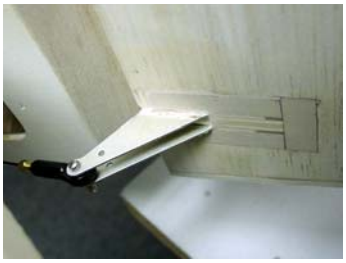
## Pull-Pull

For the rudder, Erik wanted to use a slightly different control horn system than what I had on my airplane. The rudder horn on my prototype Extra (and the one shown on the plan) is rather outdated. We are going to use the pull-pull rudder control outlined on the plan with only slight variations to accommodate the new style rudder horn.

The rudder will utilize two JR DS8411 servos ganged together and attached to a bell crank. The bell crank will have two Kevlar "Kev-cord" cables that attach to the rudder horn. Kev-cord and the end fasteners (Kev-cord connectors) are available from Aerospace Composite Products.

The rudder horn and bell crank that we used are from Nelson Hobbies and are made to match each other for this type of set up.

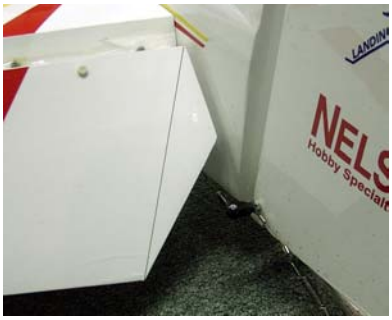




The prototype Extra uses a four-inch bolt threaded through a dowel. I mounted it very low in the rudder and it does not extend more than an inch from the surface of the rudder so it clears the elevators without a problem.

Because the horizontal stab is so low, we found that this new rudder horn, when positioned in the rudder per the plan, causes clearance issues for the elevators. If you decide to use the bolt-style control horn, be sure to consider this when positioning the dowel in the rudder and you shouldn't have any problems. Mounting it low also makes the cable exit easier to deal with (more on that in a moment).

We mounted our control horn according to the plan before we knew about the issue so we had to trim the elevators to clear the control horns. If you choose this system you can mount the rudder horn in your airplane lower in the rudder—this amount of elevator modification will not affect the way the aircraft flies, so don't be afraid to trim if you need to.

In the photo on the left you can see how we trimmed Erik's elevators to clear the rudder controls. In the image on the right is a picture of the prototype Extra with the old-style rudder horn. The line shows how much and where we trimmed for the new Extra.

It's important that the geometry for the pull-pull system be exact; if it is not then the cables may droop when the surface is deflected. Diagram 3 shows two examples of how you can set your system up and ensure tight cables throughout the entire range of motion.

In case B (our prototype Extra), notice that the distance of offset of the control-horn connection from the hinge line (B) at the rudder needs to be duplicated at the bell crank (A).

In Case A, the control-horn connection is in line with the hinge line and lined up with the pivot point. The bell crank should also have the connection points in line with the pivot point (like our new Extra).

It is very important that the width of the bell crank be the same as the width of the control horn for both systems. Do not cross the cables.

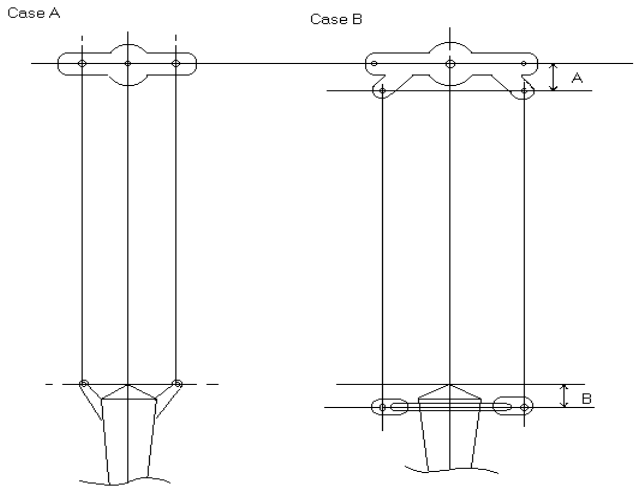



Diagram 3

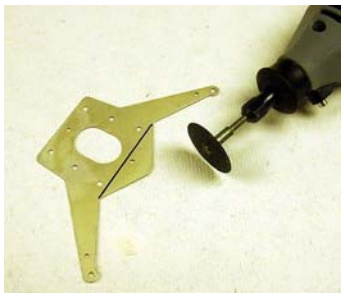
We chose a four-inch Nelson rudder horn and bell crank. To mount the rudder horn Erik sandwiched the two plates in wood to be epoxied into the rudder. Since much of the rudder's strength is dependent on the leading edge hinge cap (rudder post), we did not want to cut it when installing the horn assembly. So, before the plates were assembled, Erik cut the hinge-beveled shape from the rudder-horn plates with a Dremel and a cut-off wheel.

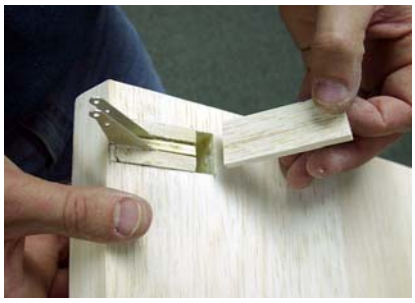
For the horn assembly, we used ¼-inch balsa on top and bottom and two 1/8-inch pieces of lite ply in between the plates. Find the best position for your rudder horn and cut the balsa and foam away to fit the horn when fitted with the wood sandwich; in our case it was 2-1/8-inches x 7/8-inches.

Erik fitted the plate separation to the steel ball of the ball ends by sanding the center lite-ply section to the thickness of the ball. Mark all of the pieces to fit the shape of the opening and cut it to leave just a bit of overhang that will be sanded flush after everything is glued in place.

We used a piece of ply at the front of the system that we could sand and adjust to get the control-connection points to align with the hinge line. Aft of the sandwich is a gap

just less than ¼-inch so that installation would be easy and a ¼-inch piece of balsa could be wedged in to hold the whole assembly tight.

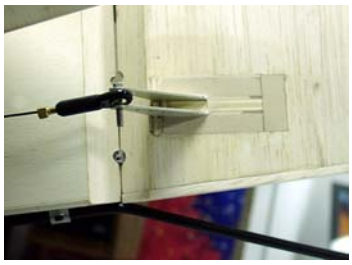




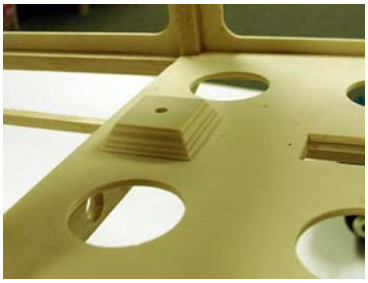
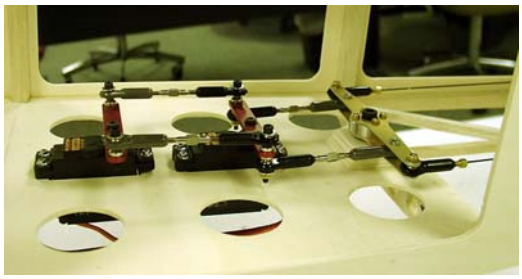
Once the parts have been fitted and cut to size, drill six holes through the sandwiched assembly for dowels. Erik used 1/8-inch dowels at the front and ¼-inch dowels for the rear four.

Epoxy the sandwiched parts together and sand the dowels flush. Epoxy the whole assembly in place being sure to align the horns 90 degrees to the centerline of the rudder. Once dry, sand everything flush with a sanding block.





The business end of the pull-pull system uses two servos ganged together in line connected to a bell crank. We used S.W.B. 2.5 full servo arms with a Nelson bell crank and Pro-Link control rods. From inside the fuselage, we made a lite-ply platform to raise the bell-crank up to line up with the servo arm.

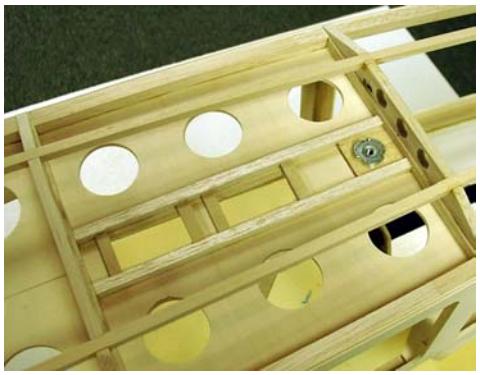



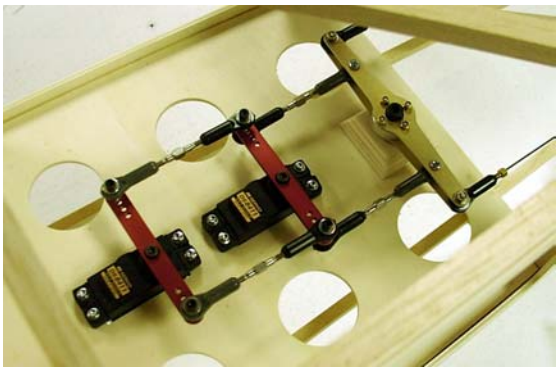
We use a bell crank rather than connecting the cables directly to the servo for several reasons; it takes the load from the tightly stretched cables rather than the servo grommets, output shaft, and bearings, and it enables the correct geometry.

For placement, we used the rudder servo template shown on page one of the plans. The servos will be mounted in the fuselage floor FL3, and since the floor is already a part of the fuselage structure only a small amount of stiffening will be needed.

Working on the bottom of the fuselage we added ¼-inch square balsa sticks longitudinally on either side of the servo openings spanning from BF2 to BF3. 1/8-inch aircraft ply doublers were added where the servo mounting screws will be and for the 10-32 blind nut fastening the bell crank. Cut these pieces to fit tightly between the balsa rails to tie everything together. This system is light, simple and strong.

We will match these servos together using a multipoint program mix on Erik's JR10X transmitter. Install the linkages as shown using the same hardware we used for the wings and elevators. The Kev-cord system uses a simple fastener that slips over the cord and the cord is then knotted. A drop of thin CyA on the knot will keep everything in place. Thread the fastener into a Nelson ball end and fit the cables.





If you followed our recommendations for a four-inch rudder horn and bell crank, the pull-pull cables will exit the fuselage right where it becomes four inches wide—roughly even with the leading edge of the stab.

The open fuselage sides work great for setup because there is no wood in the way and you don't need to guess at the cable exit point, but when it comes time to put the MonoKote on you will need something to stick the MonoKote to around the cable exit.

Erik made up some small balsa tabs for the cables to slip thru consisting of a 1/16-inch vertical-grain balsa glued to the inside of the fuselage and a 1/8-inch horizontal-grain piece glued to it and the fuselage. Laminate them together and slip it on the cable. Find the best location for the least amount of bind and glue in place. Sand them flush to the fuselage sides.

Some binding will occur at the exit point during operation when you use a short exit slot. This is normal.