INTERIORS
THE INSIDE STORY PART V

BY DENNIS WOLTER
AIR MOD, CINCINNATI, OHIO

The design is completed, the radios are checked and the airplane is safely tucked away in its workspace. So grab your toolbox and let's get started. Here's where the rubber meets the road.

The process of interior renovation actually begins to take two very different tracks at this point. Out in the hangar it's all about interior teardown, component and airframe evaluation, parts ordering, systems checking and information control.

In the sewing room, it's all about the seats being disassembled, evaluated, repaired, re-slung, painted and upholstered. The skills needed in these two distinct areas are quite different, yet they require inter-departmental understanding, communication and coordination.

At Air Mod a senior employee is given the role of job captain for each project. That person is vested with managing and coordinating the entire job, helping to ensure that every detail is handled efficiently and thoroughly.

Before we become immersed in all of the technology, I should stress at this point that, if you're doing this work yourself, it is critical that you follow some guidelines. (I guess this makes you the job captain!)

1) Stay organized. As I covered in Part IV, you need to have a parts identification and storage system in place from the get-go.

2) At project start, check everything for fit and function before any components are removed.

3) Take notes and/or pictures of how it all goes together, especially small details such as seat belt attachments, door handles, etc.

4) Weigh components as they come out and just before they are reinstalled. Changes can add up, and proper weight & balance records must be maintained.

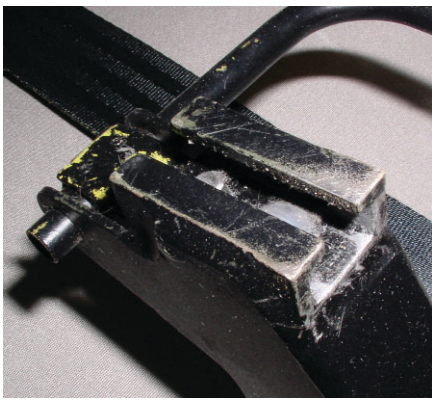
5) Save invoices, receipts and FAA paperwork so that proper logbook entries can be made.

BUILDING AND UPHOLSTERING THE SEATS

Since the seats are such a major part of an interior renovation, we'll cover this task first. All seats are checked in the airplane for function and clearance. Seat belts are evaluated for proper length and function before the seats are removed. We make a sketch of how the belts are attached, and then the attachment hardware is evaluated for correctness and condition.

Upholstery, foam and sling material are all removed and the frames are placed on workbench-mounted test rails where we pull and push, latch and unlatch seat stops, and cycle all reclining mechanisms. This will reveal any cracks in the frames, mechanical anomalies and non-functioning or worn parts.

Seat frame being checked on bench-mounted test rails.



Inspect the seat tracking stop mechanism very carefully as this is a major safety item.

All discrepancies are put on a list that is included in our initial "teardown report" to the customer, at which time a plan is implemented to make necessary repairs.

If you are doing your own interior, or having the foaming and sewing done by an automotive shop, this seat frame evaluation and repair process is best done by your A&P. Since seat repair issues often come up during annuals, your mechanic is more familiar with repair processes and parts sources than a commercial upholsterer would be.

SEAT FRAME REPAIRS

Most seat frame repairs involve worn parts replacement or component adjustment. As our airplanes are aging, we're finding more cracks in the frames.

There are two groups of piston Beech seats: pre- and post- P model. The earlier pre-P model seat frames were fabricated entirely of chromemolydenum 4100 series steel structures that were gas-welded together. They are the most damage prone and unfortunately, Raytheon has all but abandoned them in parts support. So we're on our own to fabricate new repair parts and weld the frames as necessary.

Since the seat frames hold the seat belts, proper materials, techniques and FAA paperwork are absolute necessities. Sounds intimidating, but a few simple rules can make it easier.

1) If repair of the seat frame requires welding, use a professional welder.

2) Mig or tig welding is best, as these methods allow for better heat concentration, resulting in a stronger and more controlled weld.

3) Use the correct materials and welding rod alloy. You can weld almost any ferrous material with an old piece of a coat hanger, but the tensile strength of coat hanger wire is a fraction of that of an appropriate high-tech welding wire. It's all about the weakest link!

4) Get an FAA approval. If a new seat latch must be fabricated, for example, it can become an approved part by following the procedure in FAR 21-303, paragraph B2, "Parts produced by an owner or operator for maintaining or altering their own product."

"What? I can have my own parts approved?" Yes, you can. The FAA realizes that perfectly airworthy older airplanes shouldn't be grounded for the need of an out-of-production component that can be properly fabricated in the field. The owner submits a signed request to a qualified A&P or FAA-approved repair station, asking that the component in question be fabricated as a duplicate of the original.

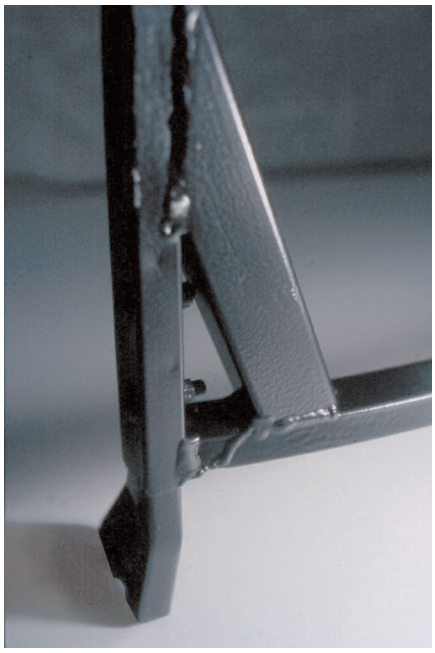
The mechanic or repair station must then research the component as to original design, material, function, fabrication process, etc. and produce the part accordingly. (Everything must conform to AC 43-13-1B.) This data is included in the resulting logbook entry with a reference made to the owner's request. Such a deal!

Fortunately most structural seat repairs just involve repairing a crack in the frame. The wise person will go beyond simply welding the crack, and analyze why it occurred in the first place, then provide additional reinforcement to keep it from recurring. Often it's as easy as adding a corner gusset as shown in the photo.

MECHANICAL FUNCTIONS

With the structural frame squared away, the mechanical functions of the seat are evaluated. Pay careful attention to the tracking stop mechanisms for condition and adjustment. We often see weak springs and misadjusted stop pins. Problems here can lead to disaster, especially during takeoff. Also, check the seat tracks, making sure that the latching holes aren't worn and are free of dirt buildup.

Seat back bottom tube completely broken away.



Repaired seat frame weld with a gusset added to prevent another failure in the future.

Next, test and inspect seatback reclining mechanisms, which come in three types:

1) Pin and hole latches were used in earlier seats, most of which have been repaired a time or two over the years. Close inspection is essential.

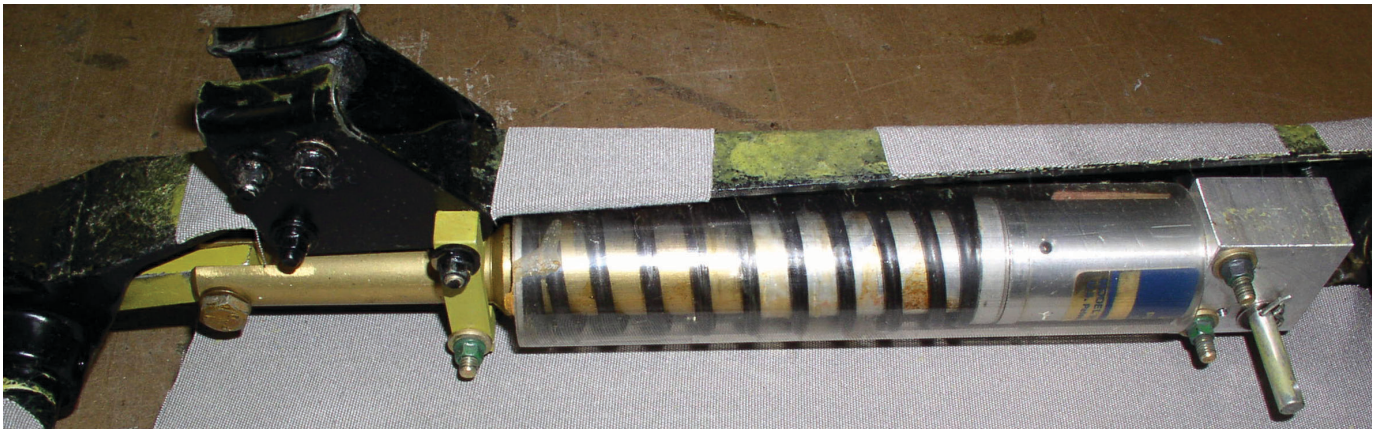
2) Three-position cam types are common in P model and newer airplanes. Missing roll pins, broken return springs and worn cams are all common problems with these mechanisms.

Early design pinhole-type latching is very prone to problems.

Current production three-position cam type seat reclining mechanism very reliable.

This is an easy way to remove a broken roll pin.

A TRICK WORTH KNOWING: The cams are secured to the shaft by hard-to-remove and often broken roll pins. You can remove the roll pin that secures the cam to the shaft by center-drilling a #30 hole from the top face of the cam down to the top of the old roll pin, allowing you to drive the pin out of the cam and shaft assembly. Works great and doesn't affect the function or life of the cam.



Current production hydrolock type reclining mechanism is very good design.

If excessive cam wear is evident, new ones are in order. Remember, having a seat back slip to a reclined position at rotation or during flare at landing could certainly make for a bad day.

3) Hydrolock-type mechanisms are basically a hydraulic cylinder and valve mechanism that allows greater range of adjustment travel. The most common problem with these systems is a broken aluminum spur gear. If a seat has a lot of slop in the back travel, it is an indication that the cylinder has lost some if its hydraulic fluid and must be sent out for rebuild.

We have had very good service from G. Nichols Company in Michigan (810-329-7083). The results are great and at a fraction of the cost of a new recliner mechanism. We also occasionally find a problem with the actuating linkage in hydrolock recliners.

TALLER SEATBACKS VS HEADRESTS

If the customer has chosen to have the seatbacks built taller, as an alternative to using headrests, the seatbacks go from our sewing room back out into the hangar or shop. The seatback extensions we make are permanently installed semi-monocoque .050-inch aluminum structures, secured with aircraft cherry max rivets. Very strong! This process does require FAA approval, involving a pull test witnessed by an FAA Designated Engineering Representative (DER).

Be very careful when having a seat

Typical alternate seatback build-up section.

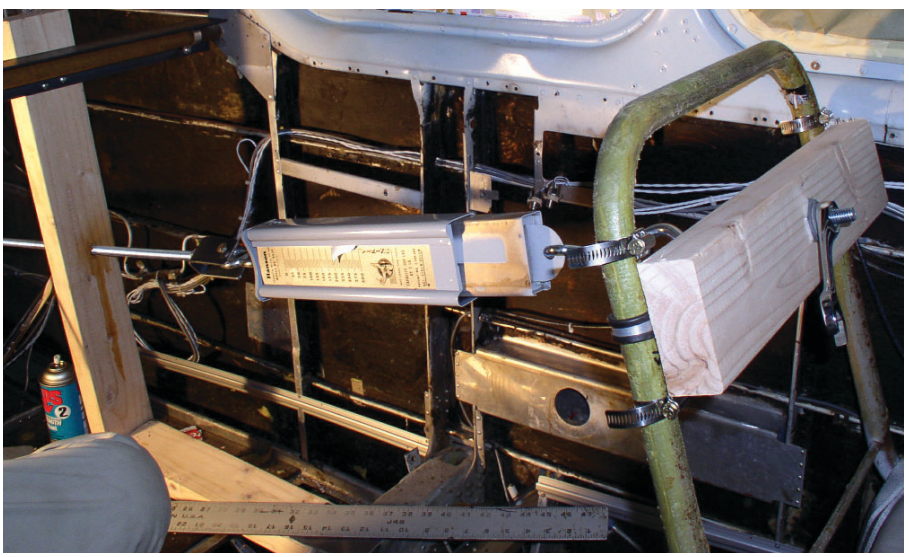
extension done. I receive several calls a year from owners who either have had this done without an approval, or who have been told by someone that an approval was not required. It can be a scary world out there.

REACTION LOAD TEST

There is a reason for requiring an approval: A failed seatback can lead to serious consequences, either during normal operation or during an accident. Accordingly, the FAA has a "reaction load test" that all certified seats must pass to verify the structural integrity of the seatback.

Basically, one must pull the seat back with a 200-lb. force, as measured by a calibrated scale, halfway between the mounting point at the base and the structural top of the seat. If you extend the top by 8 inches, you must raise the test point by 4 inches, because more leverage equals more stress at the mounting point.

Prior to 2002, the FAA permitted their airworthiness inspectors to witness the pull tests, and issue a field approval for this seat mod. But the rules changed



Seatback pull test being performed in a B33.

in 2002, and the FAA now requires a DER study and approval. This means a full engineering drawing of the seatback and proposed modification must be made, with complete materials identification and call-out.

Using this drawing, the DER performs a structural analysis of the modified seatback, and submits the data to an FAA engineering office for a test plan approval. Then the DER must witness the pull test and, if successful, issue an FAA 8110-3 form. This approval document accompanies the FAA 337 form—a copy of which you keep and a copy of which is submitted to the local FSDO. Some things were definitely easier in the good old days!

SLINGS

Before building and installing new seat foam, we install a new sling. Open frame seats (common to most light aircraft) employ a stretched canvas sling system to attach the foam to the seat frame. In time, the canvas stretches, the glue tends to let go and the sling, along with the seat occupant, sags into the frame. Eventually, you will begin to feel the frame pushing into your derriere (not too desirable a situation).

We go to great lengths to build an ergonomically correct seat shape, so a sagging sling represents even more of a problem. If the sling sags an inch or inch-and-a-half after a year or so, all of that carefully planned seat geometry is going to be in the wrong place, and your body parts will be unhappy.

The best system we've developed is to stretch two lengths of seatbelt webbing drum-tight fore to aft on the seat bottom, securing the webbing with contact cement and hog rings at both ends. Then, using heavy Dacron canvas, we stretch a new sling. You now have two structural members holding the foam in place—light, durable and reliable.

In more than 30 years, we have yet to have one failure. Since there is far less pressure on a seatback, only a new tightly stretched Dacron canvas sling is needed.

TYPES OF SEAT FOAM

Before diving into how to build seat foam, we should first discuss the foam itself. The two types of flame-retardant foam commonly used on light aircraft seats are multi-density urethane and thermal-elastic (temper foam). The most common is urethane. It's lightweight, durable and available in multiple densities and thickness.

Density refers to resistance to compression. Light-density foam is very soft, compresses easily and is used as a top layer to give the component a soft and plush feel. Heavy-density foam is used for base builds and high-load areas such as overhangs and corners. Medium-density foams are used for general shape building, lumbar and thigh shapes. These densities are rated 20 for light, 40 for medium and 60-70 for firm.

Since we have the option of measuring a person for a custom seat build, multi-density urethane foam is our material of choice. It gives us precise control and support based on the physical dimensions of the seat's occupant. Urethane foam seats that are properly built to the standard measure of man (talked about last month) are very comfortable for most people.

Thermal-elastic foam, or temper foam, has been around since the '60s. I think the two neatest materials I got to work with during NASA projects in college were Velcro and thermal-elastic foam. Thermal elastic foam can be used to fabricate a comfortable seat for a wide range of human shapes and sizes. But it is more expensive, heavier, less durable and cannot give the precise support that can be obtained with multi-density urethane foam builds.

Thermal-elastic foam is available in various densities indicated by color: green is heavy density, blue is medium, pink is light. When we are faced with fitting a very tall person in a Beech seat, a combination of multiple densities of urethane and temper foam really works well.

If you are doing the interior yourself and are unsure of your ability to build an ergonomically correct seat, temper foam is probably the way to go. It will form to the seat occupant's shape with heat and pressure.

If you fly your Beech airplane in

New sling and reinforcing seatbelt webbing.

the mountains, or in and out of unimproved airstrips, consider thermal-elastic foam for the seat bases. This material compresses at a very controlled rate, giving an extra measure of energy attenuation and perhaps reducing the possibility of a back injury. These materials are available from Skandia, Oregon Aero and Aircraft Spruce.

CUTTING & GLUING FOAM

For cutting foam, we and other professional shops use fast-cutting foam knives that are prohibitively expensive. For a one-time user, an electric kitchen knife will do the job. It's slower going, but with a little patience and practice, you'll get there.

Gluing the foam together presents another challenge. We use 3M #051135-08046 trim adhesive, available through automotive and upholstery supply houses. Don't even consider brushing this adhesive on foam. You will apply too much, and it is quite difficult to evenly spread it over the foam's surface.

We bought an expensive glue pot, but you can apply glue yourself with an inexpensive spray gun. It should hold about a quart of glue, doesn't clog up and, with a little practice, you can do a beautiful job of evenly applying just the right amount.

CUSTOM-SHAPING

In building the seat, we obviously start with the base foam first. Since most of a person's weight is carried by the seat base, two and sometimes three one-inch layers of base foam are needed to ensure proper comfort. We usually start with a one-inch layer of firm (density 70) and top that with a one-inch layer of medium (density 40).

Since space is at such a premium in a Bonanza-derivative airplane, we rarely have the luxury of adding a second layer of medium, although we'd like to. Very little body weight is carried by the seatback, so we usually use a one-inch layer of medium foam for the base of the back.

We now begin to sculpt the seat by adding foam shapes that create the ergonomically correct contours that ensure proper body support. Using the notes taken and drawings made when we previously fit the customer, we cut the various density urethane foam pieces to very precise contours and dimensions. We then carefully bond these shapes to their intended locations on the seat base or back. The seat slowly morphs into the perfect shape necessary to accommodate the customer's back and lower body shape. How comfortable!

Typical base for build.


Finished ergonomic multi-density seat build.

If we are accommodating a tall customer, and are desperate for some space between the seat base and the cabin top, we will often build the seat base foam using one one-inch layer of high-density (green) temper foam for a somewhat heavy customer, or a one-inch layer of medium-density (blue) temper foam if the customer is of average size. We then build the rest of the foam as described above.

PAINTING FRAMES

The final pre-upholstery step in the seat process is to paint the seat frames. The hardest part of this stage is cleaning. Our materials of choice are small stiff paintbrushes, mineral spirits, Scotch Brite pads and a compressed air nozzle. Scotch Brite is much better than sandpaper because it can be worked into tight places and actually sands as it cleans.

We prefer painting the seat frames and other nonupholstered interior trim with acrylic lacquer. It is safe to use, fast drying, durable, repairable and easily custom-mixed to match any interior color scheme.

I do recognize the appeal and durability of powder coating. However, since post-1961 Beech seats contain heat-treated aluminum structural parts, there is a concern that the heat required to implement the powder-coating process might put those components at risk.

It generally takes about 30 man-hours to strip, inspect, repair, sling, paint and foam four Beech seats. It takes a lot of elbow grease, but consider the process to be the foundation upon which a beautiful and comfortable interior is built.

We're off to a good start. See you in the shop next month—and 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, his wife Cynthia and 10 dedicated employees complete about 40 renovations each year at their facility on the east side of Cincinnati. Dennis has a degree in industrial design from the University of Cincinnati.