PEAK OF FLIGHT NEWSLETTER

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4960 Northpark Dr, Colorado Springs CO 80918
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APOGEE COMPONENTS

PEAK OF FLIGHT

S4A Swing-Flop Rocket Glider Design

By Branden Ren

FIGURE 1: CATHERINE LIU AND BRANDON REN AT THE WORLD SPACEMODELING CHAMPIONSHIPS IN BAZAU, ROMANIA IN OCTOBER, 2021. CATHERINE WON 3RD PLACE AMONG FEMALES IN THE GLIDER EVENT.

Editor's Note

When I saw the swing-flop wing rocket glider that Catherine Lui and her coach Branden Ren had at the WSMC in Romania, I knew it had some features that were cutting edge, particularly the torsion spring mechanism that pivots the wing without rubber bands. Rubber bands can be troublesome (see Peak-of-Flight Newsletter *#560 for details https://www.apogeerockets.com/Peak-of-Flight/Newsletter560), so if they can be eliminated, that makes the rocket more reliable. I asked Branden to share his design with you and other readers, because I like to present ideas that are exciting and unique.*

In early October 2021, we had the honor to participate the World Spacemodels Championships in Romania. This competition was postponed for one year due to the COVID-19. But because of the epidemic, it made the competition very unique and unforgettable. We participated in the event called S4A Boost Glider Duration. For those in the USA, it is called A-engine Rocket Glider Duration Multi-round. We got a perfect maximum score in the first two rounds, but didn't make it perfect in the third round, ending up with the 3rd place of the women's group (new group added this year), which was a special surprise.

The aircraft we used this time was smaller in size and different from most of the other ones. Tim Van Milligan of Apogee Components wished us to introduce our unique design to others, so we are sharing the idea and some experience to everyone here now.

FIGURE 2: HAOCI LIN HOLDS TWO SIMILAR GLIDERS. THE MODEL PRESENTED HERE IS THE SMALLER GLIDER SHOWN ON THE LEFT IN THIS IMAGE.

For the structure design, we fold the wing and then rotate 90° (this is called a "scissors-flop wing" configuration). After fully expanded, its wingspan is 475mm, body length is 420mm and weight is 13 grams. We chose Balsa wood to be the material for the wing and carbon fiber for the fuselage. The wingspan is about 100mm smaller than the most of other aircrafts in the championship. The purpose for this design is to make it compatible with the Estes 1/2A motor, which is required to use for the contests inside the country, in order to gain higher altitude and opportunity to hit hot stream (what we call in the USA a "thermal" - which is a rising column of warm air). Although the surface of wing is reduced, but on the other hand, it loses 5 grams of weight as well, which makes it having more advantage in altitude than larger aircrafts.

The dihedral wingtips at both sides are folded downward, then turned 90°counterclockwise as shown as Figure 3.

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About this Newsletter

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Newsletter Staff

Writer: Branden Ren
Cover & Layout: Derek Villar
Proofreader: Michelle Mason

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FIGURE 3: THE GLIDER FOLDED AND READY FOR LAUNCH, WHICH IS OFF A PISTON LAUNCHER.

The wings are Concave-convex airfoil, which is similar to the free flight gliders that can generate more lift at lower speed, and it performs better when it hits hot stream (thermal). Although the hot stream can't be seen or touched, it is one of the main considerations for gliders. We want to stay inside the hot stream as long as possible. If the wings are too thin, which makes the speed too high, that would let it fly through the hot stream right away instead of staying inside it. Of course, the wing section is not the only factor. Adjusting the aircraft is also very important as well. It's also an unfavorable factor that if the circling radius is too large. And about the hot stream, there are much more we can talk about. We might write another article to talk about it specifically if everyone is interested.

FIGURE 4: CLOSE-UP OF THE UNDERSIDE OF THE WING PIVOT. THERE IS A SMALL METAL CIRCULAR TORSION SPRING THAT PROVIDES THE FORCE NECESSARY TO ROTATE THE WING.

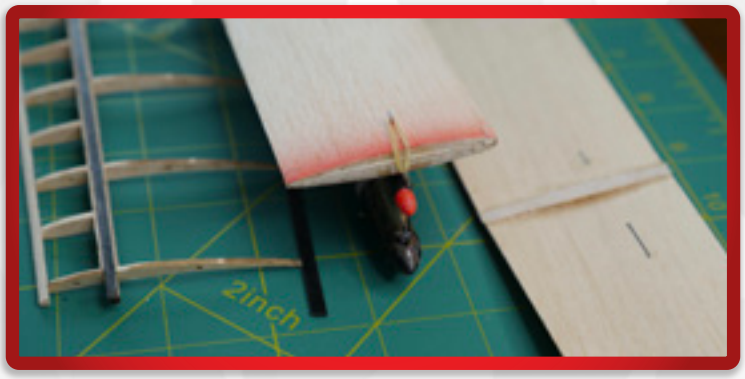

FIGURE 5: CLOSE-UP OF THE HINGE JOINT. THE WING IS FOLDED IN THE CENTER, AND OPEN IN THE RIGHT. ON THE RIGHT, YOU SEE THE UNDERSIDE OF THE WING. IGNORE THE BUILT-UP RIBS ON THE LEFT, AS THAT IS FOR A HAND-LAUNCHED GLIDER.

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We use silk as the hinge for the wing tip. It is light, thin but tough, and can be pasted using wood glue.

FIGURE 6: CLOSE-UP OF THE UNDERSIDE OF THE WING-TIP JOINT. THE HINGE IS MADE FROM SILK FABRIC.

We still use the rubber band to flip out the folded wing tip, but we improved this structure with steel wire. This improvement can prevent the wingtips being not able to be fully expanded, due to the resistance at the folding part that makes the rubber band fatigued and fail to unfold the wings after being folded down for hours. We had had this situation many times at the contest before, but it hardly ever happened again since we improved the design.

For the rotating part of the wing, we used steel spring as the power to restore. This way it is smaller and has less resistance than a rubber band while flying. Also, it doesn't need to be changed very often. This is shown in Figure 8.

FIGURE 7: THE TWO METAL HOOKS WHERE THE RUBBER BAND ATTACHES TO POP OPEN THE WING TIP. THE ONE ON THE TIP PANEL IS LONG SO THE RUBBER BAND DOESN'T HAVE TO GO COMPLETELY AROUND THE FOLDED WING.

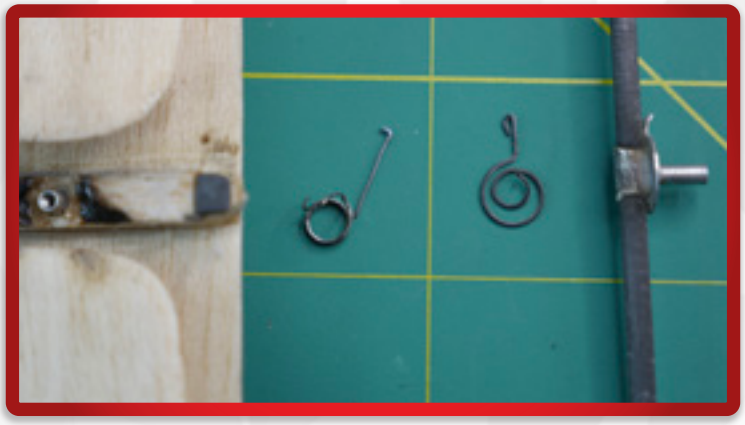

FIGURE 8: THE TORSION SPRING THAT ROTATES THE WING ON THE PIVOT SHAFT (RIGHT).

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This is only needed to be done by adding a spring groove outside the wing axel, and the spring between pylon wing and fuselage, which both sides are mounted on the wing and the fuselage. So, the spring gets compressed when the wings are rotated, and it restores as the wings rotates. You can adjust the power of the spring by changing its number of laps. We used 0.4mm steel wire and twined three laps, as shown in Figure 8.

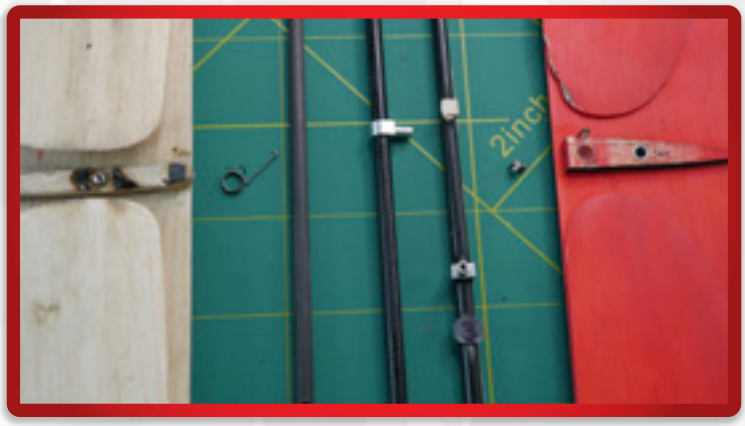

FIGURE 9: MORE FUSELAGES AND WING SPRINGS

For the wing axel, we used stainless steel tube (made from a thick needle) with aluminum alloy coat. It is expanded at one side, with a hole at the other side, using the rotating spring for the plug directly. Using the aluminum alloy processed shaft seat is also a good idea, it will be more stable. We normally apply it to larger aircrafts using 2mm screws to secure the wing right away, which makes it a lot easier to assemble and disassemble the wings while transporting. It will be much more convenient sometimes if the model takes less space while you are traveling with too many belongings.

FIGURE 10: THE UNDERSIDE OF THE WING SHOWING THE TORSION SPRING.

The tail of the wing is made of Balsa wood as well, with the traditional vertical layout. There is no movable rudder surface on the horizontal stabilizer like you'd see with other designs that have a pop-up tail for a dethermalizer system to bring the glider down so it doesn't drift out of sight. Instead, we chose the external counterweight wire rope as the forced landing system.

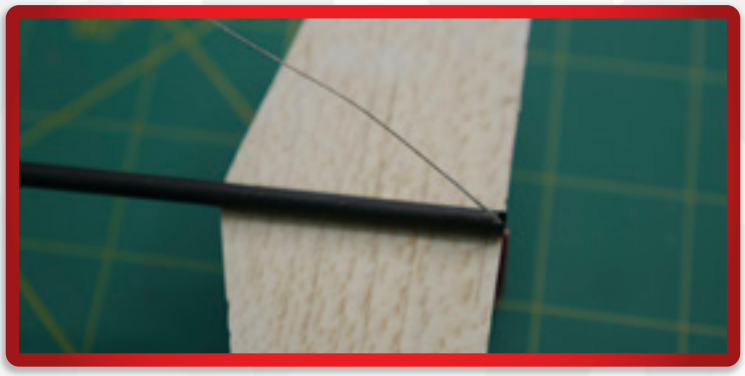

FIGURE 11: THE WIRE ROPE FOR THE DROP-WEIGHT DETHERMALIZER IS ATTACHED TO THE END OF THE FUSELAGE ROD.

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FIGURE 12: CLOSE-UP OF THE RUBBER BAND THAT HOLDS THE DROP-WEIGHT DETHERMALIZER. A DT-FUSE RUNS THROUGH THE RUBBER BAND. WHEN THE FUSE FLAME HITS THE RUBBER, IT BURNS IT IN HALF, AND THE DROP WEIGHT FALLS TO DESTABILIZE THE GLIDER AND BRING IT DOWN FASTER. NOTE ALSO THE YELLOW KAPTON® TAPE TO PROTECT THE WOOD FROM THE HEAT OF THE DT-FUSE.

The external wire rope is 0.4mm anti-rust steel cable. It is often used for the rudder surface transmission of the remote-control glider. One of its sides is glued at the tail part, and we made a little hook on the other side, using a rubber band to connect with the fixed hook at the nose. When in use, we run the cord used for forced landing, which can be burned, through the rubber band. When it is in position, it will burn the rubber band out so the wire rope with counterweight will drop to the tail, making the CG shift rearward, and that makes the aircraft descend fast to achieve the forced landing. It is commonly used in A motor contest. We hardly use it for 1/2A motor contests. However, it will help you a lot if you use the burning cord during the

FIGURE 13: TOP SIDE OF THE FOLDED WING. NOTE THE BLACK BURN STRING THAT PASSES THROUGH A HOLE IN THE NOSE AND TIES TO THE HOOK ON THE TOP OF THE WING.

FIGURE 14: THE DT-FUSE IS STUFFED BETWEEN INTO THE RUBBER BAND. JUST PRIOR TO LAUNCH THE END OF THE FUSE WILL BE LIT, AND THE FUSE WILL SLOWLY BURN UNTIL IT REACHES THE RUBBER BAND.

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test-fly and adjusting period. Of course, there is no need to use it if you pursue a perfect and complete flight path or you don't need to recycle the model by yourself.

So above is the brief introduction of our model and here's the dimension graph of it in Figure 16. At last, we hope to have more chance to communicate with everyone to exchange ideas. If you have any questions or anything you want to know about, you are welcome to leave a message or send us an email through Apogee.

FIGURE 15: CATHERINE LIU LOADS UP HER GLIDER INTO A LAUNCH TOWER IN PREPARATION FOR LAUNCH.

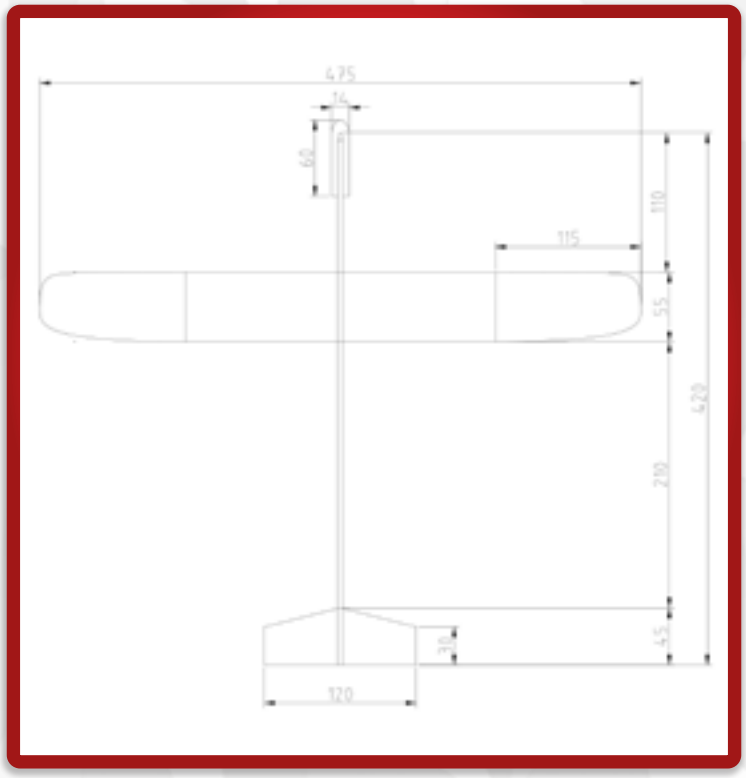

FIGURE 16: DIMENSIONS OF GLIDER

About the Author:

Branden Rea was the deputy secretary-general of the Beijing Model Sports Association in Beijing, China. From 2014 to 2020, he was also the coach of the Chinese Aerospace Model Team. He immigrated to the United States in 2018 and registered a STEAM education company, hoping to teach modeling courses in school, and also to facilitate Chinese children to come to the United States to visit some advanced aerospace museums and activities. Unfortunately, due to the COVID-19 outbreak, that has been put on hold. At present, Branden teaches some children of nearby neighbors in modeling skills.

In 2020, Catherine Lui's father asked Branden to mentor their TARC team and to help with her models for the WSMC in 2021.