Kiel Kraft SENATOR 50 by Bob Aberle

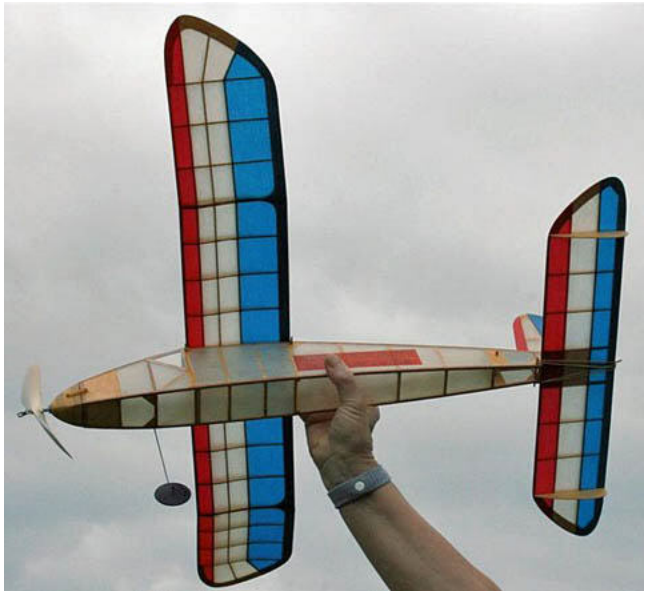
Originally a rubber powered P-30 free-flight aircraft, now reduced to 50 square inches, weighing 1.72 ounces or 48.7 grams.

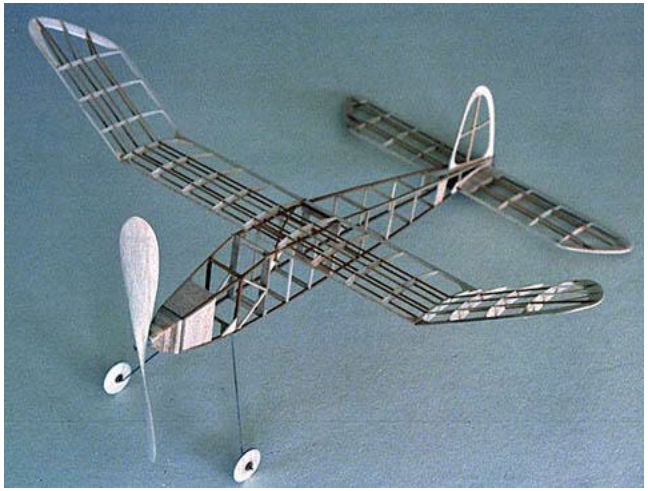
BACKGROUND

My inspiration for this month design came from the DC Maxecuters newsletter which is coordinated by Pat Daily (Washington, DC area). A while back Pat ran several photos of a Keil Kraft Kit design, called the SENATOR. It was part of a series of Keil Kraft kits with names like: Gypsy, Competitor, Ace and Achilles.

The full size SENATOR was designed by Albert E. Hatfull in 1950 and was intended for the P-30 rubber free flight category. It had a span of a 32 inches with an estimated area of abut 80 square inches. A copy of the original full size plan is also included in this issue of RCMW-FSP.

I wanted to share two photos of the original size SENATOR aircraft that appeared in the Maxecuters newsletter in September 2012. These photos were originally provided by Prof John Bird from Australia. Unfortunately John has since passed away. The SENATOR model pictured next was built by John French.





If I understood some of the background info, this full size SENATOR had a total weight of 60 grams including the rubber motor. I realize it looks like a lot of "sticks" but I was able to simplify a few items to make life easier for the scratch builder. Let me go on!

THE CURRENT SENATOR

Although somewhat arbitrary, I decided to reduce my current micro version of the SENATOR to 50 square inches of wing area, with a span of 19.5 inches. My ultimate weight, with an electric motor, battery and RC system came to 48 grams.

If I wasn't always in a hurry, I probably could have achieved a weight as little as 40 grams. That extra 8 grams prompted me to go to the next higher power level motor. I had wanted to use a 6 MM geared motor, which can support up to a 40 gram weight, but instead I opted for the larger 7 MM motor. The 6 MM had a power input of of 2.06 watts, while the 7 MM has a power input of 3.7 watts which is almost twice as much.

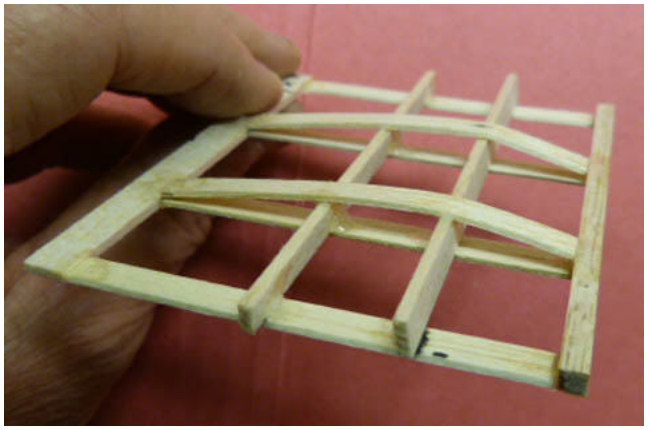
The original model had an undercambered airfoil which was typical for free flight models of its day. To keep it simple I made the airfoil with a flat bottom. This makes the wing easier to build and especially easy to cover.

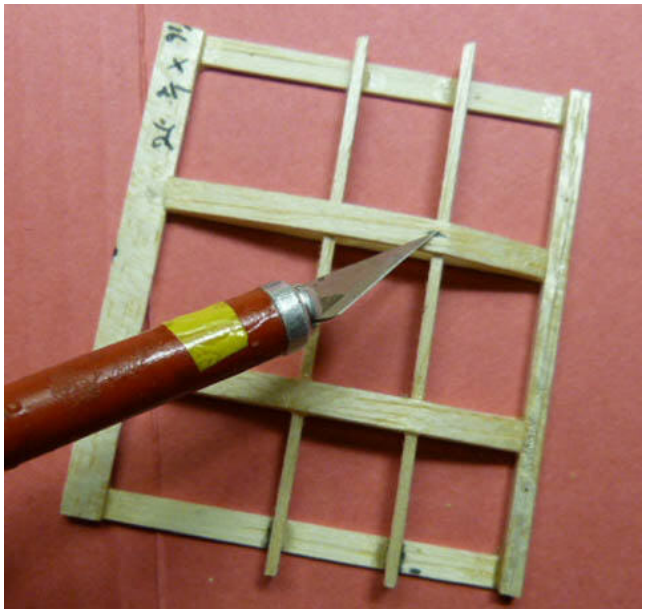
The stab area is about 50% of the wing area. Had I used the original stab with an airfoil, I might have placed the CG almost back by the wing trailing edge. But again to keep it simple, I constructed my stab, elevators, vertical fin and rudder all from sheet balsa. In doing this, I had to move the CG forward to a point 33% back from the wing leading edge.

Although most rubber powered planes had long noses, to cope with the weight of the rubber motor, I still felt I needed to lengthen the nose. I did this because my motor and battery were so light in weight. But all in all I maintained the original appearance of this design.

This is what my latest version of the SENATOR looks like, covered and ready to fly.
(insert senator-03 and 04)

So many of my readers tell me that they hate to cut out wing ribs. There are 16 ribs in all on this plane. I tried initially using a wing technique where strips of balsa are bent over the spare. The height of the spar, then determines the thickness of the airfoil. The height of each spar can get critical. Also if the wood is too soft the strips snap or break when they are bent over the spars. The next two photos tell the story. In the second photo the X-Acto knife points to where the top cap strip cracked.

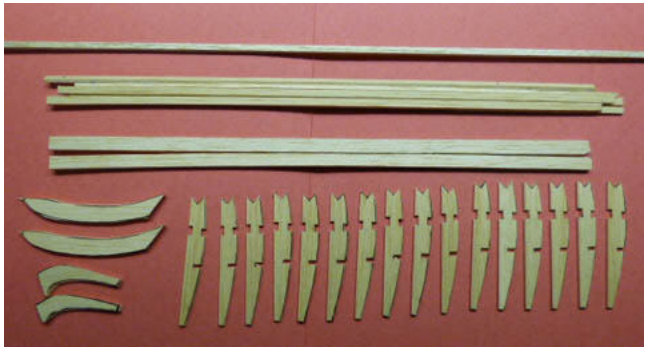




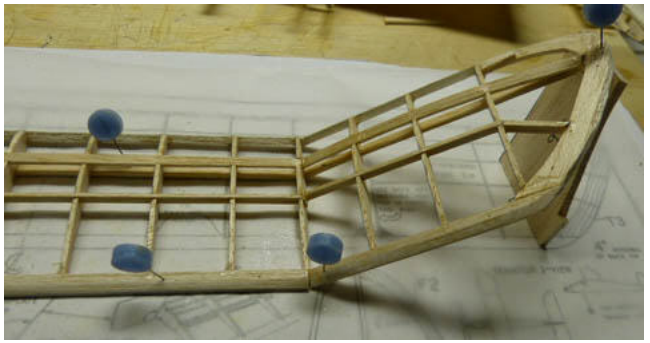
Even though you don't have to cut out ribs, the bent rib concept can have its own problems. I decided to go with the conventional cut out wing ribs.

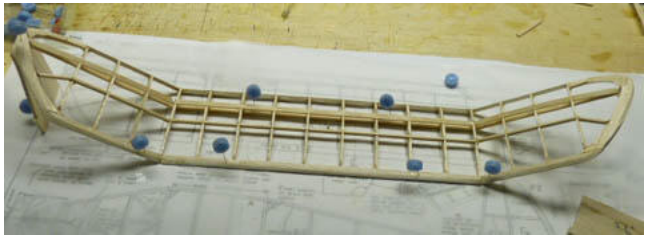
CONSTRUCTION

Lets get started with the wing. The next photo shows all the parts that go into the wing structure, prior to final assembly.

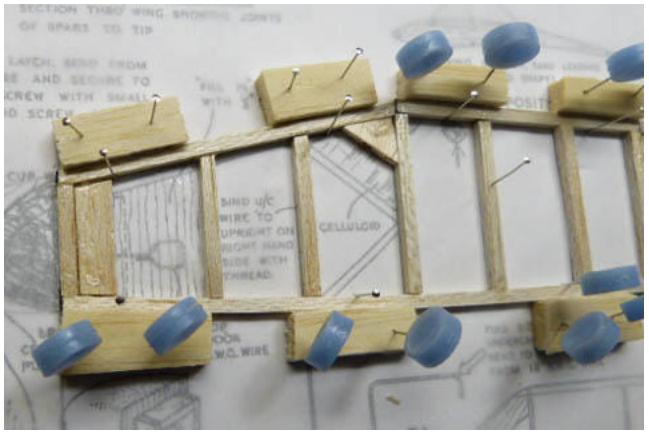


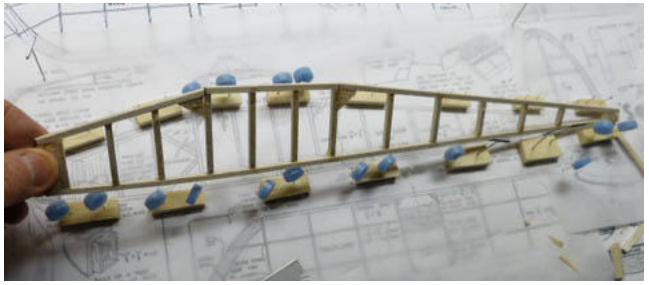
I usually strip my spars, leading and trailing edges from sheet stock, using a long metal straight edge and a sharp X-Acto knife. This way I don't have to go shopping for exact sizes of wood. Note that the wing center section is flat. There is only polyhedral at the wing tips. No wing braces were considered necessary.



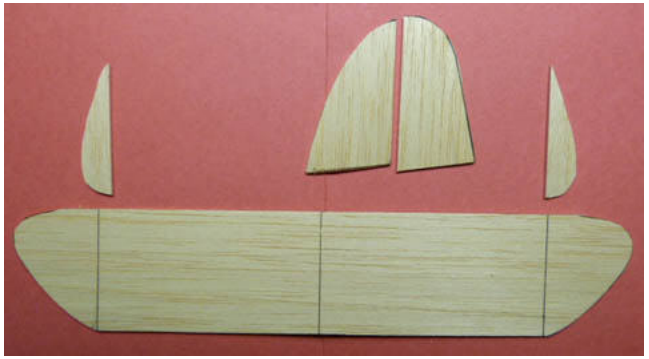


The fuselage is next. It is entirely constructed from medium 1/8 square balsa. That might be a little overkill. You could get away with 3/32 inch square balsa to save a little weight. You will notice that I make up my own assembly jig using scrap pieces of balsa along with many push pins. It's a lot easier than it looks.

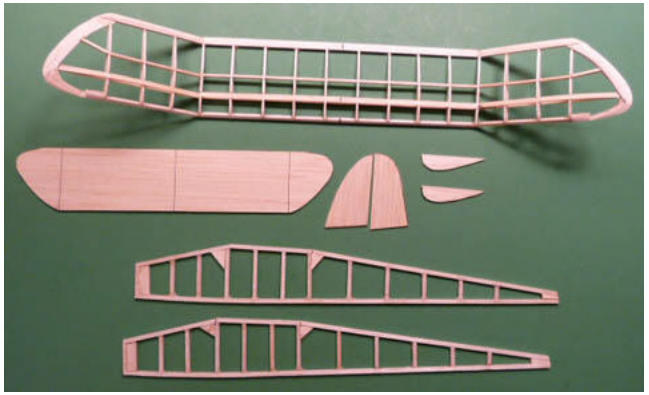




At this point I piled all the semi-assembled parts on my scale. You can see the result, 17.8 grams.

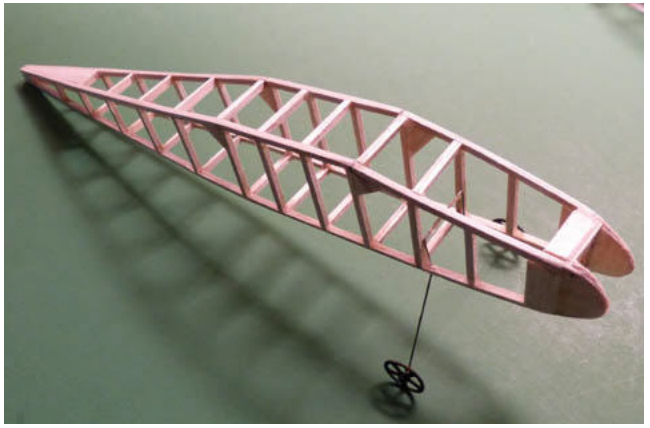


All of the tail surfaces were cut from medium 1/16 balsa sheet. Quite honestly I think you might substitute a slightly harder, 1/32 sheet to shave off a few grams. Those sub fins on the lower side of the stab are important. Don't forget them!

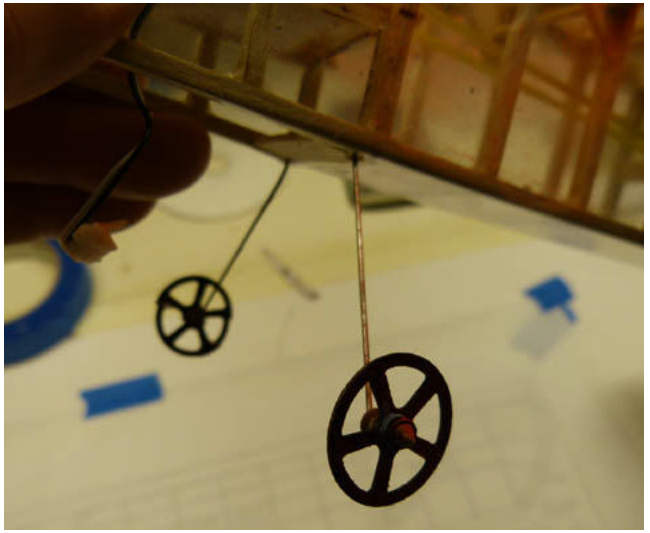


One more composite photo showing the various structural pieces, before final assembly and covering.

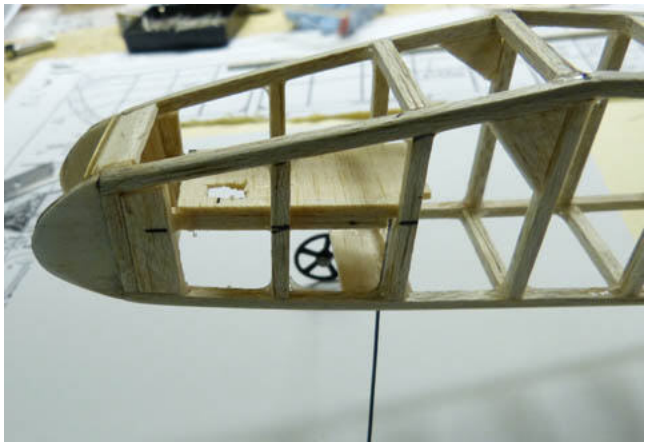
Now let me give you a few tips on joining the two fuselage sides. I first make up the landing gear wire, as close as possible to the pattern shown on the plans. I then use the landing gear to set the spacing between the two fuselage sides. Whatever width is achieved, I make it the same from about one inch forward of the wing leading edge, to about one edge beyond the trailing edge. Next I use a clothespin and clip the two sides together at the tail.

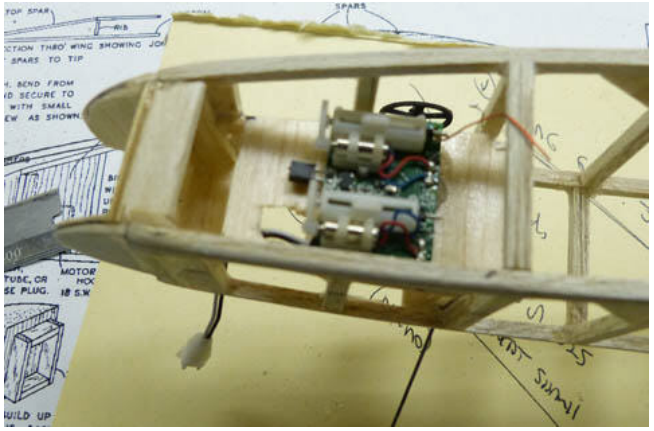


Finally I insert the firewall, align as best I can for a little right thrust and downthrust and cement the firewall in place. The landing gear and firewall use 5 minute epoxy cement. Last step is to fill in all the remaining cross pieces, both top and bottom.



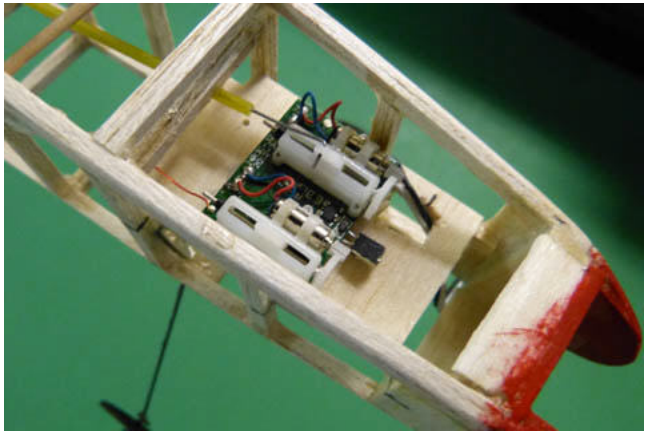
A pair of Bob Selman 20 mm plywood wheels save a lot of weight.



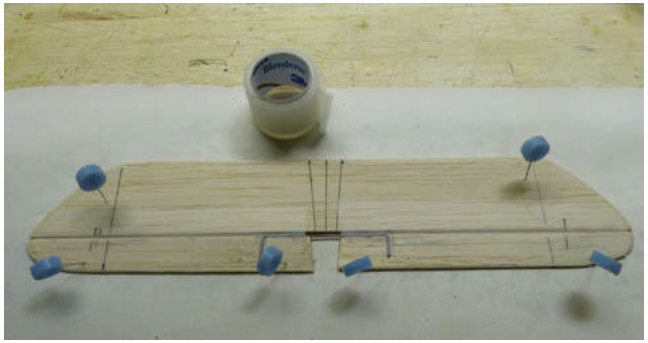


A piece of 1/16 inch balsa becomes the floor for the battery cell. The battery will be accessed from the bottom. The Mini-Vapor brick sits on top of that same battery floor. I adhered the brick to the floor first with double sided tape followed by an application of Permatex Clear RTV Silicone adhesive sealant. This adheres well and does not corrode any electrical wiring

Control rods are next. I use the usual Stevens AeroModels yellow .073 Teflon tubing with .025 inch diameter wire running inside the tubing. Keep in mind that the two servos and the ESC are built into the brick. The cable from the motor plug

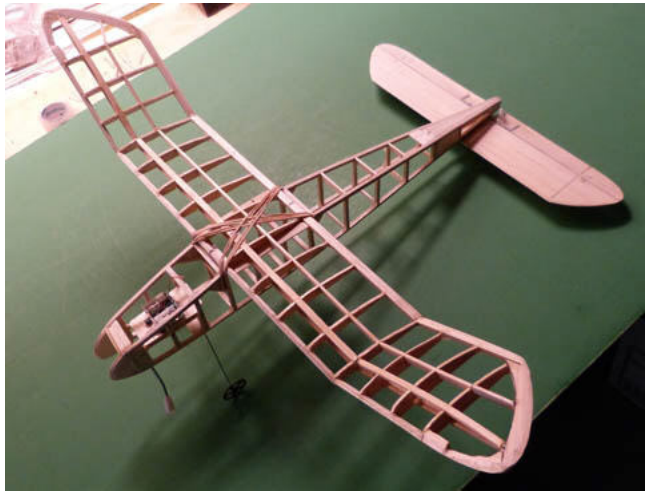


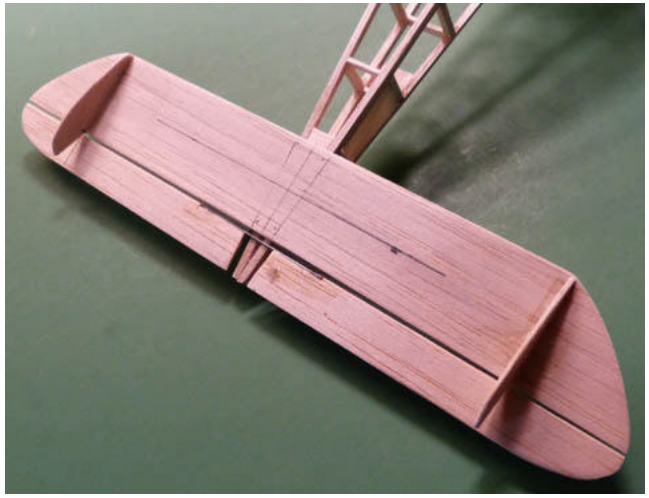
into a connector on the brick. The battery cable that exits from the brick passes out through the opening for the battery compartment on the bottom of the fuselage.

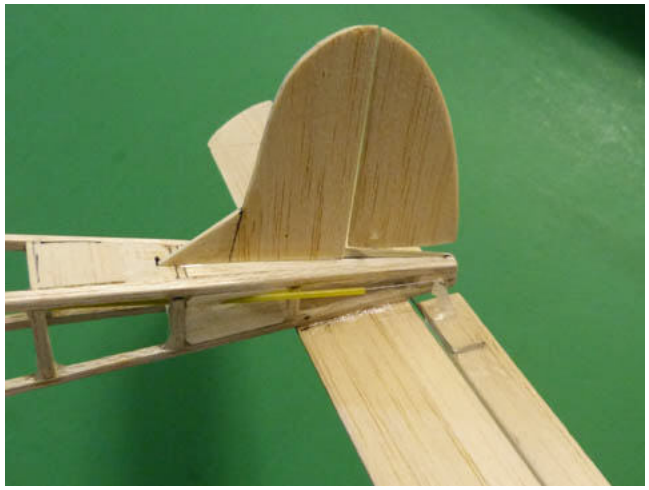


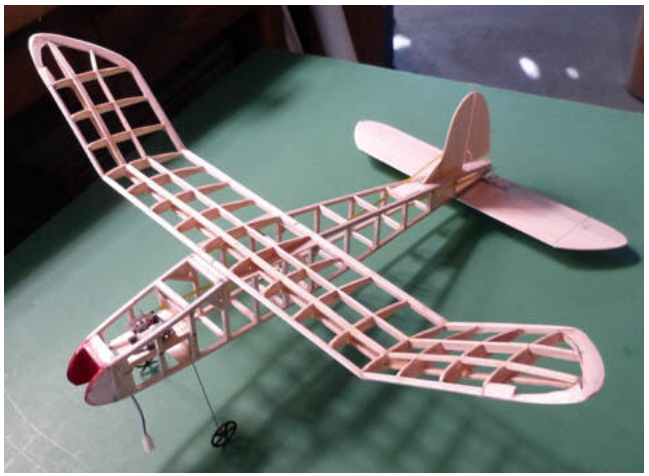
Next I applied my hinges for the elevators and the rudder. I lightly sprayed Krylon Crystal Clear (No. 1303) along the elevator and rudder hinge line. This allows the DuBro electric flyer hinge tape (No. 916) to adhere properly to the wood surfaces. The two elevators were joined with a short length of .032 diameter wire.

With the wing attached to the fuselage for reference purposes I next affixed the stab with elevators and the vertical fin with the rudder to the fuselage, aligning both surfaces with respect to the wing. Use 5-minute epoxy for the cement.



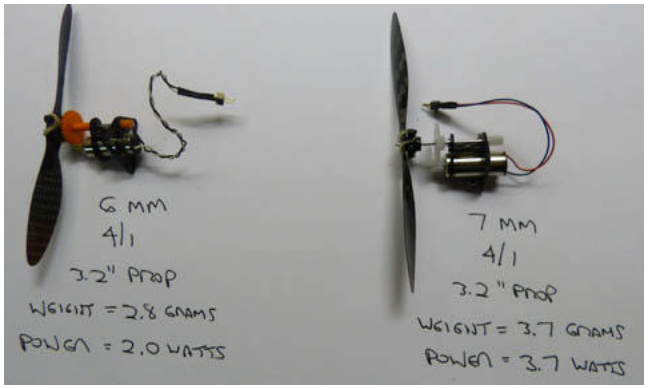






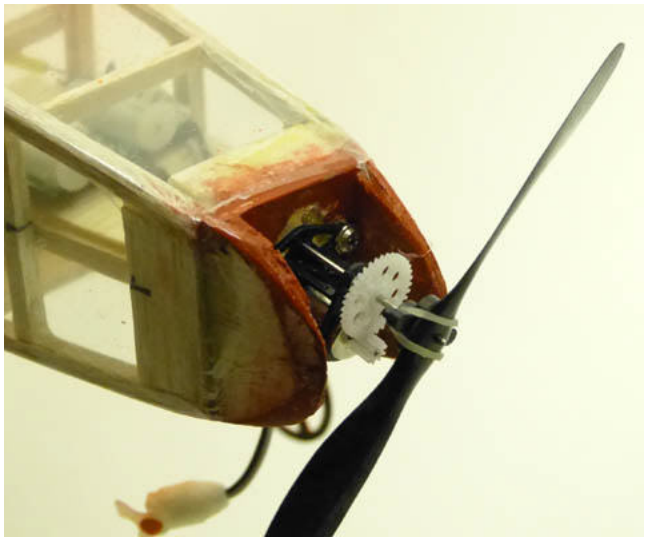
RC and POWER SYSTEMS

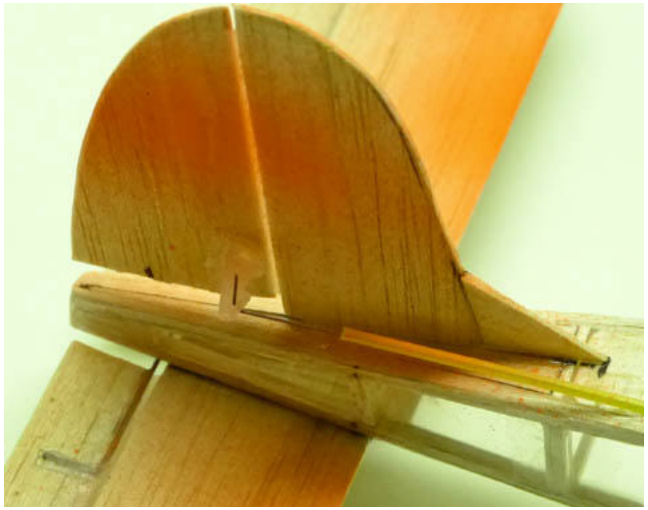
As mentioned earlier, the final weight of my SENATOR of 48.7 grams made it necessary to go from a 6 MM to a 7 MM ferrite geared motor. As you can see in the next photo, that increase in motor size only cost me less than 1 gram). For that slight weight increase, my power input went from 2.0 watts up to 3.7 watts or almost doubled. The 7 mm was the better choice.



The Micro Vapor brick weighed 3 grams and the single 160 mAh Li-Poly battery cell was 4.2 grams. The total weight of the power and RC system, with the 7 MM motor, came to 10.9 grams. In my opinion that was a great deal!

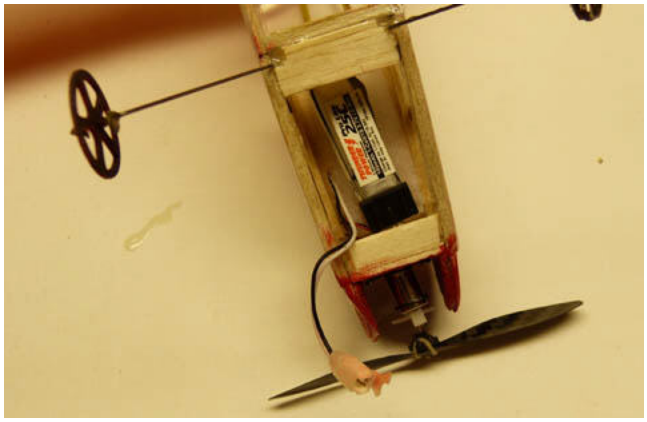
This next photo shows the 7 mm geared motor attached to the 1/8 ply firewall. Again, it was set with a "little" right and down thrust. The motor has three attachment screws. It also comes with a prop saver adapter that uses a small rubber band to hold the 3.2 inch diameter prop in place. Be careful with that prop, it is expensive!





DuBro micro control horns (No. 848) were used for both the elevator and rudder control connections.

An upside down view of the finished SENATOR. The wing and fuselage were covered with Clear Film (aka Doculam). I listed Tom Hunt's Modelair Tech as a source. If that doesn't work, just Google it. There is an outfit that handles this product from out in Oregon. A light mist spray coat of Krylon Short Cuts, added just enough color for extra in flight visibility.



The 160 mAh Li-Poly battery cell fits in a compartment on the lower nose of the fuselage, directly behind the firewall. Velcro tape was used between the battery and the compartment floor. Apply a little CA to the floor to help make the tape adhere better to the balsa wood.

Here's a last overall shot of the model ready for the first flight followed by me holding the SENATOR in his basement shop to give you a size comparison

FINAL CG COMMENTS

I've already talked about the CG. The 33% back from the wing leading edge seems to have worked fine. I did also have to move the entire wing aft a small amount. The plans show the final configuration as flown at the first flight session.

Control throw ended up as 1/4 inch either side of neutral for the rudder and 3/16 inch either side for the elevator. No expo rate control was used.

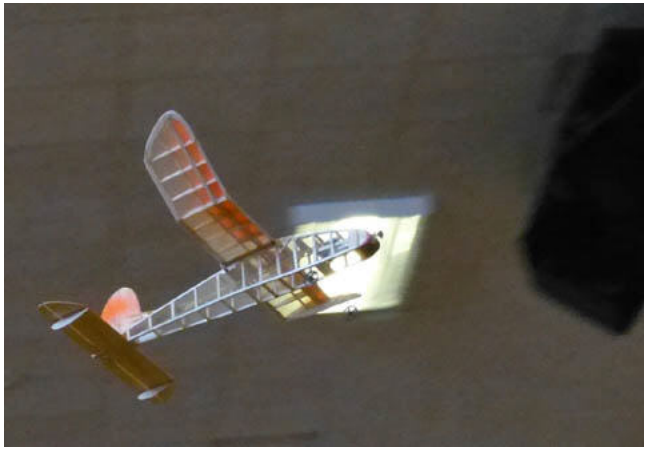
FLYING

With our terrible winter weather this season, flying has been a big problem. Obviously I couldn't fly in 40 mph winds and with snow. But that kind of weather prompted our local school to cancel our indoor flying so that certain sports activities could be performed indoors. What I ended up doing was to fly in an un-plowed parking lot near my home. I chose near sunrise when the wind was only 2 mph. Not only did I not have Tom to help me but photography would have been impossible in the low light levels.

That didn't stop me from making my first few early morning flights to verify that the little SENATOR was in deed capable of excellent flight performance.

Planes with lots of polyhedral tend to rock a lot in flight. Not so with the SENATOR. It was smooth at all speeds up to full throttle. So my CG position, motor thrust, incidence angle all worked to produce a perfectly flying micro aircraft with no bad tendencies. Even the landings were slow and steady, with no tendency to stall. A total winner!

Later on I had a chance to get a few flight photos in a local school gym which are shown below.



SUMMARY

Once again I have a benchmark for you micro flying enthusiasts. The specified 7 mm geared motor was more than capable of flying a 48 gram aircraft. I would guess that I could go to a 240 mAh battery cell, which would bring the total weight up to 52 grams and it would still fly well. So that's about a 2 ounce airplane. Once again I've proved that these little power systems, with micro brick radio systems, are capable of flying many small rubber powered free models, be they scale or the sport variety.

I wanted to mention one last thing on the subject of the SENATOR. I learned just the other day from my Canadian friend, Chris Moes, that the UK publication, Aeromodeller published last year a rubber powered free flight version of the SENATOR with a 16 inch wing span. That's pretty close to my 19.5 inch span. But also of interest is that a kit is being offered for this smaller version. Of course you would have to figure out how to install the electric motor and RC system. Considering the smaller size, it is possible that he 6 MM geared motor might work for this application. This is the website that mentions this 16 inch span version and the kit availability.

http://adhpublishing.com/shop/store/products/senator-16-plan446/

If you should build this version and convert it to e-power and RC we would love to hear from you. Next month I will have a reduced size old timer surprise for you.

Bob Aberle
baberle@optonline.net

SPECIFICATIONS

Model: Keil Kraft "SENATOR"
Designed by Albert E. Hatfull in 1950 as a Keil Kraft kit. The original was intended for the P-30 rubber powered free flight category.

Reduced in size and converted to RC and electric power by Bob Aberle 2015

Type: A micro Indoor/Outdoor Electric Powered RC sport design
Wingspan: 19.5 inches
Wing Area: 50.5 square inches
Length: 15 inches
Weight: 1.72 ounces (48.7 grams)
Wing Loading 4.9 oz/sq.ft.

RC GEAR USED

Horizon/Spektrum DX-7 transmitter 2.4 GHz spread spectrum, Spektrum Mini-Vapor brick which includes two servos (rudder and elevator), plus a brushed motor ESC

POWER SYSTEM USED

Bob Selman Micro RC LLC - 7 mm brushed motor geared 4/1), 3.2 inch diameter prop and a single cell 160 mAh Li-Poly battery pack.

POWER SYSTEM PARAMETERS

Prop: 3.2 inch diameter
Motor current: 980 mA (0.98 amps)
Voltage: 3.80 volts (under load)
Power Input: 3.7 watts
Battery Loading: 6.1C
Power Loading: 34.2 watts/pound
Flight Time: 11 minutes

MANUACTURER SOURCE REFERENCES

Bob Selman Micro RC - 7 mm brushed motor with 4/1 gearing, 3.2 inch dia. prop, single 160 mAh Li-Poly battery cell and pair of 20 mm diameter plywood micro wheels www.bsdmicrorc.com

BP Hobbies (CA cement, 5 minute epoxy cement and CA accelerator -- www.bphobbies.com)

DuBro --- (micro control horns and electric flyer hinge tape -- www.dubro.com)

Horizon Hobby (Spektrum DX7 transmitter and a Mini-Vapor brick -- www.horizonhobby.com

Krylon Products Group Inc.(Crystal Clear Acrylic Coating #1303 and Short Cuts Spray paint - Glow Orange -- www.krylon.com

Modelair Tech -- ClearFilm COV-001 covering material for the wing (also known as Doculam) Check with -- tomhunt@optonline.net