Issue 673 / March 3rd, 2026

PEAK OF FLIGHT NEWSLETTER

Apogee Components, Inc. / ApogeeRockets.com / Colorado Springs, CO



How to Design and Build Sandwich Structure Composite Fins

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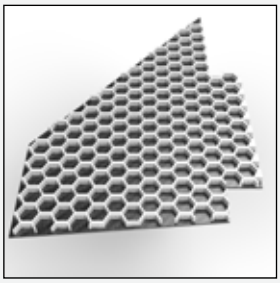
COVER PHOTO



Stratus Gale Glider kit

The Stratus Gale is an exciting slide-wing rocket glider. What makes it unique is the curved fuselage boom that gives the wing a positive angle-of-attack during glide, but 0° at lift-off. This give straight boosts, and gentle glides to the ground.

FEATURED ARTICLES



How to Design and Build Composite Structure Fins

In this issue, BYU rocketeer Alex Magee shares how a setback on his university IREC team inspired him to design sandwich structure composite fins—lighter, stronger, and smarter than traditional designs. Learn how he combined carbon fiber, 3D-printed cores, and engineering ingenuity to break the sound barrier within a 10,000-foot limit.

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The LaserLoc rocket rips skyward!



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How to Design and Build Composite Structure Fins

By Alex Magee

Tired of having your large fins push your CG too far down on your rocket? Looking to win your next drag race competition? Are you trying to push your rocketry projects to the next level in general? In that case, this article is for you.

Last year, I was unfortunately not selected for my university IREC team and I was somewhat disappointed about this. I was one of a limited number of people who had experience fabricating carbon fiber airframes and was very close to earning my L2 cert, but that wasn't enough. I decided I needed to add something to my rocketry resume that would make it impossible to resist selecting me for next year's IREC team; I would earn my L3 cert with a rocket that flew faster than the speed of sound. Now that's honestly not that hard, those L3 motors pack a lot of power, but it is hard with the local altitude limit of 10,000 feet. I needed a light and strong rocket with a lot of drag. I figured the best way to change the drag was to develop the right fins, so off I went to look at my options.

In high power rocketry, there are four generic fin options: plywood, fiberglass, carbon fiber, and metal, each with their own pros and cons. Plywood is light and cheap, but weak. Metal is also rather cheap and strong, but it's too heavy. Fiberglass and carbon fiber are even stronger, but more expensive, but were still too heavy for my rocket. So with all my options looking rather unattractive, I decided to make a new one, the sandwich structure composite fin.

So now you are probably asking, what is a sandwich structure composite? It's a composite material formed by bonding two thin but strong surfaces to a lightweight weak core. An example you know intuitively is cardboard, like shown below. The paper it's made out of is rather weak, but thick cardboard sheets are still hard to bend despite having mostly air inside. The strength comes from something called the area moment of inertia. Think of it as a shape factor for stiffness or bending strength. The larger the



Figure 1. A rather common sandwich structure composite, cardboard.



area moment of inertia for an object, the harder it is to bend. In the case of cardboard, the spacing between the sheets of paper on the outside increases the area moment of inertia and makes it much stronger. The formulas for the area moment of inertia of two different cross sections is shown in figure 2.

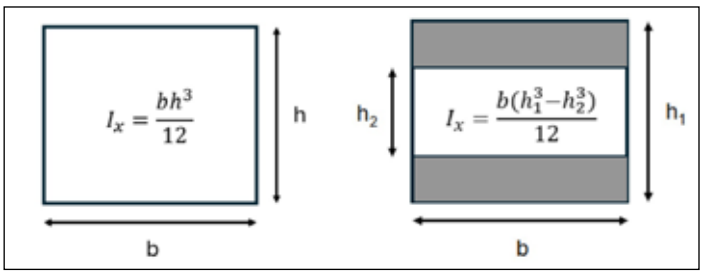


Figure 2. The area moment of inertia for a solid rectangular cross section (left) and two equally sized rectangular plates with a space in between (right).

Let's analyze the formulas in figure 2 a bit. Suppose we have a rectangular beam but we cut out the middle 50% of the cross section, like the picture on the right of figure 2. How strong is the beam now compared to the solid beam? It has roughly 87.5% of its original strength, using the formulas given. When I applied this formula to my rocket, I realized I could make my fins almost 50% lighter than if I made them out of a solid material and lose only a fraction of the strength. This weight reduction allowed me to break the sound barrier and have large enough fins to both survive the

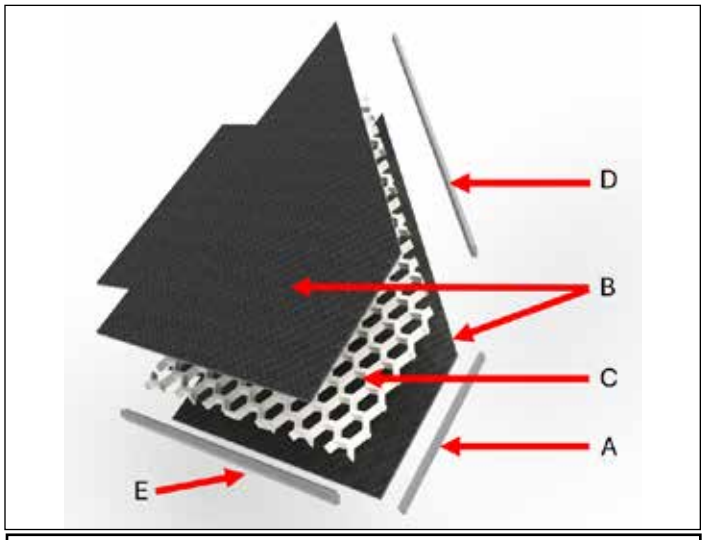


Figure 3. The parts of a sandwich structure composite fin. A: Outside edge. B: Outside panel. C: Core. D: Leading edge. E: Tailing edge.





speed and produce enough drag.

Armed with this knowledge about the advantages of sandwich composites in fin construction and therefore freed from the constraints of traditional fins, you are probably dying to use them on your next rocketry project. But hold your horses! We need to start with the basics. There are six parts to a good sandwich structure composite fin. There are two strong outer panels, a light core, a leading edge, a tailing edge, and an outer edge. The design and construction of each of these is important and will affect the aerodynamic and strength properties of your fins.

Before you even get started on any of the individual parts, you first need to pick a geometry and thickness for your fins. With those selected, you need to calculate a fin flutter speed. Apogee has published several excellent newsletters on this process, refer to those for how to do this correctly. A word of caution, those fin flutter calculations apply to SOLID fins, not the sandwich structure composite fins. This means you will need to multiply the calculated fin flutter speed by the fraction of your new area moment of inertia when compared to a solid fin. After that you should still have a generous safety factor. In my case, my L3 advisors only let me use the fins because I also promised them results from a laser vibrometry test. If your RSO learns you're using this type of fin and you haven't checked your flutter speed, he may also turn you down. So do the math BEFORE you build. As the old saying goes, measure twice, cut once.

Making Carbon Fiber Plate Layups

Once you have designed your fins, it's time to actually get your hands dirty and start building them. When I built my sandwich structure composite fins, I used carbon fiber for the strong outside panels of my fins. The process I will describe will detail how to start with uncured carbon fiber to make the fins. If you don't want to make the carbon fiber for the fins or are using a different material to make the outside panels, you can probably skip this part.

Carbon fiber plate layups are relatively simple, though time consuming if you are inexperienced or don't have adequate tools. Why use a plate layup? Because the odds that you can actually cut carbon fiber fabric or carbon fiber pre-preg to the shape of your fins is dubious at best. It is much easier and faster to cut them out of a plate with a power tool to get them to turn out well. First find a nice flat plate of glass or metal and scrub it clean with alcohol. Any imperfection on this sheet will become an imperfection on your fin, so this cleaning is crucial. Once clean, cover an area slightly larger than the size of your desired carbon fiber plate in mold release on one side of the metal or glass sheet. Keep in mind that you will need two outside panels for each fin, so size your sheets accordingly. To ensure you can get your plate layups off the glass

or metal plate, use at least two coats of the mold release and wait for it to dry between coats. With this prepped base, you can apply layers of carbon fiber fabric or pre-preg to the base. Each layer should have a different fiber direction than the preceding layer for maximum strength. If you are using fabric, apply epoxy resin to each layer. Make sure you use gloves and make sure you do not get any mold release between the layers. Also be sure to remove any air bubbles between the layers.

When you have applied enough layers to reach an appropriate thickness, it is now time to prepare the carbon fiber for curing. Place one layer of peel-ply that extends just beyond the edges of your layup. This peel-ply will allow you to have a uniform surface finish and ensure uniform resin distribution. With the peel-ply added it is time to apply a layer of breather cloth that covers the peel-ply. The breather cloth helps avoid air pockets when pulling a vacuum on the curing carbon fiber. After applying breather cloth, place a vacuum bag sheet on the material and adhere it to the glass or metal base plate. It is critical that this vacuum bag is smooth or you will end up with wrinkles in your sheet, and once it is smooth, you can connect the set up to a vacuum pump and begin to cure it at a temperature given by the epoxy resin or pre-preg manufacturer.

The final set up should look something like figure 4.



Figure 4. A completed vacuum bag set up.

When your carbon fiber plate is finished, you can cut it into the shape of your fins. It is important to check if it's warped, this happened to me and it was quite frustrating. The good news is that with sandwich structure composites, if your outside panels are slightly warped, it is not a problem unlike for traditional fins. You just need to cut out the outside panels so the two panels for each fin have opposite curvatures. This way they will cancel out when sandwiched together.



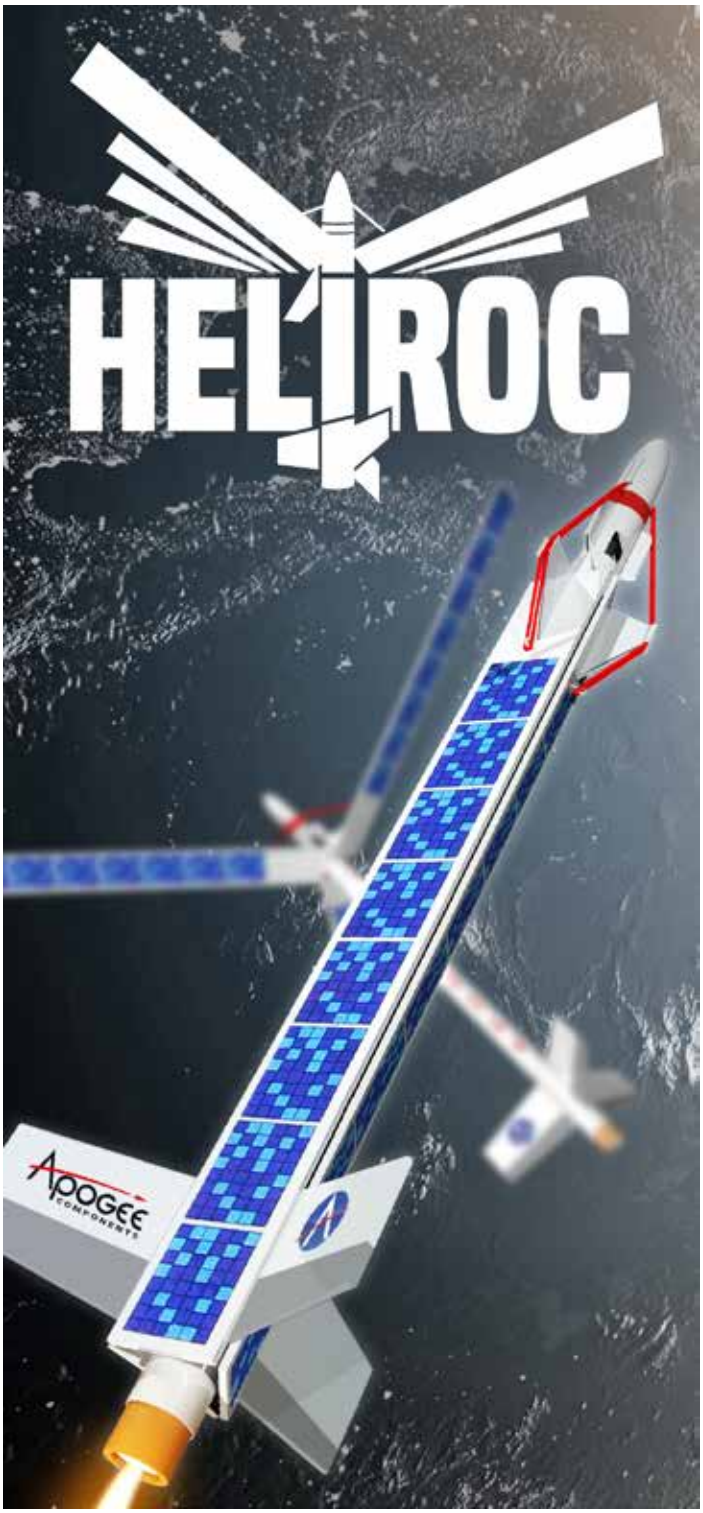




Figure 5. My finished sheet looked almost as bad as the one above, but it still worked fine!

Designing a Core

Now that you have the outside panels of your fin, it's time to select a good core material. There are several options including Depron foam, 3d printed material, even balsa wood. The ideal core is light, with good compressive and shear strength. It also must adhere well to the outside pieces. For my fins I chose a 3d printed PETG honeycomb because I knew I could tailor it to the exact shape and height while keeping it light through reduced infill. It worked well but required a massive print bed. If you are going to use a 3d printed core, make sure to use a material with a reasonably high melting point. The fins will be exposed to the heat of the sun and the motor and you certainly don't want your core turning into soup as your rocket takes off.

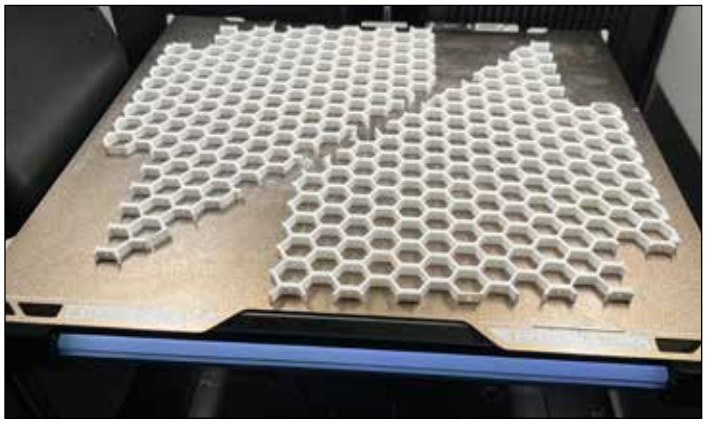


Figure 6. My PETG fin cores, freshly printed.

There is a best way to design the shape of a core. Ideally, the core is flush with the outside part on the sides of the fin facing towards the rocket and leaves a small gap on the exterior facing sides of the fin. This way you can use the fin tabs to properly align the core in construction and securely mount the fin to the rocket. It also leaves you room to attach specialized leading and trailing edges. A word of caution if you are choosing any sort of honeycomb structure: As you increase in altitude the pressure drops and

Fig

will push your core outward. If it can't vent there is a possibility the pressure will damage your fin. A good solution to this is to drill holes to connect the honeycomb sections and leave a small vent hole near the rear of the fin for the excess air to escape.

Making the Leading, Tailing, and Outside Edges

One especially nice part about the sandwich composite fins is that you have complete control of the profile of the leading and tailing edge. This allows for more control of the fin aerodynamics as opposed to typical carbon fiber or fiberglass where it is nearly impossible to machine an airfoil, rounded, or chamfered edge. The leading and tailing edges should be 3D-printed to get the proper shape that will allow them to bond to both the inside and outside edges of the outside parts. Choose a fiber reinforced filament for these parts because they need to withstand falls, temperature changes and contribute stiffness to the final fin. When printing, you should print so that the XY plane is perpendicular to the leading edge of the fin, this way they don't delaminate and contribute the maximum strength to the fin. You will need some sanding to get a smooth surface, but it is worth it.

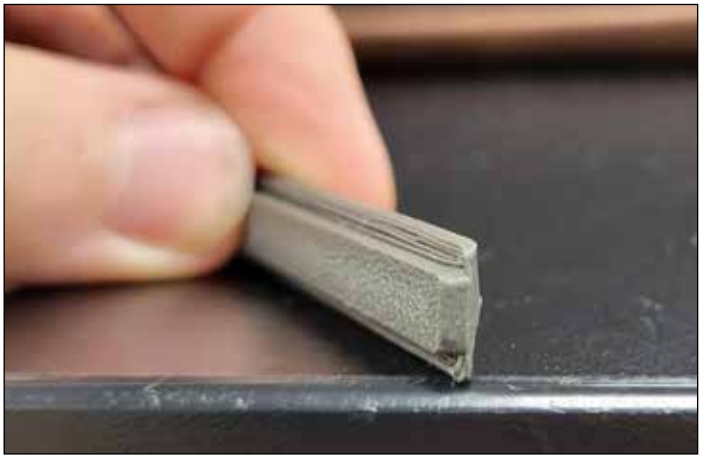


Figure 7. My leading edge. I chose a triangular shape for low supersonic drag but high subsonic drag. This one is made from PETG - CF filament. Also note how there are clear surfaces to attach it to the outside panels

The outer edge is generally simpler than the leading or tailing edges. When designing the outer edge, it can be flush with the outside of the outer panels, or it can be a fancy winglet shape like some modern aircraft. Be creative! Just make sure to leave some way to attach it to the inside of the fin assembly and print it in an appropriate plane.





Final Assembly

Assembling a sandwich structure composite fin is challenging and takes time. It is crucial to ensure good alignment for maximum strength and limit post processing. Especially poorly aligned fins will need to be scraped because the leading edge will be skewed and cause high spin rates in flight. The first thing necessary is any hard flat surface. The kitchen counter will do, but people in your house might complain so try to find something more out of the way. Place a garbage bag or other plastic sheet on this surface to limit messes, then place one outer panel of the fin on the ground so it is concave down if it has any warping. Then use epoxy to adhere the core to this panel. Use a slow drying epoxy because it will take time to adequately spread the epoxy over the entire surface of the core. Do not try doing the whole fin at once because the epoxy will drip and not properly bond one of the sides to the core.

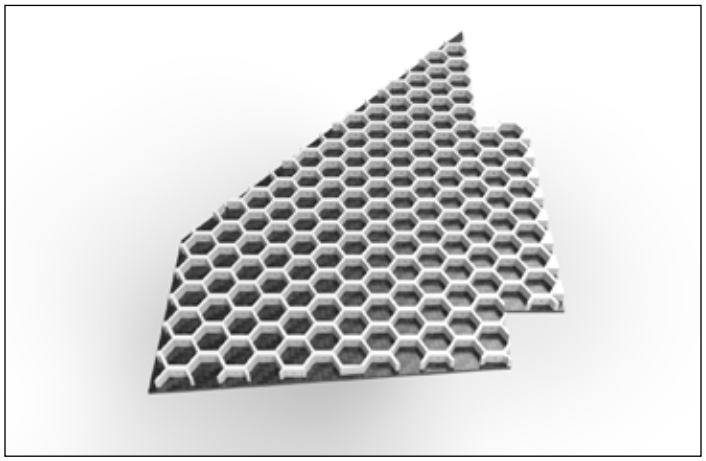


Figure 8. A render of my fin after joining the core to one outside panel.

When the core is properly positioned, use hot glue or tape to secure the core while the epoxy cures. You need the core properly aligned and you don't want a pet or friend to accidentally bump the fin and ruin the alignment. Do not let the hot glue or tape fall on the top of the core because you need it perfectly flat to ensure uniform pressure and good bonding. With the core aligned and secured, it is now time to apply pressure. You can use a vacuum bag, but it is often easier to place the glass or metal plate used for the plate layup on top of the fin assembly and then add heavy objects until at least 2 psi of pressure is attained.

Once the first part is completely cured, and I mean COMPLETELY cured (you don't want the warping to break the bond between the core and outside parts), you can epoxy the rest of the fin assembly together, making sure if there is a warp you place

the new outside panel so the warp cancels. Also ensure the epoxy side is facing down so it doesn't drip. Use tape and not hot glue to secure the positioning of the parts on the assembly. This is because tape has a uniform thickness that will help distribute pressure evenly. Once everything is secured, apply tape on the outside panels so there is a flat surface on both sides. If the pressure is not evenly distributed then the bond between the core and the outside panels will be severely weakened. When finished epoxying and taping everything together, reapply the glass or metal plate with weight on top of the assembly and let the assembly cure completely.

Post assembly

Your fins, now assembled, are nearly complete. However, they will almost certainly require post processing. The most likely issue is imperfect seams between the outer panels and the outside panels. Any gaps here will increase drag and hurt structural rigidity. These should be filled with epoxy. When the seams are filled, make sure to sand down any remaining epoxy to make your fin smooth.

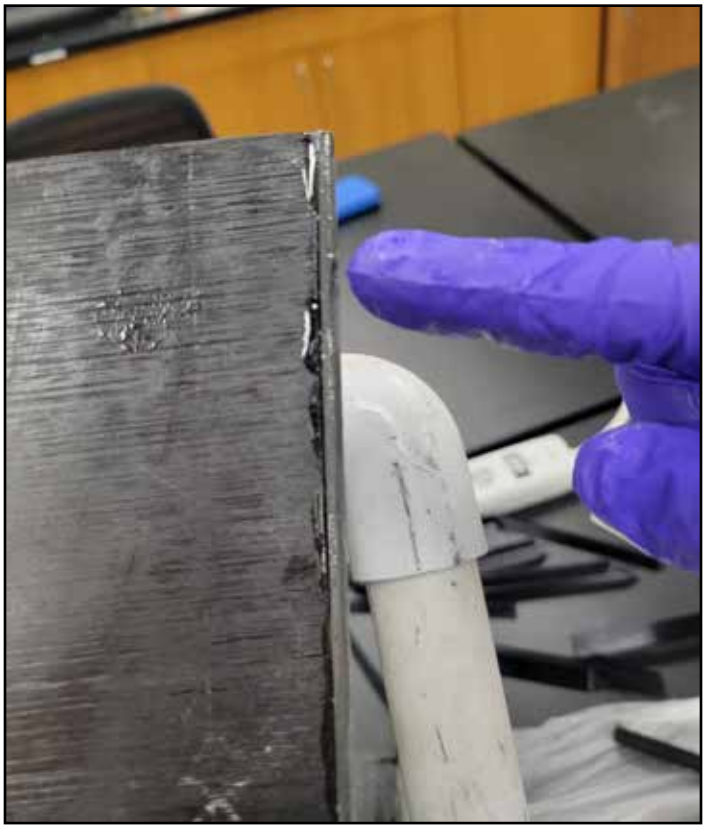


Figure 9. Filling the seams with epoxy.





Figure 10. The fins are now secured to the fin can with epoxy and fiberglass. I should have added a fillet before putting the fiberglass on in retrospect.

Once your fins have their seams filled and the excess epoxy is sanded down, you obviously still need to adhere the fins to the rocket. This requires more care than traditional fins because if you just bond to the core, your fins can still flop about. Use some spare fiberglass or carbon fiber with epoxy to make an exceptionally large fillet to secure the fins to the fin can. Another option is to use polycarbonate or nylon 3D-printed fillets to secure the fins in place. With that, you have now finished your sandwich structure composite fins!

A Personal Note

When I embarked on the journey to construct sandwich composite fins for my L3, I had only a vague idea of what I was doing. There was no instruction manual like the one you just read. Like you saw earlier, my carbon fiber plates were warped and I was terrified I would need to start over from scratch. Our club 3D-printer broke and I had to go on an expedition to find someone with a printer that could print fiber reinforced filaments needed for the leading and tailing edges. Several people thought I was crazy. When I showed them my 3D-printed honeycombs, some even assumed I was trying to make the entire fin out of PETG! Despite the opposition, I persevered and made the fins. I still haven't flown this rocket yet, but the fins are incredibly strong and I am impressed with how they turned out. High Power Rocketry is a sport that is meant to push boundaries and inspire innovation. I hope that by reading this article, you too are inspired to grow your skill in rocketry.

About the Author

Alex Magee, has been flying model rockets ever since his parents gave him one when he was six. He currently lives in Provo, Utah and attends Brigham Young University where he is studying mechanical engineering. He has a part time job researching heat transfer in ablative materials and when he is not working on his next rocketry project he is out riding his bike or swimming.



Author: Alex Magee

PEAK OF FLIGHT NEWSLETTER

Article Submission Guidelines

Issue 673 / March 3rd, 2026

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SUBMITTING ARTICLES TO APOGEE

We are always looking for quality articles to publish in the *Peak-of-Flight* newsletter. Please submit the "idea" first before you write your article. It will need to be approved first.

When you have an idea for an article you'd like to submit, please use our contact form at **https://www.apogeerockets.com/Contact**. After review, we will be able to tell you if your article idea will be appropriate for our publication.

Always include your name, address, and contact information with all submissions. Including best contact information allows us to conduct correspondence faster. If you have questions about the current disposition of a submission, contact the editor via email or phone.

CONTENT WE ARE LOOKING FOR

We prefer articles that have at least one photo or diagram for every 500 words of text. Total article length should be between 2000-4000 words and no shorter than 1750 words. Articles of a "how-to" nature are preferred (though other types of articles will be considered) and can be on any rocketry topic: design, construction, manufacture, decoration, contest organization, etc. Both model rocket and high-power rocket articles are accepted.

CONTENT WE ARE NOT LOOKING FOR

We don't publish articles like "launch reports." They are nice to read, but if you don't learn anything new from them, then they can get boring pretty quick... Example: "Bob flew a blue rocket on a H120 motor for his certification flight." As mentioned above, we're looking for articles that have an educational component to them, which is why we like "how-to" articles.

You can see what articles and topics we've published before at: **https://www.apogeerockets.com/Peak-of-Flight?pof_list=archives&m=education**. You might use this list to give you an idea or two for your topic.

Here are some of the common articles that we reject all the time, because we've published on these topics before:

- How to get a L1, L2, or L3 Cert
- Building cheap rockets and equipment (pads & controllers)
- How to 3D print parts, or a Rocket Kit
- How to Build a cheap Rocket Kit
- Getting Back Into Rocketry After a Long Hiatus

ARTICLE & IMAGES SUBMISSION

Articles may be submitted by emailing them to the editor. Article text can be provided in any standard word processor format, or as plain-text. Graphics should be sent in either a vector format (Adobe Illustrator, SVG, etc.) or a raster format (such as jpg or png) with a width of at least 600 pixels for single column images or 1200 pixels for two-column images. It is preferable for images to be simple enough to be readable in a two-column layout, but special layouts can be used.

Send the images separately via email as well as show where they go by placing them in the word processor document.

ACCEPTANCE

Submitted articles will be evaluated against a rubric (available here on our website). All articles will be evaluated and the results will be sent to the author. In the evaluation process, our goal is to ensure the quality of the content in *Peak-of-Flight*, but we want to publish your article! Resubmission of articles that do not meet the required standard are heavily encouraged.

ORIGINALITY

All articles submitted to Peak-of-Flight must not run in another publication before inclusion in the *POF* newsletter, but it may be based on another work such as a prior article, R&D report, etc. After we have published and paid for an article, you are free to submit them to other publications.

RATES

Apogee Components offers **$300** for a quality-written article over 2,000 words in length. Payment is pro-rated for shorter articles.

WHERE WILL IT APPEAR?

These articles will mainly be published in our free newsletter, *Peak-of-Flight*. Occasionally some of the higher-quality articles could potentially appear in one of Tim Van Milligan's books that he publishes from time to time.





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