PEAK OF FLIGHT NEWSLETTER

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BUILDING AN MK 82 SNAKE EYE ROCKET

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APOGEE COMPONENTS

PEAK OF FLIGHT

Building the Mk 82 "Snake Eye"

By Perry Olson

Introduction

This rocket is inspired by the Mk 82 "Snake Eye" bomb from the Vietnam era. To be clear, the Mk82 refers to the bomb; the "Snake Eye" portion was a retarding device attached to the tail of the bomb to make it fall slower so the jets could get out of the way during low level bombing runs.

This version has a different fin shape, loses the boat tail and has a different nose cone shape. But functionally it performs the same and is quite interesting to fly and watch recover.

It's definitely a more difficult build not only because of its complicated tail section but because of the sliding piston assembly inside the rocket, which helps retain the petal sections for the thrust and coast phases yet allows them to be released upon ejection.

Apogee Parts List: (Apogee part number in parentheses)

- 1ea (14812) 66mm TARC Foam Nose Cone
- 1ea (10198) 66mm x 18" Body Tube (BT-80) - 4 Per Pack (You'll use 1 and perhaps parts of another
- 1ea (10131) 33mm x 18" Body Tube (BT-55) - 6 Per Pack (You'll use part of 1 tube)
- 1ea (13045) AC-66A (BT-80) Coupler - 2 per Pack (You'll use part of 1 coupler)
- 2ea (13474) Foam Core Centering Ring 33/66 - 2 Per Pack (there might be wood alternatives to these)
- 1ea (12277) Foam Core Coupler Bulkhead Disk 66mm - (there might be a wood alternative to this)
- 2ea (14099) Balsa Sheet - 1/8" x 4" x 18" (you'll have some left over)
- 1ea (30303) Mylar Streamer 2in X 56in - 2 Per Pack (You'll use 1 streamer, but save the other as this takes some heat damage over time)
- 1ea (13057) 1/4" launch lugs
- 6ea (24006) 1.25" Rubber bands - You'll need at least six, but should have spares.

PERRY OLSON DEMONSTRATING THE SNAKE EYE ROCKET'S UNIQUE RECOVERY SYSTEM.

For the motor tube and mounting hardware you will need either

- 1ea (12019) (Recommended) Motor Mount Kit 24mm/ BT-55 - Plywood Rings - 1 per pack (And print just the thrust plate) -OR-
- 1ea (10100) 24mm x 18" Body Tube (BT-50) - 6 Per Pack (And print the 3D printed parts for the motor pod)

NOTE: The motor mount kit will be lighter and provide better performance than the 3D printed option.

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About this Newsletter

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3D printed parts

Download the .stl files to print out the 3D parts at: https://www.apogeerockets.com/Peak-of-Flight-Rocket-Plans

- 1ea HingeBottomRing.stl
- 1ea HingeTopRing.stl
- 4ea BottomHingeArm.stl
- 4ea TopHingeArm.stl
- 4ea PetalBrace.stl
- 1ea PistonReturn_A.stl
- 2ea PistonReturn_B.stl
- For 12019 motor mount kit (Recommended)

  – 1ea ThrustPlate_StandardMount.stl
- For 10100 BT-50 based motor mount

  – 1ea MotorStop.stl

  – 2ea PodRing.stl

  – 1ea MotorRetainer.stl

  – 1ea ThrustPlate.stl
- Optional 3D prints

  – 1ea 66mm fin guide.stl: to mark the BT-80 for cutting the petal bases from

  – 1ea Fin Template.stl: Use as a guide to cut the fins from a balsa sheet. Do NOT print 8 of these to use as the fins, 3D printed fins would be too heavy for this application.

  – 1ea DrillGuide.stl: used to drill holes for PetalBrace parts to go through

  – 2ea LugRing.stl: Optional 1/4" launch lugs. Save weight by using part 13057 above

Other parts:

There are just a few additional parts you will have to source on your own, though they shouldn't be hard.

- Wooden dowels. The ones I used were 2.17mm (1/16") in diameter. Round toothpicks would probably work. The hinge points on the petal assembly needs these.

General build notes:

This rocket works better the lighter you build it, so the 12019 motor mount kit is recommended. I built my prototype with 3D printed parts around a BT-50 however, so that clearly works.

There are 5 main assemblies with associated figures and build instructions. Please refer to the figures with each section to understand what you need to do. It's critical to get the glue only where it's needed and NOT where it should be avoided. Parts of this rocket need to slide or hinge to work. The motor pod needs to eject out of the rocket to reduce falling weight. So read each stage before assembling to be sure you do it right. To be clear, it's not rocket science…well, ok, it IS in a way, but this bird is a little more difficult than just slapping 4 fins on a tube.

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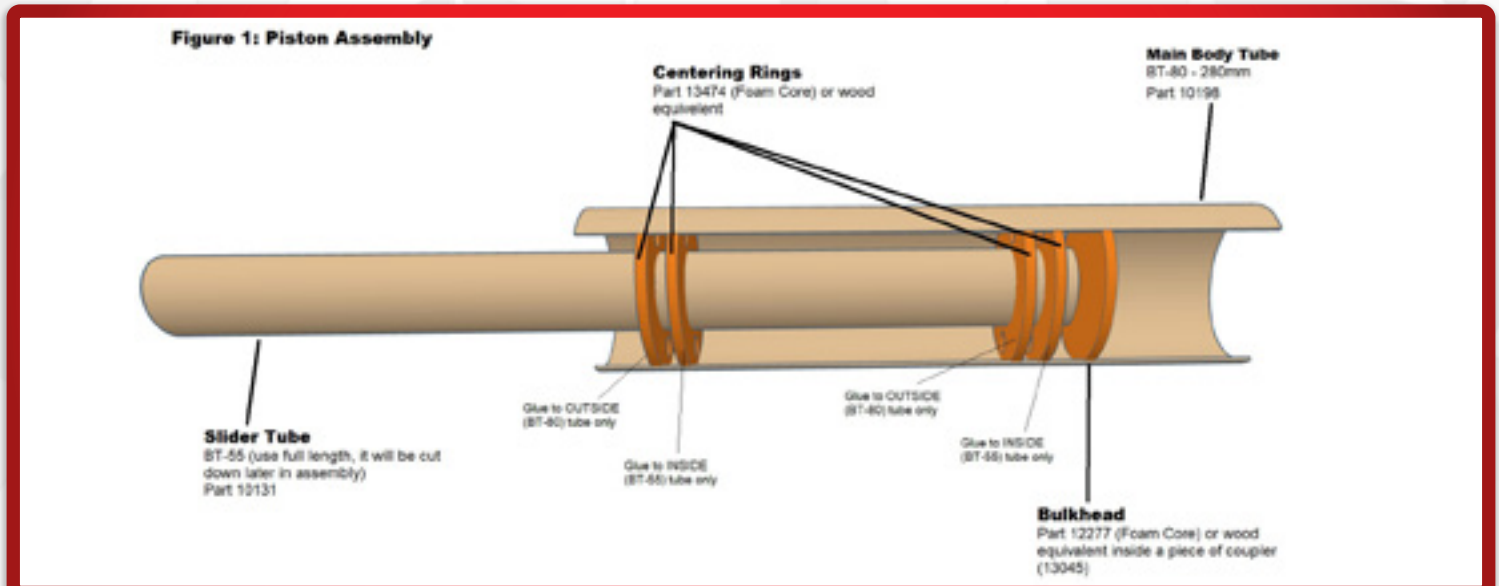
Assembly 1: The Piston Assembly

Please refer to this figure for assembling this portion:



Using the 66mm fin guide (or whatever method you're happy with), cut 175mm of 66mm tube off the full 18" length. This will become the bomb petals. Set it aside for later. For now we'll work with the remaining 66mm tube (about 280mm length) which will become the upper bomb assembly. The other tube used in this assembly will be a full length of BT-55 tube. DO NOT CUT THIS TUBE DOWN AT THIS POINT. You'll not need the whole length, but it's easiest to assemble most of the rocket first and cut it down at a later step.

Two of the 33/66 Centering rings need to be snug against the outside of the 33mm body tube but should slide freely inside the 66mm body tube. The other two rings should fit snugly against the inside of the 66mm tube but slide freely along the outside of the 33mm tube. In all these centering rings, cut or drill relief holes so the ejection gasses can escape. The ejection from an E motor is enough to push this assembly out of the rocket without these holes (I know this from experience).

When the final body assembly is together, the 33mm tube assembly will need to slide freely forward and back in the 66mm tube by about 13mm (1/2") or so.

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Work with the rings one at a time. You can't do all four at once.

Ring 1 is glued to slider (BT-55) tube: Glue one of the 33/66 rings about 13mm (1/2") from the end of the 33mm tube. If this ring doesn't slide freely inside the 66mm tube, sand the outside edge until it does.

Ring 2 is glued to main body (BT80) tube: Take a second 33/66 ring and make sure it slides freely over the 33mm tube. Sand if necessary. Once that is confirmed, remove it from the 33mm tube and glue it inside the 280mm length of 66mm tube. Glue it about 100mm down from one end and mark this end as the "top". (This doesn't have to be 100mm down, it just needs to be far enough down to fit the nosecone, and a few other components and anything more than 55mm would probably work, but I like 100mm so let's go with that.) Also, I like to drop an altimeter in this space, so 100mm gives us the room.

When this glue is set, slide the 33mm tube through the long 66mm tube so that the long portion of the 33mm tube protrudes from the "bottom" of the 66mm tube. Pull it as far as it will go (the 33/66 ring on the 33mm tube will stop against the 33/66 ring in the 66mm tube).

Ring 3 is glued to the slider tube: Using a 33/66 ring that is snug against the 33mm tube but loose against the 66mm tube, glue this ring to the 33mm tube about 1 inch up INSIDE the 66mm tube. Glue it ONLY to the 33mm tube, however, and be sure the 33mm tube is all the way down in the 66mm tube.

This will effectively trap the 33mm tube inside the 66mm tube but allow it to slide.

Ring 4 is glued to main body tube: Using the last ring, which should fit snug in the 66mm tube but slide easily over the 33mm tube, with the 33mm tube pushed all the way to the bottom, slide this last ring up against the bottom ring (#3) on the 33mm tube, then glue it ONLY to the 66mm tube.

When all is done, the slider tube should slide freely. And hopefully rings 1 and 3 bottom out against rings 2 and 4. You'll actually be able to slide the 1st ring out of the 66mm tube at this point but we'll fix that next.

Cut the BT-80 coupler 10mm long. Glue the 66mm bulkhead inside, flush with the bottom edge. Once this is dry, glue the bulkhead assembly in the TOP portion of the 66mm tube in such a manner that the 33mm tube can only slide about 1/2 inch either way. The easiest way to do this is to bottom out the 33mm tube, then move it towards the top 1/2 inch. Then lightly pinching the 66mm tube along where ring 1 is, push the bulkhead assembly down until it bottoms out against ring 1. DO NOT GLUE IT yet. Instead, mark a line inside the tube to mark its position. Then push

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it out with the 33mm tube, bottom that tube out again, and apply glue around the inside of the 66mm tube where your line is. Then slide the bulkhead assembly back down to the line again. Because you glued ring 1 part way down the 33mm tube, it shouldn't contact the glue you apply for the bulkhead. Nevertheless, it's a good idea to bottom out the 33mm tube until the glue dries.

If you've done everything correctly the 33mm slider tube should move about a half inch up and down inside the 66mm tube.

Assembly 2: The Piston Return assembly

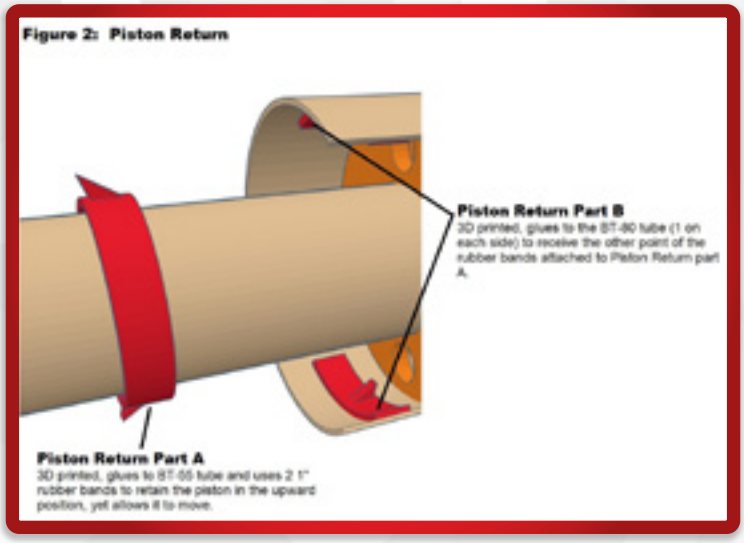

FIGURE 2: PISTON RETURN

This simple assembly applies upward pressure on the slider tube by using a couple of rubber bands. This upward pressure is necessary to retain the petals at the bottom of the rocket during the coast phase. If we allow the slider to move freely it could drift back during coast and allow the petals to open prematurely. If this happens when the rocket is moving fast, it will rip off the petals. Again, I know this from experience.

First, print a couple PistonReturn_B.stl parts. Glue these, using Epoxy, so that they are close to the 4th ring (at bottom) you glued in on the previous assembly, but be sure you leave enough room to get a rubber band on the "hook" on the part (which, naturally, needs to point up). You only need two of these so glue them opposite each other.

Then print one of the PistonReturn_A.stl parts and glue that on the Slider tube about an inch and a half from the bottom of the BT-80 tube when the slider is all the way forward. Make sure the "hooks" are pointed down and are lined up with the hooks on the "Part B" parts you just glued in.

When all is done and the glue is dry, you can use a couple of 1.25" rubber bands between the hooks to cause the slider, or "Piston", to always return upward in the rocket, yet still slide downward with just a little pressure.

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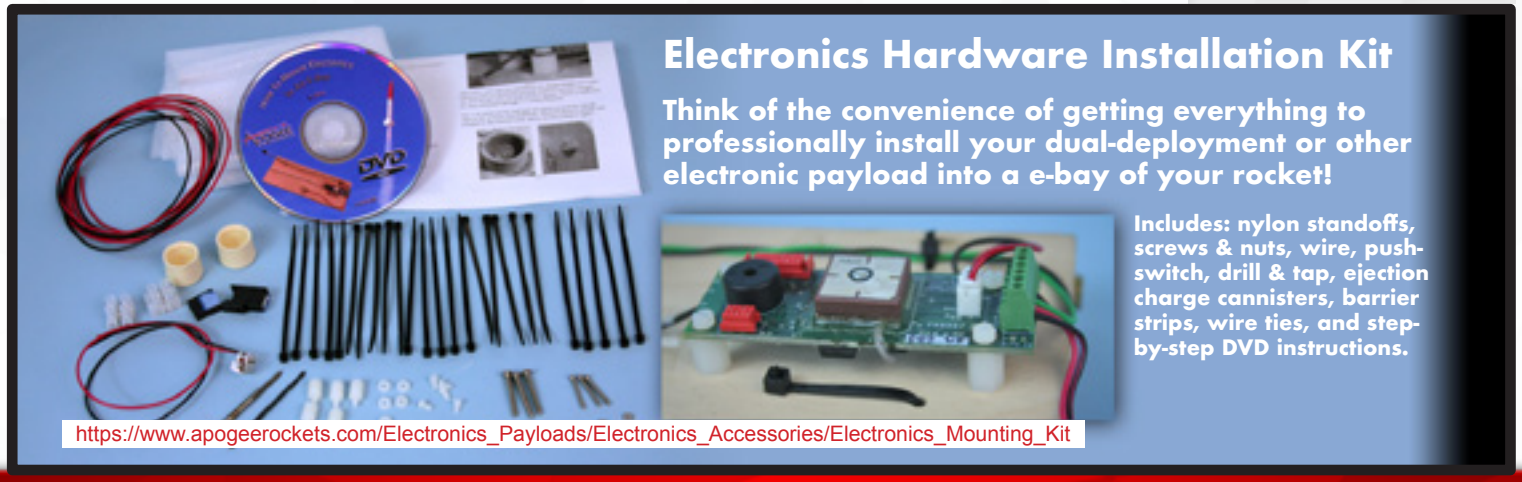

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Assembly 3: The petal assembly.

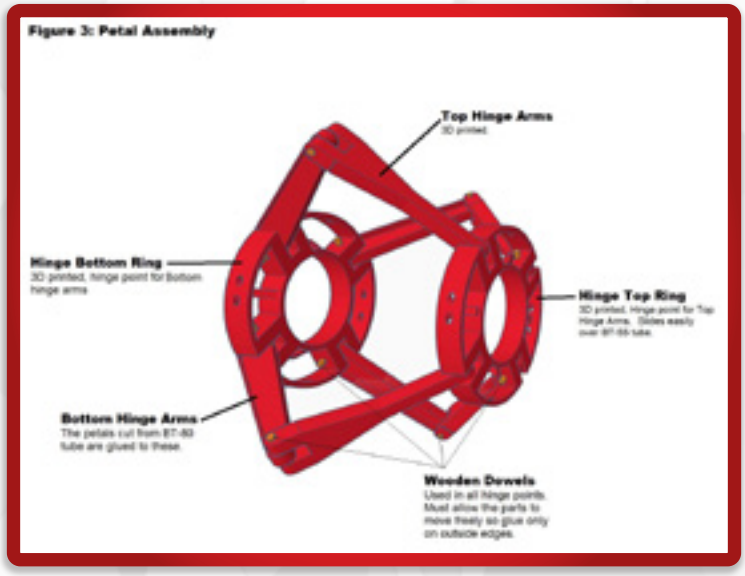

FIGURE 3: PETAL ASSEMBLY

This one may look a little more complicated and is the heart of the retarding device used for recovery. But it's really not that hard to put together and works really nice once finished. Refer to the figure above for this assembly:

This assembly can be done without gluing anything, or if you're nervous about it, use glue on the end points of the dowels.

Starting with the HingeBottomRing.stl, attach 4 of the BottomHingeArm.stl parts using dowels. These bottom hinge arms should have the flat curved surface facing outward and the wider end of the arm should be at the bottom attached to the ring. If you study these arms you will notice that once pinned in place with the dowel, they are only allowed to open so far and cannot go straight out from the ring. This provides the maximum allowed angle of the petals. NOTE: The "bottom" of the Hinge Bottom Ring is the one where the gaps for the arms are CLOSED. You'll also notice that the "hooks" on this piece point downward.

Next take 4 of the TopHingeArm.stl pieces and attach them to the top of the bottom hinge arms, again using dowels. The bottom hinge arm should nest between the "Y" shaped portion of the top hinge arms. These arms have no "inner" or "outer" surface, so you can put them either way.

Finally, attach the top of the top hinge arms to the HingeTopRing.stl piece. Make sure the "hooks" are pointed up on this piece.

Once you are done, you can put 4 x 1.25" rubber bands across the hooks and see how this piece naturally springs "open" when released. Remove the rubber bands before proceeding as they will make the next step more difficult.

Also, notice how the bottom hinge arms have two small holes in them. Those will be used in the next step to retain the petals.

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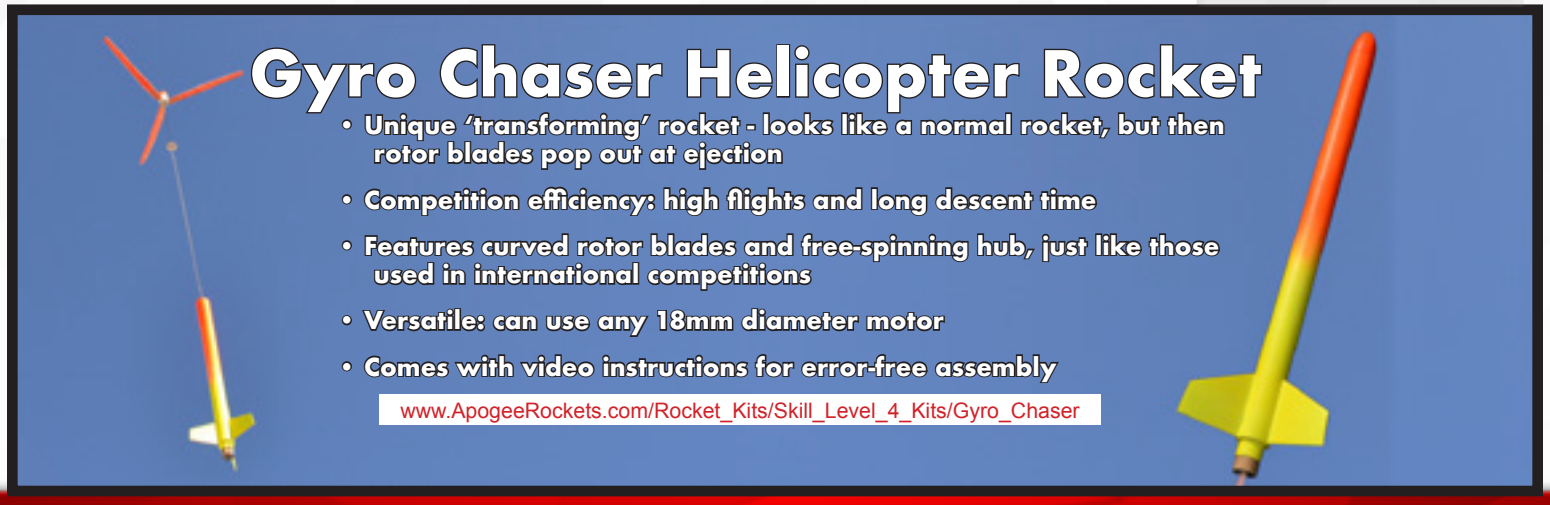

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Assembly 4: The petals

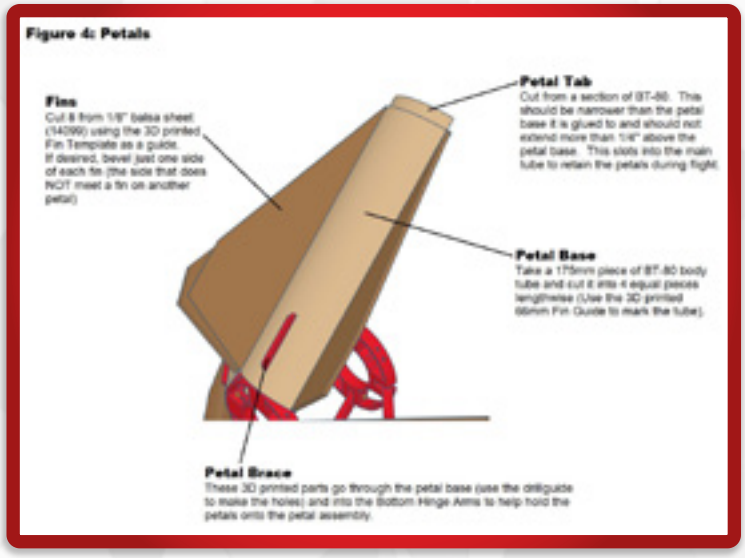

FIGURE 4: PETALS

If you've not cut that 175mm piece of BT-80 into four pieces, now is the time to do so. You'll also need a few smaller scrap pieces of BT-80 (or any scrap curved cardboard) to form the tabs at the top of the petals.

You'll also need to make 8 fins from the balsa sheets using the fin template. Make sure the grain goes along the long angled edge when you cut these out. Each petal will have 2 fins that will meet up with the fins on the adjacent petals when the petal assembly is closed, giving the appearance that the rocket only has 4 fins. This fin arrangement increases surface area when the petals are open and aids in retarding the descent rate.

Be very careful on this assembly to try to center the petals on the petal assembly arms (specifically the bottom hinge arms). It's a little tricky as the goal is to basically reform the four pieces of BT-80 back into a tube when the assembly is closed.

Using the optional 3D printed drill guide, drill holes on the mid line of each petal. The drill guide should be about ¼" above the bottom of the petal before drilling begins. The end result you are looking for is that the bottom of the petal should be right at the TOP of the Hinge Bottom Ring when the petal is closed (so you should be able to see the edge of the Hinge Bottom Ring). Once all four petals are drilled, apply glue to the curved portion of the Bottom Hinge Arms on the petal assembly and attach the petal. Then glue the petal brace through the holes you drilled into the bottom hinge arms. You may need to sand or shave the pins down a little on these braces (or drill out the holes in the bottom hinge arms a little) to make sure they fit. It's best to do this one petal at a time, of course.

Once all four petals are attached to the petal assembly, you can glue the petal tabs to the inside edge at the top of the petals. Make sure 1/4" of the tab is exposed above the petal's top edge. These tabs will slot into the main body tube to retain the petals during flight.

The easiest way to glue the fins on is to slide the petal assembly over the slider tube on the main body (but do NOT glue it on at this point). Then using something soft and springy (I used rolled up paper towels) line the 33mm sider tube INSIDE the petal assembly to press out on the petal arms when closed. You should be able to then close this assembly into a tube form again. With the right amount of outward pressure you can slide the tabs into the main

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body tube. Then working with two fins at a time, clamp them together and place them over the seam between two petals and glue the outside edges ONLY. Be light on the glue as you do not want it seeping under the fins and gluing the petals together. Do this 4 times and all 8 fins will be lightly glued in place. This is probably the trickiest part of this rocket build, so take your time and be light on the glue.

Once all 8 fins are glued on, gently open the petal assembly. Hopefully you won't have to slip a knife in between the fins to break glue apart. Remove the springy thing you put in (paper towels or whatever). With the petal assembly now open, you can glue the other edge of the fins. And at this point you WANT glue to seep under the fin, so be a little more generous. With the petal assembly open you can add additional glue over the inside edges too, to build up some nice fillets.

When everything is dry, it's time to attach the petals to the main body tube. But before you do this, put on all the rubber bands again, including the piston return bands. Then slide the petal assembly over the slider tube, close it, and slide the tabs under the main body tube. At this point the slider should be fully up in the rocket (because of the piston return bands) and the petals should be closed and as far up in the main body tube as they can go. It should look like a rocket, except there will be extra slider tube sticking out of the bottom of the petal assembly. Mark a line along the bottom of the Hinge Bottom Ring where it meets the slider tube, then remove the petal assembly. With the petal assembly OPEN, slide it on the slider tube so that the line you just marked is BETWEEN the Top and Bottom Hinge Rings. In this position, apply some glue above that line. The goal here is to glue ONLY the Hinge Bottom Ring to the slider tube, so we're trying to keep all glue off the Hinge Top ring here. With the glue in place, close the petal assembly and side it in place so the glue can now contact the Bottom ring.

When this glue is dried, you can cut off the excess slider tube so that it's flush with the bottom of the bottom hinge ring.

When all is done, you should be able to slide the petal assembly downward until the tabs clear the main body tube and the petals should snap open. All the hard stuff is now done and you've built a nice model of a Snake Eye type bomb. Now it's time to make the part that makes it FLY!!

Assembly 5: The Motor Pod

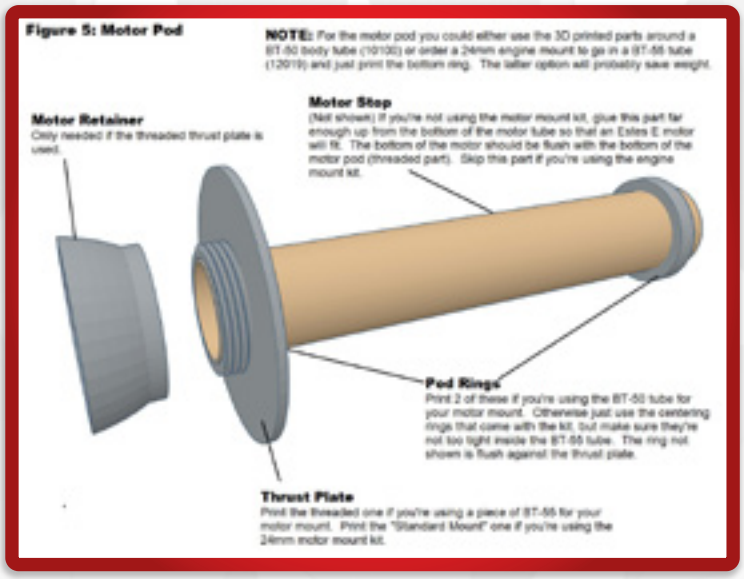

FIGURE 5: MOTOR POD

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The figure below shows the motor pod as made with 3D printed parts but for better performance it's recommended you make this with the 12019 motor mount kit.

The motor pod is designed to rear eject out of the rocket and recover on its own via streamer. This removes the weight of the spent motor from the main rocket, allowing it to fall slower. In fact, the motor pod will likely hit the ground a bit quicker than the rocket will.

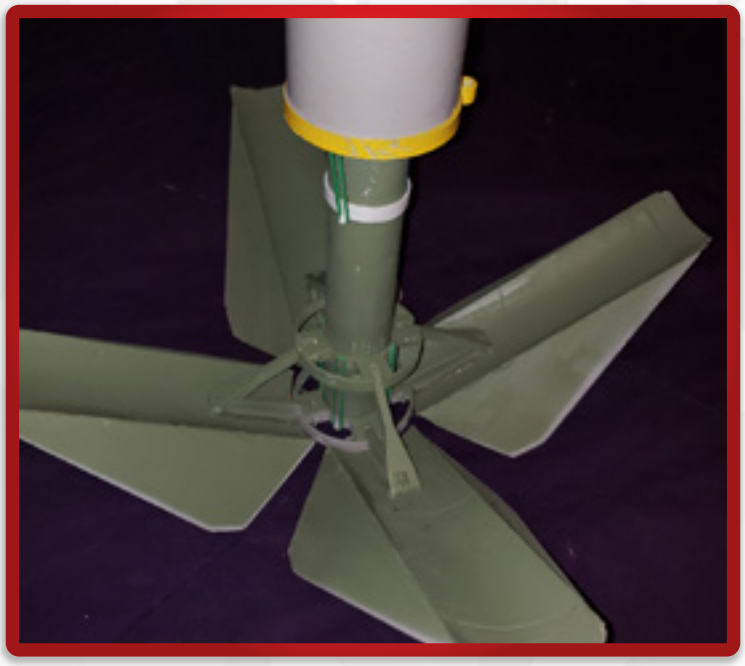
If you're using the motor mount kit, assemble the engine hook as normal through the motor tube. Then glue the "Standard mount" version of the thrust plate flush with the bottom of the motor tube so that the notch lines up with the engine hook. Glue one of the centering rings down flush against this thrust plate (or just a little higher if you prefer). Glue the other centering ring near the top of the motor tube. Make sure the centering rings are just snug inside the slider tube that this slides into. The motor mount should stay in place when inserted, yet still slide freely enough that it will fully come out on ejection.

If you're using the 3D printed parts, assemble them as in the diagram above, with the 24mm tube flush with the bottom of the thrust plate (threaded end downward). Glue one of the pod rings against the thrust plate and the other one about ¼" from the top of the motor tube (which I made about 160mm long). Finally, glue the motor stop far enough up the motor tube so that an Estes E motor will be flush with the bottom of the thrust plate threads. I just held a dowel against an E motor to get an idea of depth, then put glue on the end of this dowel and smeared it around inside the tube. Then I used the E motor to push the ring in place and removed the E motor before it could get glued in.

When you're done with the 3D printed version of the mount, it should hold an E motor when the retainer is screwed in place.

For either motor tube version, tape a 3 foot long piece of streamer to the side of the motor tube in such a way that you can roll it against the tube.

DO NOT, however, actually roll it against the tube for flight. Instead fold the streamer in half a few times until it's 6 to 8 inches long and roll THAT on the tube. The motor pod should now fit inside the slider tube below the petal assembly.



SNAKE EYE BASE OPEN

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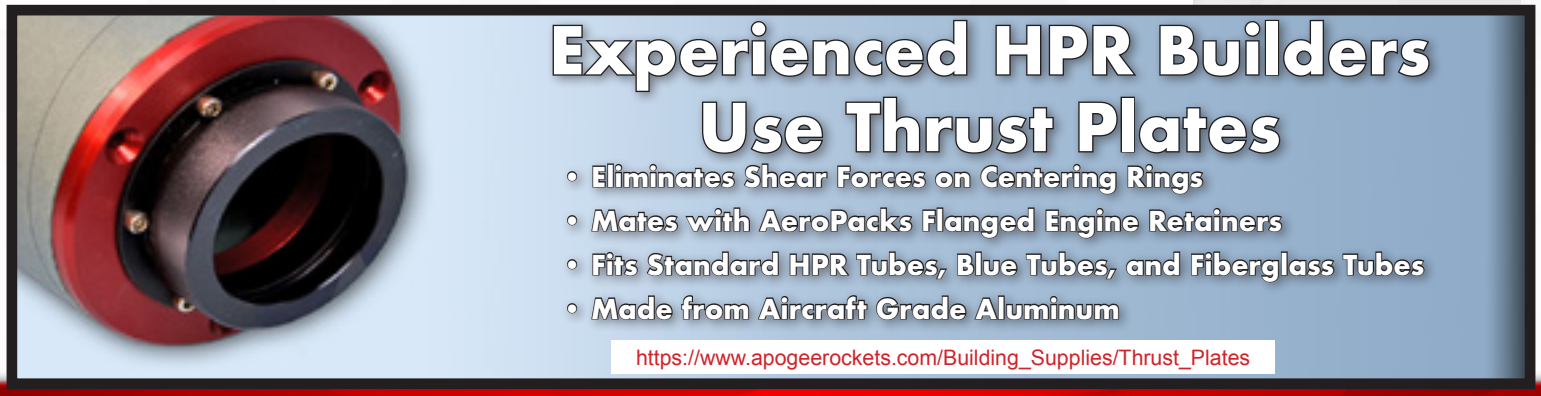

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Final Considerations and suggestions

Use the TARC nosecone specified in the parts list. This foam nosecone provides some extra cushion needed for a rocket that lands on its nose every time. I do not have the means to calculate center of pressure on this rocket so I used the old "Swing test" to find the stability point. For my rocket I had to fill the core of the TARC nose cone (it has a cylindrical cavity in it) with modelling clay. If you use the motor mount kit you can probably cut out some of this clay.

To paint this rocket remove all the rubber bands and paint the inside of the petal assembly first. Then close the petal assembly and paint the outside. Do NOT paint the TARC nosecone as it will likely just flake off anyway, or worse yet, damage the foam.

Fly this rocket on D (with a spacer) or E motors. I've flown it on D12-3's and E12-4s but the delay on those motors seems a tad short so I'd suggest the D12-5's or E12-6 motors.

This rocket has a few moving parts and naturally there can be some stress from its operation. As such it's a good idea to inspect the rocket before each flight to make sure a glue seam hasn't come loose or a fin hasn't cracked. Just like you should be inspecting chutes and shock cords on your standard rockets, you should be inspecting the petal assembly on this one.

Good luck and happy flying!

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Flight Notes

By Christopher Texler

Flying the Mk 82 was quite an experience due to its unconventional recovery as well as its interesting shape. Because of its design, the process of flying it was actually much simpler than many other rockets I've flown and can be broken down into two main parts, the preparation of the rocket and the actual flight.

The preparation of the rocket was fairly unintuitive due to my previous experience with rockets of similar size that I'm so used to prepping that I've gotten the process down to muscle memory with. With other rockets, the process that I've always used was to fold the parachute or streamer, then put in the protective ejection wadding before loading the parachute/streamer and prepping the motor. With this rocket however, none of that was necessary and I kept having to remind myself that I didn't need to keep checking the parachute and that I could just "load a motor and go".

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Flying the rocket was also an interesting experience, as this rocket is really light for its size and likes to jump off the pad at quite a fast speed. However, due to its relatively stout shape, it also likes to slow down right after engine burnout, and on the D22 that I flew it on, it only ended up reaching an apogee of ~300 ft. For this rocket, I'd recommend using a shorter delay and maybe even using a looser rubber band, as a little bit of an early deployment of the recovery system is better than a late deployment on this particular rocket.

Overall, the build and flight process of this rocket was a really fun and exciting challenge and it definitely got attention at the launch field.

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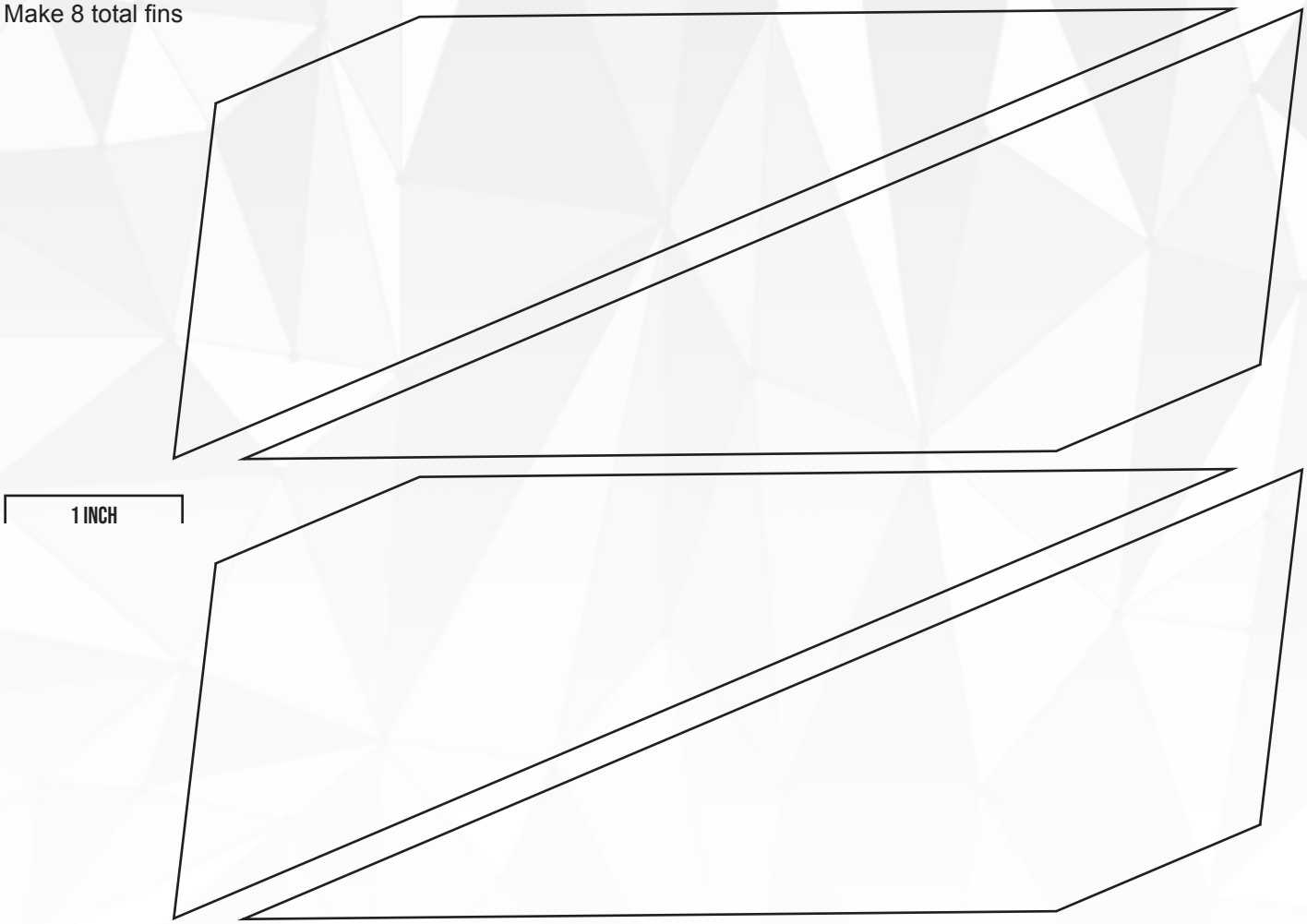
Fin Templates

Make 8 total fins