

SKYCAM

As a model flying enthusiast and a keen photographer I was attracted to the concept of a relatively easy-to-build aircraft of practical dimensions designed specifically for aerial photography. My son became interested in the idea and chose to make it the subject of a study project. He realised that such a plane would not only be interesting for us to fly, but would perhaps have a practical application for others. The result was his design and construction of Skycam, which has indeed given us much enjoyable flying with the added dimension of some good photographic results.

Early in the design phase it became apparent that it was necessary to have the camera unit positioned forward of the engine in order to prevent exhaust from dirtying the lens. Because of this, only two orthodox airframe configurations were considered practical: either a twin boom, rear-mounted pusher type, or a type featuring a pylon-mounted power plant facing either forward or aft.

The twin boom configuration was judged to be superior because the overall form would be better aerodynamically; it would have the most efficient power plant position and it would be easier to counter-balance the camera with the engine. These advantages would obviously result in better flight characteristics. It was, however, unclear as to how both rudders and elevator could operate. Bearing in mind servo location, would complicated linkage mechanisms be necessary? As this was a prototype design specifically concerned with aerial photography, it was decided to commence with the fuselage. Thought had to be given to power plant location, wing seat location and general arrangement of compartments, as these would influence the airframe's overall balance. Also, it was imperative that the chosen airframe be capable, if required, of being dismantled, either for transportation or access to internal bays, etc.

Design notes

Fuselage: To enable access to the .40's needle valve and, to a lesser extent, its carburettor (which ruled out an inverted location) the power plant had to be installed with the cylinder block to the port side. A box silencer was adopted because a conventional bomb-shaped silencer would invariably foul the prop. Despite the engine location, it was necessary for the fuel tank to face forwards in the conventional way to

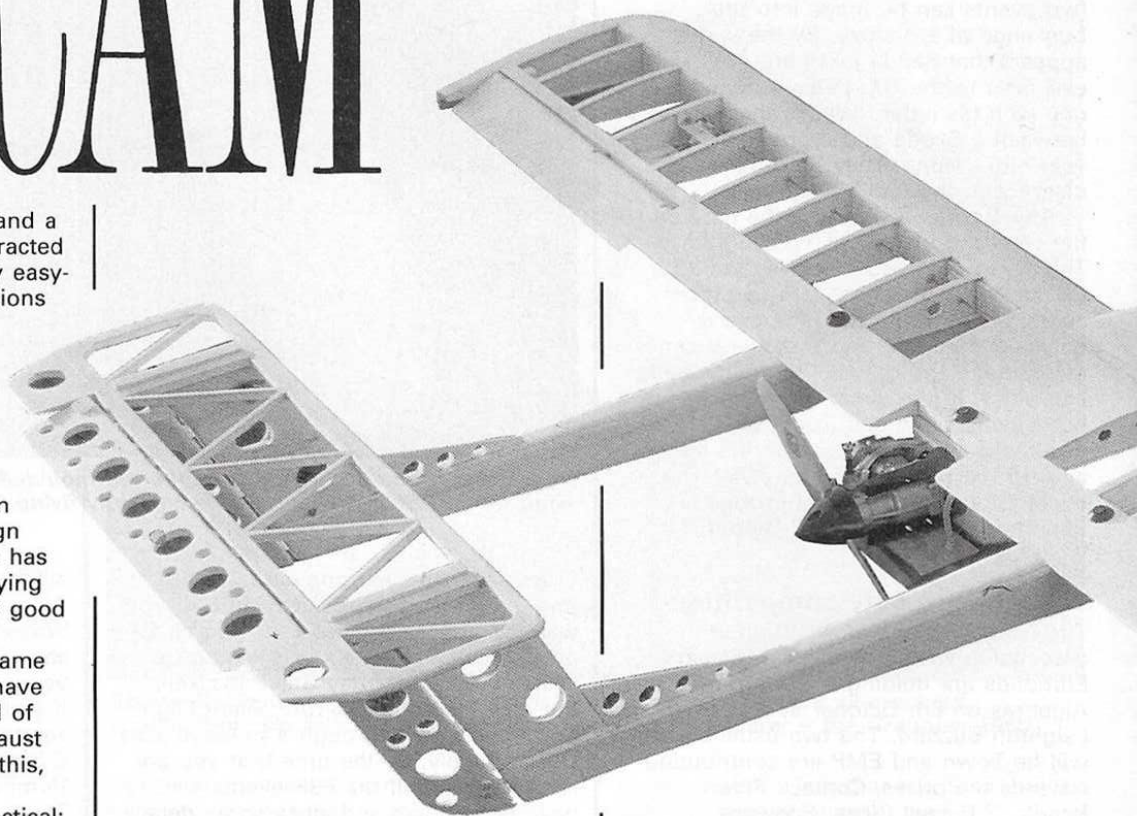
ensure reliable operation.

Fuel supply to the carburettor is made possible by brass tubes running via Former 4 and then through Former 5 (fire wall), with fuel tubing used for actual connections. This arrangement also applies to the pressurization line running from the silencer to the tank, and has the added benefit of a filler and overflow socket located in an easily accessible position, i.e. on the starboard side under the leading edge.

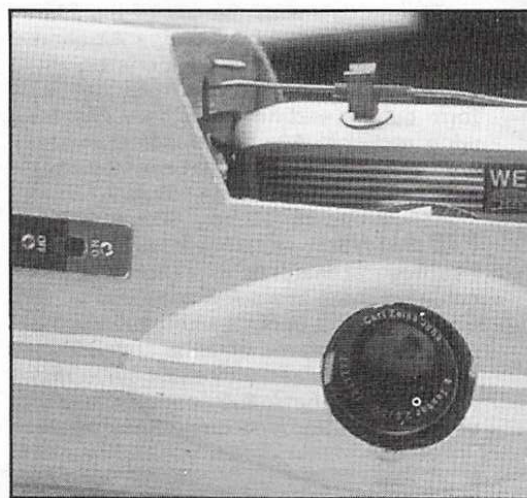
A captive nut epoxied to a 3mm ply bracket enables the wing to be connected in the usual way with a nylon bolt.

The undercarriage unit was situated just forward of Former 4, as it was considered that this position was most suitable for rotation, bearing in mind prop clearance.

The throttle servo, mounted on two supports, was located in the compartment between Formers 3 and 4. Former 3 and the additional strengthener contain both wing peg holes in order to



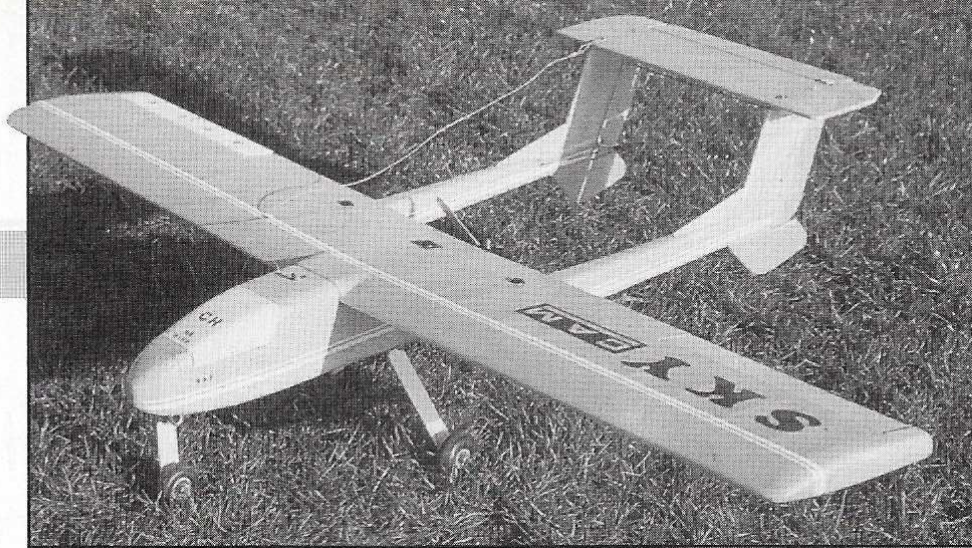
**Get in the picture
with Ian Warner's 60
inch camera plane for
.40 engines. His
father, Ron tells all.**



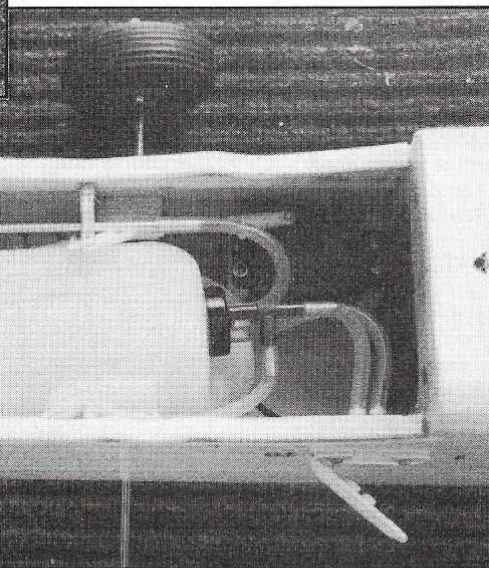
complete the standard wing mounting, designed for a clean break in the event of crash.

Forward of this is the R/C compartment, access to which is gained via a hatch on the underside. Running through the side of this section are both an R/C on-off switch and an integral, remote glo-plug socket (wires running via Formers 3, 4 and 5 to power plant). Above this is the spring-loaded main hatch mechanism, which is quick and easy to operate, and antenna outlet. The antenna itself runs via a plastic guide inserted in the wing to the fin/tailplane connection, thus avoiding the prop.

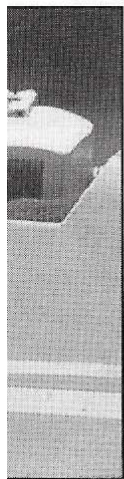
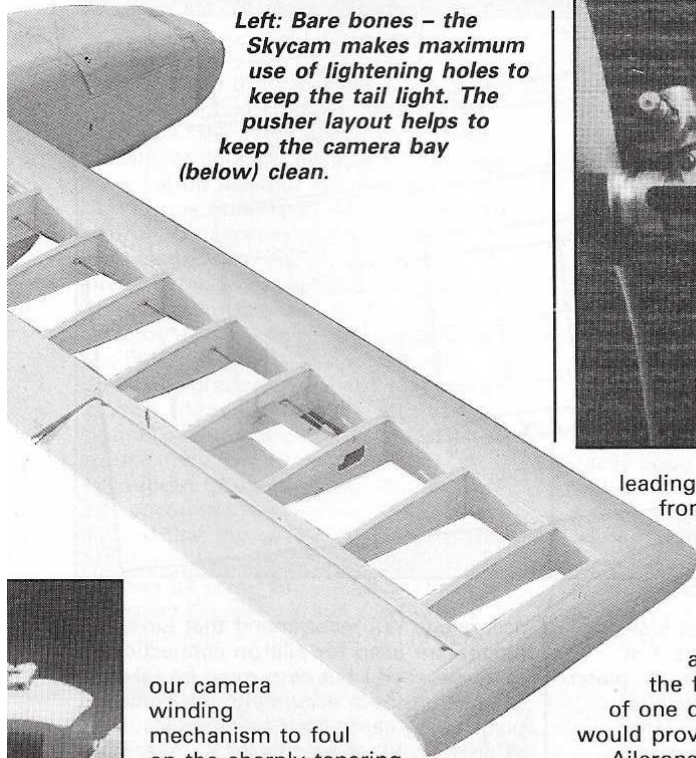
Between Formers 1 and 2 is the camera bay, which consists of two supports and an aperture in the starboard side of the fuselage. (An aperture in the port side would cause



Left: A high visibility scheme helps maintain orientation during photo sessions – the prototype is yellow. Below: Close up of the tank plumbing. Full details are on the plan.



Left: Bare bones – the Skycam makes maximum use of lightening holes to keep the tail light. The pusher layout helps to keep the camera bay (below) clean.



our camera winding mechanism to foul on the sharply tapering fuselage side). Access to this bay is gained via the main hatch, which is secured at the front by a tongue.

Within this unit – with our camera – there is capacity also for R/C batteries directly behind Former 1. It is through Former 1 that screws of a suitable size enable the nose block to be removed. This gives access to the ballast compartment, which can be loaded with any necessary weight to counter-balance the payload. Another reason, and as important, is the installation of, and access to, the front undercarriage leg.

Wings: A semi-elliptical wing airfoil was decided upon (NACA 2412) primarily because an all weather wing was desired in preference to a Clark Y type which, to an extent, is limited to use in calm conditions.

A span of 1520mm and a chord of 240mm were considered to be sufficient. A dihedral of one degree was thought adequate to ensure rotational stability; any more could cause problems as far as the booms and, specifically, fins/rudders/tailplane alignment were concerned. A shaped block, the same width as the fuselage, was positioned on the centre-line flush to the chamfered-off

leading edge. This ensured low drag from fuselage the over the wing. Below this, two dowelling pegs hold the wing in place, whilst immediately behind the rear spar a nylon bolt running through a block secures the wing to the fuselage cradle at an incidence of one degree which, it was felt, would provide adequate lift.

Ailerons are controlled in the normal way with a centrally located servo installed within a small bay, linked to two lengths of piano wire, which in turn operate bell cranks. This was a personal preference to plastic cabling. 3mm dia. ribs form the sides of both boom connection bays. Within the latter a peg socket hole runs through Brace No.2 and the main spar, and a block immediately behind the rear spar allows a nylon bolt to pass through into the boom. The area between Brace No.2 and Brace No.3 (attached to and immediately forward of the rear spar) is left uncovered on the underside to enable the boom connection peg (running through the plate) to be manoeuvred upwards and then forwards to fit into the aforementioned socket, giving clearance to the aileron con-rod. It also gives servo clearance if needed. Servo extension leads run from the fuselage via holes in ribs nos. 2, 3 and 4. The open area also allows the relevant part of the boom to fit securely between ribs and not merely to fit flush with the airfoil from Brace No.3 rearwards to the trailing edge.

The ailerons themselves are scale type, as these were considered to be the most efficient. It was felt essential to include vortex retarders as these not only reduce instability but are aesthetically pleasing.

Booms: The desired booms had to taper in both vertical and horizontal planes in order to remain as light as possible, and to ensure that the resultant airframe was not tail-heavy and was aerodynamically sound. Boom length was established by calculating the moment arm: at least 2.5 times the wing chord (measured from the main spar line).

Actual boom type was at first unclear; overslung or sandwich-type units were envisaged. However, an underslung design was eventually chosen and boom position in relation to the chord was dictated by the peg and nylon bolt method of fitting. One former was judged to be sufficient. It was placed directly under the rear wing spar (when connected) – to which the captive nut bracket was attached – together with the boom connection plate and the fin insertion guide. Two servos were needed to control elevator and, in this case, two rudders. The coupling of rudders enabled both to be operated via one control rod. The underslung booms enabled servos (connected to previously-mentioned extension leads running from the fuselage) to be installed inverted into the main bay. The unique advantage of servos being inverted allowed access to the servo horn/control rod for primary connection and subsequent adjustments via a small secondary hatch on the underside. It was also felt that of the three, this boom type was by far the most aerodynamic.

Dorsal Fins, Fins, Tail and Elevator Mechanism: Swept-back fins and rudders were adopted, as these were both aesthetically pleasing and probably more economic materially, and in any case were no harder to construct. Another advantage of these O.V.10 Bronco style

fins – swept back at approximately 65 degrees – is that they allow the booms to be significantly shorter without reducing the desired moment arm (measured in to 25 percent of the fin chord). It soon became obvious that a high 'T' type tailplane was the most suitable, as this would prevent rudder blanketing as well as elevator interference caused by slipstream from the power plant. It was also felt that this configuration would increase airframe strength when compared to a tailplane set at a medium or low position in relation to the fins. An area of 780cm² was determined minimum and, because fin chord (forward of the elevator) dictated the width of the tailplane, it became apparent the above area could only be achieved by increasing the span (contrary to initial design, visualised as an 'Optica' style tailplane). This resulted in the tailplane overhanging the fins, and thus the boom centre line, by approximately 80mm on either side. It was felt that the elevator should be as long as possible and so run almost from fin to fin, with a throw of 15 degrees up and down. As time was a factor and materials, as well as patience, were running short, no airfoil was used and the tailplane was set at zero degrees incidence.

A fin slant greater than 65 degrees would result in the double bell-crank elevator linking mechanism fouling the port fins, leading edge, bearing in mind that both bellcranks must be set directly above and opposing each other at 90

degrees to ensure zero degrees elevator movement when relevant servo is at neutral. As with the wing con-rods, piano wire and bellcranks were personally preferred to plastic cabling, the latter possibly unsuited to the sharp angles present.

Approximately 40 percent of each fin was allocated to rudder area, thus ensuring adequate taxiing control and ability to counteract side slipping either during low speed climb-outs or at high r.p.m. Rudders exceeded the fin trailing edge to equate with the area lost by the angled corners – cut out to enhance looks. Fearing directional instability, dorsal fins were added.

Construction

The only points which should be noted are:

Fuselage: (1) The camera hatch was cut from the fuselage after final shaping. (2) The nose block ballast compartment was hollowed out by a 30mm dia copper tube (as used in plumbing) with a serrated edge improving its cutting ability. This was turned to a depth of 25mm. A shaft can be run through the tube to gain leverage. Afterwards, this tube was used as a mould into which lead was poured as ballast. This was left in the tube and the resultant slug inserted in the nose.

Wing: (1) Make sure that the undersides of the ribs are packed out evenly during construction. (2) Ailerons are cut out and shaped after the wing is sheeted. Make sure this is done

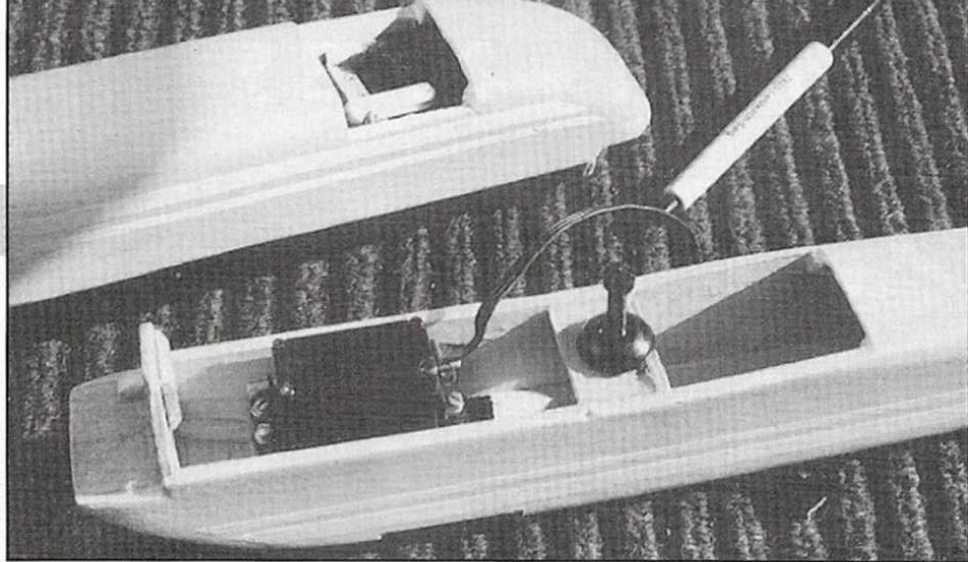
accurately. We recommend that pin-type hinges are used for aileron connection (after covering) but care must be taken to position them accurately, the pivot point being centralised correctly in order to prevent either binding or an over large gap. (3) Vortex retarders were cut out after relevant sections had been drawn onto the balsa block. Final shaping was done after retarders were fitted.

Booms: Boom profile, including ply doubler, was transferred from plan to wood via a trace from which a template was made.

Dorsals, Fins & Rudders:

(1) Concerning the port fin (elevator), make sure that both bell cranks are set at 90 degrees and rod connections to, between and from them are secure. We suggest that soldered metal clevises be used to prevent failure, considering that once fin sides are added access is totally denied. (2) Make sure that the ball and socket joint is kept to a minimum length, i.e. sufficient to clear fin and, obviously, to line up with the elevator horn. (3) The incorporation of lightening holes into all vertical tail surfaces was found to be necessary (rudders and dorsal fins prior to shaping). Location of holes is left to the individual's discretion and obviously number depends on weight reduction requirement.

Tailplane: We had to incorporate additional lightening holes into the elevator. Any additional holes must avoid elevator hinges as these exceed the rear spar.



Flight

Take-offs: On a normal grass surface from a standing start, full throttle is needed. Once flying speed is attained (usually at 30-35m) ease back until you have full up elevator (15 degrees). During this time, rudders (with a throw also of 15 degrees, which can be increased if desired) are generally effective for any required corrections. Once Skycam is airborne, ease the elevator forward to almost the neutral position and allow the aeroplane to climb out gradually. Having reached a desired altitude, return elevator to the neutral position and reduce throttle to around the cruising mark.

In-flight Characteristics: During the odd encounter with turbulent air, it was noticed that the aeroplane suffered from slight yaw, so eventually under-fins (Cessna 02 style) were added. These increased the vertical tail area to the practical limit – any more would cause

problems with tail clearance during rotation – and since then yaw has not been experienced. Flying in calm weather, Skycam will maintain a straight and level course as if travelling along a tramline.

The aileron, elevator and rudder movements specified on the plan will all be suitable for general flying, although in an average bank just a touch of aileron is appropriate. An angle of attack greater than approximately 15 degrees is not recommended at low r.p.m. as lateral and rotational instability are likely to be experienced.

Skycam is semi-aerobatic and will easily cope with all basic manoeuvres, including rolls; this came as a surprise since it was expected that the tailplane configuration would not perform as well as a more conventional type. So, if one becomes bored with aerial photography or simply runs out of film, Skycam will still give the enthusiast enjoyment.

Photography: On photographic flights it is obviously advantageous to have calm weather conditions with good lighting. After the climb, engine r.p.m. is reduced to a slow cruising speed, which prevents unwanted camera shake and provides additional time for frame composition. Personally, we have found that inclusion of the horizon enhances and generally clarifies the subject. Some good photographs have been taken from around 76m (250ft) using a 35mm focal length lens. A shutter speed of at least 1/250th is recommended for acceptable definition, and a film speed of 200 ISO would make this possible.

For specialised missions demanding maybe a dozen or so photographs – for instance, if one's time permits only one or two flights, or if the subject matter is mobile – a motor wind equipped camera would be needed.

To sum up, for general photography one exposure per flight is more than enough considering expense and repetition (although Skycam can be flown from virtually any flat location of suitable dimensions). The one basic rule for aerial photography is to fly as high and as slow as possible, remembering that the further away the subject, the shallower the bank.

Landings: Skycam lands slightly faster than the average trainer, so a low landing approach should be made coming in on the throttle, at the same time flaring out with the elevator. Finally, full up-elevator should be applied immediately prior to the main wheels touching down.

Conclusion

Skycam is a success in terms of aerial photography and general flying pleasure, as well as being aerodynamically clean and good looking. We are impressed with its performance and were surprised to discover the degree of stability attained, considering its power plant location and, moreover, its unconventional configuration.

Of course, Skycam is no aerial reconnaissance ship, but it is a platform on which a medium to expensively priced compact camera can be mounted, and from which high-quality photographs can be obtained. Although not for the novice, Skycam is by no means hard to fly – or land – and gives the weekend flier access to an interesting and satisfying aspect of our sport.



Specifications

Wing span	60 inches	152.5cm
Wing loading	26ozs per sq.ft	
R/C	5 servos	
Engine	.40	10 x 6 prop
Payload – camera	22ozs	623g
Total Weight	104 ozs	2.95kg