Building a Better Profile

Part 8 - Control System

Top Flite Tutor is one of the better profile kits

Precision Heart of the Control Line Stunter

Accuracy of construction has been emphasized in this series, and nowhere is it more important than on the control system. With careful fitting of hinges and control horns, flaps and elevators operate smoothly, with virtually no resistance - yet the hinge line gap will be tight. Control system fitting and testing needs to occur (repeatedly) before installation of the wing or stab into the fuselage.

Bellcrank Selection

A SIG nylon 3" bellcrank (Figure 1) is a common, inexpensive and practical choice for most profile and medium sized stunt ships. It features a large nylon bearing.

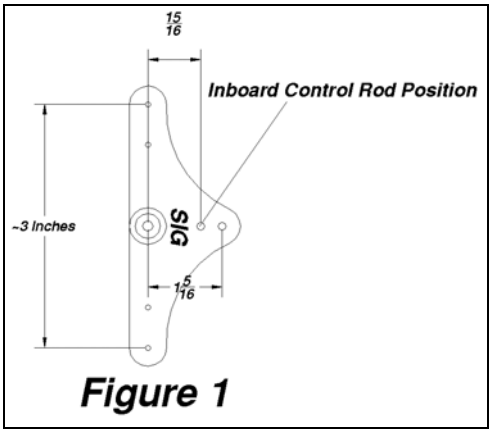


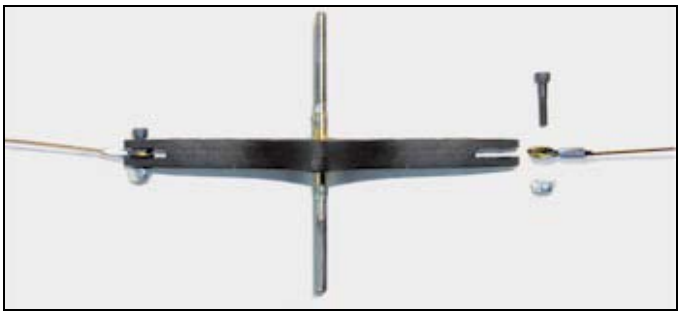
Figure 1

Many stunt flyers prefer a 4" bellcrank, with its slower control action and mechanical advantage. SIG also sells a larger bellcrank, and there are several high quality 4" bellcranks available from PAMPA advertisers. (Note that by using the inboard control rod position, the action of the SIG 3" bellcrank can be slowed, so that it is similar to a 4" unit.)

The very lightest, high tech bellcranks are made from carbon fiber nowadays. Dan Winship produces one which weighs only 7 grams (about 1/4 ounce), fitted with brass bearing points, and available with super strong crimped leadouts installed.

Winship 4" carbon fiber bellcrank

Windy Urtnowski recently developed a quality molded bellcrank with slotted arm ends for bolt-on leadout connections.



New Urtnowski bellcrank

Avoid metal bellcranks. Why? Because they have an unfortunate tendency to cut leadout wires! Further, unless properly bushed (with brass tubing), pushrod wires can rapidly eat out their holes in a metal bellcrank or control horn, just through normal vibration.

Carrier and scale CL flyers who use complex metal bellcranks (with throttle controls), run leadouts through a section of small diameter brass tubing where it passes through the bellcrank. But after seeing such an installation fail (we found out that a Mustunt can do at least six 4-foot diameter loops before it hits the ground!), I have to ask: Why even use a metal bellcranks on a stunt ship? A nylon bellcrank is strong, never cuts leadouts or eggs out its control rod hole, and nylon is a natural bearing material.

Leadout Wires

Braided .027" steel leadouts are recommended. Although at least a couple of world-class builders use solid .025" wire leadouts, I fail to see any real advantages for profile ships. Rigid leadouts are more susceptible to kinking or damage, as well as vibration.

Copper wire wrapped leadout ends

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Attach leadout wires to the bellcrank ends with a smooth loop, and neatly wrap its ends with soft copper wire. Secure the copper wire with a dab of epoxy, or thick CA. The copper tubing crimps supplied with some leadouts can slip and cause problems. Be sure to pull test the attached leadouts before mounting the bellcrank.

Control Rod Installation

The bellcrank-to-flap control rod must be bent to its proper angle, cut and installed prior to mounting the bellcrank in the wing. Instead of trying to prebend and fit both ends, simply cut the rod off, so that it extends well through the hole in the top of the wing.

Later the control rod can be trimmed and spliced with a short section of 3/32" ID brass tubing, adjusted to EXACT length, and soldered together.

A Soldering Lesson

Although soldering can sometimes be avoided, it is a worthwhile skill to develope. I use a heavy duty Weller soldering gun, rosin-core (electrical) solder, and Nokorode soldering paste. Immerse the hot solder tip in the paste and apply a little solder: like magic it will be cleaned and tinned! With fine sandpaper, pre-clean both ends of the control rod. Holding the bent end of the control rod with pliers, dip the opposite end in soldering paste, and patiently heat it and apply solder until it is nicely coated. With solder still molten, CAREFULLY wipe the excess away with a cloth. Repeat this "tinning" process for the bent end.

You need a way to hold the rod while you solder a shoulder washer on the bent end. Metal holders such as vise or pliers act as a heat sink and make soldering difficult. Try wood! Drill a 1/8" hole through a scrap block of hardwood and insert the prebent end of the control rod into it, washer in place, for soldering (Figure 2).

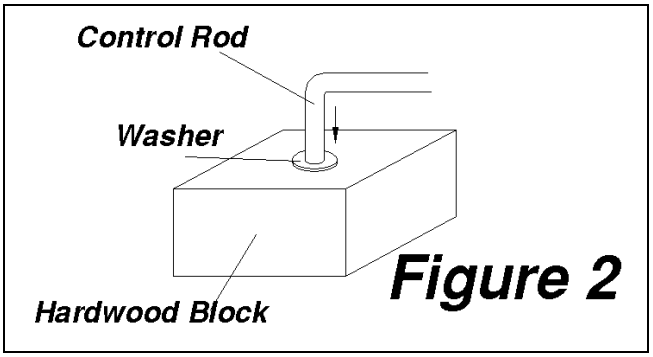


Figure 2

Pre-tinned parts solder easily. The reward is a beautiful, smooth, strong solder joint. But make sure the washer is a material which solders. Stainless steel washers do not solder! When in doubt, try tinning the washer first.

Soldering of the retaining washer occurs with the rod through the bellcrank hole, with a potential for overheating the bellcrank. (carbon fiber is just as vulnerable to heat as nylon or fiberglass.)

In the past I have succeeded in making an "instant" solder joint with a thin index card between the bellcrank and washer to protect it. However, I no longer recommend soldering it. Instead, file a small notch on the wire end, degrease the area thoroughly and use a dab of JB Weld to secure the retainer washer.

Bellcrank Installation

The SIG 3" nylon bellcrank is commonly bolted to a flat plywood mount in the center section of a built up wing.

Other types of bellcranks (and typical foam wing installations) are suspended on a long rod or bolt through the entire wing thickness.

Jam nuts and/or a dab of JB Weld or epoxy should secure nuts and washers supporting the bellcrank. A small plywood square can be added to reinforce the area where the bolt is held in the wing planking.

Joining Foam Wing Halves

The bellcrank is typically mounted in the inboard panel of a foam wing. It is usually necessary to excavate foam around the bellcrank.

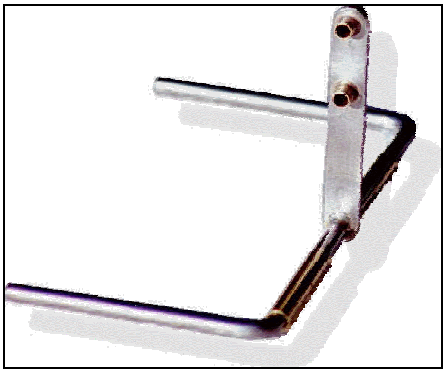
Verify the fit between wing halves prior to joining them. Sight down the trailing edge, and block sand the root area for a perfect fit. With tight wood fits, you should be able to lightly tack the joint with thick CA. For the actual joint, use a 1" wide strip of heavy fiberglass cloth over its entire length, saturated with slow epoxy glue.

Control Horns

For profile stunters, I recommend commercial metal control horns with 3/32" wires, which are "tweakable". Some feel that the stronger 1/8" wires are a necessity, but they weigh more and are overkill for most modern stunters.

In the past, I recommended using Midwest brand metal horns, with holes drilled out to 1/8" and short sections of 1/8" brass tubing (3/32" ID) soldered in. This produces a smooth, durable bushing but entails the messy job of soldering and filing the tubing ends.

It may be tempting to simply enlarge holes in metal horn arms to 3/32" and leave out any brass tubing bushings. I learned the hard way that even the closest fit between control rod end and horn arm quickly enlarges enough to vibrate and egg out the hole.



However, it makes little sense to invest such labor when excellent commercial pieces are available from several sources.

Custom Control Horns

Why would anyone want to build their own control horns? One reason might be to have a custom horn geometry.

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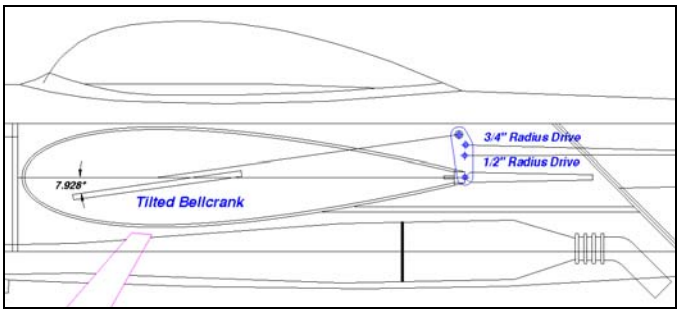
As an example, consider the custom flap control horn used in my *Special Effects* design, which is "linearized" to minimize control surface deflection tracking errors.



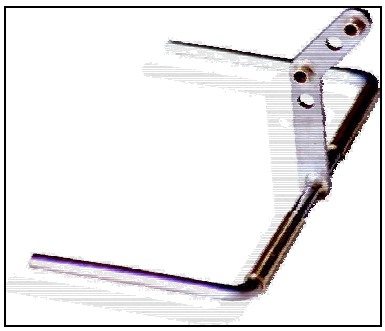
Custom flap control horn for "Special Effects"

If you find yourself absolutely bent on this flavor of masochism, remember that the joint between the control horn arm and the horn wire must be extremely strong.

Unlike the brass tubing bushings which can easily be soldered with ordinary electrical [rosin core] solder, the wire joint must be soldered with a silver braze and proper flux. As a rule, the correct solder for this job will not be melted with a soldering iron or gun!-A torch is required, and you probably want to use the MAP gas as well.

Be aware that all "silver solder" is not the same high strength material I am referring to here. A better hardware store may have it or you may have to go to a welding supply shop. My own preferred material for this critical joint is 1/16" brass flux-coated brazing rod, from the welding supply .

I recommend using the K&B brass stock for custom horn arms, which drills easily, and can be cut to shape (if you are patient) using a fine toothed blade on a Dremel saw.

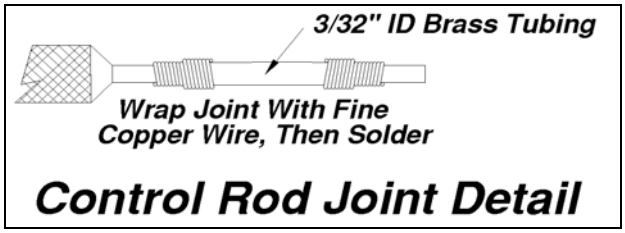


Again I have to point out the availability of excellent commercial parts of this type, e.g. Dan Winship's "laser" control horns.

Bellcrank to Flap Control Horn Rod

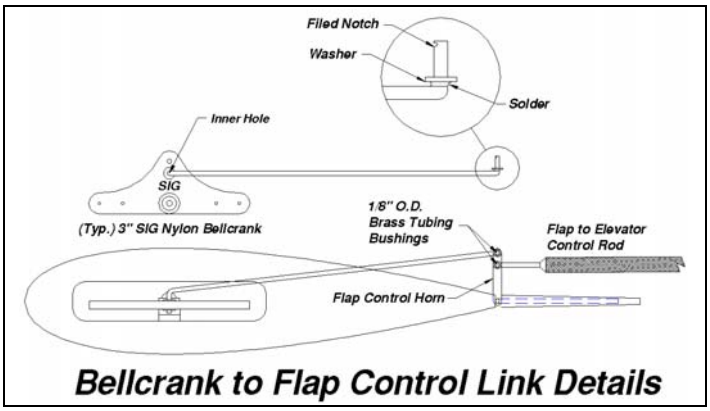
The rod between the bellcrank and flap control horn is the driver for both control surfaces. It must be carefully aligned for neutral and operate without binding. Although larger stunters sometimes use a fiberglass arrow shaft for this rod, 3/32" music wire is usually adequately stiff on a profile ship.

Earlier I suggested cutting this rod and installing a brass tubing joiner link. The advantage of this would be ease of adjustment and alignment; a disadvantage is the need for a high quality solder joint in a critical area. I got another hard lesson on this very topic when such a joint failed and cost me a favorite 3-year old profile stunter.



Now, in addition to the pre-tinning of both rod ends and the use of soldering flux to better flow the "sweat" joint between the rods and the tubing, I recommend wrapping both ends of the brass tubing joint with fine copper wire and applying silver solder to the entire surface. There will be no doubts about the wrapped joint.

Before you ask why not use some of the silver braze on THAT joint, I'll just say that the high temperature soldering required is typically fairly inconvenient there. The wire-wrapped joint is a simple, effective solution, even with electrical solder.



Pre-solder a washer next to the bend on the rod section which connects the flap control horn, and connect it to the TOP hole of the flap control horn arm. Using a Dremel tool with a cutoff wheel or a file, "ping" the very end of the control rod where it sticks out through the brass bushing at the top of the flap control horn. The small notch you make allows a drop of slow epoxy glue (JB Weld works beautifully for this) to hold the outside washer in place.

"Liberty" and "Justice", Mo'Best sister ships in silver

-Larry Cunningham