Carbon Fiber Wing-Slat Project

Images at end of this article

Why

- "Because I can"
- Not concerned with saving weight
- Earning more experience with both carbon fiber & vacuum bagging
- Speculation on my part: 4-section-per-wing slats may be more aerodynamically efficient than 2-part-per wing slats

Background

- I like having slats on my SQ-2 experimental Super Cub.
- Advantage of slats:
  - Lower stall speed (about 32 with no flaps; no power)
  - flatter AOA at low speed/stall
  - No wing-drop or other adverse flight characteristic at stall
- Disadvantage of slats:
  - Reduces top cruise speed by perhaps 7 to 9 mph
  - Additional component to pay attention to in pre-flight

Existing Design

- Aluminum skin 0.020" 6061 T6 (I assume) & ribs (spaced about 9" apart)
- 2 slats per aircraft side
- Each slat is about 94" wide (so 11 ribs per slat—2 ends plus 9 intermediate)
- Current slat chord is about 11"
- The nose of the current slats are approximately even with the bottom of the wing
  - Based on my flight tests and input from others (Randy Apling @ Carbon Concepts for instance link), I plan to keep this orientation
  - A huge "Thank You" to Randy for his input on slat design & flight testing
- Slat opening at the rear of the slat in flight is 3.25"; I plan to keep this orientation initially. Randy Apling reports good results limiting the opening to 2". I will flight test this change later.
- Slat leading edge is 7" from the wing leading edge; I plan to keep this orientation. I would have to modify my slat hangar design to change this dimension.
- Each slat currently has 3 hangars with a common, end, per se, hangar between the two slats. Hence 7 hangars per side.
- The first hangar is about 12" from the end of the outer slat. Hangars are then spaced at about 27 1/2" intervals

Planned carbon fiber slats: Design considerations

- Sticking to basic profile "as is." I don't think, without serious computational fluid dynamics analysis (CFD) on a high-power computer, that I can further optimize slat profile
- Even with extensive CFD, any slat profile optimization could perhaps end up being minimal

- My current distance from start of fiberglass wingtip to start of wing root fairing is about 194”
- Goal: Make 4 slats per side, each of which are 48” long
- Placement will have end of outer slat even with start of fiberglass wingtip; Hence there will be about a 2” gap to the start of the wing root fairing. I may add a ½” to each slat to eliminate this minor gap
- Carbon Fiber slats will be much stiffer/stronger than the 0.020” aluminum skin current slats. Hence, I plan on carbon fiber ribs spaced at each end and 1 intermediate rib @ the 24” midpoint, for a total of 3 ribs per slat
- I will space new slat hangars @ 24” intervals, for a total of 9 per side (an increase of 2 per-side from the current 7 hangars).
- The increase will add some minor weight (2 additional hangars + 2 additional hinges + 4 (per side) additional [top & bottom] mount brackets. Images of current slat hangars, hinges & mount brackets below.
- The change in hangar spacing also means more mount holes thru the fabric into the leading edge of each wing. Each leading edge is 0.020” 6061 T6, with a 1/16” felt layer, then ceconite 102-5 fabric.

CAD Design

- I created CAD versions of my existing slat profile, slat hangars, slat hinges and slat ribs in Autodesk Fusion 360. Images of each below. I also created a short video of the new carbon fiber slat design (link below).

Implementation Plans

- Inspiration for the project arises from “How to” videos from Easy Composites (link) and Mike Patey on his “Scrappy” project (link)
  - Mike does awesome builds, but his methods and tools are FAR beyond us mere mortals
- I probably will with Forrest Hoskins @ Moon Scapes 3D in Grand Junction. He has a CNC-controlled hot-wire cutter which can accurately create pieces out of extruded polystyrene foam for the slat and slat ribs.
  - Chance I might hot wire myself; Time required & accuracy of hand-effort are questions
- I’ll then create molds for both the slats and ribs
- I will vacuum bag slats out of 1 layer of 2+ oz spread-tow carbon (still need to source) & 3 layers of 5.9 oz 2x2 twill (which I’ve used extensively in other projects and which I have a roll of)

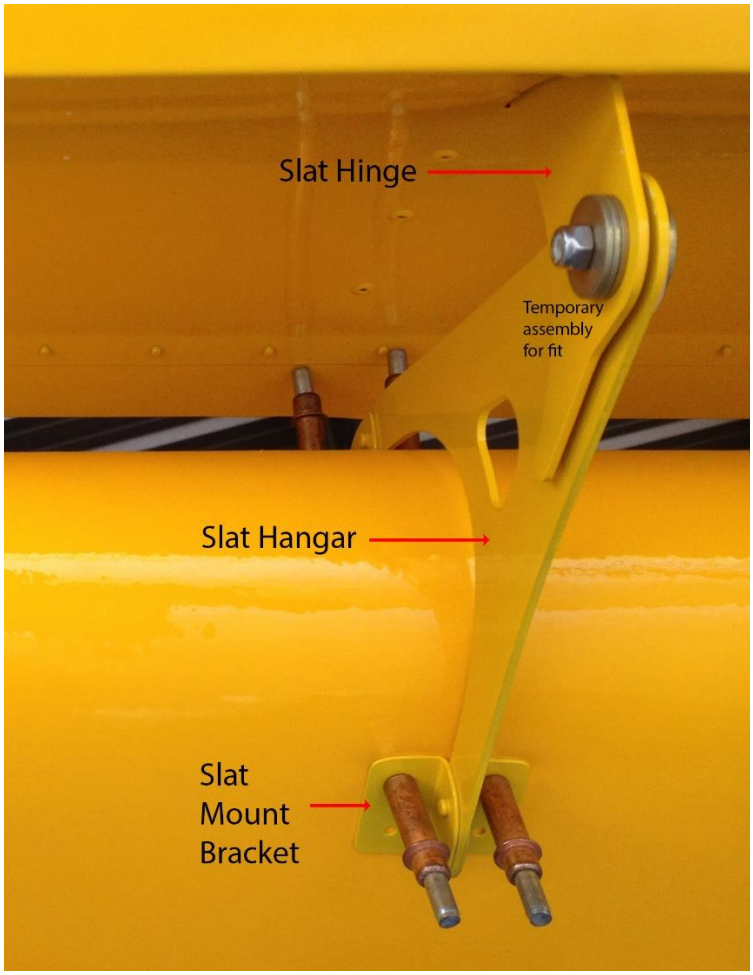
Next Steps

- Get foam “plugs” to create slat & rib molds
- Build molds
- Source spread-tow carbon
- Send CAD files to CNC service to produce additional hangars & hinges

Images & Related Files

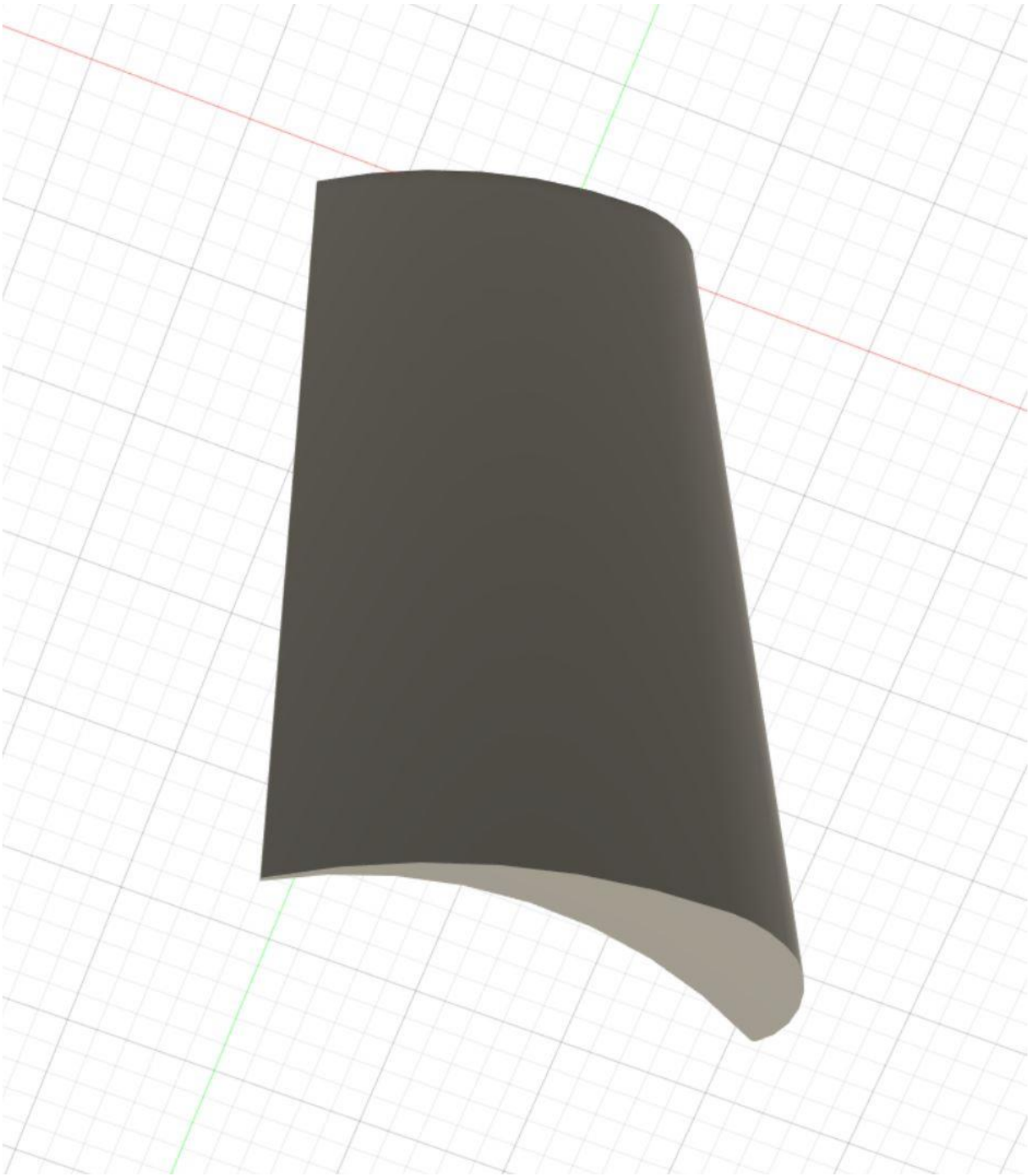
- Slat overview picture: Shows slats on both wings—link to large version of below picture

- Slat hinge, slat bracket & mount

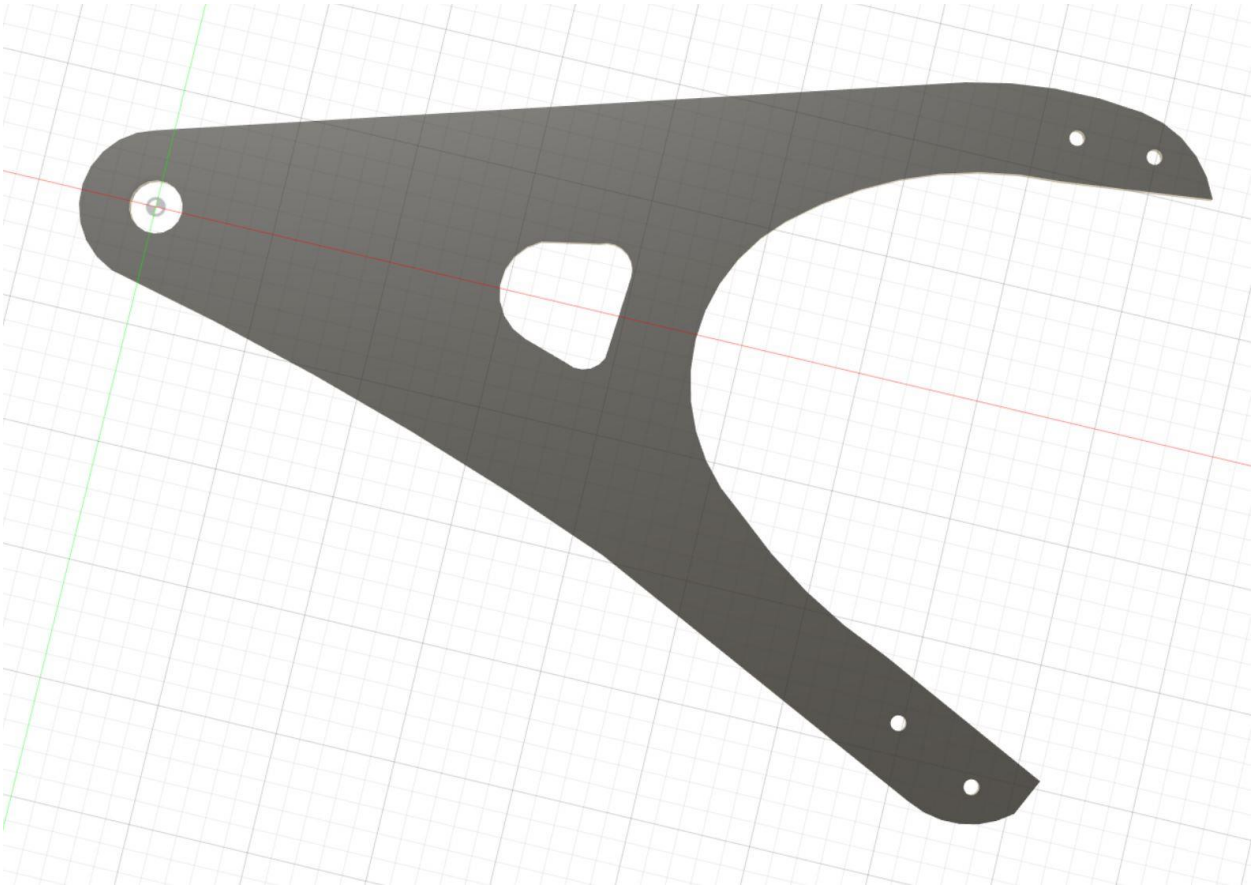


- Slat animation from CAD program—link

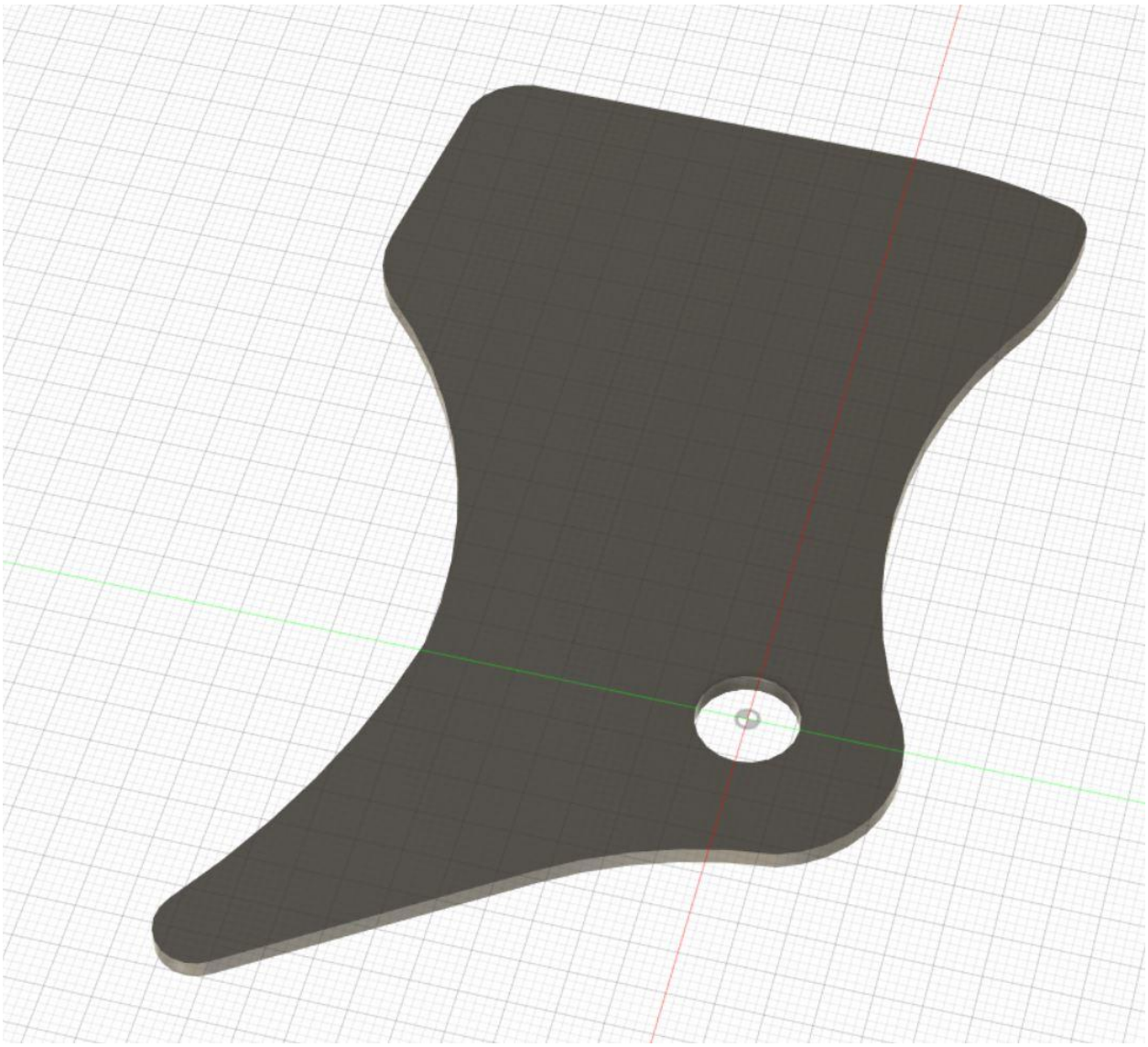
- Slat CAD overview image



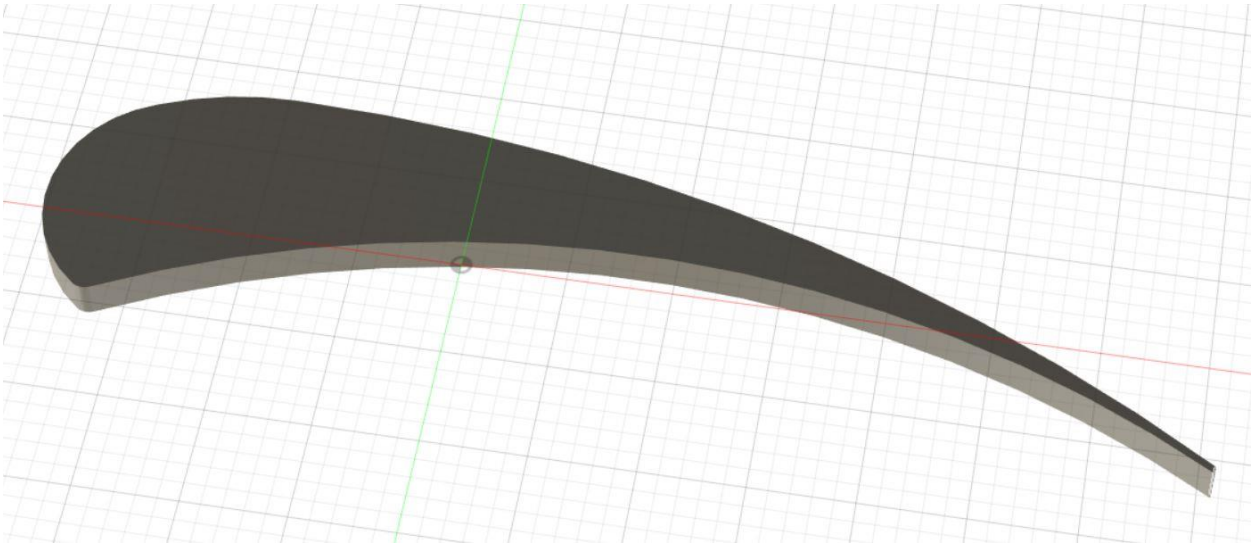
- Slat CAD Hangar overview image



- Slat CAD Hinge overview image
  - Note this is riveted to ribs; Rivet holes not shown/modeled yet



- Slat CAD Rib overview image
    - Note that the rib is a scaled down (by 1mm) version of the slat profile to permit ribs to fit within the slat



CAD Specific Files—Must have CAD Program to load or view these files

- Slat Autodesk Fusion 360 .stl & .f3d files
- Hinge Autodesk Fusion 360 .stl & .f3d files
- Hangar Autodesk Fusion 360 .stl & .f3d files
- Rib Autodesk Fusion 360 .stl & .f3d files