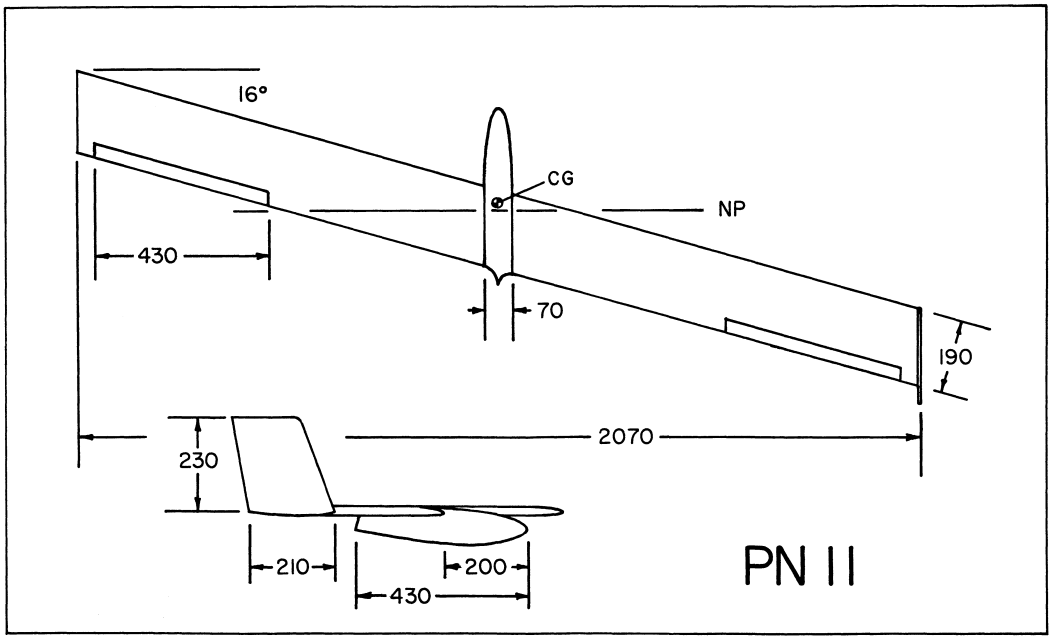
On the ’Wing... #155

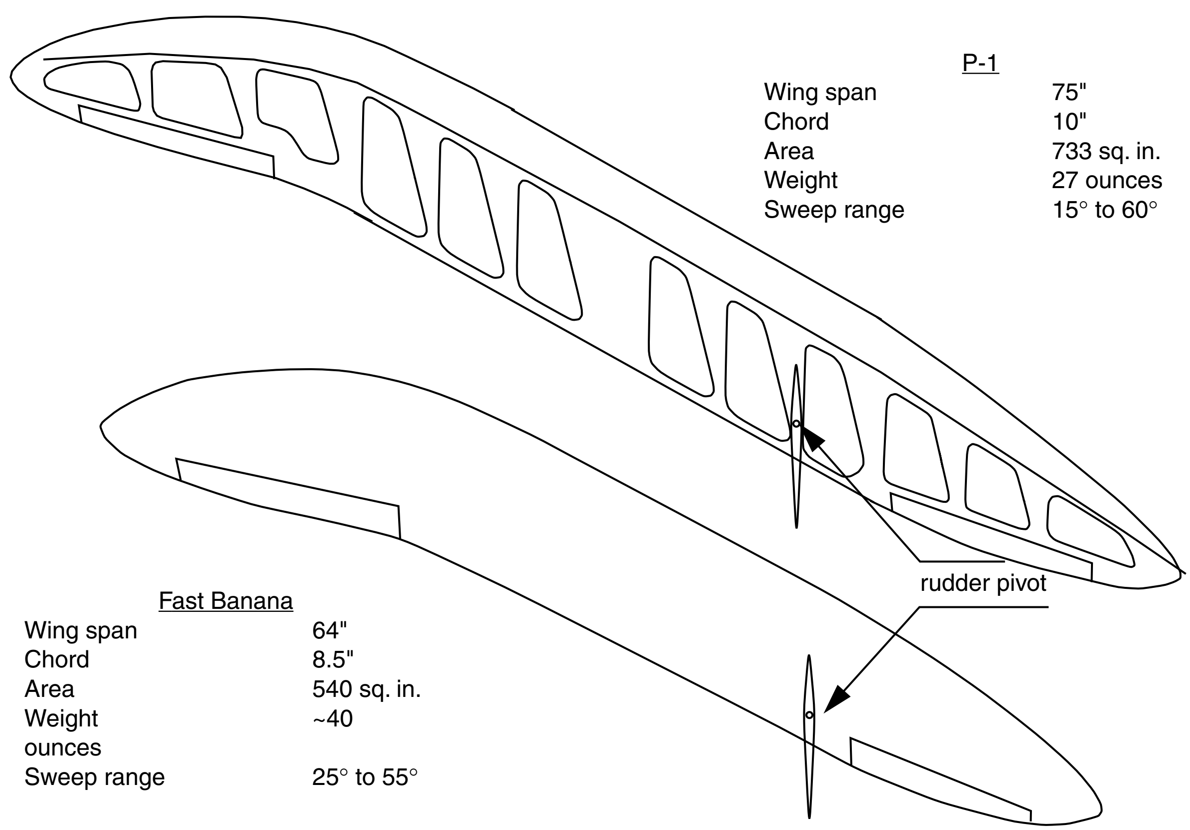
The Oblique Wings of David Freund

OK, so why is there a powered airplane at the start of this month’s column? Read on, soaring enthusiast!

The last time an oblique wing appeared in this column was back in November of 1992. That ’wing was Dieter Pfaff’s PN11. As can be seen from the included diagram, the PN11 was essentially a constant chord wing with 16 degrees of sweep and a fin mounted on the tip of the trailing wing. Despite its unorthodox planform, it flew very much like a conventional plank design. The only flight control idiosyncrasies of note were a slight tendency to climb during right turns and an associated tendency to dive during left turns.

David Freund has been designing, building and flying various tailless models for a few decades. About five years ago he decided to build a three channel oblique wing for RC slope flying, roughly based on Steve Morris’ 20 foot span powered NASA testbed — the photo at the start of this column. (More information about Steve’s aircraft is at the end of this column.) The results of

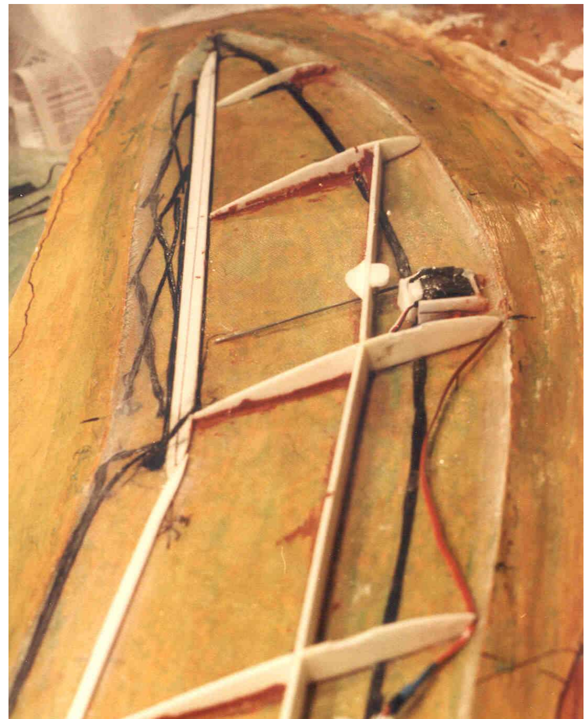




Dave Freund's Oblique Wings Planforms

Dave's skills are in two "free form" models which fly extremely well, despite their unorthodox planform and variable sweep. Modern radio equipment, with multiple mixing capabilities and adjustable rates, makes it all possible.

The fin is not used for steering, only for adjusting the sweep angle. Huge amounts of mixing are required to maintain hands-off control, but you can shift the sweep from 25 to 55 degrees using only a rotating knob above the right stick. The rudder input is used to directly trim the elevons.



P-1

The first of Dave's variable sweep oblique wings, the P-1 uses a relatively open structure using ribs and a single spar. All of the wood aft of the spar is 1/32" sheet balsa, and there is some carbon fiber in the trailing edge to add stiffness.

Because the fin/rudder controls the angle of sweep, a very sturdy servo is needed for that function. Add the skeg which tends to grab on landing, and you get the idea for what's needed. Dave reduced some of those loads by making the lower part of the fin automatically fold on landing.

The hard part of flying these aircraft is retaining visual orientation in the air. When you decide to come out of a turn is very much dependent upon the sweep angle. Even so, Dave's girlfriend learned to fly ailerons on this airplane!

Fast Banana

The Fast Banana has a wing loading twice that of the P-1, and the planform is compressed into a smaller airframe. It uses the Selig 5010 and 5020 airfoils and is fully sheeted. The name gives an indication of its flight regime and appearance in the air. The primary goal with the Fast Banana

was to better balance the roll stability and trim changes with sweep changes. This includes not only the fore-aft CG, but the lateral CG as well.

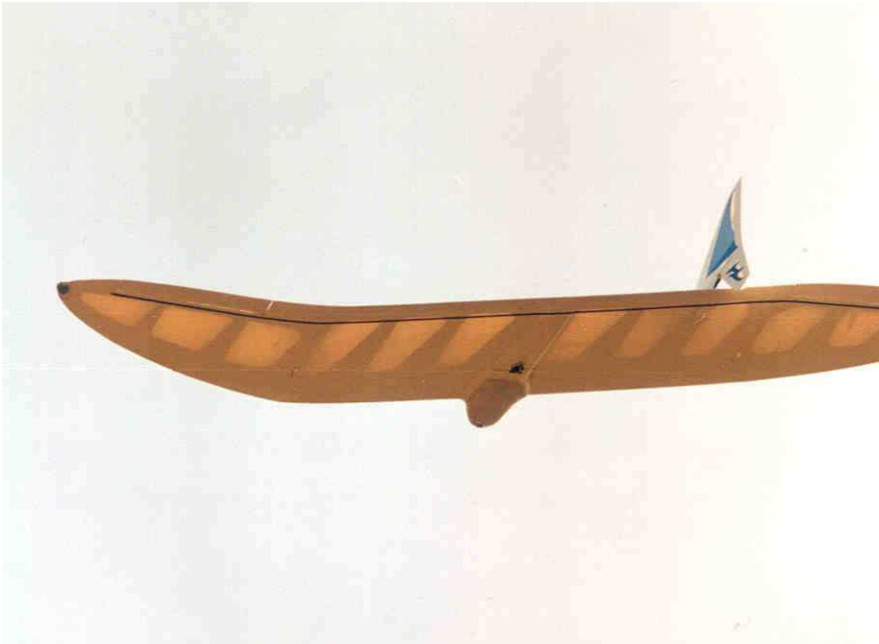
Concerns, hints, tips, etc.

Dave used a rather novel method of arriving at the correct elevon trim during the sweep change. First, the transmitter is set up to switch between two initially identical models. Small up or down trim changes are made to one elevon or the other using one model setting. Good adjustments are then copied to the other model until one set of model presets is correct. Both the P-1 and the Fast Banana will loop straight and have no bad habits upon stall.

These models are quite easy to fly after the trims are set up properly. Before trimming is complete, a lot of distracting manual tuning is required to change the sweep angle by any appreciable amount. After proper trimming, involving mixing both elevons to the fin function, the wing can be swung back and forth with the fin knob, hands off the stick. Sometimes when the glider stalls at the top of a slow loop, it will straighten out to less sweep until flying speed returns.

Dave placed the fin somewhat inboard. Placing it further outboard would give it a better moment arm. Because of the totally enclosed structure, access to the fin end of the control system is quite limited, and the whole control system is a maintenance headache. Make sure it's built strong the first time, and be sure to use a steel clevis inside. A nylon clevis will shear or open when exposed to heavy loads and will be nearly impossible to fix.

For mounting the fin, Dave made a square brass vertical fin post which was silver soldered into a round brass bushing about 0.5" tall with a control horn 0.75" of an inch long soldered to it. At first this assembly was captured in small light plywood counter bored covers in the top and bottom of the wing with the horn inside. Later he added small lightweight RC car bearings top and bottom, again captured by plywood covers. Either a straight music wire rod or nyrod is okay for the fin drive system, and a more flexible system isn't necessarily a bad thing. The square fin post fits a matching square brass sleeve in the fin so the fin is easy to remove for transport.



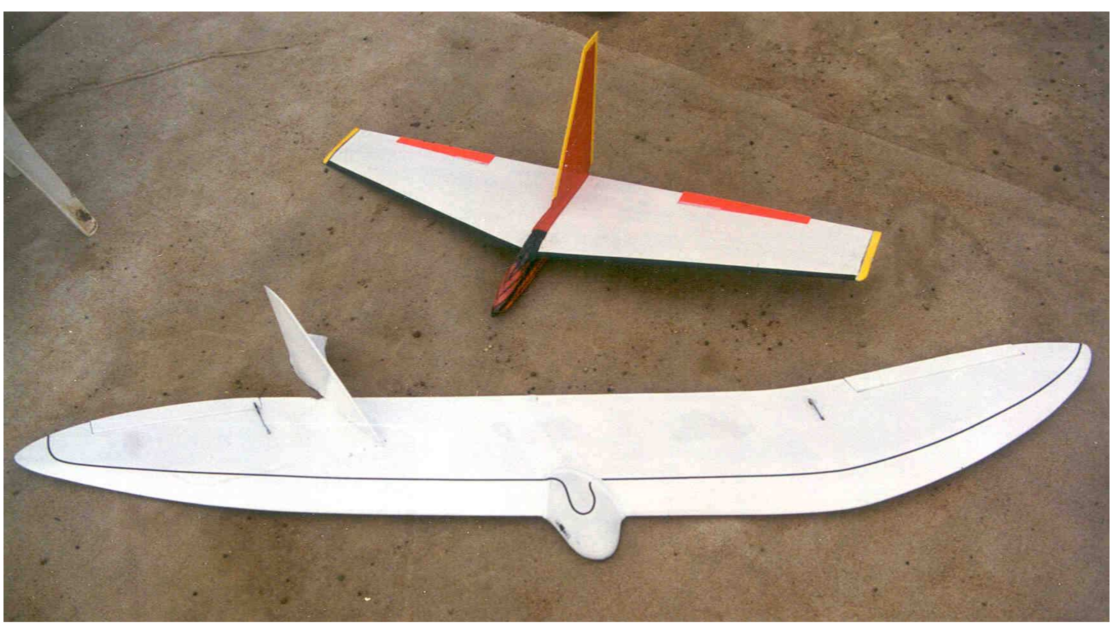
The fin shape doesn’t seem to matter too much, but the outline should be of a low aspect ratio and the surface area should be larger rather than smaller. Make sure that the fin rotates on the quarter chord point of the mean aerodynamic chord.

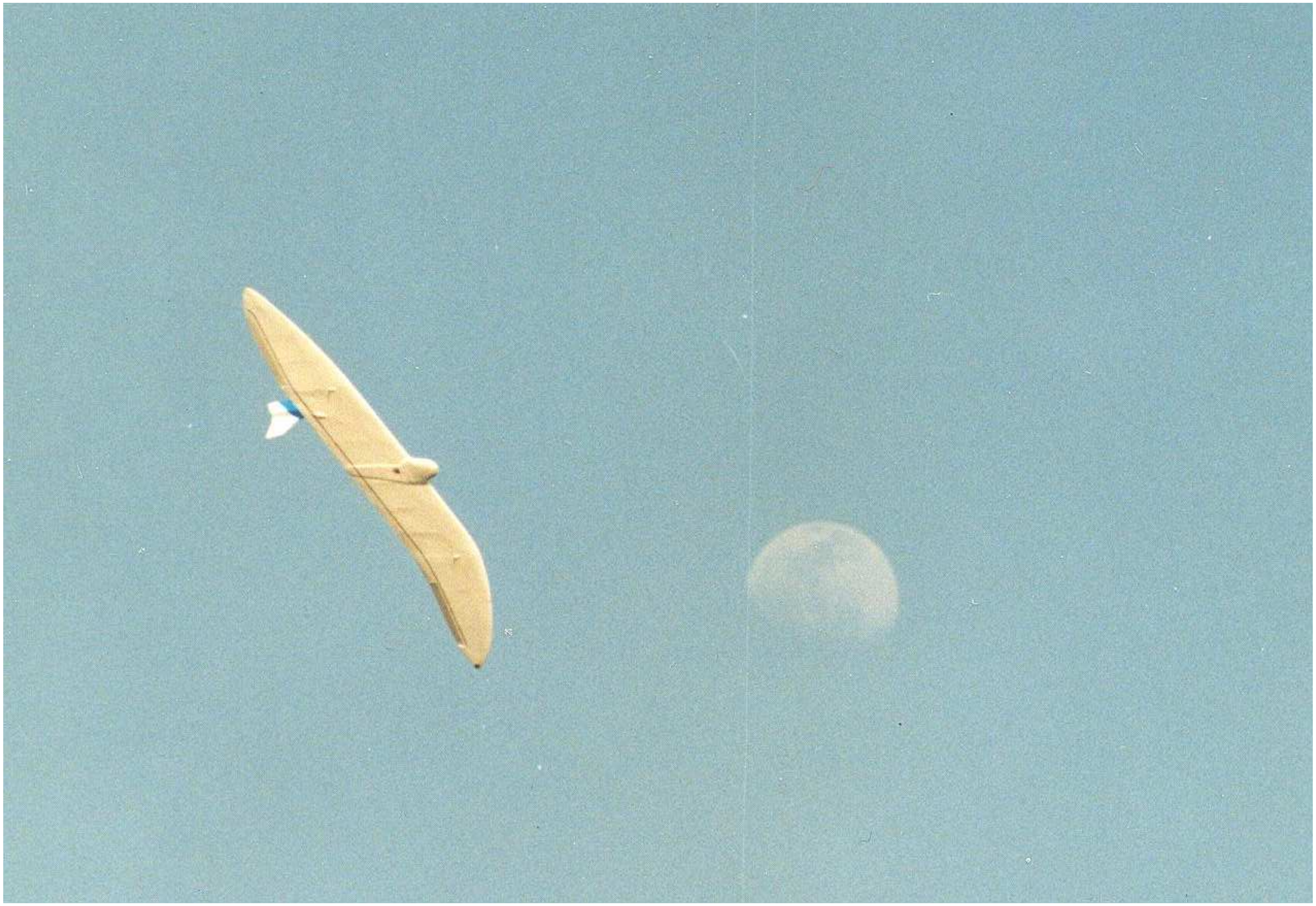
Everything behind the spars should be as light as possible. Dave says, “Don’t add anything unless it removes weight!” All gear is as far forward as possible for the same reason.

Left: Fast Banana coming out of its mold.

Next page: Fast Banana in flivght.

Below: Fast Banana and another of David's designs for slope flying.





Fast Banana ready to cross in front of the moon

More about Steve Morris' oblique wing demonstrator

Steve Morris spent two years designing, building, and configuring the NASA variable sweep oblique wing demonstrator shown at the start of this month's column. The purpose of this model was to study handling qualities, investigate various computer control algorithms for stability augmentation, and to demonstrate the feasibility of an inherently unstable asymmetric all wing design.

The sweep angle is variable in flight from 35° at take-off to 68° in flight. The model has a span of 20 feet and weighs 80 pounds. Power is two Viojett ducted fan units, each putting out 12 pounds of static thrust. There are ten trailing edge control surfaces and two moveable fins. Eighteen servos are used to actuate the control surfaces, swing the engine units so they are parallel to the flight path, and steer the landing gear. Construction is molded 1/16" sheet foam and Kevlar with an aluminum spar. The cost of materials was $25,000.

The model was mounted on a universal joint at the CG and mounted atop a car to verify the stability and control algorithms. During flight, the aircraft on-board computer reads the radio signals "uplinked" from the pilot and combines this incoming information with information gathered from six onboard sensors to produce control deflections that will both stabilize and maneuver the aircraft. Eleven data channels are recorded ten times per second and stored in the computer RAM. This collected data is then downloaded after each flight for later analysis.

The first flight of this variable sweep oblique wing demonstrator took place at Moffett field on May 10, 1994, and was without incident and picture perfect.

Steve and the oblique wing. Twin engines, twin verticals, dual wheel sets all around. The sensors for angle of attack and yaw can be seen above the starboard engine inlet.

The oblique wing in flight. The yaw/angle of attack vane indicates the direction of flight. Eighty pounds and a twenty foot wing span moving through the air at a good clip...