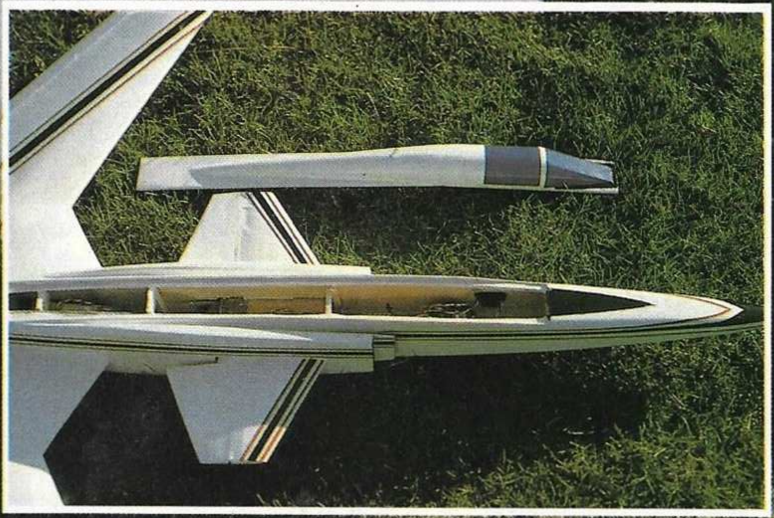
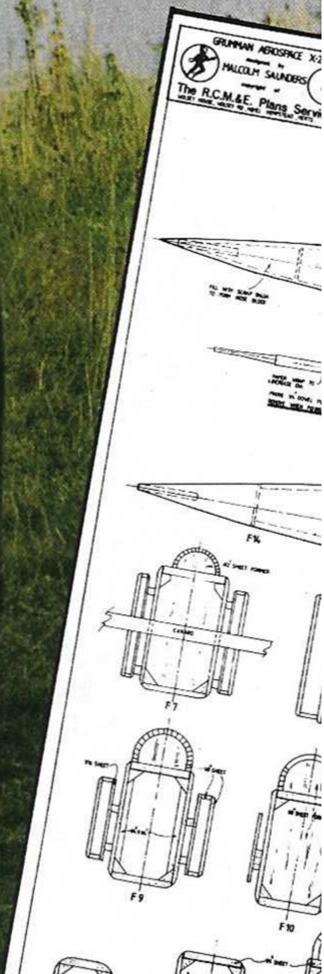
Whichever way you look at it the X-29A is dramatic. Swept forward wing aircraft are not a new concept, as Malcolm explains, but modern structural technology was required to overcome the wing twisting problems on the full size aircraft. The model is far less critical in this respect.





GRUMMAN X-29A

Tomorrow's fighter Today! Build this dynamic slope soarer and fly into the future. Designed by Malcolm Saunders

THE GRUMMAN X-29A must be one of the most interesting aeroplanes flying today. First flown in December 1984, it is quite unlike any other aircraft flying, if only for having its main wing swept forward 30 degrees.

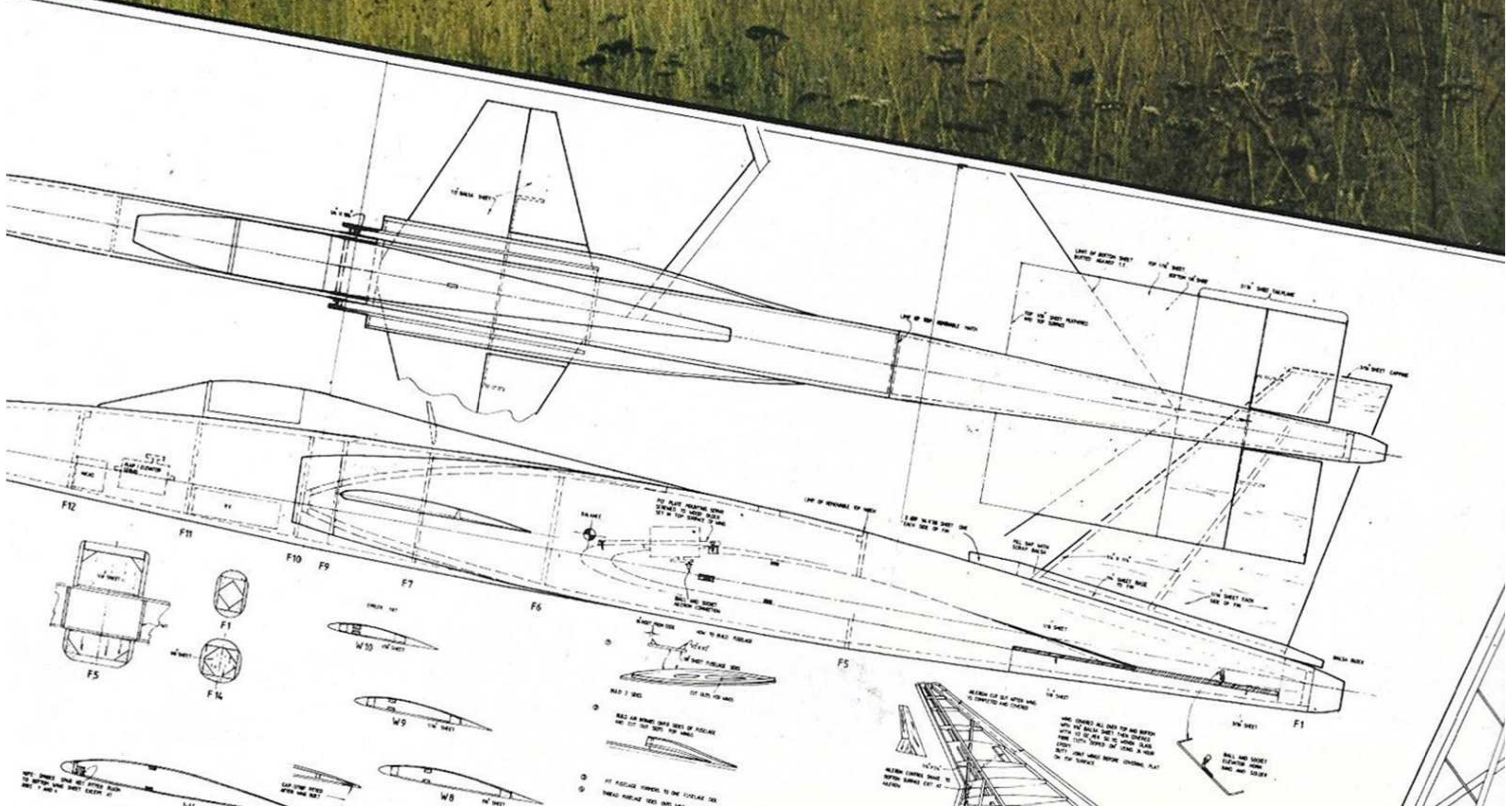
The need for swept wings first appeared with the advent of jet engine technology, engines began to deliver more power than conventional airframes could accommodate, a major problem was the onset of compressibility with increased speed.

Sweeping the wings back reduces the effective thickness-to-chord ratio and delays the compressibility effects and critical drag rise at high mach numbers (something that is unlikely to trouble model aircraft until they fly at over 500mph). On the other hand, swept back wings do have undesirable low speed characteristics such as being prone to tip stalling, which effects full size and model aeroplane alike.

In 1943 the German Junkers Company proposed sweeping the wings forward on their new high speed bomber the JU287-V1. In theory a swept forward wing has the same effect as a swept back wing in reducing the thickness-to-chord ratio, while at the same time offering significant advantages by way of higher lift over drag in manoeuvring flight, lower stall speed, improved low speed performance at high wing loadings and is not prone to tip stalling as is the swept back wing.

The JU287-V1 made some 17 test flights and proved the aerodynamic advantages of the wing form. Indeed final assembly of the definitive bomber, the JU287-V2 was under way when the factory was seized by advancing Russian troops in World War Two, but that's another story.

Sufficient to say that the low speed advantages of swept forward wings apply equally well to model aircraft as full size aircraft. Indeed but for the problem of aeroelastic divergence, all modern aircraft flying today with swept back wings would almost certainly have had their wings swept forward; just imagine a Jumbo with swept forward wings!



Your flexible foe

Aeroelastic divergence is a major problem with swept forward wings. As a swept forward wing flexes in flight the wingtips tend to turn up increasing the angle of attack of the wingtips relative to the airflow, this in turn places a larger twisting load on the wing, which if the wing is not strong enough to withstand will eventually twist the wings off the plane.

To compensate for this divergence forward-swept wings have to be very strong in torsion to prevent any twisting that could lead to catastrophic loads. In practice full size aeroplane designers have got around the problem by sweeping wings backwards and using washout, wing fences and fancy flappery to compensate for the inferior performance of the swept back wing.

What Grumman have done with the X-29A is come up with a method of building a swept forward wing using carbon-fibres that is both strong and light. From my own and other modellers' experiments in the States, a veneered foam or all sheeted wing is rigid enough for a model aeroplane up to 60in. wingspan and 9lb weight.

A second interesting thing about the X-29A is that it is the most unstable aircraft flying today, with a CG located 35% aft of the aerodynamic centre. It is totally dependant on three on-board flight computers to keep it flying.

All modellers are aware of how a model plane becomes more responsive to elevator control as the CG is moved back towards the aerodynamic centre, and most models fly with the CG a little in front of the aerodynamic centre.

Moving the CG back to the same position as the aerodynamic centre will cause the plane to be neutrally stable in pitch and twitchy to fly.

Moving the CG behind the aerodynamic centre, as in the X-29A, results in the aircraft wanting to climb, dive or do anything buy fly straight and level. Such a plane will flip on a sixpence, and is impossible for a pilot to control manually.

In building a model X-29A this presented us with our first real problem, as we must move the CG forward, preferably slightly in front of the aerodynamic centre to make radio control flying of a model X-29A possible.

Future experiment

Moving the CG forward, generally changes the flight loads on the canard as well as the moment arm through which it acts to control longitudinal stability. My solution involved changes to wing and canard incidence, wing section and areas. While this has worked it is not necessarily the best compromise and remains a fertile area for future experiment.

Finally, the full-size X-29A has what is known as 'Three-Surface-Control,' this involves simultaneous use of the canard, flaperons and strake flaps to control pitch during flight.

The full length flaperons give the main wing a variable camber wing section which is varied throughout the flight dependent upon the speed and manoeuvre being executed. The flaperons are coupled with the all moving forward canard, which is used both as the prime longitudinal stabiliser and to control airflow over the main wing to retard the onset of the stall at the wing roots.

The X-29A offers plenty of scope for the experimental modeller with regard to foreplane movements and C of G position – but not for beginners please.

The canard has an angular movement of +30 deg. to —60 deg and broad fuselage strakes run aft from the trailing edge of the main wing and terminate with large flaps (the nearest thing the X-29A has to a tailplane). The flaps are used to assist rotation at take-off and recovery from a deeply stalled condition.

From a model point of view 'Three-Surface-Control' of pitch is a little explored area, which just could be the way ahead to improving canard performance generally.

If you have read this far you may well be wondering why I ever attempted to build a model X-29A, especially in glider configuration. Well, being a paid up member of the OBE Club the X-29A presented a challenge, but with the CG position halfway down the fuselage to fit an engine at the front or back presented big weight distribution problems, while the size of our flying patch is unsuitable for any kind of ducted fan, so a glider was the only way I could explore the X-29A configuration.

The X-29 is the eighth forward swept wing model I have built and the third attempt at modelling the X-29A. The first X-29 was a small 14 inch span free flight model which flew well. The second was a much nearer scale 32 inch span model, with two channel control and was a dismal failure, the drag of the fuselage preventing a satisfactory flying speed to be achieved, but it did confirm the possibility of flying the X-29 using radio.

The third model presented here represents a complete redesign with much increased wing area, and reduced fuselage cross section area, while at the same time trying to retain at least a passing resemblence to the original X-29A.

The X-29 is an experimental model based on a full size experimental aircraft, and is no more recommended as a beginner's model than the proverbial Spitfire, but if you have some previous experience and are prepared to experiment to obtain the best results then here is a challenge to your skills.

Construction

The X-29 was designed to be built in the following order:

1. Build main wing, cover with glass cloth, install and connect up aileron servo.
2. Complete canard assembly.
3. Complete elevator assembly.
4. Build fuselage sides and air intakes complete.
5. Assemble fuselage sides over main wing, canard and elevator assemble, join sides together with fuselage formers.
6. Check alignment of flight surfaces and glue to fuselage.
7. Sheet bottom of fuselage, and top sheet between nose and hatch.
8. Instal elevator and canard servo's and connect up using snakes or push-rods as preferred.
9. Complete top sheeting on fuselage, canopy and hatch, complete elevator sheeting to rear of main wing to form fuselage strakes.
10. Build fin, cover and assemble to fuselage.
11. Complete finishing and decorating.

Main wing

Prepare bottom $\frac{1}{16}$in. sheet, butt join with cyano as necessary, lay on top of plan, glue and pin down trailing edge and bottom main spare, glue ribs in position.

Thread $\frac{1}{4} \times \frac{1}{4}$in. spruce spar through ribs and glue.

Fit aileron snake and cut slot in bottom sheet to allow snake to pop-out when wing is later removed from the building board.

Complete top sheet between rib 1 and wingtip.

Remove from board and complete second half wing in similar manner.

When both wing halves are complete, assemble upside down flat on the building board by butt joining the trailing edge, leading edge and wing spars, use 1mm ply to lap join the spar joints.

Complete sheeting between the wing ribs 1 and 1, fit false leading and trailing edge and wingtip blocks. Sandpaper and cover complete wing with $\frac{1}{2}$oz per sq.yd. woven glass cloth 'doped' on using 24 hour epoxy.

When epoxy is dry cut out hole in top surface to allow aileron servo to be mounted and connected to the aileron snake.

Complete aileron connection and test for minimum throw of 10mm up and down when measured at the trailing edge.

Canard

Cut the canard from ½in. sheet and taper to ³⁄₁₆in. at each tip. Sand to wing section and cut out flaps. Cover with tissue and dope. Hinge flaps to trailing edge and check for movement 10mm up and 14mm down measured at inboard trailing edge.

Fuselage

Cut two sides from ⅛in. sheet, butt join as necessary to form complete side.

Glue ½in. triangle along top and bottom edge ¼in. in from edge of the sheet. (Be careful to build left and right hand sides). Turn over and start assembly of air intakes by gluing ¼sq.in. strip to take inner air intake sheet.

Cut inner skins of air intake from ¹⁄₁₆in. sheet and glue in position, fit top and bottom sheet to air intake, and then fit ⅛in. outer sheet to complete air intake.

Cut out slots as required to take canard, main wing and elevator assembly.

Cut and glue fuselage formers to ONE SIDE of fuselage only. Thread fuselage sides onto wing, canard and elevator assembly.

Join the two fuselage halves together by completing gluing of fuselage formers.

When the fuselage is dry, check alignment of main wing, canard and elevator assembly and glue to fuselage sides, fill any gaps with scrap balsa.

Sheet bottom of fuselage, and top of fuselage as far back as the hatch opening.

Fit elevator/flap servo and couple up flying surfaces, check movement. Flap 10mm up and 14mm down down at inboard trailing edge, elevator 45mm up and 5mm down measured at the trailing edge.

Complete top decking and canopy, fill in between tailplane and wing to complete fuselage strakes, fit tail-pipe balsa block.

Complete sandpapering to finished shape and cover fuselage with tissue paper and dope.

Fin

Cut two fin outlines from ¹⁄₁₆in. sheet, glue leading edge and spar in position and pinch trailing edge together.

Add ¼ × ¾in. strip to base of fin and cap strip to top of fin.

Sandpaper and cover with tissue, glue to fuselage.

Finishing

Coat whole airframe with sanding sealer and rub down till all blemishes are hidden. Give two coats of Humbrol White Enamel well rubbed down with fine wet and dry. Paint blue cockpit, black anti-glare panel and lettering on tail, use car trim tape to produce red lining.

Flying

It is recommended that you start with the CG in the position shown on the plan, and the control throws as specified. As experience is gained the CG may be moved back and control movements modified to optimise performance and handling.

No claim is made for this to be the definitive model of the X-29A, please feel free to make any changes you wish, as I said at the beginning this is an experimental model of an experimental aircraft, so in experimenting you will be simulating the real thing.

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