you find that the OpenGL model works sufficiently quickly on your computer, you will probably end up using it alone.

However, swapping between the two modes involves no more than using this configuration option, then restarting Hullform.

Graphics ▸ Colours

Hullform permits selection of colours for the drawing (Window) background, text, sections, lines, waterlines, buttocks, diagonals, and highlight and shadow colour used in shaded views. The program provides reasonable defaults, but you may alter these to suit personal taste (although contrast issues must be considered).

The selection dialog box allows the colour for any of the above items to be customised. When one is selected, the Windows colour-selection dialog box appears. Any of the standard colours shown initially may be chosen. In principle, a wider range may be accessed after selecting the “define custom colours” button - but beware that a Windows bug can arise here, locking up your computer.

There is a bug in Windows 95 which may prevent you using the “custom colours” button.

When colour selection has been completed, select “Ok” in the colour dialog box. When no more colours are to be modified, select “Ok” in the “Select class ...” dialog box. (The second of these is not accessible until when “colours” dialog box is present).

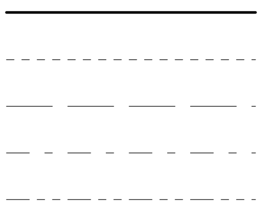
When the background colour is changed, most screen-clear operations will use this colour, but when a window is initialised (for example, in editing a hull section), the old background colour will still be used. The new background will only be invoked fully after the new colours defaults have been saved, the program has been exited, and then restarted.

If you are operating your display in a 256-colour mode or better, you may find Windows' insistence on using dithered shading patterns annoying. You can check the “solid shades” checkbox, which will force Windows to use the nearest possible non-dithered shade. Results on a 16-colour display are bad, on a 256-colour display usually good, and on displays with more colours they may be far superior.

Your colour selections are saved when the “Write configuration” menu item is selected, and when you exit the program.

Graphics ▸ Line Styles

Windows supports a range of line styles, namely



Solid
Dotted
Dashed
Dash-dot
Dash-dot-dot

Use of these on-screen to identify lines has little advantage over colour, but can be very useful when sending an image to a monochrome printer, or sending an image to a document which will be printed later in monochrome.

The Line Styles dialog box functions much like the colour-selection dialog box. You press a push button to choose which line class is to be altered, then a second dialog box appears providing the choices available.

Again, your selection is saved when the “Write configuration” menu item is selected, and when you exit the program.

Your line style selections only have effect when Windows itself produces the image - that is, for screen, printer, Windows metafile and clipboard copies.

Extra Drawing Points

Unlike other programs, Hullform places the smoothness of the drawn hull lines and sections under the user's control. This means that fast screen updates can be generated on even the slowest machine, or, alternately, high-quality drawings can be generated directly from the program.

By default, when any section is drawn, curved elements between lines are drawn using nine interpolated points. The default for curved elements of any line, between each section, is zero. The high resolution used for section drawing corresponds to the exact representation of these curves within the program; correspondingly, the non-resolution of curvature of hull lines between sections matches the lack of any explicit design detail in these regions.

The defaults are therefore the “honest” presentation of the design, as seen by the program. While more detail can be drawn, users must not forget that the extra detail generated by use of a non-zero number of extra points along each line generates no extra accuracy in hydrostatics.

But there is an important exception. The points used to construct ruling lines in plate development are generated by the program's line-drawing section. This means that additional plate development detail - i.e., ruling lines - are generated by increasing the number of points drawn on each line, between sections.

Line detail

The required value is entered in a simple dialog box. It may be from 0 to 7.

Section detail

There is no upper limit on the value which can be entered. Entry of zero gives straight section elements between hull lines, which is usually a very poor representation. But the drawing model concentrates drawing points near the region of highest curvature, so that as few as four may suffice. The default of 9 generates a shape very close to the theoretical curve, while at about 20 the curve is indistinguishable from the exact curve on a normal screen.

Screen Font

You can select the font used to display text on-screen using this menu item. All normal Windows fonts are available, but bear in mind that large fonts may run off-screen, or end up out of position on graphics displays.

The user's font selection is saved when the Configure, Write configuration menu item is selected.

View on Open

You can choose to display a view of the hull design, whenever you open a hull data file. The options are “blank screen”, or any one of Hullform’s range of graphical views.

Remember that the orientation of the perspective views is determined by your last setting of the perspective viewing position. This means the view may change between sessions.

Edit Mode

The additional edit features of Hullform 9, compared to earlier versions, can take some getting used to. To ensure the users of previous versions can take their time, the master/slave section model, and the associated automatic fairing can be disabled, rendering the program’s functionality like that of earlier versions. Spline flexibility remains enabled, but can be left constant to give pre-version-8 behaviour.

Simply check the radiobutton for editing model you wish to use. This mode will be retained in future sessions, until you change it.

Toolbar

Hullform's toolbar is heavily customisable. You have total control over whether you have one at all, where it goes on the screen, and what functions it can perform. You are not limited to a single row, either - you are permitted to occupy up to half the screen with toolbar items.

About the only aspect over which you have no control is the available set of toolbar icons - but you have dozens of these to pick from.

To add an icon to your toolbar, use Add item.

To delete an icon from your toolbar, use Delete item.

To put your toolbar somewhere else, use Locate toolbar.

To rearrange toolbar icons, use Arrange items.

To customise the delay time before the toolbar item's hint text appears, use Hints.

Add item

There is a menu function associated with each toolbar icon. Therefore, when you select "Add item", you must choose an icon and a menu function.

The dialog box has three list boxes. Any item from the program's drop-down menus can be picked, using the left-hand list box to choose the main menu entry. Normally you use the central one to choose the desired item. Where a second-level menu is provided, you will see options in the right-hand list box, from which you must also choose.

You also can configure the hint text, by editing the default hint text, which appears in the edit box below the list boxes. If you clear this text, no hint will appear for this item.

Delete item

To remove a toolbar item, you select the "Delete item", and pick its icon in the dialog box which appears. The toolbar will be immediately reconfigured, reflecting the change.

Locate Toolbar

The choices, selected using radio buttons are (not surprisingly) top, bottom, left and right. There is no recommended choice: the matter is purely one for your own tastes.

If you are a lefthander, use software like Corel Draw or Windows Paintbrush which use a left-hand toolbar, or liked the left-hand menu space of Hullform for MS-DOS, you may prefer the default left-hand position. If your word processor has a top toolbar (as in Word for Windows) you might reset the location to the top. If you liked the old Lotus 1-2-3 and Word for MS-DOS menu, you can use a bottom menu. And if you use a MS-DOS CAD system with a right-hand menu, you can put it on the right.

You may find the toolbar does not behave perfectly immediately on relocation. If so, exit and restart the program.

See page 13 for a listing of the default toolbar items. These illustrate well the functionality of the Hullform toolbar.

Arrange items

Finally, once you have selected your toolbar items, you can shuffle them on-screen. There are on-screen prompts for this process, but essentially you "drag" the toolbar items to their desired positions.

Remember when you do this, to move into place first those items to go closest to the start of the toolbar. Otherwise, when you move a later icon into position before it, it will move away from the chosen position.

Hints

The hint text which you will see when you leave the mouse pointer over a toolbar button is set when you create the toolbar entry. Under this menu item, you can choose the delay before the text appears, or prvent any hints appearing.

The dialog box you see allow you to enter your preferred time delay. The value may be entered in decimal format (e.g., 0.5 for a half second delay) If you enter a zero delay, the hint facility will be disabled.

Lines, text-edit

The dialog box you can use to edit offsets directly, available under menu item Edit, Edit sections, can have a variable number of lines. The value you enter here is the maximum that you will see; if the design has less lines than the limit, only the number of lines in the design will be shown. If the number of hull lines exceeds the limit you choose, you will see the maximum you specify, with "Back" and "Forw." ("forward") buttons enabled.

Normally, you would set the maximum to suit the dimensions of your display and your own preferred limit to the number of lines you can comfortably manage. The default value is 10.

Limits for Floating Point

In representing floating point numbers, an issue arises when the number becomes small – how do we represent one like 0.0000132 (as for some drag coefficients) to sufficient accuracy, without spreading too many digits across the page or screen?

The normal solution is to use "exponential notation", in which the number is displayed as a combination of a floating point number and a power of 10, the latter indicated by the letter "E". So, for example, 0.0000132 becomes 1.32E-5 – that is, 1.32 multiplied by 10 to the power –5 (equivalently, divided by 10 to the power 5).

Many users are comfortable with this, but some are not. In any case, the point where the "E" notation takes over can sometimes seem inappropriate. You can customise this aspect of Hullform's numeric displays using this dialog box.

The numeric value where the "E" format becomes preferable is defined by the first entry. (You can prevent its use entirely by entering a value of 0 here).

The number of decimal places used is set by the second entry. The default is 3, and it is unlikely you will want to change this by more than one either way – but it's up to you.

Write Configuration

This facility should be used when a user has altered settings, and wants to make them permanent. On its selection, the program immediately overwrites the file "Hullform.cfg" from which settings were read at program startup.

Your full program configuration is also saved when you exit the program.

Read Configuration

This option restores the program configuration which was set at program startup, or in effect at the last use of the Write configuration option.

HELP

Index

This accesses the standard Windows help feature. All the usual features are supported - for example, click any highlighted word, and further details on the topic it represents are presented.

The Hullform for Windows help system includes an index, by which you can select information on any feature of the program. It also may be accessed from within the program - see “Using Help”.

Using Help

There are three ways to access the Hullform for Windows help system:

1. When you have highlighted a menu item (or afterward) press key F1. Help on the selected program topic will be presented.
2. When a dialog box is shown to you, it will usually include a Help button. Click this or press keys Alt-H to receive help on the purpose and operation of the dialog box.
3. Use the Index in the help menu, and browse through the topics of concern.

About Hullform

This generates only a brief version number and copyright message. It is of limited use, being included mainly because many users expect it, and it is a convenient place to locate the company's name and address.

Memory

Windows uses extended memory, making many megabytes of space is available to the program from the global heap. This menu item shows how much is available, as a brief display of total free space, and the largest contiguous block available.

The global heap is used by Hullform for temporary storage, in activities such as plate development and shaded surface construction.

Windows does not differentiate between real memory and “virtual memory", the latter being space allocated in disk to take the overflow when physical memory is full. If disk activity is occurring without any apparent cause on your part, it is possible that virtual memory is being accessed by Windows. To minimise disk use (and speed your programs), try to keep the number of concurrent tasks to a minimum.

Manual Updates

Rather than the usual “READ.ME” file, Hullform for Windows places information about program changes since the printing of the manual in the Windows' help file WHATSNEW.HLP. This is automatically installed with other files.

You may keep it as installed, for later reference, or you may delete it. In the latter case, the menu item will not appear.

DYNAMIC DATA EXCHANGE SERVICES

Hullform is a Windows "Dynamic Data Exchange" ("DDE") server. This means it can be interrogated by other items of software, returning information which can be used for external analyses.

DDE is an inter-process communication protocol, based on request codes and text-form messages. Many application programs operate as either DDE servers, or as DDE clients which receive information from servers. These include databases, some Basic language interpreters and compilers, plus word processors like Microsoft Word for Windows.

Hullform responds to the following requests:

> ***BEWARE:*** *Users Word for Windows prior to Word 6 are warned that there is a crucial bug in the Wordbasic DDE code. The program, and possibly Windows too, will lock up when you use Word's DDE feature.*

Initiate

Hullform responds to a DDE initiate message with an acknowledgment, bearing application name HULLFORM, topic name STATICS.

Execute

A number execute commands are accepted. The commands are not case-sensitive.

Open filename

"Filename" must include the "hud" extension, but need not include an explicit path specification. If it does not, Hullform will firstly try to find the file in its current working directory, then in the program's default hull data directory.

Balance
Balanceall
Evaluate

These commands equate to the Statics menu items "Balance", "Balance all" and "Evaluate". They are used once the "poke' command has set up items such as displacement, LCG, heel, pitch and waterline offset, to update the program's hydrostatics variables.

Menunumber ...

This invokes a menu item with the specified number. Further arguments may be provided, to complete entries to a resulting dialog box.

Menu items are numbered from 101 upward in the File menu, 201 upward in the Edit menu, and so on.

Poke

A number of parameters may be altered using the "poke" command. With each such command is provided an item name and a value. The names are as follows:

water (or any name commencing with these letters)
waterline offset, positive upward from the chosen zero reference

heel
heel to starboard, in degrees

pitch
pitch up of stem, in degrees

disp (or any name commencing with these letters)
displacement, in the chosen measurement units

lcg (or xcofm)
longitudinal position of the centre of gravity, in length units.

vcg (or zcofm)
vertical position of the centre of gravity, in length units, positive upward

tanksg[number]
tankfr[number]
tankpm[number]

specific gravity of the contents, fractional filling and permeability, of the tank whose index number is provided in the brackets. “Number” must be a valid integer, from 1 to the number of tanks defined for the current hull.

If the poked item name does not match one of these, Hullform generates a message “HFDDE: Invalid poke command”. If the poked value can not be read, the error message is “HFDDE: Invalid poked value”.

Request

This message requests information from the program. The information comprises any of the program's internal statics variables, internal tank information, or character strings defining measurements units.

The following item names are accepted by the program. When indexed (“[index]”), the supplied index must be an integer from 1 to the number of tanks for the currently-loaded hull design, and the returned value applies to the indicated tank. Again, the program's request input is case-insensitive.

Tank Definition Terms

tankct
number of tanks defined for the currently-loaded hull design

tankds[index]
text descriptor

tanksg[index]
specific gravity of contents

tankfr[index]
fraction full

tankpm[index]

permeability - i.e., the fraction of the volume of the tank which is actually filled, allowing for internal objects

tankvl[index]
total volume of the tank. The volume contained is tankfr[index] x tankvl[index]

tankwl[index]
the level of the fluid surface (“waterline”) within the tank. The value returned is the intersection coordinate of the plane of the fluid surface and the vertical axis at the hull centreline and at the longitudinal position zero.

tankvg[index]
vertical centre of gravity position of the tank contents.

tanklg[index]
longitudinal centre of gravity position of the tank contents.

tanklf[index]
longitudinal centre of flotation position of the tank contents.

tankfm[index]
free surface moment of the tank's contents.

tankmo[index]
longitudinal moment of the tank's contents

tankms[index]
mass of tank's contents

Measurement Units

lenun
length unit, text string of two characters, either “ft” or “m “.

masun
mass unit - text string, “lb", “ton", “kg” or “tonne"

Statics Parameters

In alphabetical order:

aabove
profile area of the hull above the waterline

abelow
profile area of the hull below the waterline

displa
displacement, in the current mass measurement units

bmax
maximum beam

bwl
maximum waterline beam

cm
midsection coefficient

cp
prismatic coefficient

cb
centre of buoyancy

densty
density of water, in the current measurement units.

draft
maximum draft (actual, not of the vertical zero reference line)

draftf
draft of the hull at the base of the stem section

draftm
draft of the hull at the section nearest midships

drafta
draft of the hull at the stern section

entang
waterline entry angle - the angle made by the hull's two-dimensional waterline and the hull axis, at the waterline entry point.

freeba
freeboard at the stern section

freebd
freeboard of the hull at midships

freebf
freeboard of the stem section

freebm
freeboard of the hull at the section nearest midships

gravty
acceleration due to gravity, in the current measurement units

gz
vertical distance between the centre of mass and metacentre of the hull

heel
heel, in degrees to starboard

lcb
longitudinal position of the centre of buoyancy of the hull, in the current length units, relative to the chosen zero location

lcf
longitudinal position of the centre of flotation of the hull, in the current length units, relative to the chosen zero location

loa
length overall, taken as the distance from the foremost point of the stem to the transom section

lwl
length on the waterline

mct
moment to change trim, per centimetre (for metric units) or per inch (for British units)

mpi
extra displaced mass per unit distance of immersion

mxarea
maximum cross-sectional area of the hull below the waterline

pitch
pitch up of the hull, in degrees

sarm
"small amplitude righting moment", in units of (mass unit) x (length unit) per degree of heel

spgrav
specific gravity of water

volfor
volume displaced by the hul, forward of the section of largest area

volste
volume displaced by the hull, sternwards of the section of largest area

volume
displaced volume of the hull

waterl
waterline offset relative to the chosen hull baseline, positive upward

wetsur
wetted surface of the hull

wplane
waterplane area

xatbwl
longitudinal position, relative to the chosen longitudinal zero position, of the maximum waterline beam of the hull

xcofb
longitudinal position, relative to the chosen longitudinal zero position, of the centre of buoyancy of the hull

xcofm
longitudinal position of the centre of mass, in the current length units, relative to the chosen zero location

xentry
longitudinal position of the waterline entry point, relative to the chosen longitudinal zero position

xlcf
longitudinal position, relative to the chosen longitudinal zero position, of the centre of flotation of the hull

xmid
longitudinal position, relative to the chosen longitudinal zero position, of the midships point of the hull

xstem
longitudinal position of the foremost point of the hull, relative to the chosen longitudinal zero position

xstern
longitudinal position of the sternmost point of the hull, relative to the chosen longitudinal zero position

zabove
mean height of the area of the hull above the waterline (positive)

zbase
vertical position of the lowest point of the hull

zbelow
mean height of the area of the hull below the waterline (negative)

zcofb
vertical position of the centre of buoyancy of the hull

zcofm
vertical position of the centre of mass of the hull (VCG)

zbase
vertical coordinate of the lowest point of the hull

zmeta
vertical coordinate of the buoyant metacentre of the hull

Terminate

This message requests termination of DDE communication. Hullform cleans up its DDE work areas, and returns an acknowledgment.

HELPFUL HINTS

Following are a more-or-less random accumulation of pointers, intended to get you out of trouble in areas where problems may possibly arise.

Notes For Users Upgrading From Earlier Versions

Hullform 9 hull data files are backwards-compatible with all previous versions, and a Hullform 4 to 8 file input by Hullform 9 looks like it did in the original version.

However, there is one major change in terminology from Version 3. The stem section is section 0, rather than section 1.

The changes in Hullform 9 also mean that the vertical control points are differently specified. Previously, they were measured as a fraction of the vertical distance between adjacent hull lines. Now, the equivalent is simply the vertical offset of the control point.

The lateral control points for a pre-Hullform 8 design are imported as relative offsets, so that their numerical values remain unchanged.

Entry Of Known Offsets

A common need is to enter into the program the shape of an existing design. This is not a simple, quick process, because you have to enter the three-dimensional position of a large number of points on the outer surface of the hull. Hullform now provides a way of reading in a table of offsets (See File, Import Hull, on page 34), but the stages preceding and following this process remain.

The details of the process are as follows:

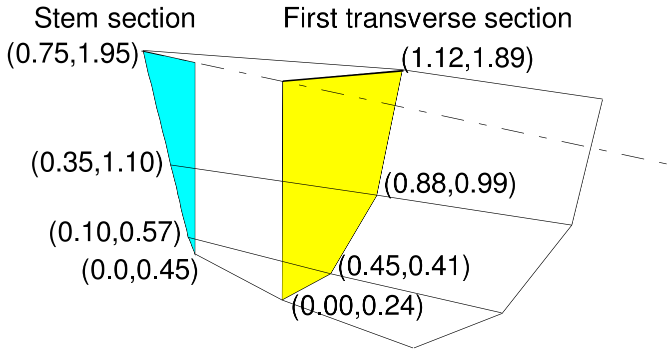
1. Obtain a set of offsets which can be entered into the program. This normally means the longitudinal and vertical positions of points along the stem, and lateral and vertical positions of points at several transverse stations (sections) along the hull.

   You will help your cause if these points are associated with identifiable lines along the hull - be they sheerline, chine, keel, waterlines, buttock lines or diagonals. This will bring two benefits. Firstly, you will automatically have same number of offset points on the stem profile and all transverse sections, and this fits well with the structure of a normal Hullform design. Secondly, there is a strong likelihood that the format of the provided data will match on of Hullform's accepted import formats.

   If you have to generate your own table, you might find it most convenient to use the program's first import format. For example, for a hull using four lines, write the four pairs of lateral and vertical co-ordinates in four columns across the page for each section (including the stem), repeating the pairs down the page for each section further aft - e.g.,

Section	Position	Sheerline	Chine 1	Chine 2	Keel
0	0.75	0.75,1.95	0.35,1.10	0.10,0.57	0,0.45
1	2.00	1.12,1.89	0.88,0.99	0.45,0.41	0,0.24
2	4.00	1.79,1.84	1.50,0.93	0.84,0.29	0,0.08
(etc)					

   Graphically, the co-ordinate pairs are arranged on the hull as below:



The “position” is the longitudinal position of a section along the hull, simple enough for transverse sections but somewhat arbitrary for the stem profile. The recommended choice is the longitudinal position of the base of the stem.

Observe that the stem base position in the example above (0.75 m) is the same as the fore-and-aft offset of the sheerline. This means that the stem head is at the exact longitudinal zero position.

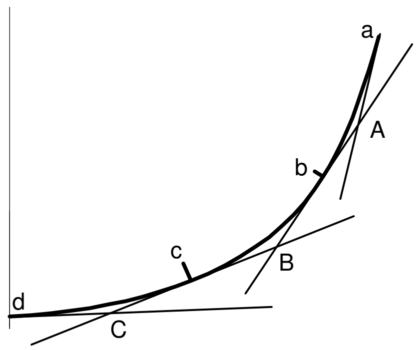
2. Next, start Hullform, and select menu item “File, Import hull”. You will need to enter the required number of hull lines (four, above) and hull sections (the number of transverse sections, plus one for the stem), and be sure to ensure that the correct import format is selected. You will probably have used the program’s default sequencing of stem first, sheerline first - if not, remove the check mark on the relevant checkbox. Click “Ok” to close the dialog box, and you will be prompted for the file to import.
3. When you have clicked “Ok”, the file will be imported. If you have entered the parameters correctly, it will be quite close to what you want.

If the design is to be of a hard-chine form, the hull surfaces between the chosen lines will be close to your requirements. For a rounded hull, however, you will need to perform some smoothing of the section curves.

You probably do not need to smooth each individually, however. You can smooth the curves for the stem section, stern section, and one close to midships, then use the line-smoothing facility to fair the curve of control points between these three.

The process is covered in detail elsewhere, but remember the basic rule - to keep fairness from one curve to the next, use relative lateral control points (the default set during the import process), and keep the lateral control offsets zero.

For a fully rounded hull surface, you can change the lateral offset of the control point between lines 1 and 2, but no other. So, for a section such as the one below (with hull lines passing through points a, b, c and d), you should perform editing using only the cursor keys. The control point at A may be moved using both the horizontal and vertical cursor keys, but control points at B and C should only be moved using the vertical cursor keys.

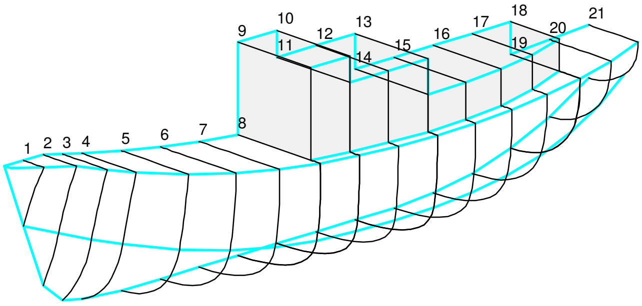


These rules are equally applicable for any component of a section outline - whether you are entering the outline of the keel, hull or superstructure. However, for a keel or superstructure, where sharp discontinuities can occur - for example, at the trailing edge of a keel, or the front of a wheelhouse - one extra device is useful.

Hullform can not represent a line moving perfectly at right angles to the hull. However, it can represent on running 0.1 mm back from a right angle. To represent such a step (to more than adequate accuracy), use two sections, one at 0.1 mm from the other. Make the first correspond to the hull forward of the step, the second to the hull aft of the step.

The example below illustrates this point. It shows the sample design, “chaser”. At the start of the superstructure, shown shaded, are two sections numbered 8 and 9, the foremost excluding it, the second including it.

Notice also that the lines which form the outer edge of the superstructure, at its top and base, are partial lines. These start at section 9, and end at 18.



Finally, the hull has been drawn without interpolating any extra points between sections. This to prevent spurious “overshooting” of the curves at remaining discontinuities, such as from section 10 to 11, and from 13 to 14, on the superstructure. You can generate the same effect while retaining the extra drawing points, by setting zero flexibility for all elements of the superstructure lines, and a large flexibility for the central line between sections 8 and 9, and 18 and 19.

Output of Waterlines, Buttocks or Diagonals

Once your design is completed and saved, select menu option Edit, Orientate lines. This feature provides the ability to convert most designs to an equivalent one using waterlines, diagonals or buttock lines.

Once your conversion is done, select File, Builder's offsets, and write the design using an “Interval for output” larger than the greatest separation expected (e.g., 100 metres). Only the intersections of your hull's lines with each section will be written.

Generating A Straight Longitudinal Line

This is a task which has become much simpler since Hullform 8. In the Edit, Smooth a line section of the program, select either Lateral offset or Vertical offset for the required line. Decide at which sections you will define two points on the required straight line, and use the “Value” option from the menu at the top of the workspace to enter the offsets at these. If these are not master sections before you enter values, you will be prompted to change them to master sections.

Next, ensure no section between these sections is a master.

Then select the “Flexibility” menu item, and set the flexibility for all pairs of sections between the ends of the straight section to zero.

When you next use the “Smooth” option, or the next time you move any part of the line if automatic fairing is enabled, the required part of the line will straighten, and will remain straight through all later operations.

INTERNET SUPPORT

Blue Peter Marine Systems offers a range of services to Hullform users and enquirers, via the Internet

E-mail contact

Our contact address is support@hullform.com.

Contacting a company in Australia via electronic mail is as quick as contacting one in your home country, and costs next to nothing on top of your normal Internet connection fees.

Our e-mail software supports Mime and Binhex encoding of attached files. In addition, all Hullform output files are in text form, so even if your mail software does not support attachment of files, you can include a problem design in your text message.

If you identify a bug in your copy of the program, and your mail software supports either of the above encoding formats, we can mail you a copy of the program file with the fix.

Worldwide Web Home Page

Our Web page is http://www.hullform.com/

The home page provides information on all versions of Hullform, both for enquirers and users. You should pay most attention to the “Hullform 9 Users Only” page, where update information, and the updates files themselves, will be placed.

If you download an update, however, you will need to use the decoding facility available under the File menu. The downloaded file, HULLFORM.BIN, is a compressed and scrambled version of Hullform, and will be unusable until it is decoded.

When you have completed retrieval of HULLFORM.BIN, use the Hullform decoding facility. Open the downloaded file, using the “Open coded file” button, then press the “Save and exit” button to select the output file and complete the conversion.

GLOSSARY

Block coefficient (Cb)
the ratio of the volume displaced by the hull, to the product of the waterline length, waterline beam and draught.

Centre of buoyancy (LCB)
the fore-and-aft location of the point about which the buoyant forces acting on the hull have no rotational effect ("moment"). It is expressed as a percent of the distance from the foremost to the sternmost extent of the waterline.

Centre of flotation (LCF)
the geometric centre of the area enclosed by the hull's waterline. For small pitching motions, it defines the line about which the pitching occurs.

Centre of mass
the point about which gravitational forces have a zero net turning moment the point through which the weight of the hull may be taken to act (equivalent term, centre of gravity).

Displacement
the mass of water displaced, equal to the volume displaced multiplied by the density of the water used.

Draught (Tc)
the maximum depth of the hull below the waterline.

Form drag
the retarding force due to the lateral displacement of water (by the "form of the hull), as the hull passes through.

Froude number
the ratio of the speed of a hull to the square root of the product of the acceleration due to gravity, and its waterline length the scaling factor used in calculation of the behaviour of waves about a hull.

GZ (horizontal lever arm)
transverse distance from centre of mass to metacentre of hull. It is the ratio of righting moment to displacement.

Heel angle
amount of rotation of hull about its longitudinal axis, from a state where its central plane was upright.

KN
transverse distance from design baseline to metacentre of hull.

Lateral control offset
the distance, measured outwards, between the intersection of the tangents at each end of the hull curve (the hull curve control point) and the location of the tangent to the lower end of hull curve above, at the same height from the keel as the control point.

Length/displacement ratio
the ratio of the waterline length of a hull to the cube root of the volume displaced the standard measure of hull slenderness. In other references, the ratio may be to the displacement in tons.

Mass per unit immersion
the increase of hull displacement required to increase draught by a unit of distance.

Maximum beam (Bmax)
the overall width of the hull, from sheerline to sheerline (or greater, if the design has some tumblehome).

Maximum draft
the greatest distance of any part of the hull below the waterline.

Metacentre
the intersection of a vertical line from the centre of buoyancy, and the centre plane of the hull. It may be thought of as the "dynamic" centre of buoyancy of the hull. For small angles of heel it is of fixed position, and it measures the inherent stability of a given hull form, independently of how it is loaded.

Midsection coefficient (Cm)
the ratio of the largest immersed area of any section of the hull, to the product of the waterline beam and draught.

Midsection freeboard (Fm)
the lesser of the freeboards of each side of the hull, at the middle section of the hull design.

Moment to change trim (MCT)
the pitching moment which must be applied to change the difference between the bow and stern heights by a unit of distance.

Offsets
vertical of horizontal distances from a (respectively) horizontal or vertical reference plane, used in constructing a yacht or defining hull sections in Hullform.

Overall length (Loa)
the distance from the bow to the stern of a yacht.

Pitch angle
The fore-and-aft axis of the hull from the horizontal. Thus, when a hull is heeled 90°, pitch implies rotation about an axis which is vertical in the hull's zero-heel state.

Prismatic coefficient (Cp)
the ratio of the volume displaced by the hull, to the product of the waterline length and the largest immersed area of any section of the hull. For yachts to operate in light-wind conditions, value a little above 0.5 are best for a hull that operates near its limiting hull speed, values close to 0.6 are better.

Residual resistance
literally, the residual when skin friction is subtracted from the total resistance due to the combined effects of form drag and wave drag.

Righting moment
the product of the buoyant force and the horizontal distance from the centre of mass of the yacht to the metacentre.

Horizontal lever arm (GZ)
transverse distance from centre of mass to metacentre of hull. It is the ratio of righting moment to displacement.

Righting moment arm (GM)
the distance from the centre of mass of the hull (denoted “G”) to the metacentre (denoted “M”). It is a good measure of the initial stability of a given hull, for a given centre of mass position.

Skin friction
the retarding force due to the flow of water across a surface, due to adhesion between the water molecules and those of the hull surface.

Total resistance
sum of skin friction and residual resistance.

Vertical control factor
the ratio of the vertical distance from a hull line to the hull curve control point (see “lateral control offset”), to that from the hull line to the prior hull line.

Volume displaced
the volume inside the hull, below the waterline.

Waterline beam (Bwl)
the width of the area enclosed by the hull waterline.

Waterline length (Lwl)
the length of the area enclosed by the hull waterline.

Waterplane area
area enclosed by the hull waterline.

Wave drag
the retarding force due to the dispersion of energy from the hull by surface waves.

Wetted surface
the total area of the curved surface of the hull below the waterline.

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