SHROUDLINES

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Special points of interest:

- "Ignition!" A short overview of stuff you could find out by turning the page.
- Jack Sprague offers up a great article on an often overlooked design issue.
- Gary Briggs provides a write up of DARS movie night in Frisco.
- He also provides pictures! Man, this guy does it all!
- Want to see your words in print? We tell you how!

Inside this issue:

Ignition!

By J. Stuart Powley

Members of the public check out DARS members' models at the recent DARS movie night.

Welcome to another issue of *Shroudlines.* In this issue we have a couple of really great articles by longtime DARS members.

First, we have a piece by Jack Sprague that covers an aspect of the hobby that not many people think about (I know I didn't). It seems that many of the preconceived ideas people have about launch guides are, in fact, wrong. This fact is important to know because although we may not think much about it, it can really affect the way our models work. Who hasn't seen a beautiful bird take to the sky, only to "go wiggly" as soon as it clears the launch rod. As it turns out, it may not be the model's fault, but rather something else entirely. Fortunately, the fix is very simple once you stop and think about it. Jack will fill you in.

Next we have another article (and pictures) by Gary Briggs. This one covers an outreach by DARS in Frisco that I'm really sorry I missed. It seems that the city of Frisco has "Movies on the Square." This year DARS was invited to participate and the resulting PR was great for the club! Gary does a great job of capturing the event for our readers in both words and pictures.

Hopefully this event will become an ongoing project for DARS, since it really exposes us in a good way to the general public (as do our other outreaches). Many thanks to all those who participate in these events!

And so, I encourage you to sit back, turn the page and enjoy this issue of *Shroudlines*. Fly 'em high and fast!

Thoughts About Launch-Lugs and Rail-Guides

By Jack Sprague; NAR since before F motors, DARS since 1988

For the last few years, I've begun to collect evidence that some of the Folk-Knowledge and Standard-Practices that we rocketry enthusiasts have been using about Launch-Lugs, Rail-Buttons and Rail-Guides are just a bit wrong. I will introduce some topics with this article and later design some real experiments and flight trials to test our conclusions. If somebody wants to help turn this stream of consciousness into an R&D report, I'll be glad to help or co-author.

Anyway, let me back up my claim of incorrectness with a few thought experiments.

<u>How long is your launch rod/ rail?</u>

If we use 3 feet (or 4 feet or whatever rod-length) as your standard answer, either in practice or in RockSim, then we are wrong. Here's why. Your rocket is fully guided by the launch rail only until the front guide/button/lug comes off of the rail. It is at this point that lots of Real-Bad-Things can happen that most of us have not thought much about.

But anyway, the real "effective rod length" on our rocket is Actual-Rod-Length *MINUS* the distance from the front guide to the rear of the rocket, *MINUS* the standoff height of the rocket on the pad. Notice that there are two subtraction terms in here that we normally ignore. But when we think about them, they actually become important. Important enough to contribute to "Rod-Whip" or "Excessive Weather-Cocking" launch abnormalities. (A couple of the Real-Bad-Things, mentioned earlier.)

****sidebar*- Rod-Whip is an observed phenomenon that results in the rocket actually being misguided and upset by the launch rod while being launched. Excessive Weather-Cocking is where the rocket at launch appears to tilt over into/towards the surface winds much farther than anticipated by the rocketeer.****

Let's make up a few realistic examples. (I will not now admit to you that these examples come from rockets in my own fleet, but they probably do.)

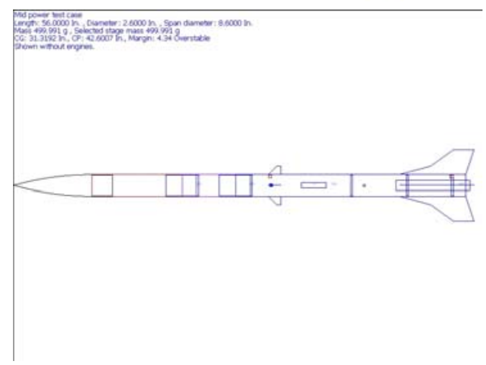
On a Big-Bertha sized model rocket, using a one-eighth inch launch rod, the top launch lug is about 8 inches from the back of the body tube. And the rocket sits up at least 3 inches more (the distance the fins extend behind the tube base) when the rocket is ready to fly.

Effective Rod Length is thus 25 inches. (36 inches. of actual rod length, minus 8 inches minus 3 inches)

Wow! The effective rod length is shorter by over 30% than the real rod length. Fortunately this is not much trouble for the Bertha, as it has good static stability. But on many rockets, those 25 inches may not be long enough to establish the speed required for fully effective fin stabilization. Bigger rockets like the Mean-Machine or the Broadsword can be very marginal in even light winds, with the very short "effective rod length" typically used.

Rod Length Assertion: Always use the "Effective Rod Length" in your planning, flying, and simulations, and remember that it may be much shorter than actual rod length.

Let's next look at a typical mid-power rocket design sitting on a



six foot launch rail. (Think of something like a double-length stretched Initiator.) The rocket is 56 inches long, with rail-buttons near bottom and just below the mid-section separation line. (Top button is 24.5 inches from the base of the rocket, bottom button is 1.5 inches forward from the base and uses the backmost engine centering ring as mounting reinforcement. When on the pad the rocket will normally use a four inch stand-off-tube to keep the motor nozzle away from the blast deflector. Effective Rail Length is only 43.5 inches. (72 inches -

(

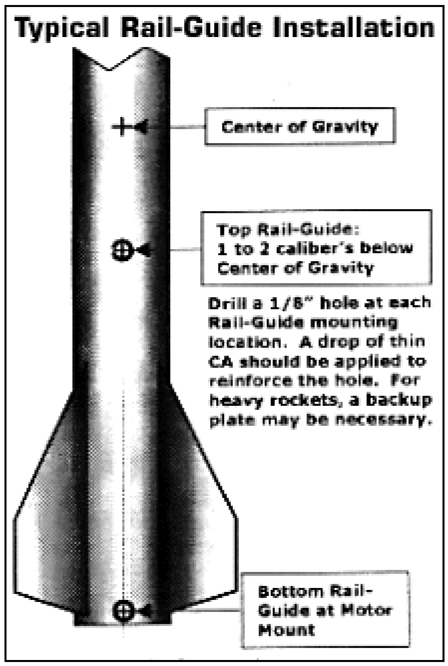
24.5 inches - 4 inches)

That is less than 4 feet, and is 39% shorter than 'expected' when thinking about the actual rod length. RockSim shows that on an E30 and on most of the Aerotech F modroc engines the rocket does not reach the minimum specified stable velocity until AFTER it leaves the launch rail. The simulation still shows a safe (but wobbly) flight even when updated to use the calculated effective rail length. While in real life the rocket has danced after launch and went unstable in moderate winds. But the same rocket/motors will fly straight with an 8 foot rail. What is going on? I think the effective rail length is part of the issue. But wait! There's more.

Where should we locate launch lugs and rail-buttons?

The second item of folk knowledge that I think is wrong is how we normally place the liftoff guidance elements on our rockets. It DOES make a difference what kind of launch guide you use, and where it is placed. Tubular launch lugs are different from launch rail-buttons are different still from launch rail-guides. And these differences can make the correct locations be different as well. Go back to the stretched Initiator example above. This model has one of the common locations for its aft rail-guide: on or near the tail end where the back motor centering-ring can be used as the support. But with just a little critical thought, this location for a launch-button can be seen as "very NOT good."

Think about what will happen when the front button moves past the end of the rail. It will then take an appreciable time for the second rail-button to also get past the end of the rail. In that period of time, short though it may be (about .25 second typical) almost anything that places or changes the forces on the rocket will try to make Bad-Things happen. Even the fin area



in front of the aft rail-button will try to destabilize the rocket.

ANY force on the rocket is going to try to spin it around the aft button.

Pitch forces (e.g., nose up or nose down) will now operate on the button rather than at the CG. And these forces will use the distance from the CG to that back button as leverage to create binding, friction and drag on the rail.

Roll forces (e.g., spin clockwise or spin counter-clockwise) will also try to spin the rocket around the aft button, again creating variable amounts of binding and drag. Fortunately roll forces are leveraged much less due to the smaller radius of the rocket body. But these two types of variable binding and dragging results are just small issues (just Bad-Things) compared to the yaw force effects.

Yaw forces will tend to move the nose of the rocket right or left, leveraged by the distance from each part to the aft-button, using the entire mass of the rocket again leveraged by the CG to tail distance. And because the aft rail-button swivels freely right or left, there is no limit to the amount of adverse yaw motion. Try to hold your rocket up by the aft button in any kind of wind to see how easy it moves. The nose and the entire tube contribute sail area, and, therefore, our carefully computed Barrowman CP is null and void. This creates a very good recipe for Real-Bad-Things to occur.

sidebar2** *The Barrowman stability equations make several simplifying assumptions to reduce the complexity of the math involved. Two of these assume that the forces on the body tube resulting from minor angle of attack differences will be negligible and self offsetting in front and behind the center of pressure. But with the aft rail-button moving the pivot to the tail, there is no behind, behind the CP. So all yaw forces applied will rotate the rocket.*

The above thought experiment shows what I believe happens to the stretched Initiator. It wobbles when the front button releases the rail. And if there is any significant wind in the quarter of a second until the aft button also comes off the rail, the model turns hard WITH the wind. Then when the rocket is no longer guided by the rail, the angle of the wind actually subtracts from the forward velocity vector, further reducing stability, and sometimes making it go negative. Dancing and/or dangerous, as shown in actual flights, rather than barely stable as seen in the simulator.

So, what I've learned from these observations and experiences says that the aft rail-button SHOULD NOT be located at the tail of the rocket. But where then is more correct?

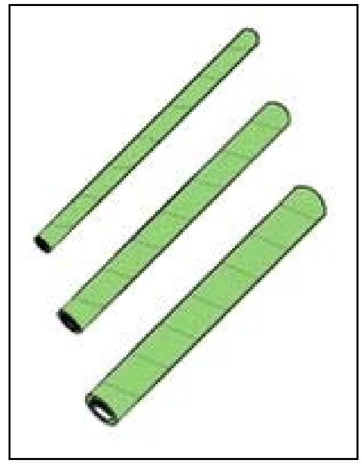
Hypothesis for Rail-Button location: When using only two launch rail-buttons, the forward button should be within a caliber in front of the CG point, and the aft button should be at or slightly in front of the CP point with the rocket in flight-ready condition.

Thought experiments show that these two important points could in fact be the ideal locations, to minimize rail drag and to maximize stability at launch. A button at the CG provides support at the point where all the equivalent mass is acting. Moving that button slightly forward shares the load a bit onto the second button reducing total friction an appreciable amount. Having the front button release near the CG does not impart or induce any uneven torque forces in any axis. And the distance between the CG and CP is typically not too long, thus minimizing the period of time that Bad-Things can happen. With the aft button at the CP, the drag forces of the button on the rail act in the same spot as the airframe stabilization forces. Releasing the second rail-button from the rail at that point also removes the tendencies of the CP to act with leverage against the aft button to destabilize things. Interested parties might be able to design a set of very interesting measurements and experiments to test this hypothesis.

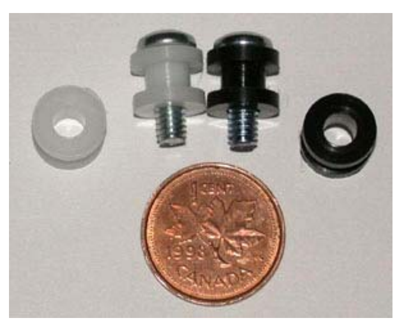
Conjecture for Lugs/Buttons/Guides: When we know enough about the differences and similarities of these lift-off guidance techniques, the "hypothesis for rail-button location" will be true for all lugs, buttons and guides.

I think we will have to develop more rigor in our terminology and thought experiments. And probably back-up the thinking with real measurements and experiments, before we decide the truthfulness of the hypothesis or the conjecture. But at least now we can define the issues more clearly.

And with clearer issues in mind, we can now look at some differences in buttons vs. guides vs. lugs. Some of these are simple and important to understand.



Launch-lug-tubes provide a very constant and predictable friction/drag on the rail. (You do clean the rod each time before the flight, right?) They spread the support forces evenly along the length of the lug-tube without corners or edges. Lug-tubes inhibit Pitch and Yaw motions but translate Roll forces (around the airframe centerline) into spin forces around the launch rod. Short segments of tube used as launch-lugs can show some of the same issues as buttons, and they will add variable drag/binding forces in changing wind conditions. Lugs are probably the most aerodynamically drag inducing option of the three liftoff guidance types, and are thus not favored for use in high-tech or high-performance models.



Rail-buttons are the next step up for aerodynamic reasons, and

they tend to support heavier models better, using the more rigid launch rail structure. Buttons made of Delrin or Nylon or similar plastic provide very little friction on the rail during launch. Round buttons tend to slide easily even in dirty rails, but may introduce variable friction levels once the forward button leaves the rail. Buttons resist Pitch and Yaw forces well only until the first button releases, then these forces can leverage against the aft button. Pitch changes force a fore/aft tilt of the button in the slot against the rail. Roll forces are less well distributed by buttons, all attempts to spin the rocket will increase the binding force on the buttons against the rail by trying to tilt the button sideways in the slot. Yaw forces become free to rotate about the second button.

Rail-guides are usually the best aerodynamic solution for fixed liftoff guidance, they tend to be small in height against the diameter of the body tube. And they can be streamlined to further reduce flight drag. But they can also be the most troublesome option. Rail-guides show the same kinds of force dispersal as buttons. But most guides also introduce sharp edges to face against the launch rails. These edges can become the focus of any binding forces and greatly increase the pressure of this interface. Increases in pressure will provide large increases in friction. [That is essentially the way an automotive breaking system works.] Guides will not free-up the Yaw forces like buttons, but will now handle them similarly to the Pitch forces, tending to rotate the guide in the rail slot. (This is the most likely sharp-edge to be pushed against the rail.) With rail-guides, in the time it takes to move from front guide release to aft guide release, forces in all three axis can/will introduce friction variables into the launch.

sidebar3 *- My wife Suzy and I are mentoring a number of TARC teams at our local high schools. Team America Rocketry Challenge assigns a specific task for the teams to accomplish using a rocket that each team designs and builds themselves. One of the performance criteria of these tasks is repeatability against a specified target like altitude. Last year, one of our teams had a very high-tech, well constructed rocket using a large modroc motor and rail-guides for lift-off guidance. After about 30 flights, there was still a large amount of variability in performance that could not be attributed to motor differences. When looking back at the data, even in similar launch conditions, light winds and similar temperature, performance would show 15% to 20% different altitudes for identical configurations of their rocket at the same liftoff mass. We then noticed some of the variable friction and binding with only the aft guide on the rail while loading the rocket. This led to a series of tests that switched to using a launch rod and lugs. Even though the ¼ inch rod was much less stiff than the previous rail, the variability in performance was cut by more than half. It came back into the range of 5% to 10% that is probably all attributable to variations in motor impulse.****

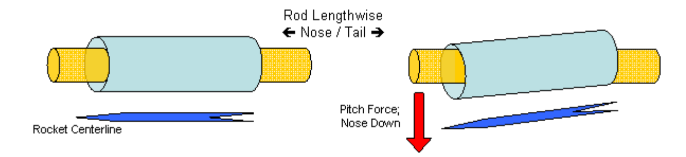
Next time I may try to better describe and quantify the forces at work in liftoff guidance; pitch, yaw and roll translated into torque or friction against the rod by lugs, and against the rail by buttons and guides. These forces will affect things differently based on yet another set of design variables, like length of lug or guide, diameter and stiffness of rod, size of button, width of rail, etc. If we want to get really detailed in this analysis, we may need to describe these forces over the liftoff time window. Even the radius offset of the rocket thrust-line away from the lug/button/guide will introduce friction variables and contribute to deflections of the rod/rail.

So while I am thinking, Fly 'em safe. And lookout for these things we think we know.

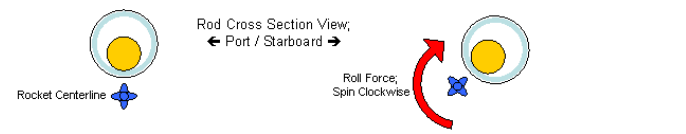
Note: For a more visual idea of just what the forces are on the different guides, please refer to Jack's charts on the next page!

Forces on a Launch-Lug

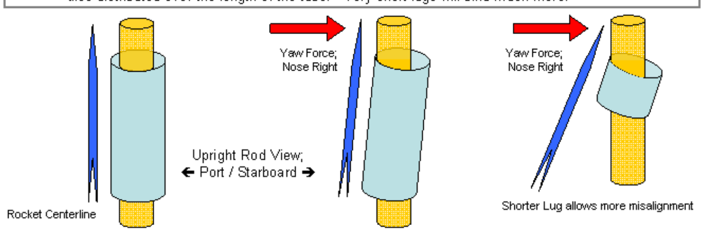
Pitch forces: (nose-up or nose-down) will apply leverage onto the tube parallel to the length axis of the rod. Leverage is distributed over length of the tube, causing slight binding, and an increase in friction.



Roll forces: (spin clockwise, spin counter-clockwise) are translated by the short leverage (radius of rocket) into rotation around the rod. Usually negligible binding or friction increase.

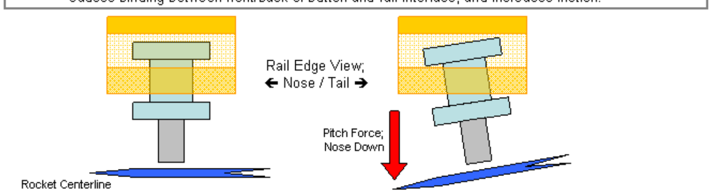


Yaw forces: (nose left or nose right) will produce binding and friction identical to the Pitch axis. Force is also distributed over the length of the tube. Very short lugs will bind much more.

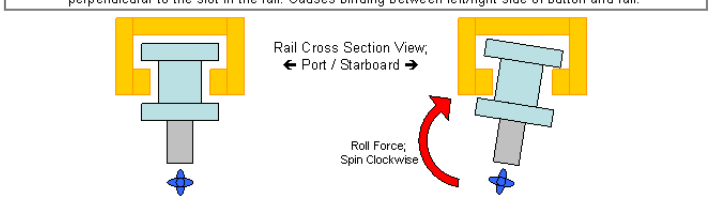


Forces on a Rail-Button

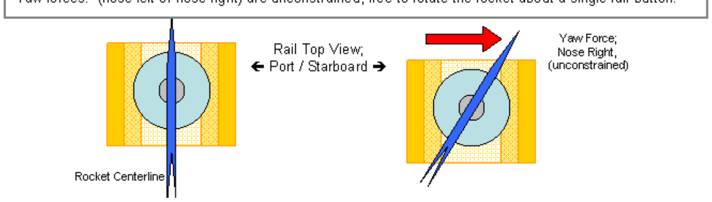
Pitch forces: (nose-up or nose-down) will apply leverage onto the mounting bolt parallel to the slot in the rail. Causes binding between front/back of button and rail interface, and increases friction.



Roll forces: (spin clockwise, spin counter-clockwise) will apply similar leverage onto the mounting bolt, but perpendicular to the slot in the rail. Causes binding between left/right side of button and rail.

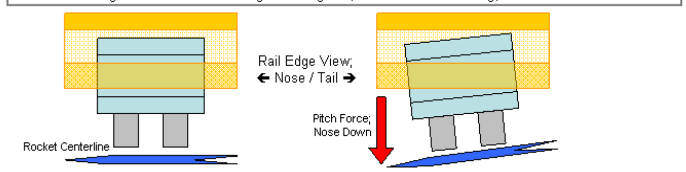


Yaw forces: (nose left or nose right) are unconstrained, free to rotate the rocket about a single rail-button.

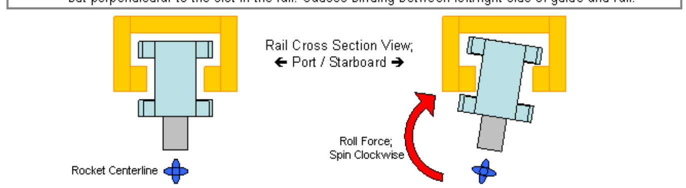


Forces on a Rail-Guide

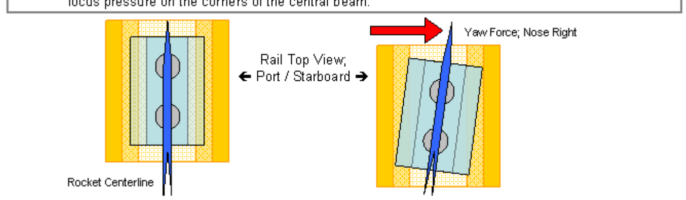
Pitch forces: (nose-up or nose-down) will apply leverage onto the mounting bolts parallel to the slot in the rail. Leverage is distributed over length of the guide, but still causes binding, and increases friction.



Roll forces: (spin clockwise, spin counter-clockwise) will apply similar leverage onto the mounting and guide, but perpendicular to the slot in the rail. Causes binding between left/right side of guide and rail.



Yaw forces: (nose left or nose right) will produce binding and friction similar to the Pitch axis, but will also focus pressure on the corners of the central beam.



Movies on the Square in Frisco, Featuring October Sky and DARS

By Gary Briggs

Frisco has some great community activities, and Movies on the Square appears to be one of them. It takes place in front of the city hall, in a large rectangular area bordered by bushes. The organizers set up an inflatable movie screen, projection and sound system, and people bring their lawn chairs, coolers and kids (don't forget the bug spray) for some movie fun under the stars.

DARS was fortunate enough to be invited to participate as the "opening act" before the showing of *October Sky* on the evening of June 27. This movie, and the book(s), has a special importance to many of us, not only because it's about a boy and his rockets, but because it was a key triggering mechanism to get us back into rocketry after a long absence. Royce and Don approached several DARS members requesting their support in staging a display and small launch just prior to the event. Flights were selected and tested at the June Frisco launch with the idea of keeping this relatively low and slow, since we had limited recovery space bordered by buildings on one side, and the Dallas North Tollway on the other.

About one hour before the start of the movie, we set up 2 tables of rockets, leveraging one of the stands used for the Fall Classic and had several other rockets free standing. Terri Magnes, Josh, and I worked the display. We had handouts with the DARS website and information about the Frisco launches. We covered most of the rocket spectrum in the display from models to L1, 2, and 3. There were lots of kids, with many interesting questions. The real show stealer was Ken's level 3 rocket, which several young attendees were convinced we would be launching (unfortunately we did not). I had several of my 60's and 70's era rockets on display, and between those and the old catalogs I brought along, I think we may have found a few more BAR's to add to our ranks. There were great conversations about "what happened to that one" and "I remember wanting one of those", etc.

Royce Frankum, Don Magnes, Doug Sams, Sam Barone, and Ken Overton worked on getting the launch equipment set up, and finally the time came for several perfect launches. Sam put up a couple of glider flights with a SW Dogfight and also flew a kit bashed Executioner. Ken had the 'big' flights with his Bullpup on Road Runner G motors. Don put up a couple of Pyramid flights and Doug flew a 2 stage (of course it was a Midget). Royce rounded out the crew with a Red Baron. The motors looked great as it got darker, and every one of the launches was greeted with enthusiasm from the crowd. Alas, it eventually got too dark and it was time to start the movie.

I don't know if there is a direct cause and effect, but the July launch in Frisco was one of the most heavily attended events that I have been to on that field, which didn't include some type of outreach event. I counted 40+ cars around 12:00 pm, but realized that I missed a few driving out with people parking out on the road!

Overall, Movies on the Square was a great event, and it appears to have had a positive effect on attendance at the Frisco field and hopefully on our membership going forward. Thanks to all who participated, and we look forward to the opportunity to do this again next year. Maybe we ask them to show *The Astronaut Farmer*?

Rockets on display

Pictures From DARS Movie Night !

By Gary Briggs

Appreciative crowds watch DARS rockets soar!

Another rocket takes to the sky!

More DARS masterpieces

Royce mans the launch button

How to Contribute to Shroudlines

No, we are not taking monetary donations, we want something even more valuable….YOUR BRAIN!!!! Or...uh...the stuff that comes out of it, anyway.

This newsletter lives and breathes because of the members of DARS. Without you we can't survive. So far several members have really risen to the challenge and given us great material, so we want more!

If you have any kind of article, picture, cartoon, rambling, etc., just send it to stu29573@yahoo.com. I usually work best with Word documents, and JPEG files, but I can make just about anything work if I have to. I can also handle stuff that is written down, but that means I have to type and that can be a bit touch and go… But I'll take it anyway!

You can also give me things at the meetings (which I almost never miss...almost), and I promise to try my best not to lose them. I can return stuff at the next meeting if need be.

In short (I know, too late) I really want this newsletter to be by the club and for the club. You guys can think up much better stuff than I can (as is evidenced by the articles we've been getting lately). So, stop just thinking about maybe writing something and actually do it! You'll be glad you did! (Or at least I will!)

DARS Officers

President	**Royce Frankum**
Vice President	**Don Magness**
Treasurer	**Tony Huet**
Secretary	**Terri Magness**
NAR Senior Advisor	**Sam Barone**

DARS

The Dallas Area Rocket Society is a non-profit chartered section of the National Association of Rocketry ("NAR"). Its purpose is to promote the hobby of consumer rocketry in the Dallas/Ft. Worth metropolitan area.

Membership in DARS is open to all interested persons. Membership in NAR is encouraged, but not required. Annual dues are $10.00 for individuals and $15.00 for families. The entire family, including children, are welcomed to the meetings. Go to the website and fill out and send an application to join or renew your membership.

The club normally meets on the first Saturday of each month at 1:00 p.m.

Visit the DARS website for the meeting location: www.dars.org

Stay connected! All of us will reach greater heights with your attendance at the club meetings.

Vendor Links (* DARS member discount—confirm before ordering)	
Aerospace Specialty Products	Aerotech Consumer Aerospace
Apogee Components	Art Applewhite Rockets (* 20%)
BMI Hobbies (* 10%)	BRS Hobbies
CLE Enterprises	Dr. Zooch Rockets
Excelsior Rocketry	FlisKits, Inc.
Hawks Hobby	HobbyTown USA— Dallas, Walnut Store (* 10%)
JonRocket	MadCow Rocketry
Mercury Engineering Co.	Pemberton Technologies
Public Missiles Ltd	Qmodeling
Quest Aerospace, Inc.	QuickBurst
Red Arrow Hobbies	Red River Rocketry (* 8.25% on field)
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