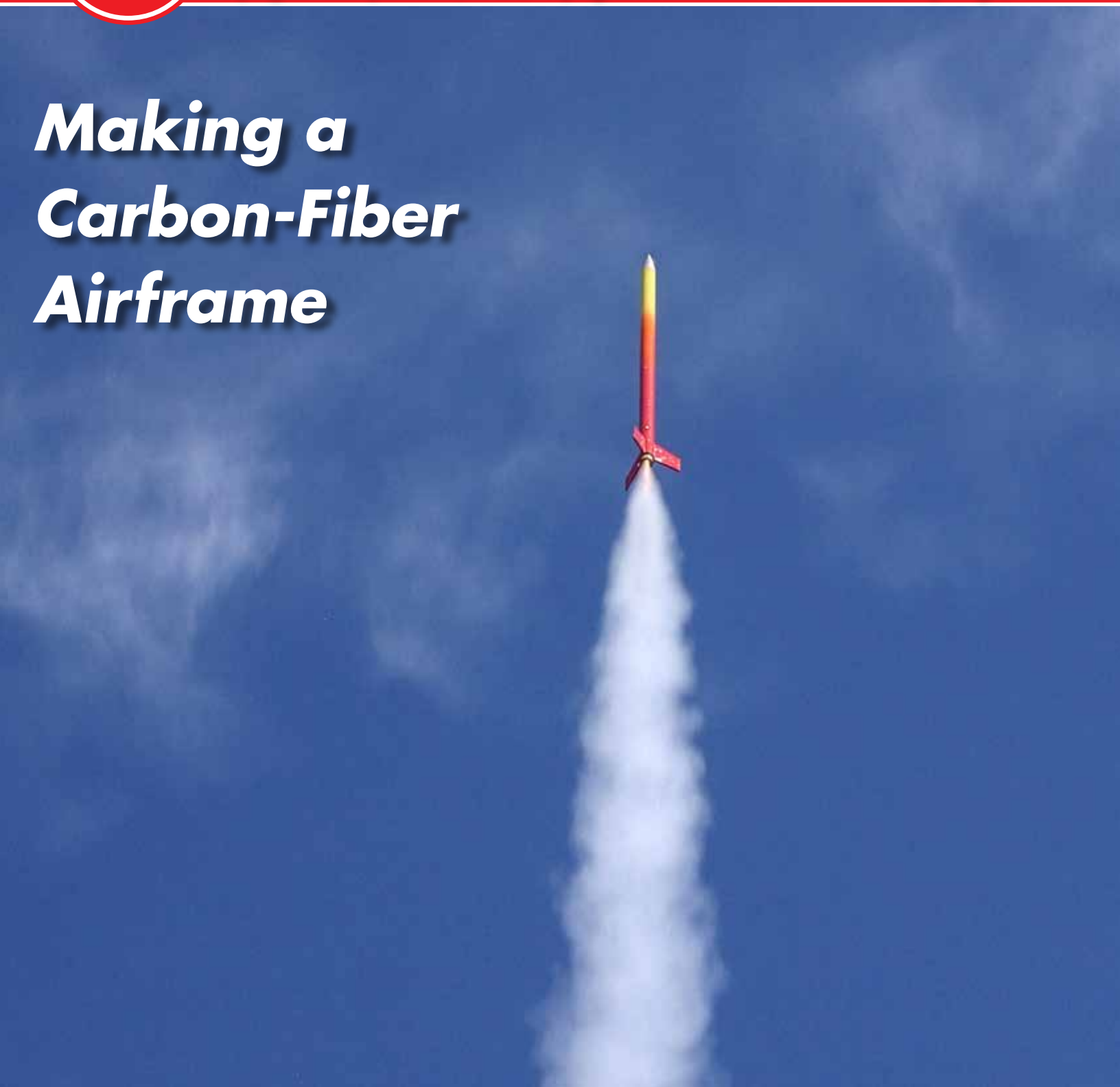
Issue 670 / January 27th, 2026

PEAK OF FLIGHT NEWSLETTER

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

Making a Carbon-Fiber Airframe



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COVER PHOTO



NeMSAR takes Flight

The NeMSAR rocket is a 29mm diameter rocket that comes with a 24mm motor mount, so it flies high and fast. Plus it is rock-solid stable. Check it out here!

FEATURED ARTICLES



Making a Carbon-Fiber Airframe

The students at University of Nebraska document their process of making a composite airframe for their IREC entry. Find out lessons learned, and the tips they recommend to others.

Apogee Components, Inc.
4960 Northpark Dr.
Colorado Springs, CO 80918
1-719-535-9335
www.ApogeeRockets.com

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One of the 13 rockets from the Apogee Maker's Dozen class-pack take off from the launch site in Pueblo, Colorado.



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PEAK OF FLIGHT NEWSLETTER
Making a Carbon-Fiber Airframe
by Husker Rocketry
Issue 670 / January 27th, 2026
www.ApogeeRockets.com

Making a Carbon-Fiber Airframe

How Husker Rocketry Designed and Manufactured SAURON, a SRAD Airframe

By Husker Rocketry, University of Nebraska–Lincoln

When our team at the University of Nebraska–Lincoln committed to building SAURON, our 2025 *International Rocket Engineering Competition (IREC)* rocket, we made one bold decision early on: rather than rely on commercially manufactured airframe components, we set out to design and fabricate our own Student Researched and Developed (SRAD) composite tubes and fins. This approach offered us distinct advantages: reducing overall costs, tailoring components precisely to our mission needs, and most importantly, regaining hands-on manufacturing skills that had faded from our program over time.

The process was far from easy. We spent weeks researching composite materials and construction methods, then consulting with faculty mentors and local experts before meticulously planning our layups and curing schedules. Our team encountered setbacks: early prototypes suffered from delamination, resin starvation, and inconsistent wall thicknesses. Each failure was a learning opportunity, prompting us to refine our lay-up techniques and adjust our resin ratios. We developed custom tooling to ensure repeatable results. By the time we produced our final set of tubes and fins, our workflow had become efficient, and our engineering confidence had grown.

Ultimately, the SRAD airframe not only met but exceeded our expectations on launch day. The structure was lighter and stiffer than the commercial alternatives we had considered, allowing us to maximize our payload capacity without sacrificing strength. Most rewarding, however, was the pride our team felt in flying a rocket that was truly our own creation. The skills and lessons



Figure 1. View of the test launch fron on-board camera





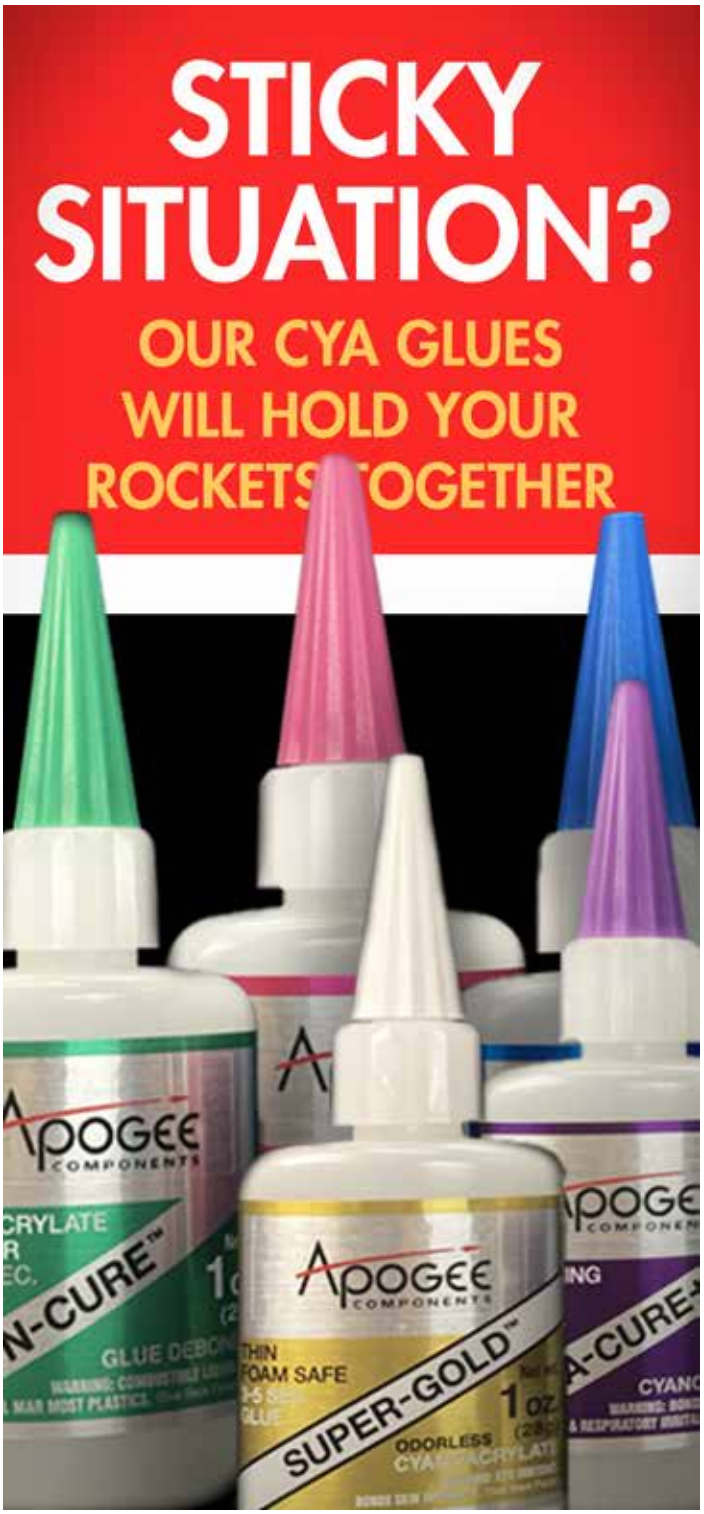
Figure 2. View of the test launch from the ground

gained throughout this process will shape our team's approach to engineering challenges for years to come.

Why Build an SRAD Airframe?

For many collegiate rocketry teams, purchasing pre-made fiberglass or carbon fiber tubes is the standard and seemingly hassle-free approach. These commercial products offer proven reliability, but come at a high cost and inherently restrict teams to whatever is commercially available from vendors. This can be a limiting factor when a project demands unique geometry, precise mass distribution, or custom structural properties.

By fabricating our own composite airframe components, we immediately opened the door to a new level of engineering freedom. We could select specific fiber weaves and resins, optimize the layup for strength in critical areas, and experiment with wall thicknesses to find the perfect balance between durability and weight savings. For SAURON, this meant we could design a rocket that precisely matched our mission profile, with every tube and



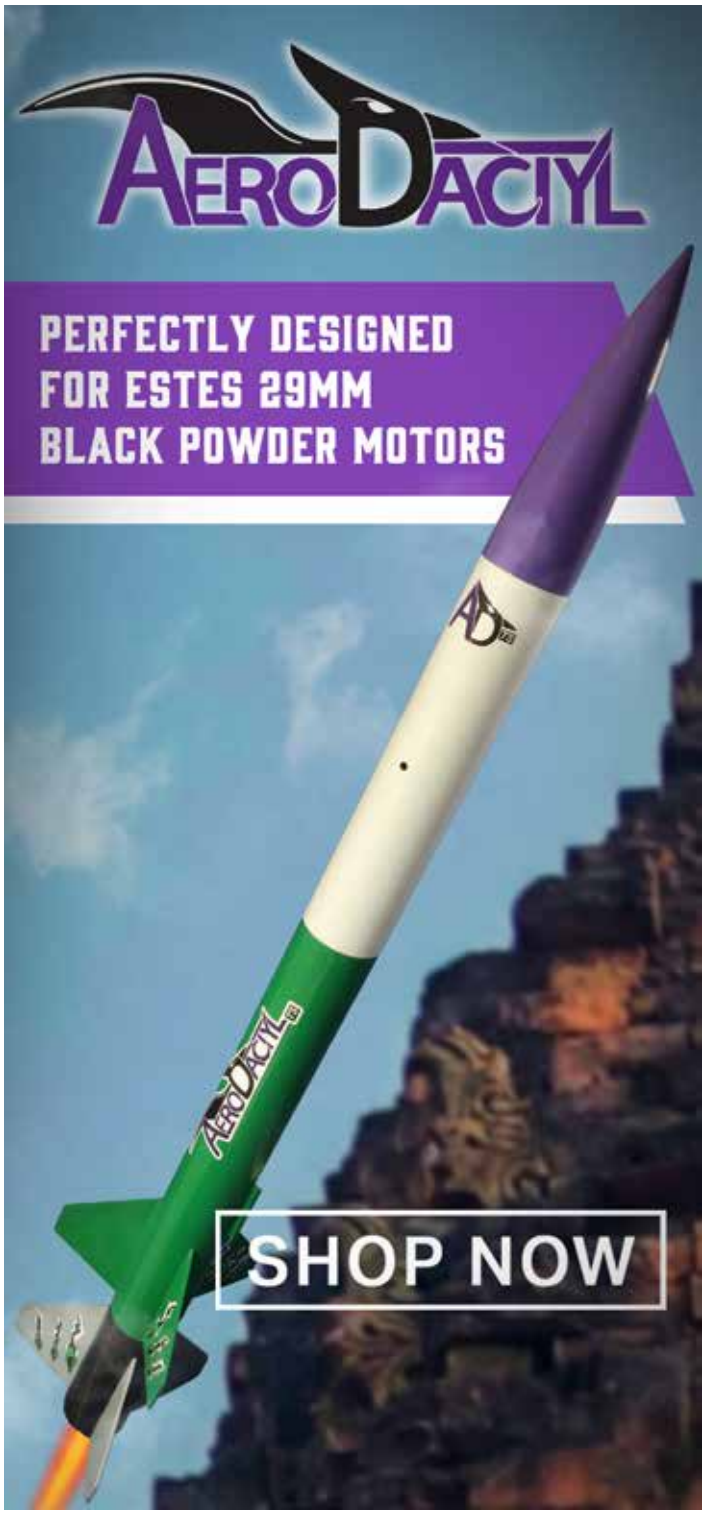




Figure 3: Loading the rocket on the rail.

fin tailored to our aerodynamic and payload requirements.

Embarking on the SRAD path also had significant educational value. Our team had lost much of its hands-on composite experience in the wake of the COVID-19 pandemic, as older members graduated before passing on their know-how. By tackling this challenge, we were able to rebuild that lost knowledge from the ground up. New members learned numerous skills: resin mixing, fiber measurement and cutting, composite lay-up setup, and curing control. These experiences also fostered a collaborative team spirit and a sense of collective achievement.

Most importantly, our success proved that students working on limited budgets can match or even exceed the quality of commer-



Figure 4 - Early mandrel usde for rolling our airframe.

cial composite structures. The confidence we gained through this process will fuel our future projects and inspire the next generation of engineers on our team.

Early Prototyping and Learning the Basics

Before we began the manufacturing process for SAURON's flight hardware, we knew it would be important to prototype iteratively, trying different manufacturing methods and materials. To this end, we produced seven prototype tubes specifically designed to rigorously test various materials, mandrels, layup patterns, resin ratios, and release techniques. This foundational phase was essential, as it enabled us to identify optimal approaches before proceeding to full-scale production.

Throughout our experimentation, we explored a diverse range of materials for the mandrels. Our trials included PVC pipe, cardboard, and hand-rolled fiberglass mandrels, each of which was strategically filled with expanding foam. This approach added an element of stiffness to the prototypes, simulating the conditions our final products would face. Each material we tested brought its unique benefits and challenges, and it was essential for us to evaluate their performance in a controlled manner.

Among the materials assessed, PVC emerged as a surprising standout. We found that it offered not only cost-effectiveness but also a significant advantage in terms of ease of release from the molds. When combined with mold release wax and a Mylar wrap, the PVC tubes demonstrated an impressive ability to separate







Figure 5 - PVC mandrel used for rolling our airframe.

cleanly from the mandrel. This combination simplified our manufacturing process and reduced the risk of damaging the tubes during the demolding stage, a common challenge in composite manufacturing.

In addition to material selection, we conducted extensive testing with different epoxy formulations. One of the most pivotal discoveries from our experiments was the epoxy-to-fabric ratio. We found that maintaining a 125% ratio by weight consistently yielded strong and lightweight tubes without introducing excess resin waste. It also allowed for optimal bonding while minimizing the risks of over-saturation, which can subsequently lead to structural issues.

Interestingly, our epoxy testing revealed that our tubes outperformed some commercial options during structural tests. Specifically, they demonstrated a lower tendency for cracking and layer separation under stress. This was a significant finding for our team, as it validated our approach and instilled confidence in our ability to produce high-quality products that could withstand the rigors of flight.

The knowledge gained from early experiments was invaluable, providing critical insight into material behavior and processing techniques, and forming the basis for full-scale manufacturing as data from prototype testing shaped our design, production methods, and manufacturing strategy. As we moved to full-scale manufacturing, lessons from prototypes have guided us in the right direction. They were the foundation of our manufacturing processes and led to successful SAURON flight hardware. Our iterative ex-

perimentation highlighted the value of adaptability in engineering, refining techniques and product quality, while rigorous prototyping and testing solidified confidence and built a vital knowledge base essential for our ongoing mission.

Mandrel Preparation: The Foundation of a Good Tube

A composite tube is only as good as the mandrel it's built on,



Figure 6 - Waxing the mandrel before rolling the composites.

and the quality of the mandrel preparation process can significantly impact the final product. In our approach, we prioritize consistency and surface quality to ensure optimal performance of the composite tube.

The preparation begins with a meticulous cleaning of the PVC pipe. Using cleaning agents, we removed any dirt, grease, or leftover materials that could interfere with the forming process. This step is crucial, as any contaminants or residues can compromise the bond between the composite layers and the mandrel itself.

Once the pipe is thoroughly cleaned, we apply multiple layers of mold-release wax. This wax serves a dual purpose: it not only facilitates the eventual removal of the composite tube from the mandrel, but also contributes to achieving a smooth surface finish. Each layer needs to be carefully buffed to ensure an even application, which helps maintain the surface quality throughout





the curing process.

Next, we wrapped the prepared mandrel in a sheet of Mylar. We chose Mylar because it is lightweight yet durable, and it provides a slick surface that allows for a glossy and low-friction finish on the inside of the composite tube. The wrapping is carefully taped at the seam to prevent any epoxy from seeping through, which could lead to imperfections or bonding issues. While using Mylar, we found that it improved the surface finish of the composite tube, giving it a polished look that can be a deciding factor in its aesthetic appeal. Secondly, we found that it enhanced the release process after curing, allowing for a clean separation of the mandrel and the cured epoxy. This reduced friction and eliminated any potential damage to the tube, ensuring it retained its intended shape and structural integrity.

By taking the time to focus on these details and the quality of the mandrel, we set a strong foundation for the composite tube, ultimately leading to higher-quality tubes that met and surpassed our expectations.

Cutting Materials and Planning the Layup

Before mixing epoxy, our preparation involved meticulous pre-cutting of all composite materials to precise dimensions. This included carbon fiber sheets designated for the booster, fiberglass sheets intended for the payload tube, peel ply for the outer surface, and Mylar sheets for the mandrel. By planning the layup, we ensured that each layer aligned perfectly with the others, which was crucial in preventing common issues such as wrinkles, uneven seams, and accidental fiber misalignment that could compromise the integrity of the final product.

For the SAURON project, we aimed for a final wall thickness of approximately 0.09 inches. To achieve this, we carefully calculated the number of wraps, taking into consideration both the fiber weight and the thickness of the materials being used.

Wet Layup: Rolling the Composite Tube

After carefully mixing the epoxy, we degassed it in a vacuum chamber to ensure all air bubbles were removed. We then began the layup process with great precision. Using foam brushes, we meticulously worked the epoxy into each sheet of fabric, continuing until the fibers became uniformly translucent, indicating even saturation.

We started with the first sheet of fabric, wrapping it around the mandrel with a firm but gentle tension to avoid any wrinkles that could compromise structural integrity. Following this initial layer, we applied subsequent sheets of fabric, taking extra care to smooth each layer down with consistent pressure. This step was



Figure 7 - Soaking carbon fiber sheet in epoxy around the mandrel.

crucial for removing air bubbles and excess resin, ensuring a solid bond between the layers.

For the SAURON's booster section, we chose carbon fiber due to its superior stiffness and strength, which are essential for withstanding the extreme conditions during launch. Conversely, for the payload section, we opted for fiberglass due to its ease of sanding and ability to minimize radio interference, which is crucial for communication systems on board.

The final layer applied was peel ply. This material is designed to create a textured surface, which is particularly advantageous for bonding later iterations of the project, such as fillets, couplers, and reinforcements, enhancing the overall durability of the structure.

Once the layup was completed, we allowed it to cure overnight in a vertical position. This orientation enabled gravity to assist in the even distribution of the resin, further enhancing the integrity of the entire assembly. This careful approach in the layup process ensured that the final product would meet the rigorous demands of launch.

Demolding and Finishing the Tube

After curing, each tube was gently twisted and pushed off the mandrel. Thanks to good mandrel prep, this step was usually quick and clean. The peel ply was removed, revealing a smooth but bondable surface. We then trimmed the ends, measured wall thickness, and performed quality inspections. If any layer bridging, dry spots, or voids appeared, we logged the issue so the team could adjust the next iteration. By the time we rolled SAURON's flight tubes, our process had become repeatable, consistent, and





Figure 8 - Laying Fiberglass sheet onto a prepped mandrel.

efficient.

SRAD Fin Manufacturing

We opted for a hybrid fin design to optimize both performance and cost-effectiveness: using a plywood core for the fins, we wrapped them in fiberglass for reinforcement. Their strength was later enhanced with carbon fiber from tip to tip. This approach allowed us to maintain lower production costs while ensuring maximum durability and structural integrity.

Each fin started as a precisely cut plywood shape, carefully crafted for aerodynamic efficiency. After preparing fiberglass skins, we applied a straightforward wet layup process on each side of the core, ensuring even coverage. To enhance the adhesion and finish, we added peel ply and strategically placed weights on top to prevent any warping during the curing process. Once the resin cured, we sanded the fins to achieve their final aerodynamic profile.

This construction method not only produced robust fins capable of enduring substantial aerodynamic loading, but also ensured they could handle the impact during landings, which is an essential factor for competition rockets, which often land in less-than-ideal terrains.

Fin Integration: Through-the-Wall and Tip-to-Tip Reinforcement

To attach the fins, we cut precise slots into the booster tube, allowing each fin tab to pass through and bond directly to the inner motor mount tube. The internal structure included centering rings on either side of each tab, creating a doubly supported joint. Once aligned, we used epoxy injection holes to fill any gaps between the fin tab and tube interior, creating a reinforced internal fillet. Ex-



Figure 9 - Applying epoxy to fiberglass on our fins.

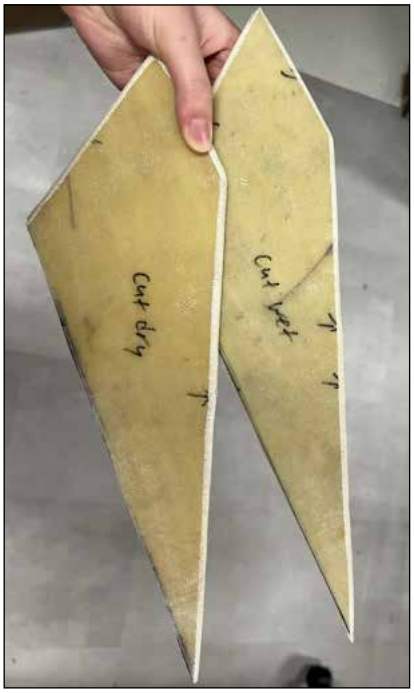


Figure 10 - Cured and sanded fins.

ternally, we applied clean, aerodynamic fillets before adding tip-to-tip carbon fiber, which connected all three fins across the outside of the airframe. This dramatically increased resistance to fin flutter and bending forces during high-speed ascent. See *Peak-of-Flight Newsletter # 592* (https://www.apogeerockets.com/education/downloads/Newsletter592.pdf) for more information on performing tip-to-tip layout.

Once the fins were securely attached and the external fillets were cured, we turned our attention to the surface finish of the airframe. A smooth, polished exterior is essential for minimizing drag, so we carefully sanded the entire assembly before applying a high-quality primer. This not only improved the aesthetic appeal but also enhanced the adhesion of the final paint layer. We opted for a bright color scheme to increase visibility during flight and make recovery easier. After the paint had fully cured, we inspected all structural components to ensure that everything was flight-ready.

Couplers, Bulkheads, and Structural Layout

SAURON's airframe consisted of two primary SRAD tubes: a fiberglass payload tube and a carbon fiber booster tube. These were connected by G10 fiberglass couplers that extended



Figure 11 - Cutting fin slots in the carbon fiber booster tube using a dremel.



Figure 12 - Carbon fiber tip-to-tip layups on fins.

at least one airframe diameter into each tube to ensure strong engagement. We installed bulkheads, avionics sleds, vent holes, and shear pins according to IREC requirements, ensuring reliable separation at apogee and main deployment.

Because our airframe was hand-rolled, we measured the internal diameter carefully to ensure compatibility with our RMS-75/5120 motor





Figure 13 - Integrated ejection charge test.

case. The result was a minimum-diameter design with minimal drag.

Testing and Proving Our Airframe

We validated our SRAD airframe through a series of rigorous tests designed to ensure reliability and performance under various conditions. First, we conducted ejection charge testing to guarantee that the payload and drogue sections separated cleanly during deployment, as any failure in separation could compromise the entire mission.

Following the ejection tests, we engaged in fit testing to confirm the proper alignment of key components such as couplers, avionics bays, and subassemblies, ensuring that all systems would function harmoniously in flight.

The most important phase of our validation process was undoubtedly the flight testing. In this phase, our hand-rolled airframe faced an unexpected challenge when it withstood a 65-mph ballistic impact due to a parachute malfunction. Remarkably, it suffered no structural damage from this event, which was a testament to the robustness of our design and construction. This incident significantly boosted our team's confidence in the strength of our tubes and reinforced the effectiveness of our rigorous testing process. Collectively, these validation stages have proven the viability of the SRAD airframe and instilled a strong sense of accomplishment in our team's capabilities and the future of our project.

Lessons Learned

Every engineering project provides valuable lessons, and SAURON was no exception. One of the key takeaways was that preparation determines success; meticulous attention to mandrel preparation, fabric cutting, and epoxy measurement proved to be more critical than the layup process itself. Additionally, we discovered that PVC serves as a surprisingly effective mandrel option. Although it's inexpensive and readily available, it allows for clean release of tubes when used with wax and Mylar. Another important lesson was the significance of documentation in preventing knowledge gaps. By meticulously recording each step and variable, we ensured that future Husker Rocketry teams could continue to advance our composite program. Most importantly, we learned that our team could successfully build competition-grade composite structures without large budgets or professional equipment.

Looking Forward

Our successful airframe manufacturing process has sparked new goals for Husker Rocketry. In the coming years, we aim to expand our composite manufacturing capabilities by learning new construction techniques to fabricate SRAD nose cones, ultimately building a fully SRAD airframe from tip to tail. We plan to implement vacuum-bagging techniques to achieve better fiber compaction and explore more advanced fiber orientations. Additionally, we seek to improve dimensional tolerances for our custom couplers. While SAURON was our first milestone, it is certainly not the last.

Conclusion

Creating SAURON's SRAD airframe pushed our team to develop new skills, rethink old assumptions, and discover the full potential of composites in student rocketry. What began as a cost-saving experiment became an invaluable learning experience, one that strengthened our engineering abilities and our team's identity. By sharing our process, we hope to encourage other teams to leap into composite manufacturing. Yes, it's chal-



Figure 14 - Team standing beside the rocket before the first test flight.

PEAK OF FLIGHT NEWSLETTER

Issue 670 / January 27th, 2026

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Article Submission Guidelines

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.





Apogee Components, Inc.
4960 Northpark Dr.
Colorado Springs, CO 80918
719-535-9335

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