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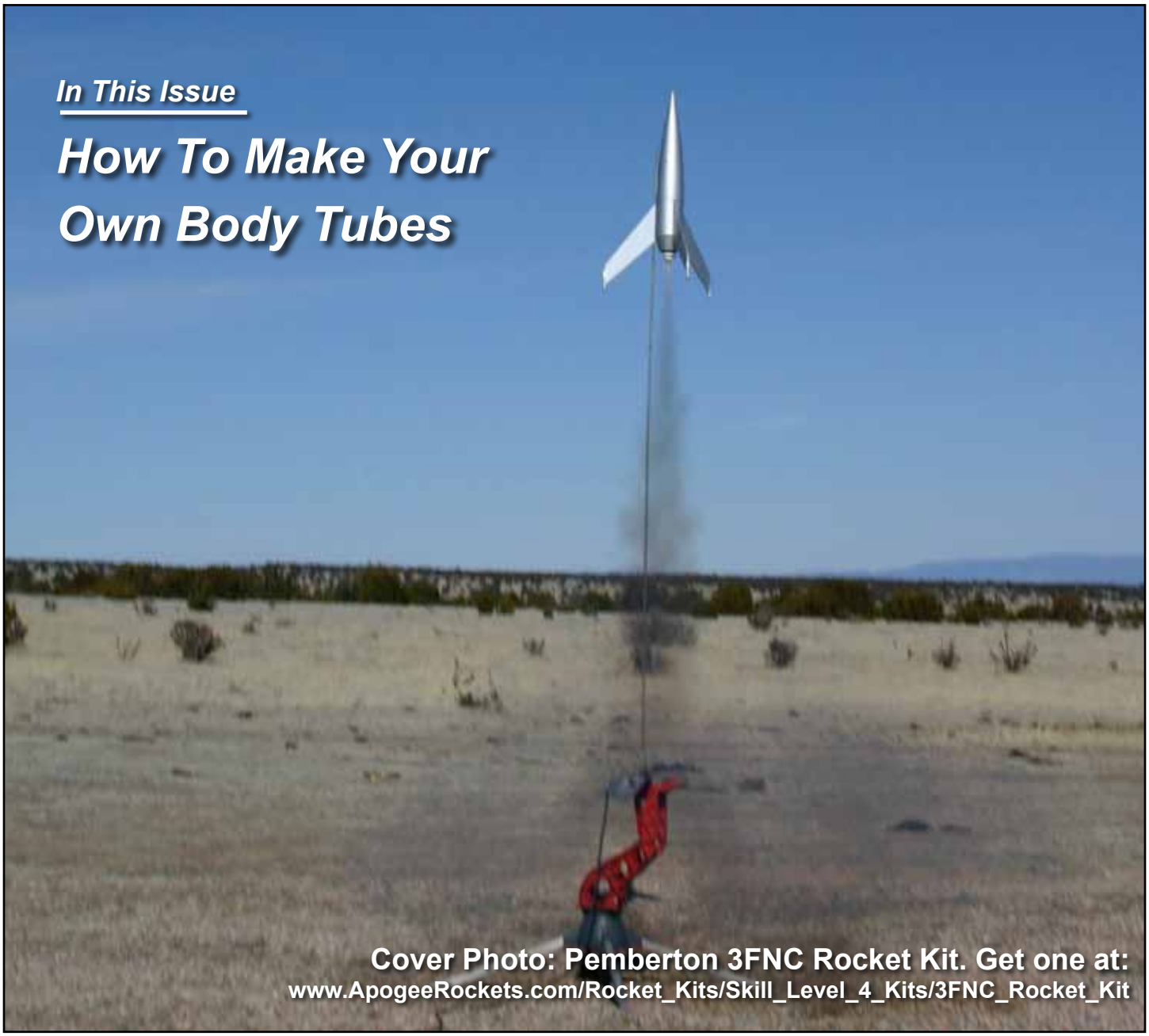
PEAK OF FLIGHT

NEWSLETTER



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How To Make Your Own Body Tubes

Cover Photo: Pemberton 3FNC Rocket Kit. Get one at:
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How To Roll Your Own Body Tubes

By Tim Van Milligan

At some point in your rocketry career, you may find that you need a custom size body tube. This happened to me in the past couple of weeks, when I needed a sleeve to fit over a standard BT-20 body tube. My options were to find a company that sold the right size tube, or I'd have to make my own.

If you are going to need a lot of tubes, I'd say to find someone that has the size tube you need. The consistency of tubes you get is worth the cost of buying a tube in my opinion.

But in the case of my project, I needed the tube right away (time was of the essence), and I didn't need a large quantity. So I decided to roll my own using ordinary copy paper.

The next question I had to answer was which type of tube to make. There are two types of paper tubes used in model rocketry: spiral wound, and convolutely wound.

You've seen spiral wound tubes, as these are the typical tubes used for the airframe tubes. The advantage of spiral wound tubes is they can be made really long. You only need a long mandrel to wind them around.

You can see Newsletter 304 (www.ApogeeRockets.com/Education/Downloads/Newsletter304.pdf) for information on how to make these types of tubes.

A convolutely wound tube is made differently from a spiral wound tube. It is simply rolled up paper that forms a tube.

The advantage of convolutely wound tubes is that they are a lot stronger than spiral wound tubes. If you've studied the engine casings on a black-powder motor, you'll see that these are indeed convolutely wound tubes. These can take a lot of internal pressure, where a spiral wound tube would split open and unravel quite easily.

The disadvantage of the convolutely wound tube is that its length is dependant on the width of the sheet of paper that you're using. So if all you have is a standard size notebook paper, the maximum length of tube you can make is 11 inches long. To make a longer tube, you'd have to get a longer sheet of paper to roll up.

This limitation didn't bother me for my project. I only needed a tube that was about 7 inches long, so a standard size sheet of paper was very adequate.

Wet Paper Crinkles

Rolling a paper tube is easy. Gluing it together is the hard part.

The reason is that when you apply water-based glue to paper, it crinkles up. The paper absorbs the water in the glue, and expands. When it dries, the paper contracts. But it doesn't lay flat again, it crinkles and puckers up.

This makes rolling a tube hard while the glue is still wet.

Compounding the problem is that wet paper is very weak. Handling the paper is likely going to cause it to tear. As you're rolling the tube, you'll need to have lots of cuss words ready. You'll get the chance to count how many you can go through without repeating the same one twice.

Another problem you'll find is that getting the edges to align is very difficult. You'll often have the edges misaligned, so that you end up with a spiral on both ends. Not a big deal in most cases, but you will have to sand the ends smooth.

The Secret: Use White Glue and An Iron

I got this secret from a long time modeler, Randall Redd, so I'll give him the credit.

White glue, the cheap school glue, is made with a little bit of vinyl in it. That means it has a little bit of plastic in it. Don't use yellow wood glue, it doesn't work the same.

For making tubes, using white glue allows us to heat up that plastic, and fuse it in the paper. This means we can let the glue dry, and then roll the tube.

While the paper will be crinkled was you roll it, when you apply heat from an iron to it, it smooths out the wrinkles and crinkles, and fuses the paper layers together.

The result is that you'll get a smooth tube without any unsightly wrinkles. And it has the strength benefits of a convolutely wound tube.

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Two layers of paper have as much strength as a commercially made spiral wound tube, but have a thinner wall and is lighter in weight! If you make the tube three layers thick, it now has the same thickness as a commercially made tube, but is incredibly strong. It is so strong, that it will impress you.

Steps For Making A Convolutely Wound Paper Tube

First, you're going to need a mandrel to wrap the paper around. This mandrel defines the inner diameter of your new tube. In my case, since I needed a sleeve tube that fit over a BT-20 tube, I used an actual BT-20 size tube as the mandrel. The mandrel doesn't need to be rigid, it only needs to be the right size. Although, a rigid mandrel is a little easier to work with.

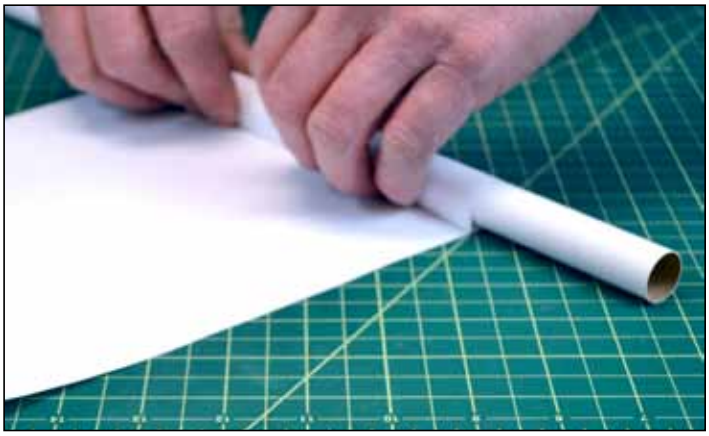

Photo 1: Roll paper tightly around the mandrel.

Roll the paper around the mandrel. The first wrap is the hardest, because you have to tuck the edge tightly under the paper as shown in Photo 1. Don't worry about the edges aligning as this point. Just make sure the paper

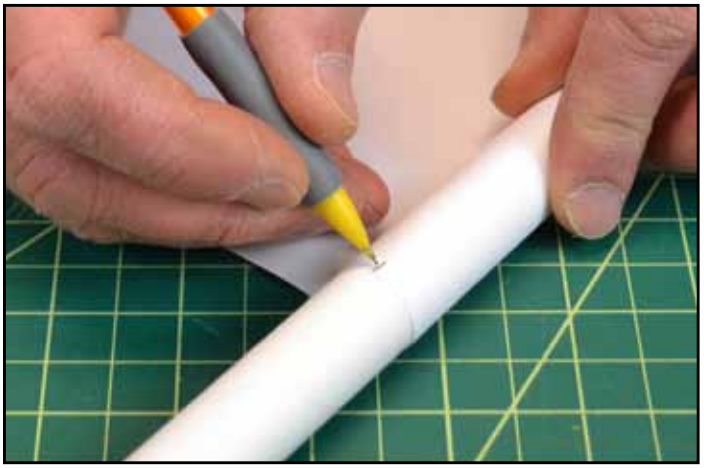

Photo 2: Using a pencil, mark the point where the paper completes each full revolution around the mandrel.

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is tight.

Step 2: Mark the paper at each full revolution

As shown in Photo 2, mark the paper at each full revolution around the tube.

I'd suggest making a 2-revolution tube on your first attempt. This will give you a strong and lightweight tube. And it is the fastest tube you can make.

Step 3: Cut the paper to the desired length

Once the roll-up is marked to the right length of full-revolution wraps, you can pull it off your mandrel.

In Photo 3, you'll draw two lines on the paper. One is for the first full revolution of paper around the tube. You need this line to tell you where NOT to get glue. More about this will be discussed later.

The second line is where you'll trim off the excess paper. Typically, you want to remove the excess length that goes beyond the full revolution.

If you're doing a three layer wrap, you don't need to have a line where the wrap goes around two layers deep.

Step 4: Apply Glue To the Overlap Side

I recommend covering your work surface with a drop cloth at this point. This is where it gets messy.

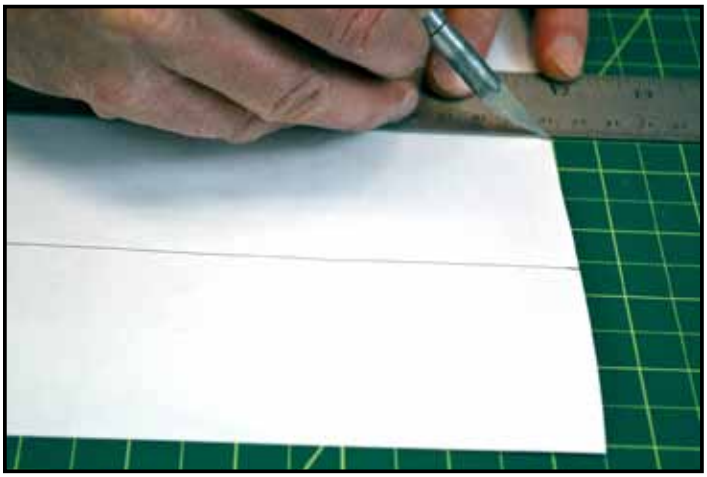

Photo 3: Mark the first full revolution with a pencil line, and cut off the excess paper at the desired length.

Photo 4: Lay white glue down on the paper.

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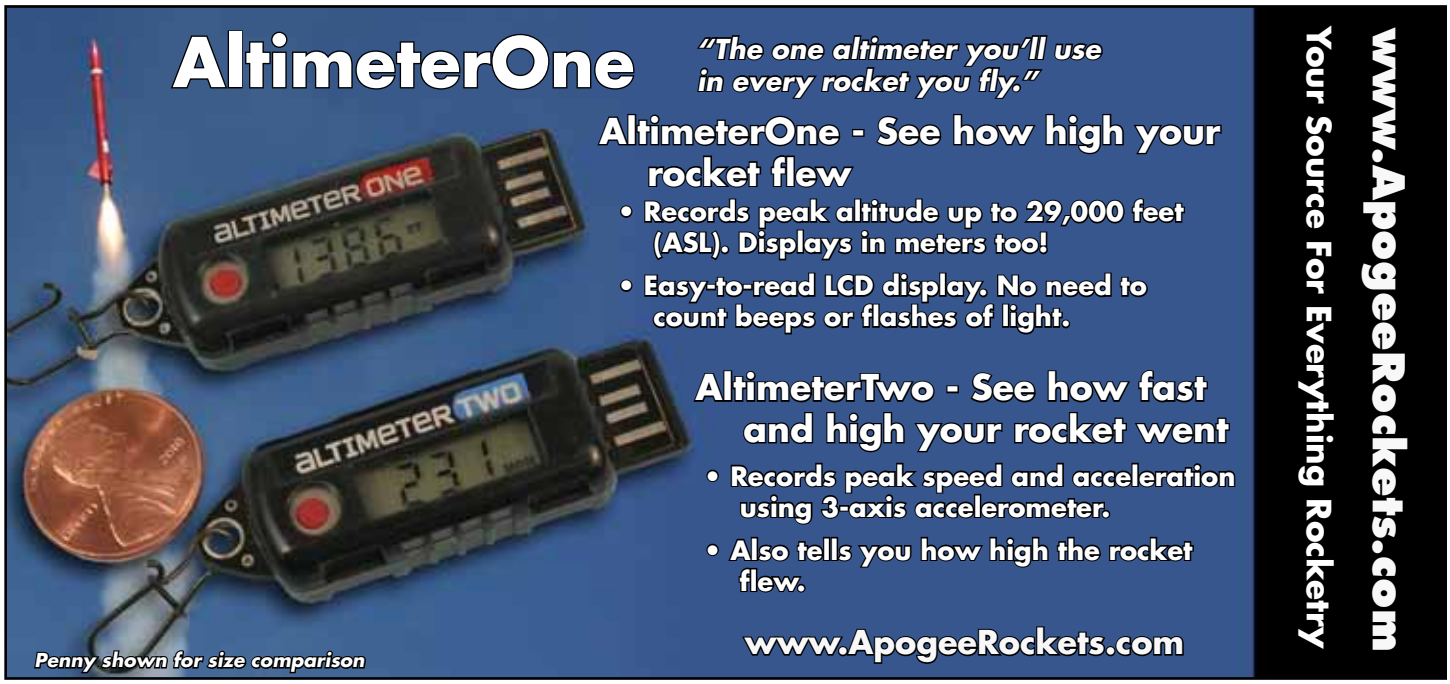

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As shown in Photo 4, take your glue bottle and spread it on the overlap side of the paper.

If you live in a dry climate, try to work fast, as you don't want the glue to dry while it is piled up as it comes out of the bottle.

You now want to work quickly and spread the glue evenly across the overlap area. Work from the pencil line towards the outer edges. Don't let glue cross over the pencil line!

You can use your clean finger tip to spread the glue (seen in Photo 5), or a thin piece of plastic, like a credit card.

I find that the thin plastic squeegie helps to even out the glue better and give a more uniform thickness.

Ideally, you want an even coat of glue covering the surface, without ridge lines. Small ridge lines are OK, but thick ones may show through the tube if they are in the outer wrap.

Also, make sure you get glue all the way to the edges of the paper. Just push the glue wave out past the edge onto the drop cloth.

Since I live in a extremely dry climate, I add a little bit of

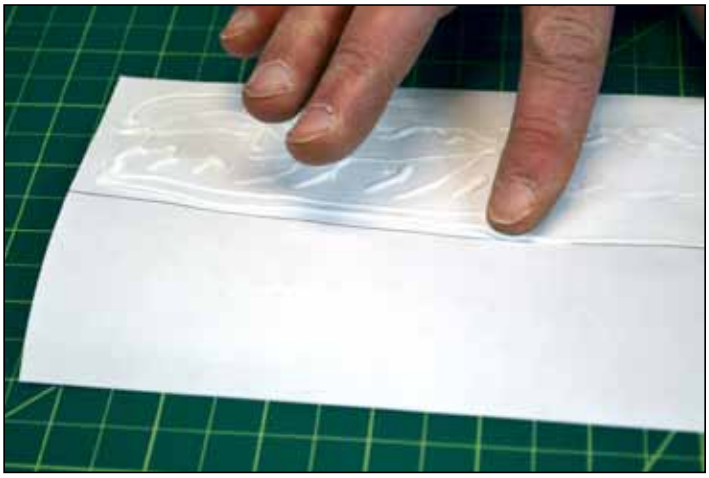

Photo 5: Spread the glue evenly across the paper, but don't get any over the pencil line. That is the part that touches the mandrel.

Photo 6: The paper will crinkle when it dries. This is normal and is OK.

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water to the glue before I apply it to the paper. This makes the glue smooth out more evenly with less ridges. But it also makes the film thinner when it dries. If it is too thin, it may not fuse the layers of paper together adequately. So if it dries, and doesn't have a shiny (waxy or plastic-like) look to it, you may have to put down another layer of glue to bulld up a little bit of thickness.

Pull the paper off the drop cloth so that the edges don't get glued down. And lay it somewhere where it can dry.

Let the paper dry thoroughly. If you are in a hurry, you can put it in front of a fan or use a hair dryer to shorten the drying time.

Step 5: Roll It Back Around The Mandrel

The portion of the paper that is flat and has no glue on it gets rolled around the mandrel first. No glue should touch the mandrel, or you'll never get it off later.

As you complete one revolution, check the edges to

Photo 8: As you roll up the paper, check the ends to make sure they are even.

make sure they are aligned perfectly. Since the glue isn't sticky at this point, you can reposition the paper easily to make sure they are perfect.

I'd suggest rolling the paper all the way up to check the ends of the tube. And also make sure that first layer is tight against the mandrel.

Carefully unroll the paper, so that it just makes one

Photo 7: Roll the paper around the mandrel. This time, make sure the edges line up.

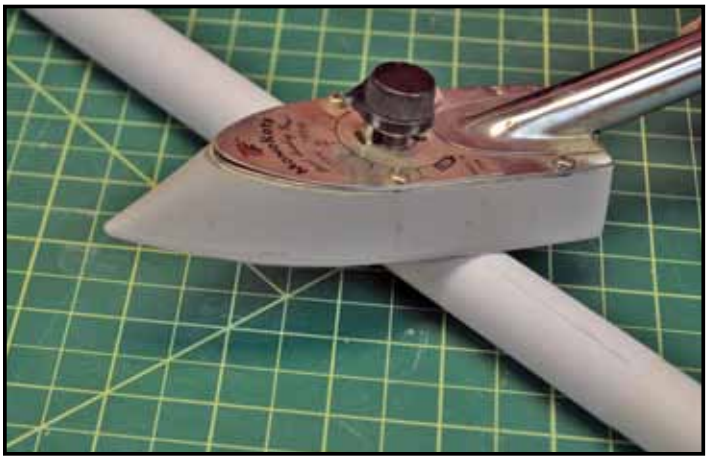

Photo 9: Iron down the paper as you roll it back around the mandrel.

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complete revolution around the mandrel.

Step 6: Iron it down

Now you'll take an iron and apply heat to the paper as you slowly roll it back up around the mandrel.

You can use a clothes iron (no steam, just dry heat), or a MonoKote iron as shown in Photo 9.

You don't have to apply a lot of pressure as you heat the paper with the iron. The weight of the iron resting on the paper is enough. It is the heat the fuses the glue to the paper. So you only need to apply the heat slowly.

You do have to work slow. Start in the middle of the tube and work toward the ends. And roll the mandrel in the direction that winds up the paper.

Photo 10: The completed tube, after it is removed from the mandrel, is strong and lightweight.

Make sure the entire length of the paper is bonded before you roll the tube. You want to avoid the situation where an air bubble is trapped between layers. This will create a weak spot in the tube.

Fortunately, this is a very forgiving method of making tubes. When you apply heat to the tube, the glue melts a little bit, and will allow the paper to slide and you can push the air bubble out towards the end.

It takes about 10 minutes to roll the tube and fuse the layers together with the iron for a 3-layer body tube.

Clean Up

If you didn't get glue all the way to the very edge when you applied the glue earlier, you can take some liquid glue and force it into the seam. Wipe off the excess with a paper towel so there is no glue on the surface.

Then iron the edge down like you did with the rest of the tube. The heat from the iron will dry out the glue as it fuses down the edge.

As I said, this is a very forgiving method of making a tube, where you can still come back and fix your mistakes.

Once you have all the paper rolled up, it is time to slide the tube off of the mandrel.

Hopefully, you didn't have glue touching the mandrel. If you did, try to apply some more heat to soften the glue, so that you can slide the mandrel out from the tube.

With this method, you can build up any thickness you

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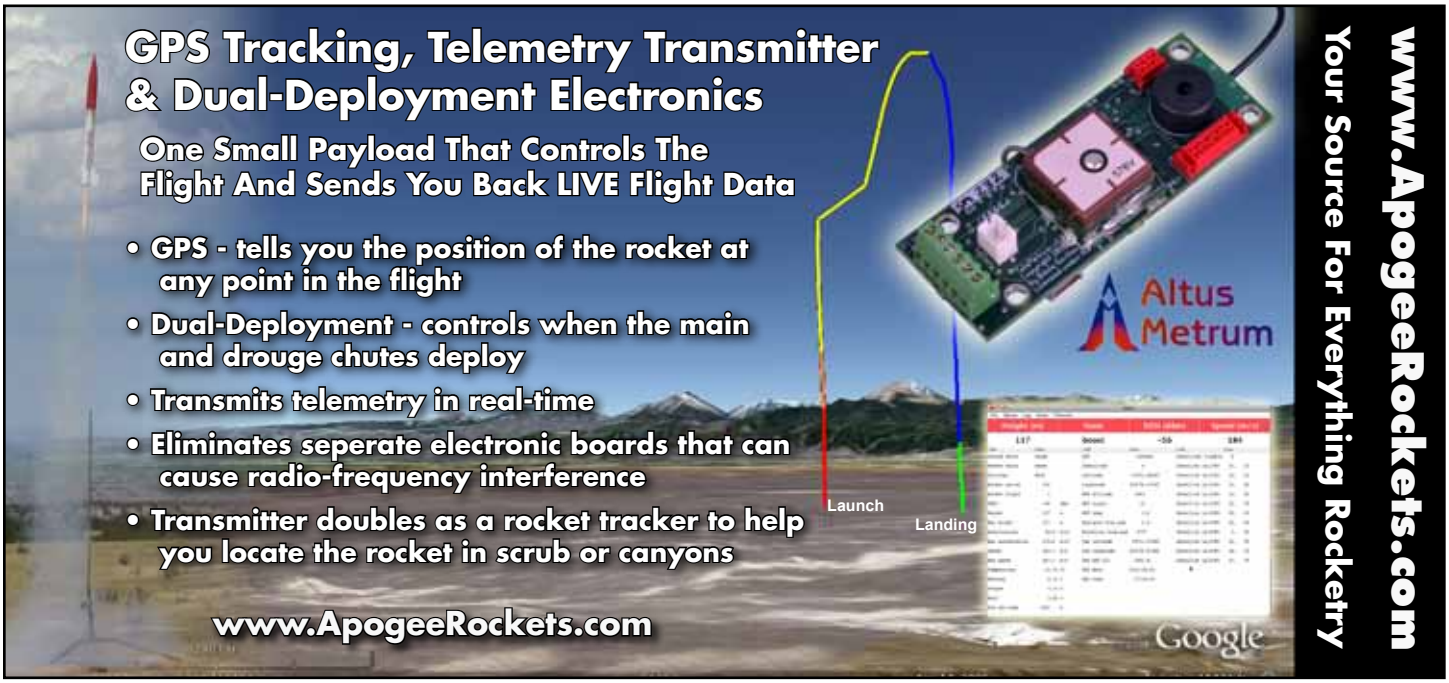

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want. You can even make thick tubes and then cut them down to make centering rings. The only limit is the length of your paper, and the mandrel you're wrapping around.

Transition Sections Too!

The other use for this technique is making awesome transition sections from paper. Not only are they light-weight, they are structurally strong too. I use this for making egg-lofting shrouds, like the one shown in the advertisement below. The plans for this rocket can be found in Newsletter 247 (www.ApogeeRockets.com/Education/Downloads/Newsletter247.pdf)

Long transitions are difficult to roll because it is hard to line up the ends. So this technique for rolling them makes the task much easier, and you won't have to make but a couple of them to get the technique down.

For more information on creating the pattern for a transition, see our video series on our web site at: www.ApogeeRockets.com/Advanced_Construction_Videos/Rocketry_Video_10 .

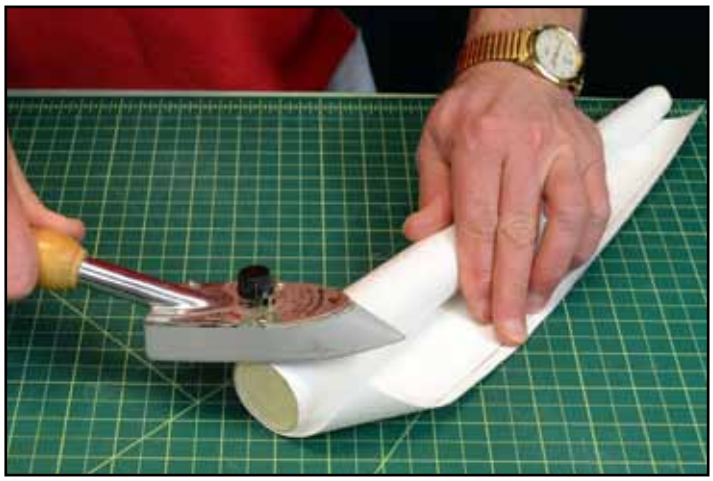
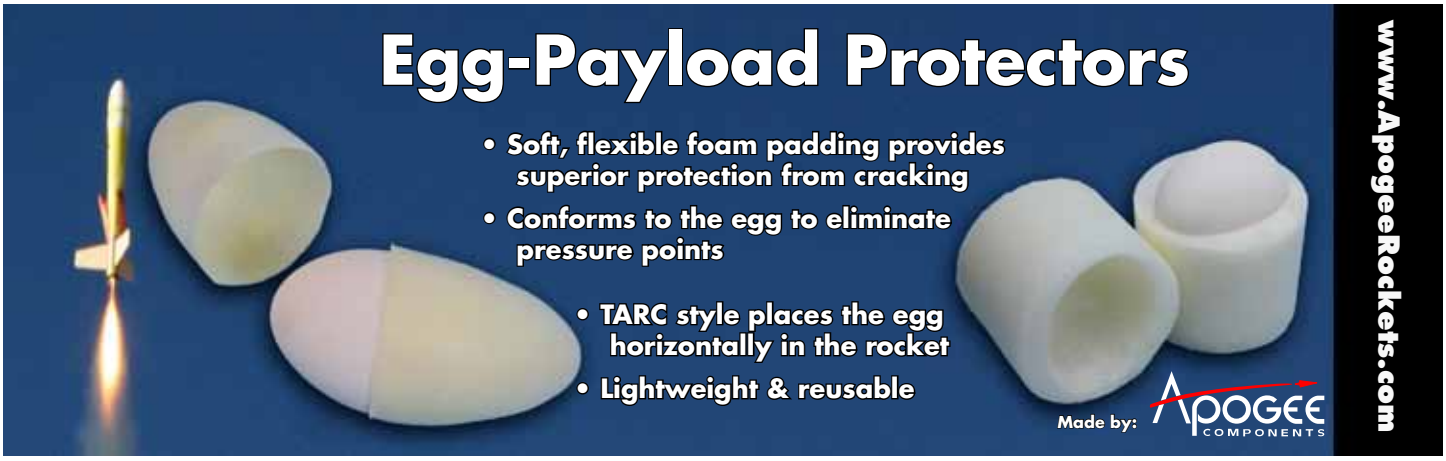


Photo 11: You can also roll transition sections using this method. You only need a tapered mandrel.

Photo 12: The completed transition (right), and the mandrel it was wound around (left).

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.