Wyvern

Skill Level 4

Parts List:

PNC-20N (2.7” long, Ogive) Nose cone
2 x BT-80 body tubes, 14.25” long
1 x BT-20 body tube, 18” long
12” parachute
EB-20 engine block
36” elastic shock chord
Paper shock chord mount
.6 oz clay nose weight
1/8” launch lug, 1.5” long
Engine hook for standard 18mm engines
Fin Shape Template
Fin Marking Template

Instructions:

These instructions attempt to be clear about all novel assembly steps. However, it is assumed that the builder has assembled some rockets before, and is familiar with some basic steps like marking body tubes, attaching shock chords, assembling parachutes, etc.

Step 1) Mark the fin tubes

The rocket uses tube fins constructed from BT-80 tubes. Because of the shape of the finished fins, two fins can be cut from a single standard Estes 14.25" BT-80 tube. In order to accomplish this, the *Fin Shape Template* needs to be laid onto the tubes carefully.

The first step uses the *Fin Marking Template* to help with the placement of the *Fin Shape Template*.

1a) Wrap the *Fin Marking Template* around a BT-80 tube and tape it so that it fits tightly. The template ought to cover the overlap tab completely when it is wrapped correctly.

PICTURE: Fin Marking Template wrapped around the BT-80 tube.

1b) Slide the *Fin Marking Template* to one end of the tube, leaving enough exposed to mark the tube at both ends of the *Fin Marking Template*. Mark the tube at both ends of the template, for each marking line.

PICTURE: Making the marks – label the ends of the tube A and B.

1c) Slide the *Fin Marking Template* to the other end of the tube, and rotate it 180 degrees (half a turn). Mark the tube again at both ends of the template, for each marking line.

PICTURE: Making the other marks…make sure the labels indicate the tube reversed.

1d) Using a door jamb (see standard Estes instructions) draw lines along the

tube connecting each pair of marks.

1e) Repeat 1a through 1d for the other BT-80 tube.

Step 2) Create the *Fin Shape Template*.

2a) Carefully cut the *Fin Shape Template* out from the pattern sheet.

2b) Wrap the *Fin Shape Template* around one of the BT-80 tubes and tape it so that it fits tightly. The template ought to cover the overlap tab completely when it is wrapped correctly.

PICTURE: Fin Shape Template wrapped around the BT-80.

Step 3) Mark the tube for cutting.

3a) Slide the template to one end of the tube, and rotate it until the center line on the *Fin Shape Template* lines up with the pencil line on the tube (marked in step 1b) that corresponds to the center line of the *Fin Marking Template*. Make sure the bottom of the template is exactly at the end of the tube.

PICTURE: Template aligned at bottom, lined up with center line.

3b) Carefully trace the outline of the *Fin Shape Template* onto the tube.

PICTURE: Tracing the template.

3c) Using a pin or other sharp-pointed tool, punch through the template and tube at each of the six lettered points on the *Fin Shape Template* (points A-F).

PICTURE: Punching the holes.

3d) Slide the template off the tube. Turn the template upside down (end over end) and slide it back onto the tube.

3e) Slide the template to the other end of the tube, and rotate it so that the center line on the *Fin Shape Template* matches the center line marked on the other end of the tube (in step 1c).

PICTURE: Template on other end of the tube.

3f) Carefully trace the outline of the *Fin Shape Template* onto the tube at this end.

3g) Punch through the six lettered points on the template again, into the tube.

3h) Repeat 3a through 3g for the other BT-80 tube.

Step 4) Cut out the tube fins.

4a) Using a very sharp hobby knife, carefully cut out each of the four tube fins along their outlines. Please be very careful, and use multiple shallow cuts instead of trying to cut through the tube in one pass.

PICTURE: Carefully cutting the tube.

4b) Cutting these tubes is likely to leave a "burr" of tube material on the inside of each cut. Use sand paper to dress the cut edges. Be careful not to rub the pencil lines off of the fins when doing this sanding. You'll need those lines later.

PICTURE: Sanding the tubes.

Step 5) Mark the BT-20 body tube.

5a) Using an Estes Tube Marking Guide (or some other means), mark the BT-20 body tube as if you were mounting four fins around it.

PICTURE: Marking the tube using the TMG.

5b) Draw a line along the body tube through each of the four marks, extending the lines at least 12" forward on the tube. These are the lines you will use to align the tube fins.

PICTURE: Extending the lines forward.

5c) Make another mark half way between two of the long lines. Extend this line forward 5". This is the line you will use to align the engine hook.

PICTURE: Marking the engine hook line.

Step 6) Cut the tube fins.

The four tube fins interlock to form the finished fin set. To interlock the tubes, each tube will intersect with another tube at six points. At each intersection, a slot will be cut in one tube from the top, and in the other tube from the bottom.

6a) Select one of the four fin tubes. Mark this one "Tube 1." Cut six slots into the tube. For this tube (ONLY), each slot should start at the TOP edge of the tube and end at one of the six pin holes you put into the tube in step 3c or 3g. The slots should follow the straight lines you marked onto the tube in step 1d. Each slot should be as narrow as the thickness of your body tubes. As a rule of thumb, start by cutting just to one side of the pencil line, then go back and cut again just to the other side of the pencil line. Both cuts end at the pin hole, resulting in a very narrow slot that extends half way down the body tube (i.e. at the pin hole). A pair of sharp scissors works well for this step, cutting quickly and accurately without leaving the burr that a hobby knife tends to leave. When cutting each slot, be sure to leave a thin piece of tubing to the "outside" of each slot. These are important when trying to make the fin unit look like a single piece at finishing time.

PICTURE: Tube 1 after the cuts.

6b) Select another of the four fin tubes. Mark this one "Tube 2." You'll need to cut six slots into this tube as well, but to make the tube all intersect correctly, you'll need to start the cuts at the top or the bottom of the tube according to the following chart:

Lettered Point	Start Slot at
A	BOTTOM
B	TOP
C	TOP
D	BOTTOM
E	TOP
F	TOP

PICTURE: Tube 2 after the cuts.

6c) Select another of the four fin tubes. Mark this one "Tube 3." Cut six slots again, starting the cuts at the top or the bottom of the tube according to the following chart:

Lettered Point	Start Slot at

A	BOTTOM
B	BOTTOM
C	TOP
D	BOTTOM
E	BOTTOM
F	TOP

PICTURE: Tube 3 after the cuts.

6d) Select another of the four fin tubes. Mark this one "Tube 4." Cut six slots again, starting all of the cuts this time from the BOTTOM of the tube.

PICTURE: Tube 4 after the cuts.

Step 7) Dry fit the tube fins.

The tube fins are assembled dry (i.e. without glue). The dry fin unit is then glued to the BT-20 body tube. Finally all of the intersections in the fin unit are glued. This step covers the dry assembly of the fin unit.

7a) Interlock tubes 1 and 2.

Find Tubes 1 and 2. Slide Tube 2 down onto Tube 1 so that the slots at the following points match up:

Tube 1, slot F interlocks with Tube 2, slot A.
Tube 1, slot C interlocks with Tube 2, slot D.

PICTURE: Tubes 1 and 2 interlocked.

Please do be careful to avoid bending the thin bits of body tube remaining after the slots were cut.

7b) Interlock tube 3.

Slide Tube 3 down onto the Tube 1-2 assembly, so that the slots at the following points match up:

Tube 3, slot A interlocks with Tube 2, slot F.
Tube 3, slot B interlocks with Tube 1, slot E.
Tube 3, slot D interlocks with Tube 2, slot C.
Tube 3, slot E interlocks with Tube 1, slot B.

PICTURE: Tubes 1-2 and 3 interlocked.

7c) Interlock tube 4.

Slide Tube 4 down onto the Tube 1-2-3 assembly, so that the slots at the following points match up:

Tube 4, slot A interlocks with Tube 3, slot F.
Tube 4, slot B interlocks with Tube 2, slot E.
Tube 4, slot C interlocks with Tube 1, slot D.
Tube 4, slot D interlocks with Tube 3, slot C.
Tube 4, slot E interlocks with Tube 2, slot B.
Tube 4, slot F interlocks with Tube 1, slot A.

PICTURE: Tubes 1-2-3 and 4 interlocked.

Again, this is easier that the table might imply. Just be sure that this fourth fin completes the full fin unit as seen in the pictures of the rocket. If you've made all of your slot cuts from the right ends of the tubes, everything will work fine.

Step 8) Install the engine hook

8a) Measure along the engine hook alignment line (from step 5c), and make a mark X inches from the bottom of the BT-20 tube.

PICTURE: Marking the tube for the hook slot.

8b) Cut a 1/8" slot into the tube at this mark, across the hook alignment line.

PICTURE: Hook slot.

8c) Apply glue along the hook alignment line, starting at the slot and going down the tube 1".

PICTURE: Glue

8d) Push the top end of the engine hook into the slot, laying the engine hook into the glue. Keep pressure on it until the glue sets up enough to hold the engine hook in position.

PICTURE: Installed engine hook.

Step 9) Attach fin unit to the BT-20 body tube.

9a) Dry fit the assembled fin unit onto the BT-20 body tube. It should be possible to line up the center lines on each fin tube with one of the four lines marked on the BT-20 tube. The engine hook will fit into one of the channels formed by the innermost interlock points in the fin unit. Align the fin unit so that the bottom of the fin unit is flush with the bottom of the BT-20 body tube. Mark the BT-20 tube to show where the top of the fin unit will be.

PICTURE: Dry fit of fin unit.

9b) Remove the fin unit from the body tube. Run a bead of glue along each of the four lines on the BT-20, stopping at the mark made in the last step.

PICTURE: Glue beads.

9c) Rotate the BT-20 tube so that the beads of glue line up with the innermost interlock points in the fin unit. The engine hook will be lined up with the center line on one of the fun tubes. Slide the BT-20 tube into the fin unit, then rotate the body tube 1/8 of a turn, bringing the glue beads into contact with the fin unit. Make sure the center lines on each fin line up with one of the four lines marked on the BT-20. Press the fin unit to the body tube all the way around then set aside to dry.

PICTURE: Lining up the fin unit before sliding it on.

PICTURE: Fin unit in place.

Step 10) Fillets

Now that the fin unit is assembled, you'll need to make each interlocking joint stronger. This is done in three steps.

10a) Using thin CA glue (e.g. Super Glue, etc.), tack the ends of each interlocking joint together. I found it easiest to hold the joint in position, then apply the glue. Capillary action will draw the glue into the joint. I glued the large part of each joint first (i.e. where the parts of both tubes inside the slot cut meet), then did the thin sliver of body tube on the outside of each joint. CA glue allows you to work quickly on this

step. Please be careful not to glue your fingers to the rocket, however. A thin rod can be useful when holding the small slivers in position for gluing.

PICTURE: Joining a joint.

PICTURE: Tacking down a point.

10b) Once all the ends of the joints are in position, use thin CA glue to glue the rest of each joint. Again, capillary action will draw the glue into the joint. I found that it was only necessary to apply the glue to outside of each joint, rather than trying to reach inside the deeper parts of the fin unit to apply glue to all sides of a joint.

10c) When the CA is dry, use white glue or carpenter's glue (i.e. yellow glue) to fillet all side of each joint. There are twelve joints, with four sides each, if you keep in mind the way you'll lay the model down to dry, you can put glue on many joints at once with no danger of runs.

PICTURE: Fillets in progress.

Step 11) Install shock chord.

Use a standard Estes "folded paper" shock chord mount to glue one end of a 36" shock chord into the nose of the BT-20 body tube. Tie the other end of the shock chord to the PNC-20 nose cone.

PICTURE: Shock chord attached to BT and nose cone.

Step 13) Install parachute.

Assemble a 12" parachute and tie it to the PNC-20 nose cone.

PICTURE: Parachute installed.

Step 14) Add nose weight to nose cone

Using modeling clay, pack .6 ounces of nose weight into the PNC-20 nose cone. The Center of Gravity with a C6-5 engine installed should be no further aft than 1" behind the top of the fin unit.

PICTURE: Balancing the rocket to determine the CG.

Step 15) Spin Test

Fully assemble the model, including the parachute and a C6-5 engine. Find the Center of Gravity by balancing the rocket sideways on your finger. Tie a 10' stout string around the rocket at this point, securing the string with tape. Spin the rocket around in a circle fairly fast. If the rocket stays nose-forward, the rocket will be stable under power. If the rocket does not stay nose-forward, add more nose weight, find the CG again, tie the string around the new CG, and repeat the spin test. Repeat until it will fly nose-forward during the spin test.

PICTURE: Attaching the lanyard.

Step 16) Install launch lug.

Glue a 1.5" long launch lug to the rocket, centered on the Center of Gravity. I cut the ends of mine at an angle to more closely match the styling of the fin unit. Fillet the launch lug joint with white glue or carpenter's glue.

PICTURE: Installed launch lug.

Step 17) Paint

Paint the rocket as you like. I used metallic green in keeping with the rocket's name, then added gold highlights using a "paint pen" found at a local art supply store.

PICTURE: Painted rocket.

Step 18) Launch that rocket!

Fly the rocket using a C6-5 or B6-2 engine. I don't recommend any other engines due to the heavy weight of this rocket. Mine was 3.6 ounces with a C6-5 loaded.

PICTURE: Rocket on the pad.

Hope you enjoy the Wyvern! Please let me know how she flies.

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