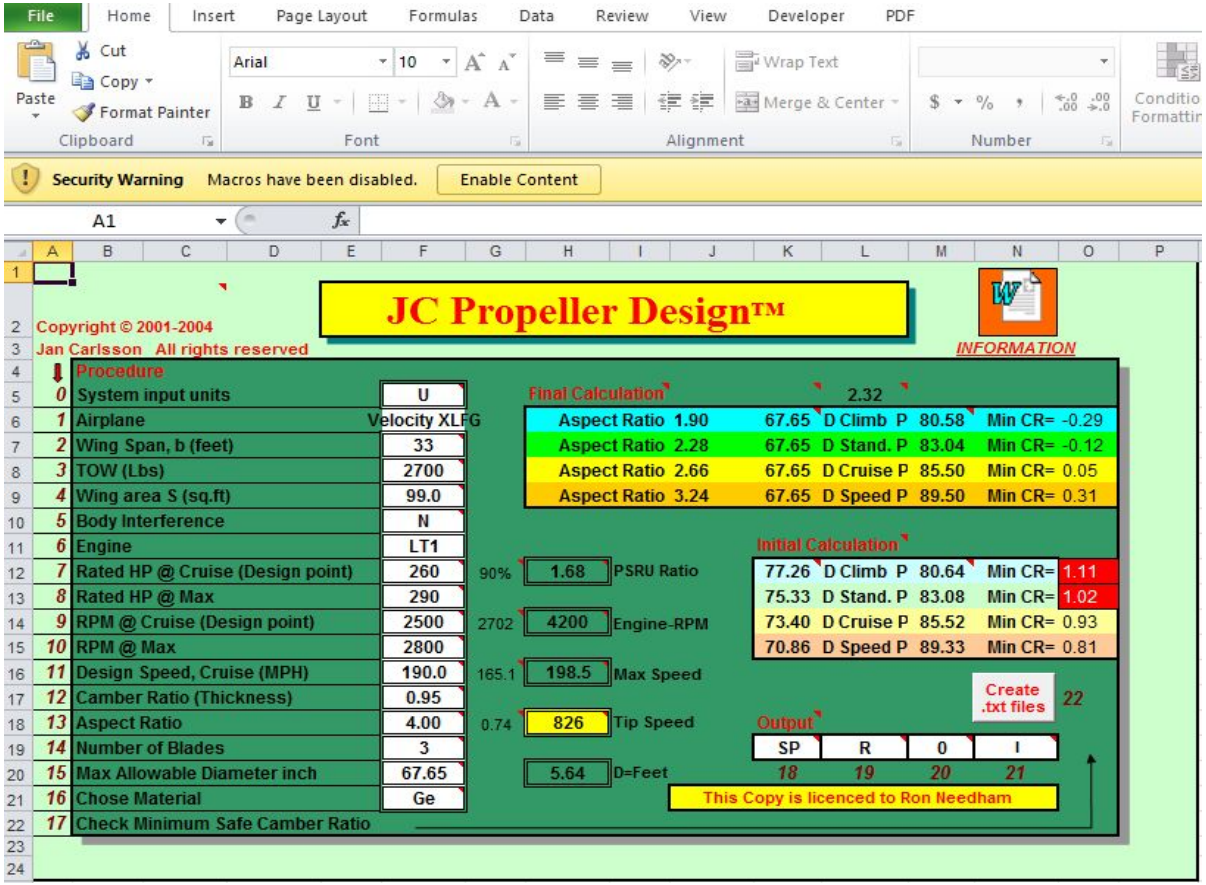
Building a Propeller For my Velocity XLFG

Hand Carving

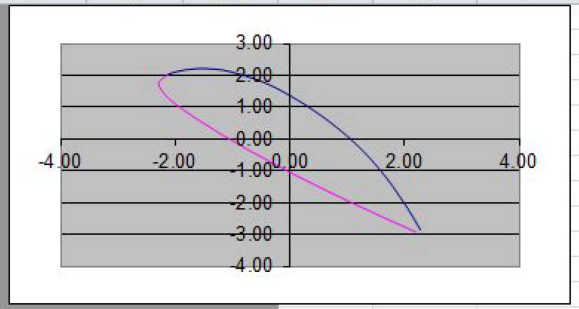
By Ron Needham
velocityxlfg34@gmail.com

Program



The program I used to generate the propeller shape is call JC Propeller.http://www.jcpropellerdesign.com/ .It is a very simple yet powerful software which uses Microsoft Excel. Once you have entered in all the data the file needs,it generates the propeller profile to accomplish the performance that you requested .

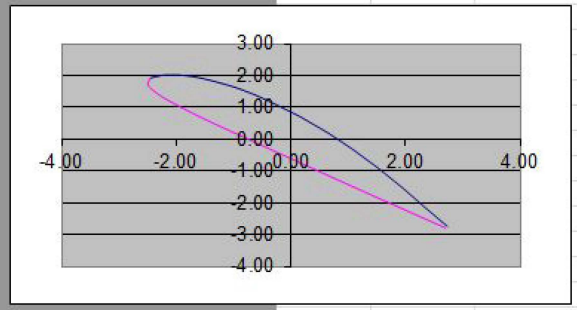
C. station	ordinates	ordinates	Station 30%	'@ Blade angle Deg		46.64	
X	Y.U.	Y.L.		XU	YU	XL	YL
-2.93	-0.15	-0.15		-2.12	2.04	-2.12	2.04
-2.87	0.07	-0.43		-1.91	2.14	-2.28	1.80
-2.77	0.25	-0.52		-1.72	2.19	-2.28	1.66
-2.61	0.45	-0.60		-1.46	2.21	-2.22	1.49
-2.28	0.68	-0.69		-1.07	2.13	-2.06	1.19
-1.62	0.88	-0.75		-0.47	1.79	-1.66	0.67
-0.96	0.93	-0.78		0.02	1.35	-1.22	0.17
-0.30	0.91	-0.77		0.46	0.85	-0.76	-0.30
0.36	0.83	-0.75		0.85	0.32	-0.30	-0.76
1.01	0.70	-0.71		1.21	-0.25	0.18	-1.22
1.67	0.51	-0.65		1.52	-0.86	0.67	-1.66
2.33	0.27	-0.58		1.80	-1.50	1.18	-2.09
2.99	0.00	-0.50		2.05	-2.17	1.69	-2.51
3.65	-0.31	-0.41		2.28	-2.86	2.20	-2.93



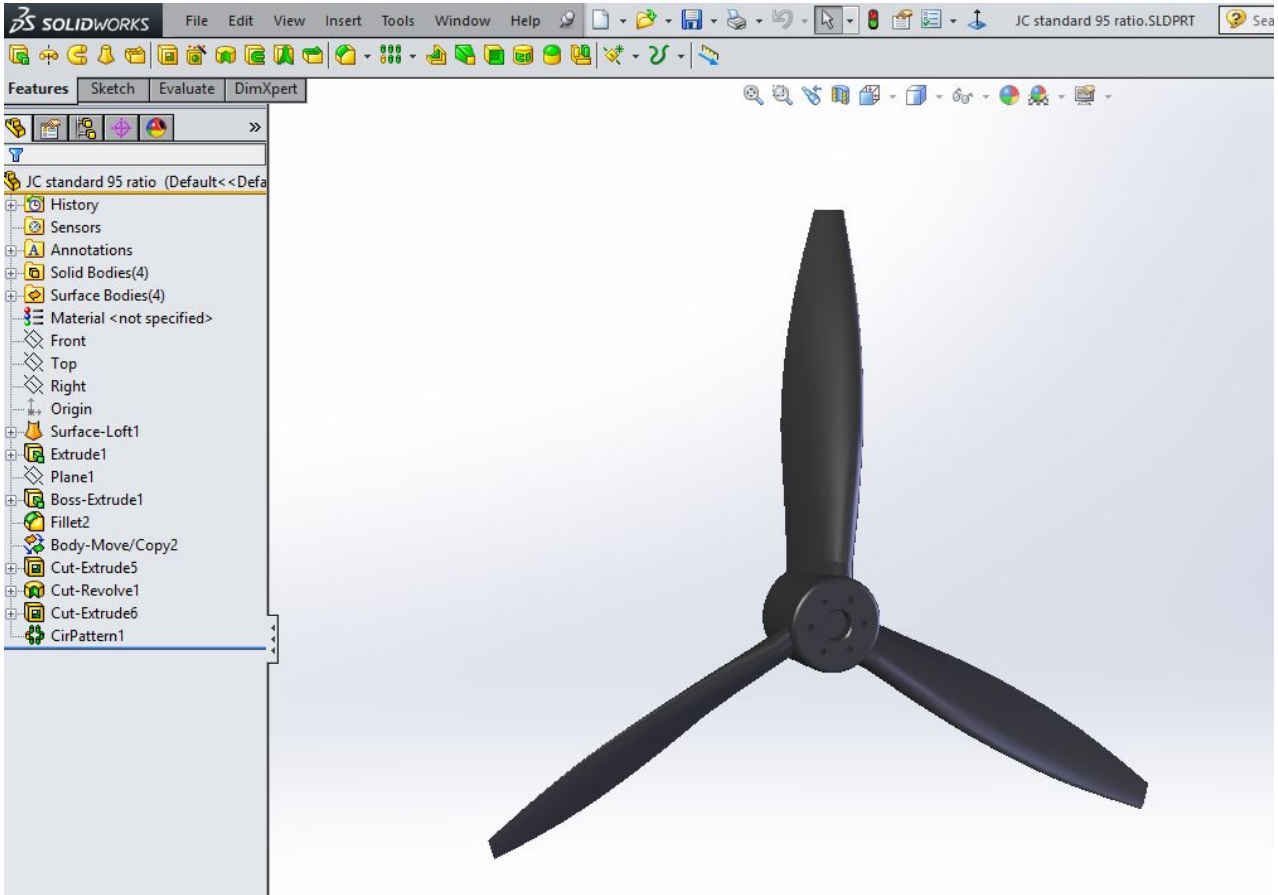
DATA AIRFOIL's

JC Std Planform

C. station	ordinates	ordinates	Station 45%	'@ Blade angle Deg		39.58	
X	Y.U.	Y.L.		XU	YU	XL	YL
-3.11	-0.09	-0.11		-2.45	1.92	-2.46	1.91
-3.02	0.08	-0.27		-2.28	2.00	-2.50	1.73
-2.93	0.18	-0.32		-2.14	2.02	-2.46	1.63
-2.76	0.31	-0.38		-1.92	2.01	-2.36	1.48
-2.41	0.47	-0.44		-1.55	1.91	-2.13	1.21
-1.71	0.64	-0.48		-0.91	1.59	-1.62	0.73
-1.02	0.66	-0.49		-0.36	1.17	-1.09	0.28
-0.32	0.64	-0.49		0.16	0.71	-0.55	-0.16
0.38	0.55	-0.48		0.65	0.20	-0.01	-0.60
1.07	0.42	-0.48		1.10	-0.35	0.52	-1.04
1.77	0.25	-0.47		1.53	-0.92	1.07	-1.48
2.47	0.05	-0.47		1.94	-1.52	1.61	-1.92
3.16	-0.17	-0.46		2.33	-2.13	2.15	-2.35
3.86	-0.39	-0.44		2.73	-2.74	2.70	-2.79

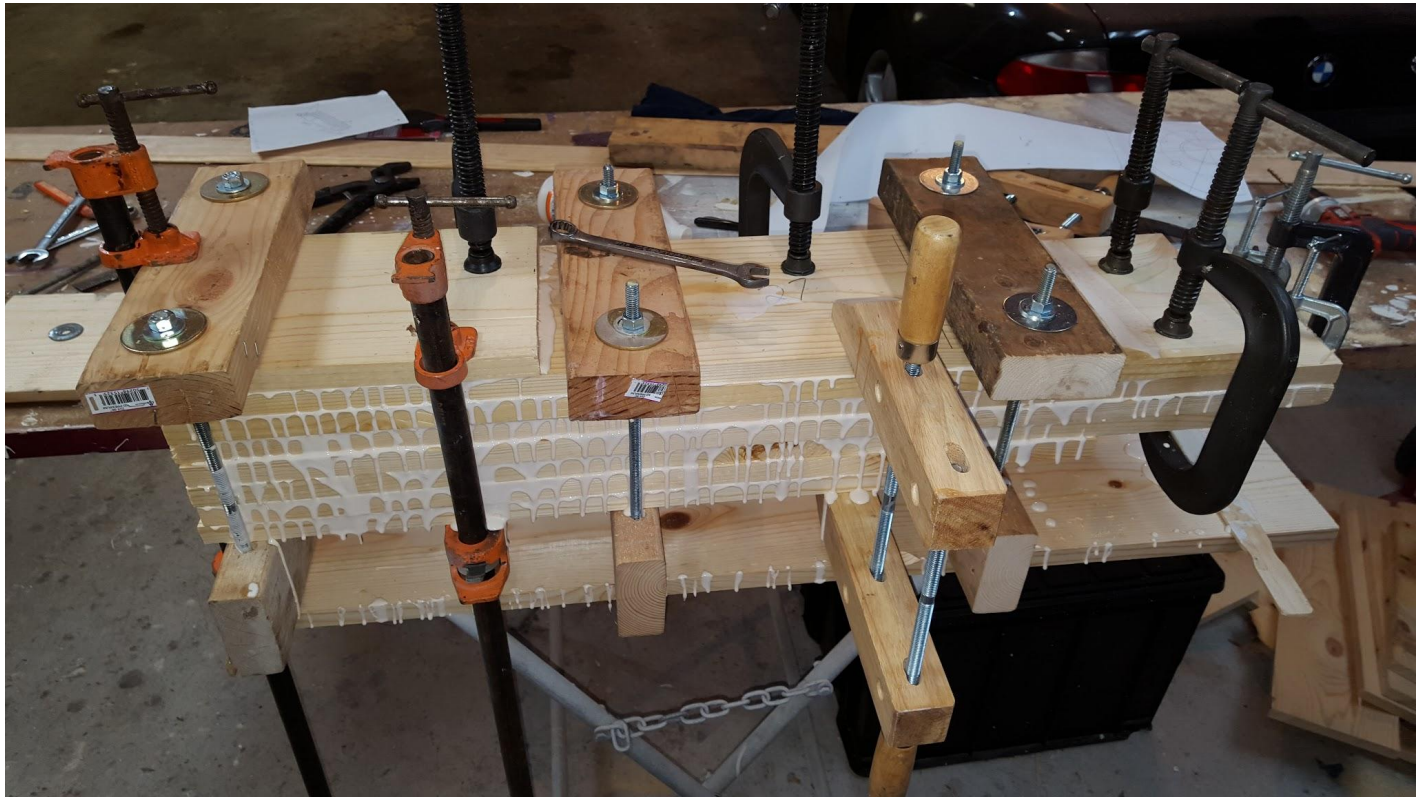


CAD



With the info from the Propeller Program I was able to model the propeller in Soildworks very easily. This is where I was able to make my templates for cutting the propeller profiles.
Using a printer and Solidworks I was able to print out accurate templates on stiff card stock.

Building Begins



Glueing the Pine blanks together, you must alternate the grain curve.

()()() This helps prevent warping .

I found the threaded bolts and 2x4 worked best for clamping. Next time I would use more of them and less clamps.

You must work very quickly, the glue sets up faster than you think.

Once the glue has dried over night, the clamps can be removed. Then the outer profile or shape of the propeller is cut for each blade .It is very important to be extremely accurate with your lay out lines and cutting since this cut shape will be your final propeller shape. Some minor changes can be made but this shape is what drives the carving of the propeller.

Now once the outer shape is cut and it is to your liking, the real fun begins.
Carving!!!.Using the card stock templates generated from Solidworks, I began carving.

I used a Saws All for the rough cuts .Next time I will use a electric Chain saw. It would make carving go much faster. I saw a guy at Oshkosh carve a blade in under an hour .

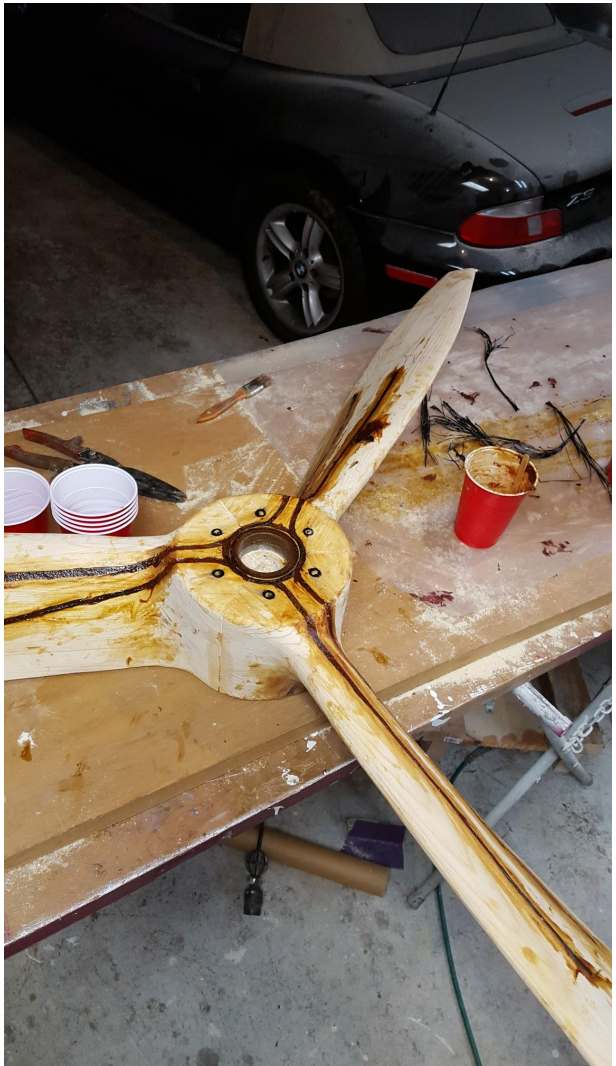
Hammer and chisel to remove the bulk of the material.

Here I’m bonding the three blades together.Notice the wood wedge holding the blades at the correct pitch.

The blades are not completely done with carving process yet but very close.

I left material on for fine adjustment once the three blades are bonded.

Since the floor is not totally flat, I wanted to make sure I could get them back in alignment once the glue cured.



Fiberglass center hub with ¼ diameter carbon fiber spars wrap around the hub and down each blade . So far very happy with the progress for the prop. It has taken 6 nights of carving to get this far.

Tools used :

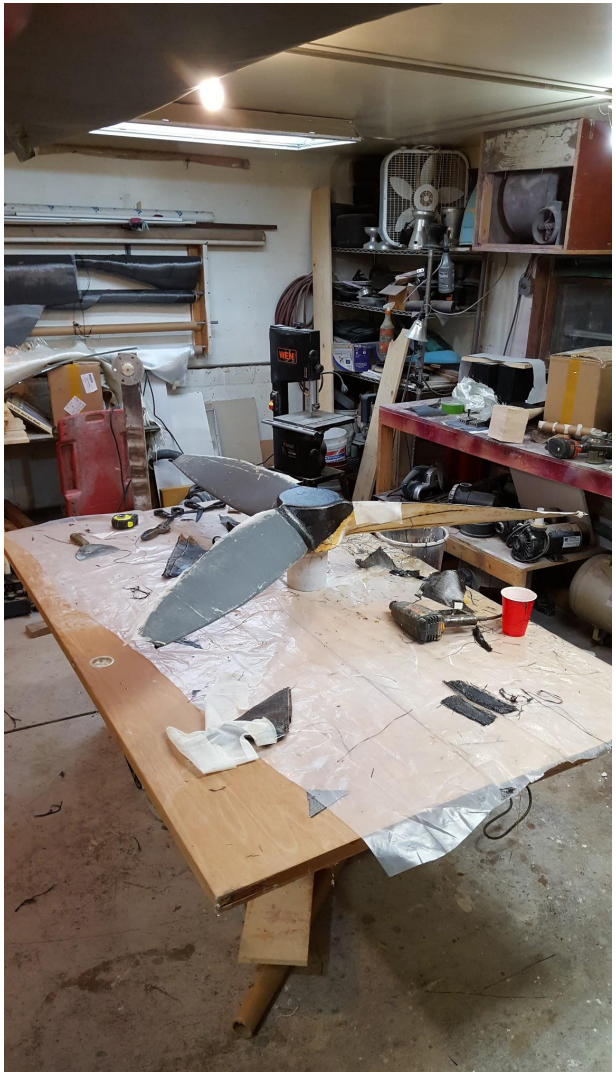
Belt sander : removes wood very fast.

Hammer Chisel for the initial rough work

Die grinder with a 2 inch drum works great for carving the hub.

Band saw

And a tool you must have is the Spoke Shave. Keeping it sharp can remove the wood in .010 chips and leaves a great surface.



First Carbon layups.
Flat side first.
layers of glass on each side of the blades.
18 Layers at the hub.
I used 3 layers of Uni on each side and the other 3 layers are Bid. I choose to use Carbon fiber, but since it is so stiff, I wanted to make sure that there was no chance of flutter in the blades. I could not come up with a way to vacuum bag this so I just did wet layups on plastic and then transferred them to the propeller. The wood is rough sanded and then coated with epoxy before the carbon is placed . Wrapping the glass over the leading edge onto the opposite side . Trailing edge glass is just up to the edge and cut off, not wrapped over.

Layup Schedule I used Copied off of this web site
http://www.ez.org/pages/alwick/index_files/Page874.htm
Layer #1 Is Bid full length
Layer # 2 is Uni-directional weave (RA 7715) full length.
Layer # 3 is Uni 50% of full length.
Layer # 4 is Uni 25% of full length.
Layer # 5 is Bi-directional weave at 15% of prop length.
Layer #6 is Bi-directional at 15%.

2 days after Flat side is glassed :
Trailing edge of the prop wood is removed back about ⅜ of an inch before the shaped side of the prop is glassed. The glass is wrapped over the leading edge about ¾ of an inch on the flat side of the blade. Once glass is stimpled out, Peel Ply is added to control the glass from moving and to give a good surface to work with during the finishing process .

Finishing lots of sanding and balancing . Balancing is done on a small ball bearing hub. Amazingly accurate . A Post It Note on the tip of the blade will swing that blade to the bottom when it is all done.

Ready to fly….
I got what I was trying for a much faster Propeller. Cruise speed now is 168 Knots almost 200 MPH :(Bad part Take off distance is suffering. The JC propeller Program calculated out exactly what to expect and it delivered!

So the outcome .
1)Carving the propeller accurately by hand was surprisingly easy... Not easier than the first one I built using the Machining center :(
I received the speed I hoped for, but now the take off distance is suffering.
2) I am considering making another one with a bit more climb characteristics.
3) If I make another one will it be wood also?

A) Foam core: Some certified blades are made with foam cores . I have been told by Catto propellers that they have considered it but they like the wood core for vibration absorption characteristics. Foam would be much easier to carve!
B) 3D print the blades. Never seen this but it should work. Bonding the glass to the PLA material will be the challenge. The core of the propeller serves as a form and does not carry any of the load.

4) Fun to do? Yes I love making things!
5) Cost: About $500 in materials. The Carbon Fiber was $350 or more of that cost .If I choose to make it out of glass it would have only cost about $200.