PEAK OF FLIGHT NEWSLETTER

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PEAK OF FLIGHT

Building Your Own Motor Adapter

By Tim Van Milligan

With the huge number of rocket engines available, people have come to the conclusion that the rocket they've built can use a lot of more than they originally thought. All they need is a way to hold the motor in the engine mount.

With a simple modification to the rocket at the time of construction, and maybe a motor adapter, this is an easily obtainable goal. Your rocket can fly with a variety of motor choices, so you aren't locked into a single size that might be out-of-stock at your favorite motor dealer.

Recently, that has been a big problem - an out-of-stock situation which limits your motor choices. A common question that we get is "why is the motor out of stock?" We don't make motors, and we order from the manufacturers long before our inventory runs out. So the problem isn't on Apogee Components' side of things. The problem is the motor manufacturers can't get them to us fast enough. They face a lot of issues themselves, like getting raw materials from their suppliers quickly enough, and the time it takes to manufacture the items.

Since we cannot currently depend on an unlimited supply of the single motor we want to use with the rocket, the next best thing is to build a versatile rocket that can use a large number of motors. And this article will show you how!

There are two things you can do to add versatility to your motor choices for your rocket that should be done prior to assembling the rocket.

The first is to put a larger diameter motor mount into the rocket to accommodate those larger motors. You can always step down to a smaller motor using a motor adapter, but you can't go up to a larger diameter if the rocket is already built. Not without major reconstructive surgery anyway. Putting a bigger motor in probably means ripping out the old motor mount and installing a new one. If you want maximum versatility, start out with the motor mount being one size diameter larger than you plan on using. So if you are building a rocket with a 29mm mount, you might consider upping the size to 38mm rocket motors.

If it is a kit, that gets a little more complicated because you would need to buy extra parts for the motor mount before you start the rocket assembly. That may not be what you want to do, and for most people, they'll build the kit to the stock size.

The second thing you can do to maximize the number of different motors you can put into the motor mount is to leave out the engine block. Most rocket kits that are designed for composite motors leave the engine block out so that typically isn't a problem anymore. The reason is the engine block is built into the rear of the rocket engine, so you don't need one inside the engine mount tube anyway.

Figure 1: Composite motors have the thrust ring built into the rear of the motor. So you don't need an engine block inside the rocket.

But you wouldn't believe the number of times that this type of question comes up from customers that call us here at Apogee Components. They are smart people, but they are relative newcomers to larger rockets, so they just don't know yet what the differences are. They are so used to building small rockets that have engine blocks, that they assume that a bigger rocket needs one too. But because the engine block is part of the motor now, they don't realize that they don't need on glued inside the motor mount tube.

When you leave out the motor block, you now have the ability to put longer rocket motors into the rocket. And that gives you a lot of versatility - probably more than you can imagine. For example, the common motor length that most people are familiar with is the Estes D12, which has a length of 2-¾ inches. If you leave out the engine block, you can insert a 24mm diameter E motor which

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has a length of 3-¾ inches. There are even longer sizes that will fit into the rocket. You can even go to a Cesaroni 6-grain G motor that has a length of 9 inches!

Figure 2: For any given diameter rocket engine, the lengths can vary considerably.

The limiting factor now is how much room you have inside the rocket to accommodate the longer rocket casings.

That brings up another common question: "What happens if your engine mount tube is too short and the engine sticks out of the tube? Does this have any negative effects?" (**Figure 3**).

The answer is that it doesn't matter from a structural standpoint. The motor sticking out the front of the motor mount tube is not weaker in any way. What matters is the centering rings holding the tube in place. If you have sufficiently strong rings, and they usually are, then the motor isn't going anywhere in the rocket.

You have to recall what the purpose of the parts are in the motor mount. Do you remember when you were in grade school and the teacher gave you a schematic of the rocket? You had to label the parts of the rocket from the

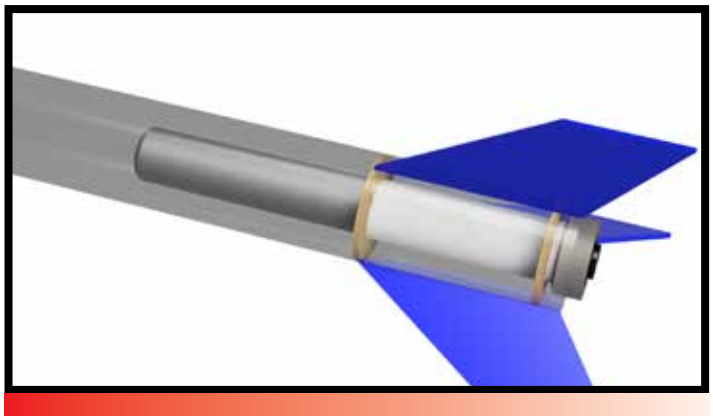

Figure 3: Is it okay for the motor case to extend forward out of the engine mount tube? Yes! This is just fine.

definitions? (see the Rocketry Reservoir at https://www.apogeerockets.com/downloads/PDFs/Rocketry_Education_Pack.pdf) There are two functions for the centering rings: 1) to align the motor concentrically inside the rocket, and 2) to prevent the motor from shifting around. You actually don't need the motor tube at all if the rings are doing their two job functions. The motor tube just is a convenience to allow us to install and remove the motor quickly and easily. That's it. So it doesn't really matter how long the motor tube is, as long as the motor is aligned concentrically (so it doesn't cant in any direction) and it prevents the motor from shifting forward or backward in the rocket. When the motor sticks out the front of the motor tube, it is not a bad thing.

However, you still have to worry about space inside the rocket for the recovery device. In particular, you'll want to have space for wadding to protect the recovery device from the heat of the ejection charge. The rule-of-thumb is to have at least one body-tube-diameter of wadding (https://www.apogeerockets.com/Building_Supplies/Parachutes_Recovery_Equipment/Disposable_Wadding) between the top of the motor and the parachute. More is better.

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If you have a baffle in the rocket ahead of the motor mount tube, that can also be a limiting factor in how long of a motor you can put into the rocket. You want some space between the top of the motor and the base of the baffle so that you don't blast a hole through the baffle with the ejection charge.

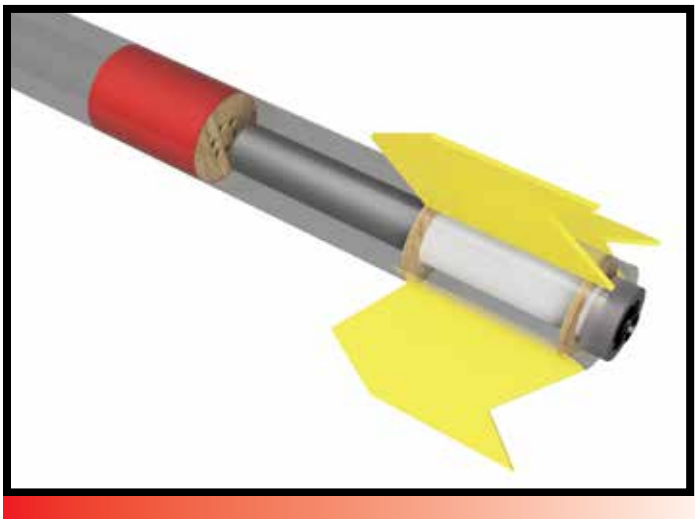

Figure 4: Just make sure there is sufficient room in front of the motor between it and the baffle or parachute to prevent damage.

If it is going to be tight, you'll probably want to use a Nomex® blast shield. I'd probably recommend one of the new Petal Protectors from Dino Chutes (https://www.apogeerockets.com/Building-Supplies/Parachute-Protection/Cloth/Dino-Chutes-4in-Petal-Protector) because they have a thicker amount of Nomex between the motor and the parachute. The closer the parachute is to the ejection charge, the more you have to worry about protecting it from the intense heat and burning particles.

Anatomy of a Motor Mount Adapter

The motor adapter is actually a mount inside of the mount already in the rocket. So it has to do the same job functions - center the motor, and prevent it from shifting around inside the rocket.

So it's going to be some rings, a tube to hold the rocket motor, and some kind of engine retention device. The engine retention device is often just a ring that is placed behind the base of the case and captured by the screw-on retainer.

Most modelers love the screw-on motor retainers (https://www.apogeerockets.com/Building_Supplies/Motor_Retainers_Hooks). I do too. They make it incredibly simple to install and remove rocket motors. But the one downside to them is when it comes to using motor adapters. It locks you into one type of motor adapter - the aluminum ones designed specifically to be used with the screw-on retainers. They are brilliantly engineered and produced, and I can't recommend them enough. They make your life a lot easier.

But that convenience does come with a fairly high financial price tag. So you have to know that going in when you decide to put on a screw-on retainer on your rocket.

Figure 5: An aluminum motor adapter that is designed to be used with the screw-on motor retainers.

The aluminum motor adapters are simple to use, because you simply slide them in, add the washer over the nozzle, and screw on the retainer cap. I did a simple 53-second video on how to use them (https://www.youtube.com/watch?v=BWhZBlyx_Fc), and in reality, you can install them in ⅓ that amount of time.

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But what if you had to design your own? Say that there was some sort of out-of-stock situation and the retainers weren't going to be an option for you because you needed something for a launch that was quickly coming up?

The big issue with making your own motor adapter to go with the screw-on retainer is preventing the whole adapter assembly from moving forward in the rocket's motor tube.

You'd want to make something that mimicked the aluminum motor adapters.

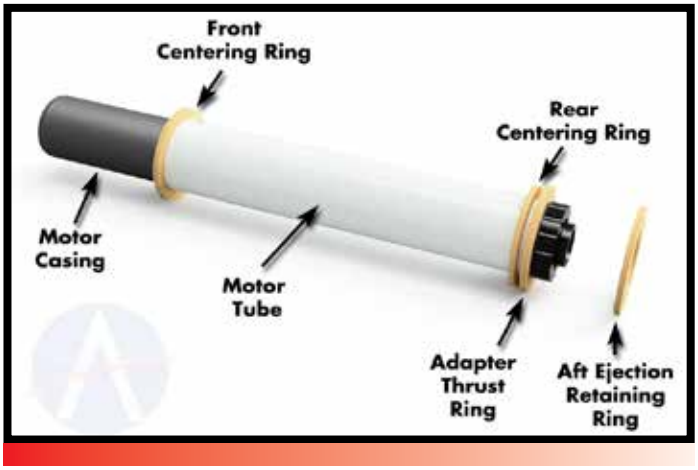

Figure 6: A homemade motor adapter that is a copy-cat of the aluminum motor adapter.

The problem is space inside the screw-on retainer.

In the aluminum retainer system, the thickness of the centering rings are pretty thin, so they can get two extra rings slid into the retainer cap and still get it to screw on. Aluminum is strong, so you can get away with making the rings things. If you were making them out of plywood, you'd have to use thicker wood to make them strong enough to hold the motor from sliding forward in the motor tube.

From **Figure 6**, the adapter thrust ring and the aft ejection retaining ring have to go inside the cap of the screw on retainer. If the wood rings are too thick the cap may just barely screw on to the base of the rocket.

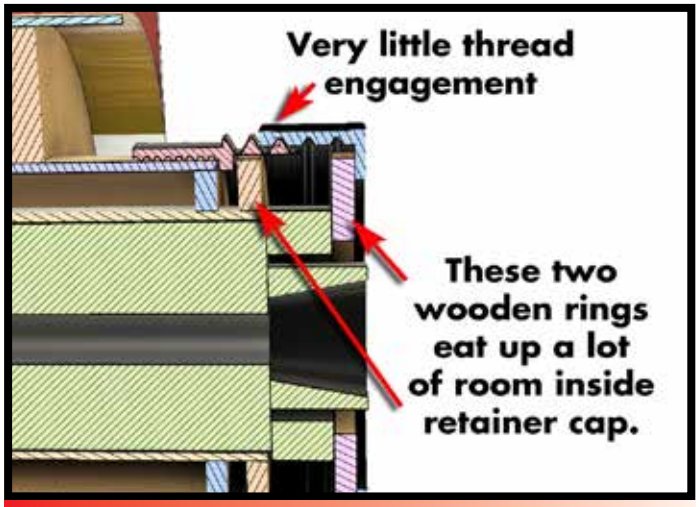

Figure 7: A cross-section view of the adapter inside a screw-on retainer. The wood rings may take up so much room that the cap barely screws on.

You might be able to make the rings out of thin fiberglass sheet. That way you could mimic the aluminum design and everything would fit nicely. But it is not without its own challenges, because cutting fiberglass is a major chore. I hate cutting fiberglass because it is an environmental mess since you don't want to breathe in the dust. But I guess it could be done if you had no choice.

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Figure 8: An exploded view of the installation of the motor adapter and the aft ejection retaining ring.

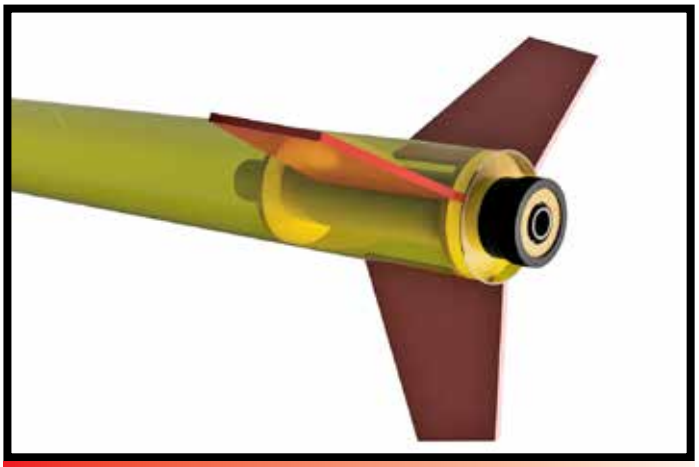

Figure 9: A completely assemble motor adapter with the screw-on retainer.

A home-made motor adapter to go with rockets that have screw-on retainers would be easier to design and build if there was a motor block inside the motor tube of the rocket. That would prevent the adapter from sliding forward in the kit's motor tube, and all you would need is a ring on the back end to prevent the motor from sliding out rearward. Basically, you can get rid of that Adapter Thrust Ring (see **Figure 6**), so that there is only one wood ring inside the cap of the screw-on retainer.

But we already said that we don't want a motor block in the tube because it limits the length of the rocket motor we can install in the vehicle.

Even with that in mind, I'd still be real tempted to glue one in. Even a glued-in engine block can be removed later (https://www.apogeerockets.com/Advanced_Construction_Videos/Rocketry_Video_201). It isn't something I'd want to do on a regular basis, but in a pinch, it can be pounded out later. By putting it in, it would prevent the motor adapter from shifting forward.

I suppose some sort of temporary "stop" can be put in front of the motor. I haven't tried this, and I'm just thinking out-loud here so proceed at your own risk. But how about putting a couple of screws through the engine mount tube to act as a stop to prevent the motor adapter from sliding too far forward in the tube?

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That might mean you have some access holes on the outside of the rocket in order to be able to install and remove the screws. These holes could be left open during launch, or plugged with some tape if you thought they would be an issue.

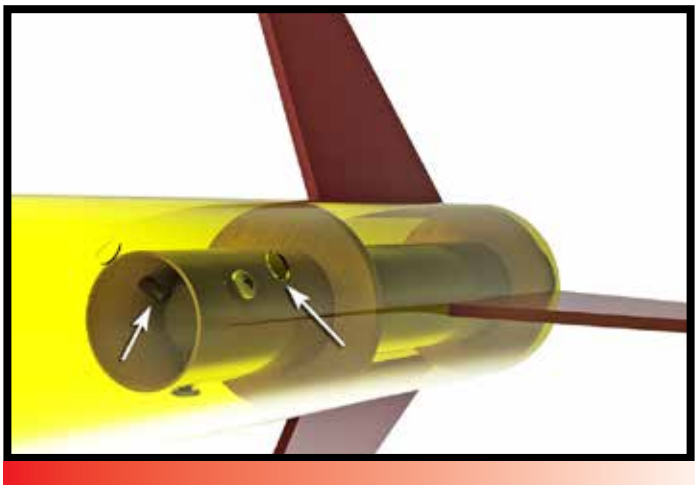

Figure 10: You might insert screws in front of the motor or the adapter to prevent it from moving forward. This would be like an engine block in the tube, but removable in case you wanted to use longer motors.

One important thing: you should never clamp down on the motor casing with a screw - such as if the screw is not in front of the casing, but in the middle of it. This would cause a stress concentration on the motor casing, and if it failed, this would be the cause.

The Flat-Bottom Engine Retainers (https://www.apogeerockets.com/Building-Supplies/Motor-Retainers-Hooks/Flat-Bottom-Rocket-Motor-Retainers) have a slight advantage over the screw-on retainers if you are using a motor adapter inside of them. There is more room inside the flat bottom retainer to accommodate the extra centering rings. So making a homemade motor adapter is easily doable in this situation. Also, note that the aluminum motor adapters can also be used with the flat-bottom retainers too.

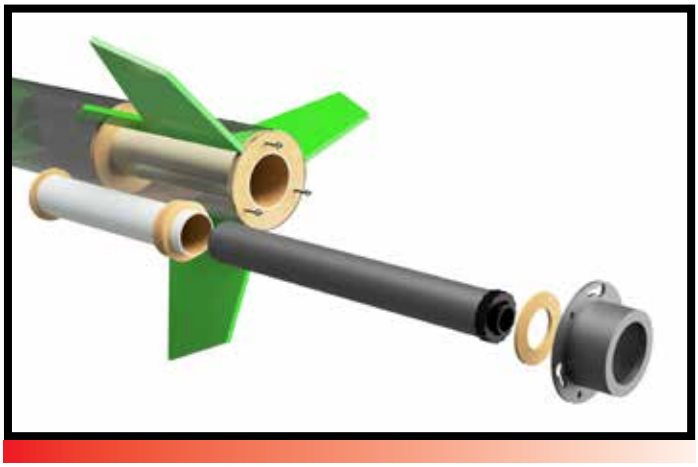

Figure 11: The motor adapter is essentially the same when using a flat-bottom retainer. The position of the "Adapter Thrust Ring" is the only thing changed because there is more room inside the Flat Bottom Retainer.

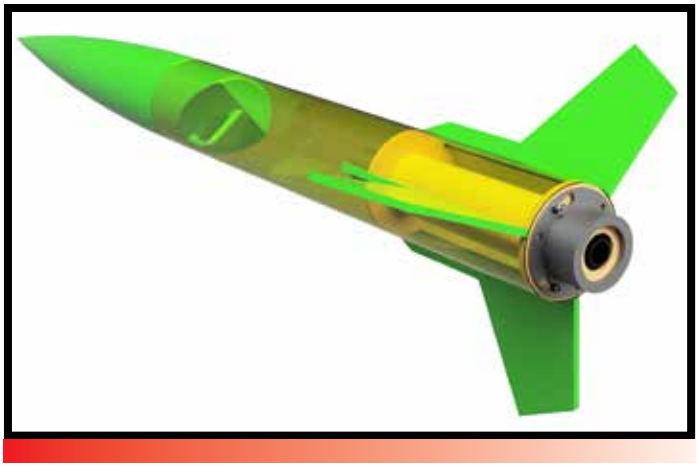

Figure 12: The completed assembly of the Flat Bottom Retainer with the motor mount adapter inside of it.

Another popular motor retention device is called the Kaplow-Clip. It is two little pieces of metal that are bent in a hook and screwed into the base of the rocket.

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Figure 13: The Kaplow-Clip retainers are cheap to make and install, and hold the motor in just fine

LOC recently released a Goblin kit that comes with a couple of motor adapters that use the Kaplow-Clip method of holding in the motor adapter.

Figure 14: The Kaplow-Clip retainers are removed, the motor adapter is slid into the rocket.

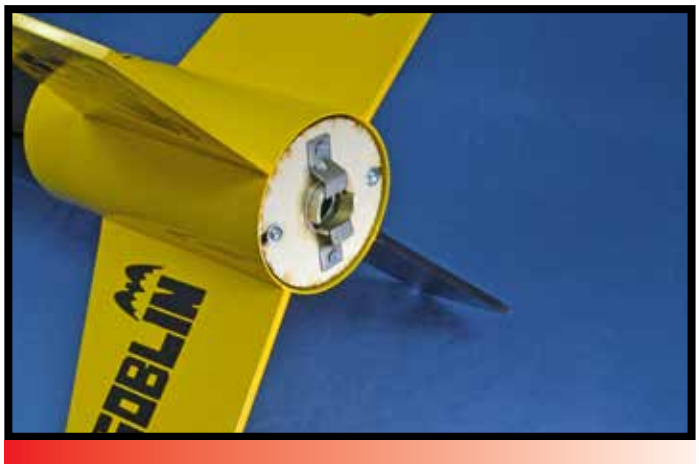

Figure 15: The Kaplow-Clip retainers are then reinstalled into the bulkhead to hold the motor in the adapter.

You Gotta Measure…

Building a motor mount adapter on your own is something I'd consider to be a Skill Level 5 task. Whenever you're designing something that hasn't been done before, it is complex because you have to utilize multiple skills. You not only have to use your creative brain to come up with the idea, but you have to use some math and engineering principles too. In this case, you'll need to watch your dimensions on all the components if you want things to fit together. We list all the dimensions that we know of on our website for components like tubes and centering rings. You'll save yourself a lot of time if you check our website for dimensions.

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. He is an avid rocketry competitor and is Level 3 high power certified. He is often asked what is the biggest rocket he's ever launched. His answer is that before he started writing articles and books about rocketry, he worked on the Delta II rocket that launched satellites

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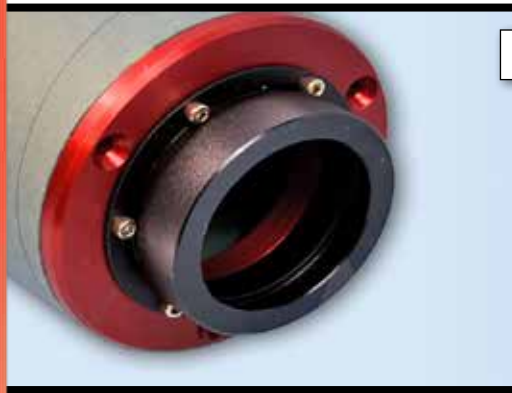

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into orbit. He has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward an M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (http://www.apogeerockets.com) and also the author of the books Model Rocket Design and Construction, 69 Simple Science Fair Projects with Model Rockets: Aeronautics and publisher of the "Peak-of-Flight" newsletter, a FREE e-zine newsletter about model rockets. You can email him by using the contact form at https://www.apogeerockets.com/Contact.

Additional References:

How to use a motor mount adapter - https://www.apogeerockets.com/Advanced_Construction_Videos/Rocketry_Video_20

Using an AeroPack motor mount adapter for high power rockets - https://youtu.be/2hQYdozP4PQ

Using the Estes Motor Mount Adapters (requires an engine block) - https://www.apogeerockets.com/Advanced_Construction_Videos/Rocketry_Video_88

Using 18mm Motor Adapters with Single-Use Rocket Motors - https://www.apogeerockets.com/Advanced_Construction_Videos/Rocketry_Video_54

Build a Motor Mount Adapter for rockets that have engine hooks - https://www.apogeerockets.com/education/downloads/Newsletter227.pdf

Strengthening centering rings - https://www.apogeerockets.com/education/downloads/Newsletter126.pdf

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