



SCALE SCENE

Balsa: The Strongest Wood

BY: Mike MacFarland

Since childhood, I've been especially fond of two things: building model airplanes and eating chocolate chip cookies. On a really great day I even do them together. When I think of ways that newcomers can get involved in scale airplanes, here's how I see the chips stacking up: The ready-to-fly (RTF) flyers typically enjoy the quick pleasure in a bag of cookies while the almost-ready-to-fly (ARF) folks like the convenience of baking from tubes of store-bought dough. Baking from a recipe is the kit-builder who makes a darn good cookie with his own personal touches. And, lastly, the scratch-builder hand-selects the eggs, uses real butter and skillfully combines the ingredients to create the most amazing delights you'll ever taste. Whatever our choice in cookies, they are all good and all bring enjoyment in many different forms. The ones we'll savor and remember most, though, are undoubtedly the homemade ones. So if you're hungry, let's dig into a fresh plate of "cookies" and talk about the main ingredient we use to make them: Balsa wood.

Baking with Balsa

Model-grade balsa wood comes to us from warm, tropical rain forests across the world, where it is cut and harvested in small quantities. I spoke with an industry expert, Mark Enderby with Balsa USA, and he mentioned a number of interesting balsa facts. Did you realize that although it is soft and contains widely spaced grain, balsa is actually classified as a hardwood? And, apparently, it's not just modelers who love this

stuff. Mark explained that the wind farm industry has been increasing demand for very lightweight balsa, which they use as a core for their

huge turbine blades. Although the balsa industry has seen an increased cost as a result of this, balsa is still a great value. Mark

added that since balsa is a very fast growing, renewable resource, they are working with tree farms and other sources to continue to meet demand now and well into the future. I can personally attest to the very good quality of the wood from Balsa USA and am glad to know they are ensuring a good supply for our future use.

Although not the lightest wood

in existence, all woods that are less dense than balsa are also very weak and flimsy. Balsa's unique, lightweight structure forms as it grows in its native soil, pumping each pore full of water and leaving large, hollow pores when the moisture is removed later. This careful drying process takes place in special kilns that dry the wood over two weeks.

Once dry, the wood is roughly one-third the density of other hardwoods yet exceeds the strength of them when compared by weight. It is amazingly lightweight and stiff, making it useful for many structural airframe parts. The secret to using this amazing wood properly in our models is in selecting the proper grain and density to fit the application.

Planks of balsa are sawn from log sections to maximize the product yield. The relationship of the direction of the cut, to the grain of the log, determines what distinct grain type the plank will have. There are three main grain classifications of balsa, commonly known as A-, B- and C-grain. A-grain is characterized by the long, parallel grain lines down its length. It is created by sawing the planks at a tangent to the surface of the log, and the resulting wood fibers run parallel to the longitudinal axis of the piece. B-grain wood is similar in appearance to A, though it has shorter lines and is typically stiffer in bending strength across the grain. It is sometimes called "mixed grain" or "multi purpose" wood since it is a combination of the other distinct extremes. C-grain, also known as "quarter-sawn" balsa, looks quite different than the others, with unique ray flecks, a mottled appearance and a very stiff feel. Since the planks were sawn perpendicular to the surface tangent, the annular rings run perpendicular to the face on C-grain wood.

Because there are three distinct grain types, we need to recognize each to decide the best airframe application. When you go to the hobby shop to select wood, there are both visual and physical clues to look for. Most balsa we find on the shelves will vary in density between 7 and 16 lb/ft³. Very lightweight balsa is classified as "contest grade", meaning it



A-grain balsa

A-grain balsa is characterized by the long, parallel grain lines down its length, is flexible across the width of the sheet, and is best used for curved sheeting on fuselages and wings, planking, forming tubes and for making sticks of wood.



C-grain balsa

C-grain balsa looks quite different than the others, with unique ray flecks, a mottled appearance and a very stiff feel. Use it for fuselage formers, balsa sheet flying surfaces, ribs and laminations between other grain types.



B-grain balsa

B-grain balsa is a multi-purpose type with shorter grain lines and is typically stiffer in bending strength across the grain. Use for flat fuselage sides, leading and trailing edges, and anywhere the other grain types wouldn't do a better job.



C-grain balsa

If you hold a piece of C-grain at a slight angle to the light source, the look often changes with how it displays the reflected light.



This flat fuselage side of a simple model was cut from B-grain balsa and has a strong resistance to both splitting and bending. This will prevent possible breaking of the sides should it be gripped between inner supports.

The fin sheeting on this scale model came from A-grain balsa and was able to bend and form well to the curved surface.

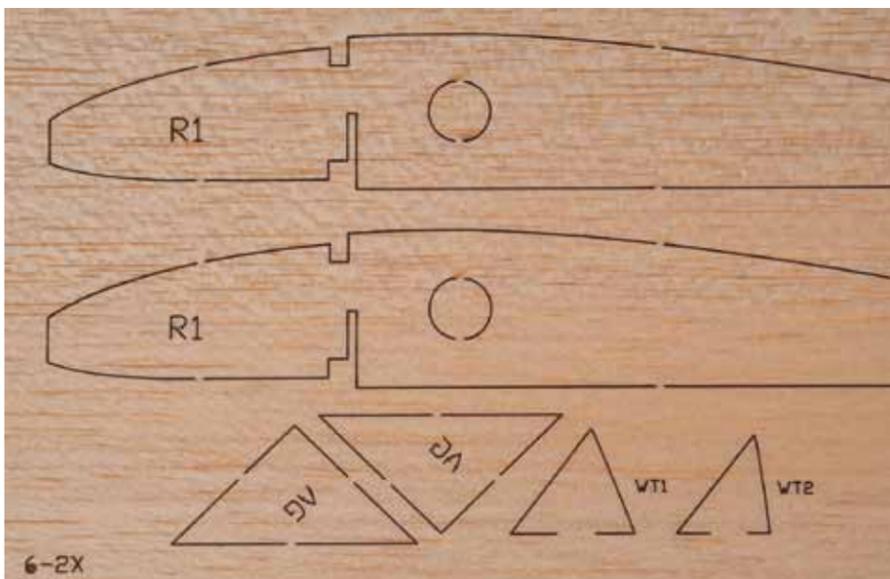
weighs between 4 and 6 lb/ft³, and can be scarce in supply. A great rule of thumb is that typically the lighter the color of the sheet, the lighter its weight. If the pieces in the bin are wavy or warped, they are probably A-grain. Contrastingly, C-grain often has a bowed edge down the length of the piece yet lays exceptionally flat on the table surface. This type is characteristically more dimensionally stable and naturally resists warping. However, because the annular rings run through the surface, C-grain often snaps

easily if bent across the face of the plank. Selecting the grain is only part of the job, with the other important part being the density. All structural, load bearing members should be cut from hard, A-grain stock. The heavier and harder pieces will always be stronger than the lighter and softer ones. A-grain wood will seem flexible across the width of the sheet and is best used for curved sheeting on fuselages and wings, planking, forming tubes and for making sticks of wood.

Because it is stiff, strong and warp resistant, C-grain is an excellent choice for fuselage formers, balsa sheet flying surfaces and wing ribs. The best choice for wood when you are not sure which would be best is B-grain, offering a versatile alternative with the benefits of the other types. Use B-grain basically anywhere either A or C wouldn't do a better job, and suggested areas are flat fuselage sides, wing ribs, and leading and trailing edges.

Since our goal is to build flying scale models, the cosmetic scale details we add all come with a price, and part of that price is weight. Selecting the minimum weight wood that is sufficient for the load that will be placed upon it is the secret to an excellent flying model. Realize that an airplane becomes such only when it is able to divert a volume of air equal to its weight in the direction of the force of gravity upon it. The resulting equal and opposite reaction force is what we call lift. The pull of gravity is

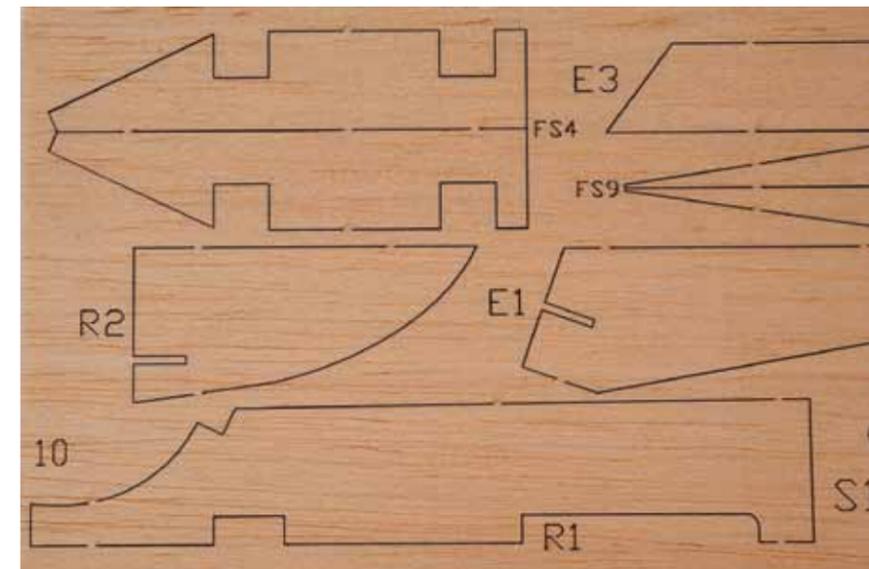
Wing ribs and miscellaneous airframe pieces were laser cut from a sheet, which is mostly C-grain balsa on the upper part becoming more B-grain beneath.



a function of its weight, so the lighter the model, the less lift it needs to produce. Since airplanes will produce lift as a function of their speed, lighter models are able to fly slower. Slower flying scale airplanes appear more scale in flight, are easier to fly, and are less prone to stall-induced crashes. So, if we select the materials carefully for our airframes, the resulting model will be a better platform for scale accessories and ultimately a more pleasing airplane.

I like to weigh all of my building wood with a digital

Density Range	Suggested Uses of Balsa Wood
Very soft/Light aka Contest Grade 4-6 lb/ft ³	All sheeting (use lightest density for surfaces to be fiber-glassed), wing tips and ribs, built-up surface ribs, most wood construction on very small models.
Medium 6 to 8 lb/ft ³	Wing sheeting, wing "D-box" sheeting, solid tail surfaces of smaller models, boxed fuselage construction, leading and trailing edges, shear webbing, blocks for carving.
Medium Hard 8 to 10 lb/ft ³	Fuselage longerons, stringers and wing spars of small to medium sized models, fuselage formers and tail surfaces of medium sized models, laminated rings for nose blocks/cowlings.
Hard 10-14 lb/ft ³	Structural sticks, fuselage stringers, longerons, structural formers and ribs, or main wing spar applications. Used for die cutting.



For example, a piece of 1/16 x 4 x 36 in. long wood that weighs one ounce would have a density of 12 lb/ft³. Also, a nice online conversion calculator which converts sheet dimensions in inches, and weight in grams, to lb/ft³, is listed in the source guide. *Tip: Multiply ounces by 28.3 to obtain the equivalent in grams. Alternately, you can let Google™ do it for you by just typing, into the search engine prompt, the number of ounces and then entering the text "ounces to grams" after the number.*

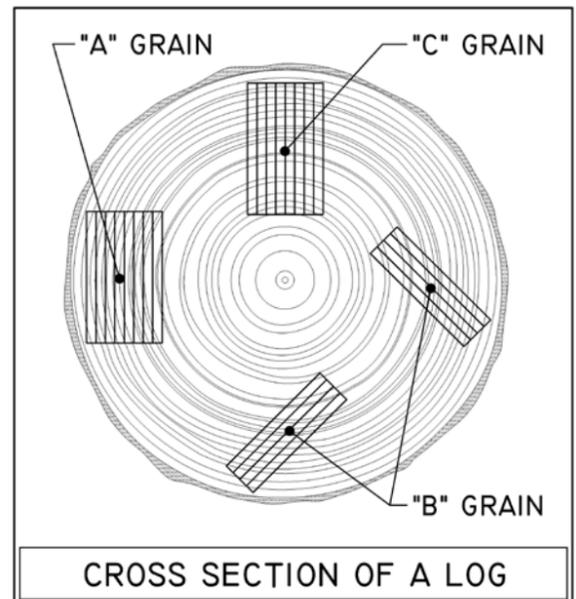
When you buy most commercially produced airplane

postal scale and write the number on the piece corresponding to the density of the wood in lb/ft³. A scale that is accurate to one-tenth of a gram, with a 500g capacity, and can be bought for about twenty-five dollars, is ideal for this purpose. Once all of my stock is marked, I've found I can easily compare and grab what I need quickly and accurately. The weight-to-density conversion is made simple through the following conversion formula:

$$\text{Density} = \frac{\text{Weight (oz)} \times 108}{\text{Width (in.)} \times \text{Length (in.)} \times \text{Thickness (in.)}}$$

These structural pieces were laser cut from medium hard "A" grain wood which can be identified easily by the long, straight grain.

This cross-section of a balsa log shows that how the planks are sawn from the tree dictates what grain type it will be.



kits, you will find the proper types of wood for the pre-cut pieces have already been included for you. Most of the wood will be heavier than necessary because the kit maker would rather err on the side of a stronger model than a weaker one. Also, if the kit has been cut using a die, the

wood used will often be harder than necessary to eliminate the crushing tendency of the process. A handy reference is the included table one, which lists the common range of densities of balsa wood and the some of the best uses of each. By knowing how to recognize a potential mistake in

grain type or density, and able to properly substitute lighter pieces, you will become a better airplane builder. In addition, when you start to plans-build or scratch-build, you will build lighter and stronger airframes. I was involved in the hobby for many years before I learned all of the ways

balsa should be properly used. You will have a great advantage if you are starting out in the world of model airplanes with this knowledge in your possession.

So go ahead and open that dusty kit beneath your workbench and pin down those plans. Tasting

that simile again, let's weigh your dough and get a fresh batch cooking in that workshop of yours! If you have any questions or comments along the way, be sure to send me an email or letter as I'd love to hear what you've got in the oven. 

Scale Scene
Source Guide

Balsa USA
P.O. Box 164
Marinette, WI 54143
Phone: 906-863-6421
Web site: www.balsausa.com
Email: BalsaUSA@BalsaUSA.com
Online wood density calculator:
www.indoorduration.com/BalsaCalc.asp

THE SCRATCH-BUILD-OFF III CONTEST HOSTED BY RC GROUPS

Modelers across the world are currently stretching their designing and building skills during the latest building contest co-sponsored by *RC Sport Flyer* and hosted on *RCGroups.com*. The original idea for the contest came from the Discovery Channel's Television "Biker Build-Off" series where motorcycle builders designed and built an original motorcycle over a preset period, and the most popular bike won. In similar fashion and since November 2008, scratch-building amateurs and professionals alike have been competing in the third of such contests for those who enjoy making their own scale, electric-powered airplanes. The building portion of the contest will end May 30, 2009, at which time only the models that have successfully flown will enter the voting round. The models within the professional and amateur designer classes that get the most votes from members of RC Groups will be declared the winners.

RC Groups is an online site where enthusiasts can find and discuss all things RC related and otherwise. Joining the site is free, and anyone who agrees to play well with others can be a member almost instantly. Within the RC Groups site are categories to narrow down the many

RC topics, and within the "Airplanes-Electrics" category, one can find the "Scale Electric Planes" forum. It is here that the contest, "Scratch-Build-Off III", is currently underway.

The contest is all about fun and the participants are some of the most generous and helpful people you'll ever meet. The rules are pretty simple, and the basics are that you have to design, build from scratch, and fly a scale model within the contest period. Because the purpose of the contest is to help bring new model designs to market, contestants must do all original design work and model prototype construction themselves. In the process, both the professionals and amateurs learn new processes and techniques and expand their skills as they post pictures of their progress online.

As the moderator of this contest and one who spends a good deal of time on the site, I have had the pleasure of meeting many talented builders. A contestant that is off to a great start with his construction is Pat Lynch of Bungendore, NSW, Australia. Pat chose to design a 1/12-scale model of the Avro Bison for his entry. Perhaps of interest is why Pat chose this model. He says, "I wanted to build something that had not been done before as a

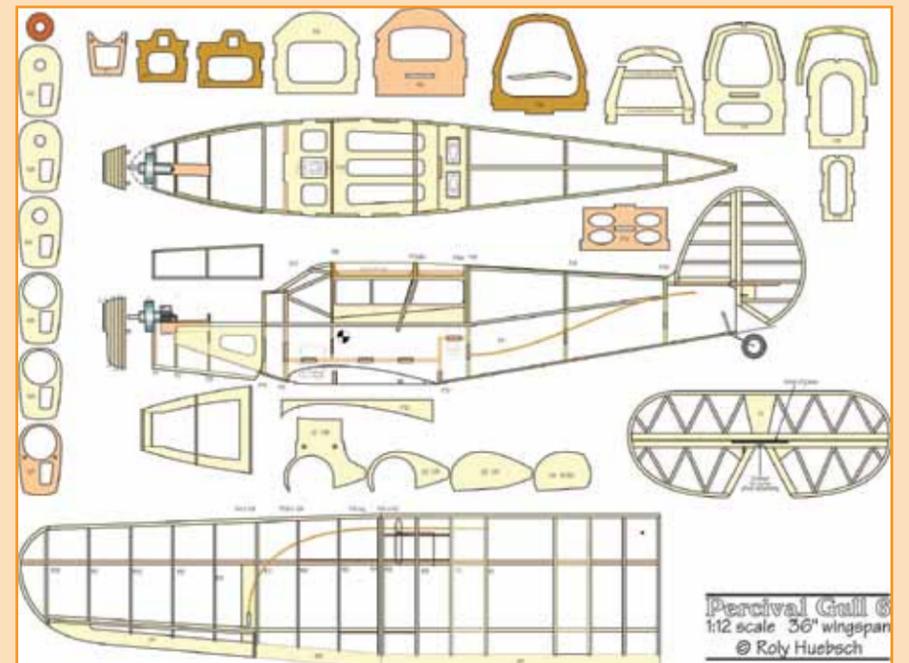
flying RC model, it had to be ugly, and I loved that it was bristled with 'stuff' — ladders, vents bumps, hatches, etc." Pat's workmanship is beautiful even when the subject is only questionably so, and he is using balsa and lite-plywood for all construction. Pat is competing in the professional class and is doing so, according to the rules, because he placed second in one of the previous two build-off contests. He adds "it's a laugh for a 65-year-old, retired electronics engineer, who has building RC for less than four years!"

Although you don't even have to make actual plans to enter the contest, amateur designer Roly Huebsch of Azores, Portugal, is doing a professional quality design job. His entry is a 1/12-scale model of the Percival Gull 6. A rare subject to model, Roly says "Growing up in a house filled with my uncle's aviation books from the '20s and '30s, I was familiar with this neat little monoplane, but it was only after reading Ian Mackersey's biography of Jean Batten (who flew a Gull) this summer that I considered building a model." Often times a movie or a book on a pilot or airplane will be the necessary impetus that brings a great new design to life. And though he hasn't started construction quite yet, Roly's plans are beautiful and his finished models are typically nicer.

An amateur contestant who has added another dimension to his design is Paul Kohlmann of Windsor, CA, who has designed a beautiful Grumman F4F-4 Wildcat. Using SolidWorks software, Paul has created an amazingly detailed, three-dimensional design that is complete with exterior scale colors, markings, and panel lines. About the project, Paul says, "The Grumman Wildcat struck me as a pretty good entry level project, with its squared-off planform and tail. Of course, that

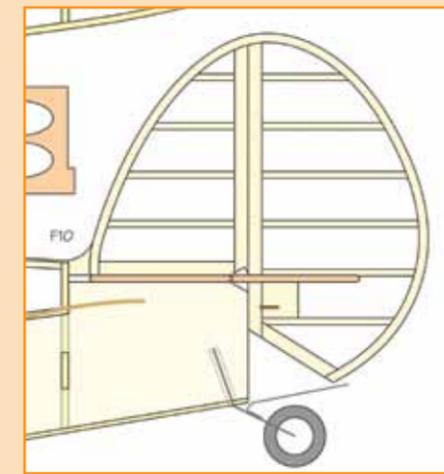
doesn't mean that I can't make a mess of it! From what I've seen so far, this is probably the most modest undertaking of the entrants. I'm going for more of a park-flyer genre as open space is pretty hard to come by in my neighborhood." If Paul's model ends up looking anything like his plans, it is going to be one to watch.

With nearly 30 contestants already entered and plenty of room for more, registration in this free contest is open until March 1, 2009. If you want to be a part of a fantastic RC event, and regardless of whether you have ever scratch-built a model before, you should give the contest a look. And since there's no penalty for not finishing on time, even a late start will be welcomed and encouraged. You'll meet some great builders, learn and share good techniques, and possibly even win a wonderful prize or two. Who knows, maybe you'll even see your efforts here in the magazine over the coming months!



Some of the contestants demonstrate their skills in graphic arts, as is evidenced in this Empennage close-up of Roly's Gull.

This 36-in. wingspan Percival Gull 6 plan is nearing completion and building commencement. It is a rarely-modeled subject and an original design from the talented hands of Mr. Roly Huebsch of Azores, Portugal.



Taking it to the next level of three-dimensional design and detailing is Paul Kohlmann of Windsor, CA. Paul has nearly completed his original design of a beautiful Grumman F4F-4 Wildcat using SolidWorks design software.

This section of the Wildcat's internal structure reveals the nice, 3D detailing Paul has put into this future parkflyer.



This fuselage stands steadfastly adjacent to the images of what it silently hopes it will become. This 1/12-scale Avro Bison model is being built by Pat Lynch of Australia.



Though it has a face that only a mother could love, this expertly-crafted Bison proudly "struts its stuff" as it continues on the process of completion.

Scale Scene

Sources

RC Groups.com
rcgroups.com/scale-electric-planes-10/
contest-thread:rcgroups.com/forums/
showthread.php?t=956827