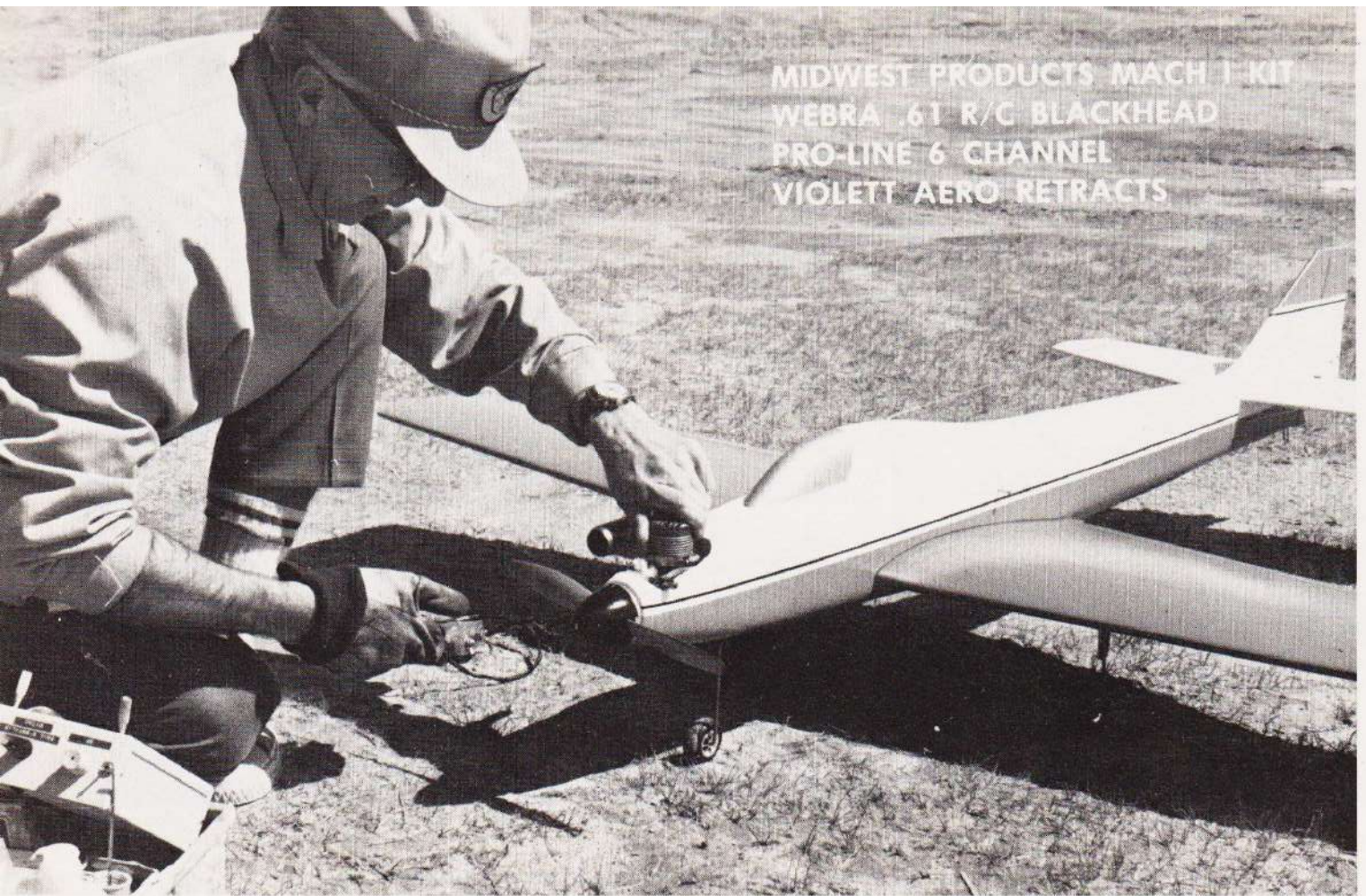


MIDWEST PRODUCTS MACH 1 KIT  
WEBRA .61 R/C BLACKHEAD  
PRO-LINE 6 CHANNEL  
VIOLETT AERO RETRACTS



Phil believes in careful approach to the finger-eating qualities of our modern sixty-size engines; hence the protective glove during starting.

## Field and Bench

BY PHILIP D'OSTILIO . . . hottest Pattern plane of the year in the most awaited kit, here with a different slant for project evaluation — an evaluation of design as well as the kit by a well-known designer and competitor. Both criteria receive a top report after a most critical and exhaustive analysis.

• Clearly, the successes achieved in Pattern competition by Norm Page with the Mach 1 are impressive. It is recognized that success in competitive flying is not easily achieved and is the overall result of a great deal of effort in several disciplines.

Since the total system for competition flying includes aircraft, guidance

system, engine, proficient pilot-loop-closure and an element of luck, it is of interest to examine one part of the total package for its contribution to this winning record, namely the aircraft. The approach, therefore, in this Field and Bench article, consists of an evaluation directed to the following topics: aircraft design characteristics, kit construction

and evaluation, field evaluation.

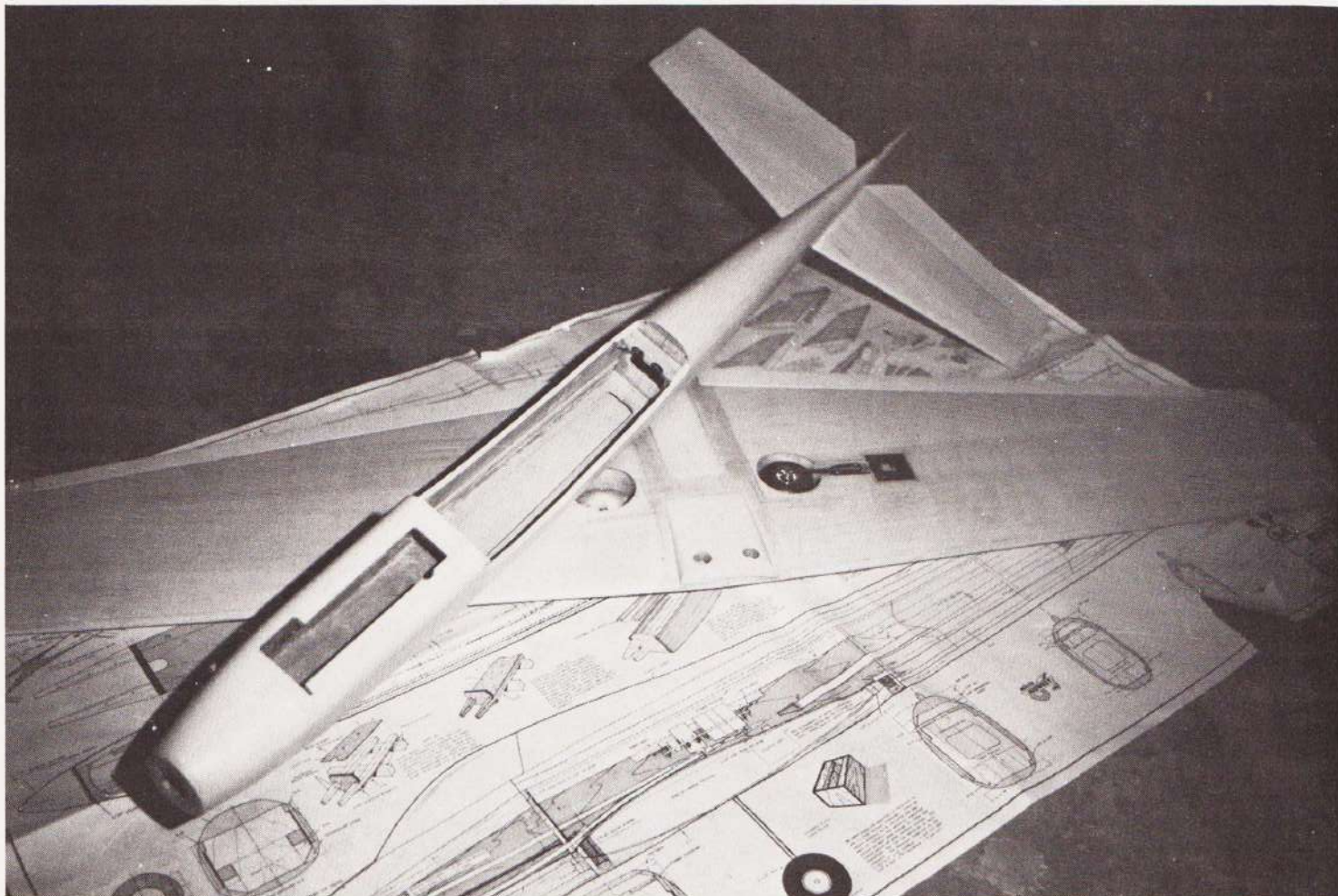
### AIRCRAFT DESIGN CHARACTERISTICS

Overall, the aircraft is large by current Pattern trends and displays extremely graceful aerodynamic lines, wheels up or extended. A closer look reveals many distinctive features which will be discussed in greater depth.

*Wing:* A relatively large area and root



Camerman got this approach shot from rather far out so it had to be enlarged many times; however it does show the flat-on approach of Mach 1.



Finished and ready for priming and painting, the Mach 1 looks good as does the Midwest plan for construction—good photo of the bare article.

chord are immediately apparent. Planform area is 725 sq. in., span 62 in. resulting in an aspect ratio of 5:4.

At a flying weight of 7.5 lbs., the corresponding wing loading is 24 oz./sq. ft. This wing loading should enable a low approach speed and gentle touch-down. It would appear that at the 7.5 gross weight, turbulent flight conditions could pose a problem — but read on!

The airfoil is symmetrical, root and tip, with the maximum thickness/chord ratio of 14%. Thickness of 1 in. at the tip and chord of 8.5 in., yields a thickness/chord ratio of 12%. Here, then, are details of significance. The wing is thin and decreases in thickness ratio outboard. Many R/C Pattern aircraft feature wings with increasing thickness ratio toward the tip or apply progressive airfoil development to achieve a non-symmetrical section at the tip. Profile drag, then, for the Mach 1 wing, can be expected to be minimal.

The taper in planform results in a planform taper ratio of 56%, which combined with the large area, is a good approach to minimizing the wing induced drag.

From a performance viewpoint, aerodynamic design of the Mach 1 will require less power for a given forward speed, or, based on current 60's at a bit over one horsepower, the forward speed can be expected to be improved.

Considering the roll maneuvering capability, the tapered planform is also an excellent approach toward reducing the aerodynamic damping with a roll

velocity. The more than adequate area should result in a plentiful margin from stall for even the most extreme maneuvers.

**CG Position:** This parameter is also of particular interest. The position shown,  $3\frac{1}{2}$  in. (23%) from the root chord leading edge, is quite forward by current practice. Technically, positioning the CG forward results in a more negative static pitching moment slope and decreased elevator control sensitivity — the elevator control stick needs to be displaced more to effect an aircraft attitude change. Some R/C flyers will refer to this characteristic as sluggishness. But, this forward CG arrangement is a very effective method of achieving a smooth flight profile.

Generally, the necessity to move the CG aft stems from the spin maneuver and to minimize the amount of forward stick needed for inverted elements of a maneuver or for inverted flight.

Thus, if the spin maneuver can be realized with the CG in the forward position, aircraft static stability is improved, control sensitivity is reduced and smooth flight characteristics achieved.

**Thrust Line/Chordline:** The dimension 0.6" approaches the force set up which is ideal for the execution of truly axial rolls. Art Schroeder recognized this arrangement and used it effectively with the Eyeball design. Norm Page has achieved the same line up, but with the low wing configuration. Positioning the chord line as nearly as possible in line

with the thrust line, when combined with the proper amount of dihedral angle, is an important design parameter for the axial roll requirement.

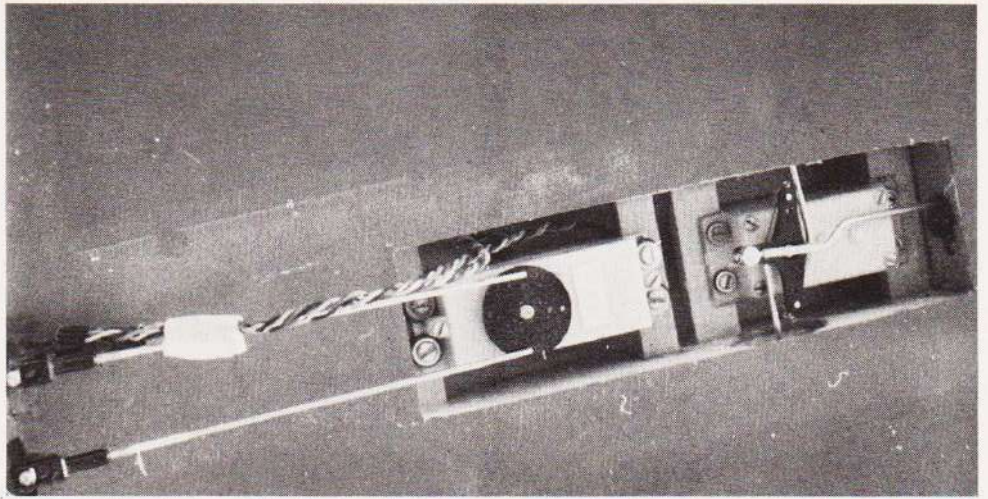
**Dihedral Angle:** Although appearing to be shallow, the leading edge sweep angle of 4 degrees contributes to the total effective dihedral angle. Approximately 4 degrees of leading edge sweep are equivalent to 0.4 degrees of dihedral angle. Therefore, the effective dihedral angle is the sum of the built-in angle, 1.8 degrees and the angle due to the leading edge sweep increment, for a total of 2.2 degrees.

**Strip Ailerons:** The strip ailerons taper in planform and thickness consistent with the wing planform and thickness changes. Of significance, the strip ailerons are not carried out to the wing tip, which is good aerodynamic practice. During aerobatic maneuvers, the wing is at a higher angle of attack compared with trimmed level flight due to the required elevator deflection or required aileron deflecting. The wing tip section is closer to stall, especially with the symmetrical section of reduced chord. The additional drag associated with the deflected aileron is purposely kept removed from the tip, precluding excessive drag build-up and an associated speed decrease during the maneuver.

**Upright Engine:** The upright engine provides minimum lateral aerodynamic drag unbalance when compared with the side-mounted engine. For either case, the additional drag increment due to the



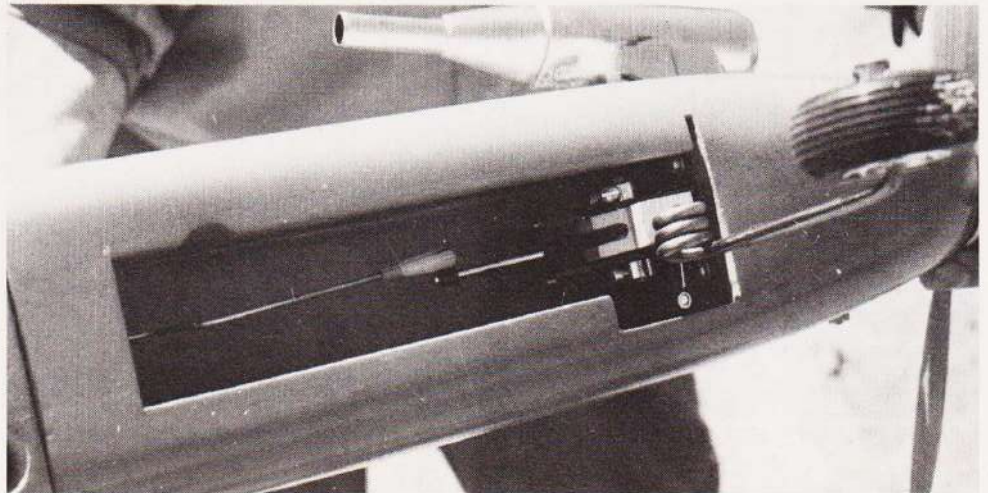
Close-up of the engine/muffler installation.



Upper section of wing with retract and aileron servos installed; regular 180° pushrod on retract.



Close-up of Violett Aero main retract gear.



Close-up of Violett nose gear installation. Lots of room provided for the nose gear.

## FIELD AND BENCH . .

muffler installation exists as a lateral drag effect. Therefore, considering the total installation, aerodynamic drag is minimized with the upright engine.

*Yaw Control (Rudder):* The rudder is sloped aft at a shallow angle. Perhaps a bit more pitch up attitude of the wing is realized due to the incremental down load of the stabilizer with deflected

rudder for the spin entry. However, the coupled effects in other coordinated maneuvers may not be entirely optimum. At any rate, this effect is not considered of large magnitude.

Overall, the aircraft design is most pleasing with its graceful lines. Appreciable effort has been applied in keeping the total drag to a minimum, especially

in the wing design and in other less obvious details. With the CG forward, a desensitized elevator response can be expected. Roll response should prove to be excellent due to the reduced damping, again attributable to the planform taper ratio.

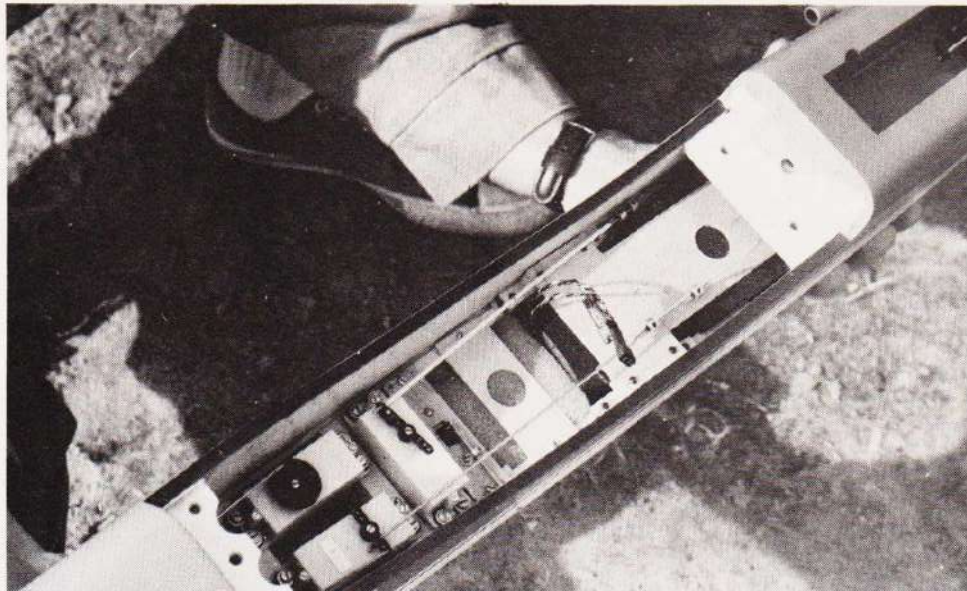
*Design Parameters:* For those readers who may be especially interested in design parameters, the following summarized data may prove of interest. (Please note that the values tabulated are derived from the Midwest kit plans.)

### Wing

area, inches squared.....	725
span, inches.....	62
projected root chord, inches.....	15
tip chord, inches.....	8.5
aspect ratio.....	5.4
thickness/chord ratio, root, percent	14
thickness/chord ratio, tip, percent	12
airfoil, root.....	symmetrical
airfoil, tip.....	symmetrical
leading edge sweep angle, degrees.....	3.7
mean geometric chord, inches.....	11.75
incidence angle, wing.....	zero
span, aileron, inches.....	25
root chord, aileron, inches.....	1.5
chord, aileron, tip, inches.....	1.0
dihedral angle, degrees.....	1.8
planform taper ratio, percent.....	57
weight, ounces.....	24

### Stabilizer

area, inches squared.....	200
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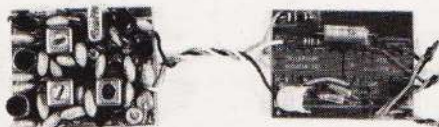
Room galore in fuselage permitting clean installation with good separation for all parts.



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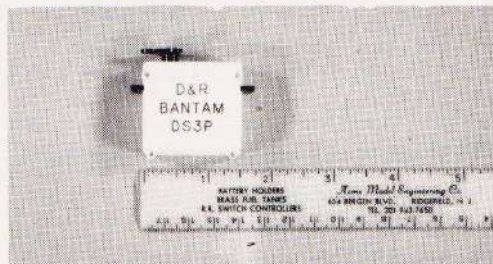


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## Field and Bench

span, inches.....	26
root chord, inches.....	10
tip chord, inches.....	5.5
aspect ratio.....	3.4
airfoil.....	symmetrical
percent of wing area.....	28
incidence angle, degrees.....	zero
elevator area.....	67
percent of stabilizer.....	33
weight, assembled, ounces.....	4.5
<i>Vertical Tail</i>	
estimated area, inches squared.....	55
percent of wing area.....	7.6
rudder area, inches squared.....	24.5
percent of vertical tail area.....	45
<i>General</i>	
nose moment arm, inches.....	16
tail moment arm, inches.....	30
center of gravity, inches.....	3.5
c.g., percent of root chord.....	23
thrust line to wing chord line, inches.....	0.6
main landinggear tread, inches.....	18

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wheel to wheel tread, inches.....	16
main wheel to nose gear, inches.....	14
overall fuselage length, inches.....	55
structural weight summary (ounces)	
fuselage.....	28
wing.....	24
stabilizer.....	4.5
total, less hardware.....	56.5
dry weight, ounces.....	112

### CONSTRUCTION HINTS & EVALUATION

Instructions printed for the assembly of the Mach 1 consist mainly of a sequence of illustrations clearly drawn, and, if followed carefully, no difficulty should be encountered with the assembly. The following particular areas are mentioned for the benefit of those planning to assemble the kit:

\*Note the instructions on the upper right hand corner of the diagram and allow a few extra minutes to label each die cut element before separating from the sheet stock. This will be helpful as you progress with the assembly.

\*Obtain a flat, portable surface, approximately 3/4" pine or equivalent, and 8-9" in width. Draw a center line on the working surface and position the base pieces for the formers on each side of the drawn center line. Follow the assembly sequence as illustrated.

\*Complete the lower (bottom) portion of the fuselage while the structure is pinned to the working surface including the final shaping of the contour. The Stanley Surform tool is mighty handy for this task.

\*Pre-drill the required nose gear holes in F-1 whether you plan to use a fixed landing

gear or retract system. This step is best done before you get too far along.

\*Plan your fuel tank installation before enclosing the fuel tank compartment. I did not have a fuel tank available until it was too late and much more extra time was spent fitting one in after the nose area was completed. Special thanks are due to my wife, Dot, who toured cosmetic counters searching for the oval type tank. I wonder what the salespeople thought as she used the plywood template until she located the Revlon 11.4 fluid oz. bottle. Sullivan Products has since solved this one for the Mach 1. Plan ahead and acquire the appropriate fuel tank container.

\*Trim the leading edge portion of the engine rails to suit your .60 type engine; this is also a step that is much easier to do prior to assembly of the engine unit.

\*The wing trailing edge station of the fuselage will require some fill-in at this junction and be sure to adhere the hardwood block to the fuselage plywood side members for the necessary structural integrity.

\*Although 4-40 screws are indicated on the diagram for engine mounting, 6-32s are recommended.

The pre-cut foam cores provided are of outstanding quality - cores are cut from low density foam. Both wing panels and stab cores are packaged and sealed - an innovation that is sure to be followed by other kit manufacturers. Practically no additional surface preparation was necessary because the airfoil profiles were identical and the surfaces so smooth. Again, a few construction sugges-

tions.

\*Assembly of each panel should be completed separately and as shown in the illustration sequence. Apply the prepared wing skins to the lower surface and follow with the addition of the L.E. and T.E. members. To trim the L.E. and T.E. pieces, try the Surform tool - a tremendous aid.

\*Save the foam core pieces since they are invaluable as work platforms while applying wing skins and good for working with the individual wing panels.

\*Next, work on the aileron detail - this step will require extra care because the ailerons are tapered in planform and in thickness. The required contours can be done systematically by patient use of a good sanding block tool. The tip blocks and dihedral detail are added as shown in the plan sketches.

Landing gear - if you elect to use a fixed gear, note the assembly of the hardwood grooved landing gear members. Use the landing gear strut to assure correct assembly.

Retract gear system used in this project is available from Violet Aero Modeling Corp., 116 Frederick Ave., Rockville, Md., 20850. The main gear and nose gear units are of high quality in design and manufacture. Following initial exposure to this design, one is left with the thought, why didn't I think of this concept?! An adjustable spring permits final trim adjustment and actuating rods are in tension and work against the spring in the retract cycle.

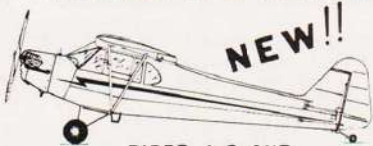
To ease the retract main gear mounting effort, make up the separate plywood boxes for which the plywood is also supplied in the Midwest kit. The plywood box sub-assembly allow recessing the wing panel using the boxes as templates. The units can then be positioned neatly in the panels.

\*Wing mounting detail is also simple - three nylon bolts are provided, including the Allen tool; sure is an improvement over L.E. dowels for alignment.

\*Stab assembly is very much like the wing. Adhere the two panels using 2-part epoxy - follow up by applying the prepared sheeting. Be careful not to let the weight build up aft; doing so may require weight at the nose to achieve the forward CG position shown.

The kit offered by Midwest Products Co., 400 South Indiana St., Hobart, Indiana, 46342, is professionally engineered; illustrations are easy to follow, parts fit well and very few additional items are needed to assemble the Mach 1. Extra details include templates to duplicate the fuselage cross

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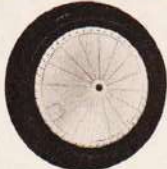
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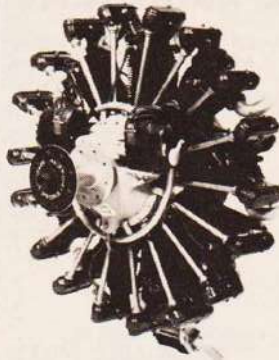
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3	6-3	6-4	50¢
3	7-4	7-6	65¢
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3	10-6	10-4	1.25
3	10-4	10-4	1.50

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sections, a clear plastic canopy, molded retract gear wells, a generous supply of fine quality and proper density balsa, decals, etc. Credit is really due the members of the staff at Midwest for this quality kit.

Finish shown on the photos was achieved simply — it just so happens that my favorite color scheme consists of white, orange and a variable third trim color (black, blue, etc.). So the color scheme shown on the kit box seemed like a natural.

The wood surface was first prepared by sanding and brushing three coats of butyrate dope. Silk was then applied, followed by three to four coats of clear and one to two coats of balsa filler. Fine sanding was applied between each coat to remove any resulting surface roughness. A sprayed base coat of white was followed by colors to achieve the color scheme on the Midwest carton. The weight increment for this finish process approximates 6-8 oz.

Guidance system consisted of a 1970 version Pro Line with one new addition, namely, the new Pro Line actuator for the retract units. This new actuator has plenty of torque for its size. The gear train is rugged and provides the necessary force to activate all three retract units with margin.

I was especially impressed with the low current drain on this actuator. Starting with a power supply voltage of 5.2, approximately 50 retract and extend cycles resulted in the supply voltage dropping from 5.2 to 5.1 volts, clearly no burden on the airborne power supply.

### FIELD EVALUATION

A Webra 61, Silenceaire muffler and a stock, Top Flite 11-8 Power Prop rounded off the peripheral requirements. Final weight of the Mach 1 was 7 lbs. dry.

The Bench portion of the project was completed on a Saturday morning and was followed by checking engine operation, setting the idle and the necessary pre-flight activities before setting out for the field.

Conditions at the site were 60°F., wind 10-15 mph and gusty. Following several photo shots by Al Novotnik of M.A.N. staff, fuel tank was topped off, engine started and the flight evaluation was at hand.

Taxi characteristics, despite the wind, were entirely satisfactory with no adverse cross wind effects. It became apparent the adequate propeller tip terrain clearance was going to be a practical advantage on the unprepared surface.

Full throttle and take-off followed — smooth and straight ahead. After several minutes of shakedown flying, the gear was retracted and the real moment of satisfaction was enjoyed. At 7 lbs. plus the fuel weight, turbulence did not seem to bother the tracking at all.

As anticipated, response to elevator was smooth and did require a bit more elevator stick displacement. Roll rate was observed to be a bit high, which was also not surprising. I had initially allowed for more aileron deflection and have since reduced the aileron throw.

Four point rolls were especially easy, requiring imperceptible elevator stick displacement during the aileron control inputs.

Spin entry was realistic — engine was throttled, nose lifted, and full up elevator and some aileron resulted in a low yaw rate, easily counted, three-turn spin. Recovery was straight ahead. This maneuver was particularly important for evaluation because of the low gross weight, light wing loading and the forward CG. No difficulty, first time.

Landings were straightforward; headings were maintained and up elevator allowed real nose high attitudes which help with any retract gear system.

Necessarily, flight evaluation was limited. Time available simply precluded acquiring the flight time to really appreciate the potential of this aircraft.

Summarizing, the aircraft is an impressive Pattern aircraft.