On the 'Wing... #158

John Digby's *Sushi RE*

Proof that fundamental theory, a well considered design process and results oriented experimentation can lead to success.

John contacted us several years ago with a question related to tow hook positioning on a plank planform. Some time later we received a message from him explaining that what was originally to be a tailless RC-HLG had turned into an electric powered tailless sailplane. The resulting airplane, the Sushi RE, appeared in the February 2000 issue of Electric Flight International, and full size plans are available through Traplet Publications. John has two other designs in the Traplet stable as well - the Sushi 400 and the Mini-Sushi.

Here's what John had to say about Sushi RE:

Basic idea

Sushi RE is the latest in a line of electric powered plank type tailless models I have designed around the Speed 400 type motor.

Prior to the RE all have been low AR wings utilizing Alfons Rieger sections and elevon control. I was very pleased with the way these models performed, as although not designed with soaring performance in mind I was pleasantly surprised by their flat glide and ability to use available lift. Spurred on by their success I decided to build a version optimized for thermal soaring.

Planform

Layout follows that of previous designs in that it uses a constant chord wing with the span increased to up the aspect ratio and wing area. I decided to stick with a Rieger section and selected the AR2411-S77 as it is predominantly flat bottomed making it ideal for built up rib construction. It is reported to be better than AR2610-S80 (a section I have previously used) for thermalling and besides Alfons had already used it on his Wega Thermik design.

For ease of transport I made the decision to build the wing in three pieces with the center section permanently fitted to the fuselage. Polyhedral was employed and for looks I swept back the tip panels by two inches.

Control surfaces

As a departure from previous designs I used a conventional rudder with central elevator. The main reason behind this thinking was that I did not want to have to connect up wing mounted servos. This way all radio gear was fitted within the fuselage, and tip panels are a simple piano wire dowel and incidence peg fit. By recessing the fuselage, the elevator could be kept as one piece. This makes connection to the servo very straightforward. Electrics are my usual package of 6V Speed 400 motor, 7X Sanyo 600AE cells and in this case a 6 x 3.5 folding prop.

Flight testing and adjustments

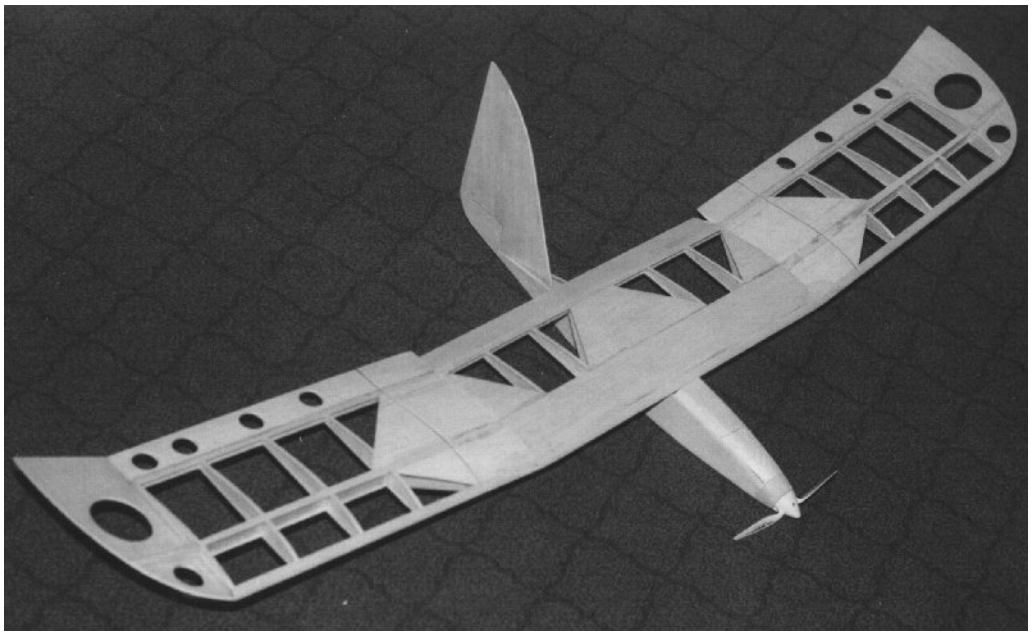
I would be lying if I said that first time out she performed flawlessly. In fact on the first launch a forward CG and not enough reflex saw her flying into the ground before I had a chance to get my fingers back on the sticks. After a few more attempts with increased reflex I decided it prudent to give up for the day and make further adjustments back in the workshop were a check of the CG revealed that I had miscalculated the 20% MAC position due to the sweep of the tip panels.

Hand launching an out of trim model carrying several ounces of dead weight doesn't do much for the structure, so in an attempt to preserve the model I removed the speed controller and 600AE battery pack replacing them with a 250mAh Rx battery in the nose.

Next time out I tried a few hand launches from the slope, each time moving the CG back and reducing the reflex until I was happy to reinstall the larger battery pack.

My flight log shows that she made her first flight under electric power on 31st January 1998 in far from ideal conditions. The next session was two weeks later, and I recorded a 30 minute flight making use of some excellent air. One peculiarity, which almost caught me out on the early flights, was a marked pitch up on applying power. I found that I could launch at half throttle which minimized the effect and have changed to a prop with a little less pitch, but it was very easy to induce unwanted oscillations as I over compensated with down elevator.

In an attempt to cure this I increased the down thrust from eight to ten degrees, but surprisingly it had little effect. The best solution has been to mix some down elevator to motor. This was not a problem encountered with my previous designs. In fact most needed some up trim at launch which could be removed as flying speed increased. To date my log shows 102 flights and it has become obvious that this model prefers calmer conditions and excels when lift is available.



Results

I feel that at 7.5 oz./ft.^{2} the wing loading is a little low for general conditions and I now believe that she would perform better if the wing loading was a little higher, as applying down elevator when flying in windier conditions only helps bring her down quicker.

Although not the complete success I had hoped for, this design has taught me a lot about plank type wings and their application to thermal soaring. As mentioned above I am sure that she would tolerate a higher wing loading, or perhaps a section with a little less camber and a lower pitching moment would help with the launch.

CG location I found was critical and I made constant adjustment along with that of the elevator trying to find optimum positions. If I were to build the same model again I would definitely drop the central elevator and return to elevon control but probably retain the rudder function. I must have hit upon a good fin, rudder and polyhedral combination a she is very stable in yaw enabling very tight thermal turns to be made.

Modifications

A recent modification has been to increase the elevator chord to 25% that of the wing I thought this was worth a try after reading a chapter on optimum elevator shape in “Tailless Aircraft in Theory and Practice.” With no further changes I enjoyed a very good flight on a flat calm evening, but further attempts in slightly windier conditions were less successful when any slight upset

would induce a stall which would eventually dampen itself out if left to its own devices. Reducing the reflex and moving the CG fractionally further forward has cured the stall and I believe less movement of the larger chord elevator reduces drag and has helped increase flight times in low lift conditions.

I am about to embark on the next stage of development that will ultimately end with a new model. Not wishing to make too many changes at once, I will firstly build a new wing employing a thinner section with a little less camber hopefully proving my theory that at 11% thickness the existing section is a little thick for the relatively low wing loading.

Other thoughts

I have recently reread an article by the late Theo Gordijn in which he relates wing thickness to wing loading and suggests wings should be flown at higher loadings. The section chosen for my Sushi RE design would require the model to be double the weight. In his article he states a "rule of thumb" whereby section percent thickness is equal to three times the square root of the wing loading in ounces per square foot. My earlier electric planks flew at wing loadings ranging from nine to 12 oz./ft.^{2} with nine to ten percent thick sections and all exhibited good glide performance and just happen to comply with Theo's rule.

Other changes to be incorporated in the new design will include foam construction and a return to elevon control surfaces as employed on my previous designs.

We're always eager to hear about the tailless designs of *RCSD* readers. If you have a project you'd like to share or a question you'd like to see answered, contact us at P.O. Box 975, Olalla WA 98359-0975, or by e-mail at <bsquared@appleisp.net>.

Resources

The Sushi RE appeared as a plan and construction article in the February 2000 edition of *Electric Flight International* magazine. Traplet Publications Ltd., Traplet House, Severn Drive, Upton-upon-Severn, Worcestershire, England WR8 0JL. Traplet Distribution USA Ltd., 3103 Tatman Court Suite 105, Urbana IL 61802 USA. <www.traplet.com>

Nickel, Karl and Michael Wohlfahrt. Tailless Aircraft in Theory and Practice, translated by Captain Eric M. Brown RN. American Institute of Aeronautics and Astronautics, Inc. Washington DC, 1994.