



BearboatSP

# BEARBOATSP MANUAL

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# Introduction

BearboatSP is the update of an earlier program called Bearboat Pro. The differences between BearboatSP and Bearboat Pro are relatively minor; much of the code base is the same.

Bearboat Pro was developed in 2002 for both PC and Macintosh. It was the successor to what is now called Bearboat Classic, which was available only for Windows. As a legacy of that time, the separate program that actually prints out the cross-section of the designs produced by Bearboat Pro and BearboatSP, is still only available as a Windows program.

BearboatSP cannot read a Bearboat Classic file. To migrate a file from Bearboat Classic to BearboatSP requires using Bearboat Pro as an intermediary bridge.

BearboatSP has more functionality than Bearboat Pro, and there is little reason not to upgrade. Bearboat Pro, aside from its ability to read Bearboat Classic files, has no functionality that is not included in BearboatSP.

BearboatSP is in active development. It is being written on a Macintosh using OS X. The ports to Windows should be functional, but there are aesthetic problems that might crop up.

This program is shareware. It may be freely distributed. There is no charge for this program. If you ever actually build a kayak, I would ask that you send me a picture.

I encourage people to send their comments and suggestions for BearboatSP. People have already made suggestions that I have incorporated. Some are ideas that were simple and intriguing to me. Others are ideas that I

had not thought of myself but which I nonetheless perceive of being of value to me in the design of my own boats. If you find features of the program confusing, drop me a line. I may be able to help you and others by making the manual clearer. ANY feedback is appreciated.

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## History

I bought my first sea kayak in 1962, the Gulf Islander, which I still own and paddle. My interest in kayak design and the actual building of kayaks started in 1967 when a teacher at my high school, Dwight Gibb, cajoled me into helping him make me a fiberglass boat for river kayaking. Once the boat was complete, he taught me the basic kayak skills. Many years passed before I built another kayak, but the seed had been planted.

The original versions of the program that became Bearboat were written in 1980 on the first HP personal computer, the HP-85, using HP Basic. That original machine had 32K of memory and a built in printer that output on 3" rolls of thermal paper. It required approximately two weeks for the computer to calculate the data for an entire kayak. I could not produce full-scale

drawings, so for my early designs I spent days in the Anchorage library plotting on graph paper the numeric data that was produced.



*HP – 85 Note the small built in screen and the roll of thermal paper used to output data*

The program has been rewritten two times since then, each time on a different OS platform with a different language leading up to Bearboat Pro. BearboatSP is not a complete rewrite but merely an updating of Bearboat Pro.

1. 1980 Bearboat (personal use) - HP Basic on HP-85
2. 1998 Bearboat Classic – Virtual Basic on WindowsNT
3. 2002 Bearboat Pro – REALbasic on Mac OSX: Mac OS9 & Windows versions available
4. 2009 BearboatSP – REALbasic on Mac OSX: Windows version available

# Synopsis

A kayak builder wrote BearboatSP. In this documentation, "your kayak" is treated as synonymous with "your design". However, this software is equally suited to designing a canoe. An open canoe would be designed simply by ignoring the deck. A closed canoe is essentially the same thing as a kayak as far as this software is concerned. It is quite possible to design a rowboat using this software; I hope some day to do just that.

The primary output of this program is a bunch of drawings of the cross-sections of the boat you have designed. The output is on simple 8.5 by 11 paper or US legal paper, which is 8.5 by 14 inches. The program accommodates to the fact that many of the cross-sections will require more than one piece of paper to draw. For these larger cross-sections, you tape a few pieces of paper together. The actual printing process is done by a separate utility program called BearboatPrint that is freely available.

The program determines the shape of the underwater section of any cross-section of the boat by determining the minimum wetted surface that will enclose the area specified by the user and constrained by the waterline width and depth of the boat at that position. With these three values, (waterline width, submerged cross-sectional area and depth) there is a uniquely determined curve that will be drawn for that cross-section. There is logic to minimizing the wetted surface as this helps minimize the resistance of the boat moving through the water.

Optionally, the program provides the possibility of additional constraints on the individual cross-sections beyond the basic three of underwater cross-sectional area, waterline width and depth. The designer can specify that the



bottom of the cross-section cannot be completely flat by providing a minimum angle at the keel line. Similarly, it is possible to constrain the sides of the underwater area to an angle less than vertical.

Overtime, I have become more interested in the character of the hull and deck above the water. Once you get to a “reasonable” point in terms of wetted surface, there are other things that are of interest in terms a designing a boat that meets other needs (comfort, stability, storage capacity, surfing performance etc.) Despite this “maturation” of my thinking, the minimum wetted surface curves remain valuable, and this program still rigidly allows only the underwater curve that is the minimum wetted surface (subject to a few "constraints" that can optionally be applied - see below). This is not, in practical terms, that much of a straightjacket. You can easily modify the cross-sections that this program provides. The program can get you into the ballpark and you can go on from here. For example, it would not be hard to design a chine boat from the cross-sections that this program provides.

The cross-section profile curve of the deck and the cross-section profile curve of the above water sides of the kayak are decided by the user choosing from one of a number of “families” of possible curves.

This methodology assures that your design will be truly smooth. There will not be any subtle "wows" in the contour of your boat as might occur with other software programs, for example ones that make use primary use of NURB surfaces. It also allows you to design the underwater hull almost separately from the above water kayak. You can optimize your below water shapes and then design the upper parts of the kayak and let the software deal with melding them into one smooth whole. The waterline and the seamline are designed, to some degree, independently.

There are many ways and materials that are used to make kayaks. In the past, I have made fiberglass boats and have used the predecessors of this program to make the plug. My own construction technique has been to cut out of foam the cross-sections of the boat at every 10 cm. I place these cross-sections, appropriately spaced apart, on a straight stick the length of the boat and plank the result.

It should be obvious that there are many other techniques and modifications that can be used. Cedar strip building techniques can result in incredibly beautiful and light kayaks. BearboatSP is quite suited to designing kayaks and canoes of this sort.

The program is also capable of making reduced size models of the boat that you are designing. You can specify, for example, that you want cross-sections that are 1/5 life-size to allow you to make such a model that can be helpful in the design process.

A secondary type output is a computer file of numbers describing the cross-sections of the boat that you have designed. (width, height etc). These files are created as comma or tab delimited files that can be "read" by other programs (spreadsheets or word processors). The ability to document your design in this great detail is particularly useful for people who might have the opportunity to design more than one boat in their career. This enables you to compare your early designs (with whose behavior you have now become familiar) with later designs. This also enables you to compare your design with existing kayaks that have features you either like or dislike.

I am personally exploring creating outputs that can be used by giant milling machines that exist in a few places in the country to carve out a life-size 3D copy of the boat the user has specified. I have been able to export

the data to one of these commercial computer-milling machines and successfully produced a plugs for several of my designs: Ursa 350, Ursa 430, and Ursa 432. There are export functions that can create raw computer files that specify the shape of the kayak in great detail. For the Ursa 430 and Ursa 432, these files were exported to Rhino OSX (<http://mac.rhino3d.com/>) and details of the final model created in that environment.

Individual designs are stored on the computer as rather small files. You can create and modify many different kayak designs. The smallness of these files makes it convenient to collaborate or share with others who have the program. It is easy to e-mail them or to place them on transportable media and transmit them this way.

There are four primary sites where the kayak is designed. These are now accessed under the **Design** menu. These four work environments are **Curve of Areas**, **Birdview**, **Sideview** and **Cross-Section**. In general the design process starts with the **Curve of Areas** and then moves forward with **Birdview**, **Sideview** and **Cross-Section**. The user can move from any one of these areas to any of the others at anytime during the design process.

## Installation

### WINDOWS

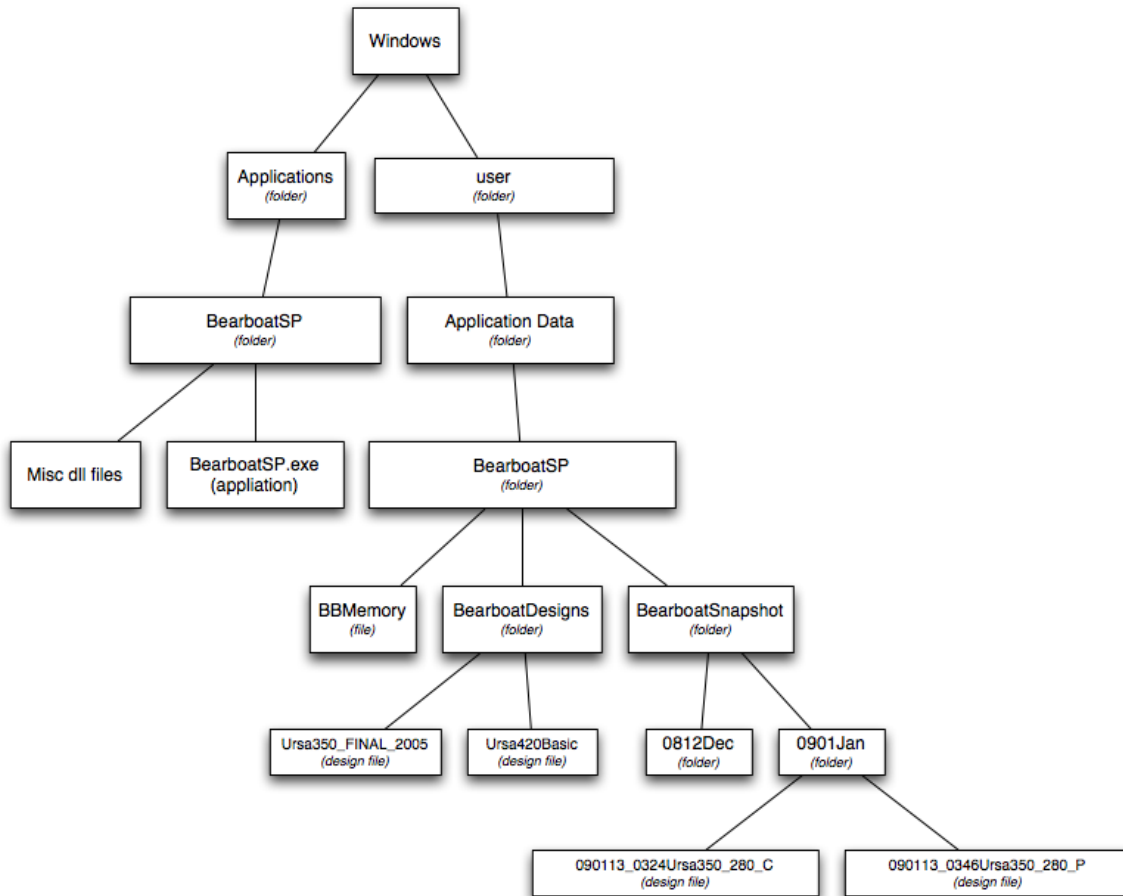
The Windows version of the program is downloaded as a zip file (compressed file) that contains a folder called BearboatSP. Modern versions of Windows are capable of extracting (decompressing) zip files. When decompressed, a folder is reconstituted that contains BearboatSP.exe (the

program itself) and several other small files called dynamic link libraries that are required for the functionality of the program. These small dll files should be kept in the same folder with the program. The folder itself is most appropriately placed in the Applications directory although this is not required. Double-click on BearboatSP.exe to launch the program.

With Bearboat Pro, all of the files created by the program were saved in the same folder with the application. Both in the Windows and Macintosh environment, this approach is now being discouraged. In recognition of this fact, BearboatSP uses a folder in the Application Data directory to store all the designs that are created and to store a new file, called BBMemory, that BearboatSP uses to facilitate the new features that are found in BearboatSP. The program will take care of creating the BearboatSP directory in the Applications Data directory. Inside that BearboatSP directory will be stored

1. BBMemory – a file
2. BearboatDesigns – a directory
3. BearboatSnapshot – a directory

The program creates these directories and files when it is first launched. You only need to worry about them when troubleshooting or when navigating to your designs using the file dialog boxes. It is also important if you wish to remove any remnant of BearboatSP from your computer. To do this, you would remove the BearboatSP folder from the Application folder and then remove the BearboatSP folder from your Application Support folder.

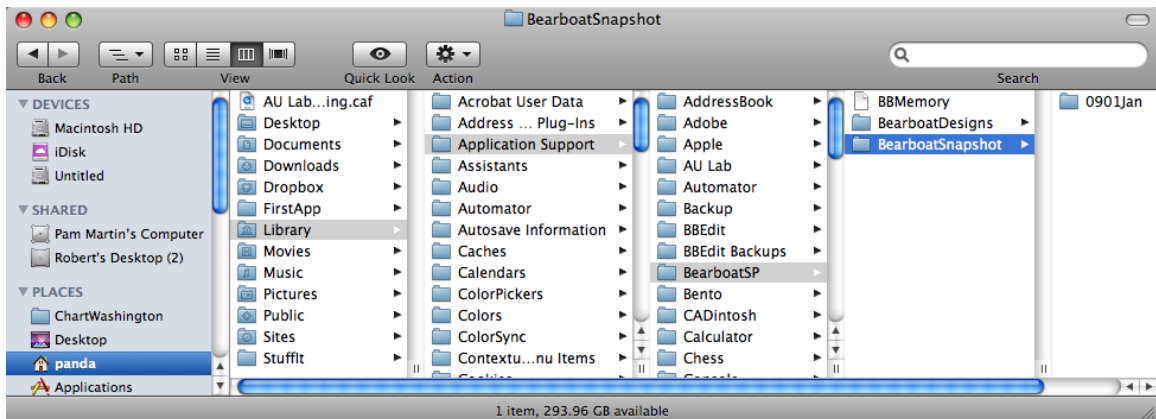


## MACINTOSH

The Macintosh version of the program is downloaded as a dmg file. When that arrives on the Macintosh BearboatSP is displayed as a file on a virtual disk and can simply be transferred to the location of choice. This is most appropriately placed in the Applications folder.

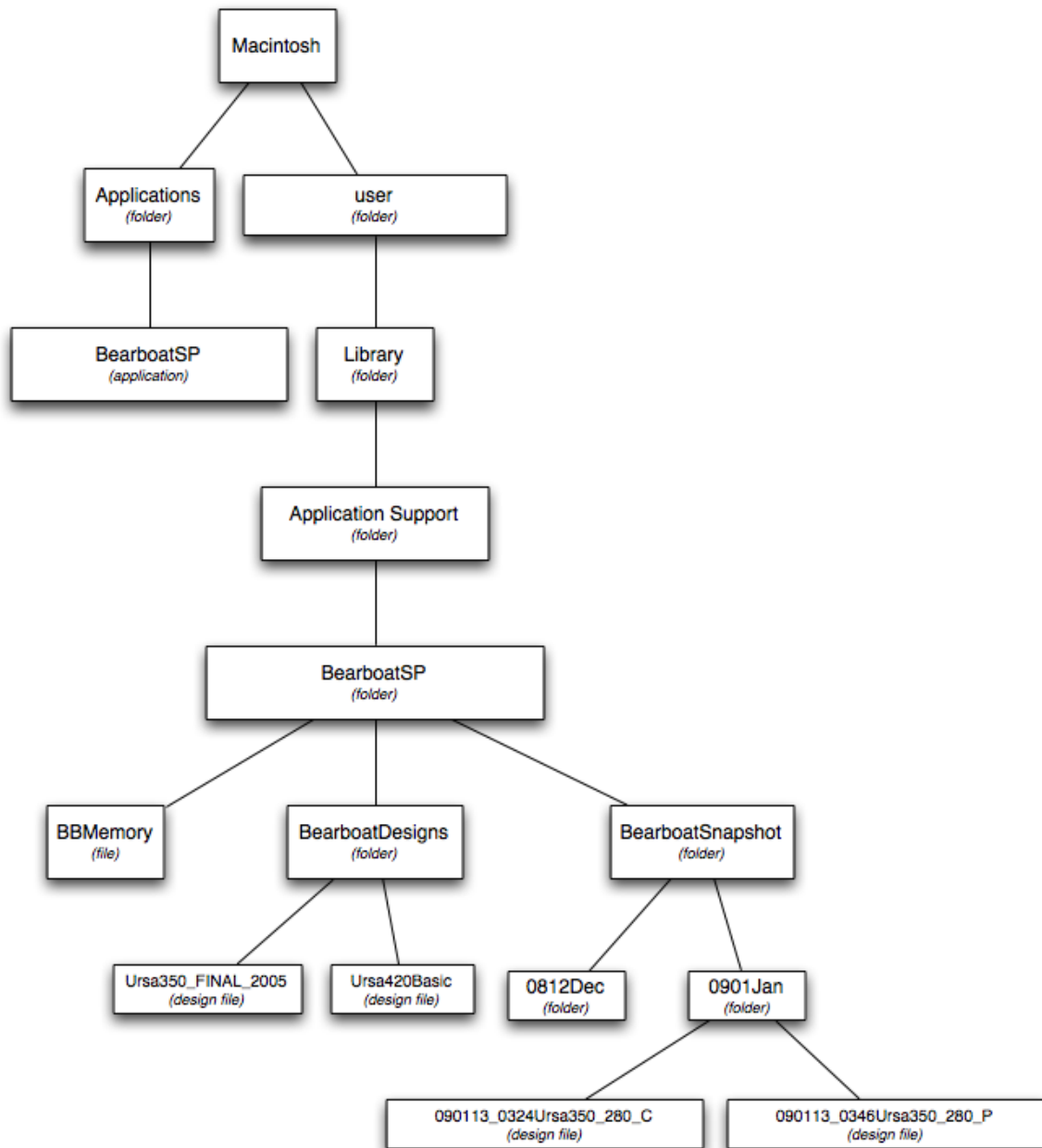
Bearboat Pro placed all created files in the same folder as the application. BearboatSP works differently. When the program is first started, it creates a new folder in the Application Support folder of the users Library. That folder is called BearboatSP. Inside the Application Support folder, you will see many other folders that correspond to other applications on your computer. This is an approach that is being encouraged by Apple.

With Lion (OSX v.7) Apple has made it more difficult to get to your Library folder. It is not visible by default. Hold down the Option key and then select the Finder menu *Go*. If the Option key is down, it will then show *Library* as a menu item that can be selected



*On this computer, the user's name is panda. This illustration shows the location of the BearboatSP folder in the Application Support folder.*

Inside this BearboatSP folder, a file is created called BBMemory and two additional folders, BearboatDesigns and BearboatSnapshot. All of this management is done automatically. It is of import primarily when troubleshooting or when navigating to the designs you have created using the file dialog windows. It is also important if you wish to remove any remnant of BearboatSP from your computer. To do this, you would remove the application and then remove the BearboatSP folder from your Application Support folder.



## Bugs

All programs have bugs. Therefore I am sure that this one does. The user should take the initiative to make sure that the output of this program makes sense before actually trying to build a boat. Make sure that the output fits your concepts of the boat you are trying to build. If the boat is supposed to

be 21” wide, make sure that it is etc. It should be obvious that I cannot guarantee the accuracy of the output of this program. Let the user beware.

Having said this, I am interested in squashing any significant bugs. If you see any anomalous (incorrect) results or strange behaviors when you are doing things that seem rational, please notify me so I can correct or clarify the situation.

## Units of Measurement

Metric units are used throughout, primarily centimeters. Make sure that if you want to design a boat that is 21 inches wide you do not end up with a boat that is 21 centimeters wide. As an option, Imperial measurements are shown next to their metric equivalents for those who are more comfortable with feet and inches. Imperial units can be turned on and off under the **Preferences** menu item.

The bow of the boat is considered to be at position 0 (zero). The stern of the boat is at position  $x$ , where  $x$  is the length of the boat in centimeters. All the measurements of where things are on the boat are based on this framework.

The surface of the water is considered the zero point of the vertical plane. Entities, such as the height of the deck or the seam, are measured from the surface of the water NOT from the lowest point (bottom) of the boat.

John Winter’s KAPER analysis program is built into BearboatSP. The units used in that analysis, popularized by *Sea Kayaker* magazine, are non-metric. Therefore, in the KAPER window, the user will be using and



viewing non-metric units. The program will convert the current design into the appropriate units for the KAPER environment.

## Terminology: Computer Interface

This manual strives to be consistent in how it refers to the various widgets that are used to specify the user's intents. These elements of the computer interface are commonly called controls and include such things as the **slider**, **checkbox** and **radio buttons**. The terms that are frequently used in the manual are defined below.

### WINDOW OR ENVIRONMENT

The program basically consists of many different windows (environments) that provide the controls that let the user design or view various aspects of the kayak. Choosing items in the main menus usually specify the different windows.

For example, there is a Sideview window that allows specification of the parameters that determine the side profile of the kayak.

### DATA ENTRY BOX

Data entry boxes allow the user to type in values for the program to use. An example would be the **data entry box** that accepts the name of the kayak being designed in the Save window. You can also specify the length of the kayak by typing it in a **data entry box**.

### LITTLE ARROW

**Little arrows** are paired buttons that allow you to increase or decrease a value by a discreet amount. A single click will increase or decrease a value by one unit. To increase the flexibility of this control, Bearboat modifies the behavior of the button when the Shift key is held down. This results in the increment value being greater so the value changes to a greater extent in response to a single click. Holding both the Shift key and the Control key down simultaneously will further exaggerate the effect of a single click. In BearboatSP, **little arrows** are frequently found just to the right of **data entry boxes** to allow an alternative way to change the value of a parameter.

## **SLIDER**

**Sliders** are commonly used to select a value from a spectrum of values. BearboatSP, for example, uses sliders to specify the placement of location lines on graphics. These placements can range between the bow and the stern of the boat. Sliders allow the user to choose values in a range between a high and a low value.

## **RADIO BUTTON**

**Radio buttons** seen on the window as a group. They allow the selection of a single choice among many.

## **CHECKBOX**

**Checkboxes** allow an option to be either selected or not.

## **TAB PANEL**

**Tab panels** allow conservation of space, grouping controls on panels that are revealed by clicking on the tabs. The user alternately accesses the groups of controls by clicking on the appropriate tab.

## **COLOR SQUARE**

**Color squares** serve several functions. A label generally identifies them and they indicate on accompanying graphics, by sharing the same color, the entity with which they are associated.

In many contexts, clicking on a **color square** causes the entity to appear on the graphic in the first place. In the Curve of Area window, clicking on the pink color square labeled Center of Buoyancy, indicates by a pink line the location of the Center of Buoyancy. If you are a synesthete, and believe that the Center of Buoyancy should be a different color, you can Option-click (Alt-click) on the square to choose a color you like.

The color of any **color square** can be changed by holding down the Option key (Alt key) while clicking on a **color square**. This will bring up a tool that allows choosing an alternate color. Clicking on the square with the Shift key down will cause it to revert to the default color.

## **CANVAS**

**Canvases** are the areas in the window that show the graphics and pictures. Often Bearboat allows clicking on the picture itself to accomplish certain tasks, for example, establishing a particular location of interest on the kayak.

## **GROUP BOX**

**Group boxes** are labeled rectangles on the window that group various controls to help organize the use of the window.

### **POP UP MENU**

**Pop-up** menus provide a list of options that “pop-up” (actually usually down) when you click on the control. Only one of the options on the list can be selected at any given time.

## **Terminology: Kayak Descriptors**

### **DECK LINE**

The line running the length of the boat in the midline connecting the highest point of every cross-section

### **KEEL LINE**

The line running the length of the boat in the midline connecting the lowest point of every cross-section

### **SEAM LINE**

The lines running along each side of the boat connecting the widest point of every cross-section

### **DESIGN WEIGHT**

The user designs a kayak effectively specifying a particular weight that determines where the **waterline** of that boat will be.

## **WATERLINE**

This is the line running along each side of the boat where the surface of the water is when the kayak is at its **design weight**. Used in some contexts as synonymous with the greatest **depth** of the boat.

## **WATERLINE WIDTH**

This is the distance between the **waterlines** on each side of the boat, i.e. the width of the boat at the **waterline**. With a boat constructed using this program, the **waterline** width at any point is less than (or rarely equal to) the **seam width** at that point.

## **DECK HEIGHT**

The distance from the highest point of the deck to the surface of the water is considered the **deck height**. **Deck heights** vary along the length of the boat.

## **DRAFT**

Distance from the bottom of the boat to the surface of the water at the deepest point of the hull is considered the **draft**. The deepest point of an individual cross-section is often referred to as its **draft (or depth)**. The **drafts** are expressed as positive numbers for the submerged part of the boat. Where the keel line is above the waterline, (at the bow and stern) the **draft** is expressed as a minus number.

## **DEPTH**

**Depth** is synonymous with **draft** in this manual.

## **SEAM WIDTH**

Distance between the two seam lines at any given point, which is the same thing as the width of the boat at that point.

## **SEAM HEIGHT**

Distance of the **seam line** above the surface of the water.

## **BOW SEAM HEIGHT**

Distance of the bow of the boat above the surface of the water

## **STERN SEAM HEIGHT**

Distance of the stern of the boat above the surface of the water

## **POSITION**

Distance, in centimeters, from the bow of the boat.

## **ENTRY (ENTER)**

**Position** near the bow where the keel line enters the water

## **EXIT (LEAVE)**

**Position** near the stern where the keel line leaves the water

## **WATERLINE LENGTH**

Length of the part of the boat that is in the water (Exit - Entry)

## **WETTED SURFACE**

As applied to a boat, this is the area of the boat that is in contact with the water. It would be expressed in centimeters squared. I also apply this term to an individual cross-section. In this context, it is the length of the line of that cross-section which is in contact with the water and would be expressed in cm.

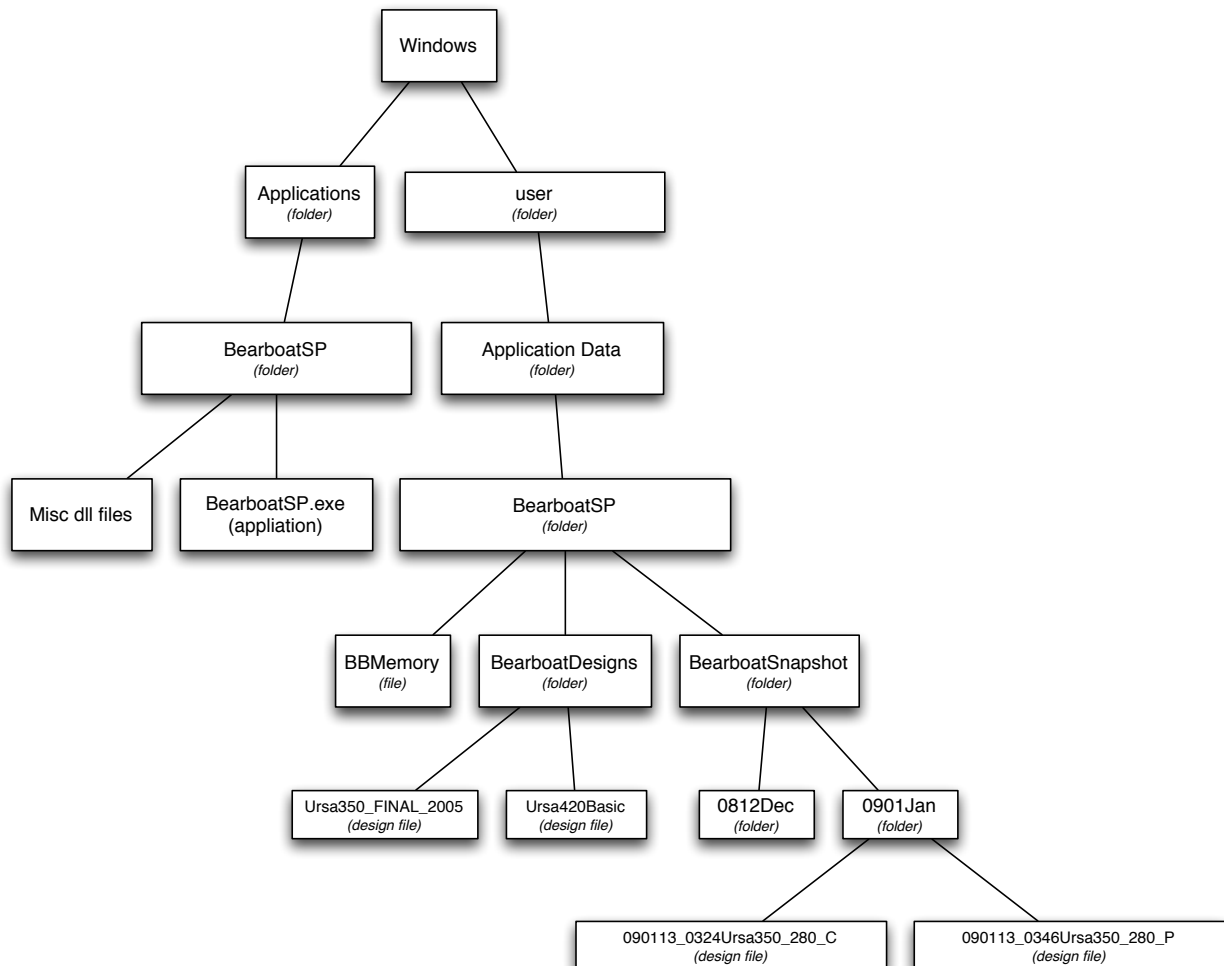
## **MINIMUM KEEL WIDTH**

This is a minimum width that the boat hull can attain. This assures that keel-like structures are thicker than the specified minimum.

## **MINIMUM SEAM WIDTH**

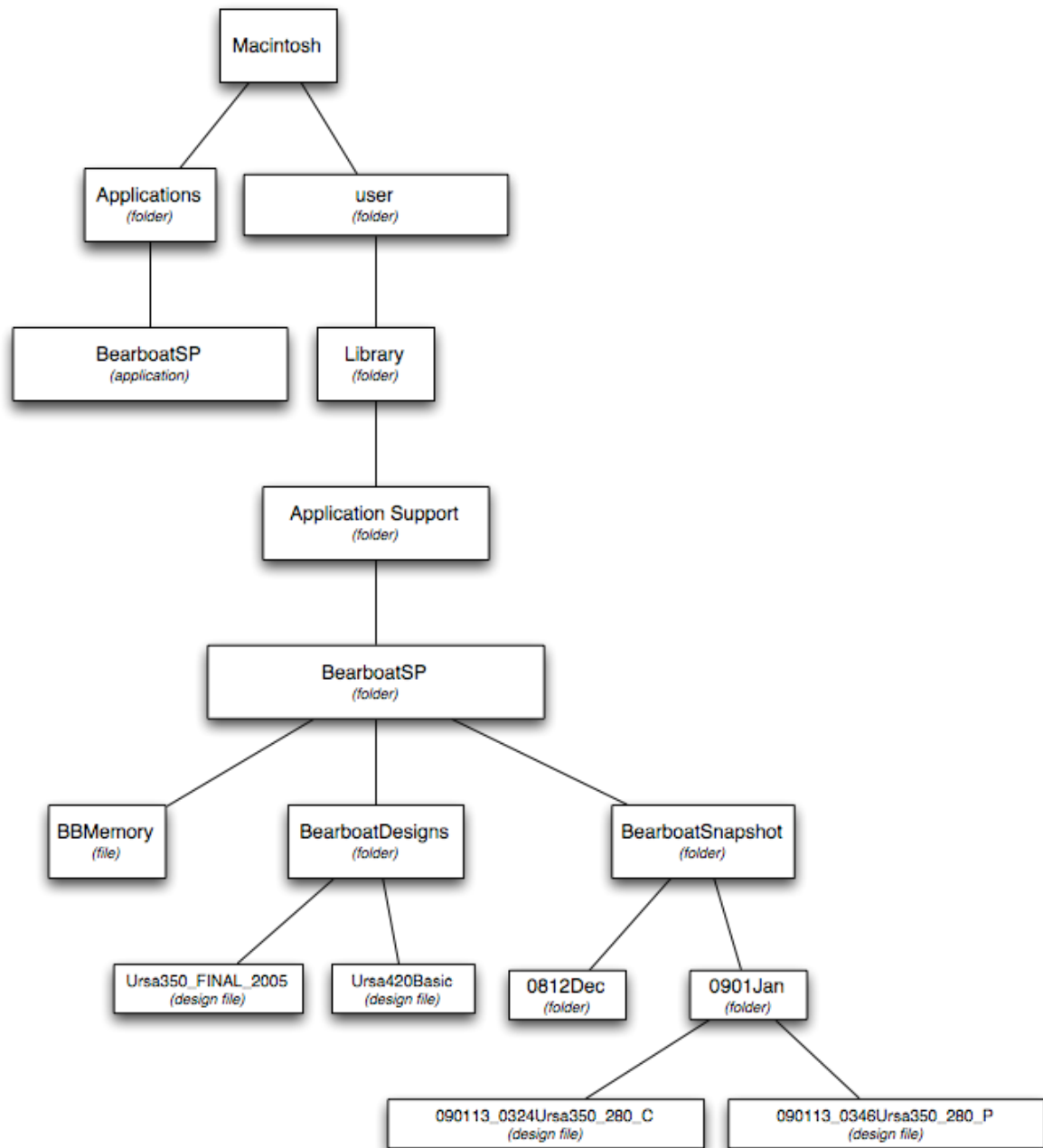
This is a minimum width that the boat can attain at the seam line. This assures that the ends of the boat are not knife-edges. For many methods of construction this is not particularly important as "real-life" will prevent knife-edges.

# FILES IN BEARBOATSP



**Bearboat Files - Windows**





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**Bearboat Files - Macintosh**

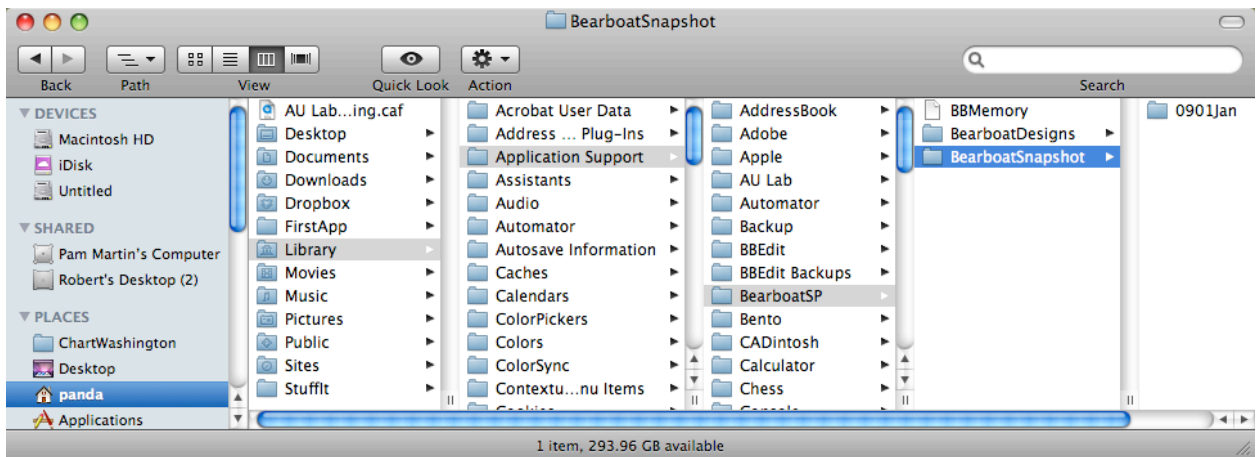
There are many files that relate to BearboatSP. These files are handled somewhat differently than was the case with BearboatPro. Bearboat Pro kept all the files in one single folder (directory), which was the same folder that contained the application. This had the advantage of simplicity. The user knew where everything was and if he wanted to rid the computer of the program or move the program to another computer, simply deleting this folder or moving this folder would do the trick.

This model is increasingly discouraged by the Windows and Mac operating systems. Those operating systems are trying to impose an order on the hundreds of thousands of files that exist on a typical modern computer. Applications themselves are “best” stored in the Application folder while the files that support that application might be found in a variety of places, some more “appropriate” than others. BearboatSP (*the application*) is most appropriately placed in the Application folder. When it creates files for its own use, they are stored in folders that are recommended for the purpose: the Application Data folder (Windows) or the Application Support folder (Macintosh). Those folders have specific locations on each of those operating systems.

When you initially install BearboatSP, the application is downloaded and probably best placed in the Application folder, although this is not strictly enforced. The program itself, when it is run for the first time, will check in the Application Data or Application Support folder (directory) to see if there is a folder called BearboatSP. If it is not found, it will be created there. Inside that folder will be placed a file called BBMemory and two additional folders, BearboatDesigns and BearboatSnapshot. When designs are created

by the program, those designs will be stored in the BearboatDesigns folder. The program will remember this location and expect to find all the designs that have been worked on in that folder. This makes it easy to find and open any of the designs that you have been working on.

With Lion (OSX v.7) Apple has made it more difficult to get to your Library folder. It is not visible by default. Hold down the Option key and then select the Finder menu *Go*. If the Option key is down, it will then show *Library* as a menu item that can be selected



*Screenshot showing Location of the BearboatSnapshot Folder on a Macintosh (inside the BearboatSP Folder inside the Application Support Folder)*

It is not too hard to move the program to another machine and include all of your previous work, but you have to do two things. First, the new machine has to get a copy of the program itself. Secondly, you have to copy the BearboatSP folder and put that folder in the CORRECT location on the other machine.

It is possible to simply start the program on the new machine and let it create the folders and subfolders in the Application Data or Application

Support folder. Then you could transfer the subfolders and files (BBMemory, BearboatDesigns, and BearboatSnapshot) to the BearboatSP folder that was created on the new machine and replace the newly created “empty” (BBMemory, BearboatDesigns, and BearboatSnapshot) files that were created on the new machine with the older, data filled ones from the original machine.

If you want to send an individual design to a friend, by email or by flash drive, this is not too hard. You could find your BearboatDesigns folder and find the file for that particular design and copy it to give it to your friend. But you have to know where it is. To make this scenario play out more simply, it is possible in the Save As... dialog window of BearboatSP to check a box that allows you to make a copy of a design to any location you might want, for example, the desktop. Then you can find that copy and send it to your friend or back it up or whatever you might want to do with a file.

The recipient can place the design file anywhere on his machine that is convenient and then open the file from within BearboatSP. BearboatSP is capable of navigating to any file on your computer to open it. After it has been opened, the recipient can Save it and it will be saved to the “correct” location for future use.

So what are these folders BearboatDesigns, BearboatSnapshot and BBMemory? As discussed above, BearboatDesigns stores all the designs that you have worked on or are working on. This is not fundamentally different than BearboatPro, which stored a similar folder with the application. The BearboatSnapshot folder and the BBMemory file are both new features of BearboatSP.

BearboatSnapshot addresses a problem that I have occasionally encountered. I have a design, and I confidently make a change. For example, I might make the kayak 2 cm narrower. I work on the design for a long-time, making all the adjustments in the other parameters. I get deeper and deeper and then I realize that I really do not like the consequences of the original change. Now I *should* have saved my old design with a different name, so I could go back to it. But I didn't.

What BearboatSnapshot does is offer a way to go back in time. Without any input from the user, the program takes “snapshots” of the state of the design, at intervals of time and at critical moments. Each of these files is time stamped. They are prefixed with the date and time that they are created. The time stamp is in the format YYMMDD\_HHMM (year, month, day, hour, minute) So if your design is called Excalibur, there will be a multitude of files called things like 090129\_1726Excalibur that are sitting in your BearboatSnapshot folder offering you the opportunity to go back in time. If you open that particular file, it will be the state of your design on January 29, 2009 at 5:26PM. It is a breadcrumb trail of where you have been. These files are small enough that they are not going to occupy significant space on your hard drive. You can find them and throw them away anytime that you want. They are just there to supplement any system that you may have to backup your old work. They are stored in monthly subfolders.

Another situation in which having snapshots can be useful is that arising if your computer crashes while you are using BearboatSP. Even if you have not done a Save for several hours, you will end up not losing more than 10 or 20 minutes of work.

BBMemory is a file that contains information that simply makes the program easier to use because it remembers useful facts from one session to another. It is not critical. You could lose this file or delete it and BearboatSP would continue to function. But it is nice to have because it remembers things like old stability calculations and the name of kayaks that you have recently been working on. Stability calculations are time-consuming to generate and are most valuable in the context of comparing one design with another. With BBMemory intact, all your old stability calculations are available for review instantly. I recently designed a kayak that was less stable than I would have liked, and in response, the stability evaluation functionality of BearboatSP has been enhanced over that offered in BearboatPro.

BearboatSP also generates many other files for other purposes. Most important are BearboatPrint files that are created so they can be fed into the independent program BearboatPrint to create the paper forms that are used in actually building a kayak. Other examples include DXF files that can be created representing your design in a format that can be imported into most CAD programs (for example Rhino) to allow you to use the tools there to refine your design. In a CAD program, if you become facile with one, you can design 3D details such as deck line attachment points and hatches. There is another file called a “particulars” file that can be created and contains much numerical data that characterizes and summarizes your design. These files can be opened by spreadsheet or word processing programs and are useful for perusal and for comparing one design with another. Other files are basically a dump of all the data that defines the surface of the kayak. I have used such files as inputs into 3D computerized milling machines that can

carve out a shape. All these type of files, when produced, are simply placed in whatever location the user decides on for her convenience at the time of their creation.

# MENU BAR

The functions of the program are available through the menu bar. This next section of the manual simply goes through the menu bar and explains all the menus and menu items, and the work environments that they contain.

## TOOL

### Tool: Restore Default Colors

This function is not implemented in this version of BearboatSP

### Tool: Drag Spreadsheet

John Kaper, a kayak and canoe designer, created a spreadsheet which was analyses aspects of kayak performance given the values of various parameters. Matt Broze of Mariner Kayaks made it easier to use by automating some of the calculations. It is available on the Mariner Kayaks web page ([www.marinerkayaks.com](http://www.marinerkayaks.com)), The **Drag Spreadsheet** menu item accesses a window that summarizes the data for your design that can be entered in this spreadsheet should you care to take advantage of it. I have placed in green data entry boxes all the parameters to carryover into the spreadsheet. These values can be cut and pasted into the spreadsheet.

It is tedious to individually enter all these values. There is one **data entry box** on this window in a group box labeled Cut and Paste into Drag Spreadsheet. If you copy ALL the text from this **data entry box**, you can paste this entire thing into the cell A9 of the spreadsheet to save the bother



of individually entering many of the parameters. **Copy** and **Paste** are menu items in the **Edit** menu. Highlight the text in this data entry box so it can be copied and pasted.

With BearboatSP the need for this tool has been largely superseded by the KAPER analysis under the Visualize menu. Most of the functionality of the Winters/Broze spreadsheet has now been incorporated within BearboatSP itself. I should thank Matt Broze for his help in transferring the algorithms used in the spreadsheet to BearboatSP and thank John Winters for his permission to use the calculations that he developed.

The spreadsheet is useful in that it not only allows you to see the predicted performance characteristics of your kayak, but it also allows you to compare your design with many other kayaks that Broze has included in the spreadsheet over the years.

## Tool: Particulars

The window associated with this menu item will show many of the values that characterize the kayak's hydrostatics. People familiar with the use of these terms might find them helpful, perhaps to compare the design with others. Some of these concepts are a little arcane. There is a nice web site [www.oneoceankayaks.com/smhydro/hydro.htm](http://www.oneoceankayaks.com/smhydro/hydro.htm) that provides clear definitions for most of these hydrostatic terms.

There is a button, **Save To Text File**, on this window that will create a text file that contains the data shown on the Particulars page. Programs such as Excel or Word can open this file. This file remembers the particulars and other summary information about your design. It can be useful for reference when trying to compare a new design with a prior.

## Tool: Constrain Cross-Section

This window allows specification of additional constraints on the computer's construction of the underwater cross-section. With no additional constraints, the computer will relentlessly create the cross-section with the minimum wetted surface given the basic requirements of creating a cross-section of a given area, depth and width.

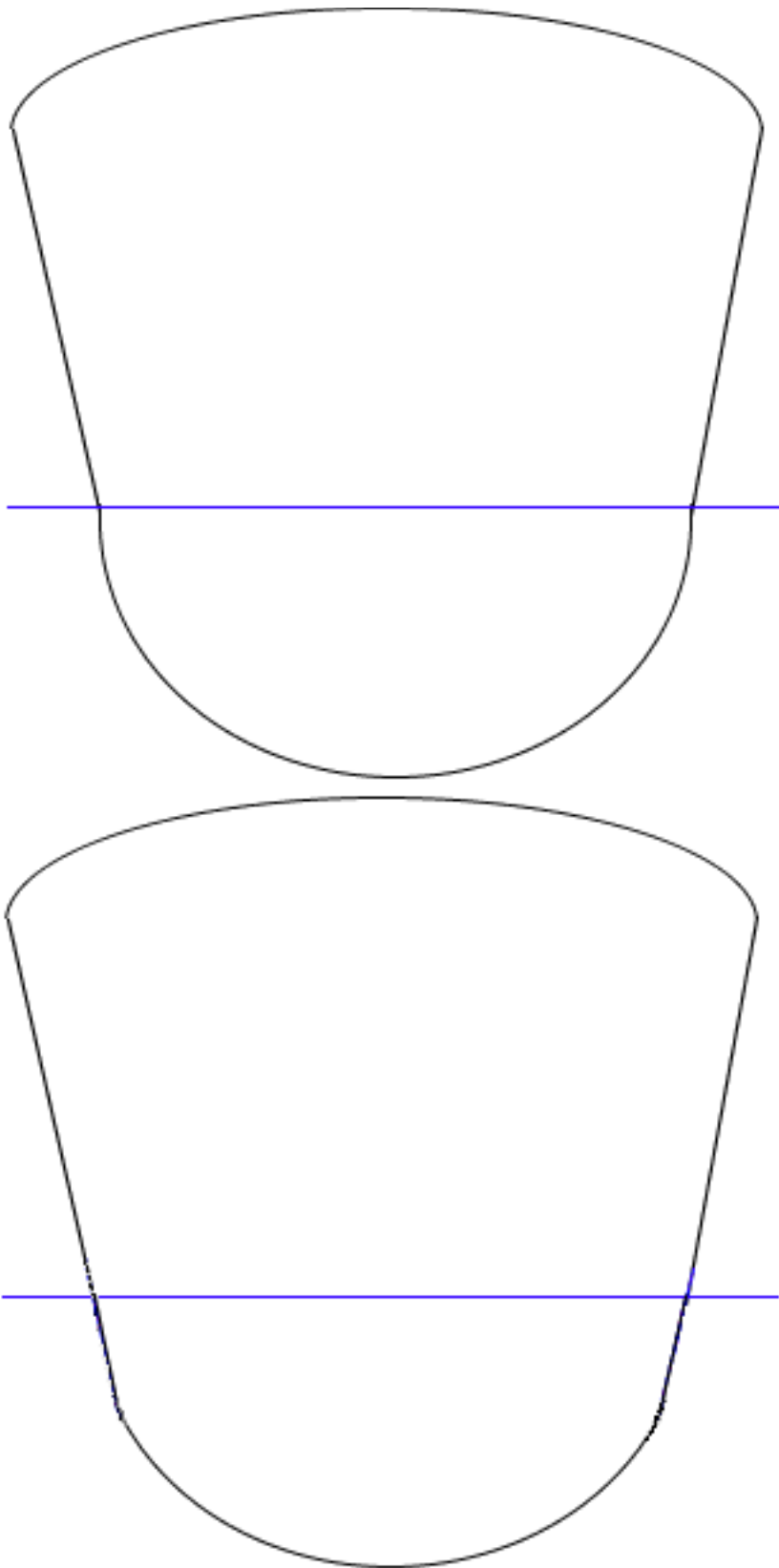
With no additional constraints, certain cross-sections may have a completely flat bottom and certain cross-sections may have completely vertical sides. There is nothing intrinsically wrong with either of these two things, but it is possible to constrain the program to prevent them. The *water angle* is that angle that the side of the underwater cross-section makes with the water surface. Vertical would be 90 degrees. This can be constrained to some lesser value. The *keel angle* is that angle that the bottom of the boat makes with the vertical in the midline. If the boat were completely flat in the midline that angle would be 90 degrees. This can be constrained to some lesser value that will assure that there is a definable keel line that runs the entire length of the boat and that the boat is nowhere flat on the bottom. Some designers prefer this. A slight angle at the keel line helps to stiffen the boat, which some construction materials will require. The program does not allow values of less than 60 degrees for either of these parameters.

The water angle can be additionally constrained by checking the box *Underwater Angle Constrained by Side Angle*. The side angle is determined by the height of the seam and the overhang (the difference between the width of the seam line and the width at the water). Normally, the underwater shape of the boat is totally independent of these variables. The effect of this

independence is that there can be a concavity at the waterline under some circumstances. In other words, when looking at the cross-section, it is possible that the side of the underwater part of the curve is more vertical than the side of the over the water part of the curve. Most commercial designs will not show cross-sections of this type from which we can conclude they are not popular although I prefer them under some circumstances. In any case, to avoid this, check the **Underwater Angle Constrained by Side Angle** checkbox. This constrains the shape of the underwater part of the curve to be no more vertical than the line between the seam and the side of the boat at the waterline. There are limitations on the power of this constraint. It will not force the underwater side to be less vertical than 60 degrees.

It is possible to "increase" this constraint by a few degrees by using the **little arrows** that appears when this constraint is checked. This is primarily useful if you have chosen to use Bezier sides. The final form is dependent on the degree of overhang at the cross-section, the chosen side type (Bezier, Hollow, or Straight) and the other parameters that are chosen.

In the figure below, the top cross-section is not constrained, and there is a slight concavity at the waterline. The bottom cross-section has been constrained by the side angle, and there is no concavity at the waterline. This illustration is from a setting where Straight sides have been chosen. The effect of this constraint is clearest in this situation. As discussed in the previous paragraph, the situation is more complex when Bezier sides have been chosen.



A **data entry box** will accept a value for *Area Too Small to Determine the Water Angle*. In general, this should just be left at the default of 15. This parameter ensures a smooth the transition of the cross-sections of the boat as they emerge from the water at the bow and the stern.

It is difficult to explain the effect of this parameter but it is not difficult to demonstrate. Take the Generic boat and in the cross-section area make

*Start* = 2

*End* = 50

*Interval* = 2

Then click the **Clear/Draw** button. The cross-sections will meld with each other very smoothly. Now go to the constraints area and change the *Area too Small to Determine the Water Angle* to zero. Now go back to the cross-section area and try drawing the same segment of the boat. You will see a region near where the boat is exiting the water where the cross-sections do not appear to be blending together well.

This occurs because when the cross-sectional area becomes very small the angle at which the underwater section emerges from the water becomes very sensitive to tiny changes in the parameters. Thus adjacent cross-sections can have considerably different angles and this causes the above-water sides of the boat to vary in their appearance, particularly when Bezier sides are chosen. By making the value of *Area Too Small to Determine the Water Angle* 15, the program uses an alternate method to calculate this angle when the cross-sectional area falls below 15, which assures a more rational behavior. You may find for some design that a value greater than 15 is required to deal with this "instability" but generally 15 should do the job.

If you have designs created with versions prior to 10/31/99 in Bearboat Classic, you should consider modifying them by changing that parameter from zero to 15.

There are two **canvases** in this **Cross-Section Constraints** window. The upper one shows a cross-section of the boat. The lower one is a representation of the kayak that shows where the cross-section lies. There is a **slider** associated with this lower graphic that allows choosing any arbitrary location. In place of using the **slider**, it is possible to click on the kayak graphic. The cross-section corresponding to the location clicked on will be chosen.

The cross-section graphic shows in “water” color the area in which the cross-section can exist. As the *Maximum Water Angle* or the *Maximum Keel Angle* constraints are applied this area becomes more constricted to illustrate their effect. By using the **slider**, the potential effect on any cross-section of the boat can be demonstrated. To actually, force the cross-sections to conform, click on the **Apply New Constraints** button. Exiting this window will also act to enact the constraints that have been specified.

## Tool: Restore Tutor Kayak...

The program includes a Tutor Kayak that is just some generic kayak that can be played while learning the program. This menu item simply restores these initial parameters of the Tutor kayak if they have become way out of whack. If the designer has specified other parameters, they will be replaced by the default values. The Tutor Kayak is not any "real" design. It just is a set of parameters that you can fool around with.

## Tool: Wetted Surface

BearboatSP will create, for any given cross-section, the minimum wetted surface within the constraints that are imposed by the designer. This tool is

for designers for whom minimizing the wetted surface is a priority. There is an “ideal” design, generally impractical, which has every underwater cross-section as a hemi-circle. Once the underwater length of the boat and the curve of area have been specified, there is only one “absolute minimum” wetted surface design, that with every cross-section a hemi circle. This window will compare your design along its length with this “ideal” design. It will, in general, not be the same because you have imposed additional constraints such as the [Birdview](#) waterline and the [Sideview](#) rocker.

The top graph shows the wetted surface of the design at hand in black and compares it to the “ideal” wetted surface in red. The wetted surface of a point on the kayak is taken to be the length of the edge of the underwater part of the cross-section. The second graph shows the magnitude (in arbitrary units) of the difference between the design and the “ideal”. This just shows the relative magnitude of the discrepancy along the length of the boat.

Below, you can use the [slider](#) and [little arrows](#) controls to query in detail a specific cross-section at a specific point on the kayak. There is a graphic on the lower right that will show this cross-section and compares it with the hemi circle that contains the same underwater area.

There are very good reasons NOT to have every cross-section an exact hemi circle. Other design considerations, for example stability, that usually override the use of pure hemi circles. Nonetheless, this window can provide useful information for refining a design.

# DESIGN

## Design: Curve of Areas

As the kayak is designed, the user can go back and forth between **Curve of Areas**, **Sideview**, **Birdview** and **Cross-Section**. It makes the most sense to start with the **Curve of Areas** although some may find this a little abstract. This is a curve created by drawing a graph of the underwater area of the boat (y axis) vs. the position from the bow to the stern (x axis). The smoothness of this graph assures that the boat will have a smooth shape as it start thin and small at the bow, expands to a point somewhere near the center of the boat and then tapers toward the stern. This curve determines a host of parameters that characterize your design such as the displacement, center of buoyancy and the prismatic coefficient.

There are a number of parameters that determine the shape of the curve of areas. *Entry* and *Leave* define the waterline length and determine where the keel line enters and leaves the water. The *Maximum Area* is the size of the largest cross-sectional area. The *Location of Max Area* is the position of this largest cross-sectional area. The *Length* is just the overall length of the boat and is less important here as the curve of areas is primarily concerned with the underwater length.

There are 4 arbitrary parameters that can be adjusted to affect the shape of the curve. Many of the curves in this program use this technique. The first parameter affects primarily the first quarter of the curve while the second the second quarter etc. As the number increases, that part of the curve becomes “fuller”. The left side of the graphic is the bow and the right the stern.



The curve of areas determines many of the properties of the boat. Any reasonable curve of areas will produce a reasonable boat. Here you can decide how fine the entry of the boat will be. Here you decide the weight capacity of the boat. The center of buoyancy and the displacement of the boat are all determined by the curve of areas. The prismatic coefficient is determined by the curve of areas.

The **Curve of Areas** window has a **canvas** in the lower right corner that shows a single cross-section of the kayak at a particular location. Values associated with that cross-section are also presented. This cross-section is at the location written in the nearby **data entry box**. The location line simply refers to a vertical line drawn on the graphic that corresponds to a particular chosen location. This will be drawn on the main **canvas** if the **Show Location Line checkbox** is selected,

There are many ways to change the specified location. A **slider** and **little arrows** and a **data entry box** are all provided for this purpose. If the **Show Location checkbox** is selected, then clicking on the main canvas that contains the curve of areas can also specify location. The windows for **Birdview** and **Sideview** also treat the location specification in the same way,

There is a **checkbox Show Max Limit**. If this is activated, it indicates the upper bounds of what cross-sectional area is possible at any given point along the boat. It displays as a pale red zone. If your curve of areas moves into this "red zone" then you are asking the "impossible".

This issue is discussed elsewhere in this manual, but basically there is an upper limit of underwater cross-sectional area that can be accommodated by

a kayak of any given waterline width and depth. This is not that complex to understand. Let's say there is a point along the length of the boat that has a waterline width of 50 cm and a depth of 10 cm. It is not going to be able to accommodate a cross-sectional area of greater than 500 cm<sup>2</sup> (10 cm \* 50 cm). That would be a rectangular underwater cross-section. If you "ask" for more than this in the curve of areas module, then later you are going to have to change other parameters in other modules (primarily the width and or depth of the boat) You cannot expect to specify a boat 16 feet long, 21 inches wide with a draft of 2 inches and expect it to carry 900 lbs. The curve of areas module does not prevent you from creating whatever curve of areas you want, but if you do not adjust other parameters when you find yourself in the "red zone" then the cross-sections will be "impossible". You will see this when you try and visualize the cross-sections in the cross-section module.

As changes are made, they accumulate on the graphic. To refresh the graphic and erase all the accumulated lines, click on the **Refresh button**. Alternatively, tap on the space bar of the keyboard. This "clean-up" method is used throughout the program.

In BearboatSP, one will see a number of small colored squares in the design areas. Frequently one can click on the squares to demonstrate something on the graphics of that page. For example, one can click on the square to the left of *Location of Max Area* to demonstrate that location.

If one wishes to change the default colors for any of the squares, one can click on the square while holding down the Option key (Alt key). This will allow you to choose a custom color for, as an example, the *Center of Buoyancy*.

The **Original Curve** button allows the user to see the shape of the curve on the boat as it existed when the user first selected the **Curve of Areas** menu item. This can help orient the user to where she started if the accumulation of changes has become confusing. If the user has actually changed the length of the boat, the button ignores this. It only restores the curve as determined by the shape curve parameters and the location of maximum area.

It's also possible, when in the **Curve of Areas** window, to superimpose a Birdview or a Sideview of the kayak being designed.

## Design: Birdview

Allows the user to view the boat under design from the top. Here the user provides the parameters that determine the width of the waterline and the width of the seam line along the length of the boat. This program assumes that the seam width at any point is greater than or equal to the waterline width. Occasionally boats are designed that do NOT obey this rule. In canoe design, it is called tumblehome. This program will not allow entering values that result in the waterline width being greater than the seam width.

The waterline is displayed in blue. The seam line is displayed in black.

There are 4 arbitrary parameters that can be adjusted to affect the shape of the waterline and 4 arbitrary parameters that can be adjusted to affect the shape of the seam line. Many of the curves in this program use this technique. The first parameter affects primarily the first quarter of the curve while the second the second quarter etc. As the number increases, that part of the curve becomes “fuller”. The left side of the graphic is the bow and the

right the stern. Click the **Refresh** button or tap the space bar to get rid of all the extraneous lines that accumulate.

The **canvas** in the right lower corner shows a specific cross-section of the kayak. The location is indicated in the **data entry box** that is seen to the left. If the **checkbox**, **Show Location Line**, is selected, then a vertical line corresponding to the main location will be shown on the main **canvas**. To see where position 300 is, enter this value in the **data entry box** and then TAB out of it. An orange line will indicate this position on the graphic.

The *half angle of entry* and *half angle of exit* are values that are of use to some kayakers trying to optimize their design. This is a measure of how fine the bow (or stern) is at the waterline. Clicking on the appropriate **colored squares** will result in graphics indicating these values being projected on the picture.

Remember when using the **little arrows** that each click's effect can be magnified if you are holding down the Shift key or both the Shift key and the Control key. For example, clicking on the *Maximum Waterline Width* **little arrows** will change the value by only 1 mm. If you hold down the Shift key, a single click changes the value by 1 cm.

## Design: Sideview

The **Sideview** window allows the user to view the boat under design from the side. Here is provided the parameters that determine the draft (depth of the keel), the height of the deck and the height of the seam line along the length of the boat.

There are 4 arbitrary parameters that can be adjusted to affect the shape of the seam line and 4 arbitrary parameters that can be adjusted to affect the shape of the keel line. Many of the curves in this program use this technique. The first parameter affects primarily the first quarter of the curve while the second the second quarter etc. As the number increases, that part of the curve becomes “fuller”. By the convention in BearboatSP, the left side of the graphic is the bow and the right the stern. The **Refresh** button will remove extraneous lines that may have accumulated.

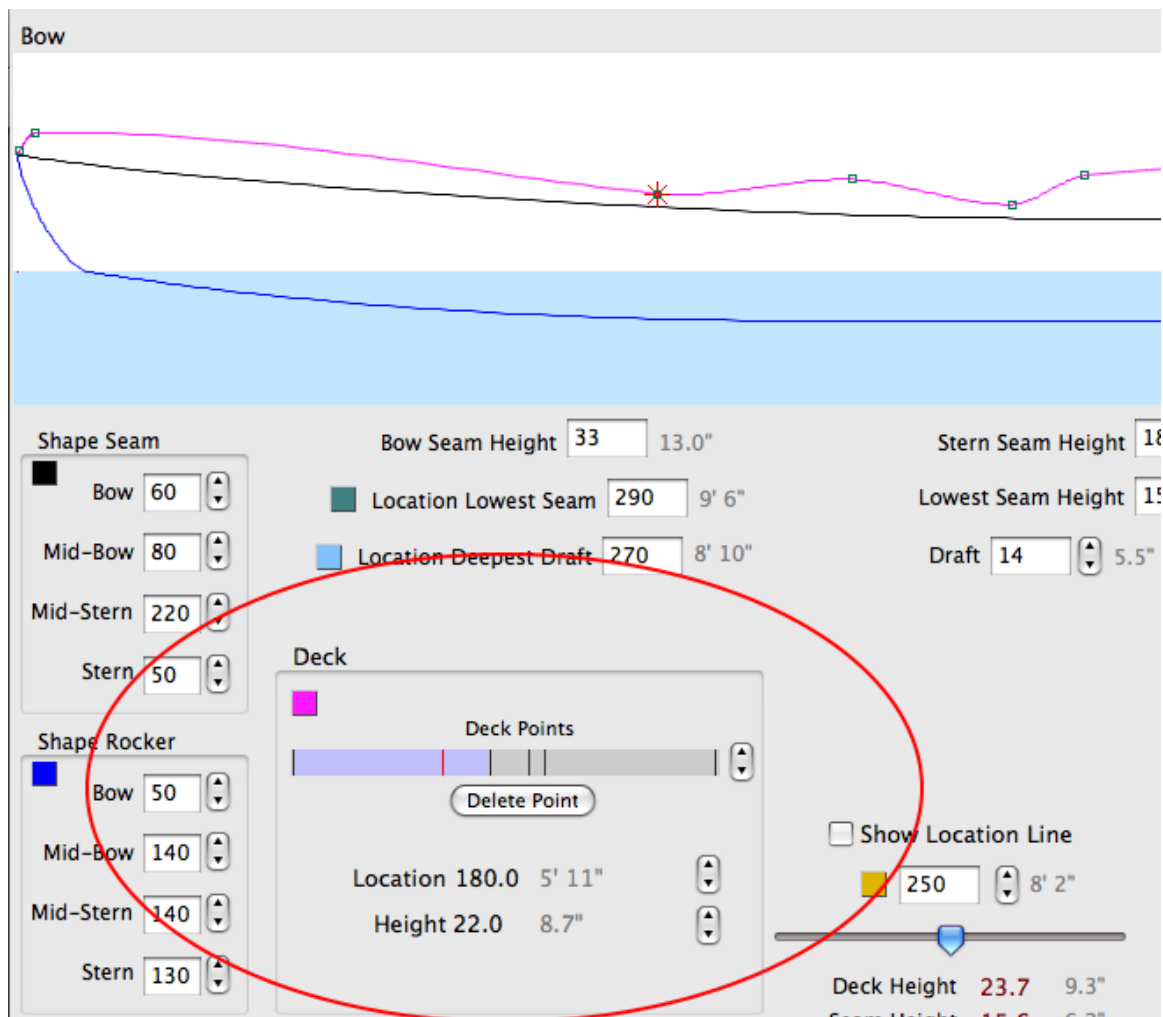
In this module, you are determining the seam line as seen from the side. This program assumes that the seam line is straight or that it dips down in the middle. Occasionally boats are designed with what is called reverse sheer. The seam line (sheer line) of these boats is higher in the center than it is at the ends. This program does not support this sort of seam line. The seam line is determined by the parameters in the **Shape Seam group box**.

The keel line is determined by the parameters in the **Shape Rocker group box**. The boat profile at the bow and stern of the boat (the part that is out of the water) is arbitrary. I have selected mathematical formulas that create a curve that I happen to like over a wide range of values. But really, this is in the hands of the builder.

The bow (and stern) of a kayak are small and easily modified. Much of the character and aesthetics of a kayak come from how these elements are treated. I consider this really to be outside the bounds of the computer program. This is where the sculptor and the artist hold sway. When building a boat, I generally recommend that designers deal with the bow and the stern last and integrate these elements in with the rest of the boat. A beautiful bow can make an ordinary boat shine.

The keel line can be manually drawn to override the default curves created in this area. It is best to use the **Sideview** window to approximate the desired line as best one can. Then go to the **Tweak** menu and choose the **Rocker** menu item. Here the designer is given the freedom to create a custom curve for the keel line that has few restrictions. Generally, this would be done as one of the last steps in designing the kayak (if done at all).

The **deck line** is handled somewhat differently from the curves described above. The **deck line** is created and modified differently in BearboatSP than it was in Bearboat Pro.

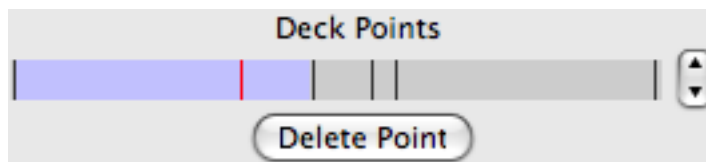


*Deck line specification box in BearboatSP*

The profile of the **deck line** is determined by a number of points, deck line points. These points specify the height of the deck at any given location. Between the **deck line** points, the computer interpolates a smooth curve that determines the height of the deck at any point along the length of the kayak.

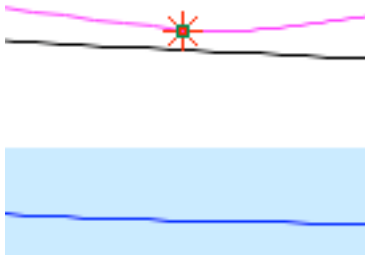
There are two places that the user can modify the deck line points.

1. Within the picture of the kayak at the top of the **Sideview** window.  
That area is called the **main canvas**.
2. Within the **Deck group box** circled by red in the illustration above.  
The **Deck group box** has a horizontal bar graphic inside it which can be called the **deck point canvas**.



*deck point canvas with the red line indicating the currently selected deck point*

The **deck point canvas** shows a number of short vertical lines along its length and those indicate the location of the various deck line points along the length of the kayak. The bow is to the left. Most of these vertical lines are black. If the user has selected a particular deck point, it is indicated as a vertical red line. Surrounding the selected deck point is a light blue region that shows the boundaries of where that particular deck point can be moved. Within the **main canvas**, the selected deck point will be outlined by radiating red lines.



*The selected deck point as seen in the main canvas*

For coarse, inexact placement of deck points, they can be simply clicked on in the illustration graphic and moved around using the computer mouse. For precise placement (to the mm), there are in the deck **group box**, **little arrows** that will precisely determine the *Location* and *Height* of the chosen deck point.

To select another deck point to become the chosen one, click on it either in the **main canvas** or on the **deck point canvas**. To create an entirely new deck point, hold the Shift key down and click either on the **main canvas** or on the **deck point canvas** to indicate where you want this new point to be. To delete an existing deck point requires the use of the **deck point canvas**. Click on the deck point to be removed so it becomes red, and then click on the **Delete Point** button underneath the **deck point canvas**. There are some little arrows to the right of the **deck point canvas** that allow you to select the deck point immediately to the right or left of the currently selected point.

Clicking on the **little arrows** that lie just to the right of the *Location* or *Height* text will change their value. Clicking on the up arrow will increase the height by 1 mm or move the location 1 mm toward the stern. Clicking on the down arrow will decrease the height by 1 mm or move the deck point 1 mm toward the bow. The convention used in BearboatSP is that these **little**



**arrow** controls act with greater force if the Shift key is held down while clicking on them. Holding the Shift key down while clicking on the up arrow next to the *Height* value will increase its value by a full centimeter. As with many of the **little arrow** controls, holding down both the Shift key and the Control key will further magnify the impact of clicking on one of the arrow buttons.

It is desirable to specify your deck with the minimum number of deck points. This will assure that the deck profile is a smooth line. Usually, 4 to 8 deck points will be sufficient to describe the entire deck profile.

## Design: Cross-section

The **Cross-Section** window has shown considerable change since the prior Bearboat Classic version. The window is activated under the **Design** menu, but this environment is equally important as a tool to simply visualize your kayak. The only part of this window that actually changes the design of the boat, is contained in the **Side** and the **Deck group boxes**. Here you can change the family of shapes that are applied to the sides and a deck of the kayak.

The program minimizes the wetted surface to determine the underwater cross-section, but it is arbitrary how the waterline is to be connected to the **seam line** and the **seam line** to the **deck line**. For this purpose, the user chooses from the families of curves that are available to determine the shape, as seen in cross-section, of the sides and deck of the boat. You choose one family for the side and one family for the deck and that is applied to the entire boat. This gives an aesthetic unity to the craft.

For the deck, I have always used **Semi-Ellipse**, which has worked well for me. Others like a more peaked deck and I have provided other options to allow for this.

For the side, the default is **Bezier**. If **Bezier** is selected, a **slider** appears that allows modification of the Bezier curve of the side of the boat. Moving the **slider** to the right tends to make the curve "fuller" while moving them to the left makes the curve "flatter". Bearboat Classic has two **sliders** for this purpose, one of which primarily affects the curve closer to the deck and the other the curve closer to the water. Having two **sliders** is an option that can be restored as a preference in the **Preferences** window. You might think that the **Straight** option would produce an angular looking craft, but this is not really the case. Many commercial kayaks, in fact, have flat sides but because of the curves in the third dimension and changes in angulation, this is not easily perceived.

Underneath the main **canvas** are the controls to look at a single cross-section anyplace along the length of the boat. There is either a Birdview or Sideview of the kayak in a **canvas** in this area. You can click anywhere on this graphic to show the corresponding cross-section. **Sliders**, a **data entry box**, and **little arrows** are alternative ways of selecting the location of interest,

It is possible to have made incompatible choices in the other design windows. It is possible to ask for a cross-sectional area at a given point that is larger than can be achieved with the depth and waterline width chosen for that same point. The program will indicate this by drawing the underwater cross-section in red and appending a triangle shape to the underwater area. These conflicts can be resolved by making the cross-sectional underwater

area smaller here in the **Curve of Areas** module or by increasing the depth in the **Sideview** module or increasing the waterline width in the **Birdview** module or some combination of the above. The Tutor Kayak boat has some "incompatible" values at the very bow of the boat. These will display in red. One could chase these down by modifying some combination of parameters, but in these particular locations they are not very important. A couple of strokes with a sander in the "real" world will take care of them. You need not be very concerned with red cross-sections that appear very close to the bow or the stern.

There are three **pop ups** on the right mid portion of the design area. The first and second determines how much of the cross-section will be shown. The third determines the “look” of the cross-sections.

The first **pop up** defaults to **Deck & Hull** which refers to the fact that , with this setting chosen, the cross-section image of the boat will includes both the deck and the hull. It is possible to choose **Deck Only**, which uses the available space to only show the deck portion of the kayak. Similarly one can elect to see only the **Underwater Only** portion of the kayak with a third option. These various choices allow more magnified looks at part of the kayak

The second **pop-up** control defaults to **Bilateral**. That is to say that one sees both the right and left side of the kayak. Other choices under this **pop-up** allow you to see only one side of the kayak allowing potentially further magnification, **Unilateral**. Is also possible to see a series of cross sections of the boat with the sections toward the bow shown to the left and the sections toward stern shown to the right, **Bow Lt, Stern Rt**.

The third **pop-up** acts only when multiple cross-sections are being shown. This **pop-up** defaults to **Transparent**. When multiple cross-sections are being displayed, each of the cross sections being shown is superimposed on all the others and all are equally visible. **Opaque: Bow** and **Opaque: Stern** show the cross-sections with those cross-sections “behind” other cross-sections being obscured. If the **Fog: Bow** option is chosen, then the cross-sections toward the stern are not invisible but rather appear fainter as though partially obscured by fog. If the **Fog: Stern** option does the reverse. The final option, **Contour**, assigns colors to the cross-sections as though they were contours on a map. You might find this more colorful than useful.

To illustrate the effect of these three **pop ups** on the images, click on the **Clear/Draw button** that maybe seen in the **group box** entitled **Multiple Sections** in the right lower corner of the page. Nothing really happens until this button is clicked on.

This **Multiple Sections group box** allows you to determine exactly which sections of the kayak are going to be draw. Provide the start cross-section, the last cross-section and the interval at which intervening cross-sections are to be drawn. Then click on the **Draw** button or the **Clear/Draw** button. With the latter, the existing graphic is cleared before the new graphic is drawn showing the cross sections that have been specified.

# VISUALIZE

## Visualize: Slice

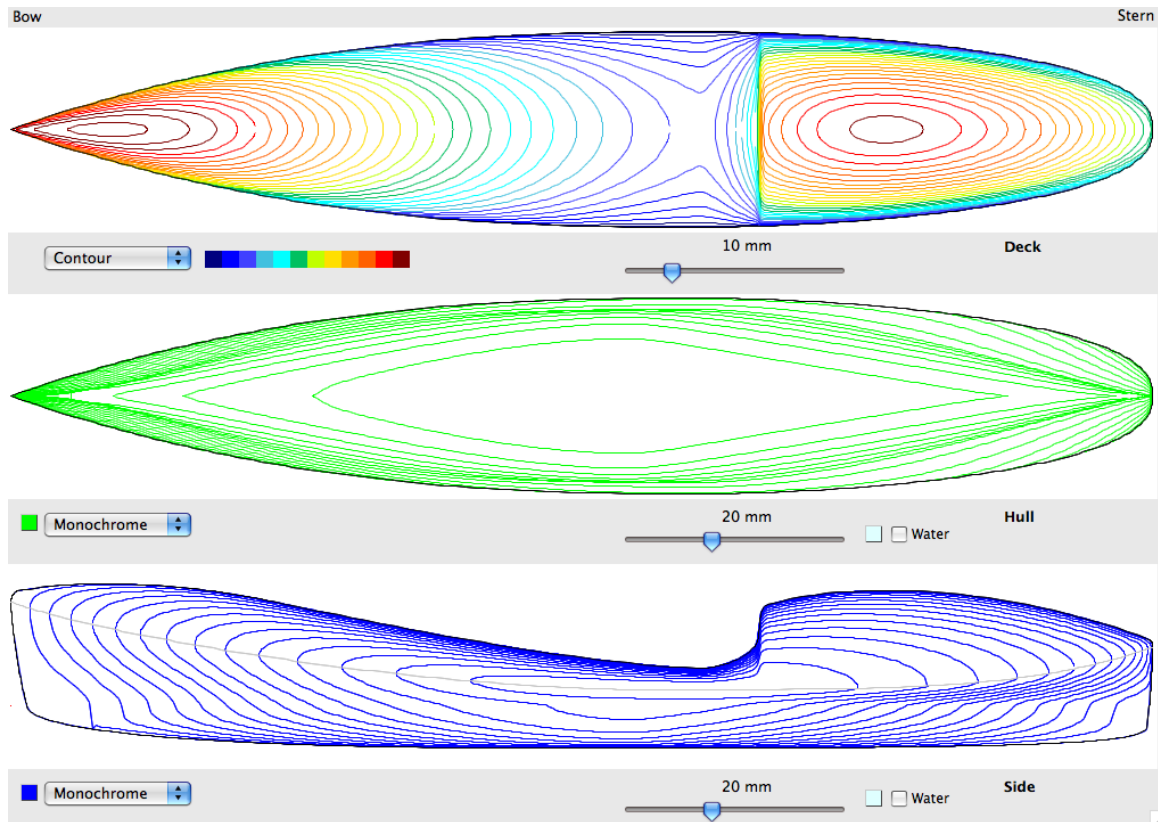
This opens the **Slice** window, which provides another way of looking at the kayak. This is purely for visualization purposes. None of the actual parameters of the kayak can be altered in this area. The **Design** menu items provide the tools for actually creating and modifying the kayak.

In the **Design Cross-Section** window, the kayak is seen as a stack of cross-sections, slices if you will, that are oriented perpendicular to the long axis of the boat. There are, of course, other ways to cut the kayak and the Slice window contains three **canvases** that show common alternatives. These are helpful in understanding the three dimension characteristics of the boat as seen on a flat screen.

The top **canvas**, labeled *Deck*, shows horizontal cuts through the deck as though viewed from above. Slices that are taken in the horizontal planes through the hull are commonly called waterlines and these are shown in the second **canvas**, which is labeled *Hull*. Here the kayak is being viewed from below. Slices made in a vertical plane parallel to the fore and aft line are called buttock lines and these are shown in the third **canvas** labeled *Side*

As the Slice window first opens, these graphics are shown in arbitrary single colors. Each graphic is associated with a color square. Option - clicking (Alt-clicking) on the square provided the ability to change to another color.

Each graphic also is associated with a **slider** to control the thickness of the individual slices (or you might think of this as the space between the slices). This allows showing an arbitrary “density” of slices on the graphic.



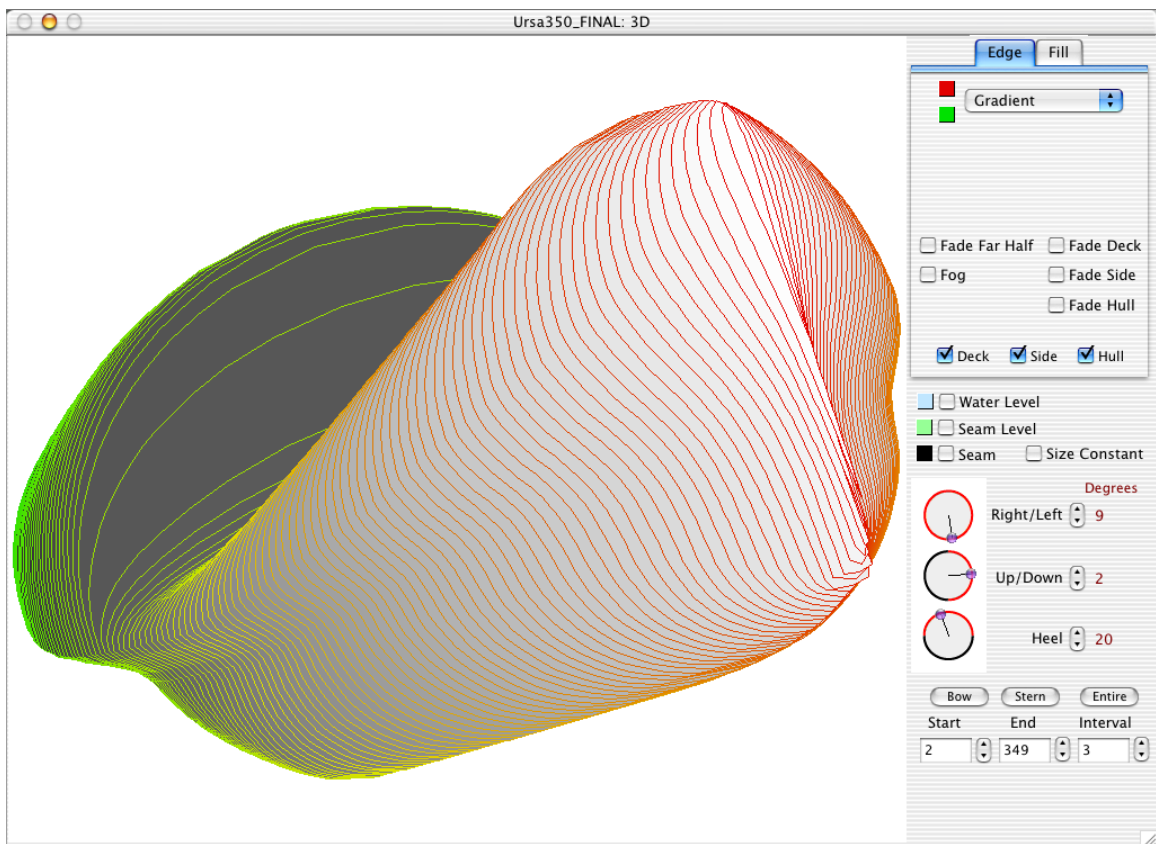
Slice images can be considered to be contour maps. Such maps are created, in a sense, by “slicing” the topography of the earth into horizontal slabs the outlines of which are drawn. To accentuate the “height” on such maps, a color scale can be added. BearboatSP allows you to visualize the buttock lines etc. as though they were contour lines. A **pop-up** allow you to alternate between monochrome, contour colors and various multicolored options.

**Checkboxes** are provided for the Hull and Side graphics to add water and show the design waterline. The default pale blue may not be dark enough for

some tastes. Remember, the color can be changed by Option-clicking (Alt-clicking) on the appropriate **color square**.

## Visualize: 3D

Here your design can be visualized in 3D space from any angle. This is simply for visualization purposes. No changes to the design can be made in this area.



There is a lot of color work in this environment. An infinite number of color schemes can be specified. Computers with graphics cards that allow specification of many colors will provide a “smoother” look. Default colors are scattered around through this window. To customize a color, click on the

little **color square** with the Option key (Alt key) held down and any color supported by your computer can be chosen. This methodology is shared with the rest of BearboatSP.

In BearboatSP, it is possible to increase the size of the display **window** if your monitor has some extra space. This will allow you to see your kayak in more detail. Most of the **windows** in BearboatSP share this capability. It is most useful in the **windows** that are displaying your design for visual analysis. Grab the lower right corner of the **window** and drag it in order to enlarge it.

The **little arrows** in the **Move group box** specify the orientation of the kayak in space. The default opening position is the kayak facing the viewer bow on. The **Heel little arrows** will tilt (or heel) the kayak around its long axis. The kayak can be tipped 90 degrees in either direction. The **Up/Down little arrows** will lift or depress the bow, rotating the kayak in the vertical plane. The kayak can be rotated so that the stern or the bow sits vertically underneath the other end (-90 to 90 degrees). The **Right/Left little arrows** will push the bow to the right or the left, rotating the kayak in the horizontal plane up to 180 degrees. To look at the boat from the stern, you rotate it in the horizontal plane 180 degrees as though it were sitting on a lazy susan.

It is important to remember some of the shortcuts that are universal in BearboatSP. **Little arrows** are used to specify the angles at which the kayak is to be viewed. A single click on one of the **little arrows** will change the perspective by only one degree. Click with the Shift key down will result in a greater change. Click with the Shift key and the Control key down will result in a yet more dramatic change. To return to the default values, click on the words that label the **little arrows**. For example, clicking on *Heel* will



return the kayak to the upright position from whatever degree of heel it has been placed. Clicking on *Right/Left* will return the bow of the boat to face the viewer. Shift-clicking on *Right/Left* will actually spin the boat 180 degrees so it is being viewed from the stern.

It is also possible to move the kayak by clicking and dragging in the **canvas** itself. At the onset, the closest part of the kayak is in the foreground. Click somewhere near the bow and “move” it by dragging a little to the right or left or up or down. When you let go of the mouse, the kayak will move in the direction that you dragged the mouse. Playing with this feature will “explain” it more easily than words. It is the easiest way for most people to examine the kayak from various perspectives. It is useful to remember, if you get “lost”, to click on the *Right/Left* label to bring the bow back to facing the viewer and on the *Up/Down* label to bring the boat back to the horizontal plane. While this interface allows moving the kayak by dragging in the **canvas**, heeling the kayak can only be done with the **little arrows** or by dragging the appropriate part of the Axis **control**.

The final way to move the kayak is by using the Axis **control**. The Axis **control** consists of three circles. There is a little dot on the circumference of each circle that reflects how the kayak is positioned. As the bow of the kayak is tilted up or down or to the right or to the left, the little dots moves to provide a graphic representation of the current position of the kayak. Conversely, it is possible to control the angle of the kayak by clicking and dragging on the little dots themselves. This is the easiest way to quickly specify the degree of heel of the kayak.

In the lower right part of the window are the controls that determine which and how many cross-sections are being viewed. It is possible to look

at only a short segment of the kayak. The “density” of the cross-sections can be adjusted with the **Interval** little arrows. This is the same interface that is used in the **Cross-Section** area in the **Design** menu.

The “look” of the kayak is largely determined by the controls that sit in the **tab panel** that occupies the upper right of the window. The 3D form may be considered to be a stack of cross-sections suspended in space. To varying degrees, this can create the illusion of a 3D solid. If the interval between the slabs is small, this may heighten the illusion.

The individual cross-sections have an edge and an interior. The color of the edges is determined by the controls in the Edge panel. The color of the interior is determined by the controls in the Fill panel. It is possible to show or not show either the interior or the edges. When the **3D** window first opens, all of the edges are shown (Deck, Side, Hull) and all of the interiors are shown (Deck, Side, Hull). This is controlled by **checkboxes** in the respective **tab panels**. Experiment with making the interiors transparent by unchecking Deck or Side or Hull or all three in the Fill tab. Different settings show different features to advantage.

In general, making the interiors opaque with the fill function makes the 3D illusion easier to appreciate while at the same time it obscures detail. (The contours of the kayak on the “far” side become obscured.)

It is possible to get confused as to which elements you are changing. Try and stay aware of whether you are working with the **Edge** or the **Fill**.

A few **checkboxes** are provided that can help the 3D illusion or at least aid in “understanding” the drawings. The **Fog checkbox** acts to dim the colors that are “further” away down the length of the kayak. The **Fade Far Half**

**checkbox** will fade the colors on the side of the kayak that is away from the user. (This **checkbox** has no influence when the bow or stern are directly facing the viewer because there is no “away” side in this position.)

For the purposes of this section, hull refers to the part of the kayak that is under water; side refers to the kayak between the waterline and the **seam line**. The deck or hull or sides can be “faded” to make them less conspicuous and differentiate them from one another. Sometimes this is an alternative to simply turning off visualization of a given component. All these tools are applied *independently* to the edge or to the interior.

A **popup** menu in the **tab panel** controls the overall color scheme. The options are as follows.

1. **Monocolor**: This is the simplest. A single basic color is used for the Edges (or the Fill). You can select any color you desire by Option-clicking (Alt-clicking) on the adjacent **color square**.
2. **Custom Colors**: This allows selection of colors for each of six elements, the deck, hull and sides for the starboard and port side of the kayak. (Right and left sides of the boat from the perspective of the paddler). One useful shortcut is to click on the word **Port** to force the starboard colors to match the port colors or click on the word **Starboard** to force the port colors to match the starboard ones.
3. **Rainbow**: Distributes most of the color spectrum along the length of the kayak helping differentiate the stern from the bow.
4. **Gradient**: The user specifies TWO colors. The first determines the color of the bow and the second the color of the stern. The

intermediate colors are blended. Appropriately chosen colors can help with the 3-D illusion.

5. **Grayscale**: Distributes a grayscale along the length of the kayak to differentiate the bow from the stern

The final set of **checkboxes** enable some miscellaneous functions. The **waterline (Water Level)** or the **seam line (Seam Level)** can be displayed on each of the individual cross-section. The **seam line (Seam)** can be drawn on the kayak. Finally, a constant size (**Size Constant**) for the kayak can be set. As a default this option is not selected. The kayak grows or shrinks as necessary to “fit” within the window. This is generally desirable as it allows more detail to be shown. However, you can specify that the kayak not change size as it is rotated.

Check out the discussion of SketchUp under the **File: Output** part of this manual. There are ways to visualize your design in 3D using third-party products.

## ANALYSIS

### Analysis: Stability

Evaluating the stability of a kayak is complex. Stability graphs provide only some of the information required to understand the stability of any given design. Many features of a kayak impact its ability to stay upright under difficult conditions of waves, wind and current.

The classic stability calculations make a number of simplifying assumptions. One assumption is that the center of gravity does not change

relative to the structure of the boat as the boat heels. This holds true for most ships, but is not true of kayaks. The paddler represents much of the mass of a kayak, and that paddler will change position as the kayak tilts. Nonetheless, some useful information is provided. It has a great advantage of being objective rather than subjective.

Exhaustive discussion of the classic stability curve is beyond the scope of this manual. A good introduction to the topic is available on the web.

[www.guillemot-kayaks.com/Design/StabilityArticle.html](http://www.guillemot-kayaks.com/Design/StabilityArticle.html)

The basic principle is that as a vessel tilts, the center of buoyancy of the ship tends to move into a position lateral to the position of the center of gravity (mass) of the vessel. The upward force of the buoyancy and the downward force of the center of gravity are not exactly aligned which applies a torque to the ship that tends to return it to an even keel. Commonly, this situation will reverse at extreme angles of tilt. For many ships, at some degree of tilt, the center of gravity will move lateral to the center of buoyancy, and there is no longer an overall righting force being applied. This will lead to capsize. Some vessels, such as sailboats with heavy keels, never reach this point of instability. Their center of buoyancy always remains lateral to the center of gravity. Such designs are commonly called “self-righting”.

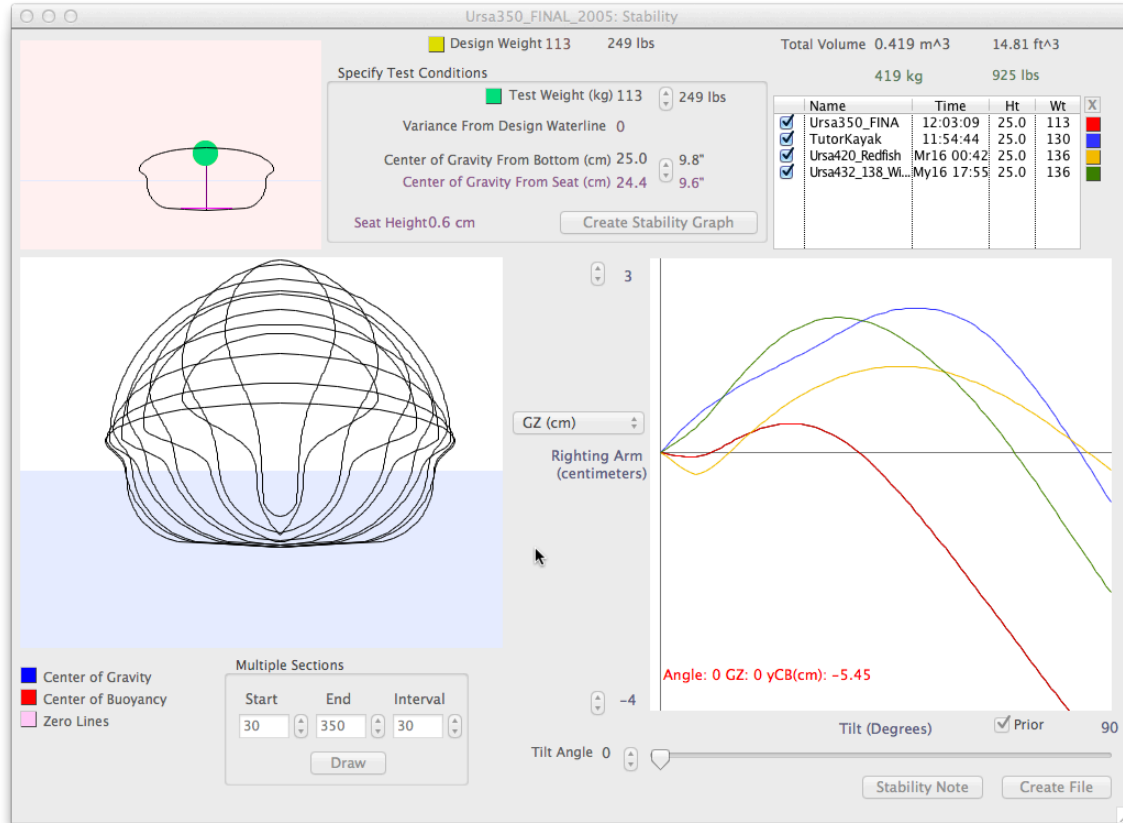
For kayaks, these calculations are made with the assumption that the paddler is sitting rigidly in the kayak. There are kayaks that are unstable at any degree of heel. To remain upright in such boats, the paddler shifts her body and uses the paddle to compensate for the tendency to capsize. For

most recreational kayaks, there is a righting force applied when the kayak starts to tip. Commonly, however, with enough angulation the forces become directed toward further tipping rather than toward a return to an even keel. The stability curve plots the righting force in the Y direction over a range of angulation in the X direction. A classic stability curve tends to climb into positive territory as the kayak starts to tilt and then it reaches a peak and the righting force begins to decline. Finally, the line of the graph falls below the zero point and beyond this point it is the inclination of the kayak to capsize.

The X axis is usually expressed in units of degrees. The Y axis is variously expressed in a wide variety of units. The shape of the curves is not affected. It is only when comparisons are being made that it is important the same convention for the Y units is being used.

BearboatSP uses righting arms. Righting arms are expressed in units of distance, reflecting the distance from side to side between the center of mass and the center of buoyancy. BearboatSP uses cm (GZ expressed in centimeters) as the default. Another common unit is the foot-pound. This is the unit used by *Sea Kayaker* magazine. The righting force is expressed as the distance in feet between the center of mass and center of buoyancy multiplied by the weight of the kayak in lbs. (righting moment). You can convert back and forth by multiplying the Y values by the appropriate constant. The shape of the curve is the same. The distinction is only

important when comparing graphs. Make sure that the units match



### *The Classic Stability window*

On first entering the stability window, the program will compute the total volume of the kayak. When this calculation is complete, the result is displayed in the right upper corner of the window. This represents the entire volume both the underwater portion and the portion above water. One might consider this to be the total capacity of the kayak. This number is expressed as a volume and a weight. The weight is just the weight of the kayak entirely filled with water. This may seem a peculiar way of expressing a volume, but displacements of boats are often expressed this way. You may think of this weight as being the weight that, when added to the kayak, would submerge it. This is NOT the design weight and should not be confused with it.

The classic stability graph depends upon the height of the center of gravity relative to the kayak. These graphs are, in fact, extremely "sensitive" to the exact height of the center of gravity. On first entering the stability window in BearboatSP, the center of gravity height defaults to 25 cm measured from the bottom of the kayak. The classic stability graph is also depends upon the displacement (weight) of the kayak and its contents. The stability window initially defaults to the design weight. **Little arrows** are provided to customize the height of the center of gravity and the test weight before creating a stability graph. When comparing one design to another it is important to try and keep these parameters the same. Slight changes in these parameters will often greatly affect the appearance of the stability graph. Changing the weight will change the waterline relative to the design waterline. As the kayak is made heavier, it will sink further down into the water. Tilting the kayak also tends to change the depth of the kayak in the water. This is tracked and calculated by BearboatSP.

Interpretation of stability graphs between kayaks and from different sources is fraught with perils. One major source of difficulty is determining where the center of gravity should be considered to be. There is simply no way to come to a consensus on this. For example, when you consider a loaded kayak, should you consider that the weight is uniformly distributed through the volume of the boat or should you consider that the kayaker is probably going to place the heavier objects lower in the boat. The kayaker represents the majority of the mass of the operating kayak. Where should the center of gravity of that mass be located? Some sources will correct for seat height. Is that fair? One brand might have an uncomfortably low seat, but that will make it look stable on the graphs even though everyone who



actually buys the kayak finds that they have to put in some padding to elevate themselves a little.

BearboatSP, by default, measures from the bottom of the boat. People have told me that there is a problem here because V shaped hulls will seem more stable than they actually are because the measurement is from the bottom of the V which is lower than where most of the mass (such as the paddler) can go. As a gesture to this concern, there is an option to measure the height of the center of gravity from a “seat”. This seat height is defined as the height above the bottom that a horizontal flat object 22 cm wide would find itself. Such an object could not be put all the way to the bottom of a V hull. I chose 22 cm because that is roughly the effective width of the human butt in this context. Obviously this is all a little arbitrary. The important thing is to think about the issue and be very attuned to how the center of gravity was determined when you read published materials. A 1 cm difference will have gross effects on the stability graph.

Once the desired parameters are entered (you might just be happy with the defaults) click on the **Create Stability Graph** button.

Generating the curve is computationally intensive and may take a minute or two. As the data is being calculated, the kayak is shown angling from the perpendicular (upright) position into a 90 degree tilt. The corresponding point on the stability graph is calculated and displayed. Once the stability graph is complete, a slider will appear under the graph that allows positioning of a pointer anywhere along the graph. Your kayak design can be viewed at any degree of angulation.

If the GZ is positive there is a force applied to try and right the kayak. If the GZ is a negative, the force applied is one to further the tendency to capsize.

For most people, a stability graph in isolation is not of great value. Their usefulness is greatly enhanced by allowing a comparison of one kayak design with another. Since the shape of the stability graph is very sensitive to the parameters used (weight and height of center of gravity) it is important that these factors be held constant when comparing one design with another. *Sea Kayaker* magazine, for example, specifies the height of the center of gravity from the top of the seat. While there is some logic to this approach because the paddler will be sitting on that seat, it introduces a variable that can be confusing. Play with the stability calculations and see that the curves change a great deal with subtle changes in the height of the center of gravity.

The program “remembers” the stability calculations that have been most recently performed and these can be displayed in this window. This capability has been beefed up in BearboatSP because the program will remember calculations from previous sessions rather than only graphs created since the program was opened. These earlier graphs can be called up by clicking on a **checkbox** labeled **Prior**. You can elect to show or not to show the individual prior graphs by clicking on the checkbox at the left of the list. Prior graphs can be deleted from the listing on this page by selecting the line from the list and clicking on the **X button** at the upper left of the list. The description (name) can also be edited but edits will apply only for the duration of the session. By default, just the name of the kayak is shown in that column. BearboatSP offers a more robust way to describe a particular stability graph. The menu item **Classic Stability Compare**, under the same

**Analysis** Menu, offers an option of creating a stability note that offers unlimited text to describe any previously created graph for future reference. The **Stability Note** button in this window allows you to write a little note about the newly generated curve.

To facilitate comparisons further, there is a button labeled **Create File**. BearboatSP is limited in that it displays only a few stability graphs at a time. The **Create File** button might be useful to some. It will create a text file that will end up in a folder called BearboatStable. A spreadsheet program, such as Excel, can open such a text file. In Excel, stability graphs can be created with the tools of the spreadsheet program. Data from several different “runs” of the BearboatSP stability calculations can be copied into a single Excel worksheet. The column labeled, GZ cm, contains the critical data.

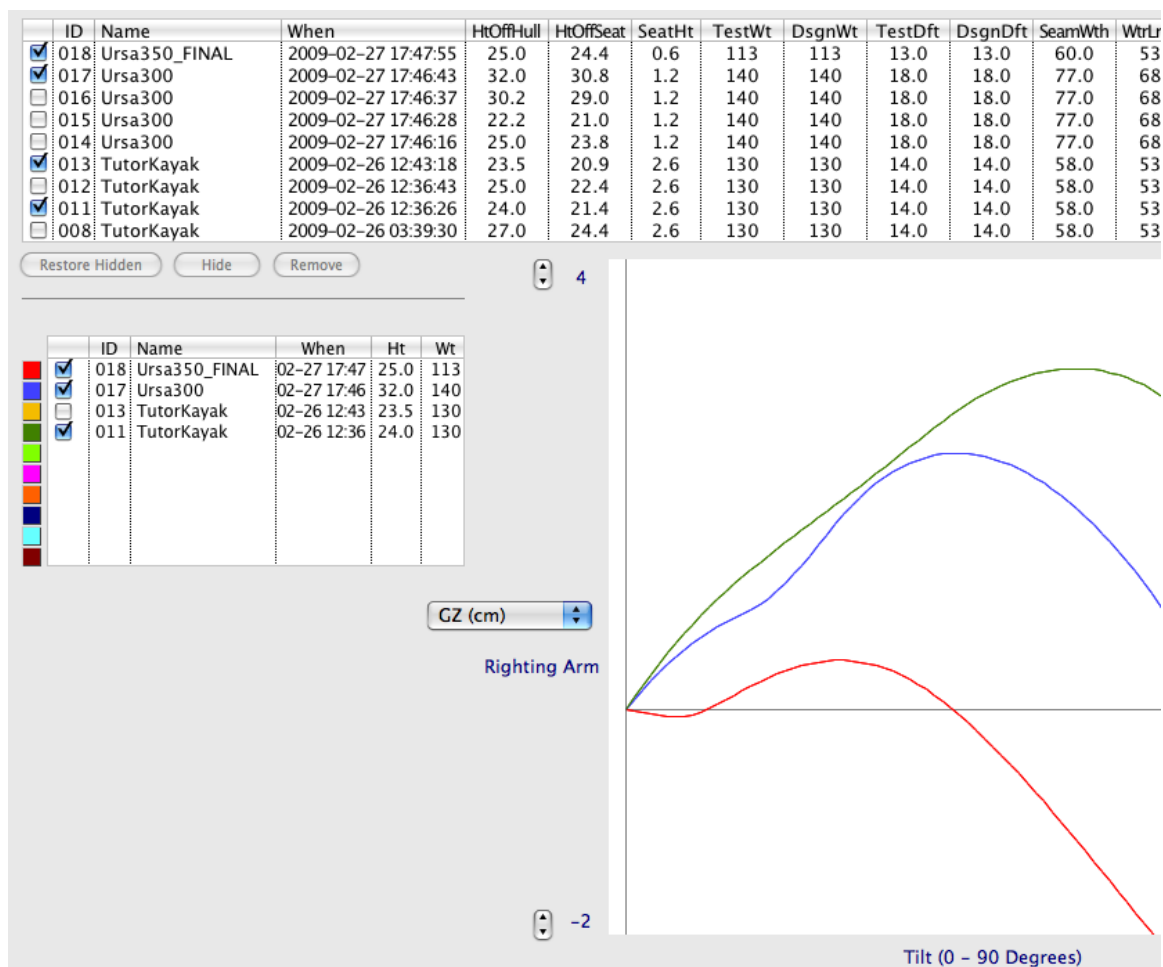
Facility with programs such as Excel will allow the designer to compare, quantitatively, the stability curves of any number of kayak designs under any number of conditions. BearboatSP even provides, in those text files, the conversion factors that are required to convert the Y axis units from one standard to another. In this way, comparison with designs published in *Sea Kayaker* is possible. Care should be taken to read the fine print in *Sea Kayaker* to make sure that the height and weight parameters “match” as well as the Y units before interpreting these comparisons. The most useful comparisons are with previous designs of your own whose handling characteristics are very familiar.

Stability curves can vary considerably, and it may be necessary to adjust the Y axis range to accommodate this. There are **little arrows** positioned at the top and the bottom of the Y axis that allow you to make adjustments if the graph “runs off” the edge of the picture.

## Analysis: Classic Stability Compare

New with BearboatSP is the **Classic Stability Compare** window.

BearboatSP remembers all the previous stability calculations that have been performed. They can all be called up on the graph in this window instantly. This is convenient because the initial calculations are time consuming. Also the true value of the stability curves is in comparing one design with another.



*The Classic Stability Compare window*

There are two listings in this window. The uppermost one stores all of the previous stability calculations, the archive list. The lowermost list box, the

active list, contains the stability calculations that are available for graphing in the **canvas** to the right. If the user checks one of the **checkboxes** in the left column of the archive list, that stability calculation will be transferred to the active list. If the user checks the **checkbox** in the left column of the active list, the graph will appear on the **canvas**.

The archive list can be used for basic maintenance. It is possible to remove a no longer needed calculation from the archive list by highlighting a particular row or rows and then clicking on the **Remove** button. This will remove those calculations permanently. It's also possible to temporarily remove items from this listing just to de-clutter the situation. Highlight the calculations that you would like to temporarily remove and click on the **Hide** button. Subsequently it is possible to bring back the hidden calculations by clicking on the **Restore Hidden** button.

The archive listing can be sorted various ways by clicking on the column headers.

## Analysis: CB Velocity Stability Compare

I have created two alternative ways to quantitatively analyze stability.

The first is called CB Velocity Stability (Center of Buoyancy Velocity Stability), which is a measure of how quickly the center of buoyancy moves laterally when the kayak is tipped. The other is called Frictional Stability and is a measure of how much water is displaced as the kayak tips. These are both awkward terms because I do not believe that there are established terms for this in the literature.

Center of Buoyancy Velocity Stability is a graph of the "speed" with which the center of buoyancy is moving laterally as the kayak is tipped. The conventional stability curve is really made up of two components. The first is the position of the center of buoyancy. The second is the position of the center of gravity of the kayak and its contents.

If the position of the center of gravity moves outside the position of the center of buoyancy, the kayak will have reached the point of instability and will tend to capsize. If the center of buoyancy remains lateral to the center of gravity, the kayak will tend to return to the upright position. With the center of buoyancy velocity curve I have attempted to dissect out these two factors. It is my opinion that the speed with which the center of buoyancy moves laterally is more closely related to the perception of stability than is the classic stability curve.

The effects of center of gravity of the kayak on the classic stability curve is very sensitive to the vertical position of that center of gravity. Therefore, changing the height of the seat or in any other fashion changing the assumed position of this center of gravity, has a considerable effect on the stability curve. This is largely independent, really, of the actual hull shape of the kayak because the paddler himself contributes most of the mass of the kayak. By considering only classic stability curves, it is necessary to be very precise about where it is assumed that the center of gravity is. Often different curves will be provided for the same kayak making different assumptions about the position of the center of gravity. One is invited into various debates such as exactly how the center of gravity is to be determined for the kayak and the paddler inside. The overriding problem, which is not taken into account with stability curves, is that, in reality, the kayaker

himself will lean to one side or another and in this fashion change the center of gravity.

Calculating the position of the center of buoyancy and graphing how quickly this moves out laterally as the kayak tilts, it is possible to get a feeling for how stable that kayak is *independent* of where you are assuming the center of gravity to be. If the center of gravity moves out laterally quickly, the boat is likely to be perceived as being stable. If the center of buoyancy does not move out quickly laterally that boat will be considered less stable.

In the real world, the center of gravity is changing in the context of a kayak because the paddler is changing her position in the boat as it tilts. The assumption that the paddler is a rigid object sitting vertically upright in the kayak simply does not mirror what actually is going on. It is possible to design a kayak with a deeper draft, which will lower the center of gravity, and the conventional curves will make it seem more stable. However this stability benefit is not as great as would be assumed simply looking at the curves. Certainly lowering the center of gravity in this fashion does help stability, but not as much however as might be expected because of the fact that the paddler is not a rigid vertical object in the kayak.

It is possible to take two designs with a very similar stability curves. One of these designs might be getting much of its stability from having a deep draft and therefore a lower center of gravity. As the kayak tips, because the center of gravity is relatively low it does not move out laterally very quickly. The other kayak might be attaining its stability largely from a wider shape that is moving the center of buoyancy laterally rapidly as the kayak tilts. Its center of gravity, being relatively higher, is moving out laterally more

quickly but this is compensated for by the fact that the center of buoyancy is moving laterally yet more quickly.

Through bitter experience, I have found that stability curves that are similar to one another will be perceived very differently if the stability of one is gained largely by having a low center of gravity and the shape of the underwater profile of the kayak largely gains the stability of the other. Of the two ingredients of the classic stability curve -- the speed with which the center of gravity is moving laterally and the speed with which the center of buoyancy is moving laterally -- the latter factor is much more important. The center of buoyancy velocity stability curve addresses only that second factor. Designs can be compared without specifying exactly where the center of gravity is or exactly what assumptions are going to be used in specifying that center of gravity.

## Analysis: Friction Stability Compare

The Frictional Stability is an attempt to try and quantify a factor that I believe is important, but I do not know just how important, in the perception of stability of a kayak. If you quickly tilt a kayak that requires that a considerable volume of water be displaced, as might occur with a very flat kayak profile or one that has distinct chines, such a kayak will have perceived to have greater "stability" although this will not show up on the conventional stability curve. A very rounded kayak cross-sectional profile can tilt without any water being particularly displaced and such a kayak might seem less stable. The dynamic resistance to tipping allows the kayaker to adjust her position to compensate. This would not be relevant when evaluating a cargo ship, but it probably is relevant when evaluating a kayak

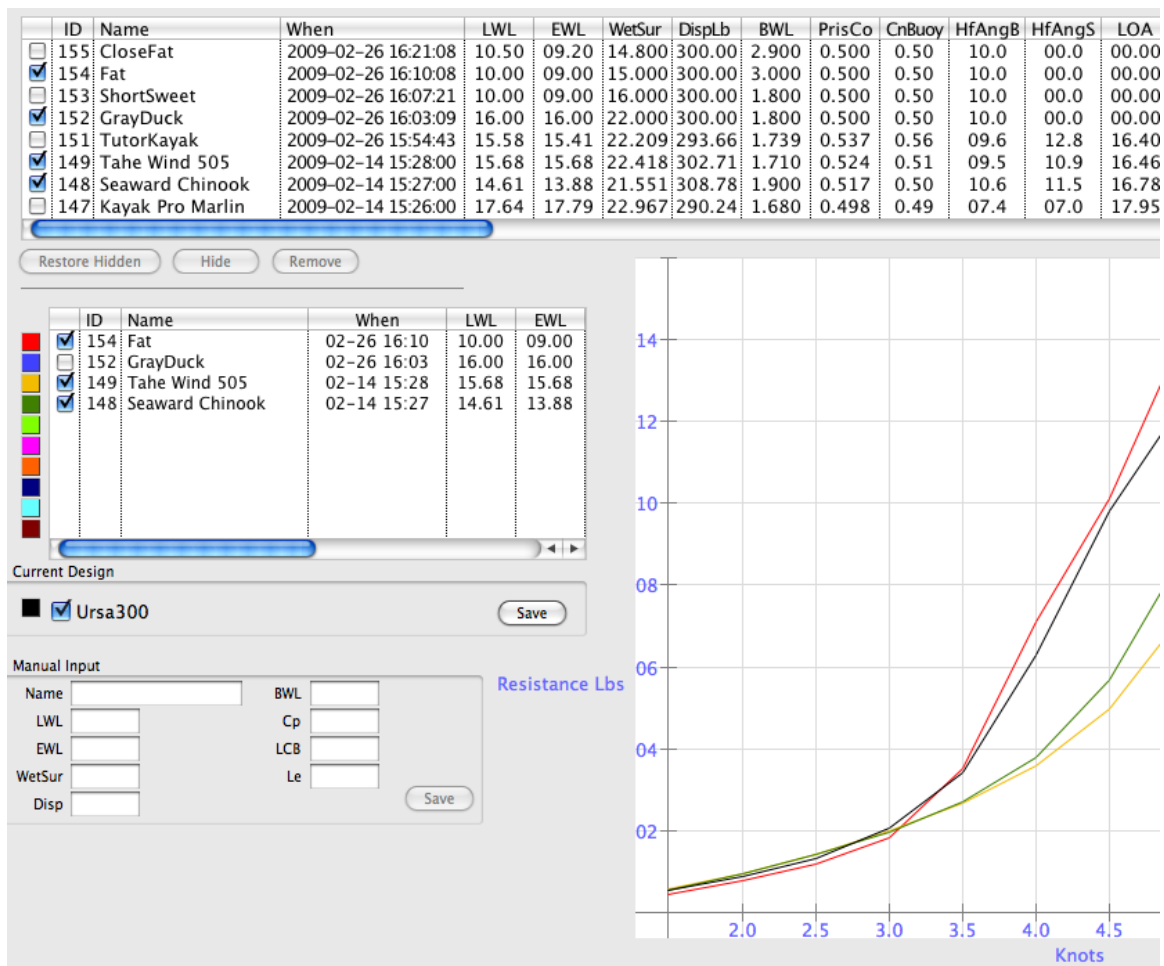


in which the center of gravity can be rapidly changed. The graph is a measure of how much water is displaced as the hull rotates a small angle.

I do not have enough experience to know just how important this dynamic resistance factor is or what the best way is to make it quantitative.

## Analysis: KAPER

*Sea Kayaker*, in their evaluation of commercial kayaks, has for years used KAPER to predict the resistance of kayak designs traveling through the water. KAPER (KAyak PERFORMANCE) was developed by John Winters and uses various parameters of a design to predict its resistance as a function of speed. Towing tests, to obtain actual data, are fabulously expensive so very few kayak designs have had real-life measurements done on them. The whole topic of tank testing and the reliability of predictive software is a complex and murky topic that cannot really be addressed here, but the interested can look up the writings of Winters, Broze and others on the Web. Matt Broze took the tools that John Winters developed and modified the Winter's spreadsheet to further automate the calculations. With some help from Broze, BearboatSP has incorporated the John Winters KAPER algorithms to permit resistance calculations within the program. This greatly simplifies the comparisons of one design with another. BearboatSP also includes an archive of previous calculations that have been done by *Sea Kayaker* over the years.



### The KAPER window

The KAPER window is set up in the same way as the Compare Stability window. On the top is an archival listing of all of the previous KAPER calculations that the user has elected to save. Below this is a second listing, the active listing, whose calculations are selectable to be graphed in the canvas to the right. If the user checks one of the checkboxes in the left column of the archive list, that stability calculation will be transferred to the active list. If the user checks the checkbox in the left column of the active list, the graph will appear on the canvas.

The archive list can be used for basic maintenance. It is possible to remove a no longer needed calculation from the archive list by highlighting

a particular row or rows and then clicking on the **Remove** button. This will remove those calculations permanently. It's also possible to temporarily remove items from this listing just to de-clutter the situation. Highlight the calculations that you would like to temporarily remove and click on the **Hide** button. Subsequently it is possible to bring back the hidden calculations by clicking on the **Restore Hidden** button.

The current design is, by default, shown in the **canvas**. If you want to save the current design to the archives, click on the **Save** button that appears in the **Current Design group box** which is immediately below the active list.

In the lower part of the window, in the **Manual Input group box**, are a number of **data entry boxes**. Here designs from third parties can be entered if these relevant parameters are known. The Winters/Broze spreadsheet, at [www.marinerkayaks.com](http://www.marinerkayaks.com), explains these parameters for the advanced users who might be interested in this functionality. The units are not metric. They match those used by *Sea Kayaker*.

The resistance data consists of a friction term and a residual resistance terms that are added together to obtain the total resistance. The archive list shows all three terms for a spectrum of kayak speeds and these terms can be seen by scrolling to visualize the right part of that listing. The header t1.5 refers to the total resistance at 1.5 knots; the header f3.5 refers to the resistance at 3.5 knots etc.

If only a single kayak resistance curve is being displayed, then BearboatSP will display, in addition to the total resistance, the frictional resistance and residual resistance as faint lines underneath the line of the total resistance.

# TWEAK

Tweaking is a new feature of BearboatSP. This functionality is accessed under the **Tweak** menu. The intention of tweaking is to allow the designer to make subtle changes in the various curves that make up a BearboatSP design. It is not the intent, that the entire design process takes place within the **Tweak** menu windows. Rather the intent is that the basic design of the kayak takes place in the areas under the **Design** menu and then the tweak functions are used if, and only if, it is necessary to make subtle changes that the conventional design environment does not allow. This is rare. There is a large family of curves that can be created under the **Design** menu. These curves have desirable characteristics. They are completely smooth and without any undulations. With the tweaking curves it is possible to create slight undulations that are difficult to perceive in the images on the computer, but might be apparent on the full-sized product, at least one created with a high precision, computer controlled, milling machine that was faithful to the mm.

I have designed many kayaks myself without having the need or desire for tweaking anything. However, my most recent design requires that the seam line develop a concavity in the mid-portion of the kayak. This is not possible with the tools of Bearboat Pro. As an example, consider the design below from Warren Light Craft.



Having such a wasp-waisting in the mid portion of a kayak is not possible in Bearboat Pro. Most designers do not want it so it is moot issue most of the time. But I need this for the design that I am currently working on.

The ability to tweak the curves was developed to allow unusual curves that are not possible with the standard tools in BearboatSP. Tweaking allows the designer to create a smooth line by designating various points along that line. These points determine the course of the line. This process is basically the same as designing the deck profile in BearboatSP. The user has control of an arbitrary number of points and positions those points where desired. The computer takes care of joining those points with a smooth line.

Initially, I have created this functionality for the rocker profile curve and the seam width curve. Users have asked for more flexibility in the design of the rocker curve, primarily as regards to the very ends of the kayak. I have never needed this as I make the bow and stern in the “real” world where they are sculpted as desired. Alternatively, final sculpting is done after passing the BearboatSP design to a full fledged 3D modeling program (for example Rhino) as is necessary if I am presenting the design to a computerized 3D milling machine.

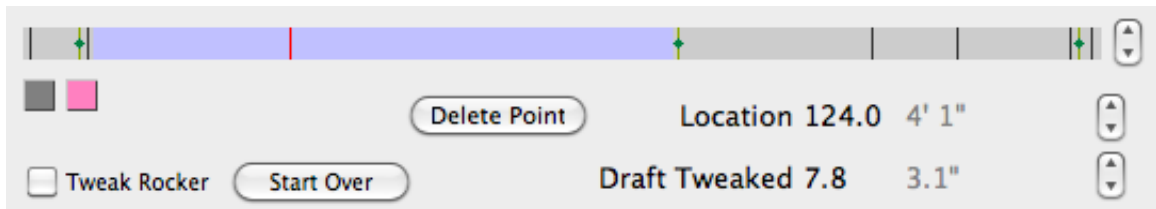
Ultimately more curves will be tweakable -- rocker curve, the seam width curve, the seam height curve, the waterline curve, and the curve of areas.

This coding is early and only the basic functionality is provided. A richer more friendly user environment will be provided in the future. When a tweak window is first opened, the computer will try and mimic as closely as

possible the original line that the designer created under the **Design** menu. This original line is essentially duplicated as a tweaked line whose course is determined by a number of points along that line. Those points can be moved to make subtle changes in the course of that line.

The designer should use tweaking only as the final step. The basic curve should be created in the regular design environment. In most cases there will be no need to tweak whatever.

Tweaking is analogous to what should be familiar from designing the deck profile. However, at this time, it is not possible to directly move the tweak points on the **main canvas** itself. Rather all the tweak adjustments have to be made using the **tweak point canvas** (the horizontal bar graphic) underneath the **main canvas**. This bar allows very precise positioning of the various points.



*Tweak point canvas for tweaking the rocker profile*

To select a point to adjust, click on the vertical line in the **tweak point canvas** that corresponds with that point on the kayak. That point will then be shown as a spot with radiating red lines on the graphic of the kayak and as a red line on the **tweak point canvas**; it is the selected point. At the right end side of the bar is a **little arrows** control that allows the designer to move to another point along the curve. Underneath the bar are two **little arrows** controls that allow fine-tuning of the position of that selected point. The

location along the length of the boat can be adjusted with one of the **little arrows** controls and the value at that point can be adjusted with the other **little arrows** control. To remove a dot from the curve, click on the appropriate vertical line on the **tweak point canvas** and then hit the delete button and that point will be removed. To add a point to the line, hold the Shift key down and click on the bar in the appropriate location and a point will be added. As is true elsewhere in BearboatSP, holding the Shift key down, or holding both the Shift key and the Control key down simultaneously, will magnify the effect of a single click. A general principle, use the minimum number of points to create the curve desired.

An occasionally handy feature is that Option-clicking on some part of the window, say at the stern or the bow of the bow, will locally magnify that part of the window. A second Option click will restore the view of the entire design.

Unlike the situation when designing the deck profile, there are points on the curve that cannot be changed within the tweak window. For the rocker curve there are three such points. The first is the point of entry of the kayak in the water. The second is the lowest point of the rocker. The third is the point where the stern of the kayak exits the water. These three points are determined within the conventional design environment of BearboatSP. They cannot be changed in the tweak window. The seam width tweaking curve has one such fixed point, the point of maximum width of the seam. Green solid dots indicate these fixed points

If it turns out, that these points are not appropriately positioned once one is tweaking the final line, it is necessary to go back to the original design

environment and move the points to the appropriate location. The designer then can return to the window to continue the tweak design.

In the lower left corner of the tweak window is a **checkbox**. If that **checkbox** is checked then the tweak curve is the one that will be used for the kayak's design. If that **checkbox** is not checked, the program will consider the original conventional curve to be the one in use.

Tweaking is intended to be the final step in the design of a given line. Once the tweak **checkbox** (**Tweak Rocker** or **Tweak Seam Wth**) is checked, it is not possible to further change the curve within the conventional design environment. If the designer wishes to go back to the conventional design environment and make changes, it is necessary to uncheck this **checkbox** first.

Tweaking is very finicky. The program insists for the rocker curve that the deepest point of the kayak is that which was designated in the conventional design environment. It is possible by positioning the points in various ways to force some of the rocker curve below that accepted by the program. On the graphic this can be quite subtle. The program itself however is relentless about this. It will detect this anomaly and revert the tweaked line back to its original state. The program also will not tolerate having a tweak line that extends anterior to the midline bow of the boat or posterior to the stern of the boat. It will not allow a tweak line that makes some other position not designated in the conventional design environment the widest part of the boat. If the designer attempts such curves, the program will not allow it. If you were designing a very blunt bow or a very blunt stern, care has to be taken that the line designating the rocker or the seam



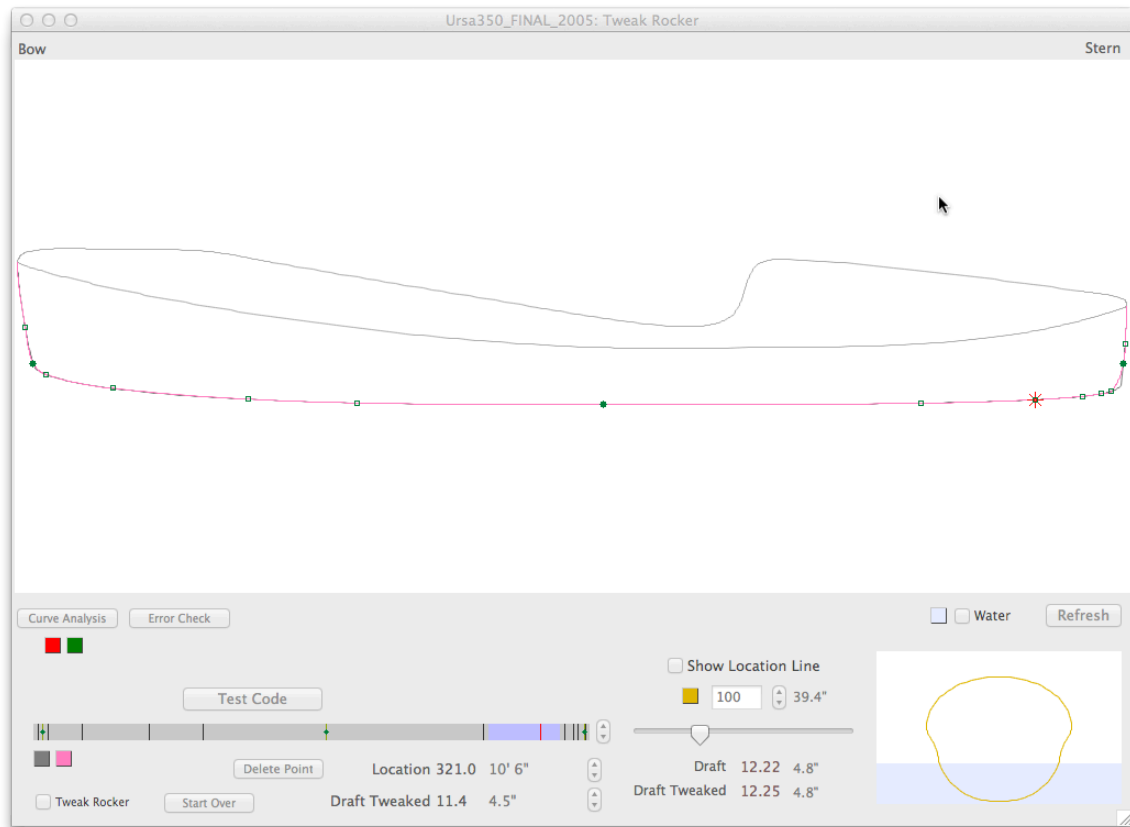
line does not actually bulge out in such a fashion that the curve extends forward or aft of the midline bow or stern tip of the kayak.

For now, tweaking is somewhat awkward. The fact that the user cannot directly move the points, as can be done when designing the deck profile, makes use of tweaking a little bit less intuitive. My own needs were primarily to get tweaking of the seam line and the rocker line functional so I could complete the current design that I am working on. In the future, I would like to make tweaking more friendly and more in keeping with the user interface used when designing the deck profile. Because of time constraints, this is unlikely to occur before the fall of 2012. Only the adventuresome should try to use the tweaking function.

In some sense tweaking is akin to the transition of a boat from a idealized computer design to one that exists in the real world. Most designs undergo some form of "tweaking" when they make this transition. This in particular has been true of the bow and stern of designs where changes are relatively easy to make and which changes might enhance the aesthetics of the design. Tweaking of the rocker line has made it possible to more closely approach the designer's final intent within BearboatSP rather than taking care of some of these adjustments when the boat is actually being built.

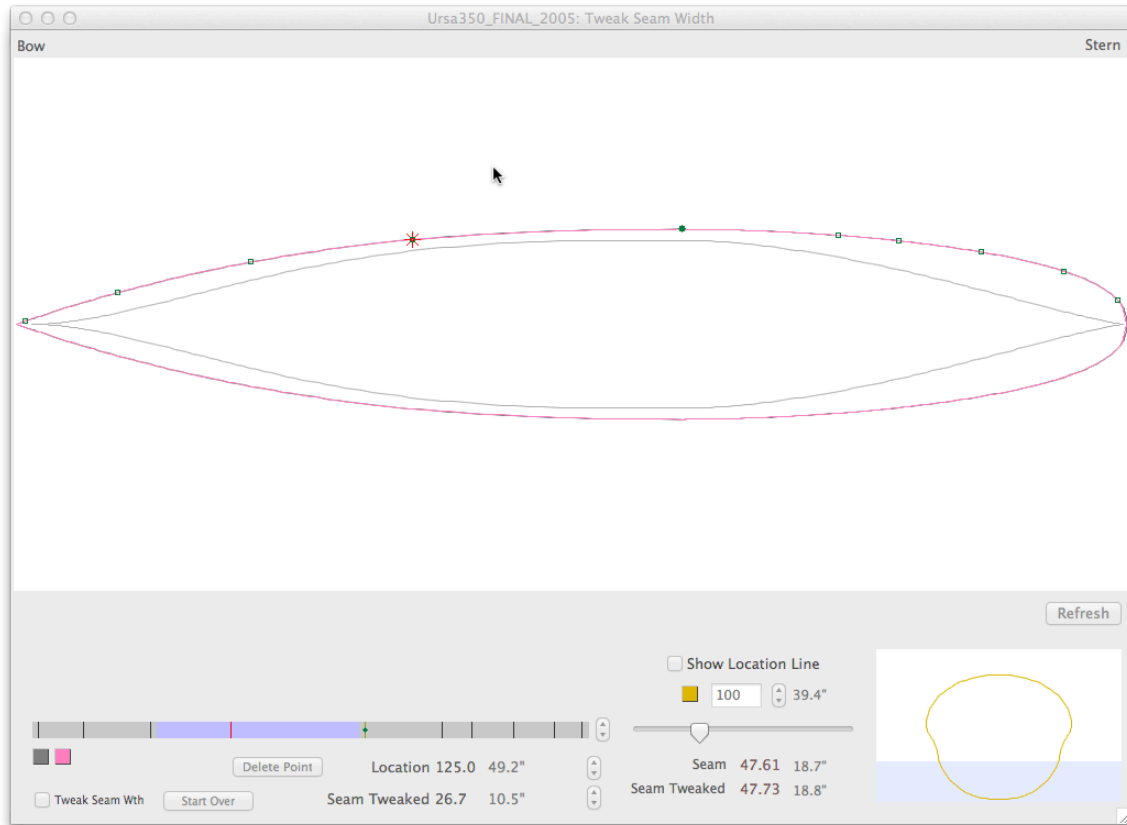
As with all functions of BearboatSP feedback is welcome. This code is very new and not well tested. If anomalous behavior is encountered please e-mail me. I will try and fix actual bugs.

## Tweak: Rocker



Rudimentary functionality provided

## Tweak: Seam Width



Rudimentary functionality provided

## Tweak: Seam Height

To be made available in the future

## Tweak: Waterline

To be made available in the future

## Tweak: Curve of Areas

To be made available in the future

# FILE

## File: Open

Opens any previous kayak that was originally created in Bearboat Pro or BearboatSP. A file dialog is presented that allows the user to navigate to any file on the computer.

When a Bearboat Pro file is opened, the initial window that is brought to the fore is the **Sideview** window. This is to allow the user to make adjustments to the **deck line**. Bearboat Pro uses a different method of creating and storing the deck line. When a Bearboat Pro file is opened by BearboatSP, it attempts to approximate the old **deck line** using the new BearboatSP format. This may not be entirely successful, so the user is presented an opportunity to manually adjust the **deck line** to match the old Bearboat Pro configuration. This is a one-time opportunity. The old Bearboat Pro **deck line** will be shown as a faint gray line that the user can try and match with the tools in **Sideview**. After the file has been saved as a BearboatSP file, then the old Bearboat Pro deck line profile will be “forgotten”.

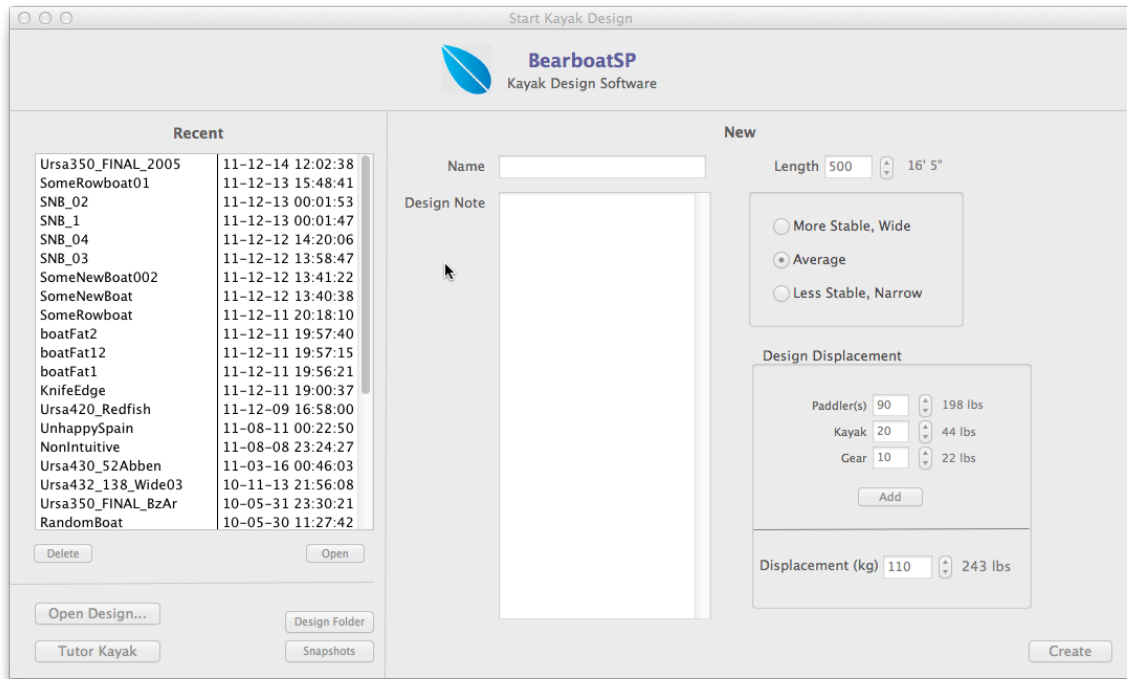
## File: New

See below. (**File: Recent**)

## File: Recent

Both **File: New** and **File: Recent** do the same thing. They bring up the beginning window; the window that appears when the program is opened for

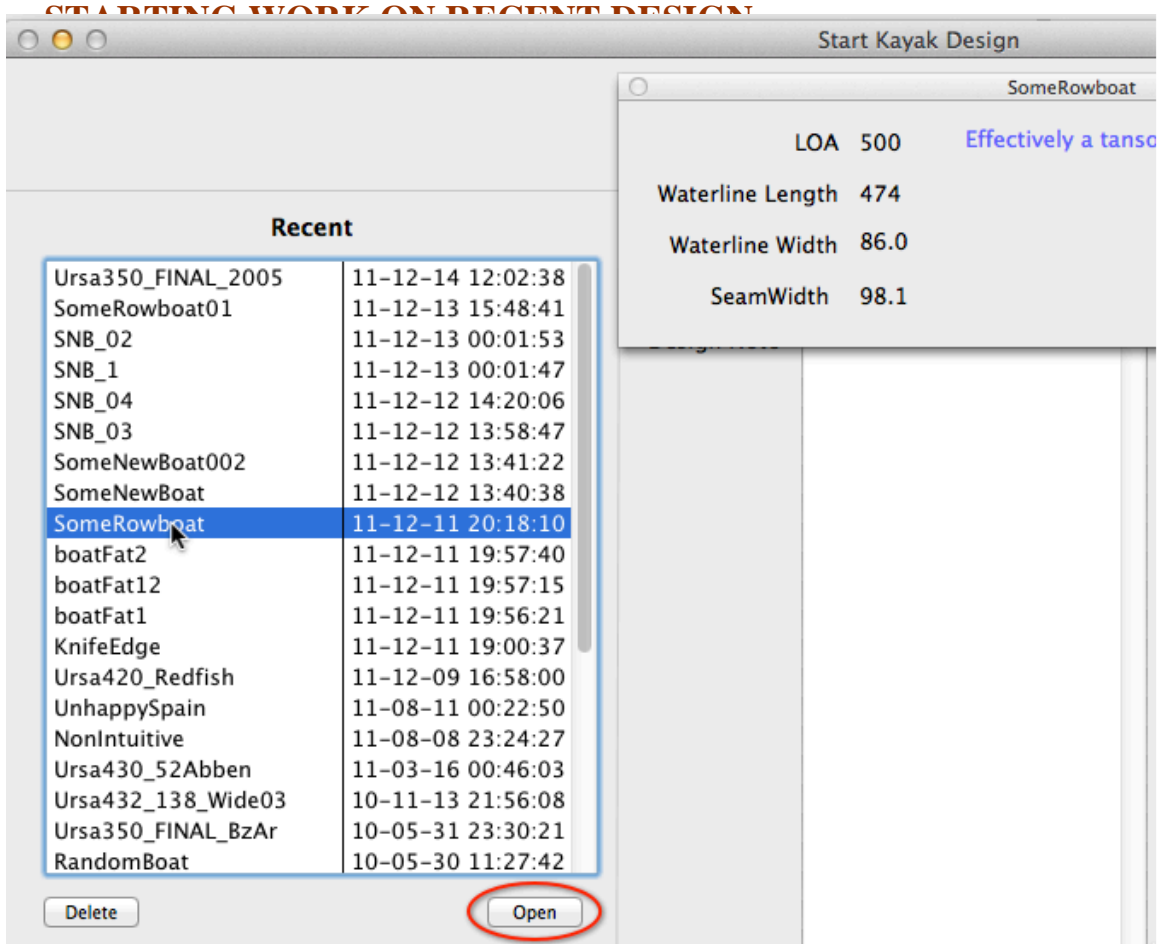
the first time. From this window, Start Kayak Design, you can start work on a design by selecting from a list of designs that have recently been modified, or open a file anywhere on the computer or start a new design all together.



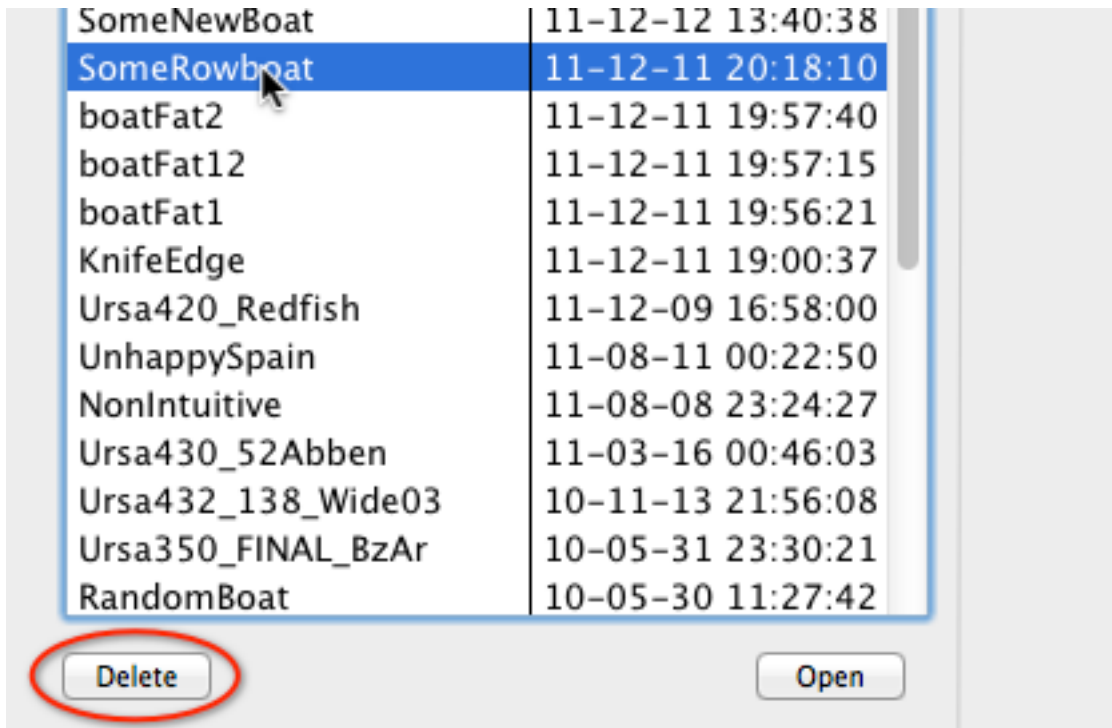
*The beginning window to launch work on a new or previous design*

There are 4 choices that can be made from the beginning window.

1. Start work on a recent design
2. Open a design file anywhere on the computer
3. Start a new design
4. Fire up the program with the Tutor Kayak.



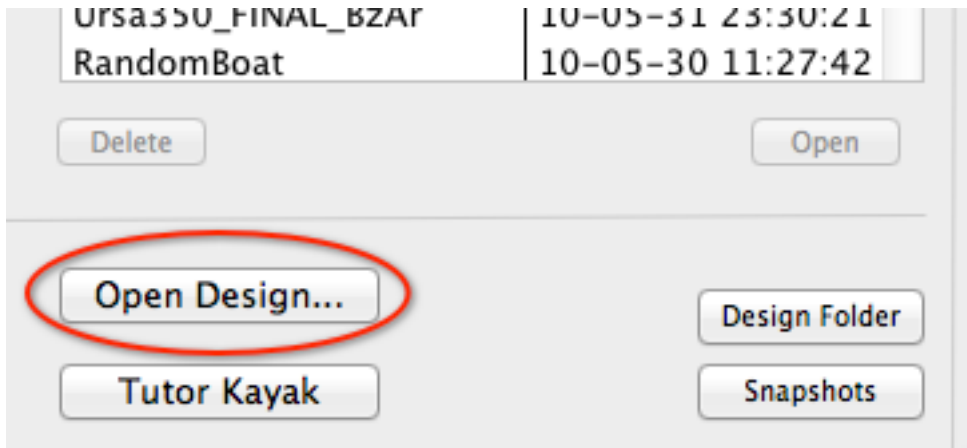
One of the functions of the BBMemory file is to remember the kayaks that the designer has recently been working on. This makes it simple to pick up where you have left off when you return to the program. Highlight the design you want and a small window will appear to jog your memory by showing a few of the characteristics of that design. Then click on the **Open** button and you are ready to go to work. This is less cumbersome than the alternative method that was employed by Bearboat Pro.



There is a **Delete** button underneath the list of recent designs. Selecting a design and clicking on this button will remove the design from the recent list but does not actually delete the design itself. This would be done to keep the recent list uncluttered by removing designs that are not under active development although they may have been opened recently.

## **OPENING ANY DESIGN ON COMPUTER INCLUDING BEARBOAT PRO FILES.**





*The Open Design button.*

If you are trying to open a Bearboat Pro file or a file that a friend sent you or if the BBMemory file is lost or corrupted, you can resort to the **Open Design** button which will bring up the standard file dialog for your operating system that allows you to find any design on your hard drive. Open that file and you are ready to start working on it.

The **Design Folder** button was created in response to changes that Apple has made with Lion. As explained above, by default all the design files are stored in a folder called BearboatDesigns which is ultimately inside the user's Library folder. Apple has made it a little more difficult for the novice user to access the Library folder. The **Design Folder** button gives access to this folder and all the designs that are in it. Double-click on an entry in the list to open that design. You can delete designs in this folder and copy designs from this folder onto the Desktop (for easy access to distribute to a friend for example). These functions can, of course, be performed using the Finder (on the Mac) or Explorer (on Windows), but this button provides an alternative.

The **Snapshots** button gives you access to all the snapshots of your work that are created when you work in BearboatSP. As explained above,

snapshots are copies of your designs that are created intermittently and time-stamped to allow you to go back in time to an earlier version of a design. This can be helpful if a design has gotten “off-track” and you want to go back to an earlier version. It also provides a form of back-up.

## STARTING AN ENTIRELY NEW DESIGN

The beginning window makes it easier to start on a new design. You are presented with a few choices right on this screen. Name the boat, provide the length of the boat, place the boat in some broad category of wide/narrow and then enter the design displacement.

The screenshot shows a web interface titled "New" for creating a kayak design. On the left, there is a "Name" input field and a large "Design Note" text area. On the right, the "Length" is set to 500 (16' 5"). Below this, three radio buttons allow selection of boat stability: "More Stable, Wide", "Average" (which is selected), and "Less Stable, Narrow". Under the "Design Displacement" section, there are three rows for "Paddler(s)" (90, 198 lbs), "Kayak" (20, 44 lbs), and "Gear" (10, 22 lbs), each with a numeric input and a unit label. An "Add" button is positioned below these rows. At the bottom right of the displacement section, the "Displacement (kg)" is set to 110 (243 lbs). A "Create" button is located at the bottom right of the entire form.

*The new kayak area of the beginning window*

There is even a little calculator to help determine what the design displacement should be. The user makes these few decisions and clicks on the Create button and the program will open up with a model that is “in the ballpark” of what the user is intending. Nothing has been set in stone. The length and displacement can subsequently be altered in the main part of the program. This simply makes it easier to get started.

## **TUTOR KAYAK**

The Tutor Kayak button just enters the program with a generic kayak that can be modified and played with. The purpose of this is simply to practice and learn how to use the program. You are not actually intending to design anything.

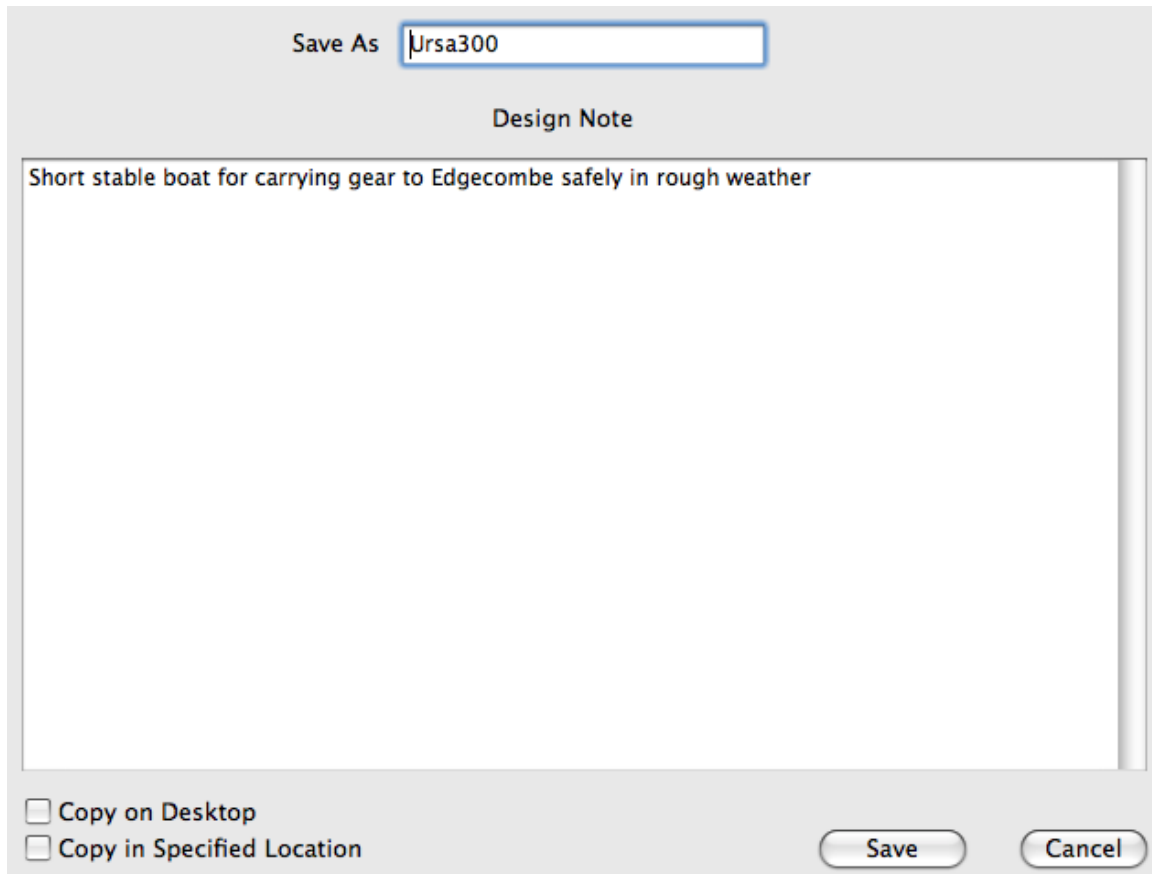
## **File: Save**

One can choose to save any design at any time. Choose **Save** from the **File** menu and the program will save the design in the designated folder, BearboatDesigns. The file locations of Bearboat are explained in the beginning of the manual in the discussion of installation. Suffice to say, all the designs are saved in the same folder (directory) on the computer hard disk.

## **File: Save As**

The Save As... menu item brings up a modal window that allows the user to specify the name of the kayak and to include a design note about this

particular effort.



*The Save As... modal window*

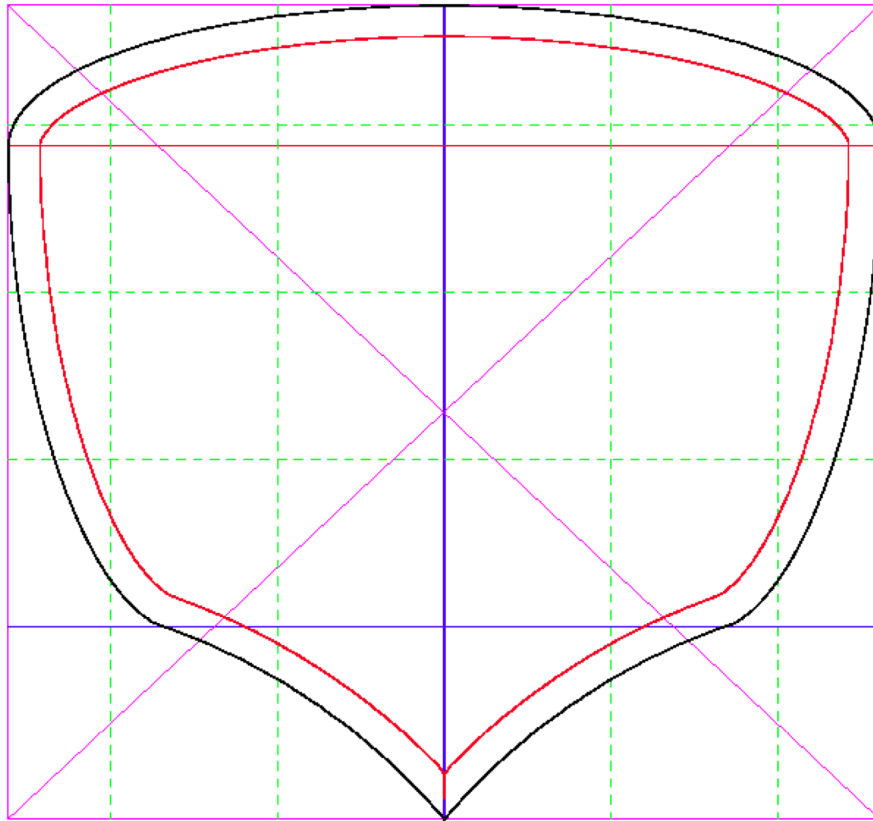
The design will be saved to the designated folder for retrieval in the future. There are two check boxes in the lower left corner that enable additional save locations. These are in addition to the standard folder, not instead of. If you are intending to mail your design to a friend or copy a design to a flash drive or similar task, it is easy to check the **Copy On Desktop** check box and have a copy of the design saved there to avoid having to root around the User/Library/Application Support/BearboatSP directories.

## File: Output

As was true of BearboatPro, the fundamental output of BearboatSP is the cross sections of the kayak being designed. To produce these cross sections, choose the **Output** option under the **File** menu. This portion of the program differs considerably from the equivalent area in Bearboat Classic.

The initial task is to select exactly which cross sections to output. This is done in the **group box** entitled **Specified Cross Sections**, the use of which should be fairly self-explanatory. This **group box** contains a **canvas** that illustrates which cross-sections are presently selected for printing. At one extreme only a single cross-section can be specified. At the other extreme, every cross-section across the entire length of the boat at one centimeter intervals could be specified. The **canvas** shows the chosen cross-section on a graphic representation of the kayak, either the Birdview or the Sideview. Radio buttons allow changing back and forth between these two views.

The next step is to go to the **Print Cross-Sections group box** and decide whether you want to have a skin depth drawn on your paper printouts. The printout below has included a skin depth of 1.5 cm, which is drawn as a red line deep to the surface of the cross-section.



Checking the Skin checkbox will force printing of a line on the cross-sections that is a specified depth away from the surface. In the upper right part of the Output window there is a **canvas** that will show a picture of this concept if the skin option is selected. This is a very useful function of BearboatSP that was not available in Bearboat Classic. A skin of arbitrary thickness can be specified. One common building technique is to create several cross sections of a kayak being designed. These cross sections will be planked with some material perhaps cedar strips. Those strips themselves have a certain thickness. It is useful to be to have cross sections that are reduced somewhat from their true size to accommodate the thickness of the strips themselves. The skin **checkbox** allows the user to specify a particular thickness of the material that will be used in construction. When the paper

cross sections are produced by the program Bearboat Print, one will see a second line which will indicate the depth of the strip and allow one to simply cut out the cross sections at a slightly smaller size to accommodate the strips that will be used.

Each sheet of paper has a line of text that describes the cross-section being drawn. The first piece of information is of the form A1 or B3. This is useful for cross-sections that require multiple pieces of paper to completely draw out. The letter (A) refers to the column. The number refers to the row. Therefore B3 refers to the piece of paper that would be taped into the second column of the third row.

A1	B1	C1
A2	B2	C2
A3	B3	C3

The second piece of information is the date and time that the BearboatPrint file was created. The third is the name of the kayak. The fourth is the position of the particular cross-section. The fifth is the scale to specifically indicate whether or not the graphic is life-size. Gridlines are provided to help align the cross-sections with one another and the individual pieces of the larger cross-sections with each other, There gridlines should be spaced at 2 cm intervals, and it would be wise to check this. If they are not at 2 cm intervals, BearboatPrint is not communicating successfully with your particular printer. BearboatPrint has a tweaking function to slightly alter the output to try and adapt to your particular printer. If the gridlines are not at 2 cm intervals, try using the tweak tool of BearboatPrint.

Other less critical data is also supplied in that one line listing, and this is

fairly self-explanatory. The Skin width is documented. Generally, this should correspond to the width of the cedar strip if this is going to be a strip built boat.

Next use the **little arrows** in the Scale **group box** to decide what size of printout to produce. Obviously, to actually create the kayak, you would want to have life-size paper printouts. However, in the design process, it can be useful to create smaller models of the kayak. The **little arrows** in the Scale **group box** allow specification of models of varying sizes, ranging from life-size to 1/16<sup>th</sup> size.

Once these preferences have been specified, push the **Print File** button. A message will shortly appear to tell that a file has been created. These files are called BearboatPrint files. They will automatically be placed in a folder called BearboatPrint. The name of the file will end with xsBBPF, which stands for BearBoat Print File (xs refers to cross-section). The file name will include the name of the design and the initial numbers will indicate when it was created (YYMMDDHHMM). For example, 0209080536Excalibur\_xsBBPF, is a file for a kayak that was called Excalibur produced on 09/08/02 at 05:36 in the morning. Note that the computer's printer does not come to life. A separate program, BearboatPrint, is used to actually produce the printout. That program will import the data from a BBPF file and actually direct the printer to create the cross-sections. As a default that program will work with the standard paper size that most printers handle, 8.5" by 11". It is also possible to use 8.5" by 14" (legal paper). Cross-sections that are too big to be included on a single sheet of paper will be created on as many sheets of paper as necessary. The user tapes these sheets together to create the final form.



Another **group box** in the **Output** window is labeled **Print Bow/Stern Profile**. Many builders use profiles of the bow and the stern in their construction. The profile is just the middle of the kayak extending from bow to stern viewed from the side. Specify how long a profile you need (in general just a foot or two) and specify whether you want to print out a profile of the bow, the stern or both. The **Print File** button is pushed to create the file that can be used by BearboatPrint to print out on paper a full-sized drawing of the profile. These files are another type of BearboatPrint files. They will automatically be placed in a folder called BearboatPrint. The name of the file will end with pfBBPF, which stands for BearBoat Print File(pf refers to profile). BearboatPrint will import the data from a pfBBPF file and direct the printer to create the profiles.

There is another **group box** in the **Output** window with the label **Grid Text Files**. This is primarily for advanced users. Creating a file using the button in this **group box** will make a computer file that contains numbers specifying in centimeters the surface of the kayak at the chosen cross-sections. This was referred to as Table of Offsets in Bearboat Classic

The word Grid refers to the fact that this data is created in such a way that programs such as Excel can read this data and present it as data in a grid with rows and columns of data. Conventionally such data can be stored as a text file with each row of information demarcated by carriage returns. Each individual piece of data in a row is separated from the data in the next column by a delimiter. The program allows this delimiter to be a TAB or a comma. These are both popular conventions and Excel, for example, is capable of importing such data in either format. You can also at least look at these files in word processing programs such as Word or text editors such as

BBEdit.

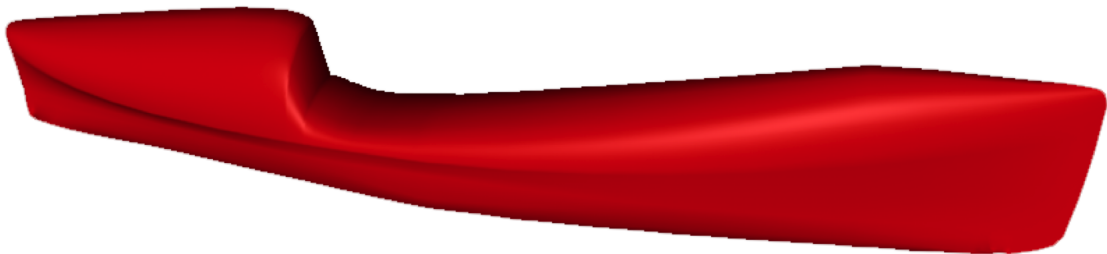
One reason to create these files is to move the data into other programs. I created the XYZ file as this file could be read, after a little manipulation, by a 3D computer-driven milling machine that was capable of carving out a plug for a mold. Other 3D visualization programs and CAD programs are capable of importing such data or at least a sophisticated user can transform this data into a form that can be imported.

The XYZ refers to a convention of referring to a given point on the kayak. The surface of the kayak is described as points in space specified by their X, Y, Z coordinates. The Z coordinate identifies where along the length of the boat the cross-section lays. A point with a Z coordinate of 50 is on the cross-section that is 50 cm from the bow. The X coordinate describes how far from the midline of the kayak that point lies. The midline of the boat has an X value of 0. The point that is at the widest place on the boat will have an X value of half the boat's width. The Y value is the distance of the point from the waterline. Negative values refer to points that lie underwater. Positive values refer to points that are above water.

The data is provided for "half" the boat. Since kayaks are bilaterally symmetric, this essentially describes the entire boat. You may have to duplicate the data set with one of the parameters (X) made equal to the negative of its value in the new set for importation into some programs. Usually, the receiving program can handle this.

BearboatSP also has the capability of exporting your design as a DXF file. The created DXF file will be placed in a folder called BearboatDXF. DXF stands for Drawing eXchange Format, which was created by Autodesk to provide for a method of exchanging drawing file information in a generic

format. Autodesk is the developer of AutoCAD, which is one of the most popular computer aided design programs. AutoCAD can, of course, read DXF files, but this format has been widely adapted by other design and display programs as a method of importing and exporting graphic files. By converting your design into a DXF file, it can be imported for viewing or further manipulation in a large number of design programs. This is a one-way street. BearboatSP cannot "read" DXF files produced by other programs.



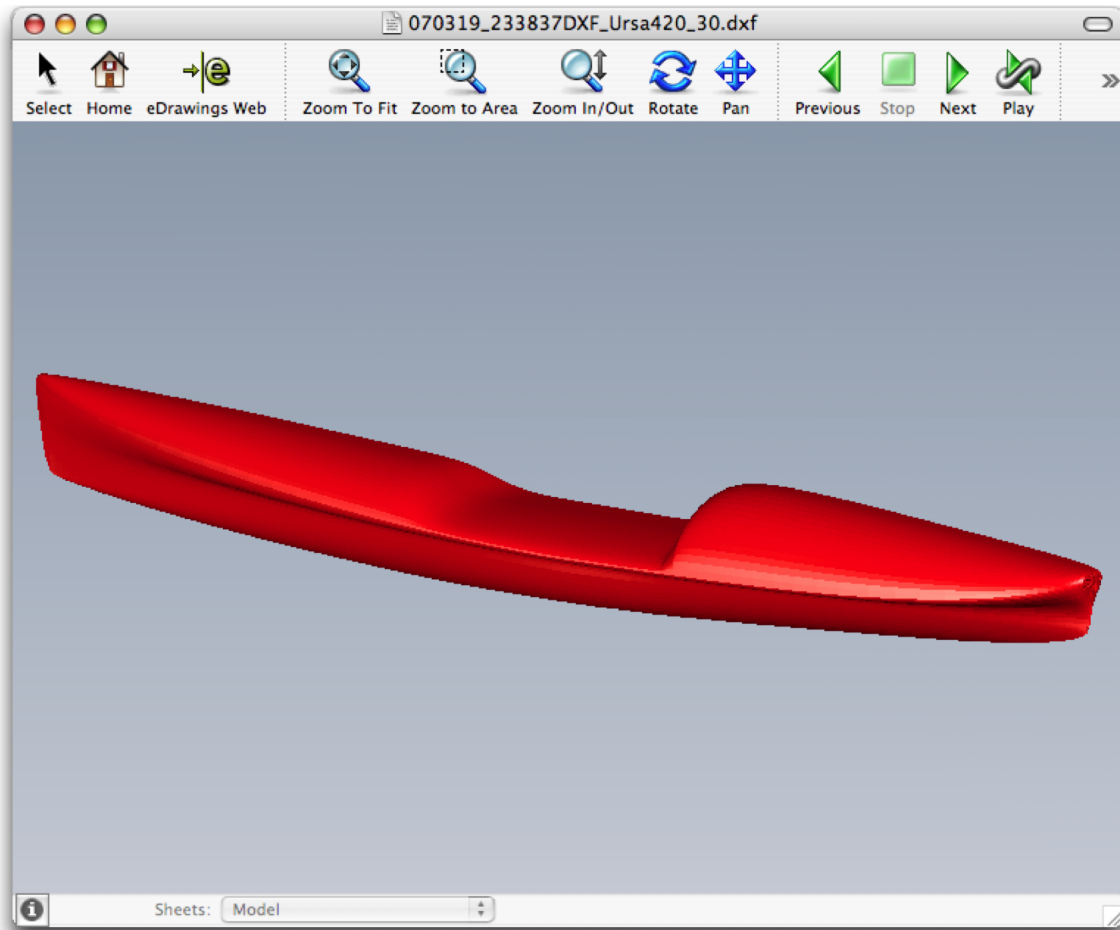
The above graphic is the result of using DXF to import a kayak design into a CAD program (in this case Cinema 4D for the Macintosh) and creating a rendering in that program.

The DXF file created is a 3D file. It is a rather "minimal" file that can be read by many programs that purport to read DXF. Users and I have, however, run into problems. Some programs will not open the file. Sometimes this is because the program is a 2D program and these are 3D files. DXF has 2D and 3D versions and some programs only deal with 2D.

There is a free program, available for both Macintosh and PC, which does a good job with handling the DXF files created by Bearboat. It is eDrawings Viewer and is available from SolidWorks.

(<http://www.solidworks.com/pages/products/edrawings/eDrawings.html>)

This program nicely renders the design that you have exported as a DXF file. Remember to select the **Both Sides** checkbox so that you will see both sides of the kayak. Below is a kayak rendered in eDrawings. There is a simple toolbar that allows rotation and magnification of the model.



*Bearboat design rendered in eDrawings*

On the PC side there is a program called acmeCADSee that is a shareware program (\$60). You can download a Demo to try it out. This program opens the file without difficulty and allows you to see the design from any point of view in 3D space. It also can save the design in a number of formats: AutoCAD 2000 dxf, AutoCAD R12 dxf, and AutoCAD R14 dxf. These are

all different “versions” of DXF. The files thus created are quite different when looked at with a text viewer (DXF files are simply ascii files).

I mention this because I have found that sometimes a program that will not open a DXF file straight from Bearboat will be willing to open it after it has been converted by a program such as acmeCADSee into another “version” of DXF. Another program that I ran across, AutoVue SolidModel Professional Desktop, had a demo version that I could experiment with and it could open Bearboat DXF files and “Convert” them to other formats. If I chose DXF as the format, then I could open the resulting file in programs that had a problem with data fresh from Bearboat.

Sometimes, the issue is related to the three-letter extension. On the PC side, try manually making sure the .dxf is the extension rather than .txt. There is a CAD program on the PC (and coming soon to Macintosh) called Rhino that is a very sophisticated program for doing 3-D design. It is cheap for what it can do, but most people doing hobby kayak design would find it expensive. If you are interested in refining your design and specifying details such as hatches and cockpit rims, you should consider this program. It also provides an entry point into CNC machining, in that many such machines will accept input from Rhino specified surfaces. Rhino will import DXF files, but will only “recognize” such files if the three-letter extension is .dxf. You have to specify in the Open dialogue box that you want to open a .dxf file and make sure the file from Bearboat has the .dxf extension. Rhino is available as free download demo that will allow you to visualize your design in any projection. It initially provides a wireframe view, but it will also allow you to see your Bearboat created design as a “shaded display” which is really quite beautiful. Rhino will also open XYZ files. Manually

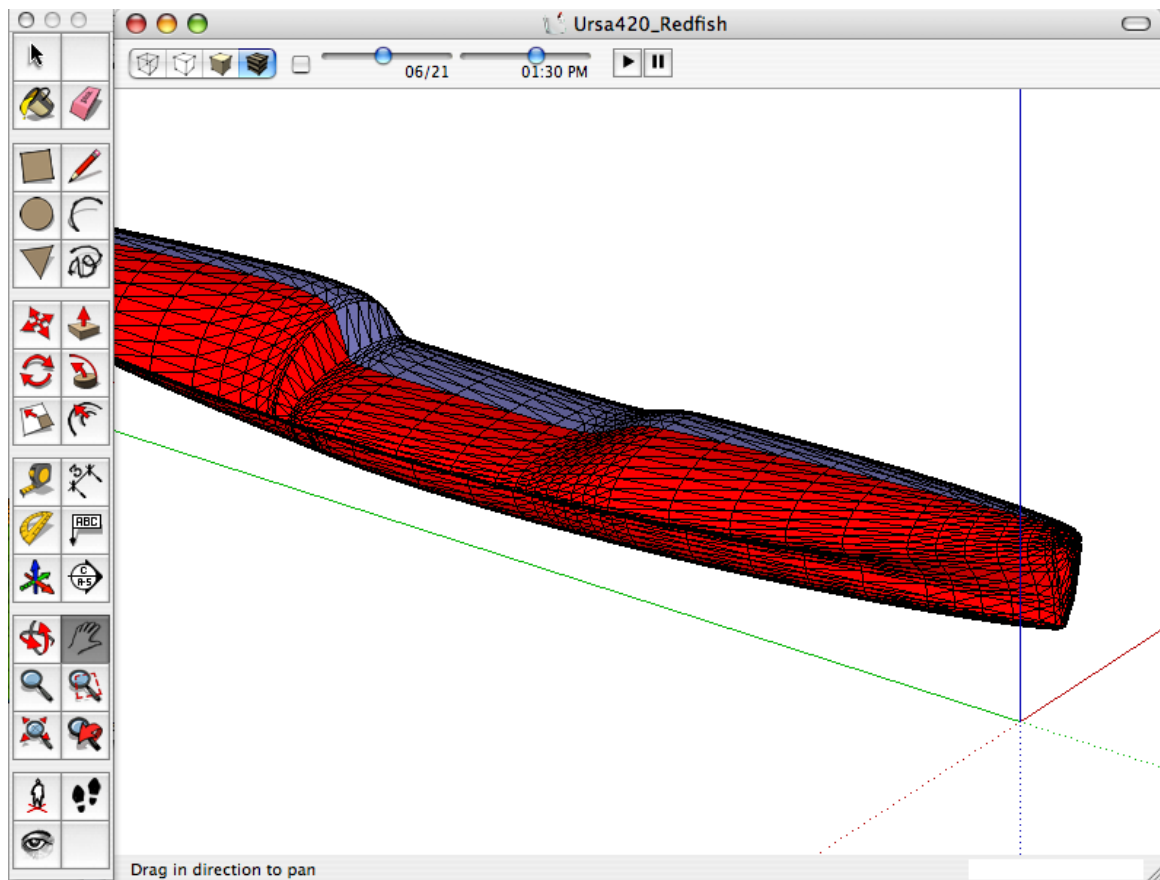
make sure that the extension is .xyz. Rhino is currently being extended to the Macintosh platform, and I have had experience with the Beta. It is very powerful and is used as a boat design program by many. It is my tool of choice for “completing” a BearboatSP design. Hatches, cockpits and other deck details can be specified in Rhino after the basic design is imported from Bearboat SP.

An exciting development as of May 2006 is the purchase, by Google, of a program called SketchUp that allows construction of 3D models. It is exciting because Google has made the low-end version of the program free, and the program is cross-platform. This program is excellent, although it is not really optimized for organic forms such as a kayak (it is most commonly used for buildings). There are high quality tutorials, and the program itself is quite approachable for a 3D program. All 3D programs take time to master. This one is an excellent introduction to the concept.

Google has made the basic version of this program free on the Web. SketchUp is most commonly used to design architectural models and is not really suited for designing kayaks. However, it is a good free visualization tool to look at your design in 3D. SketchUp is capable of examining (File: Import) the DXF file that Bearboat creates, and you can now look at your design and spin it around to your heart’s content. You can position yourself to view the boat as though you were the paddler or even look inside the kayak. It is best to create a DXF file with both sides of the kayak exported. After doing the import into SketchUp, it may seem that nothing has happened. Be sure to click on the “center object” button (third from the bottom on the left in the toolbar). This will adjust the magnification factors and field of view so that the boat is visible. Unfortunately the free version

cannot export the drawing in any formats other than SketchUp itself.

SketchUp is available for both Macintosh and PC.



*Bearboat design rendered in the free SketchUp program provided by Google*

The DXF file describes the entire length of the boat. Any restrictions in the **group box** entitled **Specified Cross Sections** are not applied. The user can customize the DXF file in two ways.

First, there is a **checkbox**, **Both Sides** that can specify that the output contain both sides of the kayak. By default only the right side of the kayak is sent. This makes the created files more compact. In general, the receiving program is capable of generating a mirror image and thus restoring the left side of the design if needed. However, if the user checks Both Sides then the resulting file will contain data for the left and right side of the kayak.

Secondly, it is possible to adjust the size and detail of the created DXF file. The file contains the location in space of points on the surface of the kayak. BearboatSP could provide an infinite number of such points. The goal is to provide only a "sensible" number of such points. The more points provided, the larger the file. The importing program may have difficulty opening a file with too many points, and you may have difficulty manipulating the design in that program if there are a huge number of points. Conversely, the fewer points provided the more of an "approximation" the file becomes. You can lose the detail of the design. There is a **slider** that allows the user to vary the number of points specified within a generous range to customize the file for different purposes and programs. Large files that contain a large number of points can take a little while to generate, so be patient.



# BearboatPrint

## BearboatPrint and BearboatPrintMacPC

There are two versions of the BearboatPrint program – BearboatPrint and BearboatPrintMacPC. These are independent programs, separate from BearboatSP.

BearboatPrint is a PC only program. For a long time, that was the only version and Mac users had to find a PC to get their actual paper printouts. That older program is still available. It is possible that it is more reliable; it has withstood the test of time. The newer program, which is available both for the Mac and the PC, is called BearboatPrintMacPC.

Using the BearboatPrint or BearboatPrintMacPC utility program is easy. These programs' only purpose is to take a Bearboat Print Files (xsBBPF or prBBPF) that have been created by BearboatSP and print out on paper the specified cross-sections or profile. The Bearboat Print Files that are produced by BearboatSP are sent to a folder called BearboatPrint that should be in the same folder as the application itself. (This folder is created if it is not already present)

The user has two basic tasks. The first is to select the particular desired Bearboat Print File (BBPF) that has been created by BearboatSP. The second is to initiate printing out that file on paper.

Frequently, it requires more than one sheet of paper to completely cover a given cross-section or profile. The programs will use as many sheets as necessary, and the user tapes them together to create the full sized cross-section.

## BearboatPrint

BearboatPrint should create drawings of the appropriate size regardless of your printer. However, some users have reported to me that their printers are slightly “off”. This will be evident if the 2 cm grid that BearboatPrint places on the printout is not exactly 2 cm. There is a tweak parameter in BearboatPrint that can be adjusted to try and accommodate for this. If your grid is too small, you can increase the value of the tweak parameter from the default 100% to 101%, for example, if you find that your grids are 1% too small.

The tweak checkbox exists to try and solve this very specific problem. I suspect that the fixable problem is relatively rare. The common household printer moves paper through rollers to allow printing from top to bottom and the common household print moves a print head to allow printing from side to side. Printer drivers (the software that runs the specific printer) are supposed to tell the computer what command to use to move the paper a given distance and move the print head a given distance.

I do not know what the tolerances are on a typical printer. It is possible that your printer might move its print head 1% more than it is supposed to. It is possible that the printer might move its paper 1% more than it is supposed to. Therefore when BearboatPrint commands to draw a 2 cm square the square that is drawn is actually a little larger. If your printer makes the SAME percentage error, in both directions, then it is relatively easy to fix in software using the "tweak" function. Set the tweak value to 99% to compensate. The problem is that this assumes that your printer makes the same error in both directions. If your printer only makes its error in one

direction, which would imply the squares that it draws are not perfect squares, then the tweak function will not work.

Therefore the tweak function will only help people whose squares are still square but just a little larger or a little smaller than they should be.

There is an option to choose B&W or color. If you have a color printer and choose B&W then color ink will not be used. In general, it is easier to deal with the colored version.

Many printers will accept legal sized paper, which is 8.5 by 14. If you have this paper available, BearboatPrint can take advantage of it to draw on larger sheets, which will reduce the number of sheets of paper required to draw the sections.

BearboatPrint can be downloaded from

<http://bearboat.net/BearboatSP.html>

## **BearboatPrintMacPC**

There are no tweaking functions in BearboatPrintMacPC. I suspect that these were rarely useful and did not try to include them in this program. This program should print on any paper size that your printer can accommodate. The basic grid in the background is a 5cm grid, and it is worthwhile to check that your printer is actually creating a grid of this size.

BearboatPrintMacPC can be downloaded from

<http://bearboat.net/BearboatSP.html>

## More on Constraints (or Why the Red Lines?)

The subject of constraints causes users more confusion than any other part of this program. Many users are confused by the fact that their designs are producing many cross-sections in “red”. The “red” is used to indicate a conflict in the chosen parameters. A further discussion of this topic follows.

Consider any random cross-section on your design. There is a basic hexagon made up of six vertices that determine the shape of the cross-section (FIGURE 1).

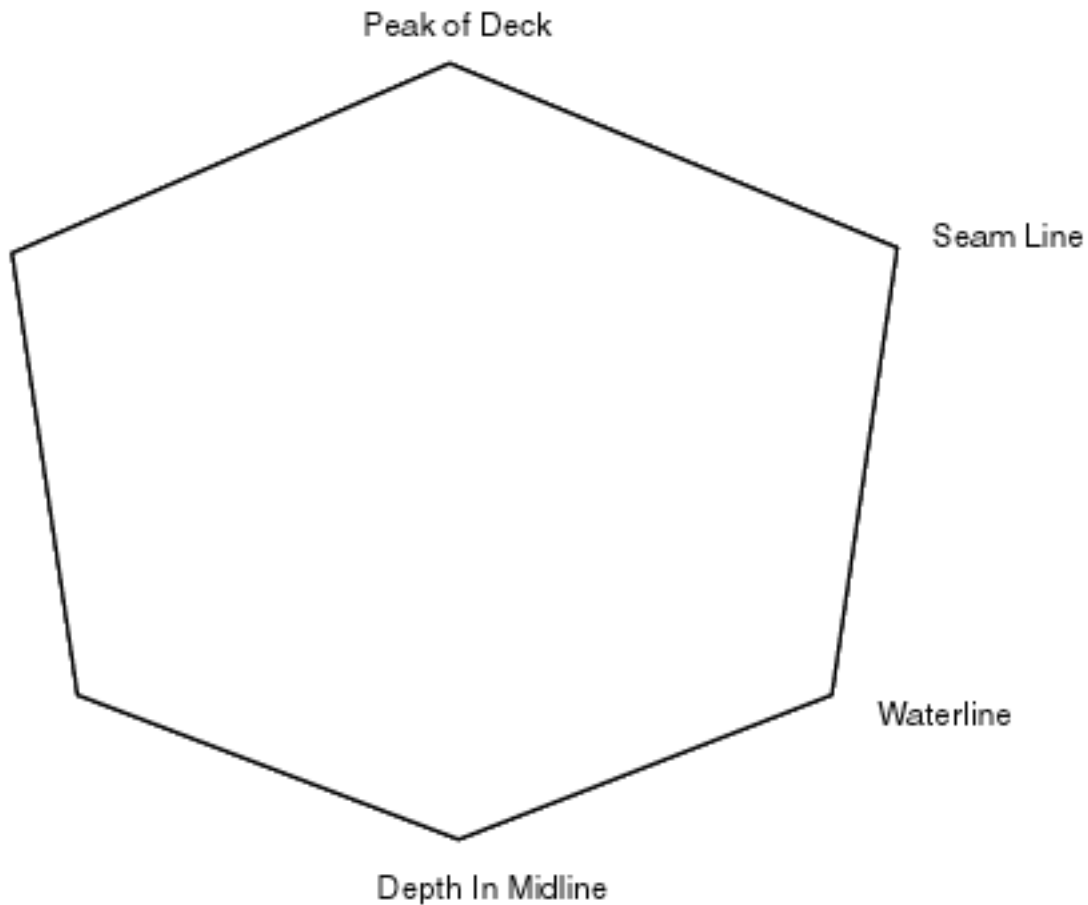


FIGURE 1

1. There is a vertex in the midline at the top. The Sideview module determines the position of this vertex; it is the height of the peak of the deck.
2. There are two vertices that define the seam lines. The Sideview module determines the height of these vertices; the Birdview module determines the horizontal distance between these two vertices.
3. There are two vertices that define the waterline. The Birdview module determines the horizontal distance between these two vertices.
4. The final vertex is in the midline at the bottom. The Sideview module determines its position; it is the depth of the kayak at that position.

Once these vertices are fixed, the program creates the curves that connect them and defines that particular cross-section. Above the waterline, this is fairly simple. The program allows the user to choose from a limited number of families of curves that determine the character of the curve that creates the deck and a limited number of curve families that determine the curve that creates the above water side of the kayak.

The creation of the curve below the waterline is more complex. The program will draw the curve that will result in the minimum wetted surface and still conform to the constraints. This depends on one additional parameter that the user has specified in the [Curve of Areas](#) module, i.e. the cross-sectional area of that underwater section. It is possible that a conflict will occur among the three parameters that determine the underwater curve of the cross-section. Those three parameters are the depth of the underwater curve, the width of the waterline and the cross-sectional area. The most frequently encountered problem occurs when the cross-sectional area is greater than that which can be accommodated by the depth and the width of the waterline. The program indicates the problem by drawing the underwater cross-section in red.

To illustrate these issues, consider the family of curves that would be created to accommodate progressively greater underwater areas if the ONLY constraint were a given waterline width and with the program trying to minimize the wetted surface. These curves seem reasonable as long as the cross-sectional area remains below a certain value. After this value is reached, the underwater sides start to blow out laterally. In FIGURE 2, you can see that the curve 5 and curve 6 are starting to bow laterally

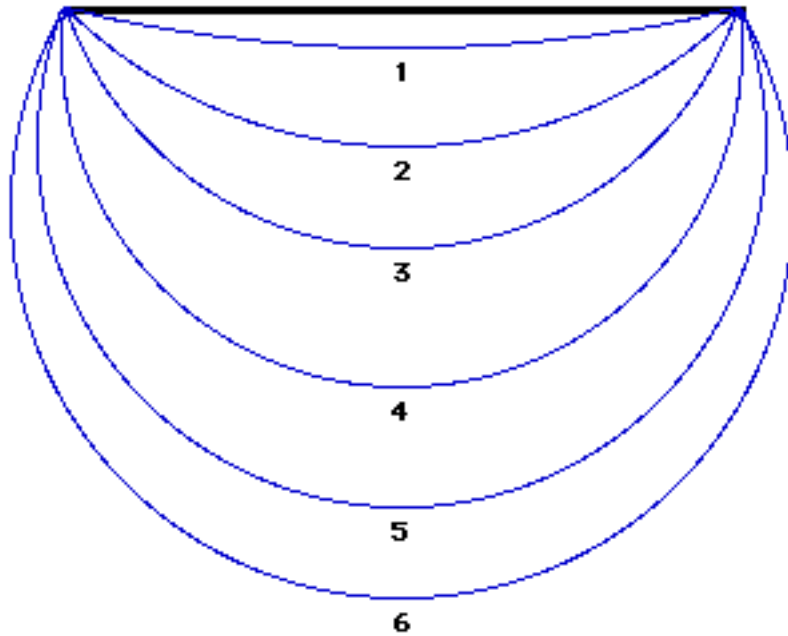


FIGURE 2

Now consider the family of curves that would be created to accommodate progressively greater underwater areas if there were TWO constraints, the waterline width and the depth. This is closer to the actual behavior of the program. Again these curves seem reasonable as long as the cross-sectional areas remain below a certain value. After this value is reached, the underwater curve starts bulging out laterally and down on each side of the midline. In FIGURE 3, you can see that curve 4 is bowing out laterally and inferiorly.

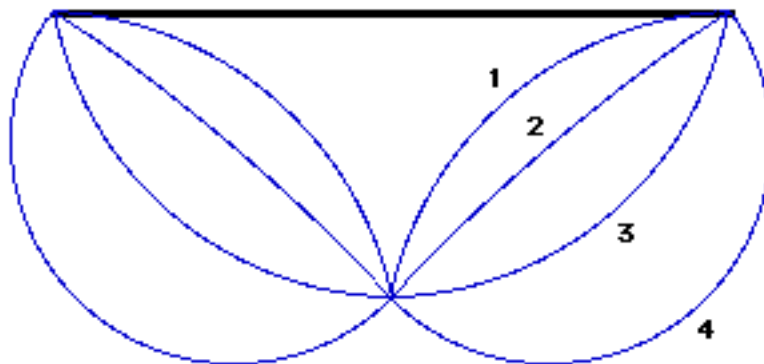


FIGURE 3

The fact that the program does NOT show curves with these bulges reflects the fact that there is an additional “unstated” constraint on the minimum wetted surface curves. First, the depth of the boat can nowhere be greater than the depth of the boat in the midline. Secondly, the width of the underwater section can nowhere be greater than the width of the boat at the waterline. So really, the family of underwater curves is constrained by a rectangle whose width is the waterline width and whose depth is the midline depth of the boat (FIGURE 4).

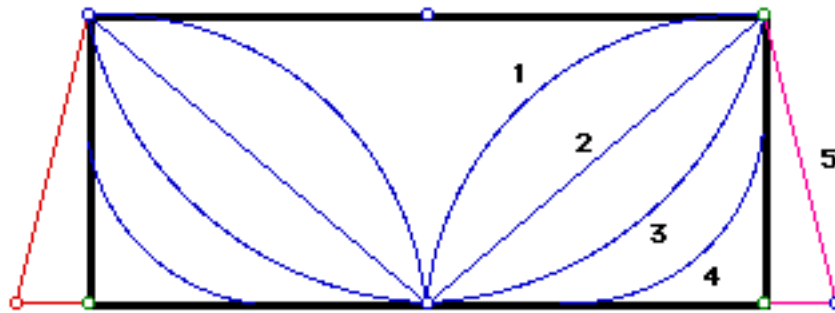


FIGURE 4

With the curves constrained by this rectangle, a problem occurs when the specified cross-sectional area is greater than the area of this rectangle. The designer is responsible for adjusting the relevant parameters so that this does not happen. The program alerts the user to this problem by drawing the cross-section in red and by appending triangles to each side of the rectangle to create a cross-sectional areas as great as that demanded by the curve of areas. This is illustrated by curve 5 of FIGURE 4. The size of these appended triangles gives the user a visual cue of how far off he is. To “cure” the situation, one can increase the depth or increase the waterline width or decrease the cross-sectional area or some combination of the above.



This is relatively straightforward. But the situation becomes more confusing when the user specifies additional constraints, particularly the water angle and the keel angle. By placing these additional constraints, the likelihood of a conflict greatly increases. The area in which the underwater curve is created is now more confined (FIGURE 5). Users may find that many of their cross-sectional drawings are plagued with red. It has become easier to specify at any given location a cross-sectional area that is larger than that possible within the other constraints.

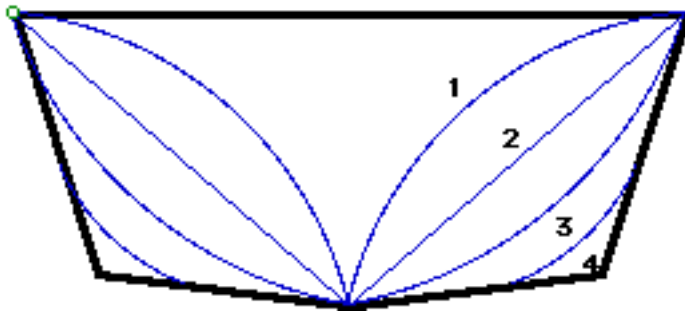


FIGURE 5

As a practical matter, it is wise to design your craft first with NO additional constraints. Once the kayak has been roughly specified, start judiciously applying the additional constraints. If you want a keel angle of 75 degrees, do not apply that value at first. Try a value like 85 degrees and then review your cross-sections to see if things are still OK. Then try 80 degrees. By working your way down towards the goal of 75 degrees in steps, reviewing the cross-sections at each step, it is much easier to understand the conflicts that may arise. Do not change the water angle and the keel angle at the same time. Make a change in only ONE constraint and see its affect on

all the cross-sections before changing the other one. This cautious technique will allow you, the designer, a much better understanding of what is happening than would be the case if you radically changed the water angle and the keel angle. If you do the latter, you may go back to the cross-sections and just see them all “having problems” i.e. all drawn in red.

Applying a marked water angle can create another conflict that will be indicated by the underwater cross-section being drawn in purple. If the boat at a given cross-section is relatively deep and narrow then a given water angle may be too severe and prevent the underwater section from getting to the required depth. The program will draw a cross-section in this circumstance that breaks out of the confines of the water angle. It is easy to simply ignore this “problem”. The underwater cross-sections will be reasonable. They are drawn in purple just to bring the situation to your attention. This circumstance is relatively rare.

As was pointed out elsewhere, minor problems at the very ends of the boat are not really all that important. Where the underwater area is very small and the depth is shallow and the width is narrow, it is easier for conflicts to occur. In this location, they are not very important as they are easily “sanded out” in the real world.

To summarize, if you are having a problem with understanding why some of your cross-sections are drawn in red, start removing or lessening any constraints that are present. By loosening these constraints, the red cross-sections will disappear. Then start reapplying the constraints in a graduated fashion, checking the cross-sections at every step. This will allow you to understand the problem and where and why it is occurring. If you do not have any special constraints applied and are still having problems, try

considerably increasing the depth of the boat. This will make the red cross-sections go away. Then start gradually reducing the depth of the boat reviewing the cross-sections at every step. This process should make things clearer. Even as the designer of this program, I occasionally find myself confused as to exactly why a cross-section is violating its parameters. The technique outlined above always clarifies the situation.

## Final Comments

This manual covers most of the highlights, but to learn the program you have to use it. Feel free to push buttons and try anything that you want. This is the way to come to a better understanding of the program. There is nothing in this program that is particularly difficult.

Remember to save some time for paddling.

There are various aesthetic problems that will rise using BearboatSP under Windows because the primary development environment is Mac OS X. These problems can generally be regarded as a minor nuisance. As the program matures, I would like to “clean up” the appearance of BearboatSP on this alternative operating systems. Some obvious annoyances are that the Quit command in Windows appears under the “wrong” menu and with the Windows version occasionally graphics have to be prodded to redraw.

Keep an eye on the Web site

<http://bearboat.net/BearboatSP.html>

for updates of the programs.

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**Bearboat Software**