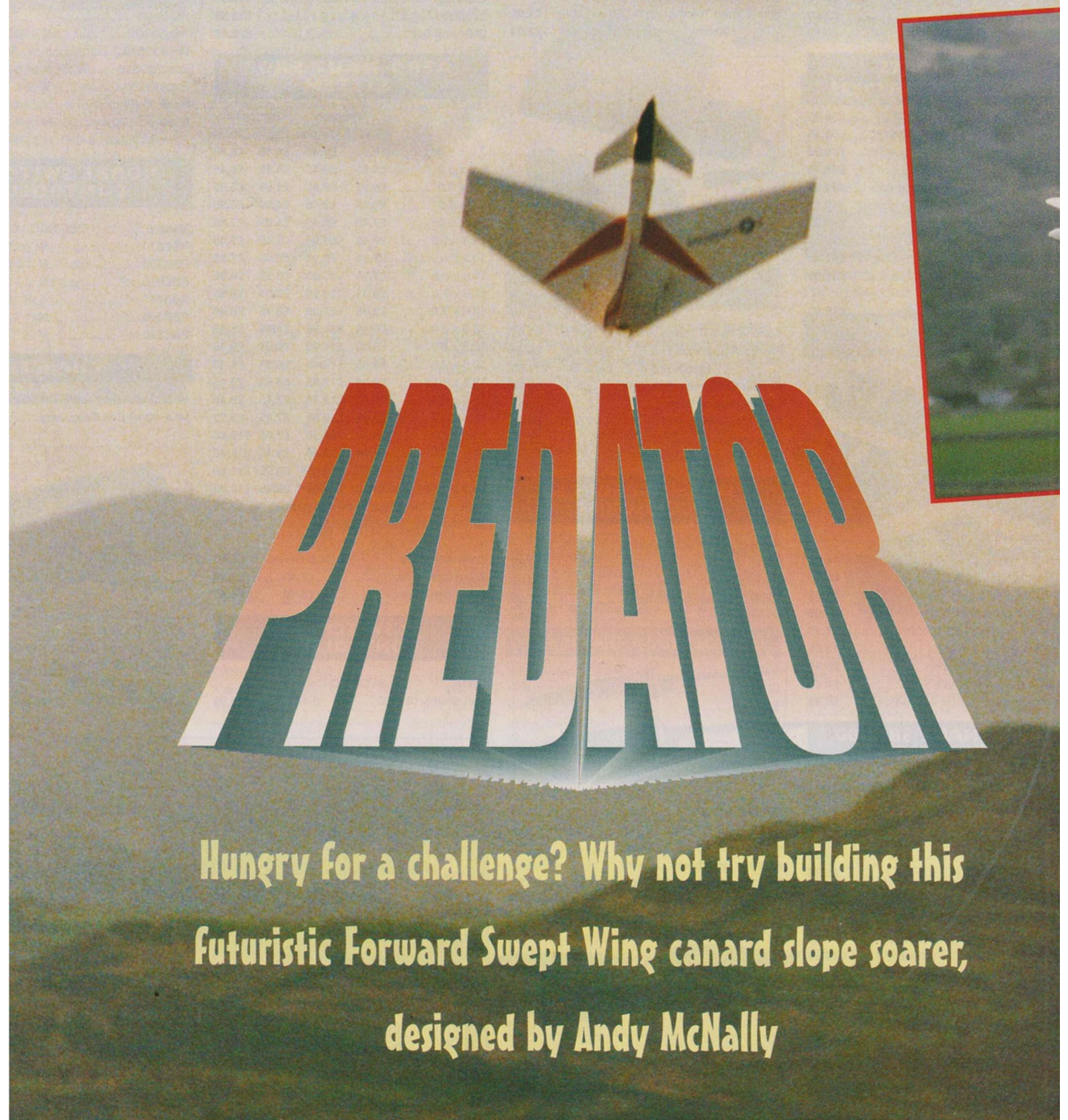
It was whilst thumbing through one of my Experimental Aircraft books at the unearthly hour of 3am whilst waiting for my five month old son to tire himself out that I came upon (once more!) the Grumman X-29, a Forward Swept Wing (FSW) aeroplane designed purely as a research tool. The aircraft first flew in 1984. It has proven to be extremely robust, with no hint of divergence, and is exceptionally manoeuvrable, though if Grumman had asked me first I could have told them that and saved them lots of money!

The first FSW aircraft flew in 1944, and was the Junkers Ju287, a prototype bomber. Apparently, the Germans not only discovered some of the benefits of FSW, but also the main bugbear, Aeroelastic Divergence. An FSW is prone to twisting under loads such as control surface deflections and this phenomena can be oscillatory, building up very rapidly until structural failure occurs. Incidentally, conventional sweep does not suffer in this manner as any divergence is self damping and tends to decrease over time rather than increase.

Advantages of Forward Sweep are potentially very great. It improves low speed handling and, more importantly, greatly improves the handling at the stall. Never will you have flown such a benign aircraft at low speed. The Predator has proved to be controllable at very high angles of attack down to walking pace!

On full size aircraft Forward Sweep also delays the rise in transonic drag, though I doubt the Predator will ever be flown to these areas of the envelope, but if any rocket-heads out there feel like trying..!

Anyway, after a very short nights sleep, I sat at my desk in work sketching what I thought might be a practical design for a FSW slope soarer in the impression of the X-29. After a bit of fiddling with dimensions to get a reasonable wing area, I ended up with



PREDATOR

Hungry for a challenge? Why not try building this futuristic Forward Swept Wing canard slope soarer, designed by Andy McNally

the design you see before you. Not very much like the X-29 now, however, apart from the forward sweep and the canards but, nevertheless, an interesting shape.

When I originally started 'laying down balsa', I wanted to leave the option open of flying the Predator without canard foreplanes fitted and I had a set of aluminium templates handy, hence the choice of a reflexed airfoil for the main wing. I have since discovered that for pitch stability with a forward swept flying wing, using a normally cambered airfoil, it is only necessary to wash in the tips slightly to provide a forward 'pitch-up' moment. It's obvious when you think about it! Therefore, a normally cambered section could be used, which would give better inverted performance into the bargain, though the reflexed one doesn't seem to adversely affect performance.

Another decision was whether to fit 'flying' canards or tack glue them in place to ascertain the correct incidence and then fix them permanently. I chose to make them 'flying' which turned out to be unnecessary - more about that later. The rest of the model is quite conventional balsa bashing.

Shall we build?

The wings are conventional in construction. Start by pinning down the $\frac{1}{2}$" leading edge followed by the $\frac{1}{16}$" leading edge sheeting, cap strips and trailing edge sheeting. Glue in place the two $\frac{1}{8}$" x $\frac{1}{4}$" spruce lower spars leaving a protrusion of 20mm at the root. Glue in place all ribs, setting the root rib at 2 to 3 degrees to the vertical to provide a small measure of dihedral as sweeping a wing forward reduces its effective dihedral. Glue in place the top spars. Fit the servo bearer so that it sits atop the cap strips and fit the two fillets, butting them to the ribs. Now glue in the vertical grain $\frac{1}{16}$" balsa spar web between all ribs, followed by the leading and trailing edge $\frac{1}{16}$" top sheeting. Fit cap strips to all ribs except R2 and R3.

Photo credit : Daryl Raggett

Photo credit : Daryl Raggett

With smooth cliff top lift and a good looking aerobatic machine to enjoy, no wonder Andy looks so happy!

Go get your chosen servo. Make sure it is centred and fit it on its side to the bearer with the horn vertical using your favourite brand of servo tape. Now fit the push rod and then sheet over the top, having left a slot for push rod exit. Don't panic and ask how you'll get at it if anything's wrong because nothing will go wrong. You've used decent clevises and it's a good servo of known quality, isn't it? If not, what's it doing in an aeroplane! Anyway, in the unlikely event of a servo failure in this area, you'll most probably have a gravity provided entry point!

Glue in place a ½" wingtip block, then when all is set solid cut away the elevon as far as the rear spars. Sand and face the spars with ⅛" balsa. Remove ¼" from the cut edge of the ailerons as shown in Fig.1 and make and fit end 'riblets'. Fit the thin ply horn bearer inside the elevon, gluing it to the top sheet. Sand and face with ⅛" balsa. Now sand the wing overall to good section, rounding the tip to taste. You now have one wing. As you probably know, they're only any good in pairs so go build another one.

The fuselage

Start by cutting out two fuselage sides from medium hard ⅛" balsa sheet. Cut out all formers, then cut a small hole in F2 to take elevon servo leads and set aside. Mark position of formers F2 and F3 on inner facing sides of fuselage sides. Fit triangular section along top and bottom inner fuselage sides except for hatch area. Glue in position F4 and F2 to both sides of the fuselage, checking they are 'square'. When properly set, glue in place F1 and F3, held with rubber bands. Sheet across bottom of fuselage, with the grain running widthways. Note the forward sheet extends into the 'air intake'. This does not appear to cause appreciable drag but blank it off if you want to. Glue in the ⅛" intake doubler.

Make the fin and notch F4 to locate it. Glue the fin in place to the bottom sheet checking it is dead straight along the line of the fuselage and make some fillets from scrap to brace the join. Fit a roughly shaped balsa nose block, noting that it protrudes ⅛" above the top of F1. Sand the underside of the fuselage, rounding off the corners to section. Sand the nose block to shape, following the general contours of the fuselage to give a modern jet-fighter appearance.

Cut out two canard foreplanes from ⅛" hard balsa. Cut slots in the fuselage sides to locate them. Do this accurately. A very small error in incidence will not be a problem but do make both sides the same! Glue them in place, no dihedral and protruding into the fuselage by ⅛". Glue in fillets above and below inside the fuselage.

Now the tricky bit - attaching the wings! The incidence is not absolutely critical, but try to it get as close as possible. It is vital though that both wings are at the same incidence. Offer up one wing to the fuselage side, aligning as per the plan. Mark where the spars will pass through (these holes will need to be larger in width than the thickness of the spars to allow for the angle). Cut the holes for the spars and check the fit of the wing. When satisfied, epoxy the wing in place and leave to set. Repeat the operation with the other wing, checking for correct incidences from front and back, and pack until well set. There, not too bad, eh?

To make the joint between the wings strong, cut some ⅛" balsa to fit across the width of the fuselage in front and behind the front spars, as per formers, thus 'boxing in' the spars. Glue them in, making sure there are no gaps as you are now going to fill this box with resin! Unusual? Yes, but it works and is lighter than you might imagine. It is also very strong. I have used this method more

Fig 1

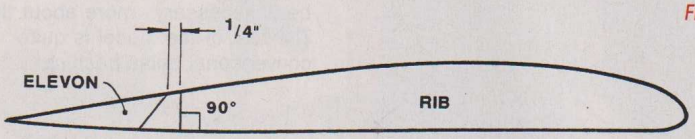
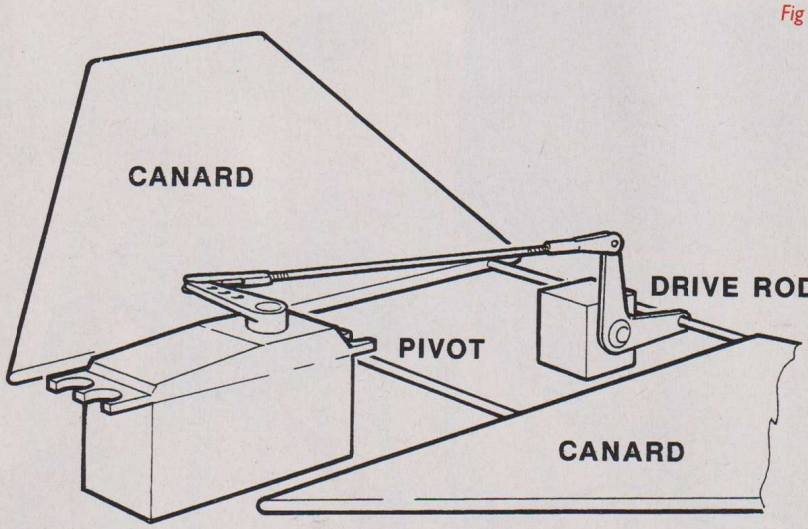


Fig 2



shows the details if you want to fit all flying canards.

Computer generated markings, whilst not scale, add interest to this jet style model.

than once and have never had it break, even when carrying obscene amounts of ballast in gale force winds! You can use most resins. Fibreglass resin is cheap and plenty strong enough.

You will need to make holes through the fuselage sides for the servo wires; you will also need to fit servo extension leads now too. I extended mine by removing the original leads and fitting new, longer ones, but don't attempt this unless you know what you are doing and are accurate with a fine tipped soldering iron.

Sheet the top of the fuselage in the same manner as the underside. Now make the canopy. It's best if you pin the canopy sides so they follow the line of the fuselage whilst you sheet the top of it with 1/8" balsa. I used Velcro to hold the hatch on. Sand the rest of the model to good shape. It should now be looking quite exciting!

It's a good idea to connect up your radio gear and check all is correct before covering. I used Solarfilm but any of the lightweight plastic films would suit. Whilst you are covering, attach the elevons. My preferred method of hinging is with covering material as it provides a good aerodynamic seal between elevon and wing. You can then add your chosen control horns and connect up the rods. Fit your radio gear, balance as shown on the plan and there you go!

The decals applied to my Predator were produced on computer and whilst not being accurate scale ones, they do add to the model's appearance.

Control throws

Start off with around 1/2" either way for the ailerons and 3/8" either way for elevator and progress to around 1" either way on the ailerons when your bottle allows!

The frightening bit!

The first flight of any radical looking model is always a nerve racking event. If you are one of the brave souls who decided to fit 'flying' canards, set them so that the trailing edge at the root is around three millimetres below datum and pray! My first flight went something like this:

Picture a cliff site, early morning, sunny but cool, in a North Westerly of around fifteen knots. I had already experienced some dodgy test 'chucks' across the football field behind the house due to a temporary aberration in my ability to calculate the CG, so I was hesitant to say the least! After the usual pre-flight checks - controls operating in the correct sense etc. - I had run out of reasons not to go.

So deep breath and away she went, straight out to the lip of the cliff then - 'whoof' - up she rose to about two hundred feet! That's one of the nice things about cliff sites, plenty of lift means you gain height quick. Time to try a turn - *"Good grief, those ailerons are sensitive!"* After several seconds of frantic overcontrolling, I got it straight and level and switched on the reduced rates. A bit less of an animal now, Predator flew around quite steadily.

The elevator response is about right but as with flying wings, too much elevator bleeds off a lot of energy. Keep loops large and fast to start with, until you get used to it. Rolls require some down elevator when inverted. If you stay inverted you will find that it will not gain height and slows pretty rapidly, due to the choice of airfoil.

Multiple vertical rolls, cobras, hovering two feet off the ground, they're all possible and I've got video tape to prove it!

The end bit

If I was to sum up this model, I would say it prefers a decent blow and is suited to someone who has mastered ailerons and feels confident. One word of warning though, don't expect it to hang around in a light drift! Even though it is safe at low speed with the nose up, you won't appreciate having to launch it every thirty seconds (unless you've got a little helper!). ●

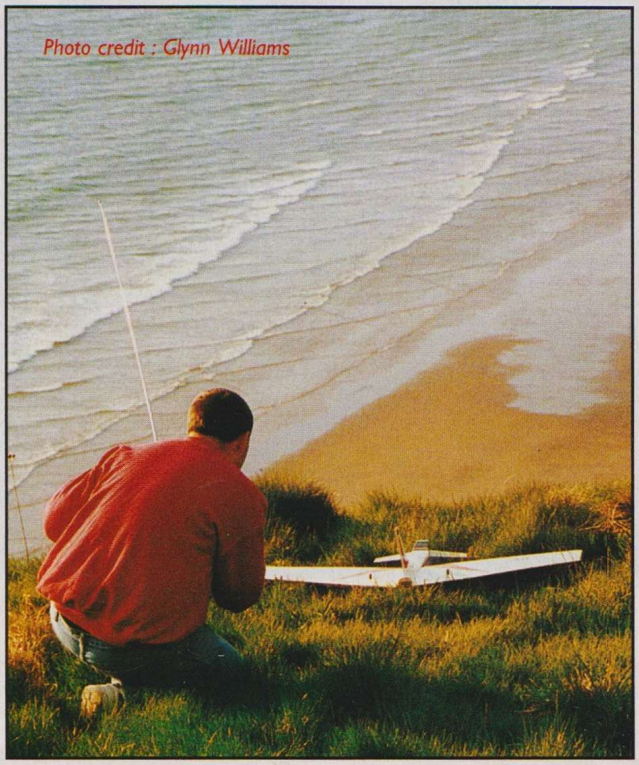


Photo credit : Glynn Williams

One last check. Is that a precarious drop, or what!

Datafile

Name	Predator
Designed By	A.G. McNally
Aircraft Type	Forward Swept Wing slope soarer
Wingspan	43.5"
Length	33"
Weight	2lb unballasted
Wing loading	9 ozs./sq.ft
Radio	Fleet PCM-MX7 (Tx mixer), Hitec HS300 servo's.