

## Breakback Swing Rig Preface.

by Niel Goodrich

The following section is a step by step set of instructions to assemble a Swing Rig kit that I provided in the early 1990's. This kit was designed for the M Class but the concepts are valid and scalable to model yachts that permit the use of Swing Rigs in their measurement rules.

My Swing Rig designs are unique in that they feature a "breakback" feature. The forward extension of the mainboom (what I refer to as the Jib Sprit) is hinged at the mast. This allows the leading edge of the jib to align with the centerline of the boat, emulating the sail setting of a conventionally rigged boat's upwind configuration. The common Swing Rig without this feature carries the leading edge of the jib well to windward of the boat's centerline which hurts pointing ability. They are sailing on a close reach all the time and on a long course the difference in sailing angles will cause the common Swing Rig to sail farther to the windward mark.

The main fitting looks complicated in my drawings and in fact it was pretty complicated to create the production mold and to do the layup of the Carbon Fiber cloth. Don't be put off by the looks though, the same end can be achieved with a simple one-off clamshell type mold. A basic mock-up of the fitting can be made with brass mandrels (round rod stock) 1/32" larger than the desired spars all the way around and hinge pin stock. The area on the mandrels to be molded should be waxed and sprayed with a release agent. Material (balsa, cardboard, etc.) should be placed between the spars to hold them in their proper relationship and the whole arrangement taped down to a waxed acrylic sheet. The idea here is to make your cast along the vertical centerline of the fitting. The area to be cast should be sprayed with release. You can use any sort of casting material to make your mold, but bear in mind that your mold will undergo some clamping pressure so it has to be tough or re-enforced in some way.

Once one side is cast, carefully remove the casting, turn it upside down to cast the second half the same way. But, before you proceed, make sure that the half mold is on the vertical centerline of the fitting mock-up, with no overlaps or undercuts. If there are then they should be trimmed away or filled respectively. Also, before you cast the second half you need to create several keyways to align the two halves once you have separated the castings. The keyways will function to re-align the two mold halves when you cast a real fitting in them.

To cast the fitting you will need brass mandrels that are the same diameter as the eventual spars you plan to use. These should have masking tape wrapped around each end so that when they are in place and the mold is closed up they guarantee that there is an even space around the mandrel for the cloth to fill.

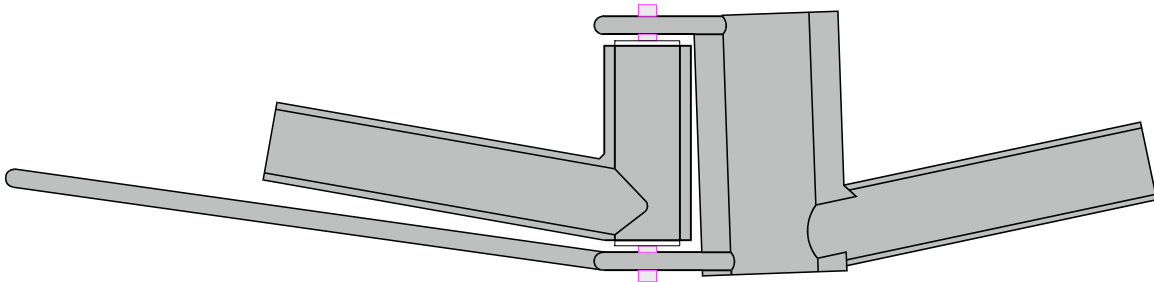
To lay-up a fitting, wax and spray release the molds and the spar mandrels and hinge pin stock. Lay a single layer of sheathing glass on the first mold half. Then follow with the Carbon cloth wetting out each layer individually as you go. Place the mandrels and the hinge pin in their locations. Make sure no cloth underlaps the taped ends of the mandrels. Once the mandrels are in place lay-up the same number of layers of Carbon, making sure that no cloth overlaps the taped end of the mandrels. Wet out the top layer of sheathing glass and close the mold and clamp and let cure.

The mandrels should break loose with a little twisting. You may have to reinsert the mandrels to extricate the fitting from the mold. The fitting will need some trimming. The sheathing glass layer is easy to score and makes a white line that shows up well against the black Carbon. Use these guidelines to outline the trimming task. I use a jeweler's saw to trim away unwanted material.

It may take a few tries to get this kind of mold making down but it does yield good results.

I hope you enjoy making, rigging, and sailing a performance Breakback Swing Rig.

# **THE GOODRICH DESIGN BREAKBACK SWING RIG.**



## **INTRODUCTION**

Thank you for buying your breakback swing rig parts kit from me. I think you'll find your swing rig to be an enjoyable challenge. I've been working with swing rigs (sailing, designing and refining) for quite a while now and the more deeply I delve the more fascinating they become. I've been sailing 50/800's on and off since the early '70's and I've seen an impressive parade of hull designs go by. But today it seems that despite the many different designs in use the top "M" sailors are all very competitive with each other. And, as I'm sure you've noticed, a lot of these sailors are using swing rigs.

Before we begin please read these instructions all the way through and examine the diagrams that I've provided. You should become familiar with the names and locations of the various elements that make up the swing rig. In labeling the locations of these elements in the diagrams I've always started with a zero point to measure from. For example, the deckline is called out as the zero point. The jib strut location is called out at 49" measured up from the deckline.

I've written these instructions for assembling a 50/800 "A" Rig, or top suit, but they can be used as a guideline for putting together alternate 50/800 rigs or rigs for other classes as well. The names of the various elements you'll be making are highlighted in bold letters to help you locate them in the text. Put a check in the burgee before each step in the instructions so that you can keep track of your work.

All parts to a swing rig are custom made. The swing rig masts are formed over an interior mandrel so there is a bit of variation in outside diameter from one to the next. The mast is longer than you need. This allows you to choose the section that you want to use and have enough left over for through-the-deck mounting. Three of the fittings parts engage the mast at different locations along its length. The interior diameter for each of these parts corresponds to the average diameter of several tested masts at each part's location. You will probably have to do some fitting to your particular mast. To fill small gaps I put a bead or two of Ca glue on the inside of the part. Once the Ca glue is completely dry test the fit, and repeat the process until a snug fit is made at the proper location. If the part needs to be opened up a little to accommodate the mast diameter use a round metal-working

file of a size close to the part's interior dimension or a dowel of similar dimension wrapped with 220 grit sandpaper. If the masthead crane's socket needs to be relieved for the mast to fit in it find a drill bit the same size as the diameter of the section of mast to be fit and clamp it into a bench vise. Wrap the drill bit with masking tape at the desired depth of cut and slowly twist the masthead crane down the drill bit to the edge of the tape. Do not force it. If it binds try using some oil or other lubricant. You may need to use several drill bits of progressively larger diameters if the socket needs to be opened up a lot. Be warned, carbon fiber sands down a lot faster than its hardness would lead you to expect. Take your time and be careful.

### **TOOLS LIST**

I've tried to make this parts kit as complete as possible but you will have to gather the following tools and equipment to put your breakback swing rig together:


- \_\_\_ Ca glue (Krazy Glue, Pic Stic, Zap, etc.)
- \_\_\_ Black indelible marking pen
- \_\_\_ Pencil
- \_\_\_ #4 finishing nail
- \_\_\_ #12 fishing leader wire or comparable
- \_\_\_ Hacksaw with a fine metal cutting blade **or**,
- \_\_\_ Jewelers saw
- \_\_\_ Round metal-working file
- \_\_\_ #220 grit sandpaper
- \_\_\_ Butcher's wax or other paste wax
- \_\_\_ Assorted drill bits
- \_\_\_ Masking tape
- \_\_\_ Sewing needle
- \_\_\_ Scotch double-stick tape
- \_\_\_ Silver mylar
- \_\_\_ 12 bowsies


### **SOME ADVANCE PREPARATION**


At this point it would be a good idea to do some additional advance preparation. Every sailor should be familiar with a variety of knots. I am assuming that you know how to tie bowlines, square knots, figure 8s and clove hitches. Knot tying instruction is available from any number of books on the subject and these basic knots are covered by most comprehensive dictionaries. All attachment points on the spars are bowlines tied on with a series of clove hitches. I use knots to attach the lines to the spars instead of drilling holes in them for three reasons. First, drilling holes into carbon fiber weakens it. Spars of carbon fiber can "unzip" their entire length with the hole as the starting point. Second, the edges of a hole in a carbon fiber spar are sharp and will fray and cut Dacron line in a matter of weeks. Also, because carbon fiber splinters easily the line may get snagged in the hole preventing you from making necessary adjustments. Third, it is a lot easier to cut a group of clove hitches off and tie a new knot in a different location than it is to align and drill a new hole in a completed swing rig. After you tie


each knot or series of clove hitches it is a good idea to finish it by sealing them with a drop of Ca glue, then trim the loose end and melt its tip to prevent it from fraying.


Throughout these instructions I call for two basic sizes of bowlines. The larger ones (LG) are anchor loops that form the attachment points on the spars. The small ones (SM) are guide loops for the sheets and control lines.


 Cut 20 lengths of Dacron line approximately 6" long for the bowline anchor loops and guide loops.


 Tie -LG- bowlines in the ends of 13 of the lengths of the line and tighten each one around the pencil. Finish the bowlines as described previously. Keep the bowlines on the pencil until you use them to prevent them from getting lost.


 Tie -SM- bowlines in the ends of 5 of the lengths of the line and tighten each one around the #4 finishing nail. Finish the bowlines as described previously. Keep the bowlines on the nail until you use them to prevent them from getting lost.

 Make a jib stay of #12 (.029" diam.) fishing leader-wire approximately 60" long with a loop at each end.


 Tie a bowline with the second to last 6" length of Dacron line through the loop in one end of the jib stay so that the loops interlock. Tighten the bowline around the wire.


 Cut a length of line approximately 8" long and tie an *extra* large bowline, roughly twice the size of a -LG- bowline, in one end. This is the anchor loop for the **JIB HOIST**.


 Take one of the -LG- bowlines off of the pencil and with the last 6" length of line tie a bowline (about the same size as a -LG- bowline) through the -LG- bowline so that the two loops interlock. This is the **JIB PIVOT LINE**.


 Mark the 3/8" carbon fiber spar stock for cutting at the correct lengths for the jib sprit and main boom. The jib sprit should be 11-1/2" long and the main boom should be 16-1/2" long. Wrap a piece of masking tape on each side of each cut mark. Take the saw and carefully cut a groove that just penetrates the tube's wall between the edges of the masking tape bands. Slowly cut only the wall of the tube closest to you using a draw stroke. Rotate the tube as you go and when you reach the end make sure that you cut through, do not snap the cut off. The object of this technique is to try to avoid making splinters that might weaken the spar's integrity. It is a good idea to seal the cut end of the spar with Ca glue even if you don't have


splinters. Use this method whenever you cut carbon fiber tube. **NOTE:** *Carbon fiber is conductive and dust or shavings that you may create while working on your swing rig should be picked up immediately with a moistened sponge or cloth.*


 Apply the paste wax liberally to a 3" long section of the jib boom starting at 1" back from the forward end of the boom. Repeat for the jib sprit. When you tie on the jib pivot line the wax will act as a release agent to prevent the Ca sealed clove hitches from bonding to the spars. The jib pivot line's clove hitches on both the jib boom and jib sprit must slide tightly but easily so that you can adjust the jib's "vang" tension. The wax also acts as a lubricant for the jib pivot line's clove hitches on both spars.


 Tie one of the jib pivot line bowlines to the jib boom toward the aft end of the waxed section. For the jib pivot line I use 6 clove hitches in a series. The first clove hitch should be tied so that the bowline knot is about 1/8" from the jib boom. Make sure that all the clove hitches in the series are tight then Ca glue them lightly to seal. Try to glue only the knots, i.e. where the lines overlap. Too much glue and the lines may not release properly, too little and the clove hitches may work free. You may find yourself doing this step over a few times, I certainly have! Once the Ca glue has completely dried, free up the jib pivot line "slide" by working the clove hitch group fore and aft along the jib boom until it moves. Push the slide forward to a point approximately 3-1/2" aft of the forward end of the jib boom. Scrape off any residue from the jib pivot slide's original location.

 Thoroughly examine the rigging drawings. Mark on the jib sprit, jib boom and main boom all the bowline locations. Then, one at a time, tie each bowline in your collection to its proper position with a series of 4 clove hitches. The first clove hitch in the series should be tied so the bowline knot is snug up against the spar. The bowline knot will act as a stop to tighten the clove hitches against. Make sure that the bowlines are in their correct locations and that they all lie in the same vertical plane, i.e. all the knots on top of the spar line up as do all the ones underneath.

 Check your mainsail for reinforcing tabs located between the broad seams of your sail along the luff. Some sails have them sewn in. If you have reinforcing tabs on your mainsail then skip the next three steps.

 Cut the Dacron reinforcement tape into 12 lengths 1/2" long each.


 Locate and mark points on the mainsail's luff halfway between each of the broad seams, the spacing should be approximately 8". Locate and mark a point along the luff halfway between the upper broad seam and the grommet in the top of the mainsail. Locate and mark two points along the luff, one 8" below the 4th broad seam from the top and one 8" lower.


 One at a time, peel the backing paper from the reinforcement tabs and place them vertically along the mainsail luff over each of the marks you've made, on both sides of the sail.


### **GENERAL ASSEMBLY INSTRUCTIONS**


Now, on to the nitty-gritty. From here the instructions are written from the deckline up. You should determine the length of mast you need to engage your mounting system and mark the mast at the deckline location.


 Mark the mast for the main fitting location at 2" above the deckline mark.


 Mark the mast for the jib strut location at 49" above the deckline mark.


 Mark the mast for the jib stay hoist location (80% of the mainsail hoist on a 50/800. For a mainsail hoist of 85" the jib stay hoist must be at or below 68" above the deck. I use 67-1/2" above the deckline mark).


 Mark the mast for the main hoist location at 85" above the deckline mark. The main hoist is measured perpendicular to the waterline from the deck up.

 Cut the mast to length 86-1/2" above the deckline mark for a 50/800 "A" rig. Use the carbon fiber tube cutting technique outlined previously.


 Slide the breakback main fitting down the mast until the top of the fitting is below the 2" mark.


 Tie a double clove hitch of Dacron line around the mast at the 2" mark and Ca glue the clove hitch to the mast. Do not glue the fitting in place, you may want to move or replace the fitting in the future. When the Ca glue is completely dry push the main fitting up snug against the clove hitch. The clove hitch acts as a retainer ring to prevent the fitting from sliding up the mast when the rig is put under tension.


 Slide the jib strut down the mast to the jib strut location mark.


 Tie the *extra* large bowline to the mast with 6 clove hitches in series at the jib hoist location mark.


 Slide the masthead crane onto the end of the mast.


 Apply the paste wax to the forward 2" of the main boom and slide it into the socket in the main fitting.


 Cut a length of Dacron line approximately 90" long for the **MAIN FRAMESTAY**. Tie one end through the hole in the masthead crane with a bowline. Tie three figure 8 knots in the main framestay line at 4", 30", and 56" away from the masthead crane for the wind indicator streamers. Thread the line through the first two adjacent holes in a bowsie. Pass the line through the last -LG- anchor bowline on the aft end of the main boom and tie the line off to the third hole in the bowsie with a bowline.


 Lay out your mainsail next to your mast. At this point you should put your mast under tension. Slowly slide the bowsie up the main framestay until the bend in the mast matches the curve of the luff of the mainsail, approximately 2".

 Cut a length of Dacron line approximately 4" long for the **FIXED MAIN HALYARD**. Tie one end to the grommet in the top of the mainsail with a bowline. Tie the other end off to the masthead crane with 4 clove hitches 1/8" aft of the joint between the crane extension and the crane's mast sleeve so that the length of the halyard positions the top of the mainsail at the main hoist location mark on the mast.


 Cut a length of Dacron line approximately 9" long for the **MAIN DOWNHAUL**. Tie one end to the grommet in the lower forward corner of the mainsail with a bowline. Pass the line through the -SM- guide bowline on the main fitting and thread the line through the first two adjacent holes of a bowsie. Pass the line through the -LG- anchor bowline closest to the mast on top of the main boom and tie the line off to the third hole in the bowsie with a bowline.


 Cut a length of Dacron line approximately 9" long for the **MAIN OUTHAUL**. Tie one end to the grommet in the lower aft corner of the mainsail with a bowline. Thread the line through the first two adjacent holes of a bowsie. Pass the line through the second to last -LG- anchor bowline on the aft end of the main boom and tie the line off to the third hole in the bowsie with a bowline.


 The mainsail is now tied to the rig by three corners. With a 2" length of Dacron line make a loop around the mast that passes through the grommet at the top of the mainsail and tie the ends off with a square knot. This loop should be fairly loose to allow the sail to slip freely around the mast. When you pull the sail away from the mast the loop should hold a 1/16" gap between the luff of the sail and the mast. Be sure to seal the square knot with Ca glue. Repeat for the grommet in the lower forward corner of the mainsail.


 Cut a length of the Kevlar (or Spectra) thread approximately 18" long to start with (you may need additional lengths if you run short as you


proceed). **NOTE:** *Use very sharp scissors to cut kevlar.* Thread the needle with the kevlar. Starting from the top of the mainsail and working to the bottom, sew one loop at a time around the mast through each of the reinforcing tabs and each of the broad seams. Tie each loop off with a square knot. Be sure to seal each square knot with Ca glue before making the next loop, taking care not to glue the knot to the mast or the sail. When you've finished all the loops go back and trim the loose ends.


 Cut a length of Dacron line approximately 10" long for the **MAIN LEECH CONTROL LINE**. Tie one end to the grommet in the lower aft corner of the mainsail with a bowline. Pass the line through the aft -SM- guide bowline on top of the main boom and thread the line through the first two adjacent holes of a bowsie. Pass the line through the -LG- anchor bowline on top of the main boom about halfway along its length and tie the line off to the third hole in the bowsie with a bowline.


 Thread the end of the jib stay without the bowline through the jib luff pocket in the jib. Pass the upper portion of the jib stay through the slot in the jib strut. You may have to open the aft end of the jib strut slot with a round needle file or small drill bit for the jib stay to pass through.


 Cut a length of Dacron line approximately 10" long for the **JIB STAY ADJUSTMENT LINE**. Tie one end to the loop in the upper portion of the jib stay wire with a bowline. Thread the line through the first two adjacent holes of a bowsie. Pass the line through the *extra* large bowline loop at the jib hoist location and tie the line off to the third hole in the bowsie with a bowline.


 Tie the bowline at the lower end of the jib stay wire to the forward end of the jib boom with 4 clove hitches. The bowline knot should be snug up against the jib boom.


 Cut a length of Dacron line approximately 27" long for the **JIB HALYARD**. Tie one end to the grommet in the top of the jib with a bowline. Pass the line through the slot in the jib strut aft of the jib stay and thread the line through the first two adjacent holes of a bowsie. Pass the line through the *extra* large bowline loop at the jib hoist location and tie the line off to the third hole in the bowsie with a bowline.


 Cut a length of Dacron line approximately 55" long for the **JIB FRAMESTAY** (sometimes referred to as a Topping Lift). Tie one end to the jib strut 5/16" from the mast with 4 clove hitches. Thread the line through the first two adjacent holes of a bowsie. Pass the line through the last -LG- anchor bowline on the aft end of the jib boom and tie the line off to the third hole in the bowsie with a bowline. Adjust the jib framestay to approximately 46" long.


 Cut a length of Dacron line approximately 4" long for the **FIXED JIB DOWNHAUL**. Tie one end to the grommet in the lower forward corner of the jib with a bowline. Tie the other end off to the jib boom with 4 clove hitches. There should be 1-1/4" between the jib boom and the foot of the jib under the grommet.

 Cut a length of Dacron line approximately 6" long for the **JIB OUTHAUL**. Tie one end to the grommet in the lower aft corner of the jib with a bowline. Thread the line through the first two adjacent holes of a bowsie. Pass the line through the second to last -LG- anchor bowline on the aft end of the jib boom and tie the line off to the third hole in the bowsie with a bowline.


 Apply the paste wax to the aft 2" of the jib sprit and slide it into the socket in the breakback elbow of the main fitting.


 Tie the lower portion of the jib pivot line to the aft part of the waxed section of the jib sprit with 6 clove hitches. There should be 1" to 1-1/4" between the jib boom and jib sprit. Make sure that all the clove hitches in the series are tight then Ca glue them lightly to seal. Try to glue only the knots, i.e. where the lines overlap. Too much glue and the lines may not release properly, too little and the clove hitches may work free. You may find yourself doing this step over a few times. Once the Ca glue has completely dried, free up the jib pivot line "*slide*" by working the clove hitch group fore and aft along the jib sprit until it moves. Push the slide forward to a point approximately 3-1/2" aft of the forward end of the jib sprit. Scrape off any residue from the jib pivot slide's original location. The jib pivot line's clove hitch slides on both the jib boom and jib sprit must slide tightly but easily so that you can adjust the jib's "vang" tension.


 Adjust the length of the jib stay until the stay tension is just taut. Adjust the jib halyard until the halyard tension is just a bit less than the stay's tension. Adjust the jib framestay length so that the jib boom is angled slightly downward, somewhere between level and parallel to the jib sprit.

 Cut a length of Dacron line approximately 16" long for the **BREAKBACK CONTROL LINE**. Tie one end off through the hole in the end of the main fitting's control arm with a bowline tight to the end of the control arm and apply Ca. Make sure that the line extending from the control arm is aimed forward. **NOTE:** *This is important to ensure that the breakback action is the same on both tacks.* Pass the breakback control line through the -SM- guide bowline below the jib sprit and thread the line through the first two adjacent holes of a bowsie. Pass the line through the first -LG- anchor bowline on the forward end of the jib sprit and tie the line off to the third hole in the bowsie with a bowline. The bowsie should be about 1/2" away from the -SM- guide bowline when the breakback control line is pulled taut. This will allow you to remove the sprit from it's socket when the control line

is loosened all the way, making the rig more convenient to travel with or store.

 Cut a length of Dacron line approximately 14" long for the **JIB SHEET**. Tie one end off to the jib boom with 4 clove hitches 10-1/2" aft of the forward end of the jib boom. Pass the jib sheet through the -SM- guide bowline on top of the jib sprit and thread it through the first two adjacent holes of a bowsie. Pass the line through the -LG- anchor bowline aft of the jib pivot line slide on top of the jib sprit and tie the line off to the third hole in the bowsie with a bowline. With the bowsie located about 1/3 the distance from the -LG- anchor bowline to the -SM- guide bowline the jib sheet length between the -SM- guide bowline on the jib sprit and the jib boom should be 3-3/8".

 Cut a length of Dacron line approximately 9" long for the **JIB LEECH CONTROL LINE**. Tie one end to the grommet in the lower aft corner of the jib with a bowline. Pass the line through the aft -SM- guide bowline on top of the jib boom and thread the line through the first two adjacent holes of a bowsie. Pass the line through the -LG- anchor bowline aft of the jib pivot line slide on top of the jib boom and tie the line off to the third hole in the bowsie with a bowline.

 Make 3 wind indicator streamers. I use light weight silver Mylar cut in 14" lengths 3/8" wide. To mount a streamer on the main framestay, place a piece of double-stick tape on the end of the streamer. Line up the inner edge of the double-stick tape with the framestay just above one of the figure 8 knots and fold the Mylar tightly over the framestay. Burnish the Mylar lightly so that the double-stick tape forms a good bond. Repeat for the other streamers. The figure 8 knots should prevent the streamers from sliding down the framestay.

Your breakback swing rig is now a complete unit. Sight down your rig from the top of the mast and make sure that the masthead crane, jib strut and main boom align. Because the swing rig is a semi-balanced rig (where the area of the jib is counterbalanced by the larger area of the mainsail) and the breakback action is set in relation to the main boom, the main sheet is all that is needed to control the rig while it is sailing. There are many ways to attach the mainsheet. The system that I've developed is quick to release and allows a lot of adjustment. To start with I modify a bowsie with a slot cut from the bowsie's edge to the third hole, making a hook out of the hole. The main sheet is threaded through the first two adjacent holes of the "*hook*" bowsie and a bowline that is just big enough to fit over the hook is tied in the end of the main sheet. To attach the main sheet to the main boom pass the end of the sheet with the bowline in it and the "*hook*" bowsie through the -LG- guide bowline on the under side of the main boom approximately 10" from the center of the mast. Then pass the main sheet through the -LG- anchor bowline on the under side of the main boom just forward of the -LG- anchor bowline that secures the main downhaul and loop the end over the

hook in the bowsie. Adjust the main sheet length by moving the "*hook*" bowsie between the two bowlines on the main boom.

### **A BIT OF BREAKBACK THEORY AND PRACTICE**

After going through all the steps in assembling your swing rig you're probably pretty anxious to get out on the water and give it a try. Before you go out and play though, I have a few more things to tell you, and you may have some customizing to do.

The main idea behind a breakback swing rig is to carry the finely tuned upwind relationship of the jib and main on all points of sail. Let us consider three boats trimmed for upwind work from a bird's eye view, one with a conventional rig, one with a swing rig without a breakback, and one with a breakback swing rig. I call the relationship between the jib's leading edge and the mast's location the rig's axis. We'll say that the leading edge of the jib on our conventionally rigged boat lines up over the centerline of the boat. In this case the rig's axis and the boat's centerline are the same, which is almost the ideal setup. Let us call the angle between the wind and the rig's axis 35 degrees. Now the boat with the swing rig without breakback action has the jib attached to an extension of the main boom forward of the mast. If the main boom is let off to leeward of the centerline five degrees for beating then the jib will end up five degrees to windward. If the rig's axis on this boat is also 35 degrees to the wind then the boat's centerline will be at 40 degrees to the wind. This boat will not be able to point with the conventionally rigged boat. On our third boat the swing rig has a hinged joint between the forward main boom extension and the mast. This allows the forward main boom extension, or jib sprit, to "*breakback*" to the centerline or even a couple degrees to leeward of centerline. In the latter case if the rig's axis is 35 degrees to the wind, then the centerline of the boat will be at 33 degree angle to the wind, more close winded than the conventionally rigged boat. A caution, although it seems that increasing the angle further might be even more advantageous, in practice, larger angles begin to retard tacking because of the larger arc the rig must breakback through to cross to the opposite tack.

The sails of a breakback swing rig are mounted in a "*frame*" system. The main frame is comprised of the mast, main boom and main framestay, which together form a relatively rigid framework that the mainsail is mounted in. The main downhaul, main outhaul, and main leech control line allow you to adjust the camber and twist of the mainsail. By adjusting the tension of the framestay you can change the bend in the mast. If the mast bend matches the curve of the mainsail luff then the sail's maximum camber should be about 40% aft of the mast. More mast bend will flatten the sail and move the maximum camber aft. Less mast bend will make the sail fuller and move the maximum camber forward. The jib frame is comprised of the jib stay, jib boom and jib framestay, forming the framework that the jib is mounted in. The jib halyard, jib outhaul and jib leech control line allow you to adjust the camber and twist of the jib. The jib framestay acts to counterbalance the jib stay tension and to adjust the jib

boom angle. The jib boom should be set so that the aft end tilts downward, encouraging it to center in lulls. The jib haylard should never be as tight as the jib stay.

If you think of the jib on a breakback swing rig as a door, then the breakback fitting is one of the hinges and the jib hoist is the other. As with a door, if the rig's "*hinges*" are not aligned, the jib won't "*breakback*" freely. In practice it is next to impossible to align the hinges because the amount of mast bend you'll use will vary with different conditions. Also, the jib stay is under a lot of tension, so small variations in the hinge pin angle have pronounced effects on breakback performance. Looking at the rig in profile, a line along the center of the pin projected upward must pass through or slightly aft of the jib hoist. If the line passes forward of the jib hoist the jib sprit will favor one side or the other, making it hard to tack in light air. It is better to have the line pass slightly aft of the jib hoist so that the jib sprit will center when the wind lets up. Don't go overboard in this direction. You want the sprit to "*tend*" to center in a lull and breakback easily when the wind picks up. Getting this balance right is one of the keys to breakback swing rig performance. After sailing a few times and setting your mainsail to a shape you like, you may find that you need to readjust the pin angle. To check the pin angle, tie a length of Dacron line approximately 70" plus, temporarily to the jib hoist. By pulling the Dacron line taut you can compare the angle it forms to that of the pin. If you want to change the pin angle loosen the breakback control line and the jib sheet. Pull the jib sprit from its socket in the main fitting and secure the jib sprit to the main boom with tape. Then pull the hinge pin out of the main fitting. Pull the jib sprit socket elbow from between the mounting tangs of the main fitting. Be sure not to lose the bearings or Teflon washers that go between the elbow and the main fitting tangs. Use a 1/8" drill bit in a hand drill to adjust one of the holes to the new angle. When you have the hole opened to where you want it, put a bead of Ca glue on the old side of the hole. When the Ca is complete dry, drill the hole again in the new location, but this time, go through the other hole as well. Check the pin alignment again. Carbon fiber cuts much more quickly than you would expect considering its hardness, so proceed slowly and carefully. Reassemble the main fitting taking care to make sure that all the parts go back together again. If your pin angle is correct, but the jib sprit still locks to one side under tension, check to see if the pin is lined up along the centerline of the mast (looking from forward aft). As I mentioned before, there is variation from mast to mast, so even though your fitting has a good "average" pin angle to start with, I encourage you to check and adjust it to your satisfaction now, before you set sail (and decide the damn thing doesn't work!).

Learning to use a swing rig effectively does not come overnight. On average, the learning curve takes about a season and a half before most people feel comfortable with one. It is characteristic of the swing rig to be fairly unforgiving. One small adjustment frequently affects several others, so it is easy to detune the rig without realizing it. It's important to focus on the swing rig's design function, to emulate a conventional boat's upwind

sail settings and to carry those settings on all points of sail. With this in mind, let me give you some guidelines for setting your breakback swing rig.

First, it is a good idea to draw a thin centerline on your boat's deck. The length of the jib sheet between the jib sprit and jib boom should be approximately 3 3/8" to start with. The length of the breakback control line between the jib sprit and the main fitting control arm should be approximately 3/4" to start with. Lay the boat on its side with the swing rig in place and trimmed for a beat. The main boom should be about 1/2" to leeward of the centerline at the main sheet guide loop location. Looking from the top of the mast down the mainsail, check the sail's shape. For light wind conditions the maximum camber of the mainsail's foot should be about 1" measured square to the main boom. Make sure the mainsail has no wrinkles along its luff. If there are, try tightening the main downhaul a bit. Wrinkles may also be caused by one or more of the kevlar mast loops being too tight. Replace any that seem to be a problem. From the stern looking forward, line up the main framestay with the mast. On a swing rig, the mainsail leech should have its maximum curve between the second and third broad seams from the top. The maximum deflection of the mainsail leech from the framestay should be approx. 4". This may seem like a bit much at first, but try it like this to start with. Now look down the mainsail from the top of the mast again and check to make sure that no part of the main leech is hooking back to windward. If it is you can adjust the main leech using the main outhaul, main leech control line or the main framestay, or a combination of these controls. Once the mainsail is set to your satisfaction, turn your attention to the jib.

The controls to shape the jib are the same as those for the mainsail. Jib luff tension is controlled by the jib halyard, camber and leech tension are controlled by the jib outhaul and jib leech control line respectively. Here I would start with about 3/4" of camber, and 2 1/2" of leech deflection in relation to the jib framestay. From the top of the mast, sight down the length of the jib luff. You want the leading edge of the jib to line up on the centerline, or slightly to leeward of it, and the jib to be in a "*conventional*" relationship with the mainsail. If the jib's leading edge is to windward of the centerline, open the breakback until the leading edge is just to leeward of the centerline by loosening the breakback control line. Notice that when you open the breakback, the jib's angle in relation to the mainsail changes too. To put the jib's angle back to where it was you have to let out the jib sheet. Let out the jib sheet and the jib's leading edge moves to windward. Thus, you can see how one small adjustment affects a lot of others. I encourage you to experiment with all the controls until you have a good working understanding of them. Mastering their relationships and being able to consistently set the jib in "*space*" is a rewarding feeling, but when you are out on the water everything changes.

A good way to start working with your new swing rig is to organize practice sessions with two or three sailors whose skill and boat speed are comparable to yours. Experiment with different settings until you think you

have your boat going pretty well against your competition. Try to analyze how each change you made affected the boat's performance, and do your best to remember what you did. Then have one of your friends change all your settings while you look away. Start from the beginning and retune your swing rig so that your boat is going pretty well again. Then have another of your friends change all your settings, etc., etc. Once you've gone through this drill enough, you should have a pretty good idea of how to use the swing rig's controls and an eye for judging when your rig is set correctly. Above all be patient. It will all come together with time.

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