DUELLIST MK II

Talk about being relaxed: here we see Dave quietly sitting on the tarmac, waiting his turn at the flight line. It *is* a pretty bird!

BY DAVE PLATT

• Over the last several years, R/C models have been developed to such high standards of performance and appearance that today the average kit or magazine design leaves little or nothing to be desired. While this is, in most ways, a marvelous state of affairs, it has produced one unforeseen disappointment: consistent near-perfection eventually results in boredom.

We were discussing this phenomenon one evening in Shakey's over a pizza and some good beer (an unlikely atmosphere, we'll admit, for profound thought), and it appeared to be generally agreed that an occasional break in normal routine, modelwise, was essential for a continuing healthy interest in things R/C.

Thus it was that, in these noisy but friendly surroundings, the Duellist was first sketched out on the traditional table napkin. My view was that a twin would be an exciting and challenging change of pace, but that the currently available twin-engined models were either scale (which seemed like too much of a jump for the average club sport flier), or else dressed-up variations of a basically single-engined design. I felt that by designing the model to be a twin from the start, I could choose suitable aerodynamic and structural features accordingly, with a better end result. I used standard balsa wood construction throughout; I believe that wood gives the best overall structural integrity to maintain a tight, sound ship during hundreds of flights, in conditions of unusual vibration and very high performance. Although I avoided scale outlines or complex building methods, good appearance was considered important, and an agreeable blend of grace with simplicity was achieved.

The first model, although heavy, flew extremely well and had only minor problems. The Mk. II here presented has been refined slightly, both in its force arrangement and in structural design, and can be made with confidence by the relatively inexperienced R/C fan. I would say that, if you can build and fly a Kaos, you are ready for this model.

Some of the more interesting aspects of the Duellist II's design might merit some explanation. For instance, I did *not* bring the nacelles as close as possible to the fuselage. Normally, twins use this feature to minimize the swing which occurs when one engine quits. While I don't argue with this logic, appearance is poor. Moreover, it seems like a cop-out to design a twin and then go as far as possible to avoid an offset-thrust situation. Instead, I placed the

Our famous super Scale man has entered the Pattern lists with this twin-engined beauty. Dave has always had an eye for looks, and combined this quality with the always-necessary functional qualities needed to win!

nacelles where they looked right, and prepared myself for heavy control corrections when one burner went out. In fact, nothing violent happened at all, and only a moderate turn resulted when one engine quit. This is easily overcome by throttling back the remaining engine to about three-quarters power, and full control is maintained, with turns either way, and landing approaches are normal. Indeed, it probably is fair to say that one of the most fascinating and pleasurable experiences is to learn what you can do with the ship with only one motor running. After you get used to the ship and come to understand its personality, you can amaze your buddies with one-engined four-point rolls, inverted eights at a near-idle, wonderful stall-turns, etc. Who is this guy, Bob Hoover, anyway?

"What about sidethrust?" you ask. (Everyone does.) Well, I don't use any, and it is not needed on this model. This is not to say that 2 degrees or 3 degrees of "out-thrust" (left on the left engine and right on the right engine) would hurt. I'm sure it wouldn't. Neither do I use any downthrust—this was used on the original ship, but eliminated for the Mk. II because it spoiled the takeoffs and the flight smoothness during power changes.

Take a look at the ailerons. They are basically strip ailerons (easy to build), but are placed well inboard, compared to a typical single-engine job like a Kaos. Thus, they are working directly in the prop slipstreams and are very powerful, despite stopping some 10″ short of the tip. Until I did this, the vibration from the wing-mounted engines kept breaking the aileron hinges at the tip end. This problem has now been licked without reducing control effectiveness. Nevertheless, it is always a good idea to routinely check the hinges on any R/C model, and a twin especially so.

With a wing span and area of 69″ and 850 sq. in. respectively, the Duellist II is intended for .19 up to .40 engines. Weight is around 9 to 9½ lbs. with retracts. (The original Duellist weighed 12 lbs., mostly due to noseweight required when the C.G. came out too far aft. The Mk. II's reconfigured nacelles and other detail changes have solved this difficulty, and the C.G. now comes out within a hair either way, "as built.")

Using .19 engines, the newcomer to R/C or to twins will have a "pussycat." We used the new K&B .29's (4.9cc), as the photos show, and this is enough power to pull the airplane up in a true 90 degree vertical climb indefinitely. However, an interesting point arises in that, under a new proposal, the AMA pattern aerobatics contest rules, formerly limited to .61, will be opened up to twin .40's. For some reason, probably connected with the greater area of slipstream generated, a twin gets greater performance than the same total displacement gives in one engine, *especially in the vertical maneuvers, where raw pulling power is needed.* With two high-performance Schnuerle-ported .40's such as the O.S. or the new K&B, this model would be a "tiger."

Not being a pattern flier myself (scale leaves me insufficient time for serious essays into anything else), but being an ex-U/C stunt flier, and thus familiar with the concepts of precision aerobatics, I feel that an interesting case might be made for using a twin-engined model with powerful engines turning low-pitch props. Such a model might have *total* vertical performance (zero slow-up in a vertical climb), even at a quite low air speed by current standards. Whether such a model would rival the *impression* created by a 120 mph, .60-powered, single-engined ship is debatable, but to a purist, this would be a side issue, and not relevant to the central point of comparative performance. I'll leave this for others to ponder.

To return to the Duellist II, in consideration of possible pattern application, the airfoil is symmetrical, but the maximum thickness is well forward, and the L.E. radius quite large. This dictates a forward C.G. position, and results in very agreeable stall characteristics without recourse to washout. The model can hang in a near-hover, maintaining full aileron control.

Structurally, the design is entirely normal, and will present no difficulties whatever. The wing is of stressed-skin type, the nacelles being added after completion to maintain continuity of the skin. The straight L.E. makes it simple to line up the nacelles using a triangle. For simplicity, the main retracts are installed in the wing in the normal way, rather than in the nacelles.

The streamlined-section fuselage is very easily built with strict accuracy of alignment, owing to a new technique. This, a variation of the time-honored "rib-tab" wing-building method, but adapted to the

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This three-quarter rear view shows the sleek, low lines of the Mk. II version of the Duellist. Dave says it's cleaner than the original.

DUELLIST MK. II—CONT.

fuselage bulkheads will, I feel sure, be widely copied and become a standard fuselage-building method in the future, especially for scale models. Apart from the trueness of the resulting fuselage, a major benefit lies in its adaptability to streamlined cross sections without complex building operations.

Prospective builders of this design are recommended also to this author's two-part article on twins in the June 1977 and Summer Bonus 1977 copies of *Scale R/C Modeler,* where a number of operational and flying hints were presented.

CONSTRUCTION

Wing. The wing is of low aspect-ratio, to provide a steady platform for the two engine nacelles. Thus, it has a wide chord, and four spars were considered desirable. The wings are built flat on the bench: one first, then this is tipped up to the dihedral angle (3 degrees, or 4¼" under one tip), while the second wing is made onto the first. A simple jig, consisting of a strip of ¼" sq. balsa, pinned down to the plans in the position indicated, holds the ribs level to the bench while building.

When the basic framework is completed, the internal items of hardware (retracts, servos, motor-control bellcranks) are installed. The wing is then skinned completely with 3/32" sheet. The nacelles can now be added, and motors installed. The simple strip-type ailerons and the wingtip blocks complete the job. Don't be tempted to add lots of plywood dihedral-braces, etc. The wing engineering is correct as shown, and added parts can only make it heavier and weaker. The nacelles are glued directly onto the outside of the stressed-skin wing. The mid-nacelle arrangement allows for plenty of gluing surface, and vibration has never loosened anything. Note that the engines (both normal counterclockwise running) are set straight ahead. "Midwest" brand spinners are recommended.

The whole wing/nacelles unit was covered in ¾ oz. glass, and finished in resin and K&B Superpoxy or Imron, but Mono-Kote could be used if preferred; strength is sufficient without covering.

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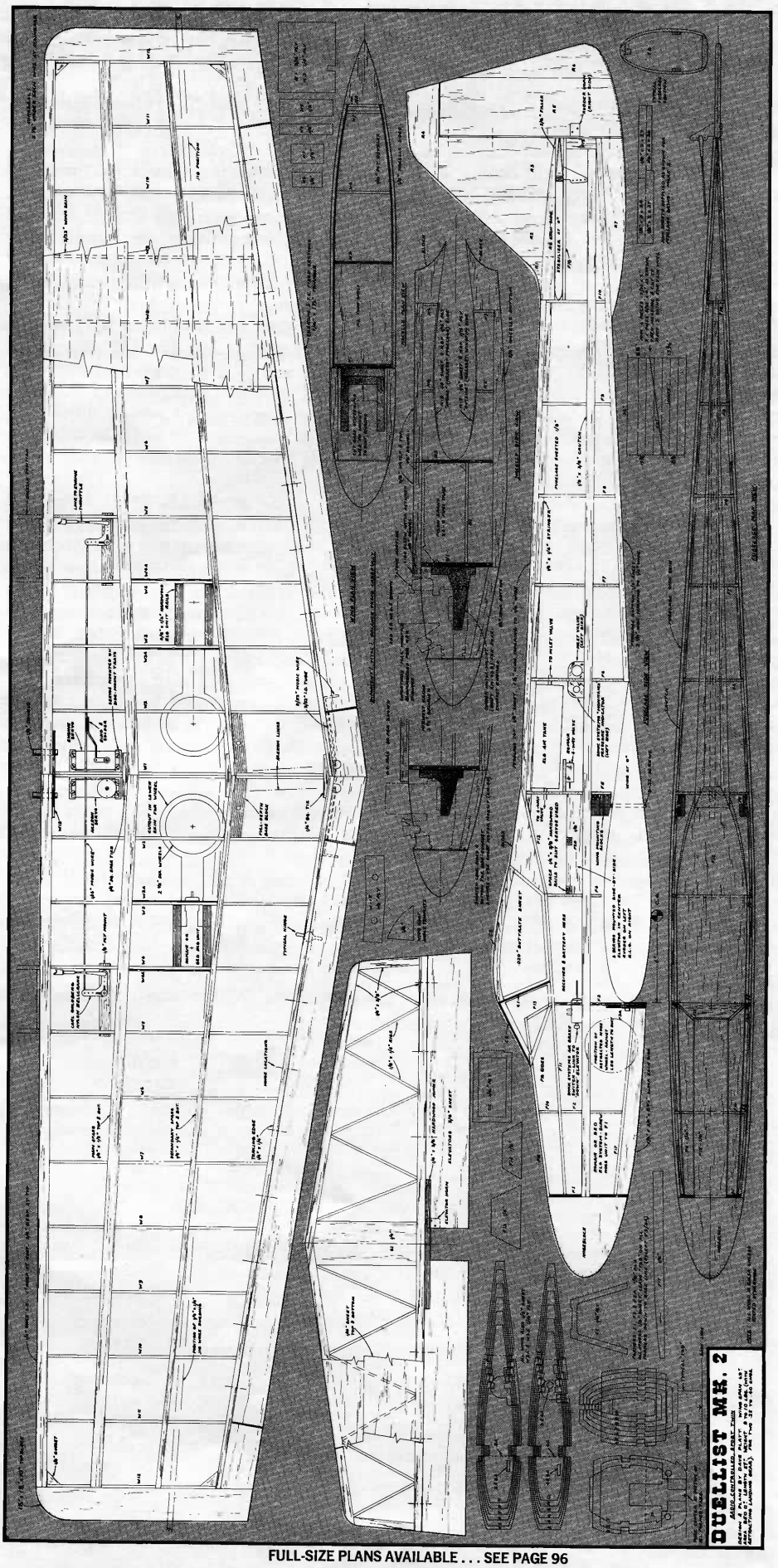

FULL-SIZE PLANS AVAILABLE . . . SEE PAGE 96

Pylon Pit Patter

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quality-control standards can be maintained without automation.

It was interesting to note that all component assembly work was done with the associated drawing in front of each worker. By the very nature of repetitive assembly work, this seemed strange. All the people there assured me that they could do their jobs blindfolded, but the drawings are used each and every time as a fail-safe checklist. This same practice is used by commercial pilots, even though all of them have gone through the checklist procedures thousands of times. For every gear-up landing, there is a pilot who thought he had the checklist memorized. Every now and then, a model takes off and disappears over the horizon with a radio that was never switched on.

Various steps along the production line have tolerance checks on a 100 percent basis, and subassemblies are constantly being tested and electronically measured before final assembly. Servos are checked for linearity and centering accuracy, and then put on an exerciser that simulates actual use. RF boards are "burned in" before final assembly to catch any initial component failures. Some of the technical procedures were beyond my understanding, but the overall impression was that Pro Line goes to great lengths to insure reliability and performance in its products.

Before leaving, I was shown the new Custom Competition radio, which contained many new features. Another new stick assembly has been designed using a "single scissor" for centering tension. It is unbelievably smooth and accurate. The encoder, the electronics which translate stick movement into signals, is totally redesigned, using Op Amps and CMOS shift registers that allow greater reliability and programmable control functions.

The new encoder board contains some 160 separate components. I questioned how something that looked so complex could actually be *more* reliable. The key to this approach is that a component failure in this design will not shut down the entire radio. Production costs are higher than standard IC circuits, but when an IC fails, scores of transistors, resistors and needed voltages drop out at one time. If something in the first channel goes bad, all the rest stop working, too.

Years ago, there was a television commercial showing a certain brand of color TV continuing to operate as a dozen or so of its electrical components were removed. Important parts, but not critical. This "discrete component" design may be the way to go . . . allowing the whole device to go on working, even without some of its parts. Jim Fosgate started Pro Line nine years ago using this discrete circuitry, and there are many old, old white boxes still working today without a glitch.

That wraps up our memorable visit with the friendly folks in Phoenix. Our thanks to Jerry Bonzo and the staff at Pro Line for accommodating the intrusion, and my apologies to the ladies in production for the thoughtless picture-taking without ample warning for them to get to hairdressers. You all looked beautiful, anyway! ■

Field and Bench

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MODEL.

Nose heaviness was corrected by moving the tank back towards the C.G. until the plane balanced at one-third back from the leading edge of the wing, without the clay. The flight pattern with the correction differed little from the first flights.

Once you see the sun shining through the doped tissue, you'll be hooked forever on this type of model. If the sale of these models is any indication of interest in "old-time" models, perhaps we should try to twist the editor's arm to reproduce Earl Stahl's designs in *M.A.N.* every once in a while?

By the way, there is no reason why the model (slightly beefed-up around the nose and landing gear) can't be powered by a Cox .01 or Pee Wee .02, and fitted with an Ace "Baby" single-channel outfit, for a change of pace for you R/C'ers.

I recommend the model and engine highly. Try them. You'll enjoy the change. ■

Duellist Mk. II

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Fuselage. Notice that all formers are cut leaving a supporting "tab" on the bottom. These tabs have a center line marked on their bottom edge. All formers are erected vertically on the fuselage plan-view, while the crutch and top pieces are added. After it is removed from the bench, the tabs are cut off and the bottom pieces are glued in place to complete the basic fuselage. Internal hardware follows next and, when completed, the fuselage side-skins are added. The result is a perfectly accurate and pleasantly streamlined fuselage, from a minimum of effort and time. As I mentioned in the main text, I feel this method beats the "top half-shell, then lift, then add bottom shell" method of building a circular or oval-sectioned fuselage. It is quicker by far, less complicated, and has equal accuracy.

Tail. The horizontal tail is merely a stripwood frame, skinned top and bottom with 1/16" sheet. Elevators from 3/8" sheet complete the job. Vertical surfaces are cut from 1/4" sheet, and are equally simple. Don't use any hard balsa at the tail end.

First Flights. Conduct a careful pre-flight check. Examine the wing for warps, check for correct C.G., and run both motors until satisfied with realibility at all speeds.

Have an experienced pilot make the first flight, just in case. Also, I suggest this first flight be limited in duration to 2 or 3 minutes. Land and check everything for integrity; then, if all is well, go ahead and have a ball! I think you'll truly enjoy the experience of building and flying a Duellist II.

Ed.: Dave has announced a custom kit for the Duellist II—see ad on page 97. ■

R/C News

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you'll have. There was a small error in the article: I referred to a spray material that absorbs oil, and called it "KD-9." You'll never find it under that designation: instead, try for "K-2R Spot Remover." Many thanks to those of you who offered kind words on the January article.

If you're not up to fully checking your system out, as a minimum, give it a good operational check before attempting to fly. This simply means a full charge and a series of simulated flights as you sit and watch television. You should move the servos at approximately the same frequency as you would while flying. A good method is to simply sit back and visualize flight after flight, giving commands and making corrections as your imagination dictates.

Why all this nonsense? Simply because many crashes seem to occur when equipment is put back into operation after a long winter of inactivity. You'll find out quickly whether battery capacity has deteriorated, whether pot wipers have developed problems from humidity, dust, pressure or wear, whether marginal components have decided to call it a day. Battery cycling on an automatic device doesn't give you insight into anything except your electrical supply: you must exercise the entire rig to turn up any other problems.

If your simulated flight turns up equivalent time and function as your previous season's use indicates, you are probably in good shape for some real flying. If operational times are much lower, or you see some hiccups that weren't there last year, package the rig up and send it back to your manufacturer for service. Don't forget, no radio can solve its own problems; it doesn't improve—it only gets worse. Radio problems are a lot better in your workshop than on that first flight with your newest pride and joy.

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One of the most repeated questions I see is on the subject of landing gear trim for tail-dragger aircraft. This probably stems from an increased popularity of biplanes that, most often, use two-wheel gears and an increasing number of two-wheel designs a la Super Circus and Migi-Ball. C. David Evanson of Anchorage, Alaska, is representative of those asking the question: "'R/C News' for May (1977), page 39, states that a bit of toe-in on the wheels of a tail-dragger can give takeoff tracking as if on rails. May I ask you if you have tried it both ways on one particular model: That is, with definite toe-in and again, with definite toe-out?

"It has always seemed to me that toe-in on a full-sized aircraft having conventional landing gear (i.e., tail-draggers such as Aeronca, Cessna, etc.) is abominable and leads to tuck-under and ground loops, unless one is very careful."

Well, David, friends of mine who are involved in full-scale work don't wholeheartedly agree with you. However, assuming you are right, that which you relate as substantiation for toe-out in full-size aircraft may be valid where actual shock travel is sufficient to radically alter the wheel camber and the gear's track. But in our relatively rigid music wire (or aluminum sheet) landing gears, the only items of major importance are rotational speed of the two wheels and their relationship to each other.

First, a model's conventional (actually, quite unconventional, when one considers how few two-wheel models we see in comparison to trike gears) must be correctly placed in relation to the aircraft's center of gravity. This placement should be as close as possible, while still not so close as to cause a nose-over on every landing. Typically, the wheel's axle should be directly under the wing's leading edge; slightly forward of the lower wing's edge on bipes. This placement permits very positive rudder control, since there is no imbalance for the rudder to overcome. As you move the gear forward, it becomes much harder for the rudder/tail-wheel combination to overcome any ground loop that might start. It's necessary to hold some up-elevator while a takeoff run starts, to hold the tail down and overcome any nose-over tendency that could develop when the landing gear is near the C.G.

Now to the matter of toe-in: when a ground loop develops from any cause, the outside wheel simply is rotating faster than the inside wheel. Problem requires a way to slow that wheel down to bring it back to the same speed as the inside wheel. This is tough to do accurately with rudder, and, very quickly, the model is all over the runway. An interconnecting axle does it, but this solution is not very scalelike, except on WW I designs that have a small subwing between the wheels.

Toe-in, however, does what is necessary very effectively. When toe-in is used, as the outside wheel transports forward of the inside wheel, it begins to drag on the runway surface. At the same time, the inside wheel moves closer to being parallel with the line of travel and picks up speed. Both actions have a tendency to automatically straighten the aircraft's run. David, that's how I see it, and the sketch should help. One thing sure: in practice, on any model I've ever flown, toe-in definitely helps.

I *have* tried it both ways: my Aeromaster was a bear to takeoff with toe-out and a pussycat with toe-in. Same thing is applicable, though less necessary, to the main gear of a trike arrangement.

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Last month, we spent a good deal of time discussing quarter-scale aircraft. This whole area of big aircraft has exploded, and I thought I had seen the limits. Not so—there is now a powered hang glider that is such a