BASIC TRAINING FOR EDUCATORS

Though model rocketry is an excellent teaching tool and a way to interest students in various aspects of science and technology, it is also fraught with pitfalls to trap the unwary educator or youth leader. These pitfalls are even deeper if the leader in question is (a) unfamiliar with rocketry to begin with, and (b) has little to no facility with manual dexterity. In working with the Cub Scouts and 4-H programs, and in discussing various rocketry programs with many other people, I've come to understand that a great deal of what we rocketeers take for granted is not at all obvious to non-rocketeers.

That is exactly the sort of information I hope you will take away from this session. As educators and youth leaders, you've probably construction-papered and macaroni-glued yourselves silly by now. Basic craftsmanship skills are all that are needed to build basic model rockets. This may be rocket science, but ***it isn't rocket science***—if you get my meaning. You already know how to glue two things together, cut and fold paper, and tie knots. That's it for basic skills. The rest of it falls under the heading of:

THE MOST COMMON MISTAKES THAT EVERYONE MAKES

This list is compiled from personal "horror stories" and those of other rocketeers who have been involved with rocketry education and youth outreach programs. Most of them involve programs run by non-rocketeers. And with few exceptions, they could have been avoided by the leaders simply reading the instructions or asking for help.

CATEGORY	MISTAKE	HOW TO AVOID IT
Construction	Using the wrong kind of glue. Parts won't stay together—usually discovered in mid-flight.	Most model rockets use nothing but ordinary white or yellow glue. Some use plastic cement. Check the instructions, and avoid using kits that require anything but white or yellow glue.
	Using too much glue, resulting in sags, overlong drying times, and parts glued together that shouldn't be.	With model rocketry, more glue is not better. A little goes a long way, and the excess can (and should) be wiped off.
	Parts that should not be glued in/on are glued in/on. Most commonly it's the nose and the motor.	NEVER glue the nose on. In the rare instance that it should be glued on, you can always do it after the rocket is otherwise completed. Motors are NEVER glued in.
	Glue not given enough time to dry, resulting in parts falling off or being inadvertently glued in.	Don't rush the process! Internal glue joints can take hours to dry fully. And if you insert the motor while there is still wet glue inside the model, you've likely just glued the motor in.
	Fins misaligned, either longitudinally (generating spin) or radially (generating wobble and spin).	Use the tricks described below.
Flight	No recovery wadding used, resulting in melted parachute or burned streamer.	Follow the kit manufacturer's recommendations for wadding use.
	Parachute or streamer packed too tightly, jamming it in the tube. Often the motor ejects from the model in protest.	Pack the recovery system sensibly. Nothing should be wadded. Parachutes are spiked and folded, while streamers are folded and rolled.
	Motor not fitted securely. It either shoots up into the rocket body or ejects without deploying the recovery system. Sometimes it does both.	If the model does not have a motor retention hook, it must be friction-fitted into the motor tube using masking tape.
	Motor inserted upside-down. In extreme cases it will actually ignite, but the results are always very bad.	The two ends look nothing alike. Make sure there is a nozzle on the end pointing down.
	Booster motor used in single-stage model. There is no ejection charge.	Make sure the motor code does NOT end in a zero.
	Wrong delay or impulse class used. Depending on the specifics, the rocket may crash, strip off its recovery system, or vanish into the sky. This last is known as Rocket Dad Syndrome.	Read and heed the manufacturer's motor recommendations. Follow their recommendations regarding the proper motor for the first flight.

BASIC ROCKET ASSEMBLY

And I'm talking in general terms here, not so much in specifics. This procedure is common to virtually all rocket kits, regardless of size, complexity or power level.

1. Assemble and install the motor mount.
2. Mark the body tube for external parts.
3. Cut out and attach the fins.
4. Attach any other external parts, such as the launch lug(s).
5. Assemble and install the recovery system.
6. Prepare and paint the model.

What the rocket manufacturers don't take into account, however, is the attention span of a single student, let alone a roomful of them. Though most rocket assembly can go very quickly, certain aspects of it cannot be rushed. The prime examples are waiting for the motor mount assembly and the fin fillets to dry. A lot of glue is brought into play here, and that glue takes time to dry.

What To Do While the Glue Is Drying:

While the glue on the motor mount is drying, the students can mark the body tube, cut out and sand the fins, assemble the parachute, and snap each other with the elastic shock cords.

While the glue fillets on the fins are drying the students must leave the rockets alone. They can either assemble the recovery system or snap each other with the elastic shock cords.

Other time-buyers will depend on the grade level being taught. You can discuss the model rocket safety code and why each item of the code was established. Go over the pre-flight checklist, describing and demonstrating each step. Go over igniter insertion. Have the students use the basic equations of motion to predict the altitude their rockets will reach. Have them draw how they would like to decorate their rockets, maybe using blank label stock as stickers. Or you can just organize a shock cord snapping tournament.

The point is that you need to be prepared for a few lulls in the activity of building rockets.

FIN-MOUNTING SECRETS OF THE EXPERTS

Marking the Body Tube: The standard tube marking guide is a rectangle of paper with upper and lower guide marks. You wrap this around the body tube, make pencil marks where indicated, and then remove the paper. Lately, though, the guides haven't been terribly accurate on longitudinal alignment. The trick is to make your marks on the tube only around the top (or only the bottom) of the guide. Then use a piece of angle bracket, or a drawer sill, or a door frame—anywhere with a long, straight V-channel—as a guide for drawing lines along the body tube through each of the marks.

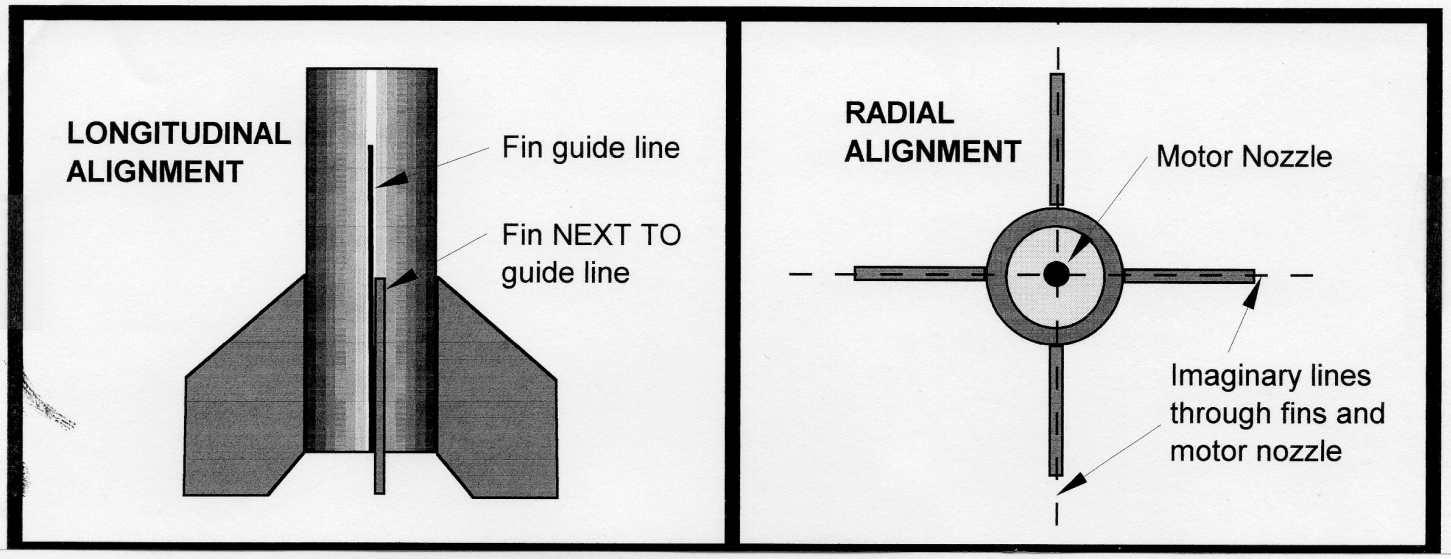
Double-Glue Joints: Most new rocketeers go for years just putting glue on the root edge of each fin and pressing it against the body tube. While this is fine, there is a method that is much stronger and much faster.

Run a line of glue along the fin root edge and even it out with your finger. Press the fin into place on the body tube and then remove it. Lightly wipe the excess glue from the fin root, then from the tube, leaving a thin coating of glue on each. Repeat for the other fins and allow just a couple minutes to dry completely. To mount each fin, apply another thin coat of glue to the root edge, press it in place on the body tube, and hold for about thirty seconds. Check the alignment and then set the tube on end to dry for another two or three minutes. Repeat for the other fins. These double glue joints are tremendously strong, and allow all fins to be mounted in ten or fifteen minutes. It's the fillets that take a while.

Proper Longitudinal Alignment: For some reason nearly all builders assume the fins are supposed to be **centered** on the fin guide lines. It's much easier to get them aligned correctly if you align the fin edge **against** the guide line. Just make sure you put all the fins on the same side of the lines.

Proper Radial Alignment: Few people figure this out themselves; most just eyeball the alignment. First make sure the glue is dry on the motor mount. Insert a motor into the motor mount. The nozzle will be dead center in the rocket. When viewed form the rear, each fin should be aligned so that a line drawn along it passes directly through the motor nozzle. You can use a straightedge to help with this.

A CHEAP VISUAL AID FOR FIN ALIGNMENT TRICKS



INTERPRETING THE MODEL ROCKET MOTOR CODES

Every model rocket motor certified by the NAR or Tripoli has a code that provides the basic information about that motor. The code takes the form of a letter followed by a whole number, then a dash and another whole number.

Example: **C6-5**

The letter indicates what level of total impulse (in Newton-seconds) the motor is in. The baseline is the A motor with a maximum of 1.25 Ns total impulse. Each letter down the alphabet doubles the maximum total impulse; so a B motor would be higher than 1.25 Ns up to 2.5 Ns, a C motor would be up to 5.00 Ns, and so on. Model rocket motors range from 1/4A (.625 Ns) to M motors and beyond.

The number to the left of the dash indicates the motor's average thrust in Newtons. By dividing the maximum total impulse of the motor by the average thrust, you get the approximate thrust burn time. In our example, the C6-5 motor would burn for approximately .83 seconds (5.0 Ns divided by 6 N average thrust).

The number to the right of the dash is the length of the delay between the end of the thrust phase and the firing of the ejection charge. The chemical used in the delay train also generates white smoke to aid in tracking. Motors designed for use in the lower stages of multi-stage models do not have a delay or ejection charge, and hence have a zero to the right of the dash. *These "booster" motors should never be used in a single stage rocket!*

EDUCATIONAL RESOURCES: WHERE TO GO FOR INFORMATION OR HELP

The National Association of Rocketry and its members are dedicated to promoting the use of model rocketry in education. Should you find yourself in need of information or assistance in using model rocketry, I urge you to contact the NAR directly. Our website has a section specifically dedicated to Education, and includes free plans and information as well as the means for contacting an NAR Section near you. The NAR Technical Services (NARTS) has a wide range of educational and technical publications available for purchase.

NAR WEBSITE: http://www.nar.org

NAR EDUCATION: http://www.nar.org/teacher.html