

This RPV is more than an interesting project designed for carrying movie cameras. It is a multi-purpose research or practical application industrial tool for carrying substantial payloads in a pusher configuration. / by Dave Scully

SPARROW

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Sparrow is a special purpose, remote-controlled model being used by the Air Force at Wright-Patterson Air Force Base to develop RPV (Remote Piloted Vehicle) technology. This design represents the groundwork of a concept which may someday see the RPV emerge as an operational weapons system performing missions which are presently relegated to manned aircraft.

The advantages of such a concept are numerous. Aircraft no longer limited by man's physical tolerances would be more maneuverable in air combat situations. Hazardous missions such as low level recon, weapons delivery, and target marking could be performed by expendable RPVs. Other advantages include a high degree of mobility, lower development, production, and maintenance costs.

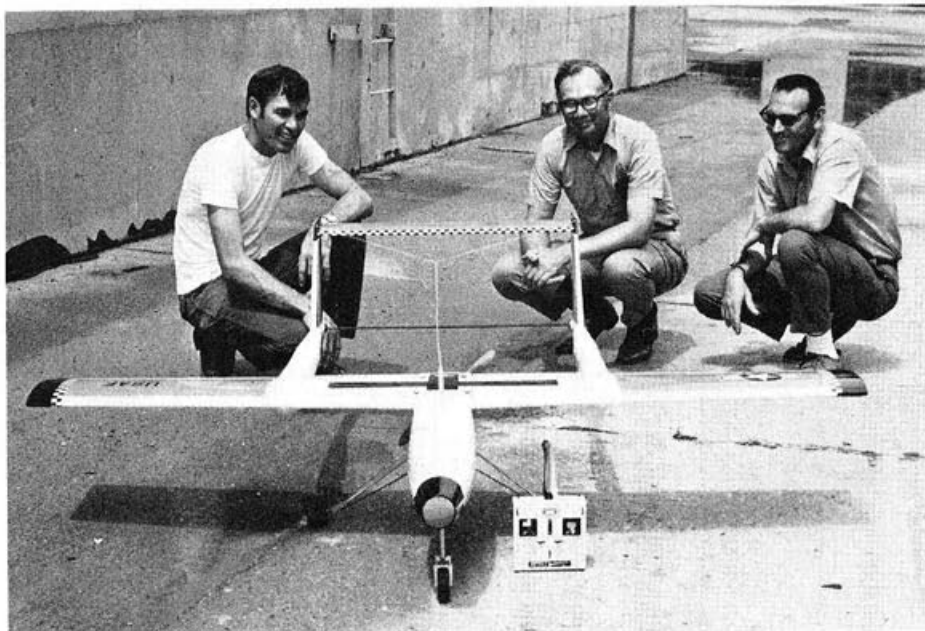
What role does the RPV play in civilian aviation? Remote-controlled models have been used for some time as an aid in the development of full-scale aircraft, and more recently as a means of obtaining special aerial sequences for the film industry. Universities and research agencies have utilized radio-controlled models for various projects, among which the development of the Hill autopilot is probably the best known.

Tomorrow's need for special purpose RPVs may exist in such areas as weather sampling, high altitude research, and environmental control. We will undoubtedly see a growth in engine development, control systems, and RPV design to meet these future requirements. Sparrow is one design which could be adapted for use where requirements dictate a model capable of carrying a substantial payload or a model suitable for aerial photography.

Sparrow was designed by a team headed by Aeronautical Engineer Raymond Fredette of the Flight Dynamics Laboratory at Wright-Patterson Air Force Base, Ohio. Mission requirements for the full-size vehicle called for an aircraft which would carry up to 100 lb. of payload and cruise in the range of 80 to 100 mph. Design considerations included an unobstructed forward view for video experiments, and the capability of accepting a variety of payload configurations. As a result, the design presented evolved as the most desirable configuration for planned remote piloting experiments.

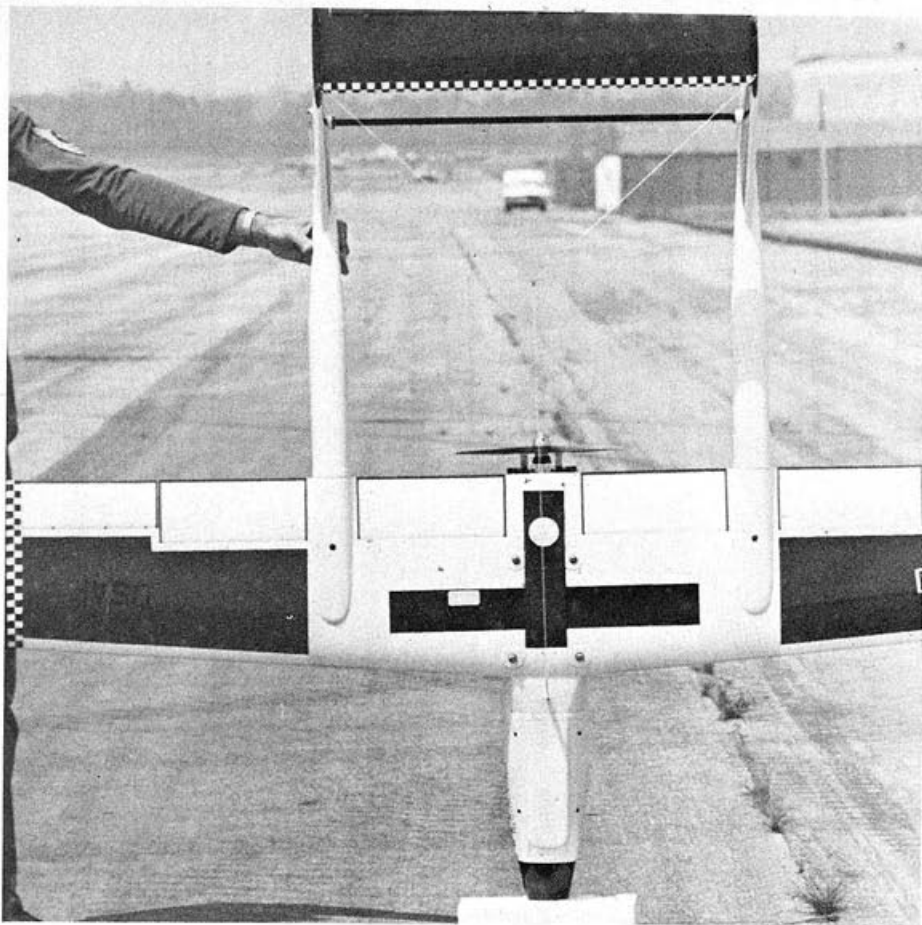
The model presented in this article is actually a half-size version of the Fredette design, which was built as an engineering aid, and proved to be extremely useful as a low-cost method of elevating performance, and developing fabrication techniques relative to its full-scale counterpart. A Sony video system was later installed, and basic piloting experiments via video were performed with excellent results.

Sparrow exceeded our expectations in its flight characteristics, and its suitability as a test bed for future experiments. Apart from a lack of readily



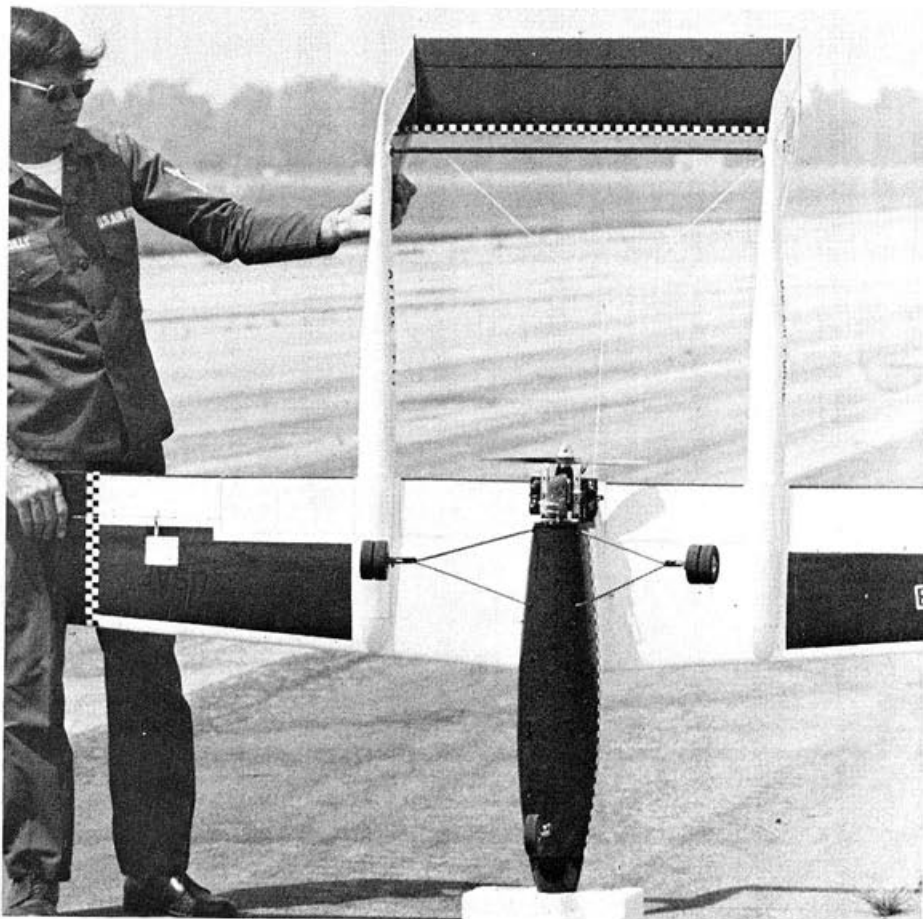
Above: Principal members of the Teleplane Team are (left to right): Dave Scully, Don Lowe, and Jim Cline. Right: Sparrow flies with 24 lb. of video equipment and both Ross 4 and Ross 6 cylinder engines. Here Jim Cline puts the starter to it while Dave Scully holds on. Below: This colorful plane waits patiently for flight duty. Construction utilizes mostly fiberglass and foam/plywood flying surfaces.





Top view shows that a great deal of flap area is available for slow flight work.

Underside, Ross 4 installed at this time. Spreader bar at tail is streamlined K&S tubing. Rudder linkage passes through it.



available engines for models of this size, I can honestly say that we encountered no major problems, either in constructing or in flying Sparrow. Our plane has flown well with a Ross 4 and even better with the Ross 6.

A model of this design as published, or possibly as an enlarged version, might be useful to a modeler interested in performing experiments of his own, or in taking in-flight movies. As I mentioned before, inexpensive available engines pose a problem and possible alternatives might consist of using two engines (60s or 80s) mounted on the booms as in the P-38. Little would be gained by shrinking the design, as the wing loading would increase with a corresponding decrease in payload capability. Generally speaking, the larger the model (wing area), the more efficient the design will be in terms of its payload percentage.

Fig. 1 shows a comparison of the half-scale to the full-scale that may be helpful to those who would want to determine their own requirements for an enlarged model.

Figure 1

	Half-scale	Full-scale
Wingspan	80"	160"
Engine	2 hp	12 hp
Wing area	7.5 sq. ft.	30.0 sq. ft.
Wing loading	3 lb. sq. ft.	7 lb. sq. ft.
Gross wt.	25 lb.	200+ lb.
Payload	10 lb.	100+ lb.

If a five-lb. movie camera was the desired payload, two 60s on the half-scale would probably be sufficient to achieve good takeoff and flight performance.

Construction

A very general description of the techniques used in fabricating this model are all that will be described, as it is anticipated that the experienced builder will adapt this design to his own proven methods of construction. Suggested changes for a simplified method of building this model would be to use a balsa wood box construction for the pod and the booms, and the more conventional method of control surface found on most RC models. The flaps could be eliminated on the half-size version, as we found we could land quite slowly without them. However, for larger models or flying fields that require steep approaches and the slowest possible touchdown, by all means include the flaps.

Pod—Fiberglass construction was utilized to gain maximum internal space to accommodate payload requirements consistent with minimum cross sectional area. As I mentioned, balsa wood construction could easily be substituted and past construction articles on scale models of the OV-10A would be a good source of ideas, however I leave this to the ingenuity of the readers. Fiberglass construction is not really difficult; the following is a brief description of the steps we used in constructing the fiberglass pod. Experiment with small parts such as wheel pants, cowls, etc. before tackling a complete fuselage. Once you learn the process, it's hard to go back to the glue and pin method of construction in terms of the savings in cost and time.

The original pattern was carved from urethane foam (Pro Foam would be

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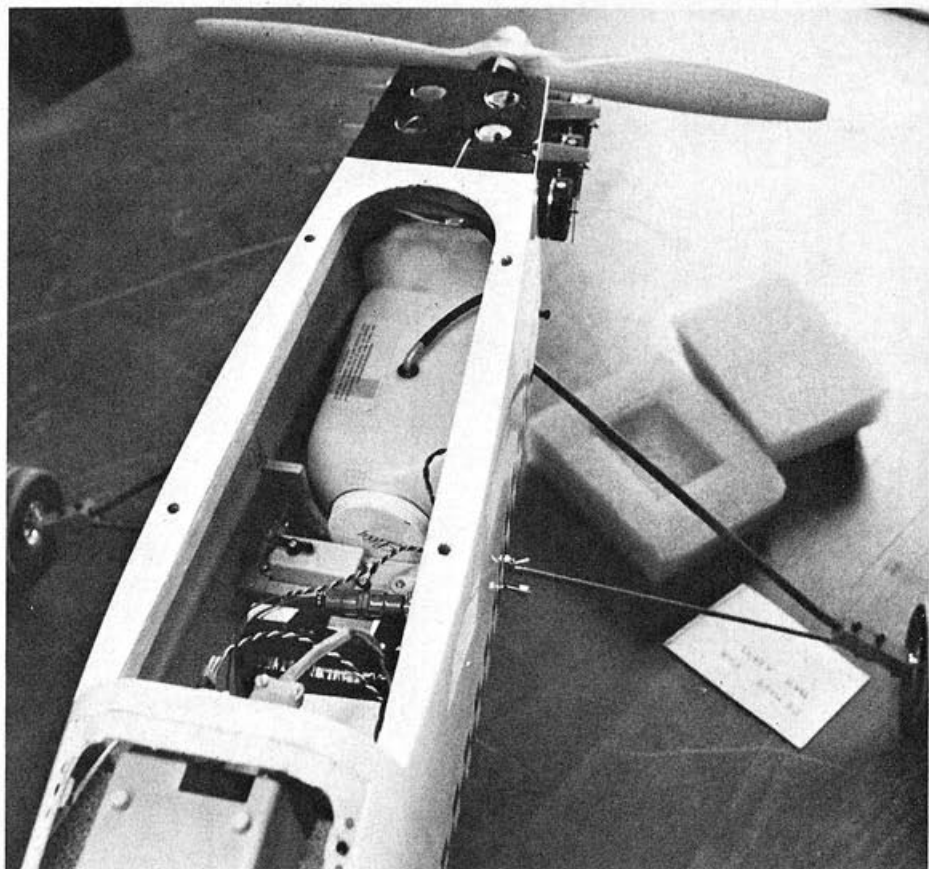
suitable for this purpose) and sealed with K&B coating resin. The resin is sanded and reapplied as necessary to obtain a smooth surface. The pattern was designed to split along the thrust line and the two halves were mounted on plywood boards. The pattern is then coated with a good paste wax and buffed thoroughly. A coat of vinyl separator is applied by brush or spray and allowed to dry. The mold is constructed by brushing on a gel coat (commercially available) to the prepared pattern and allowing it to set up. The mold is then built up to the required thickness (1/8" is sufficient) with layers of fiberglass mat saturated with polyester resin. The mold is allowed to cure at least 48 hours before removing it from the pattern and is then washed with water to remove the separator. The steps involved in making the finished pod are the same as for the mold except that fiberglass cloth is used instead of mat. The pod on Sparrow is laid up with one layer of seven-oz. cloth and a doubler of two-oz. cloth. The rear of the pod is reinforced with seven-oz. cloth to handle engine vibration. The excess cloth above the parting line of the mold can be trimmed off with a sharp knife just after the resin sets up (about 30 min.). The pod halves are left in the molds at least 24 hours and then removed, washed and held together with masking tape. They are then joined with a one-in. strip of cloth applied to the inside with polyester resin. Plywood formers are installed using a putty made of polyester resin and silica powder as an adhesive. The forward hatch is cut out last with a razor saw and a flange installed to accept hold-down screws.

Wing—The wing sections used are NACA 23012 at the root and NACA 4412 at the tip. The leading edge radius has been reduced and the forward coordinates have been modified to allow the wing to operate within a Reynolds Number range of .88 to 1.5.

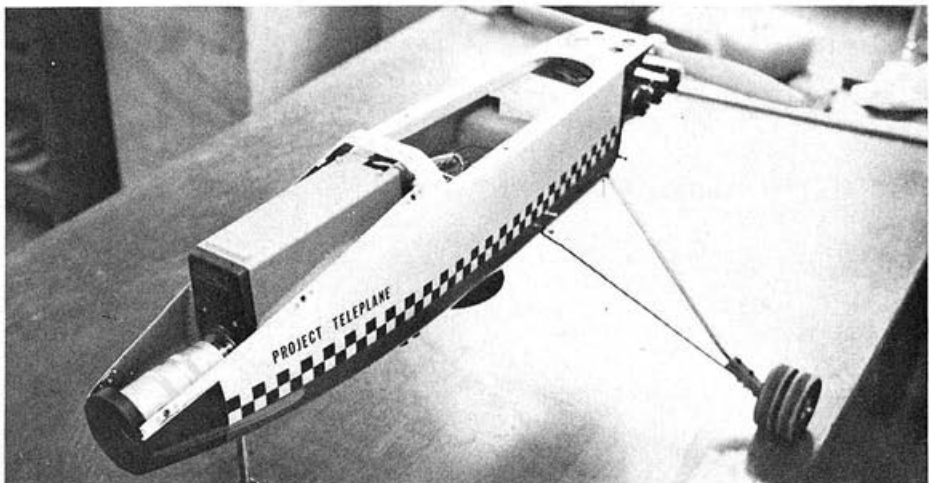
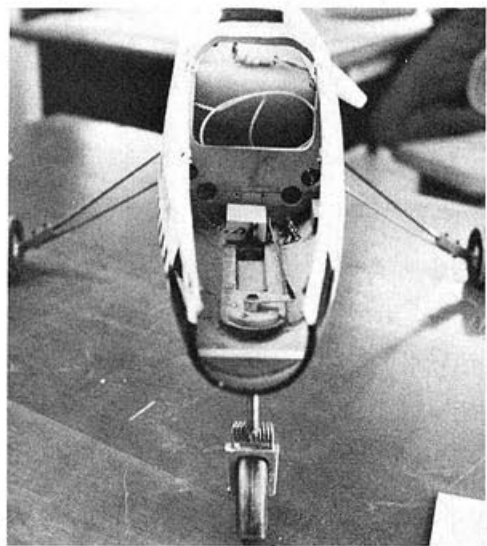
Standard foam wing construction techniques are used with the following exceptions. Access tunnels are cut through the cores using the guides provided on the wing templates. The wing is covered with 1/64th plywood using Bestine rubber cement as an adhesive on foam-to-wood bonds and Formula 2 epoxy on wood-to-wood bonds.

If the wing templates are lined up on the datum line, you will notice that the tip has effective wash out (e.g., the tip has negative incidence as compared to the root section and insures that the tip will stall last). This factor contributes to the outstanding slow flight characteristics of Sparrow and it is important to insure that the wing is built accurately. We found it advantageous to cover the wing in the same manner as a Formula 1 racer. Each wing panel was cut from a separate foam block which was parted to form an upper and a lower mold; the wing core was then placed in these

*Plans on pages 48-49
(Text continued on page 50)*



Above: There's plenty of room in here for equipment installation. Remember, it must have a payload for flight to keep the CG forward. Right: One servo pictured here is just for steering the nose gear. A parallel servo handles the rudders. Below: The pod hatch removed. That Sony TV camera, in its present location, could handle weather sampling equipment, radar, a laser, etc.



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forms while wrapping. Since the wing has no dihedral, the wing panels were joined together using the lower foam blocks as an alignment guide. The flaps are connected via a fiberglass arrow shaft pivoting on plywood bearings. The flaps are glued to the shaft with epoxy and pinned with toothpicks. The ailerons are connected using 90° bellcranks and 3/16" dowel pushrods running through the access tunnels provided in the wing. The extension harness for the boom servos are also routed through these tunnels. The wing center section is reinforced with fiberglass cloth and epoxy after joining.

Booms—The booms are fabricated from styrofoam and covered with 1/64th plywood with the exception of the section at the wing saddle, which is built up and sheathed with 1/8" balsa plank. A 1/16" balsa spline is glued down the top center of the boom and a 1/16" plywood plate is installed below the vertical stabilizer to add rigidity and serve as a mounting plate for the elevator bellcrank. The 1/64th plywood covering is dampened with a mixture of ammonia and water to prevent splitting while wrapping and is bonded to the foam with rubber cement. The plywood is lapped on top of the boom and the seam covered with a 1/2" strip of 1/64th plywood secured with epoxy. The forward section of the boom is reinforced with fiberglass cloth and epoxy.

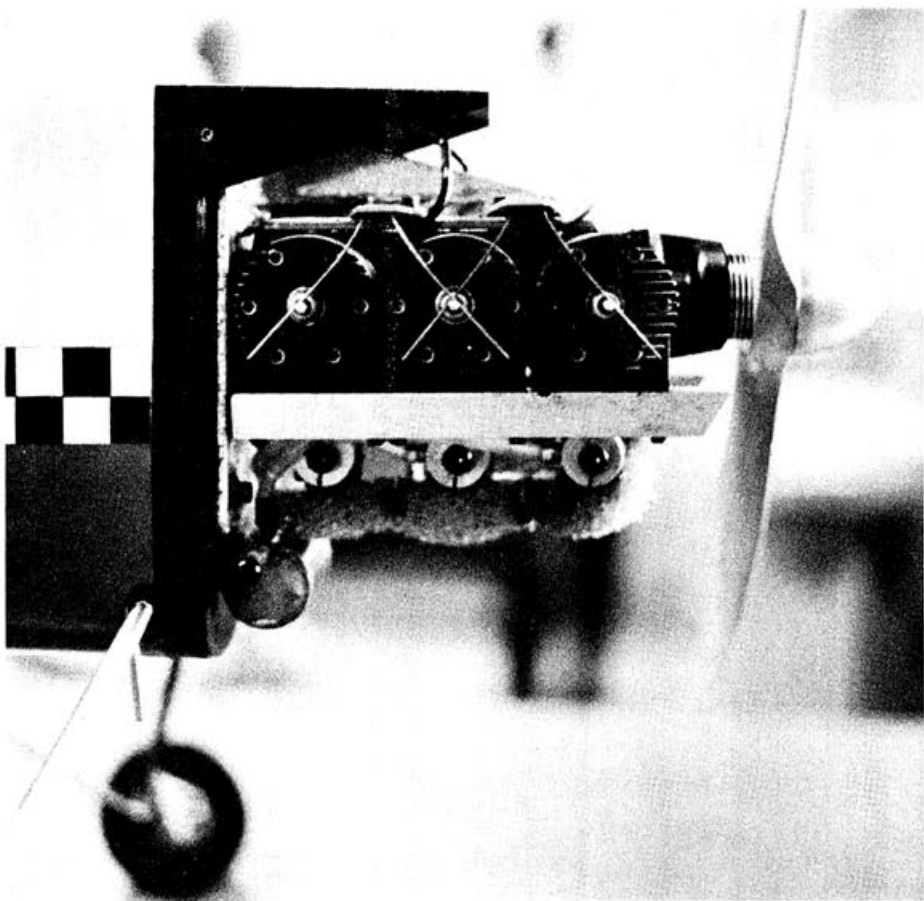
Tail Surfaces—The foam and balsa surfaces are constructed in much the same manner as the wing. Note that the left vertical stabilizer requires an access tunnel for the elevator linkage. The rudders are mechanically interconnected using a nylon linkage housed in a strut made from K&S streamline tubing.

Engine and Miscellaneous—Sparrow has been flown with both the Northfield Ross 4 cylinder and 6 cylinder engines. The Ross was chosen primarily to reduce vibration effect on the video equipment and proved to be satisfactory, although a bit expensive for the Sunday flier. The Ross was not designed to be flown as a pusher but since it is a reed valve engine it can be operated in either direction. To date our Ross engines have been operated in reverse rotation using 14/6 and 16/6 tractor props respectively without suffering any ill effects.

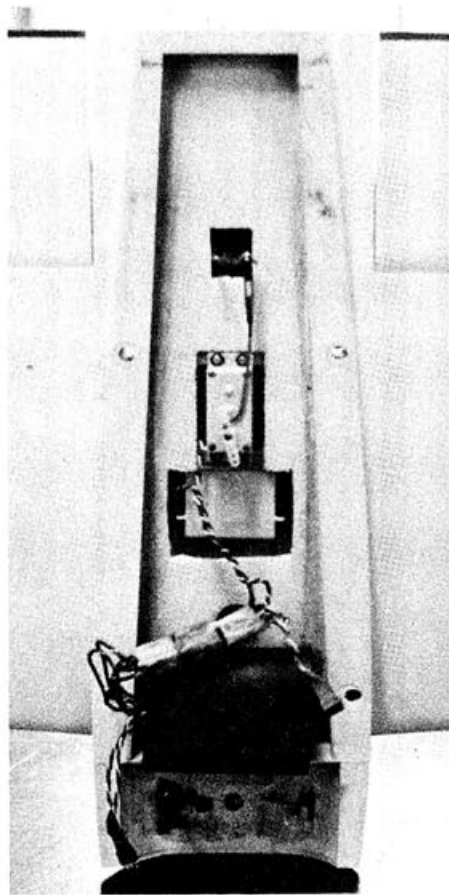
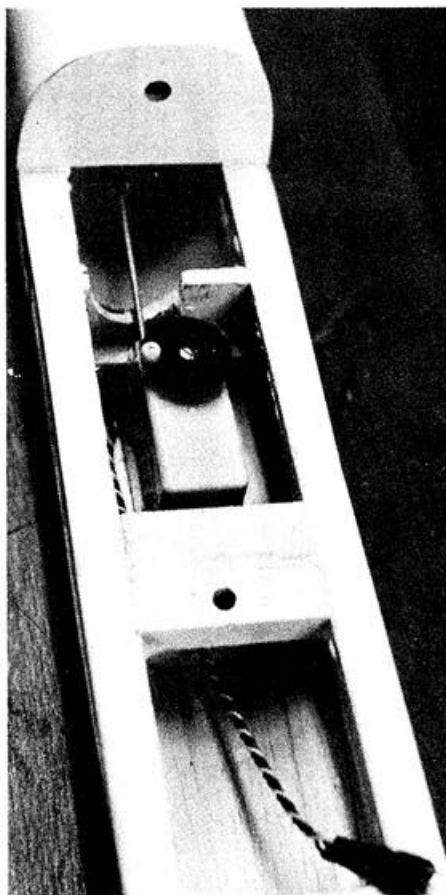
Woodcraft Mfg. was the source of our props and I believe they can supply the larger props in either the tractor or pusher configuration.

The fuel systems we use on our project aircraft are strictly homemade (Jim Cline specials) and the normal procedure is to find a container that will fill the available space. In this case we used a plastic aspirin bottle which was modified for fuel lines by using grommets (similar to the Tatone stick-a-tube method) to seal the tubing where they

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Above: Lighting all the plugs at once is easy with the springs seen here. Engine runs both ways, so a pusher prop is not required. Note sump tank at firewall. Below left: Tailboom at wing saddle shows location of elevator servo here, rudder servo in other boom. This part of boom is balsa; rear part is fiberglass. Below right: Bottom of wing shows receiver location, flap servo and aileron servo.





enter the tank. Sparrow's fuel system is not designed for prolonged inverted flight and it proved satisfactory to run a feed line from the lower rear of the tank and a vent line from the top of the tank to complete the system. With the Ross engines it proved necessary to run a larger than normal feed line (about 1/4" ID) to the engine and cobble up a brass tubing manifold to feed the individual carburetors.

The main landing gear strut was bent from 1/4" drill rod and retempered, however, two pieces of 5/32" music wire bound together with brass wire and soldered would do just as well. The tandem wheels (three-in. Du-Bro slicks) on the main gear have worked well in the absence of larger commercially available wheels.

Finishing—The model was completed using K&B products. All wood was sealed with coating resin and the model primed and finished with SuperPox paint.

Checkout—Our ground checks prior to flying consisted of the following. CG located between 21.5" and 24" aft of the nose. Control deflections: ailerons 15°, rudder 30°, elevator 25° up, 30° down, and flaps 0°-45° range. The radio was given a thorough range check both with the engine running and static. It was found that a capacitor (Erie Red Cap PN 8101-050-651-10ZM) had to be added on the Pro Line receiver to eliminate problems caused by the long leads to the boom servos. One cap was added on each channel between the decoder output and ground and the receiver was then retuned. We then went one step further and secured the aircraft to the top of a station wagon and charged up and down the runway checking for flutter and the odd chance that we could get a 4000-lb. payload off the ground. Finally, deciding that there was nothing left to tighten, adjust, or paint, the batteries were charged and we headed for the flight line.

Flying

Takeoffs with a gross weight in excess of 25 lb. (ten-lb. payload) requires a long ground roll. With 10° of flaps lowered, the model accelerates approxi-

mately 150 ft. before the nose wheel is lifted off, about 15 feet later the plane is airborne and climbs out quite rapidly. In flight, Sparrow is stable and relatively easy to fly. I'm not going to "put you on" and say that the design will fly the entire FAI pattern with a sick engine. In fact, with a three-lb. wing loading on a model of this size it should fly like a nervous brick, but the point is, it doesn't. Sparrow's flying and handling characteristics compare more closely to a light aircraft than to a model, although forgiving in most circumstances, she won't tolerate rough handling and is definitely a model for the experienced flier. The control response is positive without being touchy and stalls are gentle and predictable. (You can almost feel the controls get mushy.) With full flaps and down trim the plane can be slowed to a crawl with no indications of a stall.

I can't give much of a comparison as to the flying qualities at different weights since Sparrow has to carry payload or ballast to balance properly. The lightest weight the model was flown at was 22.5 lb. on the first test flight.

The only aerobatics that have been performed to date have been rolls and one short field landing. That is to say, I landed about 50 ft. short of a long field when I found you can't stretch a glide with a dead engine. The airplane suffered only minor damage but my pride suffered more by missing a 7000-ft. runway with a seven-ft. model.

On landing, Sparrow's sink rate is somewhat higher than one is used to (as you might have gathered), but touchdown is quite slow and, as I stated before, flaps have not been found necessary as a landing aid on this size model.

I would be interested in hearing from groups or individuals who would benefit from a special purpose model such as described in this article. Let me know the payload requirements and purpose of its use. Sufficient interest in this area might warrant production by a kit manufacturer of fiberglass and foam components that would satisfy a variety of needs.