Constructing Rudders from scratch.

Scratchbuilding of rudders is not restricted to those who build complete models from scratch. It is quite common to hear modellers who build kits refer to the rudder provided in their kit as "unsuitable" and scratchbuild a replacement.

The rudder types we will be reading about in this article are the types that are used in most powered scale models. We will not cover rudders for fast electric or gas boats, nor for sailing ship models. Nor can this article claim to describe every method of making rudders.

For model construction purposes, rudders can be divided into two types. The first type is one which can be inserted into the hull from below. This includes a simple cantilevered rudder, which is supported and located only by the tube in the hull above the rudder, and one which has a removable skeg supporting the bottom of the rudder. This type normally has a rudder post which is fixed into the rudder, so we'll call them "integral post rudders".

The second type of rudder has a tube in the hull, but also has a non-removable skeg extending out from the keel, or another hull feature, which prevent the complete rudder from being inserted from below the hull. We'll call these "removable post rudders".

These two types may also have two more variations. They may be unbalanced, where the rudder blade is all positioned aft of the rudder post, or semi-balanced, where part of the rudder surface is forward of the rudder post.

Rudders with integral posts.

Rudder construction can be grouped into three general styles: single plate, sandwich, and moulded.

Single plate Rudders.

Possibly the simplest rudder construction is shown in Figure A. It is a piece of wood glued to a length of brass rod, both being 1/8". It is not the strongest, but it is simple. To get the strongest bond between the rod and the wood, the rod extends over the full depth of the rudder blade.

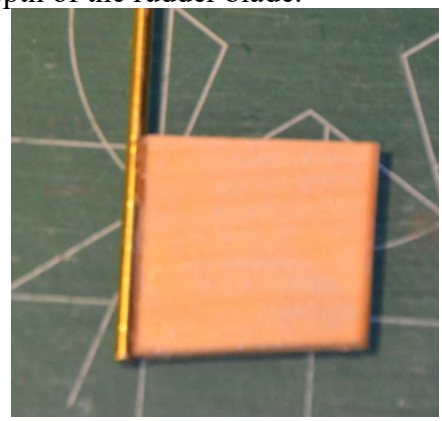


Figure A. Simple rudder.

There are 4 operations required to make it:

i) cut 1/8" brass rod to length
ii) cut 1/8" basswood to size
iii) glue the pieces together. Lay the two pieces on a sheet of polyethylene (such as a Ziploc-style bag), a piece of Saran wrap, or piece of waxed paper.
iv)epoxy the wood to waterproof it.

This style of rudder could be further strengthened by wrapping a layer of fibreglass cloth around it.

Almost as simple is the style that Phil prefers. The brass rod is slit with a slitting saw on a milling machine. The rod does not need to be the full depth of the blade. He cuts a rudder blade from copper or brass sheet and soft solders the blade in place on the shaft. See Figure B.

With this style there are also 5 operations required to make it:

i) cut the brass rod to length
ii) cut the metal sheet to size
iii) cut the slot in the rod
iv) solder the parts together.
v) remove any flux remaining from the soldering.

Don has used a similar technique but he uses a Dremel tool to cut the slot. He marks the centre of the shaft and first cuts a shallow groove, before finally cutting right through.

If you have neither milling machine nor Dremel tool, but have a drill press, it is theoretically possible to use a hacksaw to cut the slot in the brass rod. Phil suggests a saw guide could be made by taking two pieces of mild steel, say ¼" x ½", clamping them together in a vice and drilling a hole slightly smaller than the diameter of the rudder post at the joint of the two pieces. Then make a sandwich of the steel pieces and the post in the vice. That should create a 'guide slot' between the steel pieces that would hold the hack saw blade straight. It would probably take a drill press to get the hole right.

A similar method is to make the same guide by inserting a piece of 1/32" thick mild steel between the two thicker pieces, and drilling a hole the same size as the rudder post, centred in the thin sheet. Remove the 1/32" sheet and insert the rudder post to create the guide.

Figure B. Phil's rudder mounted on his NS *Savannah*

The advantage of this style over the first one is that this is stronger. This style is best suited to semi-balanced rudders, so that solder can be applied all around the rudder post.

A similar method of construction is described on the website: www.building-model-boats.com. This describes a rudder made from 0.015" thick brass sheet, having a rudder post made from 1/16" diameter brass rod. Construction of this style comprises 6 steps.

i) cut the rudder blade to size
ii) use a needle file to file a tapered groove/slot, for the rudder post, at an angle in the top edge of the brass rudder blade.
iii) solder the blade and rod together.
iv) remove any flux remaining from the soldering
v) file down the side of the rod to improve its appearance
vi) bend the rod to align it with the blade.

Figure C. The rod set in the groove in the blade ready for soldering.

This style of construction is very good for small models where it is not practical to slot the end of the brass rod.

Sandwich-construction rudders.

Soldered construction for unbalanced, cantilever rudders requires a slightly different method. This involves soldering a thin metal sheet end-on to a thicker brass rod. The method used by Garth for his new *Jim Wilder* tug involved 6 steps.

Figure D. Garth's laminated rudder.

i) cut out a blade from a thin sheet of brass or copper. One edge has to be straight to mate with the rod.
ii) solder the blade to a piece of brass rod.
iii) remove any flux remaining from the soldering
iv) cut out two thin pieces of wood the same size and shape as the brass
v) glue the pieces of wood, one each side of the brass.
vi) coat the wood with epoxy to protect it.

You could substitute styrene for wood, in which case you can emit the epoxy coating.

Another variation was used by Steve M. on his Clyde Puffer. He used a very similar method to Garth's. Steve filed a flat on one side of the rod, and this was mated to the rudder blade, and provided a better surface for the blade to grip. Instead of wood, Steve added autobody putty to thicken the rudder and shaped it to the profile required.

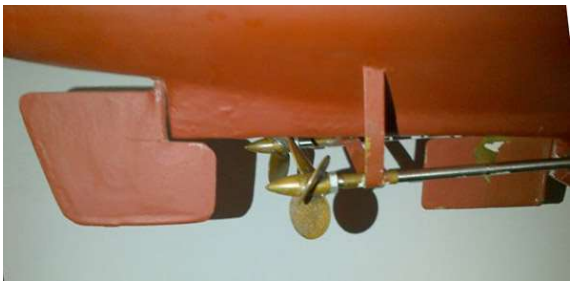


Figure H. Rudders on Steve's *Seydlitz*.

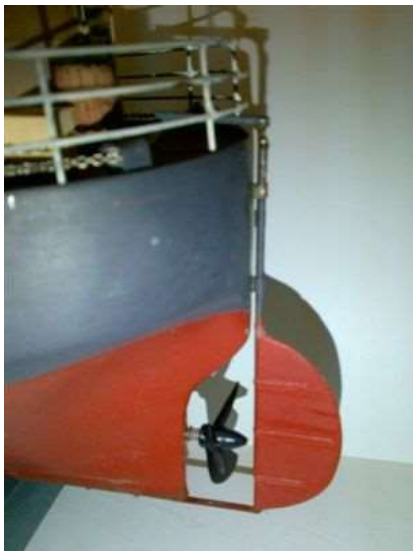


Figure E The completed rudder on Steve's Clyde Puffer.

With Garth's and Steve's methods of construction, it is necessary to support the blade so it aligns with the centre of the rod while being soldered. Cardboard, wood or metal can be used as supports. Tape the parts down onto a flat surface to prevent movement. Take care to prevent localized overheating of the rudder blade, which could cause distortion of it.

Steve's *Seydlitz* is unusual in having 2 rudders arranged in line, as shown in Figure H. On the after one, which is semi-balanced, the rudder blade was notched to provide more surface for the post to bind to. The *Seydlitz* weighs 60-

odd pounds, so he was worried about the strain on the solder joint if he didn't make it as secure as possible. The forward rudder is unbalanced and made the same way as the one for the Clyde Puffer.

With sandwich construction it is not necessary for the metal part of the blade to be the full size of the rudder. A small "paddle" can be soldered to the rudder post. One layer of material of the size of the rudder blade is then glued to the "paddle". The middle layer is of the same size as the outer layers but with a cutout to fit around the paddle. It is also the same thickness as the paddle. A third full-size layer is then glued on top.

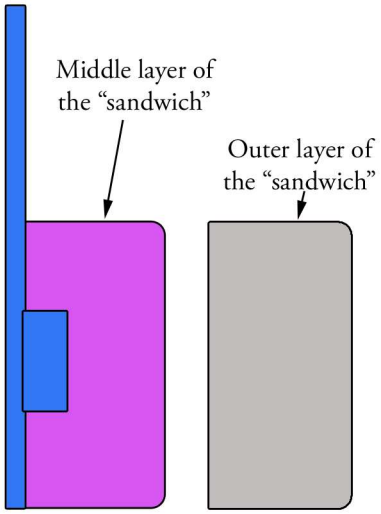


Figure F. Rudder construction using a small soldered "paddle"

In the preceding descriptions, brass rod has been used for the rudder post because it is stronger than the same diameter of brass tube. For one method of construction, brass tube is the easiest choice. Flatten the end of a piece of tube over a length of ½" (or more) and glue that into a sandwich of wood or styrene. See Figure G. The flattened tube is weaker than the original round tube, and the weakest part of all is where the tube transitions to the flattened length at the top edge of the rudder. This weakness can be eliminated by notching the outer layers and inserting the round tube further down into the rudder, and glueing securely. Any gaps can be filled with autobody putty and sanded smooth.

Brass rod can also be used with this method by filing flat surfaces on both sides.

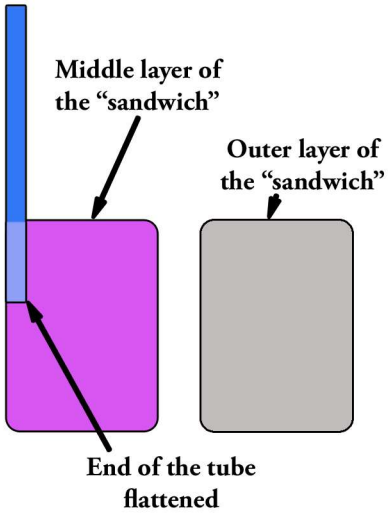


Figure G. A rudder using brass tube as a rudder post.

Cast rudders.

A completely different method of construction is preferred by Bill and Doug, in which they cast their rudders from epoxy using a wooden mould.

There are 7 steps in using this method.

i) The first step is to cut out a hole a little larger than the size of the rudder, in a piece of wood of the approximate thickness of the finished rudder.

ii) A groove is filed in the location where the rudder post is to be fitted. See Figure J.

iii) The wooden mould is then laid on a flat surface and a piece of Saran

wrap is pushed into the recess. See Figure K.

Figure J. A mould prepared from a piece of wood.

v) A piece of brass rod for the rudder post is laid across the groove and into the recess, supported so that it is parallel to the wooden mould.

vi) Epoxy is mixed and poured into the recess.

vii) After the epoxy has set, it can be taken out of the mould, the Saran wrap removed, and the rudder filed to shape.

Other refinements can be made to this design, as shown in the photos, to add strength. A brass paddle can be soldered to the rudder post, or a piece of fiberglass cloth inserted.

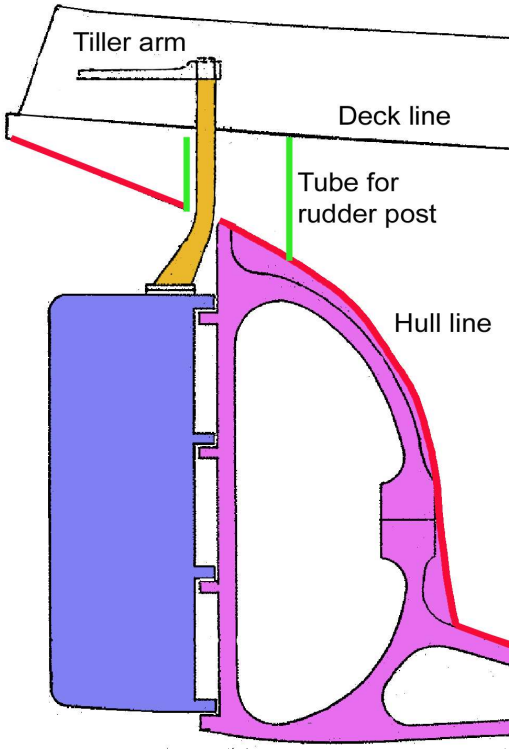
Figure K. The mould ready for the epoxy. In this photo a second piece of wood is used for the base of the mould and the two clamped together.

Not all rudders with fixed bottom skegs require a removable post, which is described later.

Figure L shows a cross-section through the stern area of a tugboat. The rudder is mounted on 4 pintles on the stern frame (shown in purple). If a tube in the hull is used which is a close fit around the rudder post, it would not be possible to fit the rudder into the hull unless a part of the stern frame was made removable. A simpler alternative is to fit a larger diameter rudder tube, shown in green. The rudder post can be inserted from below, angled forwards and up into the hull. When the rudder gudgeons are above the pintles, the rudder can be dropped into place and the tiller arm fitted. (The ‘pintles’ are the pins mounted on the stern frame, and the ‘gudgeons’ are the mating parts on the rudder.)

As with any rudder tube, it needs to extend above the waterline to prevent water getting into the hull. For those modellers who prefer to seal off the rudder post, a removable cap can be

added to the tube, with a suitable hole for rudder post.

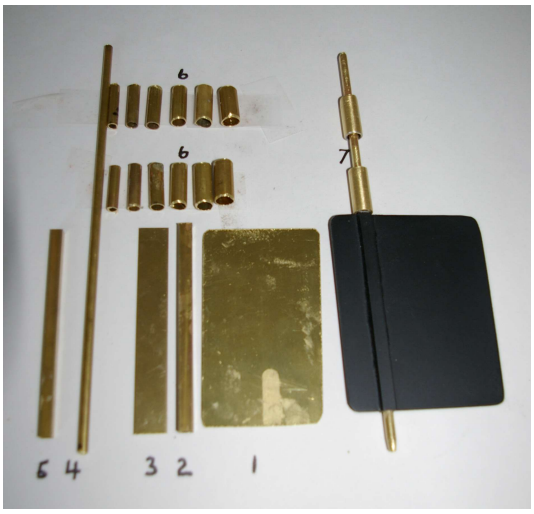


Rudders with removable posts.

With an open rudder, the rudder post can be an integral part of the rudder, as we have seen above. The rudder arm can be attached to the rudder post both to hold the rudder in position, and provide a means of turning it.

With an enclosed rudder, for example one in a fixed Kort nozzle, the rudder post cannot be part of the rudder, and has to be inserted into the rudder from inside the hull. When inserted into the rudder the post has to be able to lock into it, so that turning the post turns the rudder. Fortunately, K&S make some square section tube which makes that easy to do.

Figure L shows the construction method that Don used for his rudder on his “Maid of the Mist”.



The rudder blade is made up from items 1, 2 and 3 shown. Items 1 and 3 are brass sheet, and item 2 is square section tube. They are soldered together in the same way that Garth and Steve made their open rudders.

The rudder post is made up into one piece by assembling items 4, 5 and 6. Item 5 is square section tube one size smaller than item 2, so that it will fit snugly into item 2. Item 4 is round brass bar that fits snugly into item 5. Items 6 are successively larger diameters of brass tube fitted around item 4 to make two collars. The space between the collars forms a grease pocket inside the tube in the hull.

Item 7 shows the completely assembled rudder and rudder post. Item 4 extends through the rudder blade, and fits into the hole in the skeg which extends from the keel. A rudder arm is attached to the top of item 4 in the same manner as for an open rudder.

Rudder extensions.

Some models, scale sailboats in particular, need a larger rudder than one of true scale size. To cope with this many modellers make an extension to be fitted to the rudder when sailing. Fred has devised a simple way to do this.

The scale rudder is constructed using the sandwich method described above, but leaving a cutout in the bottom edge of the middle layer. The extension is built up the same way, but with a metal tongue glued into a slot in the middle layer. The extension slots into the scale rudder and is held by a bolt which goes through holes in the scale rudder and the extension tongue.

When the model is on static display the only non-scale feature to be seen is the small hole for the bolt.

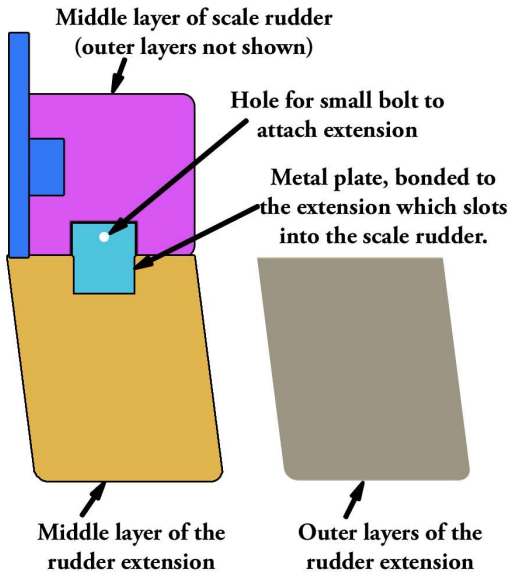


Figure A Constructing a rudder extension.

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Here are some more tips on the construction of the simple cantilevered rudder from Don. Drill a hole through the top end of the rudder post, and insert a cotter pin or small length of wire. If the rudder arm comes loose this will prevent the rudder from dropping out.

Degreasing fluid is good for removing surplus flux after soldering.

Thanks to Fred, Doug, Steve, Garth, Phil, Don and Peter for their contributions to this article.