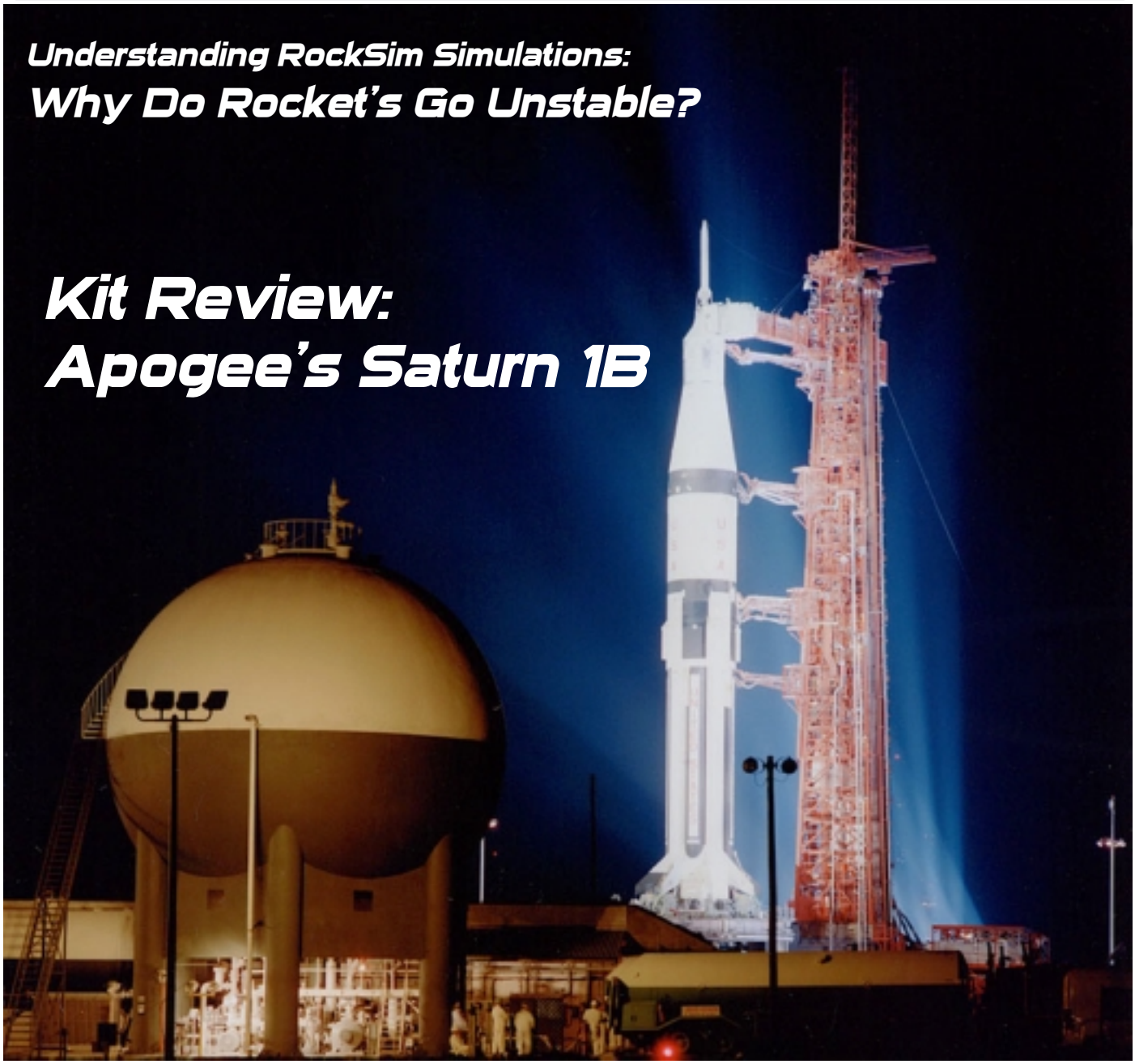
ISSUE 101 - APR. 4, 2003

APOGEE PEAK OF FLIGHT NEWSLETTER



Understanding RockSim Simulations: Why Do Rocket's Go Unstable?

Kit Review: Apogee's Saturn 1B

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PEAK OF FLIGHT

What Causes An Unstable Descent?

Here is a question from Michael J. Mangieri

"Why would an aerodynamically stable rocket tumble down after a failed ejection charge according to RockSim?

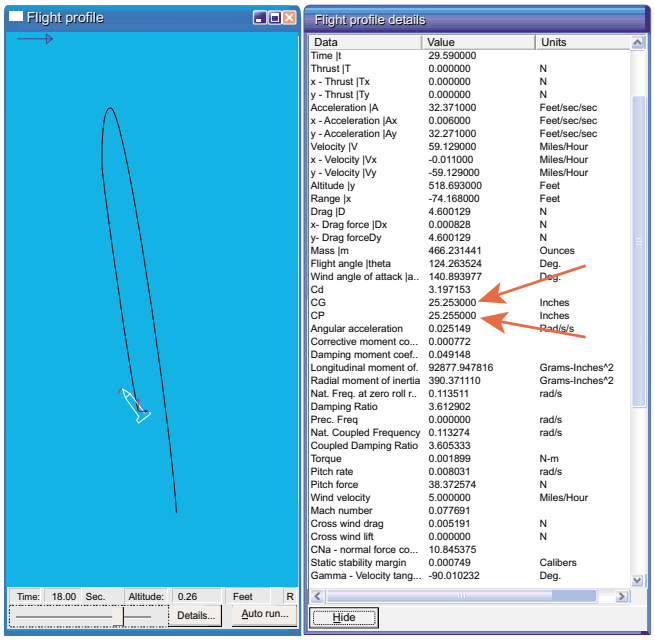
I have a simulation of an Aerotech Warthog that uses a G64 engine with the delay time specified as 60 seconds. I did this to see what the flight path (and subsequent crash landing) would be like for some of my fleet. The extended delay allows RockSim to continue the flight path without the recovery device ever being activated.

What I see in the simulation is strange ... the otherwise stable rocket tumbles down after apogee! Other rockets do not exhibit this behavior."

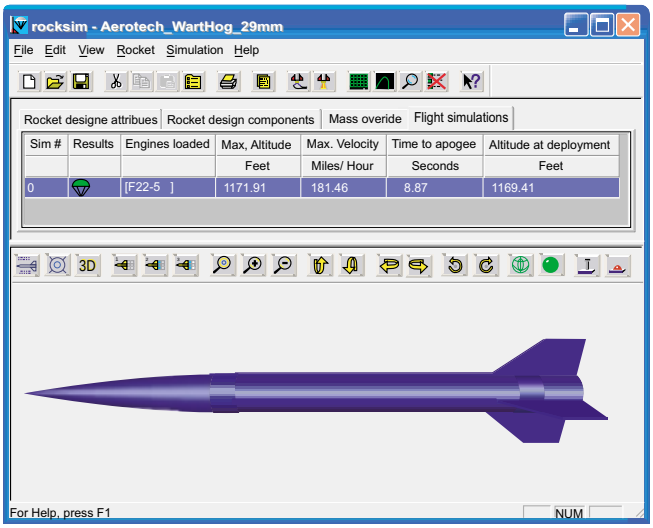
Answer

This is a good question, because it illustrates several important rocketry concepts.

First, let me say that you are actually seeing something that might actually happen in your rocket's flight. A lot of times, the first thing that people think is happening is that the software is giving misleading information. But this is not the case. In other words, you are not encountering a bug in the program.



By displaying the flight details, you can see that the CP shifted forward of the CG location



The Aerotech Warthog appears to become unstable in this particular simulation. Why?

The reason your rocket simulation is showing the rocket going unstable after the apogee point is that the Center-of-Pressure location (CP) has shifted forward of the Center-of-Gravity (CP) location. By definition, the rocket is statically unstable when the CG point is behind the CP location.

Your question might be, how did this happen?

You're probably asking yourself, "shouldn't the rocket get more stable?" After all, the back end of the model got lighter in weight as the propellant was consumed. This makes the CG shift forward, making the rocket more stable.

The answer is because the CP shifted further forward than the CG moved. This occurs when the Angle-of-Attack (AOA) changes.

Because you had a 5 mph wind in the simulation, the AOA changed when the rocket slowed down. The slow-down occured near the peak of the flight. If you take a look at the graphs below, you can see that the Wind Angle of Attack started

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Archives of this Newsletter

All the articles that have appeared in this newsletter are archived at http://www.apogeerockets.com/education/newsletter_archive.asp

Unstable Descent?

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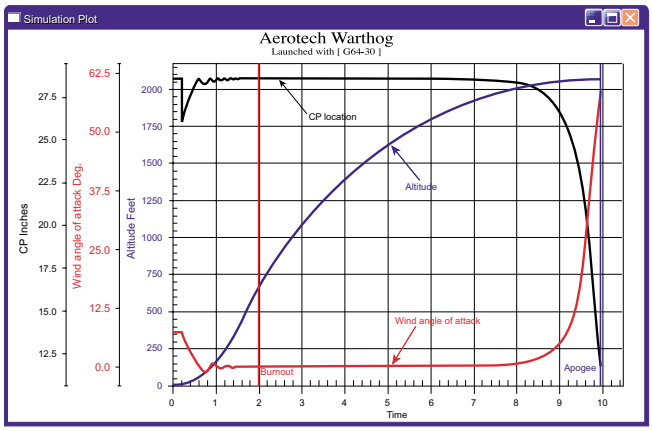
making a major swing as it got close to the apogee point. At the same time, you can see the CP moves significantly forward.

For this particular rocket, you may not care if the rocket goes unstable after it reaches the peak altitude point. But what if you had a camera on board? If the rocket went unstable, the pictures that came back might not be of the ground. You might have some great pictures of blue sky. This is just one reason that you really need the RockSim software. It takes into account the dynamic characteristics of the flight.



Looking at the simulation plot, you can see a major forward shift in CP location when the rocket's angle-of-attack increases.

Before I conclude this article, let me say that every rocket will have different flight characteristics. The Aerotech Warthog is a relatively short rocket, with small fins. If the rocket was longer, the CG would be in a different location, and it probably would be stable after the apogee point. You really can't tell unless you run the simulations.

I urge people that don't own RockSim yet to download the FREE demo version from the Apogee Components web site at: http://www.ApogeeRockets.com/rocksim.asp The demo version will not show you the graphs, but it will show you that the rocket does go unstable after passing the peak point. There is no other software that will tell you this important information, which is why I always recommend RockSim.

If you have a question about the results of a simulation, and you'd like to see them answered here in this e-zine newsletter, please send them to me at: tvm@apogeerockets.com

See related article *Stability of Short, Squat Rockets* in Apogee E-zine Newsletter #86. It can be downloaded at: http://www.night.net/apogee/Newsletter86.pdf

Reprint information:

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6 Degrees Of Freedom

splash

What does this mean to you?

6 Degrees of Freedom software means it can find the position of the rocket in the X (vertical), Y (downrange), and Z (cross-wind) coordinates, as well as Pitch, Yaw, and Roll. Splash is the first affordable rocketry simulation program that can perform this complex scenereo. This means it can give you an accurate indication of where your high altitude flights will land.

You tell Splash what conditions might vary during the flight, such as wind speed vs altitude; or the failure likelihood of the parachute failing. You can vary 18 different variables during the flight, and Splash will give you a plot of the likely landing zone. If you're flying sub-orbital flights, then you'll need this data to get permission from the FAA to launch your rocket. Right now, Splash is the only software that can do this.

Order a copy today; or for more information, visit:
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Apogee Components

Kit Review: Apogee's Saturn 1B

Photos and Article By Chan Stevens

Let me preface this review by pointing out that I have never paid more than $100 for a rocket, and my previous experience with Apogee and the daunting $175 price for this rocket set my expectations outrageously high. That said, this kit has exceeded them in every way. It is a magnificent kit for the serious modeler, though even moderately experienced modelers will find this an unintimidating build thanks to the video instructions.

The kit arrived in a surprisingly small box, with the components packed safely and efficiently. There was even room for a very nice poster of an exploded view drawing of the Saturn 1B, along with mission summaries. After looking for a parts list and instructions, I found the (2) CD-ROM instruction discs, and that's when it really started to hit me that this is far from an ordinary rocket kit. The instructions are almost completely done in Quicktime video. Since I don't have a PC in my dust-filled basement workshop, I thought this would be a significant inconvenience. Far from it, the videos are short and clear enough that you can play one, go off and do the work, then come back for more. The video instructions make all the difference in the world on this kit. As Apogee president Tim van Milligan says in the notes, just try writing instructions for tying your shoes.

This is a true 1/70 scale kit, with tubes being precisely sized rather than opting for common, commercially available tubing. All components are top quality, with fit and finish being excellent.

The assembly starts with painting the (8) fuel tank tubes. Despite the fact that the spirals in the tube are barely noticeable, the video shows a very effective technique for filling the spirals. Spraying a light base of primer and sanding back down to a bare tube leaves the spirals nicely filled. Two more coats of primer, a little 600 grit wet sanding, and two finishing coats later, the tubes are beautiful, without a trace of spiral. This finish was worth every bit of the time & effort, and should not be rushed.

Next comes the engine mount core. This was quickly and easily built using the 29mm motor mount tube, die-cut cardboard centering rings, and a couple of tube spacers. The components are excellent quality, with everything fitting perfectly. The die-cut cardboard parts break free cleanly with little or no rework. The fuel tank tubes are then glued to the engine mount core with the help of an alignment tool.

After finishing the engine mount core/fuel tank assembly, you're ready for one of the toughest parts of this project-cutting and bonding the vacu-form wraps. My only prior experience with this was the Estes Saturn 5, and after a lengthy struggle I managed to cover up most of my mistakes on that one. The Apogee Saturn 1B makes me wish for a "do-over" on the Estes. The video instructions for this are very detailed, with plenty of close-up shots and tips for lining up the wraps correctly. I was especially impressed with the numerous tips for using trace amounts of CA to avoid premature cracking of the plastic. The wraps are very tight fitting, and getting the edges to line up exactly right is very challenging. The video instructions, though, enabled this "apprentice" to do a very craftsman-like job.

Moving on to the transition section, I had to dig into the wallet a bit for supplies. To do a respectable job on this kit, be prepared to invest in a variety of quality tools and materials. Being primarily an Estes mod-roc builder, I've got basic tools, wood glue, and a bottle of CA, but the transition section on this uses four different glues (overall, you'll use seven glues plus Fix-It epoxy clay). The core of the transition is made with the basic tube & centering ring approach (plus wood glue). Next comes a paper shroud, which is bonded with

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Saturn 1B Kit Review

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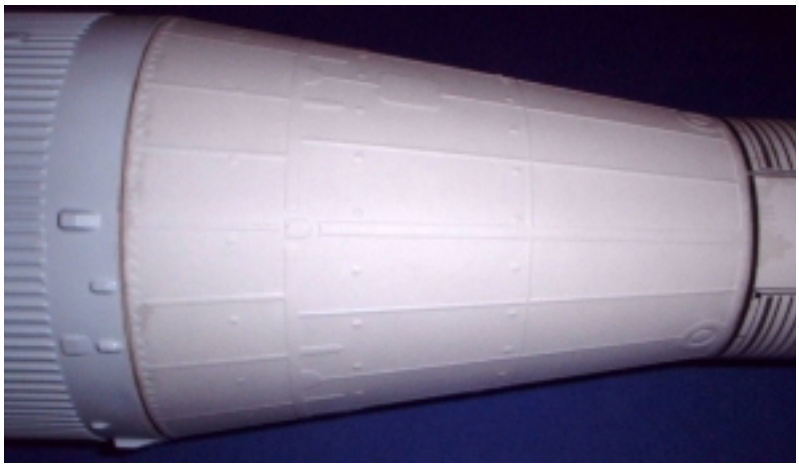

Transition features a highly detailed embossed wrap.

rubber cement. I've always been frustrated by the flat spots from using wood glue, and the rubber cement is pliable enough that the shroud is perfectly round. Glue #3 is a light application of thin CA to the paper shroud to give it strength. Once that's sanded smooth, a spray matting adhesive (glue #4) is applied to an embossed paper wrap that serves as the outer section of the transition. The dimensions were perfect, and I had a terrific fit.

The escape tower looked like a simple build, much like the capsule from my Mercury Redstone. The parts were tiny enough to call for tweezers, and once again the video instructions turned me into a master craftsman. Not only were there close-ups showing exactly where to cut the parts, and how to remove the sprue, but there were very detailed shots showing where to apply trace amounts of liquid plastic cement which yielded a strong bond without the hairs and seams left behind by the regular tube cement.

The fin assembly starts off with putty-filling the minor blemishes in the resin-cast fins. While I'm sure this is normal for resin cast parts, I was a little disappointed to find any blemishes in what had to this point been a perfect kit with flawless materials. After filling in the fins, you're now facing a choice of "regular" fin alignment, or mounting with a 2° canted alignment. The canted alignment provides a slight amount of spin, helping to stabilize the rocket during flight. This leads to less nose weight for stability, resulting in higher altitude flights. I opted for the canted fins, which is barely noticeable. Fins are bonded to the base with thick CA and to the plastic transition with a tiny wick of thin CA. As usual, everything fit perfectly.

The nozzle assembly was fairly straightforward, and includes a very nicely detailed vacu-form cover for the base. The nozzles have a slight slant to them, though I found the slant a bit less pronounced when bonded to the vacu-form cover.

With the construction just about wrapped up, I'd normally let out a sigh

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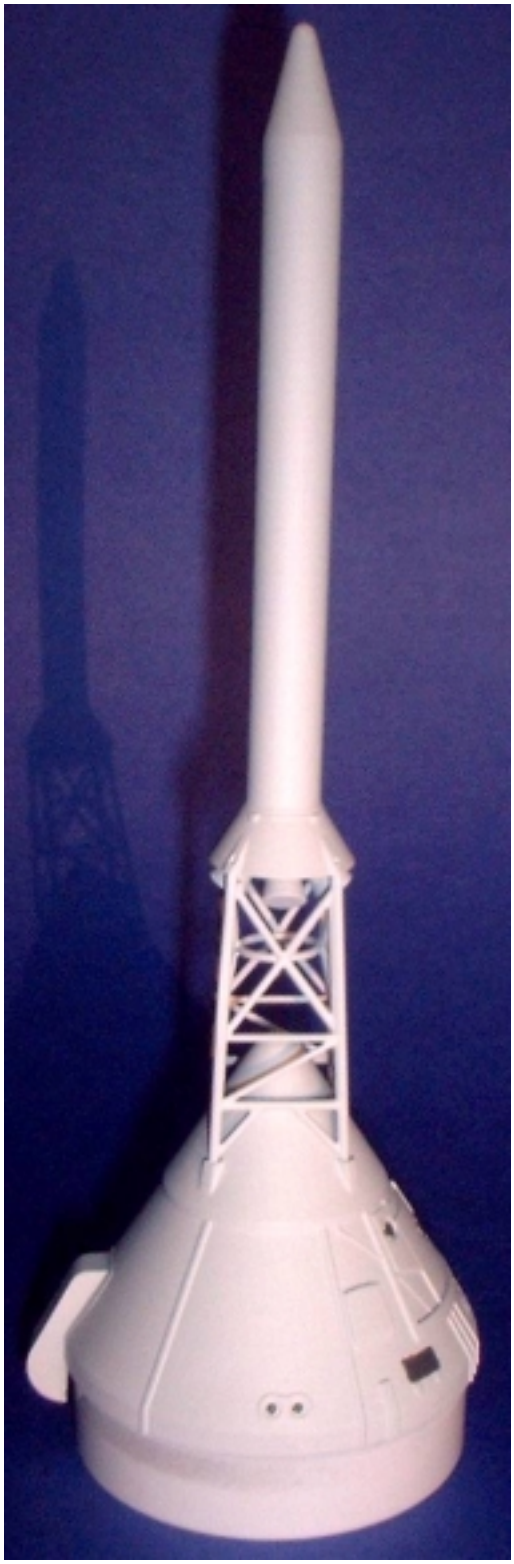


Saturn 1B Kit Review

(Continued from page 4)

of relief and enjoy the anticipation of an imminent launch. Painting and detailing a Saturn, though, is a very challenging task and takes nearly as much time as the construction itself. There are very helpful tips on filling any blemishes and tube swirls. I deviated a bit from the instructions here, though, and used a very fine steel wool pad (designed for furniture refinishing) to sand down the vacu-form wraps. This took the rough edge off the primer without damaging the wraps. After two very light primer coats, the rocket gets a couple of coats of white. I opted for Krylon flat white, which doesn't hide blemishes as well as gloss, but in my opinion offers a nicer looking overall finish.

After two light coats of white, the masking project begins for the black roll patterns. A sharp edge line along ribbed vacu-form wraps is extremely difficult. The instructions again offer some good tips, starting with using a Sharpie marker to draw a fine edge line, followed by a layer of liquid masking medium, followed by standard masking tape, pressed firmly into the valleys between ribs. I had difficulty getting a satisfactory finish with the Sharpies (note-three different types of Sharpie brand had trouble leaving a consistent finish). First of all, Sharpies leave a glossy finish, which doesn't blend well with my flat black paint. Second, the liquid masking medium tended to pull up some of the Sharpie color, though this could be due to the brand I used (my hobby store doesn't carry the brand recommended in the instructions). After a lot of trial & error, with some touch-ups applied using a microscopic paint brush, I finally got a nice, crisp roll pattern.

After painting, there's minor detailing and application of decals. This is one aspect of the instructions that I found a bit weak. While there are several very sharp photo-like drawings provided, the Saturn depicted in the drawings does not exactly match the one in this kit, and in the drawings it's tough to pick out some of the colors. I'd recommend a secondary resource like one of Peter Always's books before finishing this rocket.

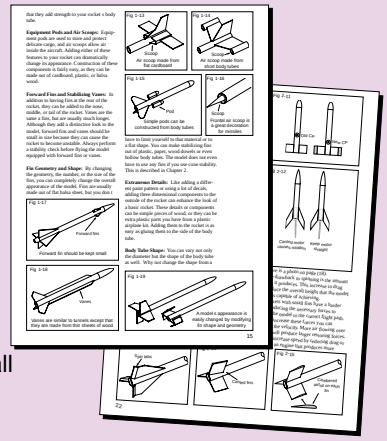
After applying all the finishing touches, final assembly of the modules and prepping of the parachutes. I was very impressed with the chutes, being made of strong nylon, and very brightly colored. To fly the rocket, a bit of nose weight is necessary, and the instructions provide estimated amounts for both the standard and 2° canted fin approach.

Since my plans for this include a scale competition next month and I'm too cowardly to fly it before then, I'll have to owe you the flight performance feedback. I plan on flying it on a low-thrust F

For information, or to place an order for the Saturn 1B kit, please visit the Apogee Components web site at:
http://www.ApogeeRockets.com/Saturn_1B.asp

So you think you know about designing rockets? Here's a test:

- What thickness of wood should you use for fins a rocket powered by a D motor?
- What are the nine types of fin construction?
- What are the other five different recovery methods besides: parachute, streamer, glider, and helicopter recovery?
- What size wing do you need for a rocket glider?
- How does high power construction differ from small rockets?



How did you do? If you couldn't answer them, you'll be happy to know the answers are in the book *Model Rocket Design & Construction.* It was written for modelers that want to build their own designs.

For more information, or to order your own copy, see our web site at: www.ApogeeRockets.com/design_book.asp

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