



Cervical Support

Lateral Support Four Places

Lumbar Support

Thigh Support

Marked image of a taller seat showing the four important ergonomic seat features.

SEAT SLINGS AND SEAT FOAM

Interior restoration expert DENNIS WOLTER discusses the importance of ergonomically correct seats, and describes how to build them from the seat frames on up.

Picking up from last month, there your seat frames are—all fixed up, painted, and sitting on the workbench. So, what's next? In this installment, we will outline how we re-structure and re-foam your seats (and next month, sew your upholstery).

Ergonomics

I think the two elements a pilot relates to most in an airplane are its instrument panel and its interior components. First, the instrument panel obviously gives us very important information about location, aircraft condition, etc., and we all know pilots are proud of their fancy avionics!

Second is the interior, the environment in which we experience the flight. The interior component most important to how we relate to that environment is the seat in which you sit. Ergonomic design is a big factor.

Before we start to build the new slings and foam on your seat, I would like to digress for a moment to tell you how I ended up in the aircraft renovation business. I think you will better understand our approach to interior renovation and seat design.

Despite my limited piloting skills, I convinced a seasoned and rather trusting FAA examiner (with the help of a 75 hp Ercoupe) to issue me a private certificate in 1962. At the time, I was working for an avionics shop at Cincinnati, Ohio's



Canvas seat sling with reinforcement webbing.

Lunken Municipal Airport (KLUK), run by a benevolent character named Joe Babis.

Joe was also a part-time Cessna salesman. On occasion, he would send me south to Louisville, Kentucky, to ferry a new Cessna back to his hangar.

In 1964, I began my studies in the industrial design department at the University of Cincinnati. The industrial design program at the University of Cincinnati is deeply invested in both engineering and human factors studies in an effort to enhance the relationship between humans and the stuff we use in our everyday lives.

What these studies showed me as a newly minted private pilot was that there existed a great divide between what I

was learning in school and the new airplanes I was occasionally flying. The instrumentation layout, noise level, ventilation, and seat comfort weren't much better than the Ercoupe designed by a forward-thinking gentleman back in the late 1930s.

Five years later and out of school, I took a job at the University of Cincinnati Medical College, working in the biomedical communication department. Of the many things we were involved in, producing medical training films was the most interesting.

One project that really resonated with me as a pilot in love with airplanes was a study being conducted using X-ray technology to observe people performing everyday tasks (i.e., standing, sitting, reaching, bending, etc.).

Of great interest were images of people sitting on various types of seats. The side view X-rays clearly showed how the spine, pelvis, and femur responded to various seating situations.

Staring me right in the face was the reason that even new airplane seats were so uncomfortable! When I started Air Mod in 1973, I knew I had to include in the renovation process, a seat designed to correctly support a person's skeletal structure as they sat in that confined space for extended periods.

When one sits in a poorly designed seat (think card table chair or wooden church pew), your brain subconsciously



Top Left: Two-layer seat base foam with tapered 1-inch thick thigh support bonded in place.



Bottom Left: Cutting a teardrop-shaped lateral support.



Top Middle: Seat back with 1-inch base foam and cervical upper back support bonded in place.



Bottom Middle: Seat back with lower back lumbar and lateral supports bonded in place.



Top Right: Correctly tapered headrest on a short seat back, contoured to create a cervical upper back support.



Bottom Right: Seat base with thigh and lateral supports bonded in place.

tells your muscles how to hold your skeletal structure in a comfortable position. After 20 or more minutes, your muscles get tired, and without thinking about it, you shift your seating position to something more comfortable.

Twenty minutes later, muscle group No. 2 is tired, and you shift to a third position, and so on. Pretty soon, all your muscles are tired, and you're more than ready to get out of that seat.

This discomfort is also a safety issue. Fatigue is often a contributing factor in why pilots crash airplanes. Avoiding fatigue-related incidents is the reason professional pilots must adhere to strict duty time limitations.

As private pilots, we have no requirements to limit our time in the pilot seat. For this reason, I believe anything that can be done to reduce fatigue when renovating an aircraft's interior is important from a safety enhancement standpoint.

Better ventilation, reduced noise levels, ergonomically correct seats, state-of-the-art instrument lighting, logical instrument panel design, and electrical system control layout can all add up to a fatigue-reducing

renovated aircraft seats to correctly and comfortably support the human body.

The first issue to address when preparing a seat for upholstery is to install a new seat sling. In an effort to develop

It's not uncommon to find a loose sling in a 40-year-old airplane that has sagged 2 inches or more.

flight environment that can have a positive effect on General Aviation safety.

So, how does all this ethereal stuff apply to your inspected, repaired, and painted seat frames? It's not very complicated. What follows here is all about how to shape the slings and foam in your

a light and strong method to attach the seat foam cushion to the frame; the industry has employed a method of bonding a tightly stretched, coated canvas material to the seat frame.

In time, the canvas material stretches, the bonding adhesive lets go, and the sling

sags. It's not uncommon to find a loose sling in a 40-year-old airplane that has sagged 2 inches or more. That, along with degraded foam, is definitely not comfortable.

Seat slings

Here's how to build a comfortable and durable seat that is up to the job of correctly supporting the weight of a person.

In 1973, we developed a simple, durable, non-sagging, two-part sling system at Air Mod that has withstood the test of time. First, we tightly stretch two lengths of seat belt webbing, bonded and clamped in place to the seat base frame using contact cement and hog rings (available at automotive upholstery supply companies).

We then stretch and bond a drum-tight, heavy Dacron canvas sling over the tightly secured seat belt webbing. The seatback gets only the drum-tight canvas sling. There is no need for webbing on the seatback as that area does not support the major portion of an occupant's weight.

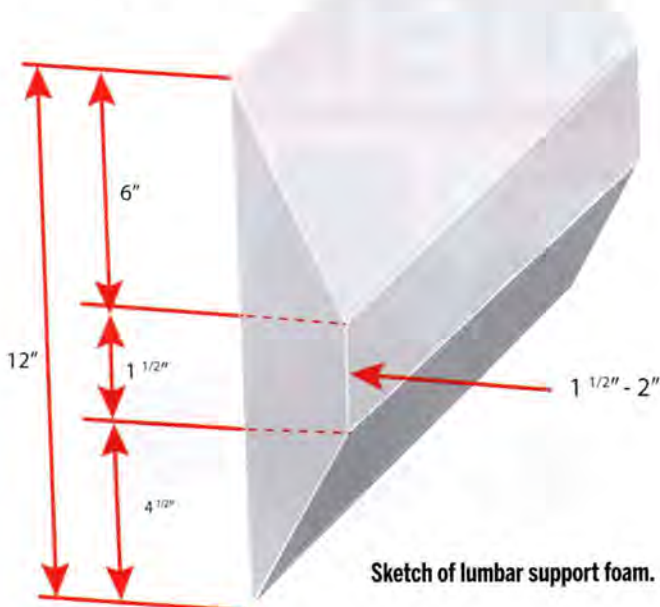
Having followed up with customers over the years, we know this seat sling system has served us well. We're just now beginning to receive seats for repair or reupholstery that we originally renovated in the 1970s and are happy to find that the seat slings are still as good as new.

Fire retardant materials

No discussion of interior renovation would be complete without discussing the importance of using flame retardant materials to enhance safety. In the unlikely event of an in-flight cabin fire, these self-extinguishing materials prohibit the spread of fire, giving you more time to get the airplane on the ground.

Flame retardant materials are available at many local upholstery supply stores. When choosing vinyl, fabric, leather, foam, insulation, etc., check the specification charts usually located on the back of the sample cards. Often listed with various flame specifications for that material will be FAR 25.853a. (*FAR 25.853a spells out the flammability require-*

Rough-cut lumbar support 40-density foam.



Sketch of lumbar support foam.

ments for aircraft seat cushions. —Ed.)

Using these approved materials will make your new interior a major part of the fire suppression system rather than a fire support system. If you plan to have your interior done professionally, verify that the interior shop uses FAR 25.853a-approved materials.

Seat foam

Over the years, the aviation industry has experimented with many different types of foam. Today there are two common types used in our General Aviation airplanes. The most common one is flame-retardant urethane foam. These foams are light, durable, available in multiple densities, and meet FAR 25.853a.

The second foam type in light aircraft use is thermal elastic memory foam, such as that marketed under the name Temper Foam. This foam is sensitive to temperature and will mold to any shape when pressure and body heat are applied.

This temperature-sensitive foam is a great product when the seat cushion must accommodate the weight and contour of numerous people. The downside of this foam is that it is heavier, more expensive, and less durable than urethane foam. For owner-flown airplanes where a seat structure can be built to suit a

specific person, I believe urethane foam is the best choice.

Before diving into the seat foaming process, I think we should touch on the best methods for a do-it-yourselfer to cut and glue this foam. A sharp electric kitchen knife will do a pretty good job of cutting the foam shapes needed to build your new seat cushions. Expect the kitchen knife to cut slowly, but it will do the job. Practice first!

Now, let's talk about gluing foam. Do not attempt to apply contact cement to foam with a brush. The use of a brush will result in the application of too much glue, the outcome of which is a poor bond. At Air Mod, we use a brushable and sprayable contact adhesive sold under the name MC5 (which we buy from Miami Corporation).

This product can be applied with an inexpensive siphon type spray paint gun. It won't clog the nozzle when left in the gun for weeks. Use spray glue to bond together different layers of seat foam.

Foam density (resistance to compression) is identified by a numbering system. We typically use three densities to build our seats; 70 is firm, 40 is moderately firm, and 20 is quite soft.

Building up seat foam

Seat base and back

Let's start by building the base foam for the seat bottom. Using a spray gun, apply a light, even coat of glue to both the top surface of the seat sling and the bottom surface of a 1-inch thick piece of 70-density foam, cut to overhang the outer edge of the seat frame by 1 inch.

Follow this with a 1-inch layer of 40-density foam cut to the same size as the 70-density base foam. This combination creates a durable and comfortable foundation on which to add the sculpting foams that will create the finished shape of the seat.

Next, it's time to bond an oversized 1-inch layer of 40-density foam to the seatback. The seatback doesn't have to support much body weight, so it does not require foam as thick as on the seat

base. We build the seatback foam to achieve comfort but not so thick as to encroach upon the legroom between the seat and the rudder pedals.

With foam on the base and back, we assemble the seat and install it in the airplane to determine where to add some of the foam shapes that will create the ergonomic support necessary for comfort and durability.

Support contours

With all the following ergonomically shaped seat components, the process is based on doing what works for you. We fit all our customers to their seats using these techniques.

If working on a club airplane, or one flown by two pilots, we typically build the seat foam to dimensions known as "standard measure of man." Using those specs results in a seat that would be comfortable for 90% of our American population.

There are three major support contours to build into the new seat: one, a proper lumbar support for the lower back; two, a proper cervical support for where your back and neck transition; and three, a correct thigh support on the



Fitting a customer in his seat in a cabin mock-up at our office.

seat base to hold your legs in a comfortable position.

Lumbar support

The first item on this list is to create a lower back lumbar support, as shown in the accompanying sketch. Start by bond-

ing together two 1-inch pieces of 40-density foam and use the electric knife to create the lumbar support following the dimensions on the sketch on Page XX. Cut slowly, and don't forget to practice on a scrap piece of foam first.

Now, it's time to sit in the seat and temporarily place the lumbar shape behind your lower back. Locate this piece vertically, lowering or raising it slightly, until the apex of the lumbar foam corresponds to the most inward point of your lower back. Once comfortably located, think about how it feels against your back.

If necessary, try adding a 1/2-inch thick piece of foam, or removing 1/2 inch from the apex of the lumbar support piece until you achieve the most comfortable thickness for your lower back. Sometimes, it is good from the start; otherwise, a little trial and error does the job. Most people seem comfortable with a 1 1/2-inch lumbar support.

Cervical support

Now, we address the upper part of your back by creating a foam contour piece we call a cervical support. On taller

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