THE STORY OF BALSA

By S. Greenhouse

From Aeromodeller Annual 1964/5 [Edited for length]

The production of balsa has a romance of its own, and while you all know what balsa is and what it can do, some of you may not know how balsa comes about and what it goes through before you buy it off your dealer's shelves. It is my object to tell you what we have to go through so that you can make your model aeroplane, or that a plastic boat manufacturer can make a stronger, more buoyant product, or that an aircraft manufacturer can obtain the greatest possible weight-strength advantage from the world's available materials.

The best way to start is with the tree. Even to see one in the woods surrounded by other trees, you would stop to give it a second glance—I know I do, but perhaps that is because I am prejudiced. Its clean, handsomely mottled bark and large leaves attract attention in a forest where most of the trees are vine- covered, and with small compound leaflets. It is hard to believe that only about forty years ago the balsa tree was considered a weed and a nuisance just because of the very advantages with which nature endowed it to serve its purpose in life. Nature did not intend the balsa tree to be the final tree in the complex chain of species following species, until as we call it in forestry, the climax association is reached. You would call this the Virgin forest. In nature's scheme of things, and nature is a wonderful engineer, the balsa tree is a tool, a tool used to achieve an end, and the end is the climax association, or the Virgin forest.

Let us start from the beginning of the chain. An open area appears in the jungle either through human agencies or from natural causes such as disease, storm or death from old age—yes, trees die of old age too. The hot tropical sun shines down on the forest floor, but the vegetation in the tropics is not static for long. At once a mass of plants begin growing in the open space. These plants could not live in the shade of the old trees, they need direct sunlight, and the only reason they are growing now is that for the first time in many, many years, they are receiving direct sunlight. Most of these plants are low to medium-sized annuals or perennials with occasional low shrubs. They form an impenetrable thicket. In an environment such as this, it would be very difficult for a young seedling to survive—the seedling which will eventually grow up to be the tree that will take over the open space left by the dying of his parent. However, in this mass of herbage there are also the seeds of the balsa tree. The wind has spread these far and wide borne on pieces of downy floss which look very much like the fur of a rabbit. As a matter of fact balsa's Latin name "lagopus" means rabbit's foot, referring to the appearances of the seed pod before the seeds are dispersed. They may have lain in the ground for years awaiting just this moment. When the sun shines hot on the denuded area, the balsa seeds spring up, in some cases as thick as grass on a lawn. They are the only plants which can grow faster than the other herbage. In doing so they shade out and kill not only the herbage but their own weaker numbers. It is a case of survival of the fittest. And this competition for light and space goes on until perhaps only one or two balsa trees are left where literally thousands of seedlings began.

There is a purpose behind this procedure. The balsa tree shading out everything beneath it leaves a forest floor practically clean. There is then enough room for the final species to develop. Nature has ordered it so that at this age the final species is tolerant of shade, and protected from the hot sun and from overcrowding by weeds, it takes root and flourishes.

Now if you were an engineer who had to write the specifications for a tool to do this job required of the balsa tree, what would you want? In the first place you would want that tool to grow fast—so fast that no other plant could catch up with it to crowd it out; not even the fast-growing, tree-strangling vines of the tropics. You would want the trees to have large crowns, yet to be few in number in order to provide shade to prevent the drying out of your final species in the hot tropical sun, but not too thick to prevent the circulation of the air, a condition which would create an ideal breeding environment for fungal diseases. You would not worry much about putting fancy colours in the wood of your tool tree, or giving it axe-breaking hardness. All you would be interested in is getting a trank big enough and strong enough to hold up the wide-spreading crown, with emphasis on speed of growth. You would also write into your specifications that you do not want this tool tree to five too long. You would want it to die off at just about the time when your climax tree has reached the stage when it is firmly established and can take care of itself.

Nature has written these specifications exactly into the balsa tree, and since it is wood we are interested in, let us look into what is happening in the trunk of our tree. We look at the wood under a microscope and we find that it is made up of several wood elements. We may be surprised that they are the same elements you find in all other woody plants. Nature has struck on a good basic construction, and like a good engineer or architect, by switching the elements around, by modifying them and by adding a pinch of salt here or a drop of resin there, she comes up with an innumerable variety of woods. But if we were to take only the basic elements as a solid mass of cellulose, which it is, we would find that it would weigh 97 lbs. per cubic foot, practically the same as for any other wood species. Compare this with the balsa board you buy in the stores which will weigh between 4 to 18 lbs. per cubic foot.

We find under the microscope that the 97 lbs. of cellulose have been blown up like a sponge. The walls of the cells, fibres and tubes are thin, so that the balsa is more air by volume than it is cellulose. Most woods have quantities of heavy plastic-like cement holding the various elements together. This is called lignin. In balsa the lignin is kept to a minimum. Many trees have other weight-adding substances, such as dyes, crystals, oils, which are all lacking in balsa. This construction in itself is one with a high strength/weight advantage, and it is this that mainly concerns us here. However, when the tree is in the forest it is given still more strength. First it has a tough, stringy bark which helps a great deal to keep the tree from snapping in heavy winds. In addition, the cells are literally pumped full of water, thus giving additional strength in the same manner that air gives rigidity to a car tyre. In a growing tree the weight of water it contains may be four or five times the weight of the cellulose.

Nature goes a step further to cut every possible corner. When the balsa tree is small the wood material is light and soft, in keeping with the size of the crown. As the tree grows older, concentric layers of wood are added under the bark, and as each layer is laid down, it is slightly harder and heavier than the layer just beneath it—the cell walls are a little thicker. The space to wood ratio is a little smaller. This is why you get some pieces of balsa which weigh as little as 4 lbs. per cubic foot, and other pieces of balsa which weigh 18 or 20 lbs. per cubic foot. However, the causes of balsa density are not quite as simple as that. Numerous environment factors enter into it. The drainage, the amount of sunlight it receives, soil conditions, competition, all tend to dictate the density of the wood of any particular balsa tree. Only one thing is outstanding—one peculiarity. If balsa is damaged in any way, such as a man walking along and striking it with a machete, or if a branch of an adjoining tree begins to rub constantly on its surface, the wood from then on becomes very hard, sometimes attaining a density of 30 to 40 lbs. per cubic foot. The natives call this a “macho” tree which means “male”. A “macho” tree is worthless for commercial purposes.

We now have the balsa tree growing nicely in the jungle, and if we are lucky and it is not eaten up by insects, blown over by the wind or becomes “macho”, it grows into a commercially valuable tree in six to eight years. At that time it is about 10 in. in diameter at chest height and it may be more than 60 feet tall. Now is the time to harvest it if you arc going to harvest it at all. You will remember that I mentioned that the wood becomes harder as the tree becomes older, and after eight years or so the wood may be too hard for commercial purposes. You will also remember that one of nature’s specifications for balsa is that it cannot live too long. About that age the first signs of deterioration begin to appear. This is usually a small area in the centre of the base of the tree, which becomes saturated with water, and the cell walls begin to deteriorate through rupture and decay. The cone becomes higher and wider with time. The tree should be moved to the sawmill before this condition, called “waterheart” goes too far. If left untouched, the tree will grow much larger. I have seen balsa trees 6 ft. in diameter at the base, and over 100 ft. high, but such a tree would be of very little commercial value. From this you can begin to get an inkling why balsa boards arc so small—we get them from logs which, of necessity, are small.

Practically all of the world’s supply of balsa comes from Ecuador. There are several reasons for this, not all of them valid, in my opinion. In spite of the great progress made in that country since the war, the backwoods where balsa is harvested is still quite a primitive place and the extraction of balsa or for that matter any other species, is quite primitive, too. This is not because we are against progress, it is because of the economic facts of life. The chief difficulty is that the balsa trees do not grow in groups, but are scattered throughout the forest. You may find one balsa tree here and you may not find another for 1/8 of a mile or more. Occasionally you may be lucky and come across an old abandoned field, or the cut for the right-of-way of a road, and find your trees in small batches. This does not happen very often. To put in expensive logging equipment such as high-lines or tractors is not feasible economically. We rely on more primitive but more economical methods.

The logger is usually not a professional. That is, he does not depend on the cutting of balsa alone for a livelihood. His main concern is raising food to feed his family and that means the staples such as rice, corn, beans and bananas. He cuts balsa for extra money when his farm duties leave him free. Sometimes this does not coincide with the demands of the industry, but he is an independent individual and we have learned to live with his routine. His tool is a broadaxe. He never uses a saw because it takes too much work and know-how to keep a saw in condition. His method of chopping a tree down is by cutting all around its periphery just as a beaver would do, and it then falls in any direction it chooses. There is one advantage to this method. It gives him a point on the end of the log like a blunt pencil point, and when the log is dragged on the ground, it acts in the same manner as the upturned runners of a sled. Immediately behind this point he cuts a groove completely around the circumference, about 2 in. deep. This is where his rope or chain goes for dragging out the log. Incidentally, he usually gets only one 16 ft. log to the tree—rarely will he get more.

He peels the log in order to lighten it further for the dragging or skidding process. He does this by chopping a series of X's in a line down the length of the log and then using his machete, he prises off the bark.

The next step is to get the log to the water which is the most common means for transporting it to the mill. Usually loggers work together under a boss or contractor and in that case a yoke or two of oxen are generally available. In the dry season the yoke of oxen may be able to drag one large log down to the river, or two or three small ones. However, in the rainy season when the oxen flounder in mud up to their bellies, it may take two teams to pull a single log to the water. Occasionally when a man is working by himself, or with a partner or two, he may drag the log down to the water by sheer man-power. Believe me, this is not the easiest way to make a living!

When the logs are in the water, they are formed into rafts about 10 feet wide, and are bound together by vines and wooden pegs which are driven into the balsa. The rafts of the various loggers are floated down the river with the help of a steering sweep in the stern, and with pole men in front and at the sides keeping it on the right course.

Within one day to a week depending on where they are logging and the condition of the river, they will come to a concentration point on the river. Here the various rafts are consolidated and strengthened. They are formed into a long train of rafts and a thatched hut is built on one of them for living quarters for the crew on their long trip down the river. A little extra money is often made by acting as freighters and they may load local produce such as bananas, coffee, or cocoa on the rafts. This pushes the logs lower in the water and helps to keep out Ambrosia beetles, the insects which make little holes in the wood.

Running a train of logs down the rivers calls for a special breed of man. In fact one who has a very strong resemblance to the old swash-buckling loggers of the early United States. It takes a strong back, an intimate knowledge of an ever changing river and a considerable amount of courage since the journey is not without danger. If you have read Mark Twain's account of life on the Mississippi you have a faint idea of what is involved, but the banks of these rivers are considerably closer together, they are rock-strewn and the upper reaches, at least, consist of a series of rapids.

In due course—up to two weeks, sometimes, depending on the condition of the river—the raft arrives at tide-water. Here the tide takes over and acts as the motive power instead of the current of the river. As the tide runs out the raft is carried swiftly seaward surrounded by a mass of floating islands of water hyacinths. When the tide comes in the raft ties up at the bank and waits for the turn. Within a day or two they are at Guayaquil where our main sawmill is located.

There was a time, not very long ago, when this was the only way to get balsa logs to

market. However, Ecuador has been extending her road system and where it is economically feasible, logs are shipped to the mill by truck. As yet, however, truck transportation accounts for only a very small percentage of our log supply.
At the mill the log rafts are broken apart and are hauled up an incline into the mill by means of a tramway. Each log is placed on the head saw, which consists of a large circular saw blade rotating beside a pair of tracks. A carriage holding the log in position is run over these tracks exposing the log to the saw. The purpose of this saw is to cut two slabs off the log opposite each other, in other words, to put two flat faces on the log.

From the head saw the log goes to one of the sash gang saws. This machine contains a series of saw blades like giant hack-saw blades. They are spaced far enough apart to cut the required thickness of the board, plus the considerable allowance for shrinkage which will take place in drying, plus enough material to remove in planing. From the sash gang saw the boards go to a cross cut saw, where the crooks are cut out as are the larger, more obvious defects. They then go to a machine called the edger. This consists of two saws movable on its arbor which are manipulated by the operator in accordance with the width of the board being sawn. It comes out of this machine as lumber but it is hardly the finished product yet.

The boards are then stacked on trucks with strips of wood between them, so that air may circulate between them and are placed in a kiln, where the moisture is removed and where, in the procedure, they go through a sterilisation process which kills the various insects and fungi which would lower the quality of the boards.

The drying process is complicated and would take too long to describe here. However, I cannot emphasise too strongly the necessity for proper kiln drying conducted in accordance with the latest scientific procedures. The wood must not be dried too fast since in shrinking as it dries it will develop checks and internal stresses, but again it must not be dried too slowly for it will be attacked by various fungi and insects. Drying follows a specified schedule of heat, humidity and circulation which must be strictly adhered to. Sometimes there are penalties that have to be paid for kiln drying. One, for example, is the fact that in order to reach sterilisation temperatures the sap substances may change chemically, giving the balsa a slightly darker colour which some hobby enthusiasts, for reasons best known to themselves, find objectionable. However, the advantages outweigh the disadvantages to such a degree that balsa should always be kiln dried.

After drying in the kiln and the subsequent cooling until they regain room temperature, the boards arc passed through the planer. This surfaces the two faces. From the planer it goes to a scries of rip and cross cut saws. These are manually operated because each board is studied individually for its best possibilities. A mass production machine here would be impracticable. Various defects are cut out to give the best grade possible. In the process, of course, the size of the lumber produced becomes smaller. That is why it is difficult to supply long lengths or widths.

This, then, is the story of balsa insofar as it concerns model aeroplanes.