

## Introduction

Do you think you can build a boat? We know you can.

Building a boat is challenging, but it is just like building anything else. You start at the beginning, follow one step to the next and end up with the finished product.

This is a scale model of Bevin's Skiff, a twelve foot rowboat.

The  $\frac{3}{4}'' = 1'$  scale means that every  $\frac{1}{16}''$  on the model is equal to 1" on the real boat. (There are  $12 \times \frac{1}{16}''$  in  $\frac{3}{4}''$  and  $12 \times 1''$  in 1', so  $\frac{1}{16}'' = 1''$ ) In this guide, we will give you the knowledge to make a model boat of a simple yet practical design. But be careful, along the way you may just learn a little math as well!

## Materials & Tools

You don't need a lot of materials or tools to build these model boats. All you need is:

- A plain letter sized manila folder or a sheet of card stock or other thick flexible paper
- A roll of half inch scotch or masking tape
- A pencil with an eraser
- A pair of scissors and
- A ruler.

You also need the pattern page- which is at the end of these instructions.

Use the ruler to make sure you get your measurements correct. But don't worry, even if you make a mistake you can just erase the line and measure it again. Remember the old carpenter's saying, "measure twice and cut once."

**Step 1) Getting the Pattern of the Boat onto Cardstock**

You need to make the model out of cardstock or manila file folders, so you will need to:

- Print the PDF pattern page on paper and later cut the patterns out and trace them your manila folder stock or other hard paper or,
- Photocopy the pattern page onto card stock or,
- Print the PDF pattern page directly onto cardstock. (If you're accessing these materials through a computer.)

Use the 4" check line on the PDF pattern page printout to make sure that the model has copied at the correct size. (Sometimes computers and copy machines distort images.)



**Step 1) Getting the Pattern of the Boat onto Cardstock**

**Math Skills**

- 4.1 Read a ruler to a usable tolerance: 1/16", 1/10", 1mm
- 7.5 Demonstrate ability to use a picture or model to help solve a problem

**Instructor Tips**

Checking the length of the 4" line is a good opportunity to introduce reading a ruler.

Many times we use building this model as an instructional tools when building the more sophisticated sailing model, or the full sized boats. It makes a great "hands on" set of instructions.

**Step 2) Label the Parts**

Label your sides, transom and center frame pieces.

Sides get labeled "bow" (the big end), "stern" (the small end), and "bottom" (the shorter edge) The bow end of the side panels is also next to the pointy end of the bottom. The bottom edge of the side panels is also next to the bottom panel.

The transom gets labeled bottom (the shorter, straight edge)

The center frame also gets labeled bottom (the center dotted line)



**Step 2) Label the Parts**

**Instructor Tips**

Boats, like almost any specialty, have a vocabulary of their own. This is a good opportunity to start exposing the students to the terms they will be using when they build, and use, a boat.

**Step 3) Cutting Out the Parts**

Cut out all the pieces on the pattern page. Make sure you don't cut the dotted center line of the center frame.



**Step 3) Cutting Out the Parts**

**Instructor Tips**

We tell our students to cut parts out and “leave the line.” This means that we want to see the line, but we don't want the cut to be more than one sixteenth of an inch outside of the line.

It's a good example of working to a “tolerance.”

## Putting it all Together

Once you have all the pieces, you can begin the really fun part -- putting your boat together. This is where we need our pencil, a ruler and the scotch tape.

### Step 4) Mark Center Frame

Mark the center frame line  $75/16$ " (or  $4-11/16$ "") away from the bottom of stem (along the bottom and transom) on the inside face of one of the sides. (The inside face has the drawings of the frames and seat riser.)



If you were building the full size boat, you'd be measuring back 75".

### Step 4) Mark Center Frame

#### Math Skills

- 4.1 Read a ruler to a usable tolerance:  $1/16$ ",  $1/10$ ", 1mm
- 5.1 Define and demonstrate the use and calculation of ratios and proportions
- 7.5 Demonstrate ability to use a picture or model to help solve a problem
- 8.1 Identify and draw basic shapes used in building process. Right angles, squares, rectangles, isosceles triangles, equilateral triangles, specific angles
- 8.12 Demonstrate and use congruency

#### Instructor Tips

The centerframe of the full sized boat is set back 75" from the bow, along the bottom edge of the side panel. This model is a  $3/4$ " scale model. Since there are 12" in a foot and 12 sixteenths of an inch in  $3/4$ ", one sixteenth on the model equals one inch on the full sized boat. This is a good demonstration of "scale"- which is just a ratio.

You also get to reinforce the idea that you are building the model using the same process and parts you would use to build the real boat. You students will see it's easier to solve problems and learn with paper than it is with wood...

Once the  $4-11/16$  marks are made on the side panels, lines need to be drawn at these points from the bottom to the top (sheer) on the inside faces of the side panels.

Draw a line straight across the side (from the bottom to the top) from this point

Put the two sides on top of one another and transfer the center frame line to the un-marked side. (Make sure you mark the inside.)

Draw a line straight across that side panel, as well.



Since the sides can be placed exactly on top of one another they are congruent.

**Step 6) Folding the Center Frame**

The center frame needs to be strong. That's why it's made of two layers of paper.  
Fold the center frame along its centerline.  
Tape the top of the frame together.

**Step 6) Folding the Center Frame**

**Math Skills**

- 8.11 Demonstrate and use symmetry
- 8.12 Demonstrate and use congruency

**Instructor Tips**

When it is cut out, the center frame's two halves are the same- just mirrored on either side of its centerline. This is a definition of "symmetrical." When the frame is folded the sides are shown to be congruent.

### Assembling the Boat Parts

Now we are ready to connect the sides to the bottom and the transom. This part is a little tricky, but just remember to make sure that you have the sides pointing the right way and you will do just fine.

#### Step 7) Attaching the Sides at the Bow

Put the side pieces directly on top of one another. Make sure the insides are "in" and the outsides are "out." You shouldn't see any of the printing.

Take a piece of tape and tape the sides together at the bow. It should make a hinge. Remember that the bow is the taller end of the side panel.



#### Step 7) Attaching the Sides at the Bow

##### Math Skills

8.12 Demonstrate and use congruency

##### Instructor Tips

When the sides are on top of one another and align exactly, they are congruent.



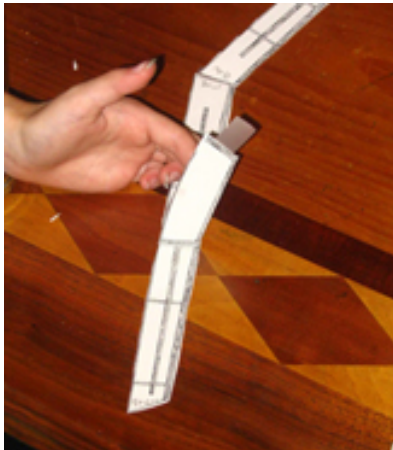
**Step 8) Attaching the Center Frame to the Sides**

Put a tab of tape on each end of the center frame



Tape the center frame to one side along the center frame line drawn in Step 4.

Remember, the narrow side is at the bottom; the wider side with the rounded edge is at the top.



**Step 8) Attaching the Center Frame to the Sides**

**Math Skills**

- 8.11 Demonstrate and use symmetry
- 8.12 Demonstrate and use congruency
- 8.8 Identify and use isosceles triangles to create symmetrical shapes and perpendicular lines

**Instructor Tips**

Now, you're going to be turning congruency into symmetry. It's very important that boats be symmetrical along their center line. If one side of the boat is bigger than the other, it will take longer for the water to pass along the larger side and the boat will turn.

Once you have fastened the center frame to the sides, you have created your first Isosceles triangle. Isosceles triangles are incredibly important to boat building because their base lines are perpendicular to their centerlines. The two right angles created by their centerline are also symmetrical.

You can have the students identify the properties of Isosceles triangles. The most commonly known property is that the lengths of the sides are the same. The students know that the sides are the same length because they measured them.

**Step 8) Attaching the Center Frame to the Sides (cont.)**

Tape the center frame to the other side along the center frame line.



**Step 8) Attaching the Transom to the Sides**

Take the transom, and put a tab of tape on both of its sides.



Tape the transom to the back of the boat. Again, remember, the narrow side is at the bottom; the wider side with the rounded edge is at the top.



**Step 8) Attaching the Transom to the Sides**

**Math Skills**

- 8.11 Demonstrate and use symmetry
- 8.12 Demonstrate and use congruency
- 8.8 Identify and use isosceles triangles to create symmetrical shapes and perpendicular lines
- 8.2 Describe and define straight, parallel perpendicular and transversal lines

**Instructor Tips**

This step is very similar to attaching the center frame. You will be creating your second Isosceles triangle. You will also be creating parallel lines- the center frame and the transom. They are parallel because they are both perpendicular to a common line- the centerline of the boat.

### Step 9) Attaching The Bottom

Now we will connect the sides of the boat to the bottom. Put tabs of tape on each side of the bottom- about 5 a side.



Start taping from the front, tape both sides as you work your



way to the transom.

### Step 9) Attaching The Bottom

#### Math Skills

8.11 Demonstrate and use symmetry

#### Instructor Tips

You must work symmetrically down both sides, otherwise you can build a twist into the boat.

Once you have the bottom on, most of the math is done

**Step 10) Attaching The Seats**

Take the seats and fold up the ends along the dotted lines.



The seats sit on top of the seat riser. (The piece that runs front to back on the inside of the boat about 3/8" from the top edge.)

The back edge of the front seat goes against the first frame.

The center seat's back edge goes against the center frame.

The rear seat goes in front of the last frame



**Step 10) Attaching The Seats and Beyond**

**Instructor Tips**

Once you have the bottom on, most of the math is done. That said, finishing the boat is fun.

Once the boat is complete, you can have the students design and test potential paint schemes. This can be a great teaching opportunity, especially if you'll be building the full size boat.

Once a design is selected, it will have to be scaled up to the full size boat. There's a whole lot of math involved in that process...

**Step 11) Attaching The Foredeck**

Put two tabs of tape of the foredeck and install it at the bow of the boat



**Step 12) Attaching the Quarterknees**

Put a tab of tape diagonally across a quarter knee.



Make a cut in the tape to the outside corner of the quarter knee.

Install the quarter knees in the rear corners of the boat.



Congratulations, you've just built a boat!

If you want to float your boat you can. Tape all the seams so water can't get in. Then, splash it! It won't last long before falling apart- so enjoy. If you want it to last longer, paint the boat with a waterproof finish (oil paint or varnish).