

## COSTS, MATERIALS LIST & TOOLS by Harley Michaelis (12/29/08)

The materials cost of scratch building a ship in the Genie line is about 25% of the cost for a comparable ARF. Cost depends on where you buy, bargains available & whether or not you buy in quantity to keep costs down per oz. etc.

**FUSELAGES & TAIL PIECES:** the wood to be ordered is the same for all ships. You just have a bit more left over of some pieces by building a smaller one.

National Balsa Co. <http://www.nationalbalsa.com/balsa.htm> has an easy to use website from which to conveniently order the needed woods, CA glue & quick epoxy. They have birch ply in up to 48" sheets & bass & balsa at reasonable prices. If you call & are lucky, you may get to speak with "Jennifer".

When doing a website order, there is a Comments section in which you can specify "light", "medium" & "hard" grade for certain balsa pieces. They also have an "Aero Light Bargain Grade" balsa category for the lightest woods needed, such as for the fin.

Heavier woods go up front & lighter behind. Here's a price list in effect the date of this document. In a required size, the minimum available can be more than needed.

### BIRCH PLY:

1/16" x 12" x 48" for fuse slab sides (SS's), doublers, & misc. (Enough for 2 ships)  
\$8.47

5 ply, 1/8" x 12" x 24" for formers, blade boxes, towhook blocking, main bolt holddown.  
\$7.26

1/64" x 12" x 24" for top & bottom fuse sub-decking, saddle top, stab root caps.  
\$6.72

1/32" x 12" x 12" for bellcrank housing in fin, blade boxes, internal splicing of SS's.  
\$2.39

### BASS:

2" x 2" x 6" for nose block.  
\$1.34

3/8" x 2" x 24" for first 10" or so of fuse bottom over sub-decking behind the nose block. If that area is thicker than 3/8", first glue 1/8" balsa to the sub-decking. Some of this bass piece can be glued to the 2" bass block to increase block height for larger ships.  
\$1.62

1/4" x 5/16" x 24" for servo mounting rails. Trim to 1/4" where needed.  
\$ .63

1/8" x 3/8" x 36" strips for blade boxes. Get extras for best choice. Suggest 6 @\$ .39 each.  
\$2.34

### AERO LIGHT BARGAIN GRADE BALS:

3/8" x 3" x 36" for fin. Cut in half, splice, cut to profile & block sand to 5/16" thick.  
\$1.95

(OR for \$3.57 get 3/4" x 3" x 36". On edge, cut into 2 equally thick pieces. Sand to 5/16". This is enough for 2 fins).

**BARGAIN, cont:** 3/8" x 4" x 36" for fuse top & bottom behind rear former over sub-decking. To minimize carving, Follow File 1 text about tapering sheet on edge down to 1/8" in profile. Then cut into 12" or so long sections at an angle for progressive splicing toward tail end. Then cut into rectangular pieces sized just wide enough to cover narrowing fuselage. If parts of the sheet are denser use it on the bottom. Behind the bottom bass piece, plan to use some of the 3/8" x 2" regular balsa sheet later specified to fill to where this Bargain Light starts.

**\$3.41**

1/4" x 1/4" x 36" triangular stock for joining fuselage behind rear former. Get 6 @ \$.48  
**\$2.88**

1/16" x 3" x 36" for triplers on sides & misc.  
**\$.74**

**REGULAR Balsa:**

1/8" X 4" X 48" for fuse sides, rudder LE, ribs, stab ribs, stab roots. Get 2 @ \$1.89.  
SPECIFY LIGHT GRADE in Comments.  
**\$3.78**

1/2" x 3" x 24" for hard endcaps, hard stab spars and hard triangular stock that secures the internal towhook plate. SPECIFY HARD GRADE in Comments.  
**\$1.63**

1" x 2" x 12" for closed compartment ahead of canopy. (Enough for two, if cut at an angle)  
**\$1.25**

3/8" X 2" X 24" for bottom between bass area & Bargain Light. Cut a 3/8" sq. strip from which to make triangular stock to go under the closed compartment. For widening the saddle area, you have choices of this 3/8" or the Bargain light 3/8".  
**\$.92**

5/16" x 5/16" x 36" for making triangular stock to use on front former & the fuse bottom back to the rear former.  
**\$.40**

1/4" x 4" x 48" for wing & stab LE's, stab root ends. SPECIFY MEDIUM GRADE in Comments.  
**\$2.65**

1/8" x 4" x 24" for stabs & rudder TE's  
**\$1.05**

**Total \$51.43** You'll have \$12 or more in leftovers, so are in about \$40 to here.

Aside from wood, you'll use about \$30 worth of adhesives, glass cloth, resin for glassing-over, a CF pushrod, cable, hinges, clevises, brass couplers, etc. sand\paper, masking tape, primer, paint & film covering.

**Total to here: \$70**

Nicest quality & lowest cost CNC cut cores for the bagged wings are available from Anker Berg-Sonne at \$85 for the Big Genie, \$80 for GP & \$75 for LT/S.

**Total to here: \$145 to \$155.**

Bagged wings require overall 1.4-1.5 oz. glass cloth plus overall carbon fiber. All require a wrapped CF spar system, epoxy & paints. CF cloth is presently a premium price. I figure these cost come to about another \$130.

Total to here: \$275-\$285 in a wing, fuse & tail pieces.

What else? From Augie. . .Plans, parts pack, Kimbrough couplers, RDS parts, etc. approximately \$50.

Total to here: Approximately \$335 on the larger bagged wing ships.

If building the Easy LT/S, you'll need 48" sheets of 1/16" balsa for the center & 36" for the tips. # of sheets depends on whether you can get 4" or 3" sheets. Medium grade is suggested. You need some that can bend over the LE area. More rigid sheets are best for flap & aileron areas. Lay wing out on graph paper to estimate need.

A few hardware items such as clevises, threaded couplers, rudder cable, music wire, tubing, etc. are needed. Specific information follows about bagging epoxy, CF spars, cloth, paint, tools, etc. in case you need the information.

**BAGGING EPOXY:** The lowest cost per wing comes from buying resin in gallons, plus hardener in quarts. It takes about 18 oz. of mix for the big Genie & about 12 for the LT/S. Depending on the mix ratio of resin to hardener, you can do 8-10 big wings. My last gallon of West Systems 105/106 purchased locally at a marine shop came to about \$100.

An excellent, low viscosity, amber epoxy is the ProBuild item MM55538 in gallons. See [www.casspolymers.com](http://www.casspolymers.com). Their tech guy, Jim Davy, has been very helpful. They have a very thin Tropical hardener, item MM55929, in quarts that gives a 3 to 1 mix with a luxurious 90 minute pot life. In these amounts, it figures out at about \$8 a wing, plus shipping. Shipping of this epoxy by regular UPS ground involves no hazardous materials surcharge.

If you do a lot of bagging or would be working with others, it would be good to buy in this amount & share the cost. Call 1-800-344-7776 to order. The stored resin will gradually thicken. This is fixed by warming it to 130 degrees. Keep some in a smaller clear plastic container for convenience in warming & dispensing. However, after warming, let it cool again to less than 80 degrees before mixing or it will abruptly gel.

Other common, but more expensive epoxies, are the E-Z Lam handled by Aerospace Composite Products (ACP) or the West, handled by Composite Structures Technology (CST). Hardeners that give the longest working time are much preferred. MSG is really nice, but more costly and also requires a HAZMAT surcharge to ship.

Common sources for composite materials are those companies. Refer to on line catalog websites mentioned in their magazine ads.

ACP is the only known source of the 72" double tapered (DT) spars. I favor using a DT spar on top & an untapered one on the bottom, but they are often out of what's needed.

For the larger birds (Big Genie, Genie Pro and Smooth Genie Pro) first choice from ACP is the .014-.084-.014 x 72" on top and a .045 x 72" on the bottom in either 3/8" or 1/2" width. However they only sell in pairs so you need to buy a pair of each up front.

For the bagged wing LT/S, the use of a .030" x 1/2" x 48" spar is first choice for the bottom & a 48" x 1/2" x .014-.056-.014 spar on top if you do extreme launches. 3/8" is probably plenty, but I've not put a wing to the test using it.

The next few paragraphs present an alternative of using no DT spars at all.

Using one .084-.014 DT spar & one .045 closely matches the core taper so uniform height webs can be used and similar fill used to level things to the cores. With ACP that means buying a pair of each. They are often out of one or the other.

Using only non-tapered spars is practical, cheaper & means that CST can be another spar source and they sell them singly. They also stock other things needed including the fine Kevlar thread used for spar wrapping. I suggest always calling either to get confirmation that what you need is in stock.

In non-tapered spars, ACP lists .045 & .060 x 3/8" or 1/2" thick x 72". CST lists .042 & .060 in 3/8" or 1/2" x 60". Pricing is virtually the same & several bucks less than using any DT.

Two .060 x 1/2" seems overkill even for the big birds. If you are a dedicated hard launcher .042 on the bottom & .060 on the top still seems more than needed in combination with the dense foam cores and overall CF in the skin. For less extreme launching, a pair of the .042 or .045 x 1/2" should do nicely. Drop to 3/8" for the LT/S.

On the Big Genie cores the thickness at the spar location is 3/64" more at the center than the tip. Uniform vertical webs are easy to make and work fine, but it will take a bit more fill inboard than outboard to level things to the cores.

For the constant chord, sheeted Easy LT/S, a pair of .030" x 3/8" x 48" CF spars will do.

ACP & CST carry 48" x .070" CF rods. These make a fine pushrod for all the ships. At the tail end you need the thin-walled brass 2-56 threaded coupler for 1/16" wire. You need to sand down the rod to fit it. At the front you can use the thicker coupler for .072" wire.

**1.4-1.5 OZ. PLAIN WEAVE GLASS:** This is used on the glassed-over fuselages & on the wing, cut at a bias to add twist resistance to the panels. Splicing is a nuisance. Get 5 yards. The 50" width will minimize splicing when cut on a bias. 1.4 or 1.5 oz. cloth has noticeable pits if the CF & glass are left unpainted as is commonly done on the bottom. Cured, lacquer-based paint weighs about nothing & is recommended for nice appearance. Rustoleum now offers a Specialty Lacquer paint that dries quickly. Common Krylon is now a slower drying enamel. Enamel painted carriers should dry 2-3 days before bagging.

1/2 or 3/4 oz. soft glass makes the fin a bit lighter. The 1.4 oz. glass is okay, but will require a bit more lead up front.

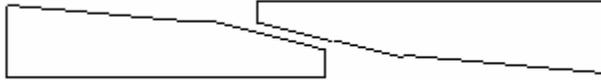
1" x 3-mil fiberglass tape, ACP item TF-01A. Get 6 yards for pre-bagging LE glassing or if you are into this for years, ask about a roll of the tape to cut cost per yard in half.

ACP carries E-Z Lam epoxy brand. I've not used it, but the 60-minute, 1-1/2 pint size kit would be the one to use if buying to do only one wing/fuse/fin and to wet out the Kevlar for the Individual Kevlar Hinges. (File #7.)

**ACP CARBON FIBER CLOTH:** My preference has been the 38" wide item WF-26, the 4.7 oz. 80/20 CF/glass. Due to general CF cloth shortage, the price keeps going up. For the big Genie or GP/SGP get 90". For the LT/S you need 80". A rectangular piece will be left over for other uses. See drawing in File #3, Part 1.

**CST:** CST lists 4.7 oz. CF cloth in 12" width. As Item 382 (1'-24') when last looked up, it was \$4 a foot. As Item 383 (25' on up) it was \$3.

Whichever ship you'll be building, in 12" width you'd only need twice its wing span. However, at \$1 a foot less for 25 feet, dollar cost is less than for 20 feet needed for the LT/S. Going for the 25' piece, you'll always have a long strip about 2" wide left over & up to 5' full width for misc. To save cloth, stagger tip section pieces as shown below.



4.1 oz cloth is as light as I would want to use. The 3.5 oz. stuff I used one time dings up with discouraging ease, even over 60 # foam.

The cloth mentioned below from [www.fiberglasssupply.com/](http://www.fiberglasssupply.com/) in Bingen, WA is another possibility, when available. Item GA 045, a 4.4 oz. cloth in 24" width ran about \$16 a square yard, but is priced by the foot.



This is a unidirectional CF with bonded-in fray control filaments at 1/4" spacing to greatly simplify cloth handling. The pic shows the pattern of the filaments with 1.4 oz. glass placed first against the painted carriers. The 24" width provides a wing top & bottom with a 5" strip left over. Two such strips can be laid s/b/s for another top or bottom.

I got 30 linear feet to do 3 wings at about \$40 each. That's cheap. Wish I'd gotten more when available.

**CF LAMINATE:** This goes between the 1/16" ply doublers & the 1/16" ply slab sides by the rear former & the fin. A .014" pre-peg laminate such as item CL2 from ACP is easiest to use & comes in a variety of sizes. This is handy stuff to have around.

CST carries MSG Resin (L135) & Hardener (H136) for 3 hours luxurious working time. Those sizes (45 oz. total) at about \$55 when last looked up are enough for three GENIE wings if carefully allotted to avoid waste. However, \$25 a can for "HASMAT shipping" is added. Convenient 2/1 mix by volume makes it easy to mix in small quantities in graduated cups. Recommended post-curing in heat is said to further increase the overall strength.

CST also carries West System Epoxy. The slower #206 hardener gives about 45 min. working time, but it is good to have a helper when doing the larger center sections. It would be best to find a local marine repair outlet etc., where you can pick up resin to avoid separate shipping costs.

Kevlar thread. This can be used in wrapping the spar system. It takes about 80 yards. CST has a 400 yard spool, item K902, for about \$17.50. You can Google for other sources.

Small Parts, Inc. (1-800-423-9009) carries drill bits in fractional & numbered diameters. Numbers 21, 40 and 51 are good to have on hand.

### MISCELLANEOUS

[www.cabelas.com](http://www.cabelas.com) has Sevalon, a nylon-coated stainless steel cable for the rudder. Fishing tackle places may have cable in bulk.

2-56 Rigging Couplers (Du-Bro) for rudder cables up front where clevises attach. You'll need 4 metal clevises, too.

One 6 pin Deans connector used for easy connect/disconnect between wing servos & Rx. A source is Radical RC. [www.RadicalRC.com](http://www.RadicalRC.com) (937) 256-7727. Some heat shrink tubing is needed in doing the wiring harness.

K & S makes wire, tubing, brass strip, etc. A hobby shop may have the K & S display rack of these things. Check your junk boxes or other supplies for the following stuff needed in small amounts: In music wire, about 4" of 1/16" & 5" of 3/32". In aluminum tubing, about 3" of 1/16", about 8" of 3/32" & 1" of 1/8". In brass tube, about 1" of 5/32". You need about 6' of 3 wire lead, & some lead shot to mix with resin to secure in the nose for balance.

Monokote for rudder and stabs. To make the rudder "T", 2" of .032" x 1/4" brass. A wire nail is included in hardware packages.

Rudder hinging is done with the Fourmost Snap Tight hinges, item #144. See end of File 2 for details.

Thin CA, CA +, quick epoxy, acetone & rubbing alcohol for cleanup, 1/4" vinyl masking tape, ordinary 3/4" masking tape, rags, paper towel roll, toilet tissue, sandpaper, etc.

Fine finishing of the LE for a glossy painted finish is easily possible with the white "Icing" putty, Item 26006, made for auto body repair by US Chemical & Plastics. See the Fine Finishing file.

### A WORD ABOUT BUILDING TOOLS

One of the best things I ever did, was have a 1' x 6' piece of 1/4" untempered plate glass made up to use as a true flat surface in bagging wings. It cost me \$25 & has several other applications. It need not be new glass, just flat, with edges smoothed. Scratches don't matter. Window glass places often have pieces on hand from replacing such broken glass.

The power tool I use most is a tabletop bandsaw. I've had a Sears 3 wheel Craftsman for over 25 years & just bought their Model 21400, a 2-wheel design that is an absolute jewel. Watch for a sale. Make sure they stock blades. This is the one tool without which I'd quit building. You can't imagine the uses you'll find for it until you have one. I clamp a 2" x 12" piece of 1/4" thick ply to the table as a fence for cutting ply & balsa to size. A grooved table is very useful in guiding small items squared up through the blade. I easily made one up to position on a smooth table when needed. Ask me to e-mail a picture showing how to do it. When a blade gets dull, it will veer off to one side. Don't cut CF or metals with it.

A small drill press has more uses than you can imagine. Also, after doing without a bench grinder most of my life, I saw a 6" 2-wheeler at ACE Hardware for \$25 & one from Harbor Freight for \$20. It has many uses & has become a favorite tool. Keep an eye out for specials at the various home supply outlets, etc.

I bought the fancy Proxxon 10" variable speed disc sander. It's overpriced, but is a fine tool & I keep finding new things to do with it. Micro Mark has a similar one. A noisy, plain old Sears disk/belt model works though.

A rechargeable hand drill comes in very handy. Sears commonly has a "half price" sale.

Good hand sanding tools are a must. Forget the aluminum "T" bar, etc. I had a woodworking shop cut me a bunch of blocks 12" x 2" x 1-1/4". They are straight & perfectly squared. Attach different grits of aluminum oxide paper on the 2" sides with 3M77. A great long sanding tool is a machined (or straight extruded) aluminum level to which roll type sandpaper is attached on the edges.

A really sharp, larger scissors is nice. I found a Fiskar's "Razor-Edged" scissors at Walmart. A few passes with a small whetstone keeps it cutting well.

6' x 1" x 1/16" bar aluminum serves as a long straight edge when marking spar lines to cut, TE's to trim straight, etc.

Single edged industrial razor blades & #11 blades are used a lot & are cheap in boxes of 100, like \$1 at Harbor Freight.

Zona razor saw replacement blades are so useful. Made by Zona Tool Co, Bethel, CT, 06801. ACE Hobby Distributors carries them, but you must buy from an ACE dealer. Item 36-119 is 4-1/2" long, 3/4" wide with its back, is .008" thick & has 32 TPI. These are great for cutting thru skins and cutting flap & aileron ends loose from a bagged wing. Tower has Zona saw sets, but does not list replacement blades.

I recently purchased a Stanley "Finishing Plane" item 12-101 for \$8. It is a little thing about 3-1/2" long. The blade, which can be resharpened, works well on balsa & somewhat harder woods such as used for the nose.

If you happen to have a cast aluminum Little Giant razor plane that takes double edged razor blades, that works well, too, in shaping the fuselage. The stainless steel blades found at usual outlets bend too easily. Non-stainless steel blades made in Germany are available from Tim Goldstein, Tim@IndoorDuration.com.

I have a nice spray outfit, but find rattle cans so much more convenient, not requiring cleanup & often only a little spritz is needed.

From Micro-Fasteners (see ads in the magazines) I picked up 1/4 x 20 & 10-32 taps & a handle. Their #2 x 5/8" "servo screws" & a hex socket head wrench for them are very useful, too. They carry aluminum socket head 1/4 x 20 x 1-1/2" bolts.

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