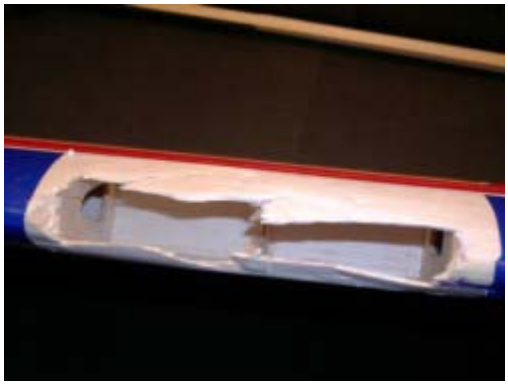
MODEL AVIATION'S Sport Aviator
The e-zine for the new model pilot

Fixing A Broken ARF Wing
by Frank Granelli



You did it! No one else saw that airplane-eating tree move 20 yards to the right and snag your airplane right out of the sky on final approach. You know you had the airplane in the clear until that tree moved, but no one is going to believe you so you might as well take the blame. Luckily the tree only caught your airplane on its bottom branches so you can reach it. It's time to put down your transmitter and to take that long, lonely walk out to scene of this very unjust incident.

Not only was this unfair, but it is also an inconvenient show stopper. It is now mid-August and you have soloed only 3 flying days ago. While the airplane is not badly damaged, it can't fly with that big hole in the wing. Ordering and building a new wing will take until mid-September. After your hard summer's work learning to fly, you will now have to sit out the best part of the remaining season waiting for parts. Even worse, your new-found flying skills will be getting very rusty and you might have to re-learn some of those piloting skills that are already slowing escaping into the great beyond.

You could go out and by a new ARF trainer at the local hobby shop. But that still requires building and trimming time. It can also get a little bit expensive. Instead, what about spending 15-25 dollars plus two nights work to get back in the air? Even though you may have never built a wood kit, you can fix that wing with a few supplies and a little wood working.

The only tools you will need are all available in the hobby shop. They are:

Gap Filling CAA	Thin CAA	Ambroid® Liquid Cement (I know it is old tech.)
Modeling pins	Pin Clamps	Micro-Fill Modeling Filler
#616 knife blades	#11 knife blades	A Hobby knife handle
12" sanding block	Low-tack masking tape	Small flexible sanding block
Razor saw	Some assorted balsa wood	Plastic film covering
5-minute epoxy	Micro Balloons Filler	

All of these items will be used throughout your modeling career. There is one other tool you will need and that is a modeling iron designed to apply plastic film covering. That costs about $25 on its own, but you should have one already since it is usually required to remove the wrinkles that came with your first airplane.

A few of the items on this list are somewhat vague. That is because different airplanes will require different size wood and brands of covering. So the first task is to make these vague items more

descriptive.

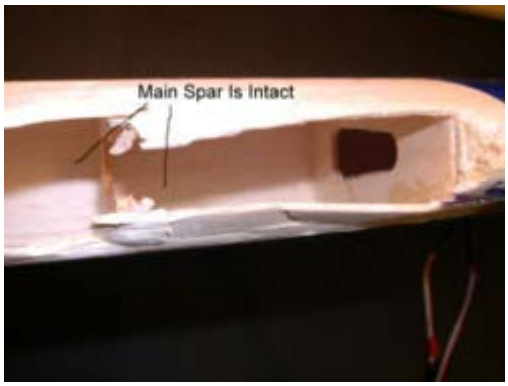


Photo1 Photo 2

Carefully examine the damaged area. The repairs discussed here work well for damaged leading edges up to three “rib bays” wide. For larger repairs, use the same techniques, but insert a ½ in. strip of .007 in. thick carbon fiber span-wise along the top and bottom of the sheeting, extending onto the existing sheeting on both sides.

Photo 1 shows some internal damage to at least one wing rib. The sheeting is crushed and cracked in many places. But the spar is sound and undamaged. If the main wing spar is cracked, stop right there. While repair is still possible, it is a lot harder to do right and far more critical. If the spar is damaged, it is time to ask a more experienced modeler to help you and it will be necessary to remove most of the wing’s covering for a complete examination.

But your main spar is fine. It is just the leading edge that could use some help. Since most of the factory leading edge is now sawdust, it will need replacing. At least one of the wing ribs is missing its front half and another is cracked. The crushed sheeting cannot be repaired and must be replaced.

Most of the sheeting used in ARF models made overseas is *usually* about 3/32 in. thick. To be a little more precise, it is 0.089 in. The 3/32 in. balsa sheeting available in the US is usually about 0.093 in. We can live with the 0.004 in. difference since most of it will be removed during the final sanding process. However, be sure to measure the sheeting thickness on your airplane in case it is a different size. Find the lightest, most flexible piece of 3/32 in. sheeting in your hobby shop, 36 in. long by 3-4 in. wide, and buy it.

Photo 3

Next is to identify what size the replacement leading edge needs to be. Use a small fragment of the original leading edge as shown in photo 3. Carefully remove any remaining wing sheeting that may be on it, at least in one small spot. Measure its height, top to bottom. For this repair, the

height needed was almost exactly 5/8 in. In order to insure a straight, warp-free leading edge replacement, try to make the new leading edge by laminating two balsa sticks together.

Photo 4

For this aircraft, one ½ x ¼ in. balsa stick and one ½ x 3/8 in. balsa piece were ideal and a perfect match for the old leading edge's height. The ½ in. width, front to back, was also just right. If it were too short, including a piece of 1/16 in. balsa sheeting in the lamination usually is sufficient.

Cut the individual balsa sticks to about one inch longer than needed to fit the open area in your wing. Laminate them together as shown in photo 4. Use Ambroid liquid modeling cement for this. What? Use a 60-year old adhesive, that isn't the world's strongest bonding agent, and then wait two hours for it to dry? Are you crazy? Why not just use thick CAA or at least wood glue?

Ambroid is old technology, but it has three advantages in this application that make it the glue of choice for much of this repair project. First, it sands like butter, leaving no high spots as would CAA adhesive. Second, as it dries, it draws the parts being glued more tightly together for firmer contact and fewer gaps. Finally, it does not contain water, as does wood glue, so it will not cause the two sticks to warp as they dry. The net result is a laminated piece that is straight, tightly bound without gaps and one that can be sanded as if it were made of a single balsa piece.

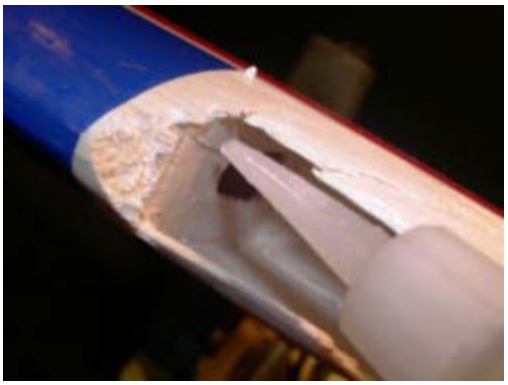


Photo 5 Photo 6

While the new leading edge is seemingly taking forever to dry, (we really have become spoiled by modern adhesive technology), work on some of the internal areas. If any of the wing ribs are just cracked in a few places, like the one in photo 5, then separate the cracks just slightly, apply thick CAA inside the cracks, realign the wood and hold tight until the adhesive sets.

Examine the wing sheeting. Much of it will have to be replaced. But if only a few cracks extend into otherwise sound sheeting, as in photo 6, apply some liquid cement and clamp the sheeting together (photo 6). Again, this area will be sanded and the liquid cement pulls the parts together for a gap-free bond.

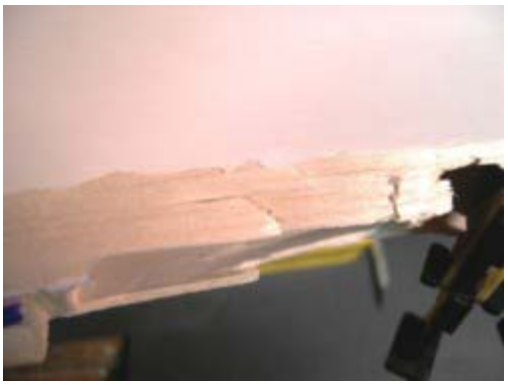



Photo 7 Photo 8

Now is the time to determine just how much sheeting must be removed. Sometimes, it is just easiest to remove all the sheeting back to the main spar. This makes wing rib replacement easier since it is easy to duplicate the rib. It also makes crack repair unnecessary as most cracks will stop at the spar's edge. But it also makes for a big covering patch. This can be especially difficult if a color matching covering is not available (more on this later).

My suggestion is to remove only as much sheeting as is absolutely necessary. The sheeting in photo 7 is just too badly damaged to survive. It is dented, crushed rearward and the cracks have separated the sheeting into individual pieces. Use a metal straight edge and a new, sharp No. 11 hobby knife blade to remove the sheeting as shown in photo 8. Do this on both sides of the wing.

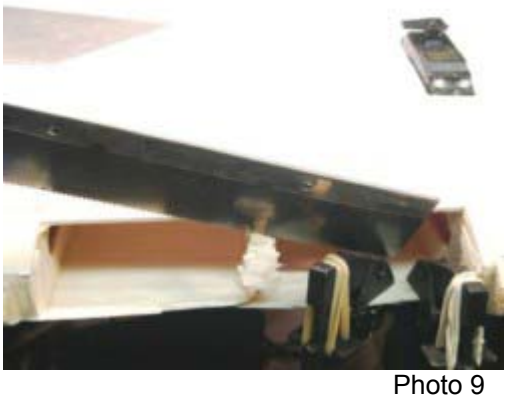
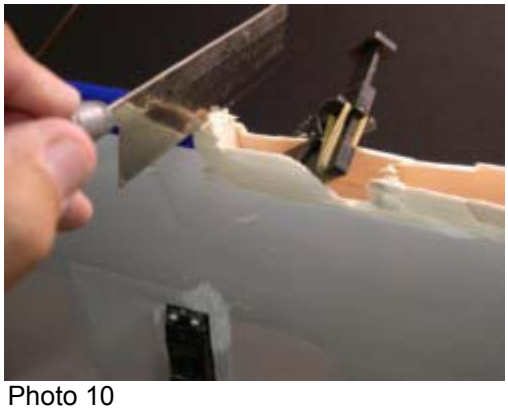



Photo 9 Photo 10

If part of a damaged rib protrudes after the damaged sheeting has been removed, cut it away using a razor saw as shown in photo 9. Then use the razor saw to carefully cut away any remaining damaged leading edge parts right up to the first sound wing rib as shown in photo 10.


Photo 11 Photo 12

Use a small sanding block to make sure the remaining sheeting edges are straight (photo 11). Also use this sanding block to remove any “burrs” from around the side wing ribs (photo 12). The final result should be an opening with straight edges on all sides as can be discerned in the following photos.

The damaged rib is going to need replacing. In addition, two outer rib pieces will need to be attached to the existing outer ribs to provide a gluing surface for the new leading edge. In this case, three new front ribs are required. If the sheeting was removed all the way back to the main spar, these ribs would be easy to manufacture. Just hold a piece of 3/32 in. balsa against the good rib and trace its outline.

Then subtract 3/32 in. (making room for the sheeting), from top and bottom along the curve. Note: this only works for wings with a constant wing chord, front to back distance. But most trainers have a constant chord wing and this article in meant to repair those types of wings. Tapered wings that have leading or trailing edges that narrow use a different technique. It is called PICKING UP *ALL* THE PIECES AT THE ACCIDENT SITE. Then re-construct the missing rib(s) as best as possible from the pieces and trace a replacement.

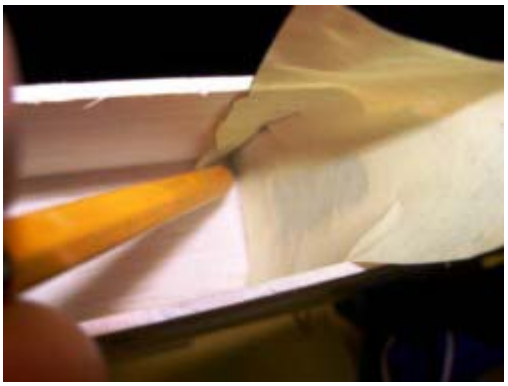



Photo 13 Photo 14

But our wing is a constant chord wing and the sheeting did not need to be removed all the way back to the spar. In this case, insert a small piece of tracing paper into the opening and up against the good outer rib (photo 13). Run a fairly sharp pencil along the edges as shown. Remove the tracing paper and cut *outside* the line. Trial-fit this paper rib template back against the good rib and make any final adjustments. Put the template onto a piece of 3/32 in. balsa sheeting and cut outside the template as in photo 14.


Photo 15 Photo 16

Make sure to mark the top side of the rib. The final result will be a really ugly tracing as shown in photo 15. Cut this out, again cutting outside the lines, with a sharp hobby knife. Then use the sanding block as shown in photo 16 to sand along the curve, never across it, down to the lines. This makes for a nice, airfoil shaped replacement rib.

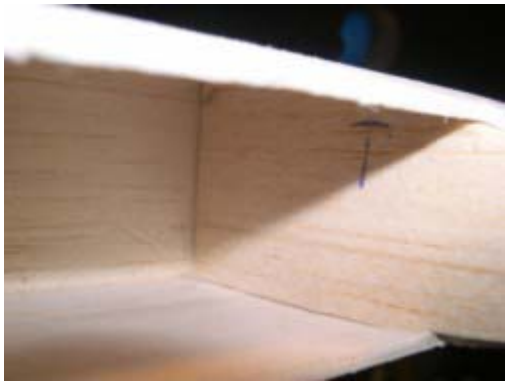



Photo 17 Photo 18

Trial fit the rib into position. Look closely at photo 17 and you will note that the rib is canted towards the camera. It is slightly too large to fit because all the cutting was done outside the lines. Material can never bee added to a too-small piece but we can sand away extra wood. Make small sanding adjustments until the rib fits perfectly.

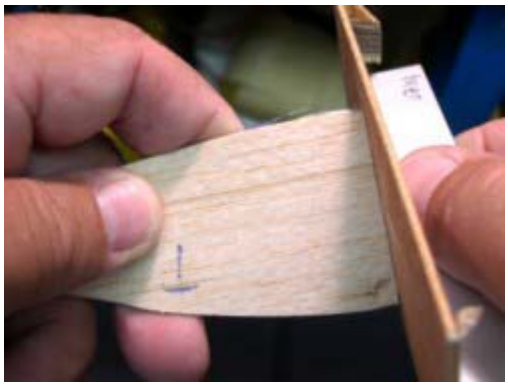


Photo 19

If just a little too much wood was removed, try sanding the back of the rib as shown in photo 19. Remove a very small amount of wood and test again. By sanding the rib back, the thicker

portions of the curve are moved rearward. This may help fill in any large gaps. Fortunately we made the rib longer than needed just for this eventuality.

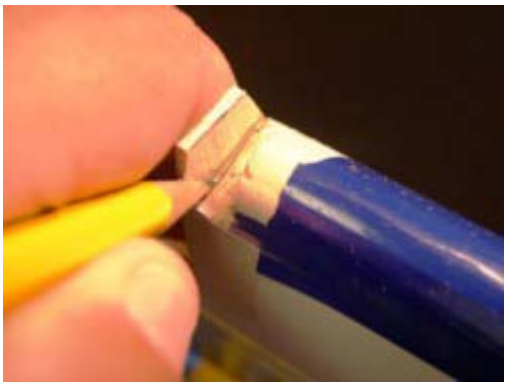
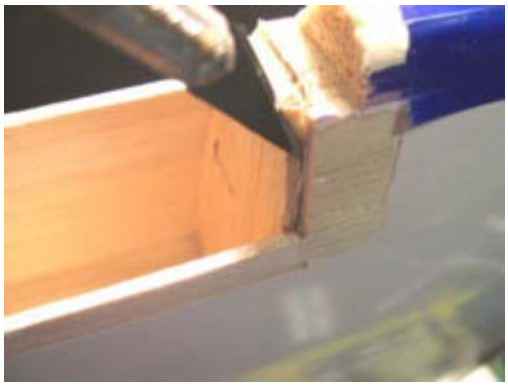



Photo 20 Photo 21

The final step is to position the wing rib in place against the existing rib. Mark where the front edge should be (photo 20), remove the rib and cut at the mark. Then replace the rib and carefully cut the portion outside the existing sheeting to its proper airfoil shape by blade tracing the underside of the sheeting next to the repair area as shown in photo 21.


Photo 22 Photo 23

Now we just need two more identical ribs. Make them from the rib you just constructed, not from the template. The fitted new rib is now a more exact template than the drawing. Place the rib on a piece of 3/32 in. sheet balsa and cut around it. Did you know that there is a hobby knife blade just about “made” for this purpose?

I don’t know what the No. 616 blade shown in photo 22 was originally designed to do, but I do know that it is great for trace cutting. The cutting edge goes against the bottom piece and the higher, dull edge, rests against the piece being traced. This protects the template while cutting an exact duplicate. Make as many ribs as required using this method. Then put them together and lightly, very lightly, “block sand” them to the same shape as shown in photo 23.

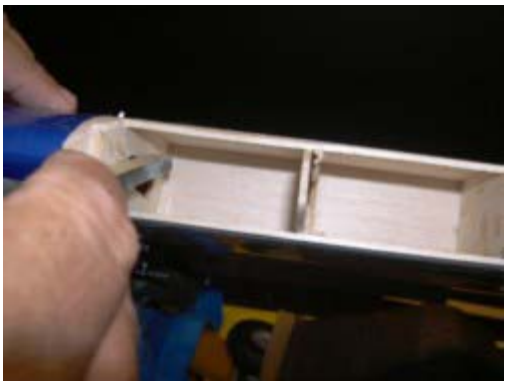
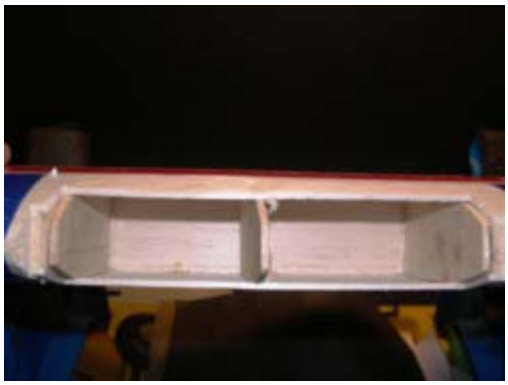



Photo 24 Photo 25

If necessary, make a small sanding stick out of some scrap balsa by gluing 180-grit sandpaper to it. Use this to sand away any adhesive residue form the repaired rib (photo 24). Apply carpenter glue to the sheeting areas that will come in contact with the new ribs. Then glue the ribs in place against the existing ribs and part ribs, using thick CAA. The carpenter's glue allows more setting time than would CAA and is fine for sheeting application. Since the new ribs are quickly held in place against the old by the fast-drying CAA, no building time is lost. The final result should look like photo 25.


Photo 26 Photo 27

By now the leading edge laminate should be dry. Place it in position, mark the cut length (photo 26) and cut outside the line. A little final sanding may be required, but again, too much is better than to little when fitting. The leading edge should fit tightly, but not be forced into position. Forcing it in place could cause a warp in the wing panel and that is not the best thing to have happen. Snug, but not tight, is the ideal fit. Notice that the leading edge is perfectly centered on the rib ends. If the leading edge "rocks" slightly, the center rib is too long. Gently remove excess wood by sanding.

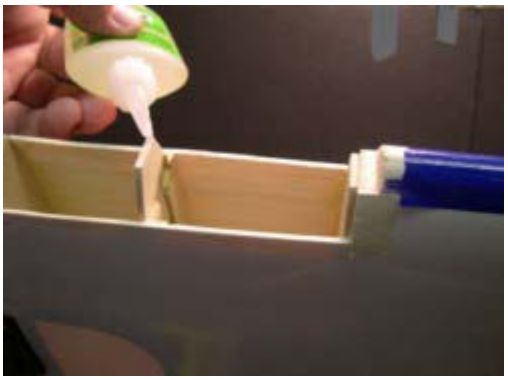



Photo 28 Photo 29

Use thick CAA to glue the leading edge in place. Apply the adhesive to the rib ends and to the existing leading edge ends. Protect the existing parts of the wing using low-tack masking tape (photo 29). Once everything is firmly in place, sand the front of the leading edge to the same thickness as the existing one.

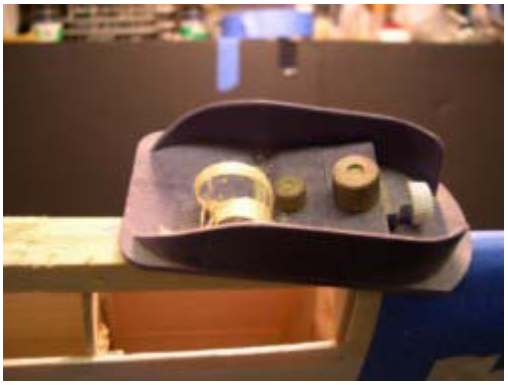
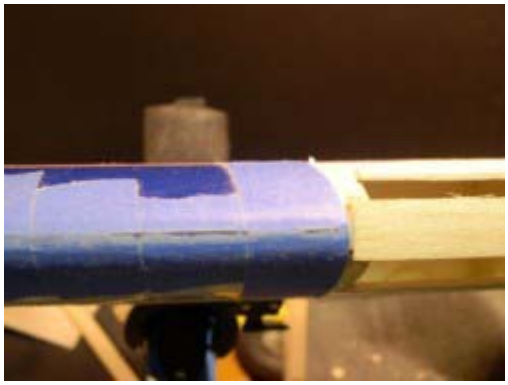



Photo 30 Photo 31

This is a lot of sanding. You may want to use a hobby razor plane for this task as shown in photo 30. Don't try to shape the leading edge yet, just make the front flush with the existing leading edge (photo 31).

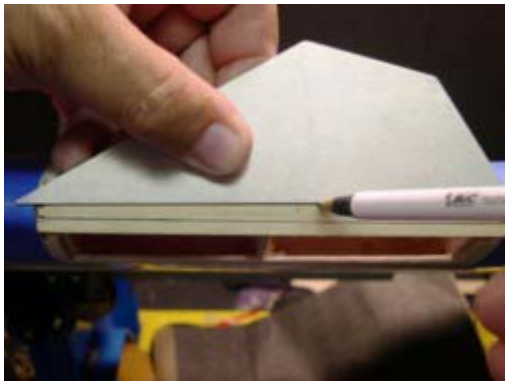


Photo 32 Photo 33

Study photo 32 carefully, click on it to make it larger, and note that a small part of the broken leading edge is not sheeted. This was the part that you measured to when determining the old edge's thickness. This same non-sheeted area exists on the leading edges remaining on the

wing. Remove the two pieces of tape protecting the existing leading edge nearest the repair and mark this non-sheeted area on the replacement leading edge. Then draw, in ink, two lines enclosing this open area across the new edge as shown in photo 33. These are you sanding limit marks. Replace the protecting tape pieces with new tape.

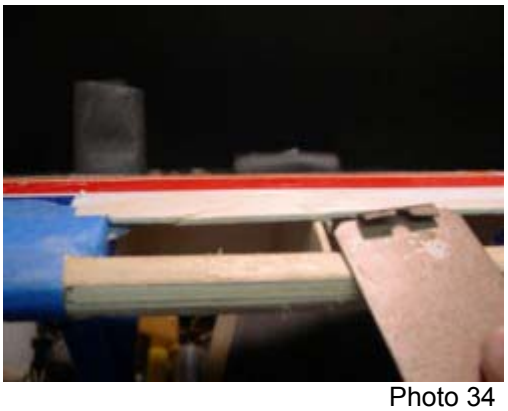
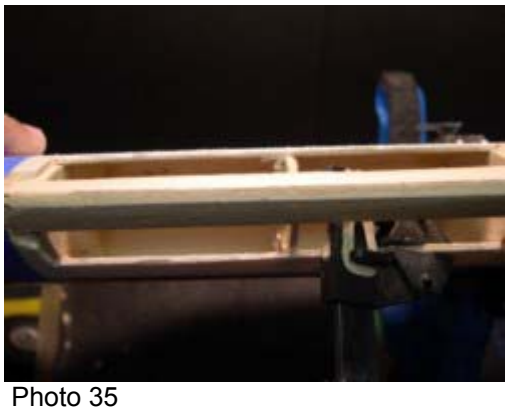



Photo 34 Photo 35

Use a sanding bar or block to sand the leading edge. Sand from the top of the ribs to the sanding limit marks in a straight line. Do not curve the leading edge, that comes later. Start by sanding the part opposite the center rib(s) and then do the edges. Then match sand the middle parts. Use a small sanding block along the length to insure everything is even. Do this top and bottom, if the wing is not flat-bottomed, until the end product looks like photo 35. Do not sand past the ink lines on the new leading edge.

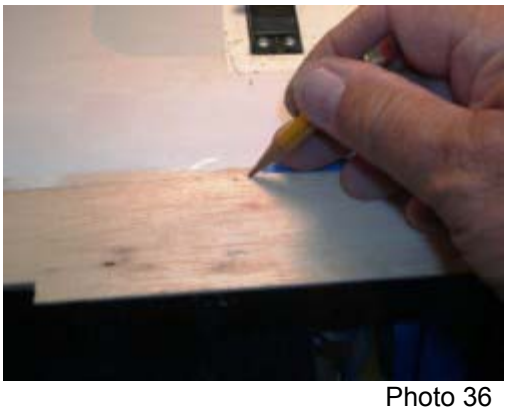



Photo 36 Photo 37

Cut a small piece of sheeting to fit the bottom opening. Make it about ½ in. deeper than is needed to reach from the existing rear sheeting to the front of the new leading edge. Position it and mark the location of the wing ribs under it (photo 36). Apply Ambroid cement on the new leading edge and on the trailing and side edges of the replacement sheeting (photo 37). Glue the sheeting in place using thick CAA on the rib tops. Fill any side holes with small sheeting pieces held in place with CAA.


Photo 38 Photo 39

Hold the sheeting in place with pin clamps, and regular modeling clamps if required, until the Ambroid dries. Be sure to pin clamp the sheeting over each center rib. That is why you marked their location. On larger sheeting repairs, it might be a good idea to glue a 1/16 in. balsa shelf under the existing rear sheeting. The shelf should protrude out about ¼ in. from under the old sheeting. This provides extra gluing area for the rear of the new sheeting. But the few inches required for this repair did not require reinforcement. Once the sheeting dries, cut the excess sheeting away (photo 39). Repeat on the other side of the wing.


Photo 40 Photo 41

Once everything is dry, remove the pin clamps. You may be left with some very ugly looking sheeting (photo 40). There is a closely guarded, long held modeler's secret to removing most of those holes and dents. In a weak moment, many "Old Timers" will usually tell it to you but then they have to kill you or something. But since I can't reach you from here, you are safe.

Simply inject, or place, a water drop over and into each dent and hole. Wait about two minutes and then hit the spot with a model covering heat gun on high (photo 41). The water inside the wood instantly expands into steam, returning the wood to its previously un-dented state, before venting out to the atmosphere (photo 41).

Photo 42 Photo 43

The final result, shown in photo 42, is an almost smooth piece of wood that needs little filling. But some areas will still need filler. For years, I used regular lightweight spackling compound. It worked well but could be seen in bright sunlight under light colored coverings. Then I tried the filler in photo 42. This wood-colored filler has more solids than commercial spackling, is stronger with less shrink and dries much faster. It is also invisible under any color covering. Apply the filler of your choice into all the dents and cracks as shown in photo 43. Allow to dry for about 30 minutes.

Photo 44 Photo 45

Using a 12 in. sanding bar, sand the repaired area to its curved, airfoil shape (photo 44). Sand from back to front, never side to side. Use the existing sides as your guide but remember to protect them with tape. Once this sanding step is completed, the airfoil is the correct shape but is also the thickness of the tape too high. Use the smaller flexible sanding block to remove this extra thickness (photo 45). Sand back to front while following the airfoil's curved contours. This sounds hard but is almost a natural reflex action and very easy to do. You are only removing a tiny thickness of material. Just a few "swipes" of the sanding bar is all that is usually required.

Photo 46

When finished, your wing repair will look like photo 46. There are no gaps. The different colored areas are Ambroid adhesive, filler or different wood colors. None will show through the final covering. In fact, only applying the final covering is required. But that can be a problem with some ARF aircraft.

It is not always possible to find an exact color match for some ARFs. Some are easy. Hangar 9 aircraft are covered in Ultracote®. Great Planes ARF airplanes are usually covered in Monokote®. Replacement covering is always available for these airplanes. Many other brands are covered in Oracover®. However, different countries have different hues of the same color.

This aircraft was covered in “Chinese Oracover” and an exact match could not be found. One color of Ultracote came very close and was used to cover the center wing joint during initial construction. We will probably use that covering for this repair. But since a few other covering areas were also damaged, this wing’s final fate will be a total recovering project. And that is another article.

When finishing your repair, remember to clean the covering surrounding the repair with denatured alcohol to insure a good covering bond. Also use a tack cloth to remove any sanding dust from the repaired area before applying the covering.

But I Only Have a Few Dents?

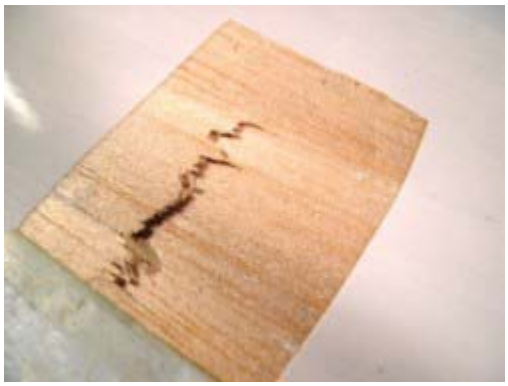


Photo 47

So you were more fortunate and didn’t crunch your wing, just caused a few dents. Consider yourself very lucky but treat those “dents” with respect. Wing “dents” are really cracks in the sheeting (photo 47). And these cracks can weaken the wing and may cause structural failure. Fortunately, there is a way to fix this problem with minimal effort.

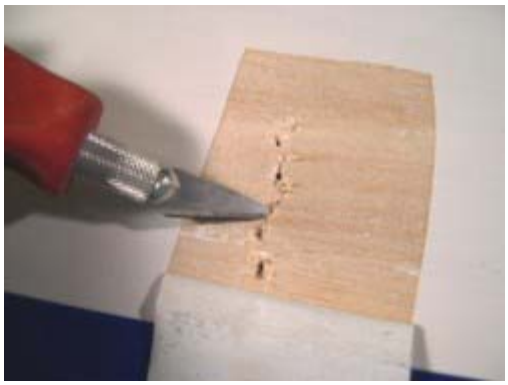


Photo 48

Remove the covering from the “dented” area. Use a hobby knife to gently pry the lower part of the sheeting upwards (photo 48). Be careful not to push the high side downwards. Don’t worry about the holes left by the knife blade. They are actually an important part of the repair process.

Photo 49

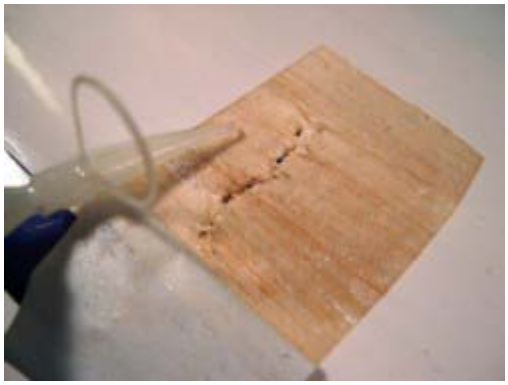


Photo 50

As you pry up the recessed sheeting, you will probably notice that there are many stress cracks in the sheeting. These are not visible once the “prying” is finished as the sheeting returns to its natural state and holds the wood fibers together. But the stress cracks are still there.

Apply thin CAA as shown in the photos to both sides of the crack. Apply the adhesive to at least 2 inches on each side of the crack. This process “welds” the stress cracks together as the thin adhesive wicks along the wood grain and open areas. Notice the darker areas in the two photos? These are actually stress cracks that have been repaired by the CAA.


Photo 51 Photo 52

The thin CAA also glued the crack fibers to each other, but it is a very weak bond. However, the bond is strong enough to keep the two sides together during final repairs. Make a small sanding block using scrap wood and 180-grit sandpaper as shown in photo 51. Sand smooth the area where you applied thin CAA.

Remove the sanding dust. We can't use regular filler here as it has no strength to hold the cracked edges together. It is just filler after all, not adhesive. Instead mix up some 5-minute epoxy and then add micro balloons. Micro balloons are actually microscopic hollow glass balls. Add enough micro balloons, be careful not inhale them or get them in your eyes, to make the resultant epoxy mixture very thick. There should not be a lot of flow to the mixture.

Photo 53

Use a ½ in. chisel blade or putty knife to apply the mixture into the crack (photo 52). Make sure to get the mixture into all the holes made by the knife blade during the initial repair step. Remove all the excess "filler" before the epoxy starts to harden. While sanding is possible, it can be difficult. Epoxy, even with micro balloons added, is hard to sand. Remove all the excess (photo 53).

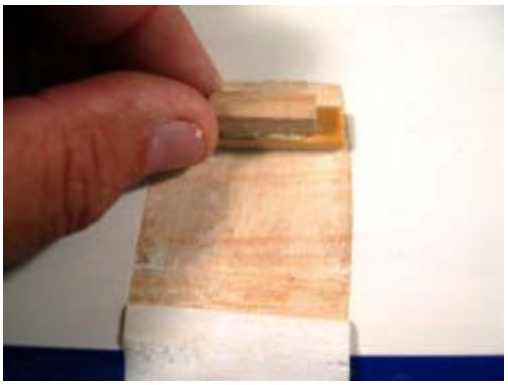
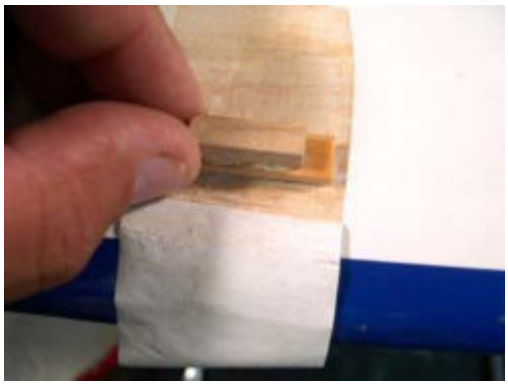



Photo 54 Photo 55

Wait about 8-10 minutes after the epoxy mixture has hardened. Then lightly sand with a small sanding block fitted with 400-grit sandpaper. The epoxy has not yet fully cured and is a bit easier to sand smooth during this time. Sand from back to front as shown in these two photos. This maintains the airfoil's curve as much as possible.

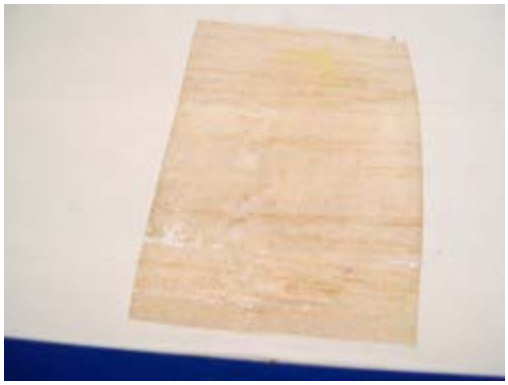


Photo 56

The final product should be smooth and strong. The epoxy holds the cracked edges together despite flight stresses. The micro balloons help prevent the epoxy from cracking during hardening and also make sure the adhesive bridges the gaps. Just recover this area with matching, or near matching, covering.

This process seems long but really only takes about two hours, not counting dry time. The final repair is nearly invisible