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NEWSLETTER

Build a Triangulation Scope

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Build A Triangulation Locator Scope

By Tim Van Milligan

In the last *Peak-of-Flight* newsletter (www.ApogeeRockets.com/education/downloads/Newsletter222.pdf), I showed you how to use triangulation to find you rocket. The key piece of equipment was two "triangulation locator scopes." In this article, I'll show you how to build them. Don't worry, this isn't going to be hard. I believe in simple and inexpensive.

Building Supplies:

1) 1/2" thick plywood: You'll only need a piece about 8-1/2 inches in diameter for each scope, but it is not necessary that the base be round.
2) 1/4 inch diameter X 3/4 inch long hardwood dowel for the pivot
3) Spruce wood strip: 1/2 X 1/4 X 8-1/4 inches
4) Two small nails or thick music wire.
5) 1/4"-20 X 5/16" Tee Nut (sometimes also called a blind nut).
6) Clear plastic cover from a CD-ROM jewel-case
7) Camera tripod

Photo 2: Simple tools, like those shown, are all it takes to put together this precision instrument.

Photo 1: Using a tracking scope like this one allows you to fix the position of the rocket by triangulation.

Tools:

1) Electric drill
2) Drill bits: 5/16", 1/4", and a small drill bit that is the same diameter as your small nails or music wire.
3) Wood glue
4) CA glue
5) Permanent marker
6) Ruler
7) Hammer
8) Razor saw to cut the dowel
9) Pin-vise to hold tiny drills
10) Sandpaper

Base Assembly Steps

1. I cut my plywood base using a jig-saw. As mentioned in the supplies, your base does not have to be circular. It is more convenient if it is, because the handle of the gun-sight will hang over the edge and will be easier to rotate.

As you can see from my photos (Photo 3), I used the cheap particle-board wood for my base because I had a big scrap piece that didn't cost me anything. I would recommend real plywood. The particle-board chips easily, and it is hard to drill a round hole through it. But in a pinch, it will work

2. Drill a 5/16-inch diameter hole to accept the shank

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Build a Triangulation Locator Scope

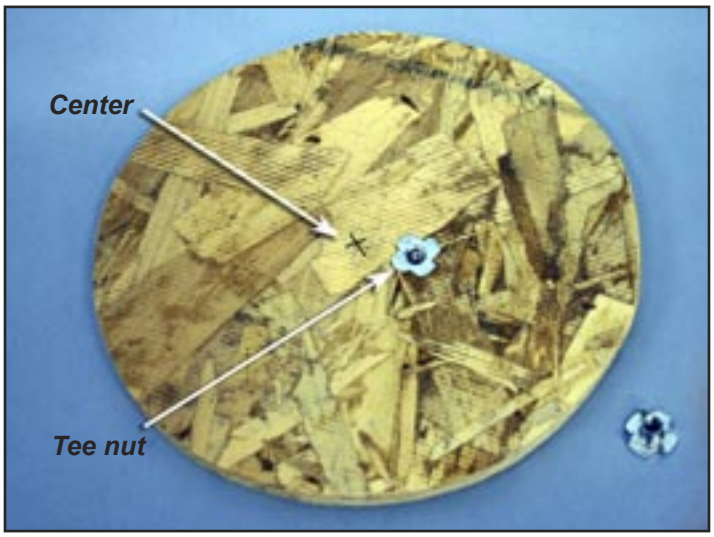

Photo 3: Bottom side of the wooden base plate. Note that the Tee nut is placed off-center.

of the tee-nut. Don't put the hole in the exact center of the wood. Put it off-center about 1 inch. You'll be drilling another hole in the exact center later on for the pivot of the gun-sight.

3. Using the hammer, pound the tee-nut into the hole. The side you insert the tee-nut into will be the bottom of the base.

4. Print out the protractor guide from the download of printouts. It can be found at: at: http://www.ApogeeRockets.com/education/downloads/triangulation.zip. Cut it out, and glue it centered on the top-side of the base using wood glue. Allow the glue to dry thoroughly. If you don't let it dry, the hole you drill in the next step will be off-center (been there, done that).

Photo 4: Tee nuts can be found at hardware stores. A four-pack costs about a $1.

5. After the glue has dried, drill a 1/4 inch hole as marked through the exact center of the protractor rosette. At this point, the base is done.

Gun-Sight Assembly Steps

6. Before cutting the strip of wood to make the gun-

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Build a Triangulation Locator Scope

sight base, measure and mark the pivot point location. It should be 3-1/4 inches from one end. Drill a 1/4-inch hole through the strip of wood at this point. Be careful, since the strip of wood is only 1/2 inches wide, it can easily crack in half at the point of the hole. That's why I suggest you don't cut it to length yet. If it cracks off, you haven't wasted the whole piece. You can simply cut it off and start drilling a new hole. Again, I'm saying this from experience.

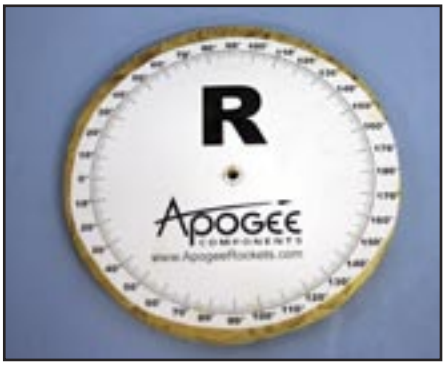


Photo 5: Finished base.

7. After the hole is drilled into the gun-sight base, cut the strip of wood to length: 8-1/4 inches.

8. From the 1/4-inch diameter dowel, cut a short length of dowel that is 3/4-inch long. Glue this into the hole in the strip of wood using wood glue. The dowel should be flush with one surface of the wood. This will be the top surface.

9. Draw a centerline down the entire length of the strip of wood using the marker. Extend it down the end caps of the wood.

10. Using a tiny drill in a pin-vise, create a small hole in the center of the short end of the strip of wood. Put it in the exact center of the end, as this will be the pointer location.

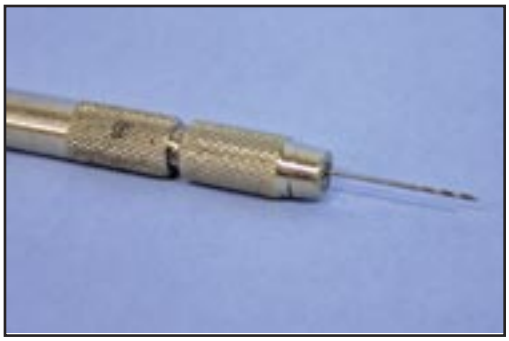


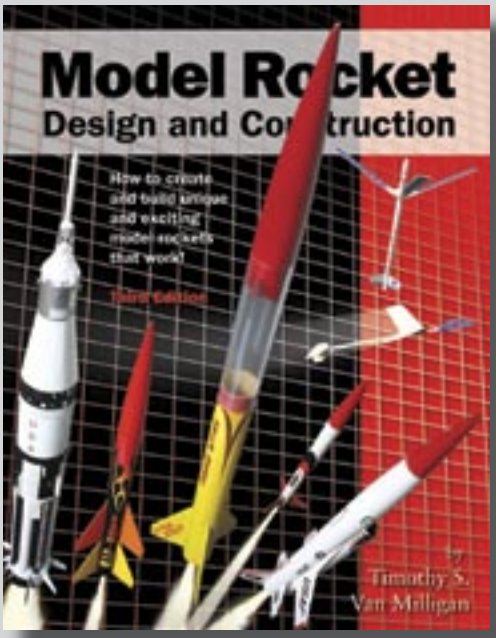
Photo 6: A pin-vise is a special tool that holds small drill bits.

11. On the long end of the gun-sight base, pound in a small nail about 1/4 inch from the end of the wood on the top surface. This will be the back sight, and also a handle that you can use to turn the gun-sight on the base.

12. From an old CD-ROM jewel case, cut a rectangular piece of clear plastic that is 1-1/4 inches wide by 3-1/2 inches long. You can cut it by scoring it with a hobby knife and then bending the plastic back and forth. It will snap off pretty easily. Sand the edges and corners smooth.

13. Draw a centerline down the length of the clear piece of plastic with the permanent marker.

14. Temporarily position the plastic piece on the end of the gun-sight base. The bottom edge of the plastic should be flush with the bottom surface of the gun-sight base. Make sure the centerlines of the two pieces are aligned. Then mark the position of the hole on the plastic piece. Us-



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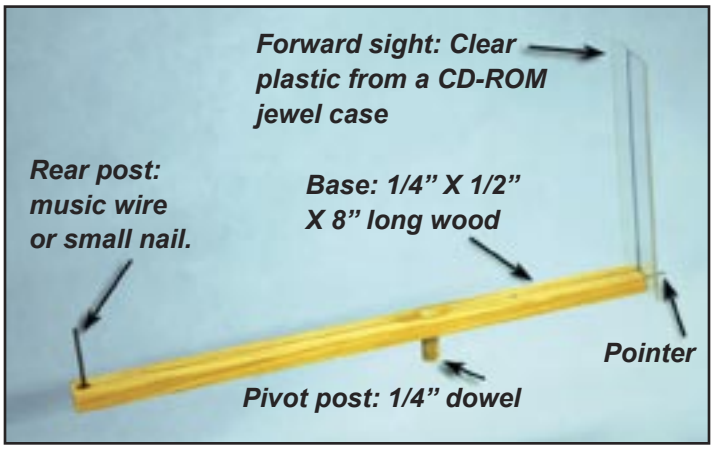


Photo 7: Gun-sight is made from common hobby-shop materials.

ing the pin-vise and the drill, make a small hole in the clear plastic piece.

15. Glue a short piece of music wire into the hole on the end-cap of the gun-sight base using CA glue. It should stick out about 1/2-inch. Then glue the clear plastic piece on the end, with the pointer protruding through the hole in the plastic.

16. Test fit the dowel on the base of the gun-sight into the central hole on the base of the protractor rosette. It should spin freely. Sand the dowel if the fit is too tight. Also, the dowel should not protrude through the base of the plywood. Sand it shorter if it is too long. The gun-sight can be removed from the base so that it isn't broken during transport to and from the launch field.

17. You will need two tracking scopes, so go ahead and build the other one using the same steps.

18. When you're ready to launch rockets, attach the base to a tripod using the Tee nut on the bottom surface of the base.

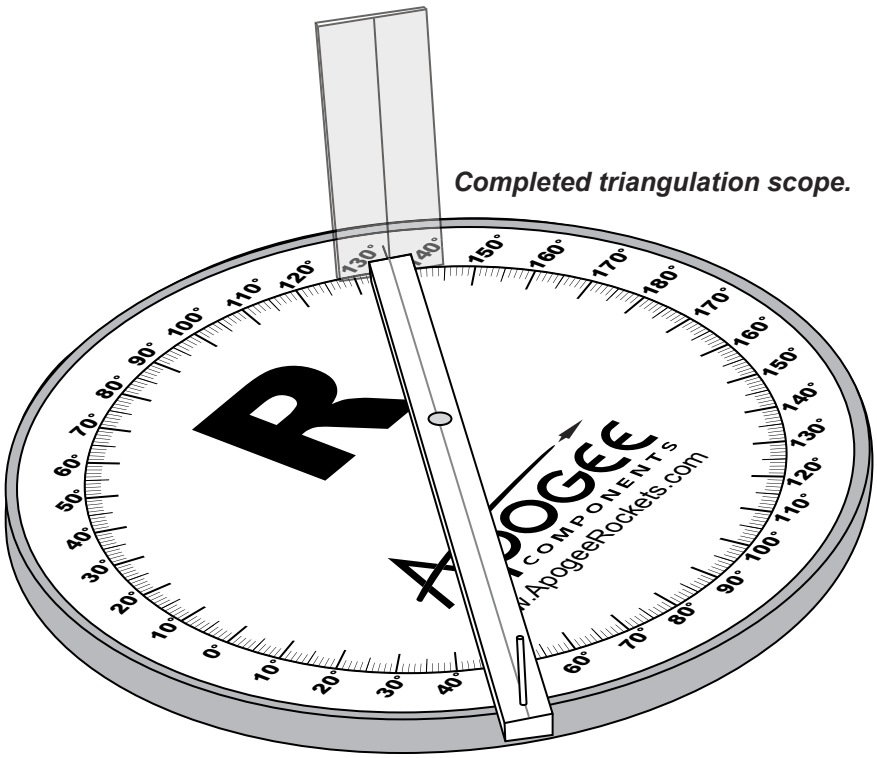
19. See the "how-to" instructions in *Peak-of-Flight* newsletter #222 to learn how to track your rockets.

Conclusion

Building this triangulation tracking scope is fairly easy and cheap. I had all the materials lying around my workshop except the Tee-nuts. In total, I spent 98 cents for a pack of four at Home Depot. I also happen to have two camera tripods sitting around. But if you don't, you can find these used at pawn shops or at garage sales for less than $10. I really like cheap projects!

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. Before he started writing articles and books about rocketry, he worked on the Delta II rocket that launched satellites into orbit. He has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward a M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (http://www.apogeerockets.com) and the curator of the rocketry education web site: http://www.apogeerockets.com/education/. He is also the author of the books: *"Model Rocket Design and Construction," "69 Simple Science Fair Projects with Model Rockets: Aeronautics"* and publisher of a FREE e-zine newsletter about model rockets. You can subscribe to the e-zine at the Apogee Components web site or by sending an e-mail to: ezine@apogeerockets.com with "SUBSCRIBE" as the subject line of the message.



Completed triangulation scope.

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