Apogee Components

PEAK OF FLIGHT

NEWSLETTER

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Cover Photo: MadCow Rocketry's Sea Wolf rocket kit. Get yours at:

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Apogee Components, Inc. — Your Source For Rocket Supplies That Will Take You To The "Peak-of-Flight"
3355 Fillmore Ridge Heights
Colorado Springs, Colorado 80907-9024 USA
www.ApogeeRockets.com e-mail: orders@apogeerockets.com

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"Lessons Learned" from the "Big Ones"

By Matt Steele

Many of the issues faced by model rocketeers are also faced by their counterparts in the launch vehicle industry. Sound engineering and good management practices, vital for rockets going to orbit, also can avoid prangs, save you money, and allow you to have more fun. Both full size launch vehicles and hobby rockets are high-energy machines that encounter extreme environments. Here's how to take advantage of their experience to avoid mistakes with your models.

Have a plan – and stick to it

We all know that plans change, but you need to have something to start with, so you know what is changing. Take the time to sit down and map out a plan. Consider what materials, supplies and tools are needed to complete your project. Don't skimp on things – it is more expensive and time consuming to head back to the hobby shop to get another part or to re-order more parts online when you run into problems.

Develop a preliminary schedule, and then realize that things usually take about twice as long to really accomplish. Build that in from the start, or you will be mixing epoxy on the way to the flying field.

Crawl – Walk – Run

You can't just go fly an "M" powered rocket the first time you hit a NAR or Tripoli field. There is a reason for the graduated certification process that you have to go through – in aerospace terms, the philosophy is called "Crawl - Walk - Run". In other words, start out simple, and through a series of increasingly difficult steps, build to the ultimate goal. If you want to do a 2 stage, six motor cluster Orbital Transport upscale with full RC, you will want to develop and fly some less expensive test birds to validate the individual techniques before rolling the dice on the "all up" version. While it doesn't always sound like it, this approach has been proven to save time, money, and tears in the long run. (This is also a common reason that big aerospace programs go awry – too many times, they skip from walk right into the run portion, and fall over face first.)

Design in margin and redundancy

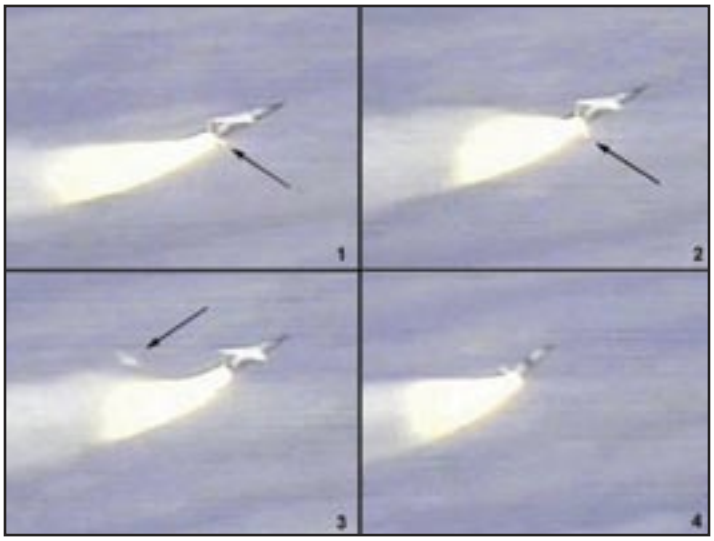

Figure 1: Nothing is worse that working on a project that doesn't work; here the fins of the Hyper-X vehicle come apart as the rocket hits Mach 1. (NASA Photo)

Most of our models are not performance constrained – unless you are building for a competition event, it really doesn't matter much if you get the maximum altitude possible from a design. In those cases, be sure to add strength where possible and practical. In the aerospace industry, this is known as "a positive margin of safety" – that the part in question is stronger than the expected launch loads by a good amount. Don't skimp on too short shock lines, weak tubes or fillets, thin or weak fins, or flimsy attach points, hardware, and recovery systems. Too many times, a little bit of extra robustness in the system is the difference between "living to fly another day" and completely re-kitting the model. For example, on the day that you get a "bonus delay" or the wind causes your model to weathercock more than expected, a good, strong recovery system can save the whole model, even under the extreme shock of a really late deployment. Otherwise, you may be digging the parts out of the ground.

Fix known problems – don't live with them!

In this business, the known gremlins in your system team up with the ones you don't know about to wreak hav-

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Newsletter Staff

Writer: Tim Van Milligan
Layout / Cover Artist: Tim Van Milligan
Proofreader: Michelle Mason

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"Lessons Learned" From the "Big Ones"

oc with your flight. Don't live with known gremlins! Eliminate or replace bad parts. Ensure that:

- Couplers are not too tight or too loose
- Parachutes and pistons slide freely in models
- Parts don't move under acceleration or shock in payload bays
- Engines are firmly mounted and retained
- The model slides cleanly up and down the launch rod or rail.

Band-aiding one problem usually leads to others.

On big launch vehicles, there is a tendency to save money by putting a mis-machined part on a vehicle. The part in question costs a lot of money, the schedule will slip if there is a delay to make a new part, and a preliminary analysis says it will work. The problem with that approach is that soon, the whole rocket is made up of little misfit parts or experiences a combination of out-of ordinary conditions – and the result is a failure of the system. One only needs to look at the Challenger disaster to see that principle at work – the poor O-ring design in the solid rocket motors did not cause a catastrophic failure until the booster was exposed to extremely cold temperatures and a high velocity wind shear at altitude.

A more painful example of where I should've taken my own advice happened this August in Serbia at the 2010 World Championships with my Bumper Wac model for S5C Scale Altitude. All summer, I had fought with a "too loose" fit of the upper coupler on my prototypes. On the final model for the competition, I thought I had fixed the problem by adding some tape to shim up the looseness. Nope! On the second flight, the piston worked so well that the upper section kept going when the motor section stopped at the top of the piston. By the time the second stage ignited, it was pointed at the ground – and power pranged into the ground. The crash was so hard, we never did find the altimeter! In retrospect, I should've fixed the coupler

Figure 2: Matt Steele's Bumper WAC separates after leaving the launch towner at the 2010 World Championships in Irig, Serbia. (Photo courtesy of George Gassaway)

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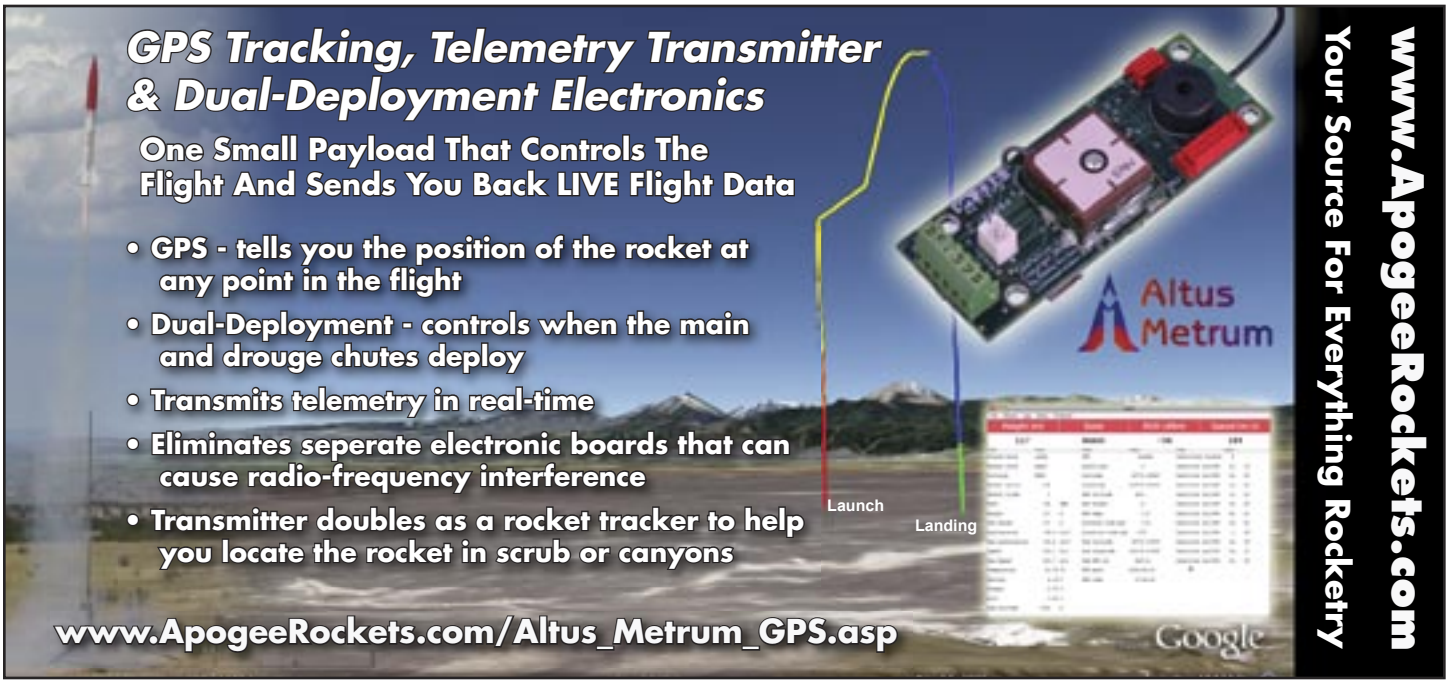

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"Lessons Learned" From the "Big Ones"

looseness problem, rather than just putting a band-aid on a bad design.

Test, test, test!

This goes hand in hand with the "Crawl-Walk-Run" philosophy. RockSim and other analytical tools are great for preliminary design, but they do not replace just building stuff and testing it in the real world. Spend at least twice as much time building and testing as you do behind the computer keyboard. The parts don't know what the simulation says it should do.

There are a number of ground tests you can do to ensure your rocket flies the way it should. These include:

- Swing stability tests for small rockets
- Pull tests on fins, shock cord mounts and nose cone attach points
- Fit checks with all the sliding/moving hardware on your rocket
- Ejection tests with altimeters
- Fit checks on launch pads and launch equipment

In addition, start with lower power motors and work up the larger ones. An "E" motor stresses the entire rocket between twice and four times as much as a "D" motor, because drag loads are a function of the square of the velocity.

Be a pro – or just act like one

Take a page from the professional aerospace industry, and you can have more fun with your models. And, remember, the discipline to do the right thing is actually hard when you are your own "program manager" – but the rewards are even sweeter when things work right!

About The Author:

Matt Steele works on rockets both big and small. He is a many-time NAR national team champion and international competitor, and flew an "N" motor long before there were certification flights. He sat on the launch console for Pegasus and Hyper-X/X-43 flights, and worked with Pershing 1a, Pershing II, Taurus, GMD OBV, Atlas AIIS and numerous suborbital vehicles. He currently promoting the Athena and Dnepr launch vehicles for satellite launches.

Figure 3: Matt Steele stands next to the nose fairing of an Orbital Sciences Pegasus mounted to an L1011 carrier aircraft prior to flight.

What is Your Plan B?

By Tim Van Milligan

I had a major case of launch fever last Friday. I so wanted to go out and fly rockets with my daughter and her 5th grade classmates. It was 69° F in Colorado Springs, December 3rd, at the beginning of winter. The reason it is so warm was there was a Chinook wind blowing off the Colorado mountains thanks to a shift in the Jet Stream. When the wind blows straight west out off the mountains, it picks up speed because it is going downhill. Speed equals motion, which means "heat."

We had this launch scheduled for two weeks, and when I saw the weather reports for a warm day, I put extra effort into getting everything ready for this launch. It was going to be a glorious conclusion to a good building session, and to the filming we were doing for our rocketry in the classroom DVD (see www.ApogeeRockets.com/Rocketry_Videos/Rocketry_Video_50.asp).

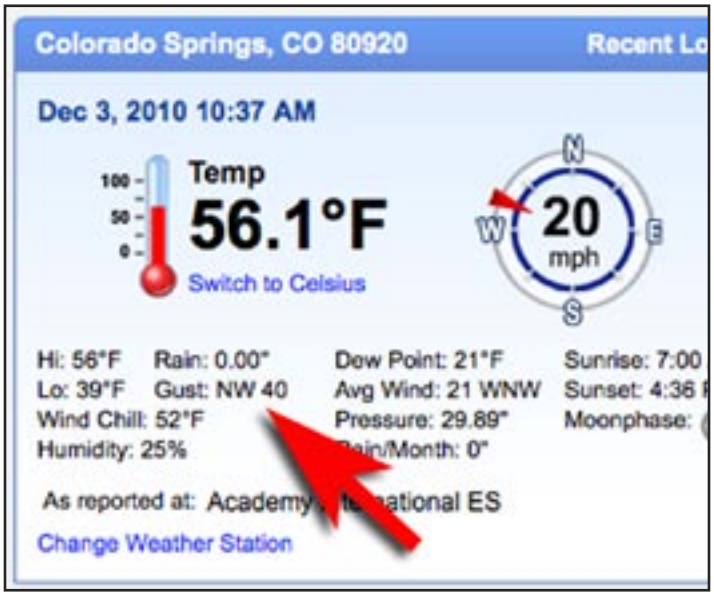

Figure 1: Screen shot from www.weatherbug.com showing the sustained winds, and the gusts.

I couldn't sleep the night before because I was so excited. Am I the only person that gets this worked up for a rocket launch? Listening to customers talk about rocketry, I suspect that there are a lot of people with a similar passion-problem. How about you?

So when I woke up in the morning, I could sense the winds picking up. Drat! -- Double drats.

But I didn't give up hope. All morning, I had a browser window open on my computer, and was watching the live weather reports from the weatherbug network. About 10:30, when the wind hit a constant 20 mph and with gusts clocking over 40 mph, I knew I had to make the call to the teacher. The afternoon launch would have to be scrubbed.

It was utterly painful to make this call. I know the students were going to be just as dissapointed as I was.

My Plan B for the day was to work on this issue of the newsletter, which you're reading now. As I was doing this, I was reading Matt's article on "Lesson's Learned" from the real space program. It was so well-timed with what I was going through that day. Because one of the lessons I learned in the past is that there is "always tomorrow." You do not have to fly rockets today, because the most important thing is safety.

Flying in breezy conditions is a lot more challenging than launching when the wind is moderate. I'd say, like Matt said in his article, when you double the size of the motor, the drag goes up by four times. Well, we're doubling the speed of the wind, and that has a similar effect as doubling the size of the motor. Complexity goes up by four times, which means there are four times as many things that can go wrong on your flight.

I'm sure you know what I mean. You've probably tried

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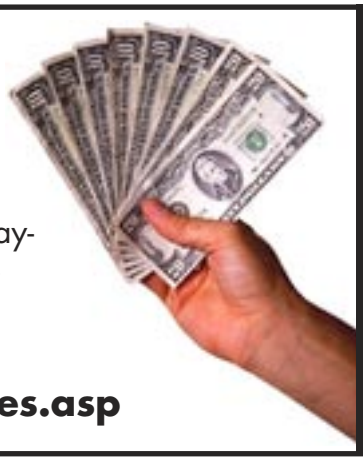

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What is Your Plan B?

to fold a plastic parachute when it is windy, haven't you? You want to hire an octopus to help you, right?

Safety in windy conditions is important here in western states were everything dries out in the winter. I've had my fair share of stomping out small fires from unstable rockets (is that a rain-dance you're doing?). Doing it in high winds with a bunch of 5th graders looking on would have been a nightmare.

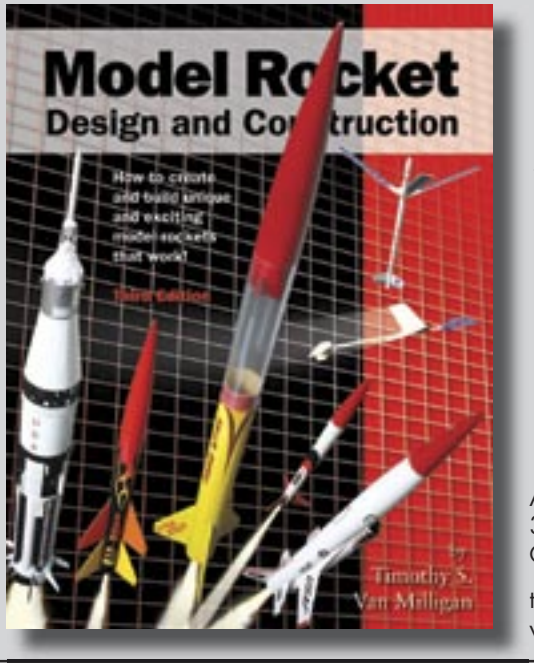
I'll be the first to admit, I get excited over a big launch. And it was very difficult to make the call and scrub it for the day. And every time I tell people that they should walk away from launching, I almost feel hypicritical, because I would have a hard time not launching too.

If you are going to be flying when the wind is really breezy, take some extra precautions. Use a higher thrust rocket motor to blast through the wind (assuming of course your rocket can handle the higher thrust motor). Avoid low thrust motors.

Above all, use a longer launcher! A rail is a lot longer and more stiff than a rod, so make the switch over to a rail.

Launching into the wind seems to make sense to avoid a long walk on recovery, but sometimes the rocket can really weathercock into the wind and can be dangerous. Know how your rocket will behave, because every rocket reacts differently to wind! If you don't know, launch straight up. And use a shorter ejection delay. Finally, remember to have more safety margins as Matt said in his article.

Figure 2: While the sky is blue, the wind is pretty stiff in this launch. The rocket is veering off course, and the smoke is already being blown downrange.



Model Rocket Design and Construction

By Timothy S. Van Milligan

New 3rd Edition Now Shipping!

This new 328 page guidebook for serious rocket designers contains the most up-to-date information on creating unique and exciting models that really work. With 566 illustrations and 175 photos, it is the ultimate resource if you want to make rockets that will push the edge of the performance envelope. Because of the number of pictures, it is also a great gift to give to beginners to start them on their rocketry future.

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Apogee Components
3355 Fillmore Ridge Heights
Colorado Springs, Colorado 80907 USA

telephone: 719-535-9335
website: www.ApogeeRockets.com

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Creating Fin Marking Guides in RockSim

By Tim Van Milligan

A common question I am asked is how to print out tube marking guides in RockSim. The simple answer is that you can't right now.

Well, you can... But it is complicated. If you just want a simple wrap, then you can use a little program called Fins Fun (http://spazioinwind.libero.it/lbenassi/FinsFun/index.html). But Fins Fun is an older program, and wasn't designed for complex rockets like the one shown in Figure 1.

The problem with a simple paper wrap fin marking guide is that it doesn't work with complex fin configurations. And when the fins are positioned at odd angles, they become even more useless.

You really need a base view type of tube marking guide. Not only can you use it to mark the locations of the fins, but you can use it to create fin jigs, like what was shown in Peak-of-Flight Newsletter 270 (www.ApogeeRockets.com/education/downloads/Newsletter270.pdf).

Now RockSim can print out the base view of the rocket.

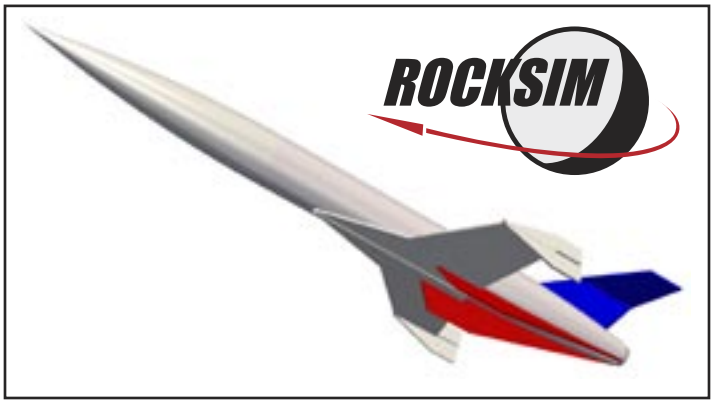

Figure 1: In this complex design, the dorsal fins are positioned at odd angles and are attached to a curved boattail. A paper tube marking guide that wraps around the tube would be impossible to make for this design.

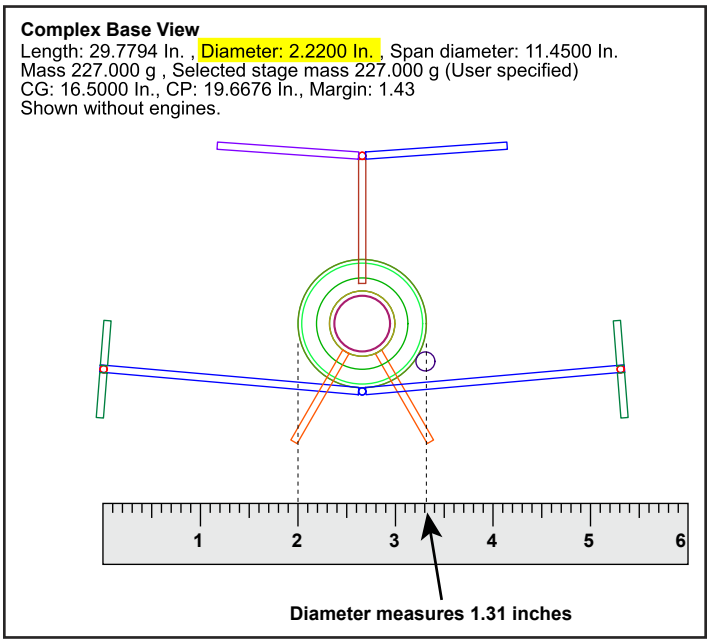

Figure 2: Start out by printing out the base view of the rocket. Measure the outer tube diameter, so you can compare it against the dimension listed by RockSim.

However, the base view is scaled to fit onto a standard 8-1/2 X 11 inch sheet of paper. What we need, unfortunately, is the drawing at 100% scale printed on the paper. We're working on this for a future version of RockSim.

In the mean time, what I do on my Mac is to print the base view to a PDF document. Printing to a PDF is standard on a Mac. On Windows computers, you'll need to install a program first that will allow you to print to a PDF. Fortunately, there are many, and most are FREE! Just go to Google and type in "free pdf printer" and you'll get several options. The one that I installed on my Windows computer is Bullzip PDF printer.

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Creating Fin Marking Guides

Once you get the pdf printer software installed, you then just print to a pdf file. When you click on the "print" button, it will then bring up a screen asking you where you want to save the pdf file. I just dumped it onto the desktop so I could find it easily.

At this point, you're ready to resize the image so it comes out exactly 100% size, so that it will match the diameter of the tube you are using.

For this final step, I'll refer you to my video that I did as a tutorial on how to print a full-size RockSim image. The major difference is we have a base view, instead of a side view. The one other small difference is that the file you will open and manipulate is a pdf docment instead of a .svg (scalable vector graphic) format. But the software you'll use to do this (explained in the video) doesn't care; it will open either format.

The video I'm talking about is "#25 Print out a full-size 2D drawing of your RockSim" at: www.ApogeeRockets.com/RockSim_tutorials.asp. It is also available on YouTube at: www.ApogeeRockets.com/Rocketry_Videos/Rocketry_Video_21.asp

I know this process isn't a "one-button" operation like you were hoping for. But by working with other tools and programs, you open up a world of possiblities for doing other cool things. I'm constantly exporting templates and views and then editing them in a graphics program. There are somes advantages; for example, it allows me to gang up all the templates on one piece of paper, so it saves me time and money. This is cool stuff for us Rocket Scientists!

Figure 3: Print out the base view to a PDF file.