PEAK OF FLIGHT NEWSLETTER

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CREATING THE GLIDING PARACHUTE SYSTEM

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APOGEE COMPONENTS

PEAK OF FLIGHT

Creating the Gliding Parachute System

By Tim Van Milligan

This article is a little bit of the history behind the development of the Experimental Gliding Parachute System from Apogee Components. I just wanted to show why this is potentially a game changing product, and what we went through here to get this product into production.

First, why is this game changing? What is the big deal?

That is an easy question to answer, because the one problem that every rocketeer has experienced is that rockets always drift away with the wind. The higher they go, the more they drift. This is a problem, because the farther the rocket drifts, the greater the odds that the rocket will be lost. Either you don't see where it lands, or it lands in an area that makes recovery impossible.

FIGURE 1: A CIRCULAR PARACHUTE WITH VENTS TO CONTROL THE ORIENTATION OF THE CANOPY.

Not only is there the problem of losing the rocket, but what makes us think that we even want to spend a good part of the day walking after the rocket? Wouldn't you rather be using your time flying other rockets rather than chasing down the first one you launched during the day?

FIGURE 2: A RAM-AIR PARACHUTE IS EFFICIENT AND HAS GOOD CONTROLLABILITY.

No one likes to lose a rocket, nor do we really want to spend lots of time trekking down a rocket.

Those are the two problems that a gliding parachute system solves. Imagine if the rocket takes off, and then returns to the launch pad, or better yet, lands right in front of your feet. How would you feel about that?

Rocketeers have been trying to mitigate these problems since the first models were launched in the late 1950s. We've done things like angling the rocket into the wind, switched to streamers, then chutes with spill holes in them, to finally dual-deployment systems to get the rockets to land faster. But they all will still drift somewhat because they can't be steered, nor can they penetrate into the wind.

How do you solve this issue?

For me, I think I was still in college in the 1980s when I first discovered the Rogallo wing parachute. While it was new to me, it had been around since the 1940s when Francis Rogallo, working for NACA invented it. Essentially, it is a flexible wing made from a single sheet of fabric. And since it is a wing, it produces lift and can be steered like an airplane.

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The potential for the Rogallo wing parachute even was explored by NASA in the 1960s as a possible way to return the Mercury, Gemini and even Apollo capsules back to the ground. The advantage is similar to the Space Shuttle, where you know the exact landing spot where the astronauts will be landing. In the early days of space travel, there were literally over 15,000 people on ships involved in the recovery of astronauts from the ocean. It was very labor intensive. So having the astronauts touch down at a precise spot on land has a lot of advantages.

There is an interesting article (see the references at the end of this article) that describes the development of the Rogallo wing glider, and the reasons why NASA instead chose to use a round parachute. Essentially, it was a development project that had safety issues with steering the wing. The original concept had struts or inflatable tubes to give the wing rigidity, and steering was done by shifting weight around beneath the canopy. That made control sluggish. It was going to take time to work out the issues, and time was not something that NASA had back in the space race days. They had to beat the Soviets to the moon.

But the Rogallo wing parachute is not the only type of gliding parachute. There is another type called the ram-air parachute, which is popular among sky divers. It is much more efficient which is why it is more popular.

And it could possibly be used for recovery of model rockets.

But the ram-air parachute has two sheets of fabric to form the wing. There is an upper layer, and a lower layer that are inflated during descent. The two sheets of fabric

FIGURE 3: A RESERVE PARACHUTE USING A SINGLE-KEEL ROGALLO PARACHUTE.

make them heavier and bulky compared to the Rogallo wing parachute. So for rocketry, you'd have to have more space in the rocket to carry it, and it weighs twice as much because of the two layers of fabric. As you would expect, there is a performance penalty that you have to account for.

The Rogallo parachute, since it is smaller and lighter, is still used in parachuting, but mainly as a reserve chute.

My Own Personal Experiences

I didn't have time to experiment with the Rogallo wing parachute until around 1991. My first test chutes made from thin mylar sheets weren't very successful. I tried to use them when I was at the try-outs for the 1992 US

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National team. Unfortunately, I couldn't get them to deploy. The reason I wanted to try them was because the NASA literature indicated they were up to 9 times more efficient than a circular parachute. So if you wanted to keep your rocket in the air for a long time, there was a lot of potential with this type of chute.

FIGURE 4: TWIN-KEEL ROGALLO PARACHUTE WITH A SEPARATOR TO HELP KEEP THE LINES FROM TANGLING. THE CONTROLLER NEAR THE BOTTOM PULLS ON THE LINES TO TURN THE CHUTE.

While I wasn't successful, this type of parachute was still on my mind. In 1995, which was about a year after I bought Apogee Components, I wrote an article about how to make a Rogallo parachute (even though I was unsuccessful in making it work). That report is still available on the Apogee website as Technical Publication #7 (https://www.apogeerockets.com/Rocket_Books_Videos/Pamphlets_Reports/Tech_Pub_7).

But alas, the idea just collected dust for a couple more decades.

I think it was in 2017 that I was visited by a modeler from the Denver area, Brian Houghton. Brian was looking to get into the rocketry business, and he dropped by my office to show me some ejection baffles that he built. He thought that he might make some money by offering them to Apogee customers. I remember vividly the conversation, and how bad I felt at the time. I just didn't have the heart to tell him that making things like baffles for small model rockets really wasn't going to yield a lot of cash for him. While baffles are cool, not everyone needs them.

I suggested to Brian that there are a lot of other things that he could make that would be far more valuable. For example, I even put a list of them in *Peak-of-Flight* Newsletter #234 (https://www.apogeerockets.com/education/downloads/Newsletter234.pdf). But as we talked, I threw out my idea to him of the gliding parachute, and how it might be revolutionary for rocketry. I pointed him to the Technical Publication that I wrote, in case he wanted more information.

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Brian went home, but little did I realize that he was hooked on the idea. Personally, I didn't think too much of the conversation after it was over. I talk to a lot of people about cool rocketry projects, but rarely do I see anything of significance later on.

But this time, it was different. Several months later, Brian again returned to talk. But this time, he had a working prototype with him. I was immediately floored. Wait — what? You have a working prototype of a project that I couldn't get to work myself?

The working prototype wasn't perfect, but it did work. And that changed everything.

From that point on, Brian and I worked more closely together to work out the kinks. Brian, as it turns out, is really good at designing control systems and figuring out all the electronic systems to make it work. The original design used GPS to control the servo and bring the rocket back down to the same spot it was launched.

I'd like to think that I'm good with the mechanical stuff, and getting things into production. So while Brian worked on getting the kinks out with the parachute and the electronics, I designed the ebay layout.

Realizing that this is a breakthrough product, I suspected that there would be some demand for it from rocketeers. If it could be made simple enough to operate and had some versatility where it could be swapped between rockets, who wouldn't want to try it? Based on this, I decided to treat it not like a one-off product, where we might make a few dozen at a time. I thought that I should be prepared for a situation that required mass production.

From the outset, my mind was thinking mass production, which required a different way of sourcing items and having things made.

While that work was going on, I also thought that we should test the market, and see if there was really any interest in the product. So we decided to show it off at NARCON 2019 in Cape Canaveral, Florida.

Brian and I did a presentation on the system at the conference, showing what its potential was, and what experiments we had done to date. It turned out to be a hit. Those in attendance were all excited about it as we were. You can see that presentation on YouTube at: https://www.youtube.com/watch?v=4ac-VFPAqIo.

Since that time, we've been trying to source reliable suppliers for the various components.

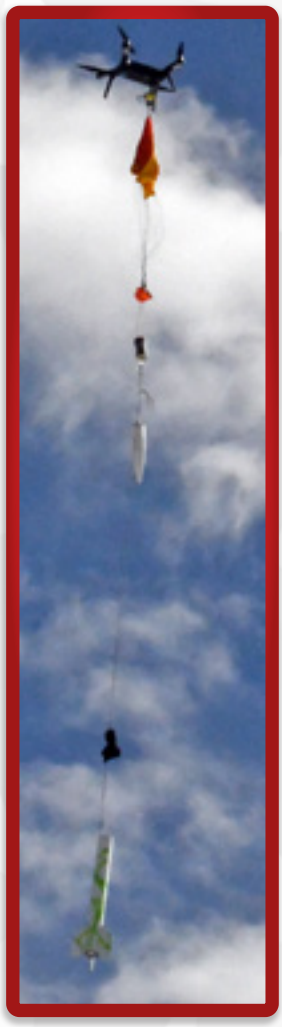

FIGURE 5: TESTING OF THE CHUTE INVOLVED DROPPING IT FROM A QUADCOPTER.

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FIGURE 6: THE ROCKET AND CHUTE WAS RELEASED FROM THE DRONE, AND JUST BEGINNING TO INFLATE.

The parachute itself has been the hardest item to acquire because it has a lot of intricate details that are critical to the success of the system. If we were planning on only a few one-off prototype chutes, it probably wouldn't have been such an issue. But we needed a supplier that could mass produce them, just in case this product turns out to be a hit with customers.

Then COVID happened…

This certainly didn't help our supply situation at all. And in some cases, it made it worse. When we started, we had planned this to be GPS controlled. But because of the world's supply-chain crisis as a result of COVID-19 and other government imposed lock-downs, the supply of computer chips became very scarce. So our plans changed with regard to the system.

We had to pivot to an RC-controlled device, where the user provides the RC equipment like the receiver and the transmitter. These consumer devices are still somewhat plentiful in the RC industry, and there are a lot of hobbyists that have their own already.

Someday, when the computer chip issues resolve itself, we'll probably try to provide an option for modelers to convert their system over. It would be an easy switch, as you just pull out the RC receiver, and put in a GPS controller.

Why is it Experimental?

This is such a new and novel system, that we don't have all the answers. We can get the parachute to work, but we don't fully know the most effective way to trim the parachute to fly straight (should it be needed). Additionally, because we don't know everything, we fear providing contradictory information. "Which is it, Tim?" "This or that?" and "What am I missing here?" I'll be transparent and vulnerable here… it is embarrassing, and I don't like answering those questions, because I don't fully know the answer.

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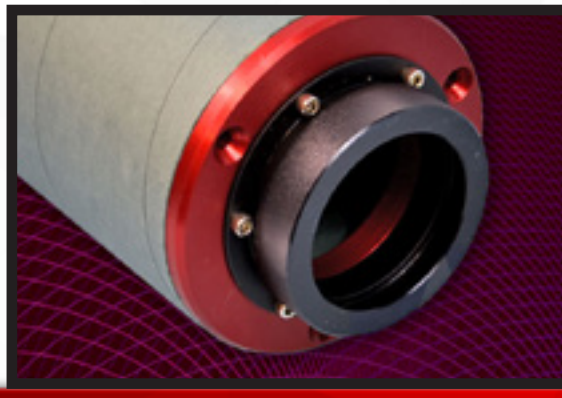

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FIGURE 7: FULL INFLATION OF THE CHUTE, WITH THE ROCKET MAKING ITS WAY TO THE DESIRED LANDING SPOT.

In the end, if a customer should ask us a question, they would probably be disappointed that we couldn't offer them a satisfactory answer. Since we know this in advance, we are stressing to customers that there may be a lot of experimenting that they have to do on their own. If you do not want to experiment, then our suggestion is to pass on this system for now. Eventually, there will be a large enough user base that maybe someone might be able to answer your questions.

I've already had people tell me that we should give this to experienced RC flyers to work out any issues. I suspect that they wouldn't make as good experimenters as real rocketeers. There is not a lot of need for a steerable parachute in the RC world, so their motivation wouldn't be as great as a rocketeer that wants to keep their rockets from drifting with the wind.

Maybe I'm overblowing my concerns about trimming them. I probably am. So far, with the production parachutes that we've received, they have performed very well. The important part is that they fly mostly straight when the control stick is in the neutral position. And from what we've experienced in personal tests, that is the case. There may not be much, if any trimming needed to get them to fly straight.

The most challenging thing we've faced so far was getting a successful inflation of the chute. They snap open so fast that the objects hanging below them often fly up into the canopy and foul it. A tangled chute is never good… right? But we've got a packing process that is much more reliable now, that we feel confident we've conquered that problem. You'll find the instructions are very detailed in

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FIGURE 8: BRIAN HOUGHTON, DESIGNER OF THE GLIDING PARACHUTE, INSPECTING THE PARACHUTE PRIOR TO A LAUNCH.

the sequence of preparation, and I've also made video explaining why each step is important.

There are a lot of things we don't know, like "what would be the Cd of the chute?"

At this point, our real questions are about performance. We have a general chart showing the size of the chute vs the weight of the rocket. But we suspect it can vary a bit depending on the wind speed. This is where we'd like input from actual users. Ideally, we'd like to collect information about descent rate compared to both rocket weight and the wind speed. We suspect that when the parachute is flying in slightly breezy conditions, it becomes a little more efficient because it extracts more energy from the wind. But we don't know without data. So for now, our weight chart vs size is based on "no wind" conditions.

Finally, the really cool thing about the gliding chute is that the flight doesn't become boring after the chute is deployed (like on a lot of rocketry flights). Once the chute is open, you have control over it. This allows you to perform aerial stunts, or just get it to land where you want.

The nice thing about it, compared to regular RC airplane flights, is that it is a gentle descent. You only have control over turning left/right, and you can't smack it into the ground once the chute is open. In RC flights, because things happen so fast, if you make a wrong input on the control stick you could easily turn your model into a pile of kindling.

If you'd like more information about the gliding parachute system, please visit the Apogee website at: https://www.apogeerockets.com/Gliding-Parachutes

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 an 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*

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