PEAK OF FLIGHT NEWSLETTER

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INSTALLING A SHOCK CORD IN LOW-POWER ROCKETS

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PEAK OF FLIGHT

Installing a Shock Cord in Low-Power Rockets

By Curtis Lee

Some people might think low power rockets (LPR) are for beginners, kids or BARs ("born again rocketeers"). But regardless of your reasons for flying them, if you hope to fly a particular LPR for as long as possible, you might need to modify the instructions that came with your model to ensure your rocket lasts longer or performs more consistently. One such modification is with the shock cord. Let's take a look at two of the major characteristics for a shock cord installation: attachment point and materials used.

Shock Cord Main Attachment Point Location

There are three main locations where you can attach the base of the shock cord in an LPR: towards the top of the main body tube (just below the nose cone), somewhere on the engine mount, or in the middle of the main body tube (such as being attached to an ejection charge baffle).

Advantages of attaching the shock cord near the top of the main body tube:

- Possibility of removal or replacement at a later time. But how easily this can be done depends on how deep it was installed into the main body tube. The deeper the install, the harder to remove later.
- For the most part, the shock cord is as far away as possible from the engine's ejection charge. This helps reduce the wear and tear on the shock cord and its mount due to ejection charge debris and hot gasses.

Disadvantages of attaching the shock cord near the top of the main body tube:

- The attachment point can sometimes interfere with the smooth ejection of the parachute, especially in smaller diameter LPRs.
- The attachment point might take up valuable space needed for a parachute or altimeter.
- When attaching a shock cord to a used rocket, extra work is often required to clean the ejection charge residue from the inside of the main body tube.

Advantages of attaching the shock cord to the engine mount:

- The shock cord mount doesn't take up any space in the upper portions of the main body tube where the LPRs often contain their recovery system.
- There's less of a chance of the parachute snagging on the attachment point.
- If done a certain way, a shock cord that's attached to the engine mount can be easier to inspect and replace in the future (more on this later).

Disadvantages of attaching the shock cord to the engine mount:

- Some engine mount methods can make it difficult, if not impossible, to replace the shock cord in the future without doing major work on the rocket.
- The shock cord is located close to the engine. This means it'll endure greater wear and tear from the ejection charge. Remember that Kevlar is flame resistant, not flame proof.

Advantage of attaching the shock cord in the middle of the main body tube:

- The cord is further away from the ejection charge than if attached on the engine mount. And depending on where the baffle is located, the shock cord may be sufficiently protected from hot gasses and debris from the ejection charge.

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Disadvantage of attaching the shock cord in the middle of the main body tube:

- In most LPR rocket designs, it's extremely difficult if not impossible to replace the shock cord after installation without heavy modification to the main body tube.

Shock Cord Material

Potential materials for shock cords are typically elastic cord, cotton kite twine, steel cable, nylon, and Kevlar. However, elastic and Kevlar (100 pound strength Kevlar should suffice) will be the two major shock cord material options for LPRs. One reason nylon isn't usually used for LPRs is because thin nylon twine or string is prone to melting.

Advantages of using elastic:

- Generally cheaper and more easily obtained than Kevlar.
- The stretchiness of the cord helps absorb some of the shock forces that may otherwise be placed on the rocket during ejection.
- It should reduce the chances of zippering or reduce damage to the body tube if zippering occurs.

Disadvantages of using elastic:

- The elastic nature of the cord allows parts of the rocket to bounce back and hit each other after ejection.
- Not as strong as Kevlar.
- It's more susceptible than Kevlar to heat damage from the ejection charge.
- The rubber will naturally break down over time, no matter how well you protect the elastic cord from the ejection charge.

Advantages of using Kevlar:

- Robust flame resistance (although not flame proof).
- Very strong.
- Usually lasts longer than elastic.

Disadvantages of using Kevlar:

- Not the best material for holding knots. Adding some white glue can help hold the knot.
- Is usually more expensive than elastic cord.
- More prone to zippering given its relative rigidity and narrow width.
- No built-in shock absorption like elastic.
- Kevlar may still need to be replaced over time if it has too much exposure to the ejection charge.

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Some of these drawbacks are minor or can be alleviated. For instance, with respect to the zippering risk with Kevlar, you can strengthen the rim of the main body tube with CA glue ("super glue"), add tape to the Kevlar where it touches the tube or make a shock cord out of both Kevlar and elastic.

These hybrid cords will often have Kevlar attached towards the bottom of the rocket as a leader, such as to the engine mount or baffle. The Kevlar cord will go up to just below the main body tube. At that point, an elastic cord is attached to the Kevlar. Then the elastic cord attaches to the payload section or nose cone.

The more robust nature of the Kevlar allows it to survive longer closer to the engine's ejection charge, but the elastic is still present to help absorb some of the shock placed on the rocket during ejection. Additionally, the elastic will help reduce the chances of zippering. And if the elastic needs to be replaced, it's in a location where it's easily accessible.

One thing to keep in mind about Kevlar is that it doesn't like CA glue. CA glue can make Kevlar cord brittle and create a weak point in the cord where it'll focus any bending in the cord in one spot, creating a future failure point.

Now that we have an overview of the available materials and where to install shock cords on a rocket, let's take a look at the different ways to attach them to the main body of the rocket. Remember that no one method is perfect for all rockets, in all applications and for all rocketeers.

Installing a Shock Cord at the Top of the Main Body Tube

There are two popular ways to attach the shock cord to the top of the rocket: completely inside the main body tube and partially outside the main body tube. When installing the cord inside the main body tube, an attachment mount must be used. One of the most well-known is the tri-fold paper mount used by Estes (Figure 1).

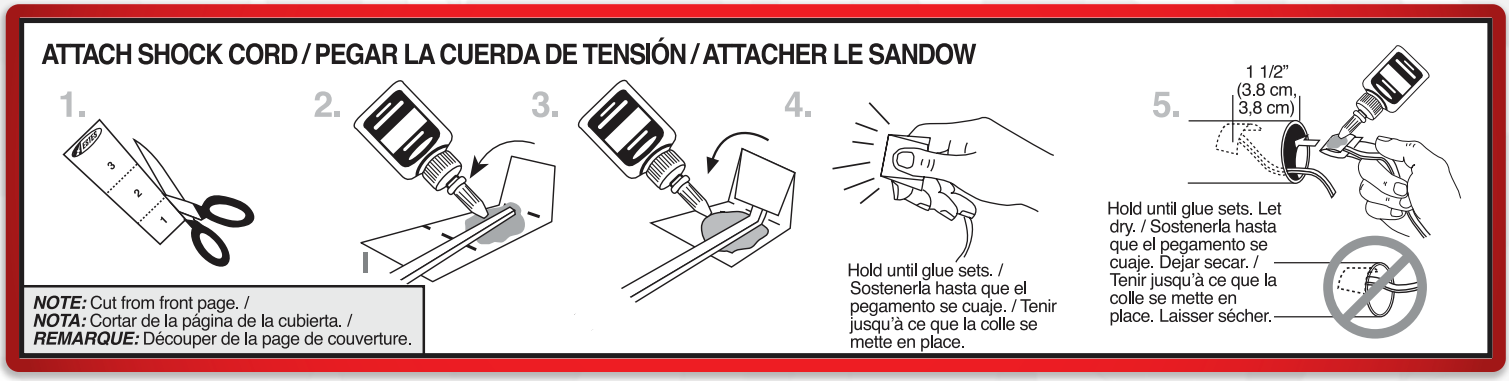

FIGURE 1: THIS IS AN EXCERPT FROM THE INSTRUCTIONS FROM THE ESTES BULLPUP 12D.

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This tri-fold method can further be modified by using a Kevlar shock cord instead of an elastic cord. Other modifications include reinforcing the paper tri-fold "tea bag" by covering it with fiberglass cloth and/or a pool of epoxy.

Another inside-the-top-of-the-tube shock cord mount is the "shock lock" invented by G. Harry Stine (Figure 2).

A third option is gluing the shock cord directly to the inside of the upper portion of the main body tube. This can be done using the LOC/PRECISION method (Figure 3) or a variation of it, such as using a single length of Kevlar and tying a series of knots or one loop on the end and gluing it to the inside of main body tube.

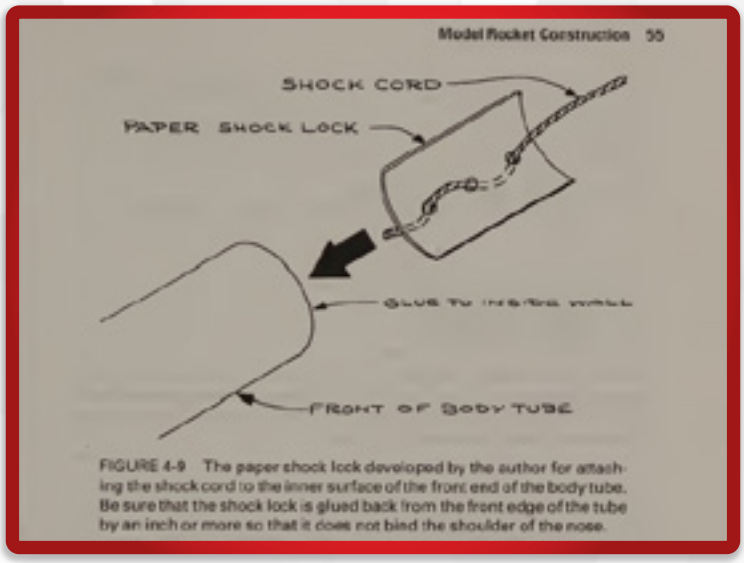

FIGURE 2: THIS IS AN EXCERPT FROM PAGE 55 FROM* THE HANDBOOK OF MODEL ROCKETRY SEVENTH EDITION *BY STINE AND STINE.

A fourth possibility is using a hard anchor point that attaches to the cord and gets glued inside the main body tube. Apogee offers a 3D printed shock cord anchor just for this purpose. A picture from Apogee's website illustrates this method (Figure 4).

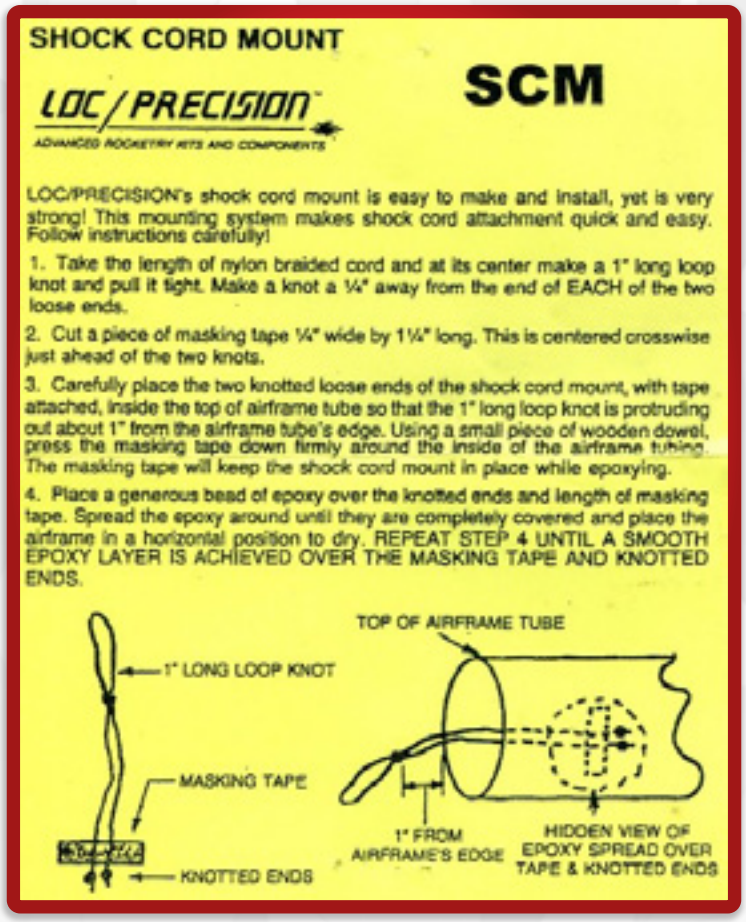

FIGURE 3: LOC/PRECISION'S METHOD OF ATTACHING A SHOCK CORD.

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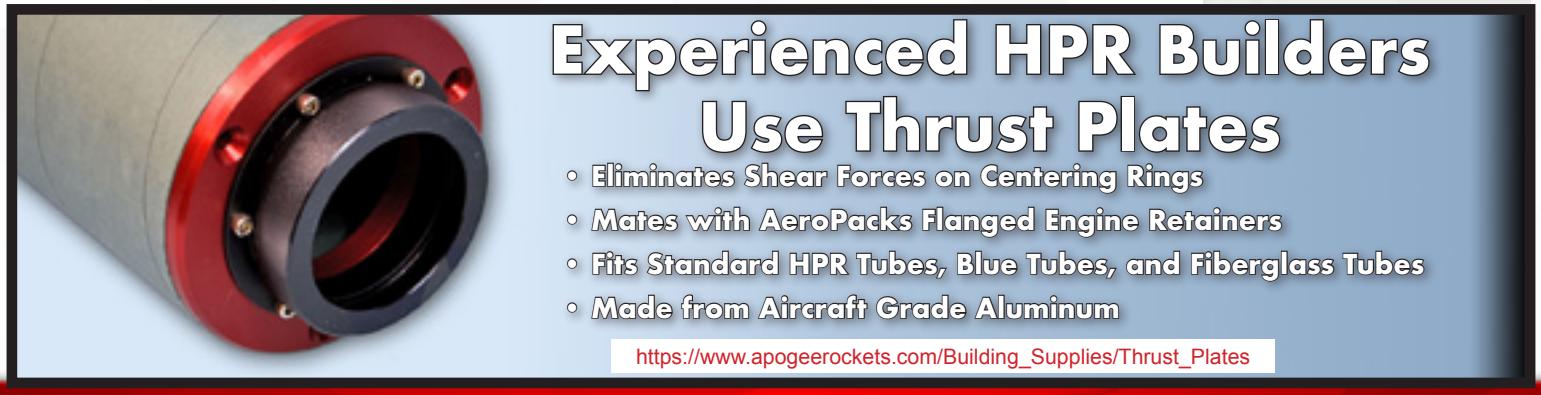

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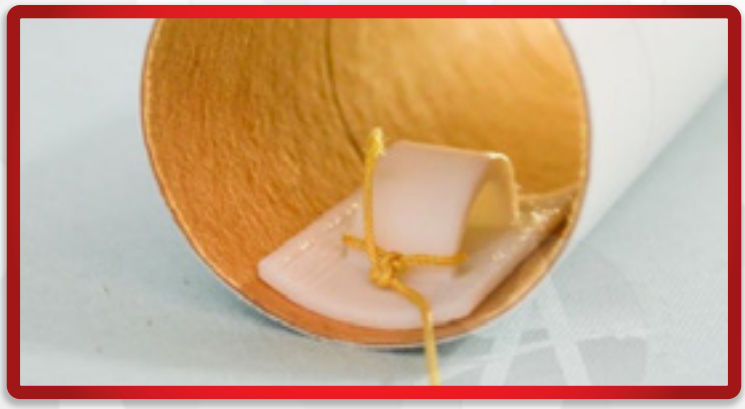

FIGURE 4: NOTE: IF YOU'RE INSTALLING THIS NEAR THE TOP OF YOUR MAIN BODY TUBE, YOU'LL PROBABLY WANT TO GLUE THE MOUNT A LITTLE BIT LOWER TO GIVE ROOM FOR YOUR NOSE CONE'S SHOULDER.

These are just four methods, but there are dozens of ways to slightly modify them.

Installing the shock cord partially outside the main body tube also offers countless variations, although here are a few possibilities.

First, there's cutting a small square hole in the tube, threading the cord through that hole, then preventing the cord from sliding back out by tying a knot at the end of it and holding it with a piece of plastic. The Estes Bandit uses this method (Figure 5).

Second, there's cutting two slits in the body tube, then sliding the cord through those slits and gluing everything in place. The Estes Wac Corporal used this method (Figure 6).

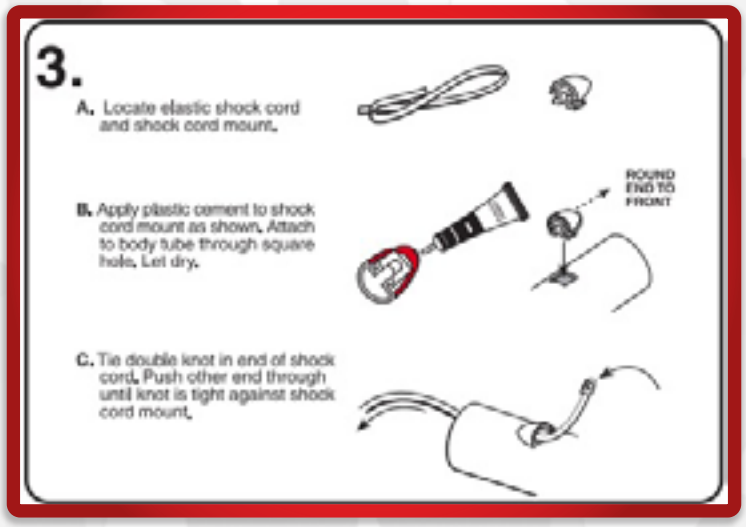

FIGURE 5: AN OLDER ESTES SHOCK CORD METHOD.

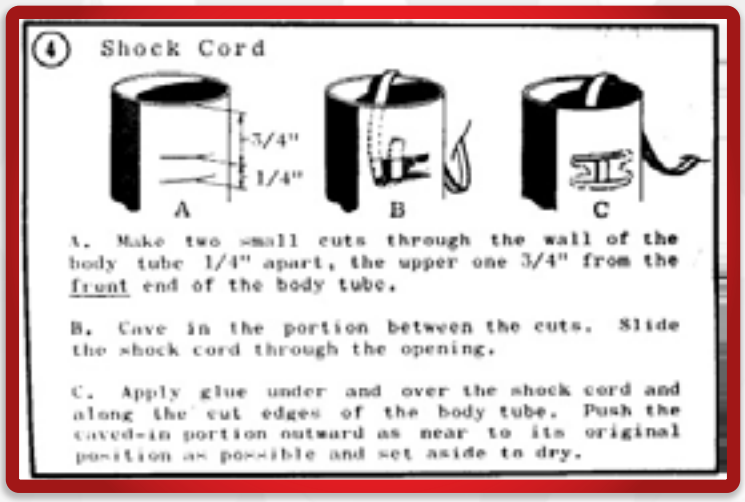

FIGURE 6: AN EVEN OLDER ESTES MOUNT STYLE.

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8.

A. Cut a 1/8 inch wide slit in each body tube 3/4 inch from front end of tube.
B. Feed each shock cord thru slit with a modeling knife. Leave 1/4 inch of shock cord extending out of slit.
C. Apply white glue to underside of 1/4 inch shock cord pieces.
D. Hold shock cord to body tube until it stays in place as shown.
E. Repeat process for attaching shock cord to Tomahawk.

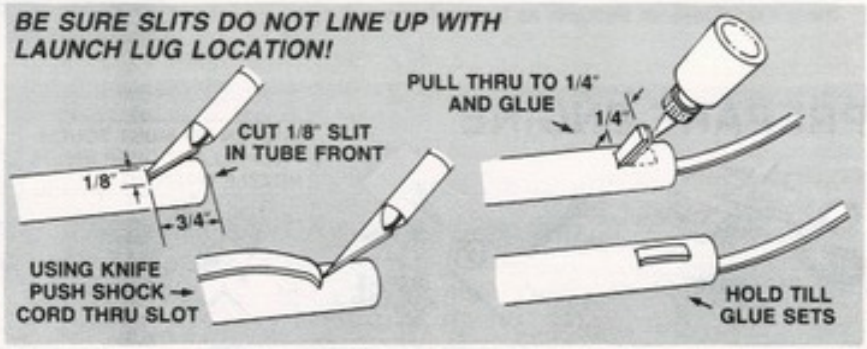

FIGURE 7: A VARIATION ON THE CUT-SLIT ESTES METHOD.

Here's a variation of the cut-slit method for the Estes Mini-Scale Combo Pak, but using one slit instead of two (Figure 7).

Mounting the shock cord partially outside the main body tube has the advantage of being relatively easy to do and requiring minimal materials. But these methods probably aren't ideal because they increase drag and require cutting into the main body tube.

Installing a Shock Cord on the Engine Mount

Attaching a shock cord to the engine mount isn't new. But Bill Stine from Quest Aerospace developed a new method where a Kevlar shock cord was attached to the front end of the motor mount tube. You can see my example of this method in Figure 8.

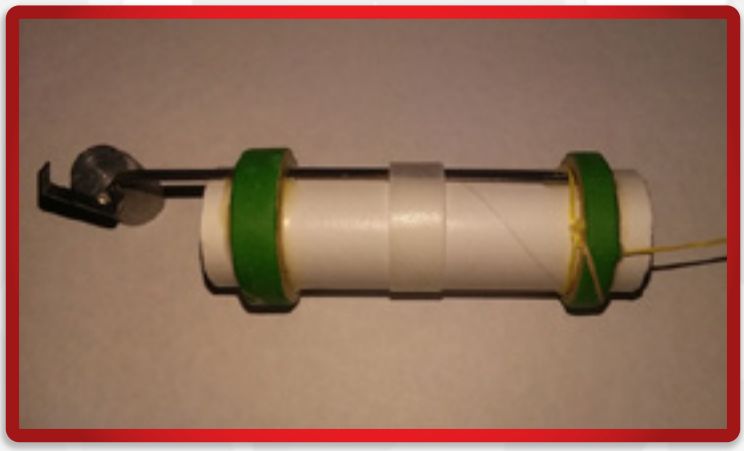

FIGURE 8: THE METALLIC OBJECT ON THE LEFT IS THE CAP FOR MY PIN VISE THAT I USED TO KEEP THE MOTOR MOUNT FROM ROLLING DURING THE PICTURE.

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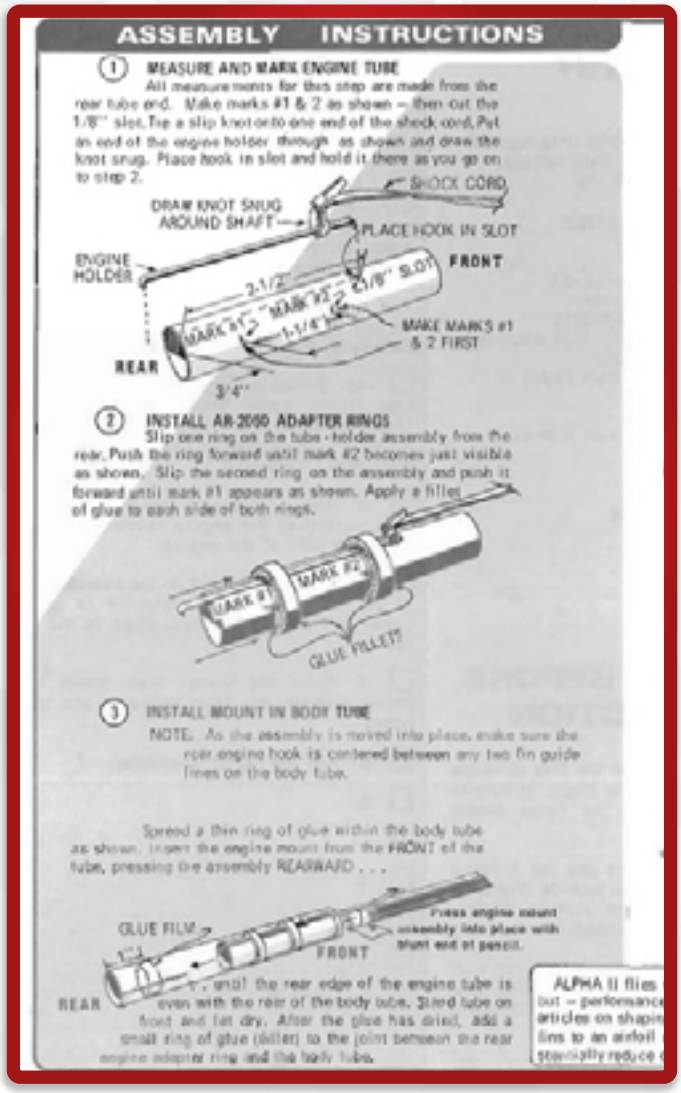

FIGURE 9

Estes sometimes used a similar approach, but instead of attaching the shock cord next to the front of the engine mount's centering rings, the shock cord was tied to the metal engine hook. This was done in at least one model, the Alpha II (Figure 9).

Earlier in this article I mentioned that one of the benefits of connecting the shock cord to the engine mount was that there were ways to make the cord removable and easily replaceable without hefty changes needed to the rocket itself.

In Apogee's *Peak of Flight* Newsletter Issue 231, Dr. Roy F. Houchin II wrote about creating a removable shock cord anchor which was installed inside the engine tube, but behind the thrust ring.

Building off that design, Chris Michielssen created his own versions of the removable shock cord mount using Kevlar as the primary shock cord material. In *Peak of Flight* Newsletter Issue 338, Michielssen explains the installation works by attaching the shock cord to the bottom centering ring (closest to the engine nozzle) and threading the Kevlar shock cord through a small tube positioned between the centering rings.

Not stopping there, Michielssen shows in *Peak of Flight* Newsletter Issue 343 how to install a replaceable shock cord to the engine mount, but for smaller diameter rockets, such as those with BT-20 main body tubes.

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Installing a Shock Cord in the Middle of the Main Body Tube

This is often done when using an ejection charge baffle. Looking at a picture from the Apogee website shows how its Ejection Charge Baffle for BT-50 has an eye screw to act as an attachment point for the shock cord (Figure 10).

FIGURE 10: A SCREW EYE MOUNT.

For LPRs, this probably isn't the most widely used shock cord installation method. For one thing, it's a method that's not easily repaired or replaced given how deeply the shock cord is installed inside the main body tube. However, if the baffle is properly built and installed far enough away from the engine, then the Kevlar cord should last a very long time and may likely outlast the rocket itself.

Another thing to consider is that attaching the shock cord near the middle of the main body tube is typically done only if the rocket has an ejection charge baffle. Baffles tend to be more common in mid power and high power rockets, which have wider body tube diameters and more powerful engines that make it more inconvenient (or expensive) to use disposable or reusable wadding.

Closing Thoughts

The above gives you an idea of the more well-known shock cord methods. But there are several variations not mentioned in this article. A good example is with special application model rockets, like those used for duration competitions.

Some of these rockets have the shock cord externally attached at a specific center of gravity point so that the main rocket body is parallel to the ground after ejection to increase drag and further slow the rocket's decent. You can see an example of this with Apogee's International Thermal Sailor rocket (Figure 11).

FIGURE 11: APOGEE ITS ROCKET

However, the primary purpose of this article was to focus on general applications with LPRs. Hopefully this article has given you some inspiration when working on your next model rocket.

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About the Author

Curtis Lee recently rediscovered his interest in model rockets. He now enjoys reliving his childhood by building and designing low-power rockets with his son. When he's not working on rockets, you can find him spending time with his family, metal detecting or restoring old-school video game systems.

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