PEAK OF FLIGHT NEWSLETTER

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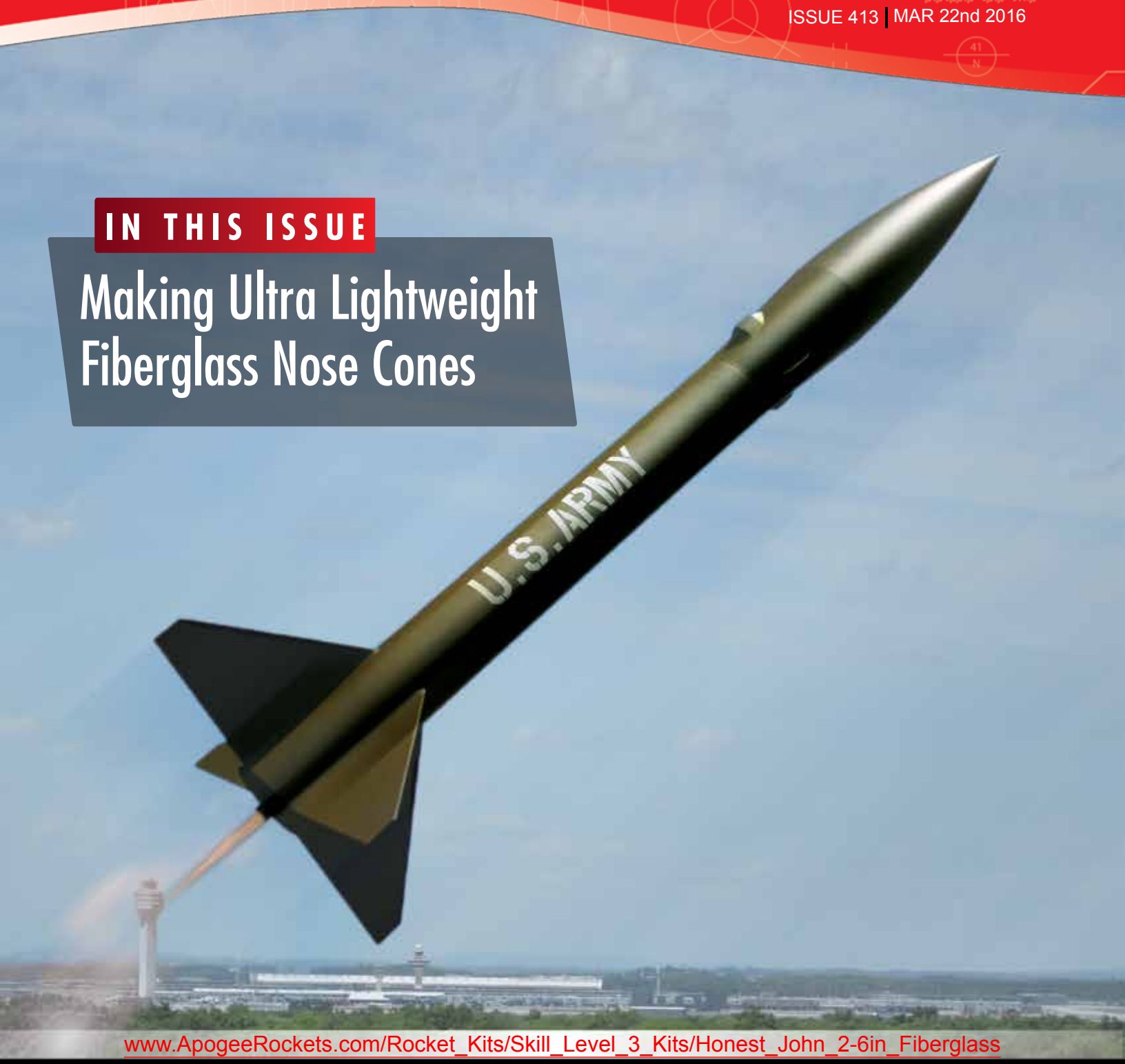

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PEAK OF FLIGHT

Making Ultra Lightweight Fiberglass Nose Cones

By Tim Van Milligan

For competition rocketry, there are times when you need to shave weight from the model. Examples are the parachute and streamer duration events. The lighter the rocket body, the lower the descent rate will be and the longer the rocket will stay in the air.

In this article, I'll show you my latest technique on how to reduce the weight of a nose cone like shown in **Figure 1**, by reducing the amount of fiberglass that goes into the part. I'll show you how to quickly make the pattern that you'll use to cut the fiberglass material.

Figure 1: The lightweight nose cone made from thin fiberglass cloth and epoxy.

I know that most modelers will never use this information, but I want to document the process that I use so that future competitors are able to continue to push the limits of rocketry.

The Apogee Technical Publication #12: "Making Cast Parts With Silicone Rubber Molds" (https://www.apogeerockets.com/Rocket_Books_Videos/Pamphlets_Reports/Tech_Pub_12) that I wrote back in 1995 documents the basic steps for making a fiberglass nose cone. I'm still using the same techniques — and vendors — that I used 20 years ago to make these ultra-light nose cones. What is different now is that I'm trying to reduce the amount of fiberglass that goes into the part in order to reduce the weight and to make the nose cone more consistent.

By consistent, I mean that the wall thickness is uniform around the entire surface of the nose cone. In the original Technical Publication #12 report, I just took a piece of lightweight fiberglass cloth and laid it over the aluminum mandrel and shoved it into the mold. The drawback of this process is that the cloth would fold over itself in order to conform to the curved surface of the mandrel (**see Figure 2**). So what you ended up with were sections of the nose cone that had three layers of cloth, and other sections that were just one layer of cloth.

Figure 2: Wrapping cloth over a curved surface results in many folds in the fabric that just add excess weight. The goal with pattern development is to create a single layer of cloth without excess material.

The objective of this article is to show you a quick way to make a pattern where there is very little overlap of the fiberglass cloth so that the nose cone has a uniform thickness.

Many people ask me what shape I use for our vacuum form nose cones (https://www.apogeerockets.com/Building_Supplies/Nose_Cones/

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Low_Mid_Power_Nose_Cones/FAI_40mm_Vac-Form). The answer is that it was cut out by eyeballing it. Back in the 1990's when I had the nose cone made, it was difficult and expensive to have a true parabolic nose cone shaped. So to save money, I just had the machinist round over the tip of the nose. If I were to make the nose cone mandrel over today, I'd go for a parabolic nose shape.

I mention this because now I have a problem; that I don't know what technical shape the mandrel has, and I need to cut a fiberglass pattern to fit it. So what can I do?

In this case, we'll to use the same trick we used to create an alignment fixture in Peak-of-Flight Newsletter #393 (https://www.apogeerockets.com/education/downloads/Newsletter393.pdf). We'll take a photograph of the nose cone, and trace out the exact outline of it.

Figure 3: The mandrel is photographed in order to find its exact shape.

Figure 3 shows the photo of the nose cone mandrel that I used for this project. This photo was then brought in to the drawing program that I use, so that its outline could be traced. This is shown in **Figure 4**. The steps for making the outline exact were discussed in Newsletter #393.

Once the outline is traced, this becomes the base pattern. Obviously, it won't go around the entire perimeter of the 40mm diameter mandrel. At this point, the width of the outline is only 40mm. In order to go around the perimeter, it

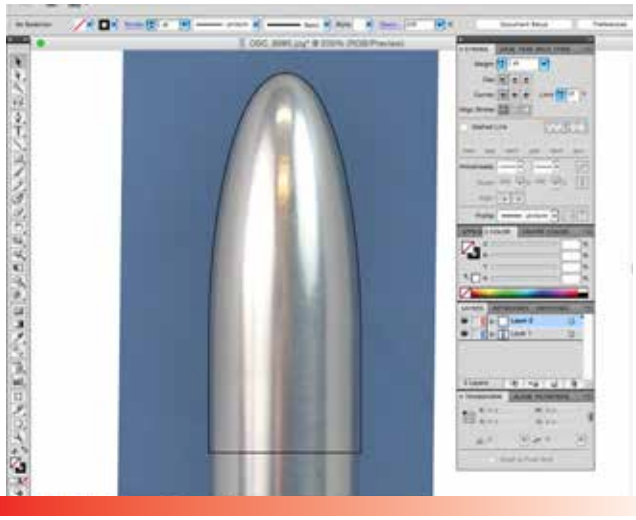

Figure 4: The photo of the mandrel is traced in a drawing program.

would need to be 125.66mm (pi times the diameter). I know that stretching it wouldn't give the right pattern. But I have found through trial-and-error that duplicating the initial pattern four times will give a final pattern that is pretty close to the right shape, with very little overlap. **Figure 5** shows the pattern duplicated 4 times.

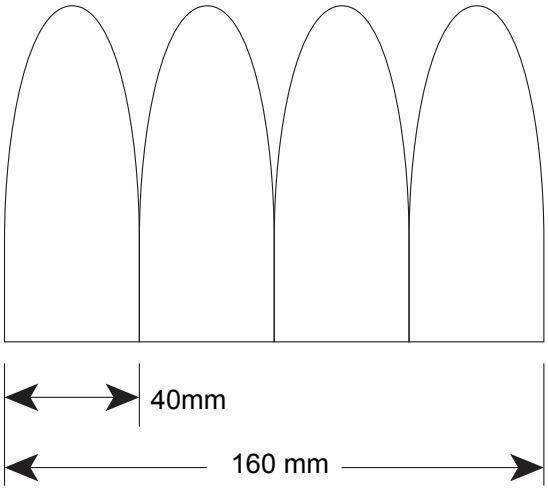

Figure 5: The outline of the nose is duplicated four times, and laid end-to-end.

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There is one problem with this though. Remember, one complete wrap would be 125.66mm, and this four-up pattern is 160mm wide. So it would overlap too much. It needs to be shrunk so that it is closer to 125.66mm.

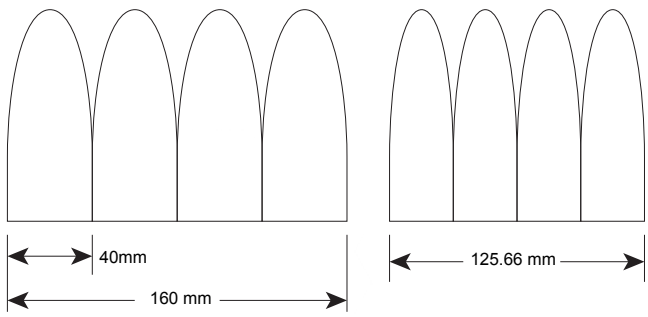

Figure 6. Resizing of the pattern is done next. The overall width of the original is too wide. It is larger than the circumference of the mandrel. On the right, the pattern has been squished to be close to the circumference of the mandrel.

That is also done in the drawing program. I just selected all four patterns and squished them until they were the right width (**see Figure 6**). Actually, I made them with a 0.2mm overlap, so the total width ends up at 125.86mm.

The pattern was then printed out on paper, and transferred to the fiberglass cloth and cut out (see **Figure 7**).

Cutting out a fiberglass pattern like this one can be tricky. I found that a rotary-wheel cutter works the best. The reason is that you don't have to hold the fabric with two hands while you're cutting it. A rotary cutter is available at stores that sell cloth. Just be careful, as the blade is really sharp and it isn't as easy to use as a simple hobby knife.

Figure 7: The pattern was transferred to the fiberglass cloth and cut out using a rotary cutting tool.

The next step would be to wet out the fiberglass cloth and place it on the aluminum mandrel. But because the nose cone would be hard to see since it becomes translucent, I painted the cloth with florescent paint. I used light coats, because I didn't want to saturate the fibers in the cloth too much.

When placing the fiberglass on the nose cone mandrel, don't use too much epoxy. You want just enough to get the cloth to adhere to the mold (and don't forget to put the mold release down first, or you'll never get the fiberglass off).

Next comes the process of moving the cloth around to get it to stick where you want, and to eliminate the gaps where the curved edges come together. This is probably the hardest part of the process.

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While the epoxy is still liquid, the fiberglass wants to straighten itself, and therefore it curls up and away from the curved surface of the aluminum mandrel, as seen in **Figure 8**.

Figure 8: Initially, the cloth wants to straighten and debond from the mandrel. It isn't sticky enough when first applied, and needs to sit a while and cure slightly.

What you have to do is to wait for the epoxy to start to stiffen up and get tackier. This is dependent on the air temperature, but I find that for good 24-hour cure epoxy, it takes about two or three hours for the epoxy to reach this stiffer state. Once it gets to that level of "sticky", it becomes much easier to work with. When you press it down, it stays put.

While you're laying it down, the important concepts are that the edges should touch (**see Figure 9**), and that you press it down so that it matches the curvature of the nose cone.

In **Figure 9**, you can see that there is a very slight gap in the middle of the nose cone where the edges are. I've found that pushing the cloth upward towards the tip of the nose cone will help bring the edges together more evenly. The drawback is that this also creates more overlap of cloth near the tip. There was also a small gap at the very tip of the nose cone. To fill it, I used a very small piece of cloth, which is easiest to see in **Figure 8**.

Figure 9: After it stiffens up, the pattern is shifted around on the mandrel to eliminate gaps along the edges.

With the trial and error from the first nose cone I decided to create a second nose cone (**Figure 10**). The pattern for this nose cone turned out better, and I'm pleased with the overall fit. On the second nose cone I further closed the gaps on the side by cutting some strips of fiberglass cloth. I then placed the thin strips of cloth over the exposed edges. This is shown in **Figure 10**.

Figure 10: Where gaps existed, strips of fiberglass cloth were used to cover them over.

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My thoughts at this point are to try to eliminate this overlap in cloth as much as possible. Even though the outer surface is smooth, where there is overlap, there is twice as much epoxy as there should be. Think about it; you have two layers of cloth to wet out, so it needs twice the amount of epoxy. The weight is crucial in these nose cones, so the amount of overlap has to be reduced to a minimum.

My plan for future builds of this nose cone is to tweak the pattern slightly to reduce the overlap near the tip. As I mentioned previously, the pattern is pretty close to optimum using the steps I laid out here, so it won't take much shape changing to get it even better.

Creating patterns to go around curved shapes is pretty complicated. But I've used this technique of creating patterns for other curved shapes (**see Figure 11**), and it works pretty well. It gets you in the ballpark quickly.

Figure 11: Other complex shapes were created using this same pattern-making method.

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. He is an avid rocketry competitor, and is Level 3 high power certified. He is often asked what is the biggest rocket he's ever launched. His answer is that 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 also the author of the books: "Model Rocket Design and Construction," "69 Simple Science Fair Projects with Model Rockets: Aeronautics" and publisher of the "Peak-of-Flight" newsletter, a FREE e-zine newsletter about model rockets. You can email him by using the contact form at: https://www.apogeerockets.com/Contact.