INTERIORS
THE INSIDE STORY PART IX

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REPAIRING HEADLINERS

As if working on your side panels last month wasn't tedious enough, we now move on to headliners. I'm amazed at how a company that had it so right could, in one year, get it so wrong. I'm referring to the headliner design change introduced by Beech in the early 1970s. I wonder if they consulted with the mythical "sky is falling" character Chicken Little. Or maybe they took the line in *The Graduate* about getting into plastic a little too seriously.

OLD HEADLINERS

All kidding aside, we need to talk about this large two-piece, semi-rigid, very temperature-sensitive headliner used by Beech for about a decade.

Almost everyone who owns an affected Bonanza, Baron, or even an occasional Duke has experienced some (if not all) of the following problems associated with these unstable headliners:

1. Being nonthermal-setting, the material becomes quite soft in hot weather and over time will sag and pull away from its mounting points, and assume a very distorted shape.

2. Twenty years of thermal activity results in shrinkage, often causing a pronounced gap between the forward and aft sections of the two headliner panels.

3. In the first year this new headliner design was used, the window frames in the airplanes did not cover the edges of the headliner where it met the top edges of the windshield and pilot and copilot windows. When the material deforms and shrinks, it pulls away from these places, creating unsightly gaps and irregular edges.

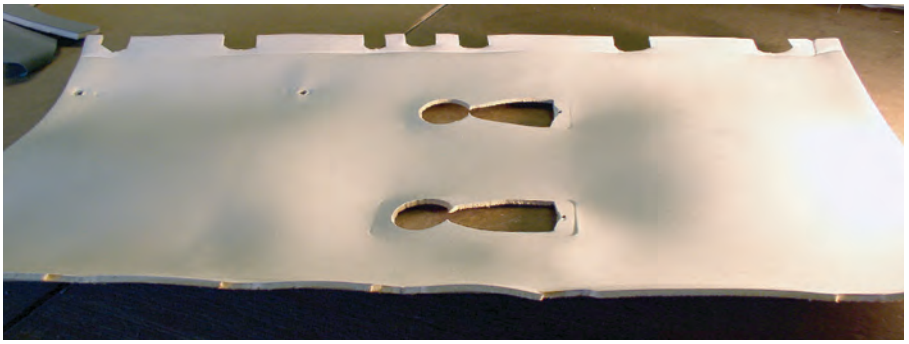
4. Age also creates a cracking problem, a result of the material becoming quite rigid and brittle as the plasticizers gas off.

5. As this headliner material loses its shape, it puts stress on the adjoining nonthermal-setting plastic window trim, causing it to also deform. You've all seen those wavy edges of the upper window trim where it meets the headliner in these '70s airplanes.

In all fairness to Beech, these problems were not foreseeable at that time. Materials manufacturing companies probably didn't know how time would affect their products. Cost and weight demands were bearing down hard on all aircraft manufacturers. It's easy for us to analyze and second-guess things; after all, hindsight is 20/20.

As with many situations, time, skill, intuition and money can do more than just fix problems; some things can actually be made better than new. So grab your tools and let's get started.

The first step is to get the headliner panels back to their designed or original shape. What is bad about this headliner material is also good. Being nonthermal-setting, heat can be used to make the plastic foam-type material soft and supple, allowing it to be remolded back to its original shape. The challenge here is *controlling* that shape, and that means making a mold or form.



Typical distortion caused by years of thermal cycles.

Reshaping the headliner panel on a wood form.

Wood formers and plywood assembled into an arc shape identical to the cabin top works great. With the panel placed on the wood form, heat is applied with heat guns until the material becomes soft. Then a sheet of .040" aluminum is form-pressed against the back side of the material, holding it evenly and firmly in place as the material cools and assumes its proper shape.

This process is repeated a section at a time until the entire panel is completely reformed to be as it was when new.

Rolled-edge headliners—The very first generation of headliners made from this material are particularly challenging due to the headliner material rolling into the edge of the windows as mentioned earlier.

Beech quickly realized the problems this caused, and redesigned the window frames to go completely around the upper windshield and window areas.

For those of you with this rolled-edge headliner, four extra steps must be added to the reforming process:

First, the formed edges of the panels are often cracked or torn and must be repaired with the polyfix and fine mesh fiberglass process described in our side panel article last month.

Second, the edge must be heated and reformed to meet the contour of the window or windshield edge.

Third, since some shrinkage has probably occurred, there is often an unclosable gap still existing at the upper windshield edge. Here a 5/8" diameter windlace cord covered with headliner material and tapered at the outer corners works well to aesthetically fill this gap.

Fourth, secure the edges at the top of the pilot's window and by the cabin door with two or three upholstery screws. This properly secured material will no longer be affected by future heating and cooling cycles. Waves and gaps are history!

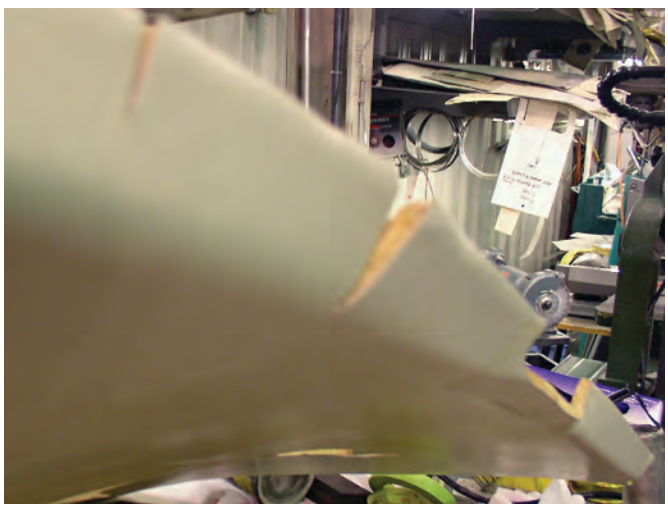
Making certain headliner stays in shape—With the headliner back to its designed shape, it's time to make certain it will not deform in the future. To ensure this, we bond .020" 2024 T-3 aluminum to the back surface of the headliner panels. For proper shape, it's important to place the headliner panel on the wood form while the aluminum panels are bonded in place.

A little trick: On some airplanes, a kink can develop where the air vent nozzles pull the headliner firmly up into place. We use a small cutting wheel to cut slits in the rigid aluminum backing. This allows just enough flexibility to minimize this kinking. Be careful to make very shallow cuts into the aluminum only.

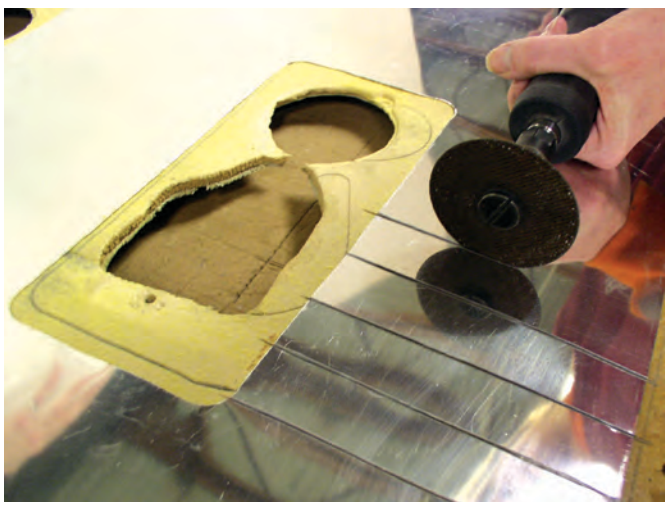
If the headliner was not in too bad a shape to begin with, this process will leave the finished side looking perfect. All you need to do is prep and spray it with the new interior color, or stretch and bond a headliner material on the undamaged surface.

If light kinking has occurred, a little heat may bring the surface back to a presentable condition. If that doesn't do the trick, light filling can be done with traditional flexible auto body fillers. However, this will modify the textured surface of the headliner, making some type of covering process a necessity.

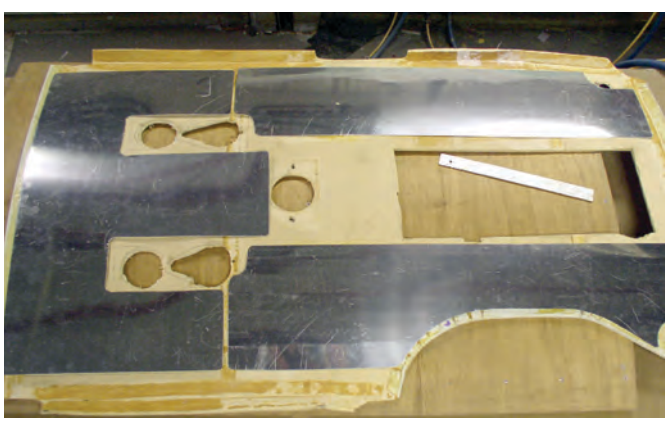
If severe surface damage has occurred, such as gouges or deep cracks, a very thin 1/8" layer of insulate or urethane foam must be bonded to the headliner. This will present a smooth soft surface that will hide all the imperfections on the old surface. Due to the thickness of the foam, it will be necessary to remove some of the original foam backing so you can reinstall the thread-mounted air vent outlets. A router bit on a moto tool works great for this task!



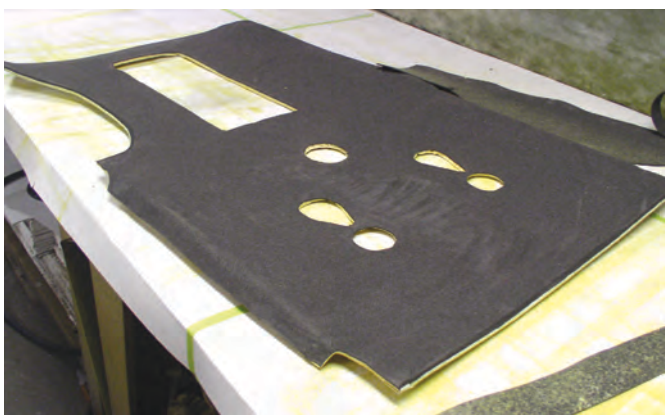
Typical cracking at the edge of an earliest generation plastic headliner.



Cutting the kink-eliminating slits in the bulging aluminum.

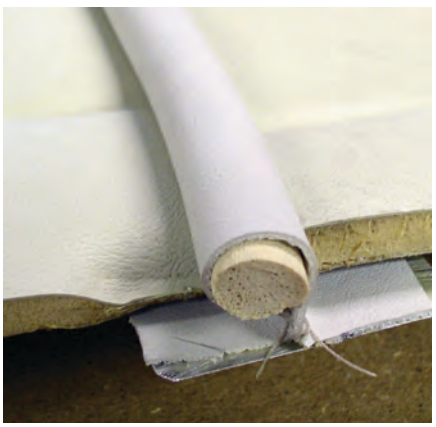


Aluminum backing bonded to the reformed headliner panel.



One-eighth inch foam padding applied to a headliner with a badly damaged finish surface.

Fixing the gap between headliners—Fabricate a 3-foot piece of windlace cord with two parallel stitches about 3/32" apart. Bond this to a 2" by 30" strip of .025" 2024 T-3 aluminum to create a standing bead of finished cording that can be slid in place to fill the gap. This cording material will expand and contract with temperature changes to create a pleasant-looking and permanent fill piece, eliminating the unsightly gap between the two large headliner panels. Sometimes you luck out. We've been using these techniques for 30 years and no failures to date!



Gap-filling windlace strip.

Typical mess caused by the bad backing foam.

Poorly secured light and vent mounting rings. Note the broken switch retainer.

CURRENT HEADLINERS

So much for Round One. It's time to move on to the last and current generation of headliners. This design is the better designed and constructed of the two types of plastic-material-based headliners. Not only is the headliner made of a more stable (though somewhat delicate) material, the air system is far more efficient in terms of the volume of air it can move.

That said, Beech did take some shortcuts that resulted in a few problems. *First,* the dropped-center design of the headliner creates two concave shapes that present the potential for any bonded finish material to pull away from the headliner as the material ages and begins to shrink.

The *second* problem is that Beech used a finish material that was bonded to a urethane foam backing that tends to break down when exposed to temperature changes and unfriendly chemicals in the atmosphere.

In as few as three years, some of these headliner coverings will begin to fall down, leaving behind a mess of black degraded foam that has the consistency of warm bubble gum. Add to this a tenacious layer of gooey adhesive originally used to bond the material to the headliner, and you have about a six- to eight-hour clean-up job involving lots of lacquer thinner, rags, scrapers, abrasive pads and patience.

The *third* big issue with these headliners is the way Beech rather poorly secured the threaded rings that hold the vent nozzles and light fixtures to the headliner. By design, these rings were intended to be structurally secured to the headliner with plates and screws, evidenced by the fact that they contain mounting flanges and holes. But to save time during assembly at the factory, Beech chose to glue them in place with a crudely applied bead of RTV silicon sealer—bathtub caulk, no less!

If a nozzle or light were removed for repair, and the delicate adhesive failed when reinstallation was attempted, a person would have to remove the headliner, disassemble and resecure the mounting ring, install the nozzle or light, and then reassemble and reinstall the headliner—six to eight hours for an experienced technician.

The real fix—In case you haven't noticed, I love making things better than

when they were new. Get out your rubber gloves and a charcoal paint mask. With the headliner face down on a workbench, remove the back side air duct access panels, the air outlet nozzles, lights and switches. Then turn the headliner face up and lift off the vinyl finish skin.

Before applying any lacquer thinner, you'll need to scrape off as much of that degraded foam mess as possible. A 1½" wide thin putty knife seems to be the tool of choice for this. Now you're down to the obnoxious adhesive I mentioned.

Brush on generous amounts of lacquer thinner and also place thinner-soaked rags on, one section at a time. Let the concoction soak for five to ten minutes. You can move ahead and apply your soaked rags to the next area, and while they're in place, go back to the previously soaked section and start scraping.

We use about a 6" piece of .040" aircraft aluminum to doggedly scrape away the now somewhat-softened adhesive from the surface of the headliner. Hint: Use an old cardboard box as a repository for the old foam and adhesive because you'll never get that gunk out of your garbage can.

Once most of the adhesive is removed, you can use an abrasive pad and more lacquer thinner to remove most of what's left. (I plan to buy stock in some lacquer thinner company.) Finish up with rags and thinner, and the worst is behind you.

Be sure to get all, and I do mean ALL, of this stuff off. Even the smallest amount of this awful material will be a real mess on the new headliner cover. (If you like doing this job, give me a call – you're hired!)

It's likely that you will uncover some cracks and creases in the headliner structural material, since it's the same composite material as the late-style side panels discussed last month. Use the cyanide acrylite repair method as required.

Light & vent mounting rings—Now it's time to properly secure the light and vent mounting rings. The vent rings are the easiest to do since they have mounting flanges and holes at their outer edges. An 8-32 countersunk screw and self-locking nut, two holes and you're done.

The lights require the fabrication of a .050" 2024 T-3 aluminum mounting plate with an 8-32 sized hole at each corner and a precisely sized hole in the center that will seat against the flange on the light's mounting ring.

You will notice that the lights have a clear plastic air seal bonnet that is secured to the threaded light mounting ring with RTV silicon sealer.

It is important to also seal the outer edge of the new mounting plate. If you don't, air can leak behind the new headliner and cause it to blow up like a balloon when in flight. I get two or three calls a year on this problem. If you're not sure, seal it.

Push switches—One final mechanical issue is the way the push switches were originally installed. Most often the plastic mounting tubes are not reusable. A short piece of the correct diameter rubber hose and a small screw clamp will securely hold a pesky switch in place. If a switch needs to be removed in the future, just remove the adjacent air vent and loosen the screw clamp through the now open vent hole for easy access to the switch.

RECOVERING THE HEADLINER

It's finally time to actually pad and recover the headliner. To eliminate the challenge of keeping bonded finish materials secured in a concave shape, we upholster the headliner in three lengthwise sections, foaming and covering the dropped center part first. We then bond a 1" wide full-length strip of .040" 2024 T-3 aluminum to the back side of the long edge of the outer cover material.

We secure the strip to the concave part of the headliner with about 60 #6 x

Scraping off the old glue residue.

Properly secured light and vent outlet mounting rings. Note the low-tech, but effective, switch and mounting components.

Inside curve retaining strips.

Finished seam along inside curve of both sides of headliner.

½" countersunk PK screws. We bond a layer of ½" foam to the headliner at the inner edge of the 1" retaining strips. Trim the foam and the outer edge and stretch the finish material outward, and *voila*, you have a beautiful blind-seam, structurally secure headliner that will never come loose in the negative curve area and never drop down.

Cut the holes for and install the lights, switches and vent nozzles. Grind off the standing points of the PK screws and you're finished! The whole process takes about 20 hours, but the results are worth it.

I get several calls a year from frustrated owners, some with three- or four-year-old airplanes and some with fairly new aftermarket interiors, who are experiencing the pulling away or sagging headliner problems. It just reinforces the adage that you'll only have to do the job once if you take the time to do it right.

NEXT MONTH we move down to carpets. It's far less complex than what we've just gone through. I think we're all ready for some easier reading. Fly safe!

Dennis Wolter is an A&P, IA and a 3,000-hour instrument pilot who started Air Mod in 1973 to bring innovative design and high-quality renovations to the general aviation market. Dennis has a degree in industrial design from the University of Cincinnati.