Free Report

Rocketry on a Budget

Model Rocketry for the Frugal and Worse

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Frequently asked question:

Estes charges like $10 for what amounts to some paper tubes, a nose cone, and balsa. When I try to design my own rockets using parts from Estes, it ends up costing even more! Surely there are cheaper alternatives!?

Yes, it is possible to build model rockets without spending as much as Estes would like you to. Exactly how much you can save depends on how much effort you are willing to exert, and how much performance you are willing to give up by using materials that are heavier or less ideal.

This article will describe several different ways to save money when building your own rockets. I've classified them in three different catagories:

Level 1 Savings: Sales, Specials, Kit-bashing, and Discount Distributors.

Level 2 Savings: Alternate Sources to Estes' Parts, Group Buys

Level 3 Savings: Creative Substitution. (or, "You built a rocket out of WHAT!!!???")

Level 1 Savings: Sales, Specials, Kit-bashing, and Discount Distributors.

The easiest way to save money is not to pay list price for your rocketry supplies. Local retailers like Toys-R-Us and Michael's have occasional sales (i.e., "anything you can fit in this bag, 40% off"), and this could be a good time to stock up on whatever rocketry supplies you need. Discontinued models are frequently reduced in price to clear them off the shelves, even at "full price" hobby shops, or from Estes themselves. Some hobby shops will offer a discount if you belong to a local club, or perhaps even non-local clubs like the NAR (National Association of Rocketry).

Hobby shop owners are not unknown to haggle - if you're willing to buy a hundred dollars worth of engines at one time, you might be able to negotiate a small discount. Get to know the people who own and run your local hobby shop. They'll probably to tell you about specials a little ahead of time, especially if you buy stuff as a result!

"Kit Bashing" refers to using the parts from complete kits to build OTHER models. A model like the Estes ARV Condor has three nosecones, several different sized body tubes, and assorted other components. If the sizes meet your needs, or inspire your muse, this can be a cheaper source of parts than buying them separately, especially if the kits you start from happen to be on sale.

I should also mention "Bulk Packaging". Estes sells certain kits and engines in "Bulk packs" (intended for school classes and scout troops and such.) While the discount on Engines is not large when you look at just the cost per engine, the bulk-pack price also includes wadding and some extra ignitors. The discounts on bulk packs of rocket kits is more substantial, but the kits available in this form aren't the most easily "bashable".

Finally, there are a number of distributors that offer Estes parts at a discount *ALL* of the time. Keep in mind a number of things when you order by mail from a discount distributor:

1) You'll be paying postage. On the other hand, you might not be paying state sales tax.
2) Some things may be delayed. While it's obvious that it takes longer for things to arrive by mail than getting them at the local store, what isn't always obvious is that the discount distributor may not have everything you want in stock, and since they probably order in bulk from Estes (or where ever), it can take a while before it IS in stock. A phone call to the distributor may or may not tell you if things are in stock.
3) If you buy a kit from "Bob's Hobby Shop", "Bob" can probably give you advice on how to put it together, where it should be launched, and so on. Discount distributors might not be so nice. If everyone orders discount mail order, "Bob" will stop carrying rocket supplies, and then where will you be when you discover on Saturday afternoon that you need another launch lug for the Sunday club launch.

Many of the discount distributors carry rocket lines other than Estes, so this may be a good lead-in to expanding your horizons. Here are some distributors that have been recommended in rec.models.rockets (r.m.r.) over the past few years, that I have dealt with personally, or that have a significant presence in hobby magazines.

1) Countdown Hobbies
3 P.T. Barnum Square
Bethel, CT 06801-1838
(203) 790-9010 (voice/fax)
CompuServe: 74640,3112
Internet: COUNTDOWNHOB@delphi.com

Model and HPR kits, parts, motors, and supplies; discontinued kits; space and science items; collectors items
Catalog: $2.50

10% of an order is returned as a credit for your next order. Old kits, many manufacturers, and a helpful owner. Countdown isn't usually thought of as a discounter, but 10% is something.

2) Belleville Wholesale Hobby
1827 North Charles Street
Belleville, IL 62221-4025
(618) 234-5989
(618) 234-9202 (fax)

Estes, MRC, and Custom model rocket kits, supplies, etc., at discount from retail.
Catalog: $2

30% off Estes (full line), 35% off Custom, 40% MRC. $30 minimum order. Also has things like "retailer's parts assortment" that may be appropriate for clubs.

3) Magnum Hobbies
P.O. Box 124
Mechanicsburg, Ohio 43044
(513) 834-3306 (voice and fax)

High power kits, motors and supplies; also Aerotech Class C composite motors
Catalog: $2

Approx 33% off Estes. A major player in the HPR-lite and full HPR arena, Magnum also carries the Estes line. In addition, they sometimes have "Estes equivalent" parts at very low prices (i.e., tube connectors in various sizes for $0.20)

4) America's Hobby Center 800-989-3989

These guys have a big advertisement in every issue of *Sport Rocketry* magazine. In addition to substantially discounted (40% or so) "Specials" every month, they have significant quantity discounts as well ($10-50: 10%, $50-100: 20%, $100-$400: 30%, over $400: 40%.) However, the word on r.m.r. is that at least the people at the other end of the order phone number are pretty clueless when it comes to model rockets.

Level 2 Savings: Alternate Sources, Group Buys

I mentioned above that Magnum sometimes has "Estes Equivalent" parts. Estes is not the only company in the model rocketry business. While Estes may be forced into relatively high prices by a multi-tiered distribution scheme (if you want Toys-R-Us to sell your kits, you have to give them a big discount off "list" price, and then they'll get annoyed if you undersell them by mail), Many of the other companies in model rocketry are not so blessed/constrained. The "2nd Biggest" model rocket dealer, Quest, has prices that are quite a bit cheaper than Estes, ESPECIALLY when it comes to parts. The Quest parts aren't the same sizes as the Estes parts, but if you are starting from scratch, it might not matter.

As an example, a Quest T-2018 body tube is $1.50, while an Estes BT-20 (about the same size) is $2.70. The Quest body tubes also have a nice white finish, which helps when it comes time to paint your model. Quest nosecones, adaptors, and motor mounts are similarly less expensive. A similar example is LOC MMT.95, which has the same ID as Estes BT-50, but is slightly heavier, white, nearly twice as long, and cheaper.

Quest also offers bulk packaging of ALL their engines and kits. Their engine prices tend to start off lower than Estes, and get even lower with the quantity discounts.

"Balsa Machining Service" (BMS) will turn out balsa nosecones in a number of shapes, including fully custom shapes and also including shapes equivalent to most of the Estes line. Prices are lower than Estes, even without the quantity discounts that BMS has available.

Apogee Components is apparently going out of the parts and kits business, but until they stop selling, their body tubes and nose cones are also lower in price than Estes, even for the "exotic" phenolic body tubes, ABS nosecones, and Kevlar shock cords.

Even a "full priced" hobby or craft shop will have balsa sheets (from Midwest Products or Balsa USA) at prices lower than Estes "BFS-xx" sheets.

For even lower prices, various (uh, dedicated, I guess), hobbyists occasionally take out several middlemen, and decide to buy body tubes directly from the paper company that makes them for Estes, or an equivalent. In order for this to work, they have to order a hundred tubes or more of a given size, but, they figure, there will be other people around happy to buy 36 inch white BT-60s at $1 each.

Seek out such people and keep in touch, and you too can benefit from their thriftiness (or perhaps insanity?). If they happen to be mailing distance away, you would probably have to buy 20 or more tubes to cancel out the cost of postage, but then you can sell extras to YOUR friends. Such a purchase might be ideal for larger clubs.

A lot of the "Small" components of model rockets have identical but less expensive equivalents available from quite mundane sources. The most obvious example is that "snap swivels" used for detachable and tangle-resistant parachutes, are available in the fishing section of any sporting goods store. Here are some others:

Elastic Shock cord:	Elastic band material (sewing store)
Rubber shock cord:	Airplane rubber (hobby store)
Shroud lines:	Coat or carpet thread (sewing store)
Streamers:	(1") Surveyors flagging tape (hardware store)
Screw eyes:	Screw eyes (Hardware store)
Dowels:	Dowels (Hardware or craft store)
Microclips:	alligator clips (electronics store i.e., Radioshack)

Level 3 Savings: Creative Substitution. (or, "You built a rocket out of WHAT!!!???")

Ahh. Here is where life gets interesting. By being somewhat creative, you can build a model rocket, and maybe even a high power model rocket, for ridiculously little money (indeed, even

for $0 if you hang around the right trash bins.) In addition, this is your chance to experiment with all sorts of interesting materials. Some may turn out to have significant advantages over more traditional rocketry materials, others will be interesting only because they are less expensive.

Let's go over the different parts of a rocket, starting with the "major" components, and see what sort of alternative materials are available.

A) Body tubes.

Unfortunately, it is difficult to come up with alternative tubes that are as smooth, tough, and lightweight as the ones Estes uses (but, see above for suggestions on where to get the same tubes at lower prices.) Still, by trading off one thing or another, there ARE alternatives.

Existing tubes: Rumor has it that the fact that BT-60 is the same diameter as the core tube of a roll of paper towels is no accident... We're all familiar with paper tubes from wrapping paper and so on that might be usable for building model rockets. Aside from being harder to paint than the coated tubes from most Model Rocket manufacturers, such tubes tend to be a little on the weak side. It has been suggested that both these problem can be improved by painting the tubes with sodium silicate solution ("Water glass".) Various paints and varnishes may have similar effects.

Mailing tubes are available in several sizes, and are heavy enough for HPR-lite models (in fact, *Sport Rocketry* magazine has published plans that specifically call for mailing tubes.) Fabric stores may be willing to give you the long cores from rolls of fabric. A high-tech friend may have access to cores from plotter or fax machine paper (typically VERY thick and strong.) At least one surplus store in the bay area has nice (if short) paper tubes designed to hold batteries (3 "C" cells, in this case.) $0.10 each. Heavy, large-diameter (six inches and up) paper tubes are used as concrete molds, and should be available at building supply stores.

Clear plastic tubes of about BT-60 diameter can be found in 4 and 8 foot lengths at hardware stores - they're designed for protecting fluorescent lamp bulbs. PVC and similar plastic pipe is commonly available for irrigations and such - rhm@fc.hp.com (Bob Miller) says that 3/4" thin wall (sched 120?) PVC tubing is a good fit for 18mm engines.

Roll your own tubes:

A few layers of average quality (i.e., copier) paper and some ordinary glue will make an "OK" body tube if wrapped around a hard form (like some wood doweling or a piece of pipe) of appropriate size. Higher quality paper (i.e., "vellum") or higher quality glue (i.e., epoxy) will make even better tubes. (Some competition fliers swear by BT-5 sized tubes that are a single layer of vellum sealed with a 1/8" seam held together with double-sided scotch tape.)

It may take some practice to make tubes this way without ending up with the tube glued to the form, wrinkles and bulges, and excess glue all over everything. One hint is that white glue can be applied to flat paper, let dry, and then reactivated with a hot iron to form the actual joint. Another hint is to use some waxed paper or plastic wrap around your form. Heavier weight paper may also be used.

The body of many a competition egg-lofter is little more than an extra-long "shroud" made from relatively thin cardboard (or thick paper.)

Mylar (copier transparencies) "glued" with double-sided tape, is interesting for smaller diameter tubes.

A material with a lot of promise that I haven't seen used much is corrugated cardboard - the corrugations lend great strength to weight ratios. You can remove one "flat" side of the cardboard by dampening it with a wet sponge, and then peeling it off after the (water soluble) glue has softened. "One-sided" corrugated board is available some places as a packing material. The one-sided board is much easier to roll, of course! You'll end up noticing that corrugated cardboard comes in quite a variety of thicknesses!

Body tubes may also be rolled from more exotic materials. Fiberglass is probably the easiest to get a hold of (and forming a simple tube might be a good intro to fiber-glassing techniques.) Kevlar, carbon fiber, and stiff polyester are reasonable fabrics, and polyester, epoxy, and CA, are interesting resins to use. (Of course, with some of these materials, you are no longer in the "low price" arena, except in comparison with purchased tubes of similar composition.)

Why is everyone hung up on TUBES, anyway? There is no particular reason that a model rocket airframe has to be tubular. Conical airframes are relatively popular, and have some structural advantages to pure tubes as well as being a little easier to form than exactly round tubes. (The Apogee Egglofters use a long cone formed from a piece of relatively lightweight card stock.)

In fact, there is no reason that the airframe of a rocket even has to be round. Triangular or square airframes can be constructed easily from any flat and suitably strong material (cardboard, balsa, foam-core board, etc.) Be somewhat careful to join the seams strongly enough to withstand the engine's ejection charge.

B) Fin materials

Balsa sheet is relatively inexpensive, and even more so if you get one of the "grab bags" of various pieces that are frequently available (and usually the pieces are big enough to be used for model rockets.) Similar grab-bags of low-quality thin plywood are available, and for that matter, a 4-by-8 FOOT sheet of 1/8 inch hardwood (furniture quality) plywood from a lumber store will probably keep a whole club supplied for a long time.

Stiff cardboard can be used to make fins, especially if several pieces are glued together "ply-cardboard" wise. Material as thin as index cards can be used on small models.

WARNING *Some of the following materials are significantly heavier than the materials usually used for model rocket fins, and may shift the center of gravity of the model far enough back to make the model unstable. CG/CP calculations or "swing" tests are advisable when creating designs using improvised materials.*

Pieces of plexiglass large enough for HPR-lite fins can frequently be found in plastics stores as "scrap" at low prices. Other plastic scrap usable for fins might be found in unexpected places. For example, Old CD-ROMs can be cut into pieces to provide

nice shiny fins. Any printing you don't like can be carefully removed with paint remover (be careful not to get the paint remover on the plastic parts, though. They'll start to dissolve and get smudged. The part protected by the aluminum film can be cleaned without problems.) Large fins made from CD-ROMS tend to be on the brittle side.

G-10 (fiberglass) sheet is available from surplus electronics dealers in the form of "printed circuit board material" and in smaller pieces as "insulators". Usually, the circuit board material will have a thin coating of copper on one or both sides.

C) Nose Cones

The same grab bag of balsa that gives you cheap fin material will probably yield some "large" blocks of balsa that can be shaped into nose cones using a lathe, or electric drill. Peter Alway's *"The Art of Scale Model Rocketry"* contains the best description of how to do this that I've seen, even if you aren't doing it for a scale model. If you have a real lathe, you can probably make nose cones from harder wood as well. If too heavy, perhaps they can be hollowed out to reduce the weight.

Other materials like Styrofoam or florist's foam might be usable in a similar manner, although the resulting surface is likely to be rather "un-pretty" without coating it with something else or with extensive filling.

Of course, purely conical noses can be rolled from paper in a manner similar to rolling body tubes. For added strength and rigidity, these can be filled in with expanding polyurethane "insulating foam" from a building supply store. Such paper cones tend to be lighter than either balsa or plastic nose cones provided by rocket manufacturers, so be sure to check the stability of the resulting rockets. Metal washers can be coated with glue and pushed into the foam to adjust the weight.

Given an existing nosecone, slightly larger copies can be made by oiling the cone, and then covering with a sort of paper mache' made from paper toweling (which has good wet strength) and white glue. As with paper cones, these can be filled with foam to improve their strength. If paper toweling doesn't have enough wet strength to make it easy to deal with for you, try pop-up or even tub-style baby-wipes (rinse off the cleaning solution first.) More exotic materials than paper mache' can be used, of course.

But for a nose cone big enough to justify fiberglass construction, finding a suitable form to use as a mold may be a major part of the problem. In theory, you ought to be able to make a mold of an existing nosecone in plaster of paris or something similar, and apply the paper mache'/whatever on the inside to achieve an exact match for the external dimensions, but I haven't been able to get this to work. These techniques tend to work better on somewhat larger nosecones (BT-55 and up) where you can use pieces of material that are big enough to hold onto.

Lightweight modelling compounds like "Model Magic" have potential to be used in making nosecones. Small (BT-5) cones can even be made from much heavier materials like "Friendly Plastic" without their weight becoming excessive. A sawed-off piece of expended engine casing can be used to anchor the material and simultaneously provide a correctly sized shoulder, and some useful mass.

The little plastic cases that grocery-store "gumball" machines dispense their wares in aren't bad if you are looking for hemispherical noses. Plastic Easter eggs give you a choice of several shapes, and tend to go on sale at substantial discounts just after Easter.

D) Miscellaneous parts

Engine blocks can be made from cut-off pieces of an expended engine casing (works for any size motor, too!)

Drinking straws can be used for launch lugs, especially if you can find paper drinking straws. Plastic straws can be tough to glue — hot-melt glue-guns are said to work. You can also simply tape the launch lug to the rocket body with masking tape - the forces on it aren't all that high. Or use a flyway launch lug carrier as described by Paul Gennrich in the June, 1994 issue of *"High Power Rocketry"* magazine.

Finally, small loops of wire at the nose and base of a rocket can serve for launch lugs as well.

Parachutes can be made from all sorts of plastic sheeting that is readily available. Trash bags, dry cleaning bags, grocery bags, "space emergency blankets" (which are aluminized mylar), *"pizzaz wrap"* giftwrap (more mylar), plastic tarps, the list goes on and on. One r.m.r. writer likes the orange trash bags that become available around Halloween so you can make your bags of leaves look like giant pumpkins. I really like the way clear plastic looks on the way down (giant jellyfish), but it won't help locate your rocket if it lands in tall brush or a tree.

Of course, you can also make parachutes from fabric. Some sewing stores will carry rip-stop nylon for making raincoats, but a good kite supply store will have materials that are thinner, lighter, tougher, less porous, and available in a wider range of colors.

Shroud lines can be made from carpet or coat thread (a heavy thread available in sewing stores), Dacron fishing line (which is usually braided — *Monofilament is not recommended*), or kite string (braided Dacron or nylon is especially nice.) The shroud lines can be attached with any number of sticky things, but brown polyester packing tape seems to combine light weight, stickiness, and tear resistance better than some other choices.

Sewing elastic has already been mentioned for shock cords. Kevlar cord for heat resistant shock cord mounts can be found at kite stores, and sometimes as fishing line. Watch out for newer materials like "Spectra", however. While these are stronger than Kevlar, and may have other advantages for the kite flier or fisherman; they aren't heat resistant like Kevlar!

Another heat resistant shock-cord mount material is braided wire leader material, also available in fishing supply stores (although some claim that this is more likely to cause *"zippering"* of your body tubes).

While you are in the fishing section or kite store, check for snap swivels and/or quick connect links. Snap swivels are often used to allow parachutes to be disconnected from models when not in use (and hopefully, prevent some tangling of the shroud lines.) They can also be used to make your nosecones interchangeable. Fishing stores will have have a wide variety of small snap-swivels that are both better and cheaper than the ones sold by rocket vendors, and kite stores are likely to have even larger swivels carefully selected from somewhere or other and rated up

to several hundred pounds.

Good quality cellophane makes nice streamers, sort of like the ones that Apogee sells.

Self-adhesive fiberglass tape designed for drywall seams is useful for reinforcing motor tubes and the like (coat with epoxy.)

Fireproof crepe paper, or fireproofed cellulose "insulation" can be substituted for recovery wadding. Look also for after-Christmas sales on cotton flock — which is spread around the base of Christmas trees to simulate "snow.". It is also treated to be flame retardant and makes good cheap wadding (stay away from the *polyester* flock, because even though it doesn't burn, it melts into a wad that could stick to the shock cord).

E) Motors/Engines

I suppose that an article on cheap model rocketry would not be complete without at least some comment on the sorts of advertisements that read "build your own rocket engines for only pennies apiece." While I personally am not the sort of person who would categorically condemn those people interested in making their own rocket motors, I do feel that model rocket motors are one of the places where you do get your money's worth. While it may be possible to build your own motors using only a few cents worth of chemicals, there is a lot left unsaid. Some of these unvoiced "gotchas" include:

1) In order to get to the pennies each price range, you have to buy your chemicals in large amounts, so your out-of-pocket expenses are high.
2) You have to make or buy various special tools for making the motors.
3) You'll need assorted amounts of safety equipment and test fixtures, beyond the actual construction tools.
4) You'll need a relatively large land area for your testing.
5) You'll probably be engaging in what the local police will consider illegal activities, both in making your motors, and in using them. It doesn't take much of a lawyers time to cancel out your savings!
6) The finished "cheap" motors are unlikely to have delay or ejection charges, and will vary a great deal from motor to motor in performance. This will result in a lot of "crashed" models, which will more than make up for the "pennies" you've saved by making your own.

I'm also interested in amateur pyrotechnics, and recently bought a copy of *"The Best of American Fireworks News, Volume 2."* There are a couple of excerpts in there that are particularly telling. One article mentions using commercial A8-3 rocket engines as a "quick and easy way" to make skyrockets.

This is followed up by another comment that includes:

> *"I have made rocket engines from scratch for years, but have just recently discovered that the time savings, reliability, and better performance of commercial engines make them a viable alternative."*

These are discouraging remarks for the would-be motor maker, but the most important reason NOT to make your own motors is implied in item (5) above — "Model Rocketry" enjoys certain legal exemptions because it has shown itself to be an exceptionally safe hobby over the years. If you make your own motors, you are no longer protected under those exemptions - you are no longer participating in "Model Rocketry".

If you happen to have or cause a major accident, the press won't be clued in to this "distinction," so aside from the people who actually got hurt, the reputation of the hobby will be damaged, and we'll be another step closer to having model rocketry outlawed.

Launch your rockets with confidence

Whether you're building a rocket from scratch or from a kit, test them before you fly them. Not only will you be able to tell if they will be stable, but you can find out how high they'll fly, how fast, and where they will land. You can also switch rocket motors and see how that affects the flight.

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