

# BAC

**Jeremy Collins invites you to build a model of Britain's ill-fated tactical strike aircraft. Designed for .25-.35cu.in. engines and 4-function radio.**

**T**HE TSR2's UNUSUAL LAYOUT, with the long nose and delta-like wings and the sheer bulk of the aircraft (try and see the prototypes preserved at RAF Cosford or the Imperial War Museum at Duxford) make it an impressive piece of machinery. The TSR2 had a chequered history. Born from an Operational Requirement for a tactical strike and reconnaissance aircraft able to fly at transonic speeds very close to the ground, it was designed to provide a tactical nuclear strike capability for the RAF and would have replaced the Canberra and also the Vulcan in its low-level role. The design combined elements from both the English Electric and Vickers proposals to OR339 and OR343, with the final design bearing closest resemblance to the English Electric design. As the TSR2 was a total 'weapons system' and Vickers had most experience in the electronics area, they were given leadership for the project, with English

Electric responsible for the construction of the hardware. Four prototypes were built, but only one (XR219) had flown when the project was cancelled in 1965. At that time the prototype had completed 24 flights and shown superb handling characteristics, although dogged by early problems with the engines and undercarriage. The single prototype that had flown ended its life as a gunnery target at Shoeburyness, assessing the damage absorbed by modern airframes. All jigs, production tools and parts were ordered to be destroyed. Fortunately two prototypes survived and are on view at the Aerospace Museum at Cosford and the Imperial War Museum out-station at Duxford.

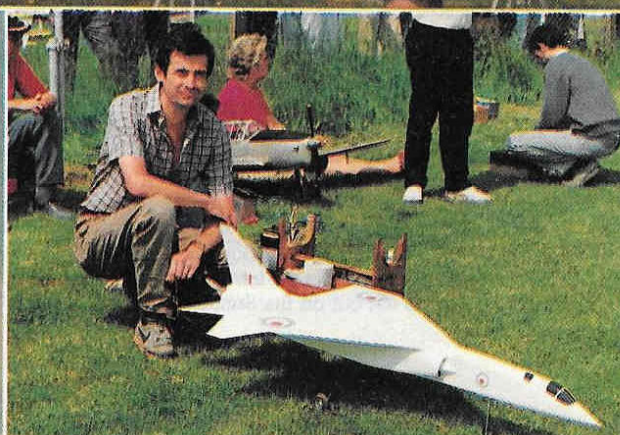
The TSR2 had been on my list of possible models for a long time and publication of the superbly detailed scale drawings in *Scale Models* in early 1985 put it high on the 'desirable' list. However a true-scale model, using ducted fan propulsion, did not appear

possible because of the small wing area.

A study of some of the all-sheet near-scale models by Alex Weiss prompted thoughts of a similar approach to modelling the TSR2. Indeed the design and construction methods owe a lot to those used by Alex for his range of all-sheet models.

## The Model

I would describe the model as a 'cartoon scale' design. I have stretched some of the dimensions to provide desirable model characteristics and in particular the wing leading edge has been brought forward to provide additional wing area while retaining the scale planform. The air intakes are moved forward a similar amount to maintain the relationship between wing root and intakes. To restore the characteristic long nose of the prototype, the fuselage has been extended forward of the wing leading edge. The effect of these stretches is not noticeable, and I think the model manages to retain the distinctive proportions of the prototype. In



# TSR2

other respects the outline is basically accurate, helped by the largely rectangular fuselage cross-section of the full-size, which lends itself well to the all-sheet construction. Control is by conventional ailerons and an all-moving tailplane (though lacking the anhedral of the full-size), unlike the prototype which used all-moving tailerons to control both roll and pitch, the wings carrying flaps only. Judging from the flying performance, true taileron control would probably provide enough authority, but I'm afraid I wasn't that confident at the design stage!

Power is provided by an OS 25FSR ABC driving a 9in. x 6in. pusher prop and it is worth pointing out that a powerful engine is essential for this model. Use of a 'cooking' or 'sport' .25 is unlikely to provide sufficient urge, although a sport .35 might well be adequate. Using such a motor might require a larger fuel tank and some small adjustments to engine bay layout.

## Construction

Construction is straightforward and is almost entirely from 3/16in. and 1/4in. sheet and 3/4in. and 1/2in. triangular stock. A fixed undercarriage is used, which although detracting to some extent from the in-flight appearance is practical. Substituting a dolly

undercarriage would improve the appearance and save some weight at the risk of damage to the fuselage bottom and propeller on landing. Hand-launching might also be practical, as the low-speed handling is quite docile. I will admit that I have not tried this. If you have reasonably large hands it is possible to grip the fuselage at around the undercarriage position, but I have also suggested a recessed handhold on the plan which would provide a better grasp.

A lot of wood goes into the model and selection of the balsa for wing and fuselage construction must therefore be done carefully. Each sheet of 3/16in. x 4in. balsa should weigh not more than two ounces, so light and mainly soft balsa should be used. The sheets for the wing should be slightly firmer.

The design adds more than adequate rigidity, although the wing will seem very floppy before it is attached to the fuselage. Although the TSR2 has a long nose, which helps keep the CG in the right place, try and keep the aft end as light as possible. I had to add 4 ounces of weight to the nose and on the plan have shown the servos and nicad installed further forward (compare to the photographs) so as to help keep the CG in the right place.

## Wing

Construction can usefully start with the wing, as this will be needed to line up the aileron pushrods during fuselage construction. Cut out and glue together the wing components from 3/16in. light balsa. Sand smooth on both sides, separate the ailerons, sand leading and trailing edges to section and glue in place the anhedralled tips. Mark on the underside of the wing where the fuselage will be glued and then cover the wing undersurface in white Solarfilm or similar, leaving the fuselage/wing glueing area uncovered. Cover and hinge the ailerons after epoxying the torque rods and control horns in place.

## Fuselage

Fuselage construction commences by cutting out the front and rear fuselage sides from 3/16in. x 4in. balsa, noting the outline marks on the plan. A strip approximately 3/8in. wide must be added to the 4in. sheet to provide adequate width. The rear fuselage incorporates most of the air intake sides as well, so there is a considerable overlap of front and rear fuselage sections. 3/4in. and 1/2in. triangular balsa stock is glued along the edges of the fuselage sides. Saw-cuts will be needed in the triangular stock to allow it to conform to the curved edge of the sides. Note



Heading and main colour photographs show one of the prototype TSR2's on display at Cranfield. Fortunately, two examples are still on public view at RAF Cosford Museum and IMM Duxford. How successful the aircraft would have been, had it seen active service, remains conjecture, but it may well have been serving still with the Royal Air Force.

Illustrations on the left are Jeremy Collin's TSR2 model, it recaptures the exciting lines of the prototype and is equally exciting to fly. The fixed undercarriage could be dispensed with (using a 'dolly' or hand-launch) for those of you who fly regularly from a grass strip.

that the triangular longerons extend beyond the rear end of the forward fuselage sides to provide support against the fuselage bottom and wing underside when the fuselage sections are mated.

Cut out the fuselage formers from 3/16in. and 1/4in. sheet, plus the ply nosewheel and motor mount formers. Drill for steerable nosewheel mount (F3), pushrods, servo cables, aerial tube, radial motor mount and fuel pipes (F12). The aerial is run internally in the fuselage through a servo pushrod outer, emerging at the base of the fin.

Glue the formers to the right-hand fuselage sides, using templates to set the nosewheel bulkhead and motor bulkhead at the correct angles. This will ensure that they are at right angles to the centreline when the fuselage halves are joined and pulled in front and rear. No side or downthrust is required on the engine. Add triangular bracing to the formers where indicated. Fashion and glue up the main undercarriage blocks from hardwood and glue firmly in place between formers F8 and F9. If the undercarriage is being omitted and the model hand-launched, leave out the undercarriage block and fill between F8 and F9 with soft block. After the fuselage is planned and sanded to shape, recesses can be carved out between F8 and F9 to provide fingerholds for hand-launching.

When all the joints have set firmly, join the forward right-hand fuselage side to the rear right-hand fuselage side, ensuring correct line-up whilst the glue dries. When set make up and fit the servo rails, fit the servos and install the control snake outers, along with any necessary bracing to provide support. A tip for securing the plastic outers where they pass through formers is to wrap the outer with a couple of turns of masking tape and then drip cyano onto the joint once the outer is installed. I used Sullivan 'blue' control rods for all connections on the prototype model. On the prototype the aileron/nosewheel-steering and elevator servos were set abreast behind the nosewheel bulkhead, with the throttle servo slightly behind and below these. The fuselage width is a little narrow for three standard servos abreast. The prototype required 4oz. of noseweight in order to achieve the required CG, so if it is possible to squeeze the entire radio equipment in forward of the nosewheel, this will clearly have a useful benefit and I have shown this arrangement on the plan. The aileron connection is indirect, via a 120 degree crank located below the wing leading edge. Complete the link to the nosewheel and the servo ends of the remaining pushrods. Line up the partially completed fuselage with the wing and finalise the aileron pushrods.

The left-hand rear fuselage side can now be added, along with any triangular stock bracing, and when set the rear end pulled together and glued firmly, clamping whilst the glue sets. Note that saw-cuts will again be needed in the triangular longerons to allow the rear end to be pulled together. Now add the left-hand forward fuselage side, taking care to maintain absolute trueness along the centreline.

Bolt the engine mount in place using Loctite on the threads and temporarily fit the engine in order to finalise the throttle pushrod. Remove the engine.

Make up the all-moving tailplane horn from a standard commercial item. The standard 14g tube through the pivot is sleeved with larger diameter tube each side of the pivot point to provide added rigidity. Carefully

mark and drill the fuselage sides and fix the horn assembly in place, epoxying the brass tubes to the ply reinforcement discs and these discs to the fuselage sides. Note that the horn is free to pivot at the centre of the brass pivot tubes. Glue in place the platform for the fuel tank and attach the fuel tank with double-sided servo tape and small locating blocks from balsa. Locate the tank as near to the bulkhead as possible. Ensure that the clunk pick-up is at the rear, with the delivery pipe to the front. This will ensure continued fuel feed when the aircraft is flying nose-high with a part full tank. I have built the tank in permanently with no provision for access, but it should be fairly simple to provide an access hatch.

Cut out the tailplane parts from 1/4in. balsa and sand to section. Mark and cut slots for the pivot tubes and epoxy these in place with hardwood reinforcement strips.

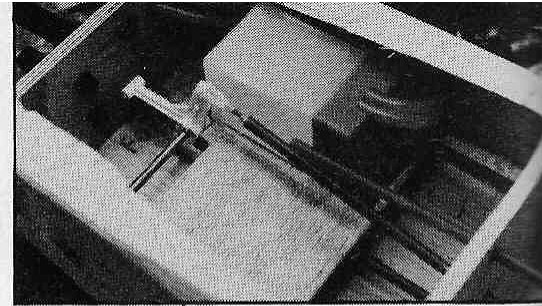
Make up the fuselage bottom in one piece before gluing to the part-completed fuselage. This ensures that the fuselage remains true.

The fuselage top can now be added, forward and aft of the wing position. Before fixing the aft fuselage top, cut a slot for the fin. Razor plane and sand the fuselage to section. Add the remaining formers for the air intakes and build these up as shown on the plan. The front part of the intakes as far back as P5 are planked with strips of 3/16in. balsa. Strengthen the inside of the intakes with a strip of 1/32in. ply.

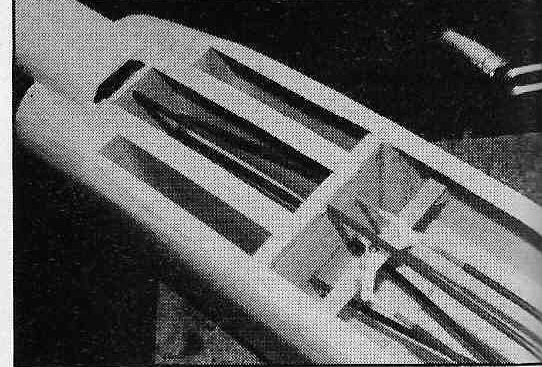
Add the soft balsa noseblock and the fin/rear fuselage fairing and then carry out final shaping and sanding. The cockpit area can either be fashioned from block, with the windscreens subsequently painted on, or can be moulded from acetate. If moulding, add a pilot etc. before fixing. Cut out the access hatches for servo, receiver/nicad and tank bays, face the edges with 1/32in ply, and fit catches.

## Finishing

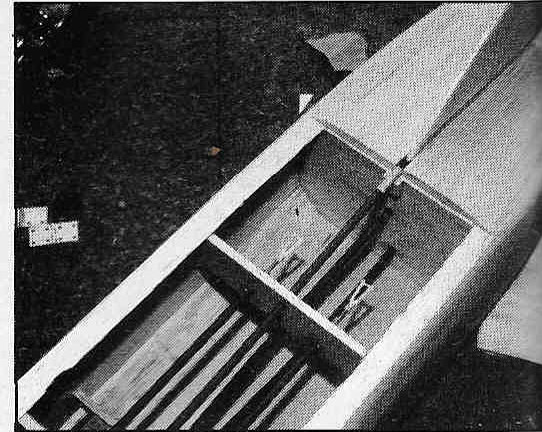
Once a satisfactory finish has been achieved the wing can be finally glued in place, remembering to connect the aileron pushrods. Add any necessary fairing around the wing/fuselage/air intake joint and then



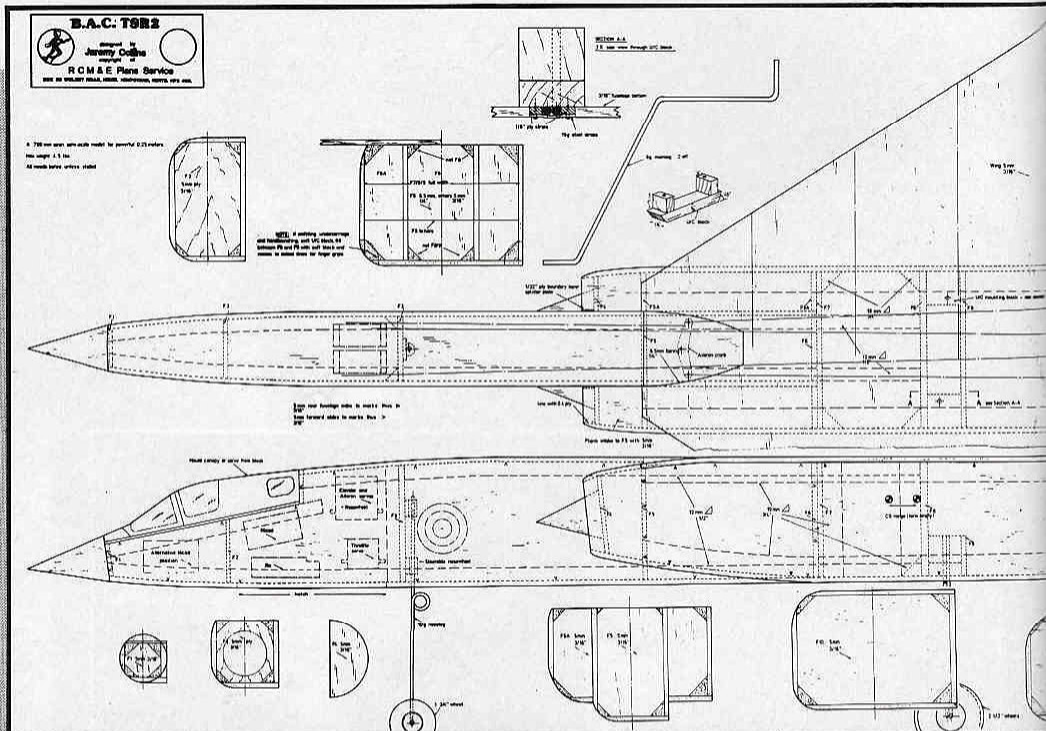
Fuel tank has, of course, to be installed in the reverse position for the pusher engine. Note the tailplane bellcrank.



Aileron bellcrank and 'snakes' are evident in the illustrations above and below, top snake is for rudder operation.



Copies of the plan, shown below, are available from the ASP Plans Service, PO Box 35, Wolsey House, Wolsey Road, Hemel Hempstead, Herts HP2 4SS. Order RC1552 price £4.75 plus 55p postage.

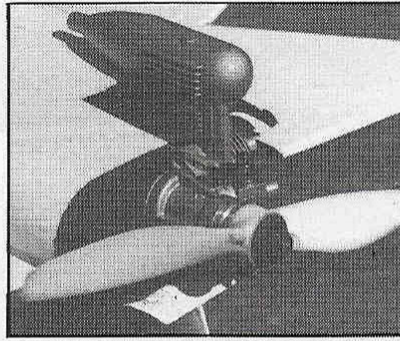


add the fin. Cover the model with white Solarfilm. Various markings and national insignia and serials can now be applied. Note that the roundels and fin flash should be in pale blue and red. Service serial numbers are in pale blue. The tailpipe area can be painted in steel grey and the whole engine bay and tailpipe area thoroughly fuelproofed. Although all prototypes of the TSR2 were finished in anti-flash white, it is likely that had the aircraft gone into service it would have carried the low visibility camouflage generally worn by low-level Vulcans, so this is an alternative colour scheme.

All that remains now is to fit the main undercarriage and wheels and to install the receiver and nicad. Check the balance of the model and if necessary add weight to the forward ballast compartment. As noted, 4ozs. of lead had to be added to the nose ballast bay on the prototype. The theoretical CG was calculated using two different methods, and treating the aircraft as both a tailed-delta and a true delta. The results placed the CG within a range 12.5 and 14ins. forward of the trailing edge. The model has been flown with a CG towards the rear limit with no handling problems, but I cannot advise a CG behind this point. The CG shown should be achieved with an empty tank; a full tank will move the CG back slightly. In this condition the aircraft should almost balance on the main wheels.

The model should only just return onto the nosewheel if the rear of the aircraft is pushed down to the ground and released. Bend the main undercarriage legs slightly if the CG is correctly located, but the model does not have this near-equilibrium about the main wheels.

Weight of the original model (without fuel) was 4lb. 7oz., and this should be regarded as the maximum with a powerful .25 engine such as the OS25 FSR ABC. Check all controls for full and free movement (and correct sense), with control throws as shown on the plan. The ailerons appear to be quite small, but with a movement of 3/8in. each way at the inboard trailing edge, control is entirely adequate. The all-moving tailplane must have plenty of movement. The prototype has 3/4in. movement each way, measured at the inboard trailing edge.



*O.S.25FSR engine is installed in prototype model, this is the minimum power suggested with the undercarriage fitted.*



*Servo bay and nosewheel location, note that this arrangement differs from the plan. Nose on, below, the TSR2 looks sleek and menacing.*

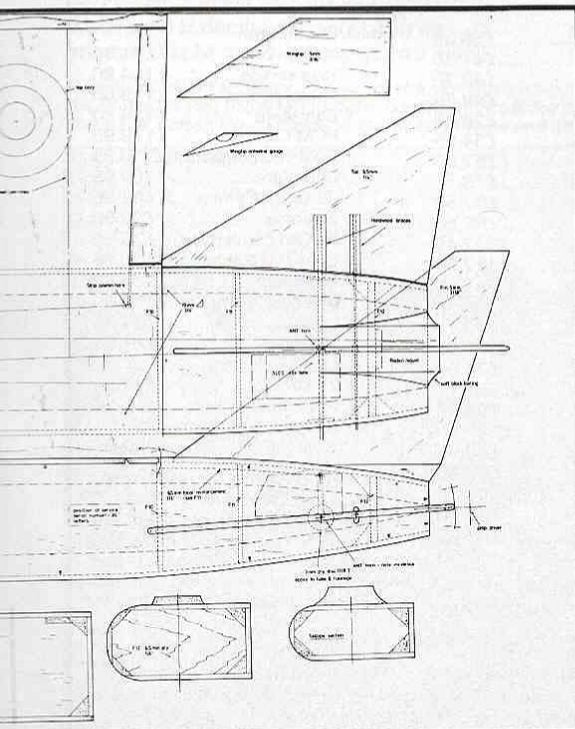
## Flying

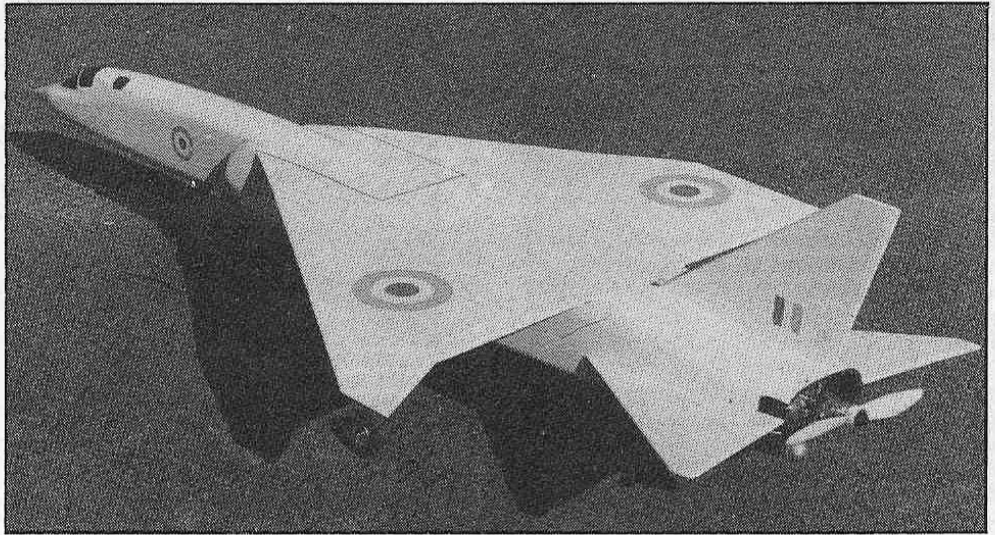
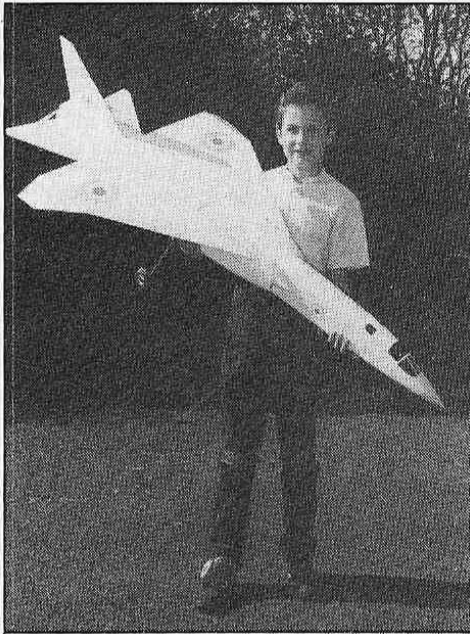
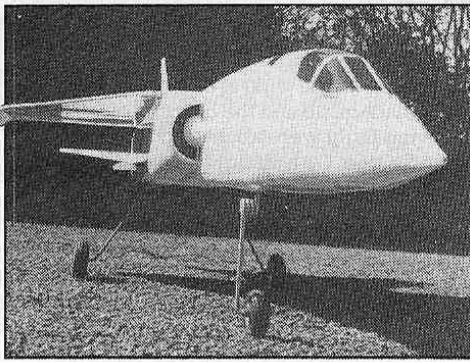
Now for the crunch! By the time the model was complete, the wing area looked to be totally inadequate and the chances of achieving flight were about as good as that of a bumble bee. On a straight calculation of weight and net wing area, the wing loading is over 2lbs. per square foot, so a hairy first flight was anticipated. I took the completed model along to a Club night meeting, and most members showed some scepticism about its likely flying ability.

I picked a deserted day at the flying field, fuelled up and started the engine. The first attempt at take-off resulted in a bounce after about five yards and a clipped propeller which cut the engine. Thereafter the following technique was adopted for take-off. On release, hold full down elevator until the model has reached flying speed. This will be after about twenty yards on short grass and the down elevator will help to keep the nosewheel on the ground. Tracking is good despite the narrow track and once take-off speed has been reached, ease in elevator to lift off. Avoid excessive rotation as this may result in the propeller clipping the ground. Once off the ground the model flies as if on rails, with almost neutral stability. If you have flown a .40 powered aerobatic model, TSR2 should hold no terrors.

Control in all axes is positive and height can be maintained on about two-thirds throttle. Rolls with the engine torque are positively twinkling, somewhat more restrained in the opposite direction. Turns should be kept fairly open as there is a tendency to 'mush' if too much elevator is pulled. Landings are quite straightforward and in fact the first two landings were made deadstick with no problem. Possibly the most unexpected feature of the flight performance is the good slow speed handling and general good manners of the aircraft.

With the tiny wing I had expected fairly vicious characteristics and I can only assume that the fuselage is contributing considerably to the overall lift. The only danger area is orientation, as the model is very slim and dart-like and it can become difficult to be sure of orientation at a distance — must visit





**No doubt about it, the TSR2 has all the qualities for a new and thrilling flying experience. Construction should be within the capabilities of a reasonably experienced modeller.**

the optician.

After the first couple of flights, the only modification made was to fit a longer undercarriage to give increased ground clearance. This is shown on the plan. No alterations to trim were needed and the engine has performed quite adequately with only silencer pressure to the tank. Use of a pump does not seem necessary with the OS25 FSR. A slightly larger tank, or possibly twin tanks, might be useful to extend the flight time, but beware of moving the CG too far back. Cooling of the engine may potentially be a problem. I have cut away the

fuselage side around the cylinder head, but I have not fitted any airflow baffles to divert cooling air to the engine. So far no problems have arisen, but if there is any sign of hardening-up in the air I would suggest some form of air scoop to ensure a good flow into the engine bay.

So, out with the balsa and off to the building board. Let's see if we can have more models of the TSR2 flying than there were full-size! Additional references:

*Aeroplane Monthly* November 1985, January 1986; *Scale Models* February 1985 (scale drawings), March 1985; *Royal Air Force Yearbook 1976* (includes cutaway drawings) 2nd and 4th Prototypes (XR220 and XR222 respectively) preserved at Aerospace Museum RAF Cosford and at IWM Duxford.