PEAK OF FLIGHT NEWSLETTER

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MAKING CARBON FIBER NOSECONES WITH A 3D PRINTED MOLD

& TIM'S MESSY DESK

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PEAK OF FLIGHT

Making Carbon Fiber Nosecones with a 3D Printed Mold

By Tony Smith

A lot of people are building rockets and making rocket parts with 3D Printing. As we know, 3D printed parts are not as strong and light as composite parts. On the plus side, you can design and print parts for your rockets pretty cheaply. Composite parts are a lot stronger than 3D printed parts, but making plugs and molds can put some people off from trying it. In this article, I am going to explain how I combine 3D printing and composites to make rocket parts that are light, strong, and require less time to build over traditional composite modeling. I am going to show you how I prep my 3D printed molds after printing them, and how I paint and lay up light parts. I am not going to explain how to design the nose cone that I am using as an example in this article. There are a lot of CAD (computer aided design) programs around that you can use to design your rocket or rocket parts.

I designed this nose cone in Fusion 360. I use Fusion 360 because it is free for hobbyists and does what I want. After I modeled the nose cone, I modeled the molds for it and printed the molds in PLA plastic. By modeling the nose cone in CAD and 3D printing the molds, you save a lot of time. You do not have to physically make a model/plug, prepare it to be molded, and make the molds. You just have to print the molds and prepare the surface.

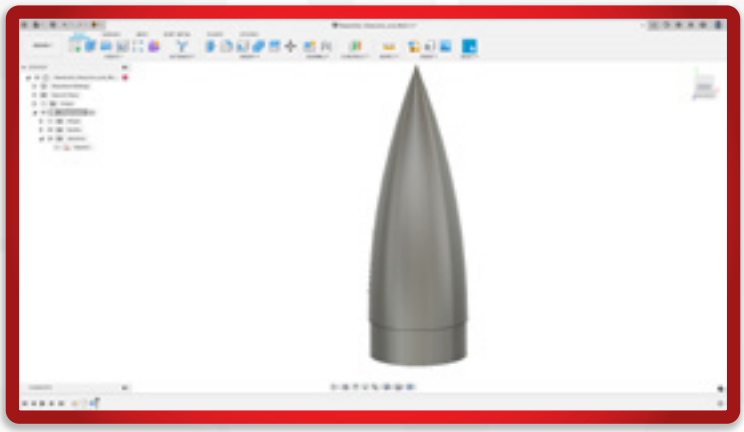

FIGURE 1: THE 3D MODELED NOSECONE WHICH ACTS AS A DIGITAL PLUG.

The next step for me is to get a mirror like surface on the molds, because I like my parts to be painted in the molds. The parts are lighter by painting them this way than painting them later. Some people just spray a coat of mold release on the molds and layup parts after they print the molds. That is fine if that is what you want to do.

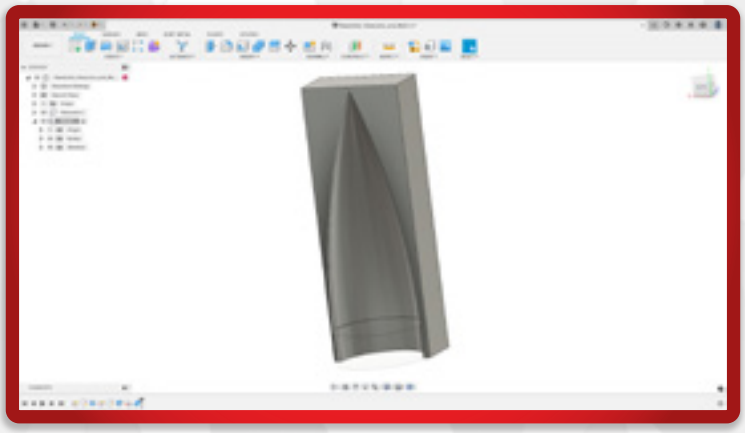

FIGURE 2: THE MODELED MOLD FOR ONE HALF OF THE NOSECONE. READY TO SLICE AND 3D PRINT.

If you do not prep the surface of the molds after you print them, the surface on your part will have the same finish as the mold surface and you will have to do the following steps on every part to get a smooth surface. To get a smooth part, you first sand the part with 100 grit sandpaper. Next, you spray your part with a good primer. I sometimes use a 2-part automotive primer or automotive filler primer in a can. I like Duplicolor because you can spray it on thick and it sands easily. After you spray the primer on you should be able to see any imperfections on the part. If you need to repair a section on the part, you should repair it now. To fill spots, you want to use a lightweight automotive glazing putty. I like Evercoat body shop glazing putty. It is a 2-part putty. You mix it up and spread a thin coat of it on the imperfection. Use it sparingly, because the more you put on, the more you have to sand off the part.

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Next sand the part with 220 grit sandpaper. Spray another coat of primer on the part. If you still have an imperfection on the part, repeat the above process to fix it. Once the part looks good, sand it with 320 grit sandpaper. The part is ready to paint now. If you paint it at this point, you can use paint in a can or automotive paints. It does not matter which one you use, because you are going to use an automotive clear coat over the paint.

FIGURE 3: THE 3D PRINTED MOLD, MASKED FOR THE FIRST COAT OF PRIMER.

FIGURE 4: THE MOLD WITH THE INITIAL PRIMER COAT APPLIED AND READY FOR SANDING.

If you use an automotive 2 stage clear coat in a can, wait until you are ready to clear coat the whole rocket. You wait because the 2-part clear in a can I use is only good for 48 hours. I use SprayMax 2k Clear in a can. It is expensive and if you do not have a large part that needs a clear coat, you will waste what is left of the clear coat. I use automotive clear, because it is UV rated and it gives you a hard shiny finish.

If you do not want a shiny finish, use a satin clear coat. Remember to spray on the paint and clear coat sparingly if you are worried about weight. If you do not want to use a clear coat over the color, but still want a nice smooth shiny finish, after you paint the part, sand the part with 1000 grit sandpaper, then 1500 and 2000. The surface should have a haze on it now, but will look shiny when you hold it up to the light.

Next you want to polish the part with automotive polish. I use Griots Complete Compound. Follow the instructions on the bottle of polish you buy and use. Your part is now ready for use after painting and clear coating.

After the molds are printed, I sand the surface with 60 grit sandpaper to get rid of the printing lines. Next, I mix up some epoxy automotive primer and brush a thick layer of it on the surface with a paint brush (Figure 3). You can use primer in the can also. I use Duplicolor when I do (Figure 4). After it is dry, I sand the surface with 220 grit sandpaper. I will brush another layer of the primer on the surface if it needs it and then sand it with 320 grit sandpaper. Once the final sanding with 320 grit is done, I will paint the surface with spray paint. I spray 3 coats on the surface and let it dry. After the paint dries, I wet sand the surface with 1000 grit sandpaper then 1500 grit. The surface of the mold should be very smooth now. I then polish the molds. The mold surface should have a mirror finish on it now.

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I then apply 3 coats of wax, waiting 12 hours in between coats. Here is a pro tip: When you wipe the coat of wax on the mold, do not let it dry. Wipe it off before it gets hard. If you let it dry, the PVA (Polyvinyl Alcohol) will not brush on smoothly on the mold and you can ruin the finish on your mold and your part. After this, the mold is ready for laying up parts.

For the layup, I first use a foam brush and brush on a layer of PVA. You can also spray it on. If you do not have a paint gun, you can buy a Prevail sprayer kit and use it to spray on the PVA. If you do use the Prevail, you have to water down the PVA a little to get it flow nicely out of the nozzle. I just brush it on because it is easy and you only need a foam brush.

Once that is dry, I spray a coverage coat of paint onto the surface of the mold. The color depends on what I want it to be. If I am not sure of what color I want, I will just spray a coverage coat of primer on the surface. I paint the part in mold to prevent pinholes in the part, and painting the part now instead of later makes a lighter painted part.

After the paint has dried, I will make a template of the mold to cut out the shape of the carbon fiber. The number of layers of carbon cloth will depend on how thick you want the nose cone. As a general rule, the amount of epoxy you use will equal the total weight of the carbon fiber. Cut out your carbon from your templates and weigh it. The weight will be a good estimate of how much epoxy you will need. I always mix up a little more than needed, just in case I need a little more epoxy. Since carbon fiber or glass cloth does not like 90-degree bends and corners, I will mix up a little epoxy with cabosil and put it on the bends and corners.

FIGURE 5: ONE TYPE OF VACUUM STORAGE BAGS.

Cabosil is just an epoxy thickener. I just add enough to the epoxy so it does not run. In the case of this nose cone, I apply the thickened epoxy at the tip of the nose cone mold and the ridge line of the mold.

If you are going to use a vacuum bag on your layup, you will not have to use the thickened epoxy. To make the lightest parts, you should use a vacuum bag on your parts. If you want the lightest part, I am going to explain a very cheap and very effective way to vacuum bag your part. You will need to go and buy vacuum storage bags (Figure 5). Buy a bag that is big enough for your mold to fit inside. You can buy them online or locally. If you want, you can buy a professional vacuum pump, but it is not needed for this project. The pumps are expensive, but work extremely well.

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FIGURE 6: PEEL PLY APPLIED OVER A CARBON FIBER LAYUP, COMPLETE WITH THE OVERLAPPING PERIMETER.

FIGURE 7: BREATHER CLOTH LAYERED ON TOP OF THE LAYUP.

FIGURE 8: MOLD AND LAYUP SEALED IN VACUUM BAG WITH ADDITIONAL BREATHER CLOTHS UNDER THE EVACUATION PORT.

If you are making parts professionally for other people, I would invest in a professional vacuum pump. You will also need to buy peel ply and breather. You can buy them online at any composite store.

After you have finished laying up the part in the mold and it is still wet, you put a layer of peel ply on the part with about an inch of overlap (Figure 6). Then put a layer of breather cloth over the peel ply (Figure 7). Place the mold in the vacuum bag and seal it (Figure 8).

Next take a shop vac and place it over the valve on the bag and turn on the shop vac (Figure 9). It will now pull a low-pressure vacuum that is needed. Keep the mold in the

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bag until the epoxy has dried (Figure 10). After the epoxy has dried, remove the mold from the bag. Remove the breather and peel off the peel ply from the part (Figure 11). Remove the part from the mold and trim it at the seam line. Do not rinse the part yet. Take a little water and sprinkle it on the part and the mold and place the part back in the mold (Figure 12). The PVA now acts as a low tack glue to hold the part in the mold. Take some mold release wax and apply it to the flange of the mold. This will prevent the epoxy from sticking to the mold.

We are now going to join the two parts with a seam made of epoxy mixed with cabosil. Mix up some epoxy and add cabosil, to thicken the epoxy so it does not run. Put the thickened epoxy in a cake piping bag and put a thin bead of epoxy on the seam line of the part. Do this to

FIGURE 10: THE FULLY EVACUATED BAG PULLS THE LAYUP TIGHTLY INTO THE MOLD READY FOR THE EPOXY RESIN TO CURE.

FIGURE 9: PULLING A VACUUM WITH A SHOP VAC.

FIGURE 11: THE PART AS IT LOOKS AFTER REMOVING THE BAG, BREATHER AND PEEL PLY.

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FIGURE 12: THE PART TRIMMED AND REINSERTED INTO THE MOLD TO BE JOINED TO THE SECOND HALF.

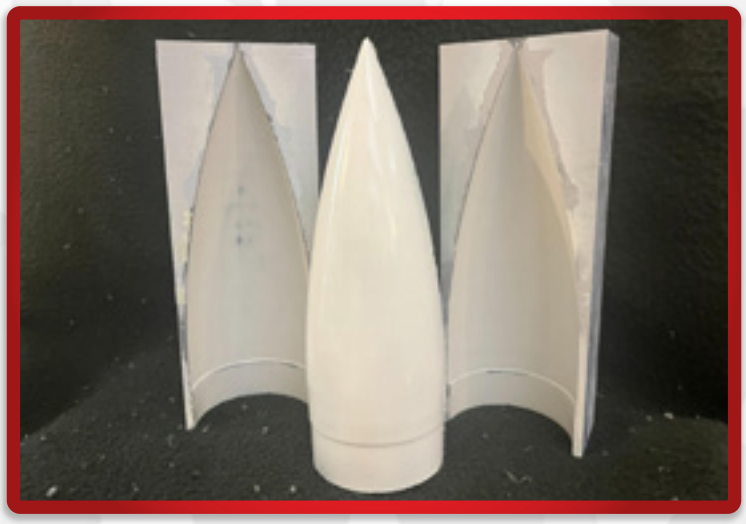

FIGURE 13: AN ASSEMBLED NOSE CONE, FRESH FROM THE MOLDS. THE MIRROR QUALITY SURFACE FINISH OF THE MOLDS WILL TRANSFER TO THE PARTS PULLED FROM THEM.

both parts. Now join the two halves of the mold and clamp them together. Look inside the mold and you should see the two bead lines. They should have a gap between them. Take a small stick and move the beads so they touch each other. Let the epoxy cure. Once the epoxy is cured, you can remove the part from the mold (Figure 13). You should have a very strong, lightweight part now ready for use.

For an alternate example, I am not going to vacuum bag the part because weight is not critical. I brush a coat of epoxy on the surface of the mold. I lay the carbon cloth on the surface of the mold. I use the brush to stipple the surface of the carbon. I allow the epoxy to rise up through the carbon cloth so it looks wet. I lay another layer of carbon down on the previous layer and stipple again adding a little more epoxy to the surface.

Since I am not vacuum bagging this example, I take paper towels and soak up as much epoxy as I can from the layup. I do this just enough so the layup does not look wet. The wet look is just extra weight. I then set the part aside to cure.

Once the layup has cured until the epoxy is no longer sticky, the part can be trimmed. For a really light seam, I will just apply a bead of thickened epoxy all around the edge of the molds applied with a little bag filled with the thickened epoxy. The bead of thickened epoxy is not as strong as the seaming strip, but works really well. If the seaming bead

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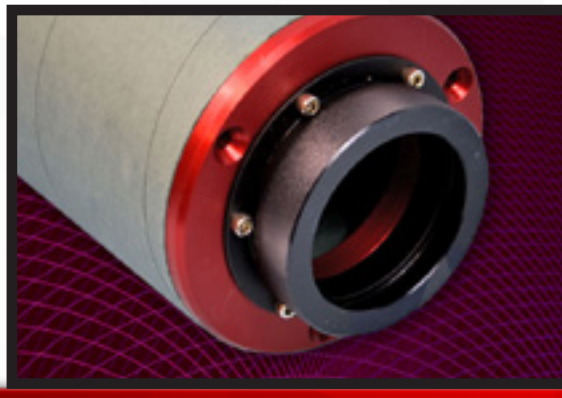

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is something you would like to see me demonstrate in the future, let me know. For the strip, I am going to cut a 1/2-inch strip from the carbon fiber, long enough to go around the edge of the mold.

Now I am going to line up the molds and clamp them together. Next, I will mix up a little epoxy in a cup. I brush the epoxy on the carbon fiber strip. I will put this strip over the seam line, inside the mold over the layed up part. I use an acid brush to smooth out the carbon strip inside the mold. I then set the mold aside to dry. Once the part has dried in the molds, I take off the clamps and separate the molds with plastic wedges. I carefully remove the part from the molds.

Next, I use a file to file the excess epoxy off of the seam line. I then rinse the part off with water. The part is now ready for use.

If you want to learn how to make a composite rocket tube, I would recommend you take the course on how to build composite rocket tubes on the Apogee web site (see *Peak Of Flight* Newsletter #481 - https://www.apogeerockets.com/education/downloads/Newsletter481.pdf, and https://www.udemy.com/course/make-ultra-lightweight-carbon-fiber-tubes-for-model-rockets/). They show you how to make carbon fiber rocket bodies that are smaller in size, but the same technique is used in making larger bodies.

These are components of the rocket I am currently building (Figure 14). This rocket is my own design. The nose cone molds I used in this article are the same ones I am using to make the nose cone for my rocket. The body of the rocket is fiberglass and the nose cone is carbon fiber. I am going to make carbon fiber fins for it next.

FIGURE 14: NOSECONE AS DESCRIBED IN THIS ARTICLE, AND PLYWOOD FINS.

FIGURE 15: MATERIALS REQUIRED FOR SMOOTHING THE MOLDS: (LEFT TO RIGHT) POLISHING COMPOUND, FILLER PUTTY, PRIMER PAINT, AND SURFACE PAINT.

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FIGURE 16: MATERIALS REQUIRED FOR LAYUP: (LEFT TO RIGHT) MOLD RELEASE WAX, PVA, EPOXY HARDENER, AND EPOXY RESIN.

If you are having trouble locating the materials and you live in the United States, you can purchase all your materials from Fibre Glast (Figure 15 and Figure 16). If you live in Europe, you can purchase everything from Easy Composites.

I hope this article has taught you how you can use 3D printing in printing your own molds and laying up light parts.

About the Author

Tony Watkins is a retired Airforce Airborne Cryptologic Linguist who speaks 3 languages. He likes to share his knowledge of composites with his fellow rocket modelers and is always asked to do composite work, such as fiberglassing cardboard tubes, making carbon fiber nose cones or making composite rocket tubes. When asked, he always helps. He has worked in composites for over 25 years and has done composite work for world class RC modelers. He holds an AA in Foreign Language from DLIFLC and a Diploma in Electronics Technician from Pierce Community College. He also holds an Extra Class amateur radio license. Currently, he likes to build model rockets, RC airplanes and RC helicopters.

He is very honored to write an article for the *Peak of Flight* newsletter. He currently lives in Arizona and is building a completely composite rocket from scratch. He looks forward to writing more articles for the newsletter and meeting more rocket modelers and helping them as much as he can.

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Tim's Messy Desk

By Tim Van Milligan

I appreciate all of you that wished me a happy birthday on the 22nd. It was a wonderful day, and I appreciate all the well wishes. The team here at Apogee gave me a great birthday card, and we celebrated with goodies as well.

It has been a couple of months since my last blog (issue 576 - https://www.apogeerockets.com/education/downloads/Newsletter576.pdf) describing what's going on in my little corner of the world. And I've got to say that a lot has been happening.

Daddy-Daughter Trip

In July, I had a fun daddy-daughter trip with Ashley to NARAM in Missouri. It was hot, but was quite successful for Ashley. Even though she is considered a Junior flyer, she had to compete against the adults for a spot on the USA national team. And she did really well, qualifying in three different events. But she'll cut it back down to two events for the World Space Championships in Texas next summer: S6 (1/2A-engine streamer duration), and S9 (1/2A-engine Gyrocopter duration).

This was a well attended event, with 27 Juniors and 41 Seniors competing. I was really impressed at how well it was run, with plenty of non-flyers helping out to run the range so that nobody had to wait to get a rocket into the sky. Well done everyone!

All the Juniors were able to earn a spot on the team, which is fresh blood into the hobby. I've volunteered to write a newsletter to spotlight the new team members so that we all get to know who they are. I hope that it gets out to everyone in the rocketry community that wishes to support the home team.

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New Designer Here at Apogee

At the beginning of August, we hired Martin Jay McKee to be our new product developer here at Apogee. Martin is a local rocketeer that flew under my radar in our search for help. I didn't realize that he was out there, and boy was I surprised with his talent.

He is already working on several projects. You saw one of his little creations in Newsletter 580 - https://www.apogeerockets.com/education/downloads/Newsletter580.pdf with the Dolphin rocket plan. How cute was that one? I was very impressed by it myself, and enjoyed launching it.

The next two rockets that Martin is working on are downscale versions of the Peregrine and the Katana. The scaled down version of the Zephyr went over very well with customers, so we decided that we should do the others in the series as well. We flew the rockets last weekend, and they were beautiful flights. It is so nice to have help in the product development world. We've got big plans for a lot of cool Apogee products.

The GPS Gliding Parachute Status

People always ask me how the GPS gliding parachute is coming along. The good news is that since Martin came on board, I've had more time to work on it.

Unfortunately, there are some changes to what we originally wanted it to do. Since the Covid pandemic, it has

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been hard to get the electronic components necessary to build the GPS part of the product. So we're backing it down to just being an RC Gliding Parachute. So instead of a computer bringing it back home to your feet, you'll have to use an RC set-up to steer it yourself.

That means you'll have to get your own RC transmitter and receiver. Any RC airplane system will work, as it only needs a single servo to turn left-or-right.

The next step in the project is to create the instruction book on how to rig everything up. This is the part I've been dreading since it is a bit more complex than any rocket we've done before. But we're pretty far along, and I can't wait to start shipping it. I don't have an estimated release date yet, so please be patient. If you're a subscriber to our *Peak-of-Flight* Newsletter, you'll be one of the first to know its availability.

Halloween Fun

The next major holiday is Halloween. We thought we'd have some fun with it this year, and put out some vinyl decals so you can make a spooky looking rocket. Look for those decals sometime in September, so you have plenty of time to build and decorate your autumn themed rocket.

Martin is also working on a different rocketry plan for our newsletter that will also have a Halloween theme to it. I don't want to give away the secret yet, so just be sure to check your email box every Tuesday when we put out these newsletters.

SLS Launch

As I write this, the SLS launch is scheduled for Monday the 29th. I envy you people that live in Florida that might be able to witness the launch from a nice viewing area. My daughter Allison (who got married in June) moved to Florida and is begging me to come watch it with her. Unfortunately, I'll have to watch it here on a live-stream. But I'm really looking forward to it.

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Tim's Messy Desk

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Finally, school is going back into session. I talked to a teacher last week that was interested in rocketry. My suggestion to him was to do rocketry early in the school year. The reason is that the weather is still great compared to other times of the year, and most importantly, it really engages the minds of the students. Nothing excites students like rocketry, so it focuses their attention on learning. And with the SLS going off, there should be a lot of excitement about that as well. So remind those teachers to do rocketry early in the school year and not wait until good weather comes around again in May of next spring.

That is what is on my desk, and I'm thankful for those of you that are interested in this little corner of the rocketry world. It's a small corner.