

## Chair-E-it Construction – Part 2 Shoulder Straps

Designed by Al Geist

Part 2 covers making and attaching shoulder straps to Chair-e-it.

**Materials:** Two ¾" nylon cable hangers (Home Depot electrical supplies row)  
Two ½" nylon cable hangers and four ½" #10 screws and nuts to hold the hangers  
10 feet of 1" polypropylene (or nylon) strap  
Four small grommets (I used eyelet grommets from sewing store)  
Piece of 6mm hex mesh (I just did a web search and ordered in color to match chair)  
12 feet of ½" ribbon to sew around edge of the mesh straps  
Buckles and adjusters: 4 adjustment sliders, 1 double adjust chest strap buckle

**Strap Material.** In researching backpack and hip belt straps, I found that polypropylene straps were recommended over nylon straps. The reason given is that polypropylene straps do not absorb as much sweat (or water if rained on), and are much more resistant to UV damage from the sun's rays. The price of both were about the same so I ordered polypropylene straps off the web and used them throughout the Chair-e-it construction. I used 1" wide strap in the shoulder straps, and a mixture of 1½" wide and 1" wide in the hip belt construction described in Part 3.

**Step 1.** Putting lower strap attachment points on the Chair-e-it frame. The two ¾" nylon cable hangers are placed right against the inside of the pivoting seat tube. When the screw is tightened the strap will be tight and should be at a slight angle as shown in figure 1c. The hanger will be snug but can still rotate on the lower tube. This is OK. I found that the rotation allows the shoulder strap to pull straight against the screw when under load and I found that the hangers do not slide side-to-side in use. I cut two 16" long pieces of 1" wide strap, burned the ends to prevent fraying, and put a grommet in one end of each. In an early prototype I just poked the screw through the strap without using a grommet. This worked for about 100 miles of hiking, then one of the screws pulled out through the bottom of the strap on a Philmont practice hike. I fixed it on the trail by poking the screw through the strap again a little higher. When I got home I made new 16" lower straps with brass grommets. To avoid cutting any strap fibers when putting in the grommet (and thus maintaining the full strength of the strap), I pushed a sharpened pencil through the strap to open up a hole big enough for the grommet. The grommet then clamped down on these pushed aside fibers. This worked very well and the straps have been to Philmont and back with no signs of pulling out as you can see in the photos below, which are after Philmont.



Figure 1a. Rear view of location of ¾" nylon cable hangers



Figure 1b. shows grommet in strap and ½" #10 screw and nut



Figure 1c. Front view of lower attachment showing strap angle

I used 16" bottom straps for two reasons. First, it gives a wide range of adjustment to different size chests. I also found myself loosening them on short water breaks on the trail to get a nice breeze between my back and the pack. Second the extra strap makes a good handhold to pull the straps tighter.

**Step 2.** Putting upper shoulder strap attachment points on the Chair-e-it

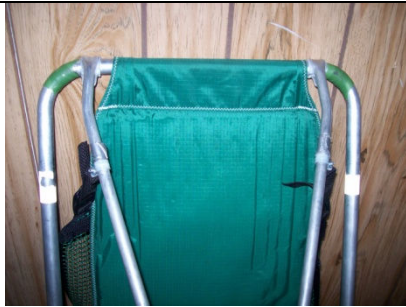


Figure 2a. Rear view showing 1/2" nylon cable clamps on "V" brace, 5" below top bar. Adjust up or down to suit your torso.



Figure 2b. Close-up of upper attachment showing 1" wide duct tape placed above clamp to prevent sliding up under load

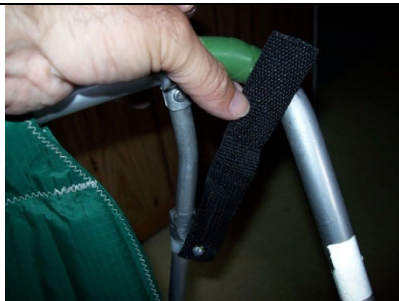


Figure 2c. Front view showing 7" long adjustment strap (with grommet). This adjustment compensates for different size loads moving the V bar backwards



Figure 2d. Front view showing upper part of shoulder strap attached. The length should be set so that the wide part of the shoulder strap is right in front of the sling.

At this point you can create shoulder straps, buy them, or cut them off an old backpack. In my early prototypes of Chair-e-it, I just cut padded straps off an old backpack I had in the closet. I sewed the four adjustment sliders to the top and bottoms of the two padded straps and laced them into the top and bottom adjustment straps and I was ready to go test comfort, fit, and durability.

The next steps describe building the cool, lightweight, hex mesh shoulder straps that the final version of Chair-e-it has. These are the shoulder straps I used at Philmont and they really reduced the amount of sweat generated on the chest and around the straps.



Figure 3. The hex mesh shoulder strap. The top of the strap is on the left. The strap is 3½” wide. Not counting the buckles it is 21” from the top to the bottom and the top of the chest strap is 12” from the top

First, the theory around the comfort of lightweight straps particularly carrying heavy loads.

What makes a shoulder strap uncomfortable? It is the feeling that it is cutting down into your shoulders. This feeling can be caused for several reasons. First, the contact area of the strap may be small causing all the load of the strap to be concentrated on a small area of your shoulders. This can be caused by straps being too narrow for the load carried, or too ill fitting. An example of the latter is a wide padded strap, but the entire load is actually carried by a narrow grosgrain strap running the length of the padding that presses hard on the shoulders in only a couple places. A second form of discomfort is the edge of the shoulder strap cutting down into the shoulder. A classic example is the squared off edge of a leather strap cutting down into the shoulder like a knife. A more modern example is the shoulder strap being twisted so that the edge of the strap is pressing down on the shoulder rather than the full width of the strap. This twist need not be a complete flip of the strap; it can be just a tendency of the strap to roll over to one side on a particular person with a particular load. A 2 inch wide padded strap will cut down just as deep on a shoulder as a 2 inch wide non-padded strap. So padding does not help if the pack weight is too high compared to the surface area of the shoulder straps. Where padding does help: it helps with ill fitting, it spreads the load more evenly over the contours of the shoulders, and it eliminates sharp side edges. A drawback of padding is that it is insulation so it increases sweating under and around the straps, which leads to discomfort and sometimes rashes. Modern shoulder straps use layers of wicking materials and/or vents to try to reduce sweating.

To have a comfortable shoulder strap one would want a

- wide strap to spread the load across a larger area of the shoulders
- strap that laid flat and followed the contours of the shoulders
- strap with no sharp edges to cut into the shoulders
- strap that would reduce sweating around the strap and chest

The Chair-e-it hex mesh shoulder straps have features that address each of these comfort bullets. The straps are 3½” wide, which is as wide as will comfortably fit across my shoulders. The



thinness and stretch of the straps allow them to follow the contours of the shoulders. The header and chest strap ensure that the Chair-e-it shoulder straps lay flat across the full 3½” width. The ribbon running around the strap eliminates any edge cutting into a shoulder effects. The wide mesh design allows the sweat to evaporate off the clothes worn underneath.

**Step 3.** Bias cut the hex pattern for the straps and sew ribbon around it. First pull on your piece of hex mesh and note that it stretches in some directions and doesn’t stretch at all in others. In particular, it does not stretch in the direction that the lines run. If you look at figure 3, you will see that the lines in the hex are lined up to run the length of the strap so the strap does not stretch in the direction of the load, but is able to stretch and follow body contours in other directions. The straps were cut out as two 21” x 3½” rectangles of mesh (with no stretch in the 21” direction). The bottom 8” was tapered from 3½” to 2” and the tops and bottoms of the mesh were rounded.

It is important NOT to cut the straps out with the bend shown in figure 3 already in them, because somewhere in the bend they will have stretch in the load direction.

Start at the point where the chest strap will be. Fold the ½” black ribbon over the edge of the hex mesh and sew it all the way around the mesh. Leave the last couple inches not sewn in order to put in bend and to cover the end of the chest strap in Step 4.

**Step 4.** Put fold in mesh and sew in chest strap. Pull up and fold over a small triangle of mesh in order to put the bend in the strap. A 10” length of 1” wide polypropylene is used for the chest strap. It runs completely across the shoulder strap and is sewn to the ribbon on both sides and across the folded over mesh in the middle. This helps hold the mesh wide and flat at the chest. It also prevents the pull of the chest strap from distorting the shape of the mesh (remember it can stretch a lot in certain directions). Once the fold is sewn down, wrap the last part of the black ribbon around the mesh on top and the end of the chest strap on the bottom and sew it down (see figure 4).



Figure 4 To put curves in the strap, fold over the mesh on itself on one side and sew this triangular fold to the chest strap that runs underneath.

**Step 5.** Put in header. Note that the top slide adjuster is offset to the outside of the strap. This is because the upper strap attachment has to go around the sling in the chair, while the 3½” of strap should sit in the middle of your shoulders.

The header is key to the comfort of the lightweight mesh straps. I tried the mesh straps at full load without the header and the strap pulled into a one inch wide bunch on the shoulder. The analogy is the hammock with a bar at the head and feet holding it flat vs. a hammock without that pulls into the narrowest possible shape when you lay in it. I tried a plastic stiffener, but it bowed under full load so I stuck a small flat piece of steel in the header to hold the mesh flat at the top. In particular, I used the striker from the official BSA flint fire starter. I had a pile of these left over after replacing these strikers with 3" hacksaw blades in the scouts' survival kits. The striker had a good size and stiffness to slip into the header pocket formed by placing 1" polypropylene straps on top and bottom of the mesh and sewing through both on three sides. Once the steel plate was in place the pocket was sewn shut. With the header and chest strap working together, the 3 1/2" strap lays flat across the shoulders and chest spreading the load evenly.



Figure 5 The header is the key design feature that makes the mesh strap work. 1" polypropylene is sewn to both sides of the mesh and a stiff steel shim is slipped into the pocket formed before the edge is sewn shut. This holds the mesh flat and wide under load.

**Step 6.** Add adjusters to bottom



Figure 6. Bottom slide adjuster is sewn on top of the mesh. Be sure that both the ribbon and the mesh have several sewing seams run back and forth over them. (Same is true for the top slide adjuster.)

**Step 7.** Adding a GPS holder. Even if you are not carrying a GPS at Philmont, it is nice to have a place on one or both straps to be able to hang anything that has a belt clip. I hung my DeLorme PN20 on my right strap and clipped a small compass/thermometer to the left side chest strap. I let the boys do all the “naviguessing”, but as advisor I wanted to be sure I knew where we were and how much farther we had to go. The boys did a good navigating job. We sometimes stood at intersections for a long time, but we never got lost.



Figure 7. To carry my GPS on the top of the right strap, I sewed a 1½” wide strip of Polypropylene to the black ribbons on each side. I used 1½” to match a belt width. The belt clip on my GPS case clipped right on.

As for hanging items off the straps, I read about a modern backpack design that hung the water off the shoulder straps. The theory being to spread the load more evenly in front and behind you so you walk more upright. Water being one of the denser items you carry, it made more sense to put it in the front (rather than having something bulky like a sleeping bag roll on your chest). I actually tried this with an earlier prototype of Chair-e-it and it works terrible! It put all the water weight directly on the shoulders rather than spreading it between the hips and shoulders. Second, the water containers covered much of the chest causing much more sweating. My shirt was so wet I thought one of my water containers had been leaking – but it had not.

I met someone who owned one of these front-back backpacks. He explained that his backpack had metal rods that ran from the front bags to the hip belt in order to transfer the front load to the hip belt. I asked, “Didn’t this make the backpack very complicated to put on?” He said it did and he doesn’t use it anymore for this reason and because he found the more traditional backpack designs more comfortable.

I then had my “Duh!” moment and realized that the best place to put the water weight is directly on the hip belt that way the weight doesn’t have to get transferred through the pack, my back, and then to the hip belt. Having the water on the belt makes it easy to reach while you are walking. It allows you to see how much water you have left (something that is hard to do with camelbacks). It puts the water at your fingertips when Chair-e-it is put into chair mode. When converted to a fanny pack, the fanny pack has your water for the side hike. And as an added bonus, having liter bottles on each side means you can be purifying one while drinking out of the other (a tip I learned from AT thru-hikers). A win-win-win-win-win idea.



When you are finished with your shoulder strap construction your Chair-e-it should look like figure 8. There six adjustment points on the straps to customize the fit to your body. At the top of the mesh so that the black headers are behind your shoulders and just in front of the sling. At the bottom of the mesh to adjust how tight or loose the backpack is pulled to your body. And on either side of the chest strap clip to adjust where the straps sit on your shoulders.

Before doing custom adjusting we need to make and attach the hip belt, because this determines how far up or down your back the frame rests. Hip belt construction is Part 3



Figure 8. There are six strap adjustment points to help get a comfortable shoulder strap fit. Plus the clips on the “V” bar can be moved up or down for custom fit to torso length.