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NEWSLETTER

Feature Article:

Development of the Fly-Apart Rail Guides

Cover Photo: Tim loads a superroc onto a launch rail utilizing "fly-apart rail guides"

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Development Of The Fly-Apart Rail Guides

Written By Tim Van Milligan

I came up with a cool invention last week, and I'm pretty confident that I could have patented it, because it is so unique and novel. But because it has such a wide benefit to the rocketry community, I think I'll just put the idea out there so that everyone can make use of it. We're at a unique period in rocketry right now, where a lot of cool things are coming together all at the same time. By not releasing this right now, I could have slowed things down and hampered you from a useful bit of technology for your next project.

The invention is called a *Fly-Apart Rail Guide* (see Figures 1 and 2). It really doesn't look anything like a rail button, but it accomplishes the same mission as a rail button. It helps to guide the rocket up a launch rail pad. The "Fly-Apart" portion of the name means that it literally comes apart and detaches itself from the rocket. The result is that as soon as the rocket leaves the launch rail, it loses a bit of drag and weight, and therefore can fly a lot higher into the air. That is the real benefit of this invention; a device that allows a rocket to fly higher into the sky.

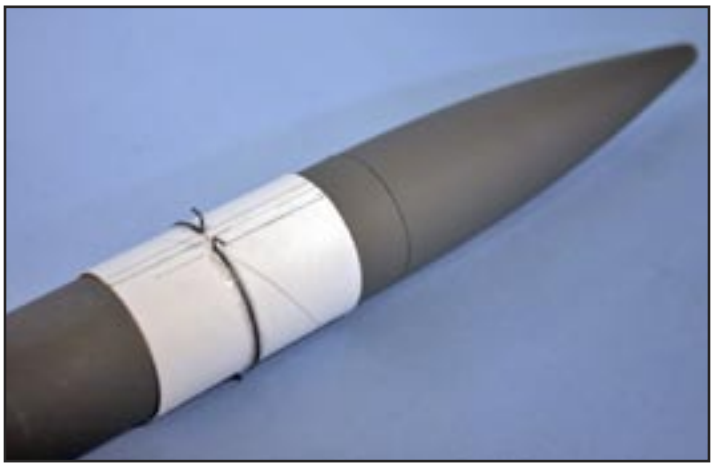

Figure 1: Fly-Apart Rail Guide. The music wire hooks engage a standard rail launcher.

Figure 2: Opposite side of the Fly-Apart Rail Guild. The cradles (two pieces of tube) are held snugly against the body tube by a rubber band.

Let me explain how I came to create this new invention. I'll run the risk that it may look like I'm trying to say "look at what I've done." That is not my intention. I think that this particular device would have been invented by someone sooner or later. My purpose in writing this is that I want you to have an inside-the-scene look at the design process. It is my hope that you'll gain some knowledge about inventing things. If you know how it is done, then maybe you'll come up with some cool stuff too.

Why do I care about your future inventions? That is a great question. First of all, I'm not the type of person that thinks "today's technology" is all that will ever be available. You've probably run into some people that think that the world is going to run out of oil in the next 100 years. I say, "who cares." I think it is naïve to think that something better won't be discovered or invented that will replace oil, or extend out our known supply for an additional 1000 years. With that in mind, I want to be a person in your life that encourages you to take risks and create new things. I'd love to see a massive increase in rocket technology. And second, I would love to sell some of the new rocketry items that you might come up with.

The Problem

It has been said that "necessity is the mother of all new inventions." I agree with that, at least with all the little inventions that I've come up with myself. I usually start with a problem, and then I need to find a solution to that problem.

In this case, the problem came to light when I got a call from Mike Konshak, the launch director of the NARAM-52 event here in Colorado next August. By the way, have you

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given any thought to coming out here for that event? Now is a good time to start making plans. See www.peakcity.org/

One of the contest events is F-engine Superroc Altitude. As the rules state: "the purpose of this competition is to achieve the greatest altitude possible with the longest rocket possible without impairing the structural integrity of the rocket."

These are going to be some really long rockets. The rules of the event (www.nar.org/pinkbook/21_SRA.html) show that for the "F" motor class, the rocket has to be a minimum of 200 centimeters (78 inches, or 6.5 feet) long, with a maximum length of 400 centimeters (13.1 feet). The rocket can actually be longer than 400 centimeters, but you don't get any extra points for it.

Because this is an altitude competition, you also want to minimize weight so that the rocket will fly higher. To minimize the weight, typically you will make the rocket out of skinny tubes, because they are lighter weight than large diameter tubes (makes sense, doesn't it?). The size of the engine will usually determine the maximum diameter of the rocket, since you'd want to avoid any unnecessary weight. In this case, the choice is going to be either 29mm or 24mm tubes.

The point I want to make by going through the rules is that these are going to be really long and slender rockets. We're really flying a long noodle.

If you've ever seen these types of competition models, you know that they are hard to handle. Even carrying this kind of rocket out to the launch pad can be a mighty challenge. They want to wiggle and jiggle while you're walking, and if you bump them against anything, they are very easy to kink. Once they kink, the game is over; they'll never fly

Figure 3: An F-engine Supperroc rocket can exceed 13.1 feet tall. A slight wind can easily bend it in half.

straight again, and they'll most likely kink on the way up. If your rocket kinks before it reaches apogee, your entry is

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disqualified.

Here's the problem: launching them.

Think about this… You have a long rocket that is going to be three times longer than a standard 4 foot long launch rod. If you put this rocket on that kind of launch rod, then the top 3/4ths of the rocket is going to be unsupported. If there is any hint of a breeze, that top portion of the rocket is going to be bent to one side. If it doesn't kink just sitting there on the launch pad (which the odds are likely to be in the 80% range), how straight of a launch do you think your going to get if the rocket is pointing to one side as it takes off? We talked about these types of rockets recently in Peak of Flight Newsletter 239 (www.ApogeeRockets.com/education/downloads/newsletter239.pdf): "Why do Tall and Skinny Rockets Go Unstable?" Basically, the rocket is going to go unstable as soon as it lifts off.

What are possible solutions?

1. A longer launch rod?

A long rod (more than 6 feet long), is going to have the same problems as the long rocket. It is like long noodle that will tend to bend in the wind. That means that this really isn't a good solution.

2. A thicker diameter launch rod?

This might work. A thicker rod will be stiffer, and therefore you can make it long enough for these superroc type models. But the disadvantage is the launch lug hanging off the side of the model. Do you really want the extra drag? After all, the object of the contest is to fly as high as possible. So the answer is "no." You don't want the extra drag of a huge launch lug.

3. A tower launcher?

This would actually work! And this is what the hard-core competitors will take out to the range with them. The other advantage is that it eliminates the need for a drag producing launch lug on the side. Therefore the rocket is going to go higher in the air.

The problem with a tower is that it is expensive. And finding one to buy is a real challenge (hint: there isn't one available that I know of). So you'll have to make your own.

The other problem is that a tower is big and bulky. Taking a tower launcher with you to the launch range is a hassle, especially if you are going to be driving a long distance to Colorado for NARAM next summer. You're going to need a long van or to pull a trailer behind your car just to get it to the range. And you're going to need to spend a

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long time assembling it from the component pieces once you get to the range.

What about borrowing another competitor's tower launcher? If you got a good buddy, that is possible. And I'll tell you a widely-known secret—even die-hard competitors will allow you to borrow their tower launcher (rocketeers are really friendly people). But the caveat is that you can use it when they aren't. That means you'll be waiting around a long time for them to be done with it. Since this is a contest event, you can be assured that they are going to take their time and wait for the optimum launch conditions (when the wind isn't blowing). Like I said, you're going to be waiting a long, long time, and then you'll scramble like the dickens to get your rocket into the air. And because you're scrambling, the likelihood of you making a mistake goes up dramatically. And Murphy's Law will come into play, which means the wind will be blowing like a hurricane when it is your turn to launch. I've come to the conclusion that you're really sabotaging yourself if you borrow someone else's launch pad for a competition flight. And I think your competitors know it, which is why they are so happy to let you use it…

4. A tube launcher?

This is a cool concept. You have a long tube and put the rocket inside it. Essentially, it is a type of launch tower. The tube would support the rocket and prevent the wind from trying to bend it. I've seen Norman Pfund, a member of our local club here in Colorado Springs, use this type of launcher on high-power rockets. It does work. But I've

Figure 4: A tube launcher built by Norman Pfund.

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never seen anyone use it for long rockets like these super-roc competition models. The reason is that I think that this type of launcher would have the same type of problems as a tower launcher; namely, transporting it to the launch range.

5. A rail launcher?

First of all, they are long enough, and they are stiff enough to for these types of rockets. That's great! The other advantage is that usually the host club will have several launch rails available for the high-power fliers (at NARAM next summer, one of the other events is 'Giant Sport Scale,' which might also necessitate a rail launcher, so the host section will have them available). So using one, when you actually want to use it (when the winds are light), is possible; and you don't necessarily have to take your own rail launcher out to the range with you.

Note: if you want plans to build a dirt-cheap rail launcher, see Peak-of-Flight Newsletter 235 (www.ApogeeRockets.com/education/downloads/newsletter235.pdf) This rail

Figure 5 (right): A launch rail is a lot longer than a rod and can even be extended further if necessary.

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launcher design actually breaks down and then is no bigger than a fold-up lawn chair. That means if you wanted to take one with you, it is not nearly the annoyance as bringing a tower launcher.

But now you have the problem of large rail buttons hanging off the side of the rocket. This is similar to having a large diameter lug on the rocket. The extra drag is going to cost you a lot of altitude.

The other problem is that usually the long superroc style rockets are skinnier at the top and wider at the base where the motor is. Why? Because you can reduce weight even more if you use skinnier tubes, which is the same thing we said previously. So what you'll see is a long rocket that is very skinny at the top, and uses several transition sections to gradually increase the diameter until it is the motor diameter at the base. Launch rails only work with rockets that are a constant diameter, or where one of the rail buttons is mounted on a stand-off. Again, do you really want a stand-off on the side of a tiny tube? On a rocket like a superroc style model, it is going to act like a fin and make the rocket less stable (exactly what we don't need).

It was this very problem of how to launch the superroc models that Mike Konshak called me to talk about. Since he is the director of the NARAM contest, he wants to come up with a solution that is easy so that it would encourage people to participate in the event.

As you might conclude by the title of this article, the solution I came up with was to use a rail launcher. The advantages of a rail launcher are so overwhelming in my opinion, that I set my brain to work on a solution that would allow theses superroc models to fly off of them.

Here is the process that my brain used to define the problem, and come up with a solution.

First, I didn't want to use rail buttons. As mentioned before, a large rail button on a skinny rocket is going to be a significant source of drag. And since this is a contest event, I wanted the rocket to fly as high as possible.

"Would a "small" rail button work?" I asked myself. I could probably live with that.

But where would we find a tiny rail button? Mike suggested to me that maybe a nylon screw could be used as a rail button. Ooh. I liked that idea.

But that leads to another problem. Where am I going to find a rail that has a smaller slot that would fit a tiny rail button? Maybe we could custom order an extrusion? Ouch, that would be very expensive. Who would pay for that? Could I sell them to competitors? Probably not. Could the

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host club of NARAM pay for it? Probably not. They have enough expenses to deal with. OK then, the tiny-slot rail launcher is too cost prohibitive.

"How could we use a standard rail launcher that clubs already have?" I asked myself. I really liked the idea of the tiny nylon screw as a rail button. I could live with that. So maybe a special type of button that fitted around the head of a nylon screw head? (See Figure 6) I suggested to Mike that maybe we could cut this type of rail button in half. "Why?" he asked. If it was cut in half, we could have the parts fall off the rocket as it left the rail, leaving just the nylon screw head exposed on the rocket. That is an interesting idea. It would remove a lot of drag from the rocket.

Figure 6: Could a "half-button" be fashioned that would grasp a small nylon screw head like this?

That special button would have to be custom made though. But the good news is that making a plastic button is a lot simpler to produce than a custom metal extrusion. I could make it out of urethane resin, like I do for several of the items we currently make (such as the glider pod hooks at www.apogeerockets.com/glider_pod_hooks.asp). The techniques for making custom plastic parts can be found in Technical Publication #12, which can be ordered at: www.apogeerockets.com/technical_publications.asp.

That is where I left the conversation with Mike. I thought the idea was a winner.

But as soon as I hung up the phone, another idea popped into my head. "If we're going to be dropping parts off the rocket as it left the launch rod, couldn't we drop off the nylon screw head to get rid of all the drag?" This would be optimum. Hmmm…. The wheels in my head were churning again.

"Where have I seen a launch guide that dropped off a rocket?" I asked. I knew I've seen something like this before. It was nagging on me now. Then it hit me as an eureka moment.

"Model Rocket Design and Construction – Third edition" I said. That is where I've seen this before.

All this time, you thought you were reading about how to invent something new. Sorry, but this article is really a lengthy advertisement for you to buy my book (www.apogeerockets.com/design_book.asp). Surprise!

Just kidding… This isn't an advertisement to buy the book.

But the next step in inventing something, which comes after identifying the problem and looking for the obvious solutions, is to do research on what other solutions have been tried in the past. In the case of model rocketry, I have to

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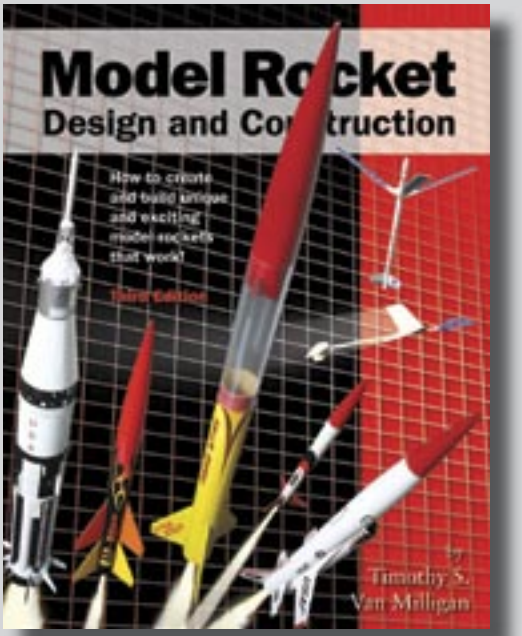

Model Rocket Design and Construction

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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say that the book *Model Rocket Design and Construction* is probably the first place that you should start your research. So if you don't have it already, start your library by getting this great book.

On page 57 of the book (third edition) is a little illustration of the fly-apart launch lug. I got this idea from Jim Flis, who calls it a "pop-lug." I personally don't use the name "pop-lug" because there was a previous mechanism called a "pop lug," which is also shown in the book on the same page. Because of this, I changed the name to a "*fly-apart* launch lug."

I then took the concept of the fly-apart launch lug, and looked for a way to attach it to a launch rail instead of a regular rod. The first thing to go was the lugs. They wouldn't work anyway. I thought I might replace them with the "half-button" idea that I thought of earlier.

But to me, cutting the plastic button in half seem like a pretty big chore. Then each side would have to have been mounted to the cradle on the fly-apart launch lug device. I got to thinking that all I really needed was a small U-shaped piece to engage the rail. Why couldn't that part be made out of music wire? After all, I was going to need a piece of music wire anyway for the hooks to hold the rubber band. Since I couldn't think of any good reason why it couldn't use music wire, I decided that this was the approach I'd take. In fact, the more I thought about it, I couldn't see why I couldn't just make the whole thing from a single piece of music wire. While it makes a more complex part initially, it makes assembly of the device much easier.

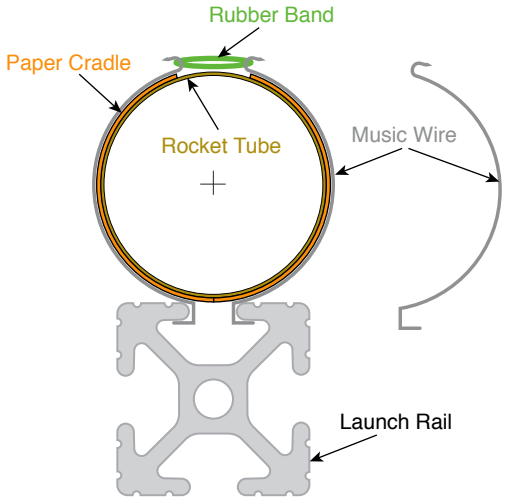

Figure 7: Cross-section of a rocket using Fly-Apart Rail Guides.

Then I got to thinking again… "Do I really need the cradle section to hold the wires against the rocket tube?" On first impression, I didn't think that I would need it at all. I could probably get it to work with just music wire. Cool!

But then I got to thinking about what would happen to the wires after launch. They would release from the rocket

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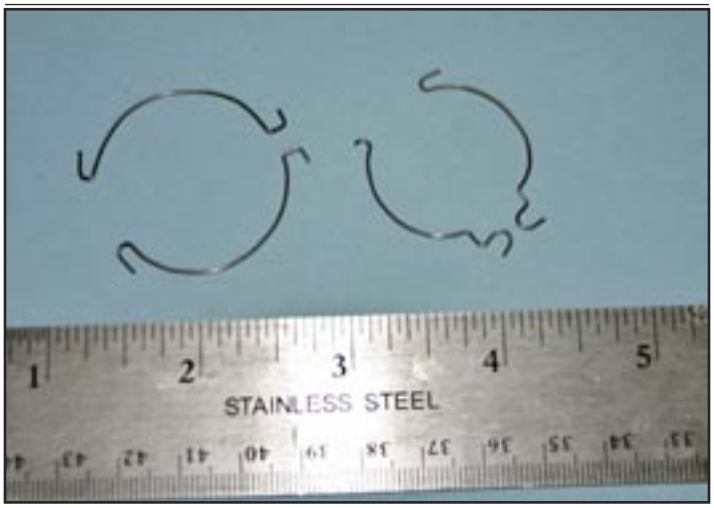

Figure 8: Bent music wire is the key to the fly-apart rail guides. Left side is the standard shape, while the set on the right has a small stand-off in it.

and fall to the ground. "Would I be able to find them on the dirt after launch?" Not a chance. They are so small that I'd never find them to be able to reuse them for another launch.

This gets me to a concept I like to call "usability." You can come up with a really cool invention, but if it is hard to use, or it can only be used once, then its value has really diminished. I wanted to create a gizmo that was easy to use, and could be used again and again. That is why I left the cradles on the device. In fact, I recommend painting them fluorescent orange or fluorescent red so that they stand out better and are easier to find at the base of the launch rail after the rocket has gone skyward.

At this point, I've got the basic concept down, and there

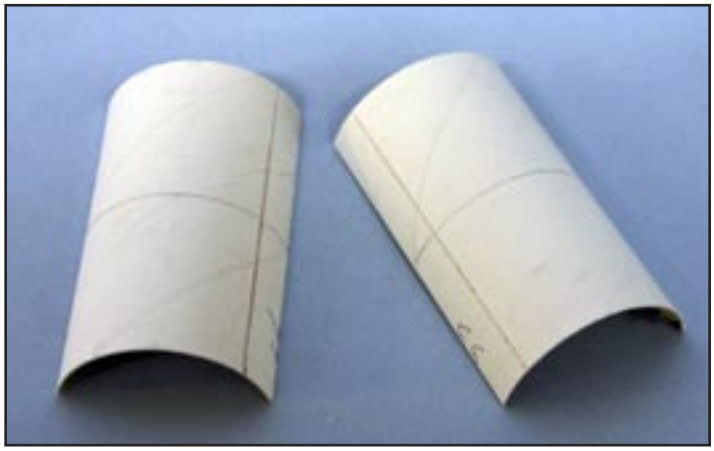

Figure 9: The paper cradles. The pencil lines drawn on them are used to help align the music wires.

Figure 10 (top): The stand-off version of the fly-apart rail guides.

is only one last small problem to work out. "How do we handle the situation where the rocket is skinnier at the top than at the bottom?"

First I thought of a balsa-wood stand-off of some sort. But where would I mount it? I looked at a cross section of a launch rail to see how it would have to engage the extrusion. Like a regular rail button, the device really needs to touch both the inside edge and the outside edge of the rail at the same time. If I put a balsa stand-off on the device, that would solve the problem of the invention touching the outside of the rail.

Then it hit me. If I just extended the music wire a little longer, it would have the same effect as a balsa stand off. And it would mean one less part to fabricate to put this thing together.

At this point, the basic concept was in my mind of how I wanted this thing to look and work. I was just about ready to start making a prototype to test it out.

One last step to do, draw it out on a piece of paper. I knew that the tolerances of how the metal music wire was bent was going to be fairly critical. So I drew out the device as accurately as I could. Once this was done I could start bending wire and cutting the cradles from a piece of tube.

I'm happy with the way the first devices turned out. It is

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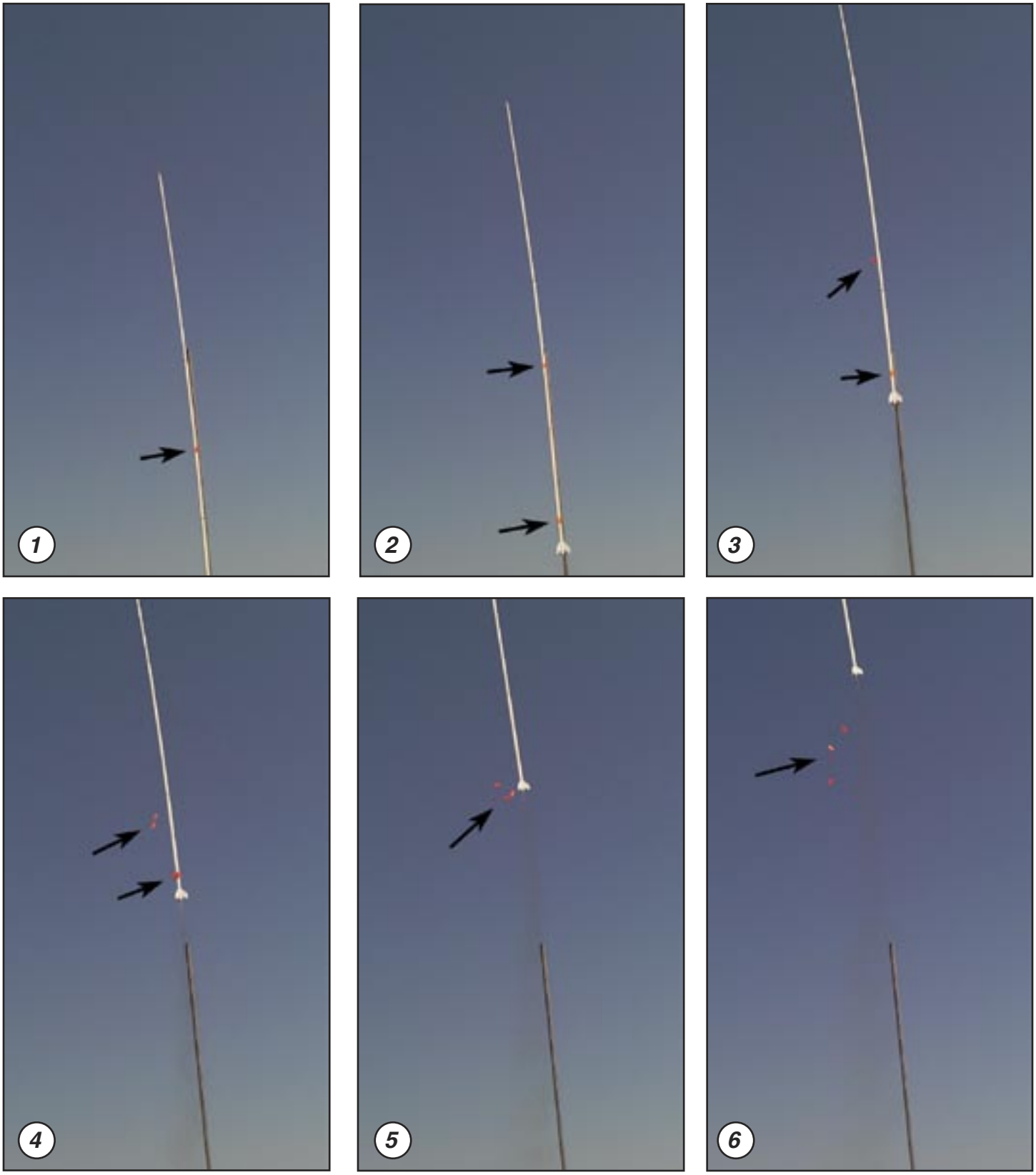
Figure 11: Video sequence of the fly-away rail guides falling off the rocket as it clears the launch rail.



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hard to bend the wires accurately, but it is not impossible. I took my time, and each wire piece took about five minutes to bend to the correct shape. Is it perfect? Nope. But a little bit of slop in the fit isn't a problem for these low power rockets.

The cool part is that there isn't really any special parts you have to buy. Music wire can be found at any hobby shop in the country. And the cradle is made from a tube the same diameter as the rocket. All told, the cost of the thing is less than 50 cents. That is certainly in the budget of any rocketeer.

Universal Utility

One last question went through my mind. "Can this concept be used for other rockets too?"

YOU BET!!!

The invention is scalable to any size model rocket, and could be used on high power rockets too! That means universal utility on any rocket.

Think about that for a second. What are the implications? What are the advantages?

For starters, it means you may not need to attach rail buttons or launch lugs to your rockets ever again. One of the things we always try to do is eliminate drag as much as possible, so this would mean that our rockets could fly higher. And for scale models, you also remove the unsightly launch lug that really makes a beautiful rocket ugly.

I'm also a huge proponent of using longer launch guides, even on small model rockets. The faster the rocket leaves the pad, the more stable it will be, and therefore it will be more predictable. That translates into safer flights. And a safer flight is always good for everyone in the hobby. I really would like to see smaller rockets flown off longer guides, just like high power rockets.

And that is why I decided to disclose this new invention to everyone right now (and why I decided not to patent it). It is like the car company Saab that decided not to patent a lot of their cars' safety features. They allow other companies to use them because it means safer cars for everyone, which may save lives. I too want everyone to have safe rocket launches.

Conclusion

The drawings in this newsletter for the Fly-Apart Rail Guides are for a specific size rocket. But I think you can figure out how to make your own sizes for your own projects. I'd suggest you start by drawing out a cross section of the rocket next to the launch rail. Figure 12 shows the cross section used by most clubs around the country. It is the 1010 rail from 8020 industries. The standard rail is 1.00 inch square, with a gap of .255 inches for the rail button.

Bibliography:

Developing Creativity - Developing a child's problem solving and design skills takes on additional excitement when combined with model rocketry. This easy to use, step-

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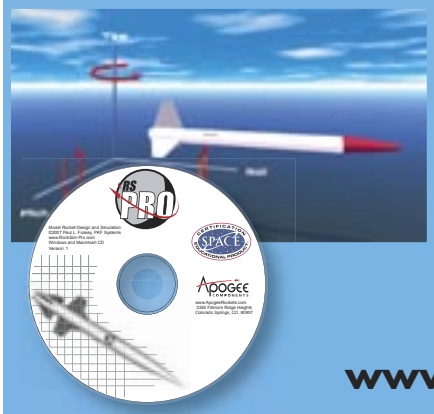

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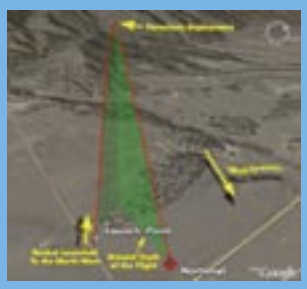

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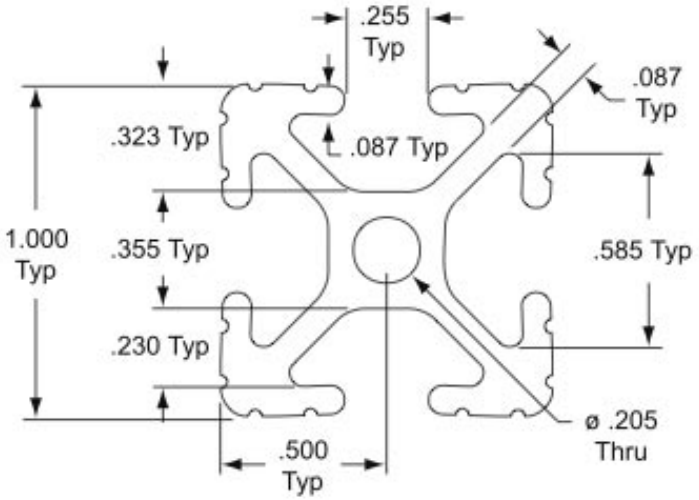

Figure 12: The dimensions (inches) of the standard size rail called "1010" from www.8020.net

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Casting Parts with Silicone Rubber Molds, Technical Publication #12— www.apogeerockets.com/technical_publications.asp

Model Rocket Design and Construction - Third Edition – by Timothy S. Van Milligan. This massive, 328-page guidebook will give you a ton of ideas on how to improve your rockets and make them look more unique. Find it at: www.apogeerockets.com/design_book.asp

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. Before he started writing articles and books about rocketry, he worked on the Delta II rocket that launched satellites into orbit. He has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward a M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (http://www.apogeerockets.com) and the curator of the rocketry education web site: http://www.apogeerockets.com/education/. He is also the author of the books: *"Model Rocket Design and Construction," "69 Simple Science Fair Projects with Model Rockets: Aeronautics"* and publisher of a FREE e-zine newsletter about model rockets. You can subscribe to the e-zine at the Apogee Components web site or by sending an e-mail to: ezine@apogeerockets.com with "SUBSCRIBE" as the subject line of the message.

Figure 13: The superroc model on the launch rail. The rocket did crimp in half during the flight, but the fly-apart rail guides worked perfectly.