ISSUE 90 - OCT 11, 2002

APOGEE PEAK OF FLIGHT NEWSLETTER

Winning the $50,000 NAR Team America Rocketry Challenge

How To Stabilize Your Rocket Using Canted Fins

Rocketry Web Sites Worth Seeing

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Rocket Web Sites Worth Visiting!

In the last issue, I had a little request for help. I asked for people with web sites to add a new link to the Apogee Components home page.

A number of people did add a link, and I'm very grateful. I've decided to say thanks by posting their web site's URL address here in the newsletter. I checked them all out myself, and I think they're all worth visiting.

http://www.vahpr.com/rvlinks.html - Virginia High Power Rocketry submitted by Jerry O'Sullivan. Lots of descriptions of high power projects and "build" articles of various big rockets in progress.

http://www.raketenmodellbau.org/ - German rocketry web site. If you can read the German language, you're in for a treat. This is a well designed web site that has a professional look to it (I'm jealous). Submitted by: Tom Engelhardt

http://www.RocketFarmers.com - Home page of Kevin Houser of Tucson, Arizona. Kevin says he gets a lot of people that drop by his web site to see the "cool video from onboard".

http://www.moondoggie.net - Moon Doggie Rockets is the rocketry home of Steve Robb. Here is a nicely organized web site. I really like the way he organizes his launch history, as it makes it easy to navigate and loads quickly on my dial-up modem.

http://www.lees.tcimet.net/~lisa/gws/rocketry.html - Excellent web site of Lisa Lees. Shows how to build a low-cost launch controller, launch pad, and even a wind tunnel made from cardboard boxes. You can definitely see these kids are having fun with rocketry.

http://www.artapplewhite.com/index.html - Art Applewhite sells UFO kits. They range in sizes from Quest MicroMaxx to 9 inch diameter models that require D motors.

If you don't object, I think I'll continue doing this in future issues. So if you have a web site, and if you want some free advertising to help you attract visitors, here is how it works. Just put a "NEW" link back to the Apogee web page on your site. I'll then post the url of your web page here in this space to let people know about your site. That way, your URL will be seen by over 3,000 people that receive this e-zine newsletter.

If you like to put a short description next to sites you recommend, you are welcome to use this one that describes the Apogee site:

Apogee Components has information on designing and building your own rocket models. They also have rocket design software, "how-to assemble rockets" books, rocketry project ideas, teaching tips for educators, and a large assortment of construction materials. You can also subscribe to their free e-zine newsletter which often contains free plans, construction tips, and technical articles about rockets.

Just link to our main page at:

http://www.ApogeeRockets.com

If you do put up a new link on your site, please let me know, and I'll come visit your site too. mailto:tvm@apogeerockets.com. Be sure to include a description of your web site that I can use here in the e-zine.

Are You New To Rocketry? Need Some Advice On How To Save Money?

There are certain *"select"* Quest products that could be used to get your rocketry project going for an amazingly low price. We'd be happy to recommend products that will fit your rocketry program and save you money..

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- **Rocketry Education:** *"Where do I find additional rocketry info?"*
- **Expanded Operations:** *"I didn't expect you to respond to my email question over the holiday weekend. You're the best!"*

Call for a free recommendation: 1-719-535-9335, or visit our web site at: http://www.ApogeeRockets.com/quest.asp

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Save Money On Rocketry

How To Stabilize Your Rocket Using Canted Fins

By Tim Van Milligan

Let me tell you a story about a difficult rocket stability problem I faced earlier this year. I had a rocket that was short, and that had small fins. According the the Barrowman stability method, this rocket was unstable. The only way I could make it stable was to add a ton of nose weight to the rocket. Unfortunately I didn't want to do that with this particular model.

The rocket was the new 1/70th scale Saturn 1B.

There were several reasons I didn't want to add a ton of nose weight to the model. First, the nose cone didn't have enough room inside it for all the clay that I needed to shove into it to move the CG far enough forward. Second, with all the nose weight in the model, the rocket was definitely going to land tip down. The tip, in this case, is a fragile plastic Apollo escape tower. It was surely going to break this tip off if it was the first piece of the rocket to touch down.

Finally, the rocket was pretty light weight, and I didn't want to force users to buy expensive "G" motors to launch it into the air just because of the weight in the nose. It's light enough that it could be flown on high thrust E motors, which are significantly cheaper in price than G motors.

Since this was a scale model, I didn't have the option of making the fins larger. I needed a different way to make the model stable.

One of the methods I recommend to increase the stability

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EMRR on CD - Just $10!

Introducing Essence's Model Rocketry Reviews (EMRR) second release of "EMRR on CD". For those that have enjoyed EMRR online, now you can have it all, offline and lightning fast on your CD-ROM player. In addition, you can have it a special Apogee Components' Newsletter Price: $10.00 (regularly $15.00). Just click here: http://www.rocketreviews.com/calendar_cd/apogee_emrroncd.shtml

1253 Reviews/Articles
410 Authors
6405 Flight Logs
741 RockSim Files
559 CP Listings
1651 Recommended Motors
1157 Opinions
280 Stories
307 Hints/Tips
156 Rocket Specific Tips
Clay Brothers' VideoRocketry Website Grab (Sept'02)
Estes Educator Website Grab(Sept'02)
A Field Guide to American Spacecraft Website Grab (Jan'02)
FlyHybrid.Org Website Grab (Sept'02)
NAR's Website Grab (Sept'02)
TRA's Website Grab (Sept'02)
Apogee's RockSim Demo Software (ZIP file)
Apogee's RockSim Rockets (CD page)
CompuRoc (ZIP file)
SpaceCAD.com's SpaceCAD Demo Software (EXE file)
SpaceCAD.com's SpaceCAD Rockets (ZIP file) (Sept'02)
VCP (standard and Win98+ Versions) (ZIP file)
WinRoc (ZIP file)
wRASP (ZIP file)
Aerospace Speciality Products Catalog (PDF) (Sept'02)
Aerocon Systems Website Grab (Sept'02)
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Estes Rockets Website Grab (PDF Jan'02)*
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Giant Leap Rocketry Website Grab (Sept'02)

Spin Stabilization

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of a rocket in my book *Model Rocket Design And Construction* (http://www.apogeerockets.com/design_book.asp) is to cant the fins slightly. What this does is to cause the rocket to spin about its centerline during the upward trajectory. Effectively, the CP is moved rearward. Because of this, the spinning rocket becomes more stable.

This was just what I needed for the Saturn 1B rocket. The one remaining thing I needed to find out was how far to cant the fins. I wanted to remove as much nose weight as possible, but I didn't want to change the scale appearance of the model.

My solution was to turn to John Cipolla (www.aerorocket.com), and ask him if he could give me an answer. He did some work, and a few days later he gave me an answer: just cant the fins 2 degrees.

I was skeptical, because 2 degrees doesn't seem like a lot. It would barely be noticeable on the Saturn 1B rocket. So I decided to perform some flight tests. I built two models, one with straight fins, and another with fins canted at 2 degrees.

During the first phase of the flight tests, I added a ton of nose weight to the model with the straight fins. On each succeeding launch, I then removed a little bit of the nose weight. I kept removing weight between flights until I felt confident that I had reached a minimum stability point. The model was a nose heavy pig, and it would wobble and weathercock pretty bad. But it was straight enough to say it was a success.

To make the Saturn 1B stable using the small "scale" fins, it was decided to cant the fins to make the model spin.

Then I tried the model with the canted fins. Even with the minimum nose weight, it screamed upward - and perfectly straight. I couldn't believe my eyes!

I was pleased with the result. The kit was now a great flying machine because the minimal amount of nose weight. It boosted high on inexpensive econojet F motors from Aerotech. And the fins retained their scale dimensions. The only subtle flaw was that the fins were canted slightly by 2 degrees. Nobody, except a hardcore scale modeler would even care, let alone even notice.

How does this affect you?

Wouldn't it be great if you could have a tool to determine how much fin cant you need to add to your rockets?

For the past month, John has been working to turned his spin equations into a little computer program that will be available to you and other Apogee customers. This will be part of FinSim v2.0 that we are now happy to say is ready for shipment.

This new version of the FinSim software that will help you determine how far to cant your rocket's fins to achieve a straighter flight. You'll be able to make lighter weight rockets by removing some of the unnecessary nose weight. These lighter rockets are safer to fly, and will actually boost straighter into the sky. And since they are lighter, you can use less expensive; smaller motors to launch the rockets. So you'll save yourself some money too.

FinSim with the new "SpinFin" subroutines computes how fast your rocket will rotate when you cant the fins, as well as how far aft the CP will move rearward when the rocket is spinning during ascent. This is the first time the non-professional rocketeer has had a tool to compute the spin stability characteristics of his rocket. I don't even know if NASA has this capability.

What's the downside to spinning rockets?

One reason people may not want to force the rocket to spin is because of the extra drag on the model. You see, it takes energy to cause the rocket to spin. This energy has to come from somewhere; and it is lumped into the drag of the rocket. This is appropriate, since the drag is the summation of those forces that want to slow the rocket down. Other forms of drag include: skin friction drag, profile drag, interference drag, induced drag, and base drag.

The SpinSim portion of the software will determine the

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Spin Stabilization

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increase in the rocket's Coefficient-of-Drag (C_d) due to the spinning action. From this, you can make tradeoffs in the design of the rocket. You may not want a great deal of fin cant if you want a high altitude. You'll be able to see the affect long before you even build the model.

On the other hand, if you need a lot of stability in your rocket design, you can see how far back the CP will move with each degree of fin cant.

The other problem canted fin cant might pose is that the extra forces on the fins could possibly cause the fins to break. That is why you don't want to cant them too much. When you cant the fins, it exposes is flat side to the airflow, increasing the forces on the fins due to the increased surface area. This extra force tries to bend the fin and break the glue bond that holds it to the rocket body tube.

That is why SpinSim is a part of the FinSim software. FinSim is designed to compute the forces on the fins, and determine if they'll break off. Once SpinSim determines the new C_d of the rocket, FinSim automatically tells you if they are sturdy enough to be launched.

RockSim makes it all possible

The new FinSim program requires much more information about the rocket than it did in the past. But with RockSim working in conjunction with FinSim, getting the information you need is a simple three-step process:

Step 1: Design your model in RockSim v6.0. FinSim reads the new RockSim XML file format, so it automatically finds out the physical parameters of the rocket like the fin's shape,

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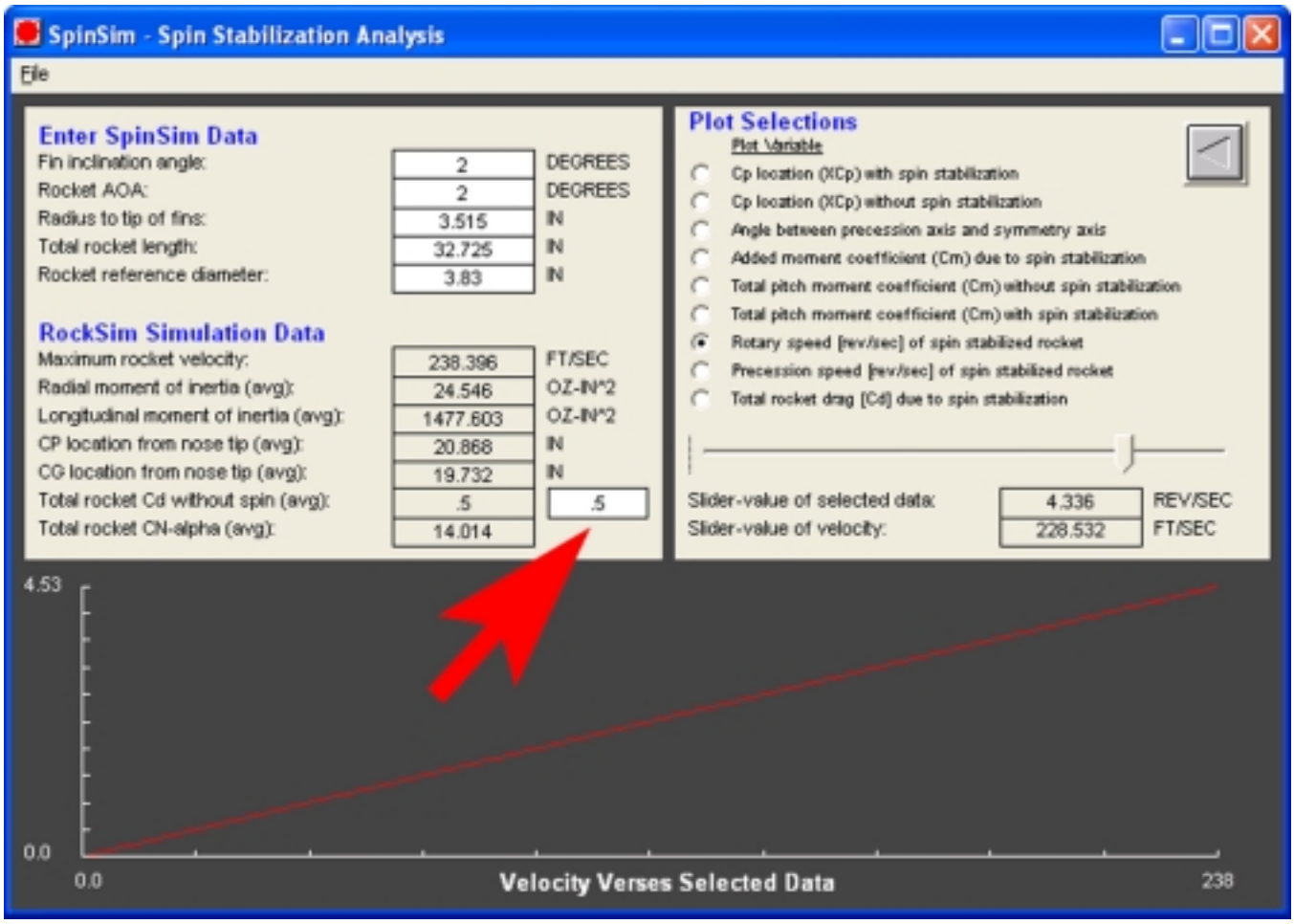

FinSim v2.0 comes with a comprehensive .pdf how-to file that shows you exactly how to import the design data file from RockSim v6.0. The big red arrows show what buttons to click!

Spin Stabilization

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size, and what it is made out of. From this, it can determine how strong the fin is, and how much force it can take.

Step 2: Run a RockSim simulation with a specific rocket engine. There are many parameters about the flight that aren't computed until the engine is loaded and the rocket is launched. This includes the longitudinal moment of inertia and the radial moment of inertia. I know this sounds scary. But don't worry; Rocksim computes it automatically. The final part of this step is to export the simulation results to a data file. This is a little used feature that RockSim has had for several years. If you want to check it out now, you can read about it at: http://www.apogeerockets.com/education/newsletter16.asp

Step 3: Start the FinSim, and open the RockSim design file. Then go to the "SpinSim" portion of the program, and open up the RockSim simulation data file.

That's it. You're now ready to start telling the FinSim software the cant angle of the fins. From this, it instantly tells you the new CP location, the C_d, the rotation rate and other parameters that you can use to tweak your design. Finally, switching back to the bending stress portion of FinSim, you can determine if the fins are strong enough to take the extra drag caused by the spinning rocket.

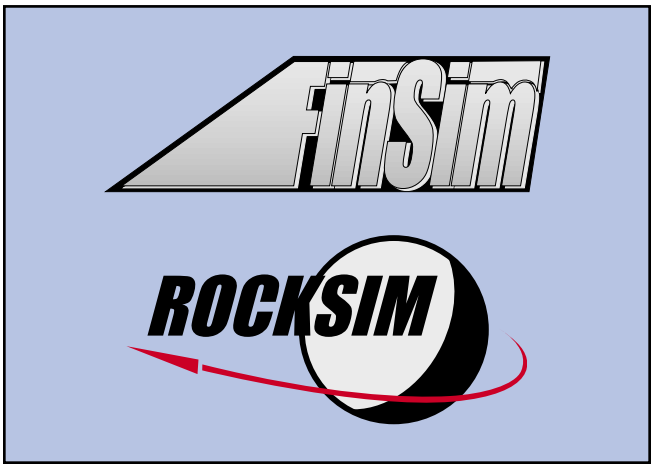
FinSim v2.0 is now ready for shipment. To order it, simply go to the Apogee web site and use our secure ordering system. The direct link it: http://www.ApogeeRockets.com/finsim.asp

You're probably asking, "OK Tim, how much is this great Spin Stabilization feature going to cost?" We were thinking of charging $30 for just the SpinSim portion of the program. That would be on top of the $10 cost for the FinSim structural analysis portion. But we finally settled on just $30 for both programs combined together. So you've already saved $10!

As I found out with my Saturn 1B kit, spinning the rocket can give you options with your rocket design. That includes decreasing the weight of the rocket so you can use smaller motors, lessening the chances of damage due to a hard landing, and moving the CP aft on rockets with small fins. If you have a rocket that you find is difficult to make it fly straight-and-true, then you need this program right away.

And don't forget, FinSim still determines the structural aspects of your rocket. It will tell you:

- Fin flutter speed (up and down flapping motion),
- Fin divergence speed (which is a twisting of the fin)
- Fin destruction conditions (fin bending stress due to speed and angle-of-attack).



You need this information to make sure that your rocket will come back in one piece.

Do you need to be a rocket scientist to use FinSim?

Not really. I know that most of the people that fly rockets are doing it just for fun, and they don't have a technical background. We spent a lot of time making sure that it was easy-to-use and that it presents the most critical information in a format that people can relate to. For example, it will tell you the rotation speed in revolutions per second; and the CP location in inches from the tip of the nose. But if you are a rocket scientist, you'll find some hard-core information like pitching moment coefficient, Normal Force coefficient, and the actual stress forces on the fins.

Also, you don't need to be a computer genius to use either FinSim or RockSim. If you need help with any of our programs, just pick up the phone and give me a call. Unlike a lot of companies, when you call us, you'll talk to a real live person, and get FREE technical support. I don't run Apogee Components as a "second job." It is the only job I do. When you call during normal business hours, you'll actually talk to me, not an answering machine. And after hours, you can email me, and I'll try to answer back as quickly as possible — even on weekends and holidays.

My goal here at Apogee Components is to give you lots of tools that you can use to design, build, and fly model rockets. I also realize that you won't buy unless we provide you with speedy-friendly service, and full support after the sale. We hope that you'll put us to the test and compare us to other companies.

Order your own copy of FinSim v2.0 with the new spin-stabilization capability today at:
http://www.ApogeeRockets.com/FinSim.asp

Launch Strategy For The $50,000 Team America Rocketry Challenge

By Tim Van Milligan

As everyone in the hobby knows, the National Association of Rocketry (NAR) is coordinating the Team America Rocketry Challenge for the Aerospace Industries Association. They are going give away approximately $50,000 in savings bonds, and the total prize pool for the sponsoring schools is approximately $9,000 in cold hard cash. (see http://www.nar.org/TAchallenge.html)

The challenge for the school teams "involves designing, building, and flying a multi-stage model rocket (less than 3.3 pounds liftoff weight, 125 grams propellant in NAR-certified model rocket motors) that takes two raw eggs and an electronic altimeter as close as possible to exactly 1,500 feet. Of course, the rocket must fly safely and the eggs must return undamaged!"

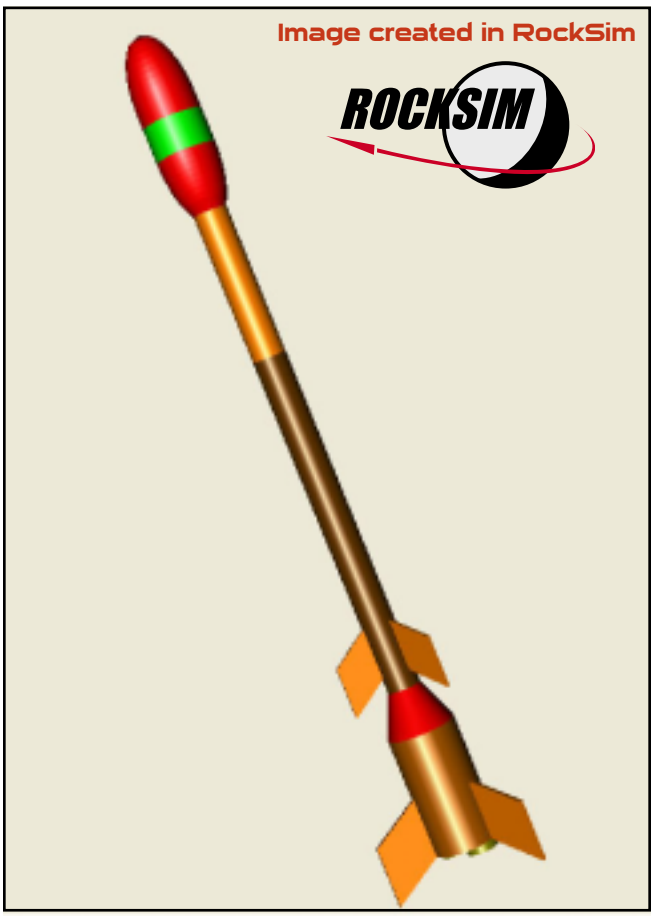
There are a lot of NAR sections helping out local schools to design and build the rockets. I think this is great, and I encourage everyone to help out. You can get more details on how to lend assistance with a local school at the NAR web site.

Designing and building the rocket to carry the two eggs is going to be a great head-scratching activity for most students. But each school is also supplied with a copy of our RockSim software; so their task is made somewhat easier.

In this article, I thought I'd give some hints and tips on the event. Even with my advice, I don't think I'm making it any easier. Make no mistake, this is a hard event. There are a lot of design tradeoffs that can be made. Each team will have to determine how they'll want to approach the contest. Do they want to go for minimalism and high performance, or do they want to go for brute force and high reliability.

To get my mind in gear to think about this event, I spent a couple of hours working through a few RockSim designs. By the way, if you want my final RockSim design file, it will cost you $10. You can email me with your payment info if you want it badly enough. I created the designs in v6.0, so if you have an older version, you'll need to upgrade to view the design.

In my design, I went for the minimalist approach. That means I wanted a lightweight rocket with good low-drag flight characteristics. The driving force behind my design was that I wanted it to use black powder rocket motors. This makes staging a little easier and keeps the cost per flight down.



A two stage egg-lofter that would qualify in the Team America Rocketry Challenge.

If you've ever done NAR competition, this configuration would be familiar to you. Everything about the design is "competition" oriented. From lightweight vacuum formed nose cones, to a Mylar® parachute.

The downside of this design is that it can't take a lot of abuse, and everything has to work perfectly. For example, Mylar® parachutes often get burn holes in them. There is the possibility that these holes could cause the chute to fail, and the eggs to crack from a hard landing. In that case, you're dis-

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Team America Challenge

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qualified.

That is why there are tradeoffs. Some teams may choose to go with a more reliable nylon cloth parachute; which is heavier. That will change the entire design right there, because the tube in this particular design isn't big enough to hold a cloth parachute.

You're probably wondering what is the brute-force approach. I would consider that method to use the biggest motor combination possible. This would put the model well over 1,500 feet. But to compensate, it would include a separate device (altimeter/accelerometer/timer/RC activation) to deploy the parachute while the rocket is still traveling upward - right at 1500 feet. This could be expensive, but it could be used if the rules allow it.

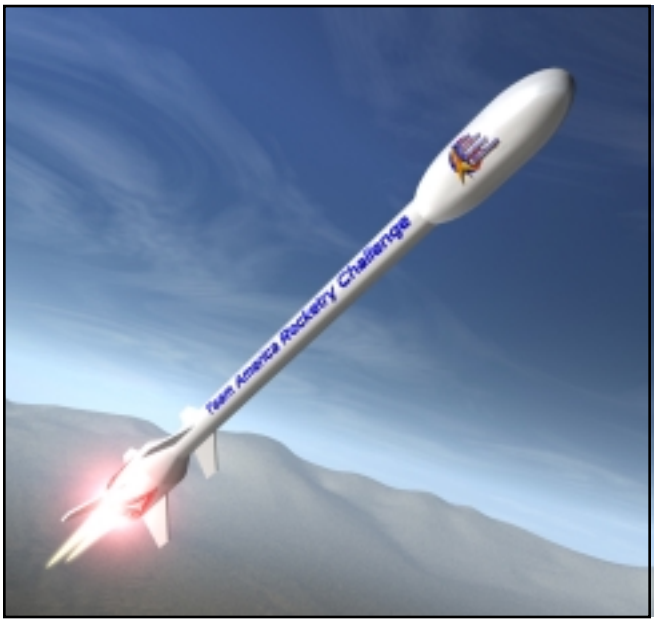
What are some things that I learned in this exercise that might be useful to teams competing in the event?

1. Build the rocket airframe as lightweight as possible. That will give you more options as far as motor combinations go. Also, notice that the eggs weigh 60 grams each, and anticipate that the altimeter with its mounting hardware will be in the range of 25 grams. Specifications on the Adept altimeter can be found at: http://www.diac.com/~adept/A1ds.htm

2. It is possible to use black powder motors for this event. My design used a cluster of two D12-0 motors in the booster stage, which then were staged to a single D12-7 motor in the sustainer. Clustering is more difficult than single use motors, but in this case, I think it will be easier than trying to ignite a black powder motor with a composite E30.

3. Where I found difficulty was with the C_d of the model. This is one of those configurations that can confound the DATCOM C_d prediction method (with RockSim uses). My design as predicted by RockSim had a unusually low C_d value. If your team has an odd shape rocket (like my design), I suggest running your designs in AeroCFD to get a better C_d value. Or use a fixed C_d of around .5 to .75. I really think you should test fly your design a bunch of times to make sure you can narrow down the C_d value prior to the actual competition flights.

4. Flight strategy is going to separate the steely-eyed missile men from the wanna-bees. You have to be ready to fly in any launch conditions. Just ask any NAR competitor. They have their high performance models, and then their clunkers. Each would be flown in different conditions. The only way to be prepared to to test fly the models as much as possible before the competition. Over $9,000 is at stake for the winning



school, so it is worth it to test fly at least a dozen times. The team with the most test launches is going to have a huge advantage.

5. The models are going to drift long distances - look at your RockSim file to see how far downrange they will land. You want the rocket to come down slow so you don't crack the eggs due to a hard landing. Therefore, I recommend using optical tracking as much as possible during the test flights to determine altitude. That way, you don't have to worry about losing your altimeter.

6. These rockets are going to be heavy. So you really need to watch your lift-off velocity. When running your RockSim simulations, assume a 4 foot launch rod instead of a 3 foot one. You're going to need the extra length unless you're using really high thrust motors. Make sure the rocket clears the rod with sufficient speed! When you actually fly the rockets, I'd really recommend using a rail launcher. But your team will have to supply your own for the event (according to the rules). If you do use a rail launch pad, make it as long as possible. The faster the rocket leaves the pad, the straighter it will fly.

7. You really need a straight boost if you are using the motor's ejection to deploy the parachute as close as possible to the 1500 foot target altitude. If there is any wind, these nose heavy models are really going to weathercock.Therefore:

A) Use a longer launch rail (see above)
B) Use RockSim to help you aim the rocket a little bit de-

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Team America Challenge

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pending on the actual wind conditions

C) Spin the rocket by canting the fins a few degrees to make sure the rocket flies as straight as possible.

8. Parachute deployment reliability is going to be something that a lot of teams will overlook. This is critical if you are using a plastic parachute that is stuffed into a small tube. Practice folding the parachute and blowing it out of the tube. Don't overstuff the wadding. If your parachute fails, you'll be disqualified.

9. You have to recover the model to make sure the eggs didn't crack. Since these rockets are really going to drift, you should work out some type of recovery plan with the members of your team. Walkie-talkies will come in handy. Anticipate humid conditions in Virginia for the fly-offs. That means it may be really hazy, and the model might be difficult to see. Use tracking powder.

10. The CG is going to be pretty far forward on these rockets. What a lot of teams will do is make their fins smaller to make the rocket less stable. This isn't a good idea. Stay with the bigger fins that RockSim initially suggests. Why? Because the heavy rockets are generally going to fly slow; which means the aerodynamic forces are going to be small. Don't make this worse by making the fins smaller.

11. As any NAR member that has flown dual-egglofting competition will tell you, always-*always*-**ALWAYS** put a solid bulkhead between the two eggs. The reason is that eggs will shift around during the launch and landing. A lot of cracked eggs can be attributed to one egg smashing into the other. For a bulkhead, you can use a thin disk of balsa wood or thick cardboard.

12. Egg lofting models have a tendency to sway back and forth underneath the parachute. I've seen a lot of cracked eggs because the capsule hits with a high horizontal velocity (due to swaying), even though it is descending slowly. You should put a spill hole in the parachute to help stabilize it and to prevent swaying of egg capsule.

I hope that this article will help you out if you are competing in the Team America Rocket Challenge, or if you are a mentor helping out a local school that is competing for the prize. If you do win the prize, please remember Apogee Components and any help this article was to you. Maybe you can spend some of that $9,000 grand prize here (hint, hint...).

other resources to help you out:

If you're building a competition style rockets for the first time, I recommend the Apogee video book: "Building Skill Level 1 Model Rockets," because it will show you proper techniques to use when assembling lightweight rockets. Technique is important, and the only way to learn the right way to do things is by watching an expert. That is the big advantage you'll have with this video book.

The book Model Rocket Design and Construction would also be an immense help when designing your rocket. It has a lot of ideas that you can use to build lighter weight rockets that are also very very strong. In the Team America Rocketry Challenge, you're going to want a strong, lightweight rocket.

Lightweight vacuum-formed plastic egg capsules designed to hold two eggs are sold by Pratt Hobbies. Their web site is: http://www.pratthobbies.com. Look for the DEC-1 nose cone. Be sure to tell Doug Pratt that you were recommended by Apogee Components in this article, and Doug will send you a ***FREE*** HSPP-1Y set of two small HeatShield Parachute Protector.

Note: Mylar® is a registered trademark of E.I. du Pont De Nemours and Company for there brand of polyester plastic sheet.

About the Author:

Tim Van Milligan is the owner of Apogee Components (http://www.apogeerockets.com) and the new 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 the FREE e-zine newsletter about model rockets. You can subscribe to this e-zine at the Apogee Components web site, or sending any message to: ezine@apogeerockets.com with "SUBSCRIBE" as the subject of the message. This article may be reprinted as long as this paragraph is also included.

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