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NEWSLETTER

Feature Article:

Competition Plan: The Eggs-Terminater

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Contest Plan: Build the Eggs-Terminater Rocket

Written By Tim Van Milligan

Are you still giving some thought to coming to Colorado on vacation next July to attend NARAM 52? I hope to see you here.

In order to get you a bit more prepared, I thought I'd present a few plans and some flying strategies. Even if you can't attend, I think you may pick up a few tips from this article that may help you with a future rocket project.

In Newsletter 245 (www.ApogeeRockets.com/education/downloads/Newsletter245.pdf), I presented the first plan that could be helpful for you. It was for the "F-Engine Superroc Altitude" contest event. Now, I will go over what I consider an easier event, even though it has more points than the superroc event. This event is "E-Engine, Dual Eggloft Altitude." The name for the plan is the "Eggs-Terminater." It is an obvious play on the word exterminate, because if the rocket fails, it will completely exterminate -- as in utterly destroy -- your payload of raw eggs.

The goal of the event is to launch two chicken eggs (at the same time), to the highest possible altitude, using an "E" size rocket engine. You must get the eggs back, and they can't be cracked. If the eggs are cracked, even slightly, your flight is disqualified.

This is an event that really gets spectators excited. They seem to "get" the whole purpose of the event, and the anticipation of eggs going splat somehow drives them into a frenzy.

You'll notice that whenever a news organization comes out to a rocket contest, the event with the eggs in it will always get mentioned by the reporter. You can just read the expression on their faces when you talk to them about the fragility of the payload. They obviously must have cracked a few eggs on the floor of their kitchen. So when you tell them that these eggs are going to reach 1,800 feet in the air before plummeting back to the ground, they get as excited as a kid in anticipation of fourth of July fireworks.

And there will be quite a few "splats."

When launching eggs, I like the rocket designs with the ice cream cone layout. The long conical transition between the egg capsule and the engine has some big advantages. First of all, the internal volume is much larger than designs using straight tubes. That extra volume means you can more easily stuff a bigger parachute into the rocket. And since the front end of the rocket is so large, the parachute will exit the rocket easily too. Getting the parachute to come out reliably is a critical factor in having success in this or any parachute event.

Figure 1: The Eggs-Terminater hangs on a launch rail.

Finally, the transition also reduces the drag on the rocket. Obviously, that is going to help the rocket travel higher in the air.

The downside of almost any egglofter rocket is that

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they are clumsy to support on the launch pad. You will need some sort of stand-off or tower design to support them in a vertical position. The conical shaped egglofters, like the Eggs-Terminator plan, are no different. The transition shape does make it a little harder to support the rocket on the pad if you haven't done some pre-planning. I'll help you with that part here in this article.

The Secret To Winning

As I mentioned in Newsletter 245, I strongly suggest that if you want to win in any altitude event, that you go with a very long launch rail, and the Fly-Apart Rail Guides to support the rocket on the pad. This egglofting rocket is no exception. In fact, I've got the photographic evidence that the rail is the secret key to victory.

If you don't come off the pad with the rocket going perfectly straight-up, then you're going to lose altitude and diminish your chances of having the highest flight. That makes sense, doesn't it? A rocket that is traveling at an angle from vertical isn't going to go as high as one that flies straight up.

A short launch guide in this event is going to cost you big time. Because of the two heavy eggs, the rocket is really going to lumber off the launch pad. If it isn't guided for a sufficient length so that it can build up speed, it is going to turn non-vertical as soon as it clears the pad.

A couple of weeks ago, I participated in a rocketry contest held in Denver, Colorado. All of the serious com-

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Figure 2: A similar rocket to the Eggs-Terminater inside a tower launcher. Note the short distance (at the top) that the rails of the tower guide the rocket.

Figure 3: Because the rocket doesn't leave the tower with sufficient speed, it weathercocks strongly into the wind as noted by the curved smoke trail.

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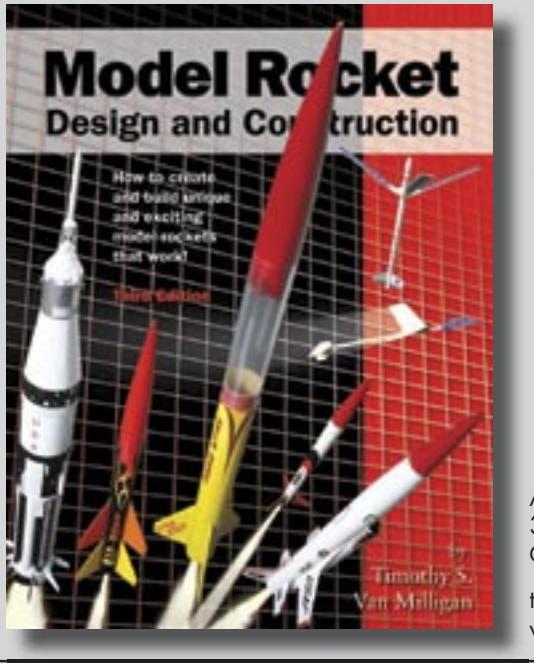
Figure 4: The rail launcher allows for a much longer distance where the rocket can build up speed so that when it leaves the rail, it flies straighter.

petitors were flying their egglofters out of a 3-1/2 foot long launch tower. Because the bottom of the egg-rockets were not really supported in the tower (see Figure 2), they were somewhat free to float around and point in any direction they wanted. They were only supported side-to-side at the top of the rocket, at the fat part of the egg capsule. The length of tower supporting them from that point (measured upward) was probably only about 12 inches.

You're right if you're thinking that 12 inches isn't long enough for the rocket to gather sufficient speed to keep itself going straight once it exits the tower. And that is exactly what happened. Even in a very calm wind, the rockets came out of the tower and then weathercocked strongly, as can be seen in Figure 3.

In contrast, the two flights that came off the 8-foot long launch rail (Figure 4) were awesome. My daughter's rocket, which didn't have airfoiled fins (she's only in "A" division, which is for kids), reached an altitude of 603 meters, which was a new NAR record for her age group. She whipped almost everyone, including the adults (me too).

My one personal flight came off the rail fairly straight, but I was launching in very high winds on the second day of the contest. It had a good start, but either the ejection charge deployed about 3 seconds too early, or the egg capsule somehow prematurely separated from the transition. In either case, it only reached 331 meters. Fortunately, the eggs survived which meant I got a qualified flight in the event. Had I been smarter, I would have flown it a second time. But because it was windy, I was too tired from chasing



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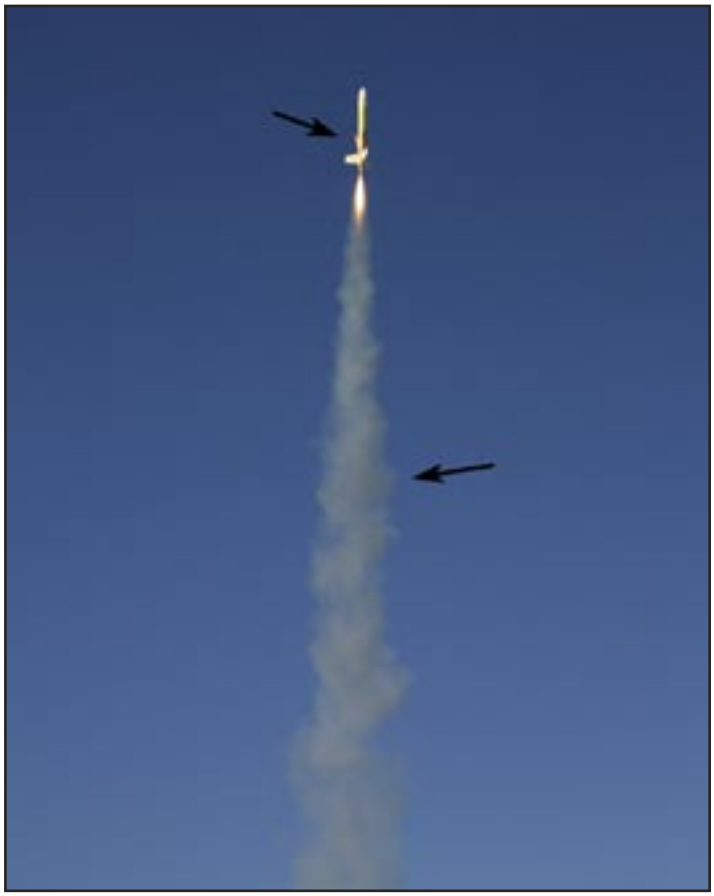

Figure 5: The straight smoke plume is a good sign. Note that about 30-feet up in the air, the Fly-Apart Rail Guides are just popping off the rocket.

all the other rockets we launched that day and I didn't have the energy to go after one more that was sure to drift a mile or more. I chickened out… (get the egg-related pun?)

As in any contest event, the other big secret to doing well is *reliability.* You have to build the rocket to be consistent from one flight to the next. That way if you make adjustments between flights, you know exactly how those adjustments will play out to your advantage.

For example, if you don't practice your folding technique on parachutes, you won't develop a procedure that will allow it to consistently open every time you launch it. By the way, my parachute folding technique is show in Newsletter 199 at: www.ApogeeRockets.com/education/downloads/Newsletter199.pdf

In contest flying, sometimes you take too many risks in order to get a winning edge and you end up cutting down on your reliability. I'm not immune from this kind of "launch fever." At this contest, in the "B-Engine Streamer Duration" event, I swapped out streamers from a small one that I knew I could consistently deploy out of the rocket, to one that was much bigger and I thought I might be able to get out of the tube with a little luck. It did come out, but it suffered a weird attachment malfunction, and didn't unfurl completely. I would have gotten a better time had I stuck with the streamer I knew would have worked consistently.

Other Construction Notes

The Eggs-Terminator is fairly straight forward in how

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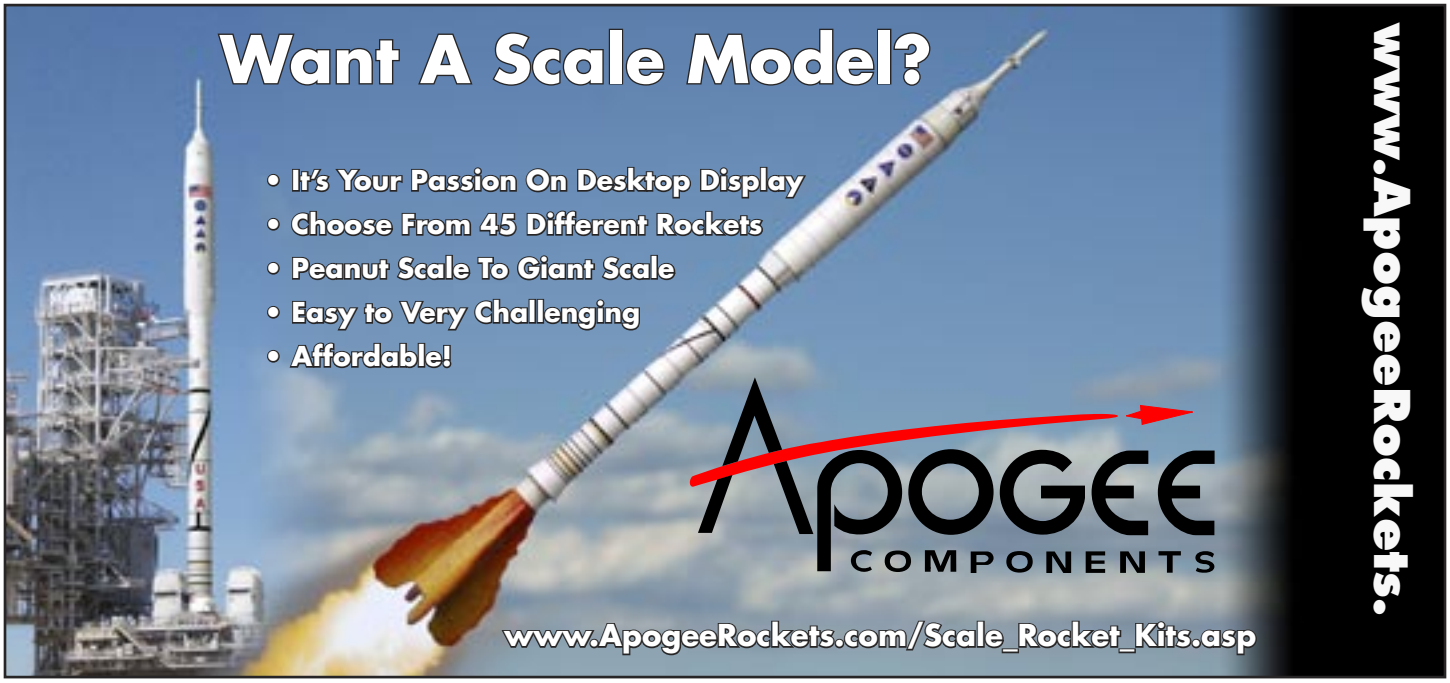

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it is put together. The transition section is a structural part of the rocket, which means that it needs to be strong and rigid. Therefore you should use wood glue to assemble it. If you've seen my video on putting together a paper shroud, I typically suggest rubber cement so that it is easier to get a circular cross-section on the part (www.ApogeeRockets.com/Rocketry_Videos/Rocketry_Video_11.asp). This kind of transition is the exception, and I do recommend wood glue, even though you'll probably end up with a bump at the seam. I personally practiced building about 6 of them, and I finally got my technique of pre-rolling them to the point where the seam didn't turn out half bad.

Figure 6: Cut a spill hole in the chute, and also route the suspension lines over the top of the canopy to increase the chute's strength.

The capsule is a dual-egg cone from Pratt Hobbies. The eggs are very snug in the cone – that is the way it works. You can't get any padding on the sides of the egg, only a little bit at either end. Because of this, you have to make sure the egg doesn't swing back-and-forth as it descends. It needs to be oriented so that it will always touch down on its tip. So put a spill hole in the middle of the chute (see Figure 6). That will help minimizing the swinging tendency of the chute.

While we're talking about the parachute, you also need to use the over-the-top technique with the shroud lines. Two eggs are very heavy, and will put a lot of stress on the point where the shroud lines attach to the plastic canopy. By making the shroud lines go over the top of the canopy, it will be much stronger.

When I launched my flight, the two eggs each got wedged tightly in the halves of the capsule. I had to sacri-

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fice the capsule and cut it open to remove one of the eggs. After I did that, Russ Anthony came over and let me in on a little tip. You put a pin hole on the tip of each half of the capsule, and then you just blow a little air into the plastic. It worked like magic – the egg seemed to literally pop out of the capsule. I wished I learned that trick before I had to cut it open.

Remember where I talked about having a premature separation of the egg capsule from the transition section? There are a couple of things you can do to minimize this from occurring on your flights. First, you have to wedge the nose cone tightly onto the transition. But do this only when you have the rocket on the launch rail as a final step before you launch it.

Additionally, you can put a little bit of rubber cement on the inside lip of the transition. This will give it a little bit more tack and help keep the nose cone from wiggling around as you are getting it ready to launch. I've not tried this yet, but I've heard that it does help a lot.

Just getting the rocket onto the launch rail is sort of tricky, because you have to lay the rail down on its side. The nose cone with the heavy eggs will want to fall off, as it does not have any sideways support as it sits on the transition. You may want to temporarily tape the nose cone on. Just be sure to remove any external tape prior to launching it, or you may hear that loud splat sound as it comes down ballistically. Having a friend help you swing the rail up to its vertical position while you hold onto the eggs is a very smart idea too.

Building the Fly-Apart Rail Guides

The hardest part about building this rocket is making the Fly-Apart Rail Guides. Because you don't have a

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Figure 7: The Fly-Apart Rail Guide cradle (background) is kept round by temporarily placing two cardboard disks inside. Use the pattern sheet as a guide for cutting out the right size/shape piece of fiberglass cloth.

Figure 8: The fiberglass cloth is wrapped over the transition. One layer of cloth is sufficient to hold the shape.

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straight section, you have to make a transition to hold the rocket and use that as the basis for the cradle parts.

I created a small transition from heavy paper as a starting point. This time, I did assemble it using rubber cement, since I needed it as round as possible. To keep it round while I was working on it, I placed a cardboard disk inside each end (see Figure 7). The disks were just tacked in with a little glue, and were removed when the assembly was complete and the resin had hardened.

Figure 9: The cloth is wetted with liquid epoxy. Squeegie off any excess resin with paper towels.

Then I cut out a piece of heavy fiberglass cloth, using another printout of the shroud template as a pattern (Figure 8). I wrapped that cloth over the paper shroud and wetted it out with 5-minute epoxy. You have to work fast, as epoxy will harden fairly quickly. Fiberglass is tricky to work with, because it wants to slide around on you. The epoxy resin is no picnic either, as it seems to get on everything. There are a lot of safety precautions when using fiberglass and epoxy, like always wearing disposable gloves, so just be advised.

In place of epoxy resin, you can use thin CyA glue. But it kicks off so fast (almost instantly) when it hits the fiberglass, that you have to work very quickly. The epoxy will make a better looking part, but the CyA is quicker if you are in a time crunch.

I actually made two sets of Fly-Apart Rail Guides. I didn't want to take a chance on losing on part during a launch, when I needed to fly the event at least twice (my duaghter flew the same design too, so that increased the risk of losing one, *which we didn't*). For the first one, I shaped the wire rail guides using the technique described in Newsletter 245. Because the rocket is so heavy, I needed one for each end to support the weight. Therefore, I

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Figure 10: The first-edition rail-guides used music wire as the stand-offs to engage the launch rail. These wires were difficult to bend and to align correctly.

had to make four sections of music wire pieces.

It was a little tricky gluing the wires to the fiberglassed cradle sections. I had to make sure the ends where the wires engaged into the rail would be lined up pretty straight, because I didn't want them to bind on the rail as the rocket was taking off.

After gluing them to the sections, I put another layer of fiberglass cloth over the wires to make sure that they

Figure 11: The "second-edition" uses balsa rail-guides (two required, mirror images of each other),

wouldn't pop off at launch (see Figure 10). I'm glad I did that. Since they were so well affixed to pieces, I was able to slightly tweak their position and orientation so they wouldn't bind on the launch rail.

These wires were tedious to bend properly, and therefore, for the second set, I actually redesigned the rail guides to get rid of the music-wire piece that engages the launch rail. This I call the "second-edition" version of the rail guides, and I built the part that engages the rail out of balsa

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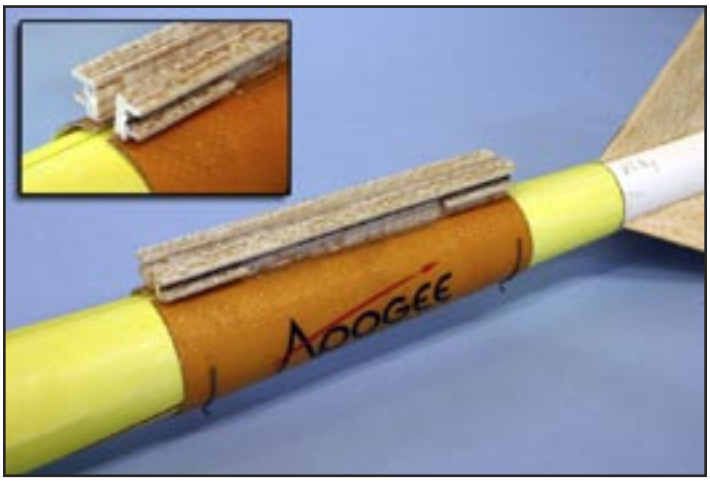

Figure 13: The "second-edition" Fly-Apart Rail Guard is made from several pieces of balsa wood. The inset shows the cross section that engages the rail launcher.

wood (see Figures 11 and 12). The only music wire I used was to create the rubber band hooks. It isn't very critical that they be shaped perfectly, since they only need to hold the cradles together.

Finally, I painted the insides fluorescent orange (although you may want to paint the whole thing a flourescent color. The reason for that is to make them easier to find as

Figure 14: This back-side view of the Fly-Apart Rail Guide shows the rubber bands on the music wire hooks. I also added two strips of balsa wood along the mating edges of the cradles. This prevents the edges of the cradles from slipping over/under each other.

they flutter down to the ground after the launch. To unsuspecting spectators, the launch of a rocket utilizing fly-apart rail guides is shocking. When the rocket leaves the rail, the cradle guides pop off and make it look like the rocket has exploded into a bunch of parts, or that you shredded a fin off the vehicle. I heard one of my competitors say I DQ'ed the flight because it came apart on launch. But that is the way it is supposed to work! It is very cool to see in real-

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time, because it disorients your focus on the rocket itself, and therefore it really does look like an explosion.

Be sure to put your Name and NAR number on the cradles. They will scatter near the launch area, but it may take you a little searching. If you don't find them both, someone is bound to stumble across them lying on the field, and then they can return it to you.

As mentioned, in the plans I have modified the Fly-Apart Rail Guides to get rid of the music wire that engages the rail. I've found they are far simpler to build if you use balsa wood to create the rail guides. These are then glued to the fiberglass cradles. The only wire used is for the rubber band hooks shown in Figure 15.

Figure 15: The completed cradles for Eggs-Terminator Fly-Apart Rail guides.

Other Flying Tips

The E-Dual Eggloft Altitude is a very high weighting-factor event. That means you get a lot of points for a successful flight. Therefore, during the heat-of-battle, when you've got a million other rockets to fly that day, keep this in mind. It is worth flying this particular event early in the day to make sure you accumulate those points. And it is really worth winning the event, because your point total will increase dramatically. So I would suggest flying two times and really going for broke on the second attempt (since you are allowed two flights). At the increased risk of cracking eggs, on the second flight you might decrease the size of the parachute down to an 18-inch diameter canopy to save a little weight and eek out a few more meters in altitude.

Other Uses For This Rocket

This is a somewhat versatile rocket design, as it can be used in several egg-lofting events.

First of all, it can be used for the E-engine Dual Eggloft Duration event. The only thing you would need to change is to put in a larger 36-inch diameter parachute. The large shroud has plenty of room to accomodate this bigger chute.

You can also use the same plan for "single-egg" events using E-engines too. All you need to do is to swap out the Pratt Hobbies dual-egg capsule with Apogee Components' single-egg vacuum form capsule (P/N 20102 at www.ApogeeRockets.com/nose_cones.asp). Now you'll have E-eggloft altitude, and E-eggloft duration too.

I probably wouldn't use this specific plan for the D-Engine egglofting events, because I think you could save weight and get extra altitude by modifying the transition to neck down to a 18mm motor tube instead of the current 24mm size. But you could use this plan as your back-up rocket if the weather conditions are so poor that flying an Estes D12 motor would be more reliable in getting the rocket back. Just remember, when flying egg-lofting events, you have to get the model back to prove that you didn't crack any eggs. Otherwise, you'll be DQ'd for a non-return.

Download the Plans And Pattern Sheets

I've created a large file containing the RockSim plans for this rocket, a side view, and the patterns for the transition sections and the fins. You can download this from the Apogee Components web site at: www.ApogeeRockets.com/Education/Downloads/Eggs-Terminater.zip

In conclusion, I've given you all my secrets, so you should be ready to do well in the big contest. NARAM-52 information is at: http://www.peakcity.org/

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. 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 a 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 the curator of the rocketry education web site: http://www.apogeerockets.com/education/. He is also the author of the books: *"Model Rocket Design and Construction," "69 Simple Science Fair Projects with Model Rockets: Aeronautics"* and publisher of a FREE e-zine newsletter about model rockets. You can subscribe to the e-zine at the Apogee Components web site or by sending an e-mail to: ezine@apogeerockets.com with "SUBSCRIBE" as the subject line of the message.