PEAK OF FLIGHT

NEWSLETTER

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PEAK OF FLIGHT

Pushing Rocketry To The Extreme: The World Space Modeling Championships 2016

By Tim Van Milligan

Very few people fly competition rocketry, probably because it takes a high level of dedication. I understand, as most modelers just do rocketry for fun. But this past month my family and I went to the Ukraine to compete at the intense "World Space Modeling Championships". It's here that I got to see some of the most advanced rockets in the world. In this article I'll share some of my experiences and what I learned.

To begin, I didn't compete myself, but both of my daughters did. I just helped them to prepare for the contest (**Figure 1)**. We literally started preparing last summer (2015) just after they were selected for the team. It was a busy 11 months of preparation. Together we designed and built dozens and dozens of rockets to try to make better rockets than what they used at the 2014 championships in Bulgaria (ApogeeRockets.com/education/downloads/Newsletter373.pdf).

Figure 1: We packed the rockets without the fins attached to save room in the suitcases. They were packed in the white paper tubes for additional protection. The numbers on the plugs told us the mass of each tube.

The biggest takeaway I had from our previous experience was that our fiberglass body tubes were not up to the same quality standards as the Europeans. They make tubes that are smoother and lighter weight than ours. I talked a bit more in-depth about what they were flying in Peak-of-Flight Newsletter #412 (ApogeeRockets.com/education/downloads/Newsletter412.pdf).

Therefore, I concentrated this past winter on learning how to make better light-weight fiberglass tubes. By this spring, I had developed a technique to get the tubes under 5 grams with a nice smooth surface. I'll share my techniques in a future newsletter. But, unfortunately, as I found out, my tubes are still not as light as the Europeans'. We learned how important a gram or two is and that they make a huge difference in the S6 event (which is A-engine, Streamer Duration).

My daughter's models (**Figure 2**), weighing about 11 grams (which includes the fins and nose cone), couldn't catch any thermals. However, other models weighing about 8 grams were catching thermals and doing well in the contest.

Figure 2: The lightweight streamer duration models weighed about 11 grams (tube, fins, and nose cone).

I have come to think that all the work I did on making tubes was less than productive. Sometimes you find out that you went down the wrong path with the technology you pursued.

I wasn't the only one to find this out.

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Remember the advanced helicopters of the British team that I talked about in Peak-of-Flight Newsletter #403 (ApogeeRockets.com/education/downloads/Newsletter-403.pdf)? Well, they abandoned that design this year for something completely different. They felt that the rocket was too heavy and wouldn't boost as high as the competition. This year, they showed me their latest technology which included a 3D printed hub that had seven small rotor blades on it (**Figure 3**). The blades were ultra light, weighing about .3 grams each (**Figure 4**) .

Figure 3: The British team's gyrocopter used seven rotor blades that plugged into the 3D printed rotor hub.

The British had a phrase about weight: "*If it isn't there, it can't weigh anything.*" That pretty much summed up the minimalist approach that was used by all the teams. We discovered that one team had a foam ejection plug that was built up from sheet foam instead of being cut as a

Figure 4: The feather-like rotor blade from the British team's helicopter model.

solid plug that we use (ApogeeRockets.com/Building_Supplies/Body_Tube_Couplers/29mm_to_54mm_Couplers/40mm_Foam_Plug). Just shaving a little wedge of styrofoam was enough to justify the time commitment necessary to make the multi-piece part (**Figure 5**).

Figure 5: A built-up foam ejection plug we found on the field from one of the other teams. All this work to shave off a tenth of a gram or two.

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The one area we as a team did well this year was in the altitude events. My girls both competed in S1A (A-engine Altitude) (**Figure 6**). Essentially, this is a staged event, where you have a 1/2A in both the booster and sustainer. In the previous contest in 2014, we had disaster after disaster: lost models, missing altimeters, and no staging of the models. We didn't have any successful flights.

Because of that, we practiced a lot. That practice paid off. On the Junior team, the USA team had nine out of nine successful ignitions of the upper stage motors during the contest. That was a huge accomplishment, as most teams had a success rate of less than 50 percent. While our team had two flights that were disqualified, they took home a silver medal as a team. I know you're wondering, so I'll fill you in on the two DQ's. The first had to do with the upper stage not releasing from the booster stage. The top stage's motor ignited, but the model didn't separate. In the second case, the streamer in the upper stage failed to deploy, which is an unsafe flight.

The winning model flew to an altitude of 430 meters (1,410 feet). My daughter Ashley's rocket flew to 394 m (1,292 feet) for a second place finish. That's not too bad for an "A" size rocket engine.

My daughters both flew the Streamer Duration event. Their flights were all qualified, but as mentioned previously, they didn't catch any thermals. They didn't get the spectacular flights

Figure 6: Ashley Van Milligan has her two-stage A-engine altitude models measured prior to their launch. Strict rules govern the minimum size of the rockets.

you get when your model rises up in a thermal. It is the little things, like just a couple of grams in mass, that are so critical at this level of competition rocketry.

My favorite event, which you could probably have predicted, is helicopter duration. In international competition, it is actually called gyrocopter duration. It is given the designation of S9 on the event list.

Again, weight is the big enemy in this event. My daughter's model weighed in at 21 grams without the rocket engine, while the winning models were in the 16-gram range. She had three good flights with all the blades deployed and spinning during descent. But again, her models didn't catch any thermals so she didn't even come close to a medal. She finished in 9th place out of 33 contestants.

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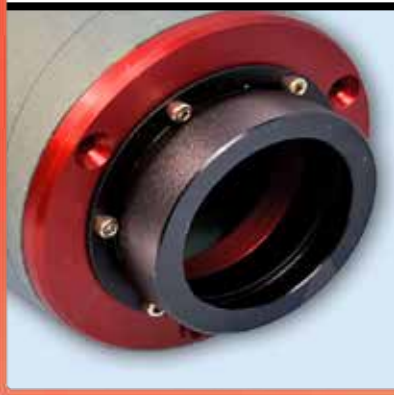

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Figure 7: Alyssa Stenberg preps her gyrocopter for launch. The model is similar to the Eastern European designs where the tips fold up for increased blade area. You can see the tip panels are also swept rearward.

One thing our team learned in this event is that recovery wadding is not allowed to separate from the rocket for this event. If it does, your rocket is disqualified. This is a big change for this event and others in the same contest. It seemed unfair, but a number of teams had DQ's because of this wadding issue.

My overall impression of the contest is that quality models that are lightweight are very important to doing well. We built a lot of models together in preparation for this contest, and that helped. That repetition of the building process helps a lot because learned a lot during the process, and I can say that the models the girls built got better with practice. They used models that were built in July rather than the ones that were built during January and February.

The other trend that I saw in Ukraine is a move away from using balsa wood in the construction of rockets. While balsa is a miracle material in rocketry because it has such a high strength to weight ratio, it is hard to get the consistency from one model to the next. If you sand an airfoil into a fin that is just a little bit off, the rocket may not fly a perfectly straight trajectory on its flight. If you're aiming the rocket slightly in order to catch a thermal that is off to one side of the field, that little bit of off-trajectory will likely mean you won't get the rocket into the thermal.

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My final lesson that has been reinforced to me at this contest is the importance of special "tools" and "fixtures" to build the rockets. It is more than just fin jigs, which have alway been important for absolutely straight fins. While talking to the modelers, they told me of things like nose cone jigs to make sure the shoulders are on straight, vacuum bagging materials, and special molds to make fins and helicopter blades. Personally, I invested in a lot of special tools to make it easier for my daughters to build their rockets. For example, because my workshop gets cold in the winter and it takes forever for the epoxy to cure, I created a special oven to cure the epoxy a bit faster. Think of an Easy-Bake oven built from rigid styrofoam panels, that uses an incandescent light bulb for a heat source, and you have an idea of what it looks like.

Figure 8: My oven uses two light bulbs to warm up epoxy so it cures faster during the colder winter months.

I'm fortunate to have access to some other special tools here at Apogee Components to make rockets. You already know of my laser-cutter that I use to cut everything from balsa fins to cardboard fin jigs. It was probably used on every rocket we built in some way or another.

Figure 9: Some of the many special tools that I created to make parts and to assemble rockets faster and with higher precision.

The other tool that I have here at Apogee is a 3D printer. I only just got it in June, so I didn't use it as much on these international competition style rockets as the laser cutter. But I did use it to make "heads" for the piston launcher we used and a special rotor hub for the gyrocopter model (**Figure 10, Page 7**).

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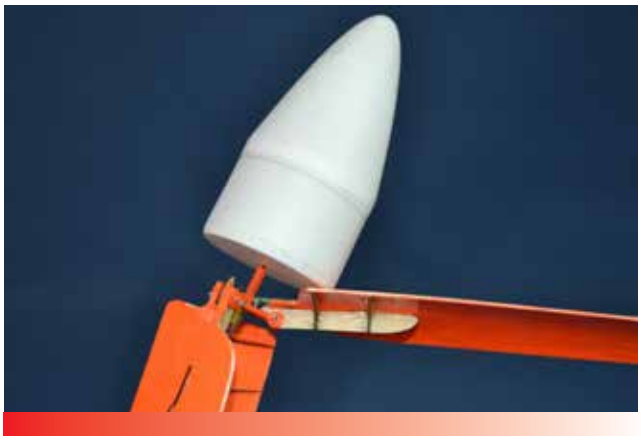

Figure 10: The rotor hub on my daughter's helicopter was created using a 3D printer. The hub allows for the blades to be oriented at the right pitch angle, and they make model assembly happen much quicker.

I also used the 3D printer to make a new nose cone mold that is lighter than the current FAI nose cone we sell (ApogeeRockets.com/Building_Supplies/Nose_Cones/Low_Mid_Power_Nose_Cones/FAI_40mm_Vac-Form).

I'll probably release this new nose cone as an official Apogee product in the near future. The nice thing about it is that it has a vacuum formed shoulder that goes with the parabolic shaped nose. The advantage of the shoulder is that it makes it easier to attach a shock cord to the nose cone versus using a foam plug (ApogeeRockets.com/Building_Supplies/Body_Tube_Couplers/29mm_to_54mm_Couplers/40mm_Foam_Plug).

www.apogeerockets.com/RockSim/RockSim_Information

Figure 11: A new lighter-weight two-piece vacuum-formed plastic nose cone that was created from 3D printed molds.

A couple of days before we left for our trip, I experimented with using the 3D printer to make some molds that I could cast up some fins. Inside the mold, I put some paper skins and then filled the cavity with expanding grow foam (**Figure 12**). They were kinda cool, but there is still a bit of work to do to make competitive fins that other modelers were using.

Figure 12: This is a mold I 3D-printed to make foam-core fins. The paper skins were put into the mold and filled with a two-part expanding grow foam.

I've said this before, but I think 3D printers are going to revolutionize the way we make models. There is a lot more you can do with them than just printing nose cones and fin cans. Right now, I'm using printing "tools" that we can use to make other rocket parts faster and with higher quality.

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For example, just this past week I printed some centering wheels that I use on my laser cutter (**Figure 13**). These wheels allow us to cut fin slots in body tubes a lot faster than we ever did before. This increase in efficiency will allow us to keep the price down on future rocket kits that we produce here at Apogee.

Figure 13: These 3D printed wheels allow body tube slots to be cut quicker on our laser-cutter.

Over the next few months, I'll probably write more about the types of things that I did to build the rockets for this contest. I already know I want to show you more about my gyrocopter hub and the fiberglass tubes that I created. I'll probably think of other things too. I'm happy to share my knowledge, in hopes that you'll pick up where I left off and take this hobby even further.

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 (ApogeeRockets.com) and also the author of the books: "Model Rocket Design and Construction," "69 Simple Science Fair Projects with Model Rockets: Aeronautics" and publisher of the "Peak-of-Flight" newsletter, a FREE e-zine newsletter about model rockets. You can email him by using the contact form at ApogeeRockets.com/Contact.

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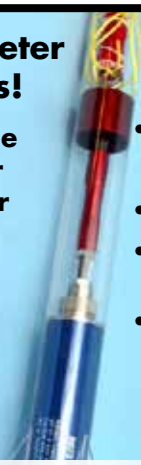

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