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CONSTRUCTION

All that is required is a good flat surface 60' or so long to which a *3/16* sheet of balsa can be securely attached with pins. First step is to make up the six bulkheads, B1 through B6, as shown in the various x-sections or, the plan. B1 Is made of two pieces of 1/16" plywood. B2 is the firewall and is made of 1/4" plywood. B3 at the leading edge of the wing is made of 3/16" balsa and 1/16" plywood. The rest of the bulkheads B4, B5, and B6 are made of *3/16"* balsa and 1/16" plywood. Note the pushrod guide on B5. Also note that B6 is temporarily made deeper than needed and later cut away on top after the fuselage sides have been attached. Next make up the two 3/16' balsa sheets which run underneath the turtle deck and above the bottom block. The top one runs from B3 to B6 and the one on the bottom runs from B3 to the rudder post. Their outlines can be plotted by referring to the widths shown in the various bulkhead drawings at their respective locations. On each of the 3/16" sheets mark a center line as well as the bulkhead locations. In addition, draw the center line on each bulkhead on each side. Align the top 3/16' sheet to a line drawn on your working surface which is about 60" long and secure it in place with pins. Attach the three bulkheads B4, B5 and B6 to the sheet using the various centerlines as references for their alignment. Remember that the fuselage framework is being built *upside down.* Make sure the bulkheads are all square and liar their centerlines are all in alignment. Next make up the motor mounts from 1/2" hardwood and assemble them together with the three bulk-heads B1, B2, and B3, along with the fuel compartment floor. Do this separately from the rest of the structure. Make sure mounts are parallel to each other and square to the bulkheads. Now attach the two sections together using the line previously drawn on the working surface as an alignment reference. Note that the engine mounts should be parallel to the working surface. Next attach the 3/16" sheet which runs along the bottom of the fuse to the bulkheads and temporarily let it run forward and attach it to bulkhead B3 at the leading edge of the: wing. The section of this sheet which is within the wing well will later be cut away after the sides have been attached.

Now the basic fuselage structure may be removed from the working surface for the rest of the construction. Attach the stringers in the fuel tank compartment to which the fuselage sides will be attached. Bevel them to match the contour of the bulkheads. Also bevel the upper and lower 3/16" sheets to match the contour of the bulkheads. Next make up the 1/8" fuselage sides with the 1/32" plywood doubler which runs from the wing trailing edge at B4 forward to the front of the firewall at B2. These sides should be made somewhat oversize in height since they will be curved when they are assembled to the fuselage framework. Attach the fuselage sides to the framework. You should be able to do this without spoiling the fuselage alignment. Dampen the outside surface with ammonia and water if you think bending them dry is going to be a problem. Once the sides have been attached to the framework, trim their top and bottom edges even with the two 3/16' sheets in preparation to attaching the top and bottom blocks. However, before the blocks are attached, the *3/16"* sheet within the wing well should be completely cut away and the rest of it lightweighted as desired. At this point the rest of the construction is fairly straightforward and shouldn't present a problem to anyone who has built a kit-type Pattern airplane.

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The Mach 1, of course, should be built with as little deviation from the plan as possible, although there does seem to be some tolerance in its flying characteristics for building errors. A few I've seen which had fairly serious looking alignment problems still seemed to trim out and fly OK. Of the three I've personally set up, none required weighting of the wing tips and all trimmed out with the elevator, ailerons, and rudder in the neutral position. One of them, which I didn't build wouldn't spin with the normal elevator throw until a gap in the elevator hinge line was sealed.

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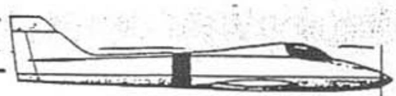
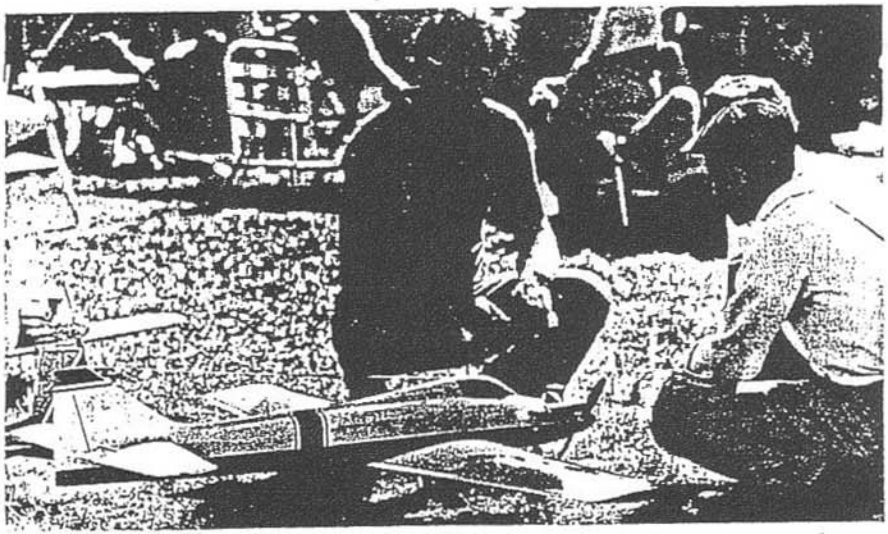
And here we have the Champ himself with the bird that is doing it all so very well. This particular shot was taken at 72/73 Tangerine contest.

MACH 1



BY NORM PAGE

Model Airplane News continues its Parade of Champions with this latest entrant in the contest arena—imagine a plane that can win the Masters, Tangerine and Southwestern Champs in the short period of five months!



• I don't know how much "masterminding" really went into the design of the Mach 1, but I like to think that maybe a little bit did, anyway, especially in view of its contest performance record over the last couple of years. Since its introduction in the spring of 1971, it has placed first in nearly every sanctioned contest entered. Of the 12 contests entered during 1971, there were ten firsts, one second and one fourth. Since the end of 1971, the record is a little better. All contests entered were won except one, the Nats, where it placed fourth as it did the year before. Of course, the best win to date was the 1972 Masters in Huntsville, where the U.S. FAI Team was selected. This win, I suppose, required what one might call a little bit of masterminding.

At first glance, the Mach 1 might look like a conventional design. However, closer examination will reveal several departures from the usual Pattern shop used today. The fuselage is 57" long and the wing area is 715 sq. in. –

(Continued on next page)

MACH 1 . . . CONTINUED

and that, I think you'll agree, is a large airplane in anybody's book! As a comparison, the average Pattern ship used at the Huntsville Masters contest had a fuselage length of 50 in. and a wing area of 674 sq. in..

Another departure from the usual is the relatively high taper ratio of the wing, nearly 2:1. Again, the average Pattern ship used today rarely exceeds 1.5:1. In addition, the Mach 1 has a wing which has a nearly straight leading edge. The only other Pattern ship around which sports a somewhat straight leading edge is Phil Kraft's Quick Fly. Also the low aspect ratio of the Mach 1 is fairly unusual. For an area of 715 sq. in., 62 in. is not very much span.

In designing an airplane such as the Mach 1, consideration was given to certain performance characteristics in order for the finished design to be as competitive as possible. Some of these performance characteristics were general and some were specific in that they pertained to the airplane's behavior in a particular maneuver. The general performance characteristics are somewhat more obvious than the specific performance characteristics and will be discussed first.

Probably the most important general characteristic is smoothness of flight. If you are using a design which exhibits smoothness of flight, then you can go on and achieve gracefulness in your pattern. Smoothness and gracefulness together are two things that the judges are looking for in every one of the maneuvers. Next to smoothness of flight, predictability is probably the second most desirable characteristic. The ability of an airplane to behave the same flight after flight is a valuable and indispensable asset. Predictability adds greatly to the potential of achieving precision and consistency in the performance of your maneuvers. Smoothness and predictability, to a certain extent, tend to go hand in hand. You achieve one and you tend to get the other.

Another general characteristic important to have is for the design not to be too critical, "critical" in the sense that its performance will be sensitive to a mediocre engine run, for instance, or to the setting of the trims should they be off just a little, or to your timing should it be off a bit, for some reason or other, or to the C.G. placement such that the weight of the fuel burned off during the flight seriously affects its flight characteristics, etc. *Smoothness of flight and predictability without being critical, which leads to gracefulness and precision in the performance of your pattern, are essential to a good competitive airplane design.*

So much for the general performance characteristics. Let's now take a look at some of the specific performance characteristics. They're less obvious and a bit more interesting to discuss. For a couple of reasons, the ability to perform good rolls was one of the primary performance considerations in the

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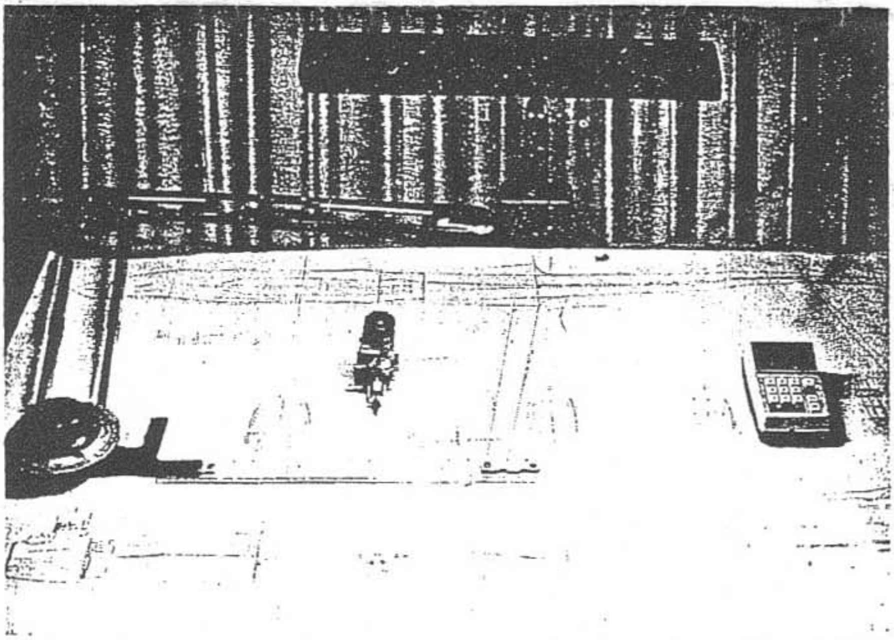
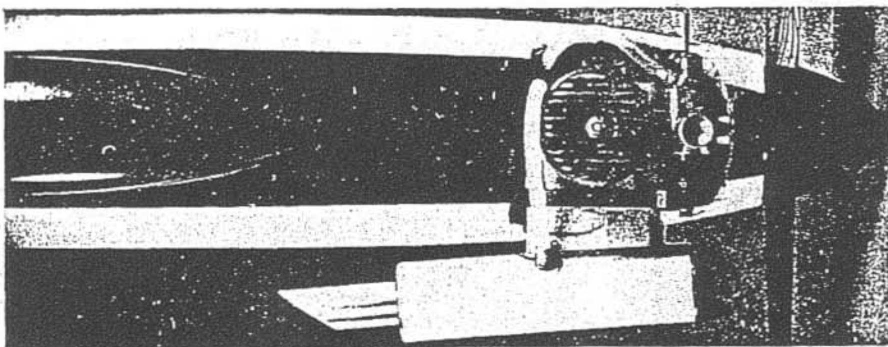
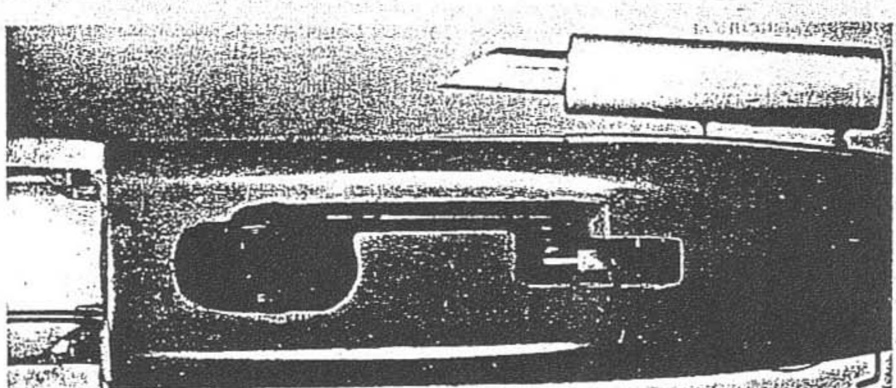


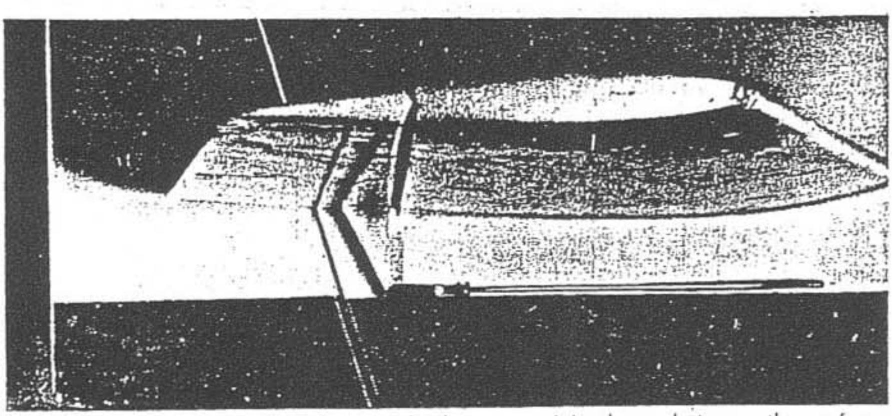
Nothing like a computer to help get you the answers. Care is important when working out details.



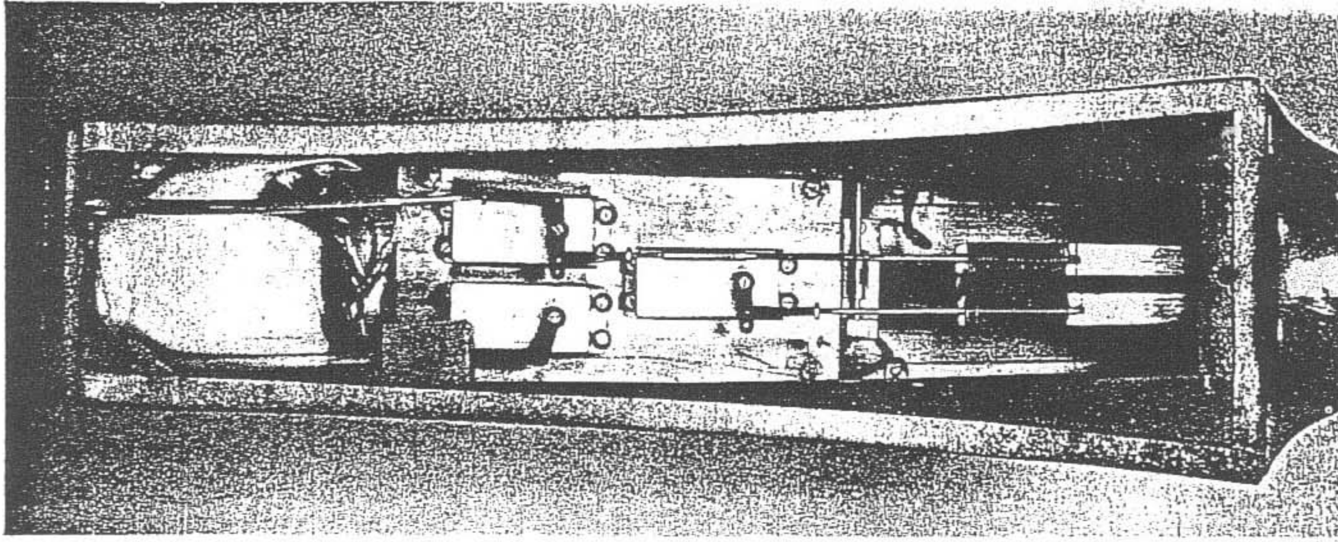
No frills here, just the bare opening with clearance for tuning—note manifold pressure.



Pro Line retracts, again no frills, just the bare essentials necessary for installation.



V'ed leading edge, as discussed in article, keeps a minimal gap between the surfaces.



A look inside the fuselage discloses plenty of room to accommodate all the required essentials—note jam nut used to lock Quik-links.

MACH 1 . . . CONTINUED

design of the Mach 1. If you look at the distribution of the K factor points for the various FAI Pattern maneuvers, you'll notice that of the six most difficult maneuvers with the higher K factor (15 points), half of them are rolling, one looping and the other two are combinations of the two. I think it's pretty apparent that there is quite a bit of emphasis on the rolling maneuvers. At least, they are apparently considered to be somewhat more difficult than the rest. In adiition, I've noticed that over the years there has been and still is, to a certain extent, a real lack of skill in the general performance of the slow and four point roll. I feel this is primarily a result of Pattern ship designs which generally handicap the flyer in the execution of these maneuvers. The problem centers around the interaction of top rudder with the roll rate or, in the case of the four point roll, where it interferes with holding the vertical points. Because of this interaction of controls, you see a lot of flyers doing slow and four point rolls using little or no top rudder and compensating with extra up and down elevator when the wings are more or less level. This, of course, causes the airplace to deviate from a level straight path, which, according to the rule book, is a basis for downgrading. Moreover, in an effort to minimize these deviations, the maneuver is often performed quite rapidly, making it look quick and somewhat lacking in gracefulness. This interaction of the rudder with the roll is a flight characteristic which I feel is intolerable if you are not to be handicapped by the design you are using in competition.

Another area of concern in the design of the Mach 1 was the stall characteristic, particularly as it pertains to spin entries. Here again, I've noticed over the years that there has generally been a real lack of skill in the execution of spin entries. It seems as though the only thing anyone is interested in these days is the spin exit heading. As a result, you see a lot of extremely sloppy spin entries. The problem centers around the ability of the airplace to stall without dropping a wing. A lot of designs which have a tendency to top stall won't do this consistently. And if you haven't noticed, this is a requirement in the performance of the spin maneuver. The rule book, under the description for that maneuver, says the airplane "pulls up into a stall and commences the spin." It doesn't say the airplane "snap-rolls out of a nose high attitude into a spin," which is the way you see it done by a lot of flyers. As a matter of fact, at the judges' checkout and briefing at the World Championships in Doylestown

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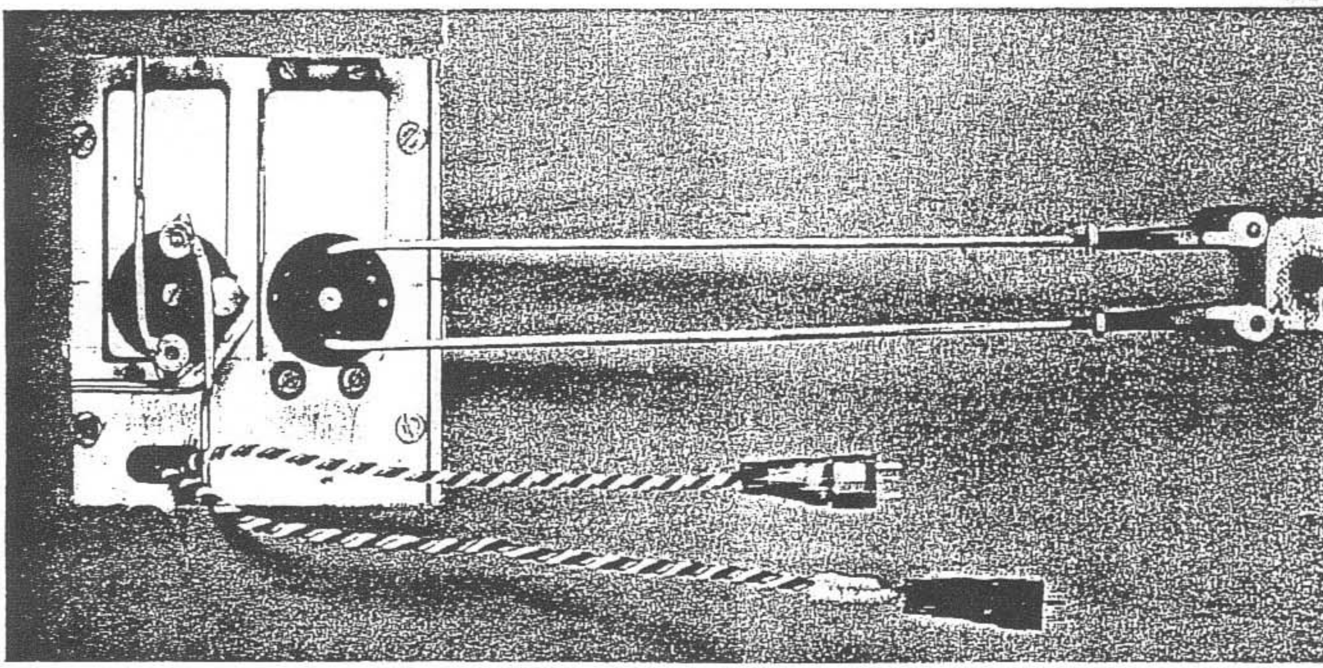

Close-up of aileron and retract servos—Z bend used for aileron pushrods, and over and under method for 180 degree retract linkage.

Mach 1

(Continued from page 30)

(1971), about half of the judges were giving zeros for the spin maneuver if they did not see the airplace drop its nose with its wings level during the stall before entering the spin.

Looping maneuvers, of course, are important, too, and consideration was also given to their performance in the design of the Mach 1. Generally, loops require the elevator response to be smooth in pitch and that the action of the rudder and ailerons be fairly gentle, particularly around neutral. Here again, as with the slow roll and the four point roll, there should be no tendency for the use of rudder to cause the airplane to roll. The reason for this is that more often that not you'll be required to perform your maneuvers crosswing and, as a result, the tendency to drift will have to be compensated for primarily by the gentle use of rudder. And if the use of rudder in the loop causes roll, then you've again got an intolerable problem.

So, with these general and specific performance characteristics in mind, the Mach 1 design evolved. Its evolution took a lot of thought and time in order to be sure its configuration would be able to achieve the desired flight characteristics. At this point it might be interesting to discuss the various aspects of the Mach 1 design in order to understand both how it evolved and at the same time how it works.

Strangely enough, one of the first considerations in the detailed design of the Mach 1 was *its size.* The decision to make it relatively larger was made basically for two reasons. First, over the years, I've noticed that the larger Pattern aircraft seem to have extremely good visibility from a judging viewpoint. As a result, the placement of the maneuvers distance-wise doesn't seem to be nearly as critical as it is for the smaller aircraft. You get the smaller aircraft just a little too far away and you give the impression you are trying to hide the maneuver. It becomes difficult to tell exactly what the airplane is doing, whether its wings are level, or if it is tracking on a straight line, and so on. A little closer in and you're likely to exceed the 45 degree height limitation. Secondly, the larger Pattern aircraft has the additional advantage of improved aerodynamics . . . the larger they are, the better they fly. What's the smoothest flying airplace of them all? It's the Boeing 747, of course, the largest of them all. I think Vic Husak recognized this principle and employed it in his large Pattern designs like "Mr. Slick." It's a little like a ship on an ocean of waves — the larger the ship relative to the size of the waves, the smoother it rides.

One problem with the larger Pattern aircraft is that they develop more drag and as a result, tend to be slower. So consideration had to be given to the speed. I wanted a large airplane which would still cruise fairly fast and perform relatively large maneuvers. Since the wing on the average Pattern ship has about five times the frontal profile area of the fuselage, it is the main producer of drag, especially when you take into account the additional effects of parasitic and induced drag. Thus it was decided to keep the wing fairly thin in an effort to keep the drag down and the speed up. However, one of the problems you encounter when you use thin airfoils is that they are too efficient, resulting in too flat a glide to make reasonable approaches. A flat glide increases the difficulty of hitting the spot during the landing perfection maneuver. Hence a low aspect ratio was chosen. The low aspect ratio wing is quite efficient at high speed, but relatively inefficient at low speed. In other words, at low speed the low aspect ratio wing tends to develop more drag relative to its lift than a high aspect ratio wing. This is probably

because the tip losses with a short wing tend to involve more of the wing area at low speed. Anyway, in the case of the Mach 1, once it is slowed up for an approach, it has a nice angle of descent. This means, of course, that you must first bleed off the excess speed before you try to plan your approach. Once you do, it approaches and lands normally.

Fast, thin winged airplanes don't always have the good stall characteristics so important to really nice spin entries and landings. In an effort to assure reliable wing level stalls, the leading edge of the wing was kept nearly straight. This tends to reduce the possibility of tip stalling and increases the tendency for the wing to stall at the root first, which is what we want. Sweeping back the leading edge has the opposite effect and tends to induce top stalling. This in turn tends to cause one wing or the other to drop first during a stall. To counteract this tendency, a thicker percent tip airfoil is employed on many of the swept wing designs in use today. The thicker tip lowers the stall speed of the tip, or more properly, increases the angle of attack at which the tip will stall. It's a little like having wash-out, except it also works upside down. In addition to no tip stalling during a normal stall, I wanted the Mach 1 to be able to tip stall easily with the use of rudder to assure that once it had been stalled, it would go a spin. For this reason, a high taper ratio was chosen to be used with a nearly straight leading edge.

As a result of this combination, you get a reliable stall and spin entry along with an added bonus. Recovery from the spin is almost instantaneous. As soon as the rudder is released the spin is broken and recovery can be accomplished in one eighth of a turn without reversing the controls. This, of course, makes hitting the entry heading with the exit heading a lot more reliable. One thing I didn't anticipate about the way the Mach 1 spins, is its gentleness. This, along with its stall and spin recovers characteristics, makes the spin an outstanding maneuver for the Mach 1.

For the same reason the Mach 1 was made large for visibility, the wing was placed on the bottom of the fuselage. In this location, the wing's visibility is much greater for both contestant and judge. It affords the judge a lot better opportunity to see the wing at all times, making it easier for him to determine whether they were level in loops, or on takeoff, or in a horizontal eight, and so on. It's a little like the placement of the maneuvers. You are supposed to place them so that the judge can best determine their quality. Not too close, not too far out, not too high and so on. In the case of the airplace as it presents itself in the sky, the attitude of the wing during the maneuver is one of the things the judge uses as a reference in determining the value of the maneuver. Like the placement of the maneuvers, I think the wing should be placed where it is the most visible and this a good reference for the judge. Some flyers take the opposite viewpoint. They hide it in the middle of the fuselage so that the judges can't see the attitude of the wing a good part of the time. This to me is like hiding the maneuvers by poor placement. Along the same lines, the nearly straight leading edge of the wing of the Mach 1 affords an additional degree of visibility and reference for the judges. The same, of course, would also be true if a straight trailing edge were used.

In addition to visibility, the placement of the wing on the bottom of the fuselage has some aerodynamic advantages. It developes less drag there than it would if it were placed either in the middle or on top of the fuselage. The reason for this has to do with the drag resulting from the flow of air around the fillets at the intersection of the wing and fuselage. In level flight there is greater pressure on the bottom of the wing than on top (otherwise it wouldn't be flying). It's probably more proper to say that there is less pressure on top of the wing than on the bottom. In any case, the low wing configuration offers the least amount of interference for the air flowing around the root of the wing where the pressure is the greatest (no fillets or fuselage below the wing). A shoulder wing airplace would have slightly more drag and a midwing airplane would have the most drag of all (since there are interfering fillets above and below the wing). The only advantage in raising the wing I can see would be to bring it nearer the thrust line. However, the same thing can be accomplished by lowering the thrust line which is actually what was done with the Mach 1.

As mentioned before, an area of primary concern in the design of the Mach 1 was its performance in rolling maneuvers. The key to the performance of good slow and four point rolls is to use the rudder so as not to have any effect in the roll axis. Both rudder and dihedral tend to result in rolling forces. The rudder's tendency to roll the airplace is determined by the position of the center of pressure of the rudder and vertical stab combination relative to the roll axis. In general, if the center of pressure of the rudder and vertical stab combination is above the roll axis of the airplace (which is the usual situation), then the use of rudder will tend to cause roll in the opposite direction to which it is applied. In other words, right rudder would tend to cause left roll and left rudder would tend to cause right roll. The rolling tendency can be increased by raising the position of the center of pressure of the rudder and vertical stab combination, or reduced by lowering it.

The tendency for dihedral to cause roll is dependent on a couple of things. How far the wings are from level and whether there is any yaw present (which could be caused by rudder). While dihedral alone will tend to roll an airplace level from a bank, it is the effect of dihedral in the presence of yaw caused by rudder that is of the most interest. A low wing airplace with positive dihedral in level flight will tend to roll right if caused to yaw right, and to roll left if caused to yaw left. As you can see, in the usual Pattern airplane, the tendencies of rudder and dihedral to cause roll are opposite in effect. If the design is proper, they should balance each other in nearly all attitudes, but only when rudder is being used. The balance is particularly important when the wings are in either a level or vertical position. An airplane in level flight should remain wings level when rudder is applied. For example, if right rudder is applied to an airplane in level flight, its tendency to cause left roll should be counteracted exactly by the dihedral's tendency to cause right roll in the presence of right yaw. The same sort of balance should also be present in a knife edge position. The tendency of left rudder, in a left wing high knife edge position, to cause right roll should be counteracted exactly by the dihedral's tendency to cause left roll in the presence of left yaw. As you can see, under these circumstances, there is a convenient balance that occurs when the amount of dihedral is proper for the location of the center of pressure of the rudder and vertical stab combination above the roll axis. In the case of the Mach 1, enough dihedral was used so that the airplane would groove, hands off, right side up. But not so much that it wouldn't also groove upside down. The rudder area was then placed to produce the balance in relative rolling effects.

The rest of the Mach 1 configuration is fairly straight forward. The thrust line was kept low so that it would be nearly in line with the wing. Actually it passes through the wing. This situation aside from being good aerodynamically, is convenient for the use of a flat fuel tank with the upright engine mounting. The low wing placement in addition to other advantages previously mentioned, is also convenient for the mounting of one servo in the wing to operate all the retract units. Moreover, because of the wing's nearly straight leading edge, not much of it extends forward forward of the C.G. and as a result there is plenty of room up front to install the tank and mount the nose gear retract unit without the necessity of having to notch the wing's leading edge for the wheel well.

One consequence for having lots of room forward of the wing is that people often think the Mach 1 has a long nose moment and a relatively short tail moment. However, this isn't really a true observation. The tail moment is about twice the nose moment as is the situation with most other Pattern designs. I think the problem arises from the variety of ways in which people measure moments. Common practice is to use the leading and trailing edges of the wing and stab, and the location of the engine cylinder head as references in making these measurments. This, in my opinion, is completely erroneous, at least as far as being meaningful in any way, and particularly for use in comparing various designs. I feel moments should be measured from a point where a center of force is acting to the C.G. of the complete airplace. In the case of the tail moment, it would be measured from the center of pressure (or center of lift) of the horizontal stab and elevator combination (or the vertical stab and rudder combination if you are interested in the tail moment in yaw) to the C.G. The center of pressure for the stab and elevator combination is generally fairly close to the thickest part of the average area chord and tends to move rearward toward the hinge line when the elevator is used. The nose moment should be measured from the prop line to the C.G.

One unusual item relative to the rest of the Mach 1's configuration is its C.G. placement. I usually run my C.G. forward as far as possible without losing any of the airplane's tracking ability. In the case of the Mach 1, this turned out to be somewhat farther forward than any other design I've used to date. This kind of C.G. placement seems to cause dampening in all axes, particularly pitch. This is the reason for the Mach 1's fairly large elevator. As a result of this type of setup, the controls in all axis are quite soft, which means that fairly large control movements are generally required to perform the maneuvers. This takes a little getting used to at first, but in my opinion, is worth it.

So much for the thoughts that went into the development of the Mach 1 design. Let's now take a look at its construction, primarily as it pertains to the method used in building the fuselage straight without the use of a jig of any kind.

CONSTRUCTION

All that is required is a good flat surface 60" or so long to which a 3/16" sheet of balsa can be securely attached with pins. First step is to make up the six bulkheads, B1 through B6, as shown in the various x-sections on the plan. B1 is made of two pieces of 1/16" plywood. B2 is the firewall and is made of 1/4" plywood. B3 at the leading edge of the wing is made of 3/16" balsa and 1/16" plywood. The rest of the bulkheads B4, B5, and B6 are made of 3/16" balsa and 1/16" plywood. Note the pushrod guide on B5. Also note that B6 is temporarily made deeper than needed and is later cut away on top after the fuselage sides have been attached. Next make up the two 3/16" balsa sheets which run underneath the turtledeck and above the bottom block. The top one runs from B3 to B6 and the one on the bottom runs from B3 to the rudder post. Their outlines can be plotted by referring to the widths shown in the various bulkhead drawings at their respective locations. On each of the 3/16" sheets mark a center line as well as the bulkhead locations. In addition, draw the center line on each bulkhead on each side. Align the top 3/16" sheet to a line drawn on your working surface which is about 60" long and secure it in place with pins. Attach the three bulkheads B4, B5, and B6 to the sheet using the various centerlines as references for their alignment. Remember that the fuselage framework is being built *upside down*. Make sure the bulkheads are all square and that their centerlines are all in alignment. Next make up the motor mounts from 1/2" hardwood and assemble them together with the three bulkheads B1, B2, and B3, along with the fuel compartment floor. Do this separately from the rest of the structure. Make sure mounts are parallel to each other and square to the bulkheads. Now attach the two sections together using the line previously drawn on the working surface as an alignment reference. Note that the engine mounts should be parallel to the working surface. Next attach the 3/16" sheet which runs along the bottom of the fuse to the bulkheads and temporarily let it run forward and attach it to bulkhead B3 at the leading edge of the wing. The section of this sheet which is within the wing well will later be cut away after the sides have been attached.

Now the basic fuselage structure may be removed from the working surface for the rest of the construction. Attach the stringers in the fuel tank compartment to which the fuselage sides will be attached. Bevel them to match the contour of the bulkheads. Also bevel the upper and lower 3/16" sheets to match the contour of the bulkheads. Next make up the 1/8" fuselage sides with the 1/32" plywood doubler which runs from the wing trailing edge at B4 forward to the front of the firewall at B2. These sides whould be made somewhat oversize in height since they will be curved when they are assembled to the fuselage framework. Attach the fuselage sides to the framework. You should be able to do this without spoiling the fuselage alignment. Dampen the outside surface with ammonia and water if you think bending them dry is going to be a problem. Once the sides have been attached to the framework, trim their top and bottom edges even with the two 3/16" sheets in preparation to attaching the top and bottom blocks. However, before the blocks are attached, the 3/16" sheet within the wing well should be completely cut away and the rest of it lightweighted as desired. At this point the rest of the construction is fairly straightforward and shouldn't present a problem to anyone who has built a kit-type Pattern airplane. (Ed: *For those who would prefer working from a kit, we suggest Midwest Products' excellent kit of the Mach 1 for only $49.95. Address: 400 So. Indiana St., Hobart, Ind. 46342.*)

TRIMMING AND FLYING

The Mach 1, of course, should be built with as little deviation from the plan as possible, although there does seem to be some tolerance in its flying characteristics for building errors. A few I've seen which had fairly serious-looking alignment problems still seemed to trim out and fly OK. Of the three I've personally set up, none required weighting of the wing tips and all trimmed out with the elevator, ailerons, and rudder in the neutral position. One of them, which I didn't build, wouldn't spin with the normal elevator throw until a gap in the elevator hinge line was sealed.

The effect of having *air gaps* in the various *hinge lines* is something you should be careful to avoid. Any *gap* at all will greatly reduce the effectiveness of the control surface. This can really be a problem with the ailerons, particularly of the *gap* varies from one side to the other. Trimming out an airplace with such a wing can be nearly impossible because of the resulting differences in lifting characteristics of each wing panel. The best way to avoid this

problem is to make sure the hinge lines are all absolutely tight. Actually putting a web across the hinge line is a good idea and is done on some full size aircraft. I shape the leading edge of all my control surfaces to an accurate "ν" and hinge them absolutely tight so that they pivot around the apex of the "ν."

One problem relative to trimming out the Mach 1 is that it is easily built and finished too light. I've built two of them which came out just under seven lbs. and in both cases found their performance to be superior when they grossed out between 7-3/4 and 8-1/4 lbs. It is my personal belief that each design generally has an ideal gross weight at which the airplane's performance will be at a maximum. While I prefer to fly the Mach 1 at eight lbs., I have flown two of them that were excellent at nine lbs.

When the Mach 1 is set up properly, the controls should feel soft in all axes. No more control movement should be used than is just necessary to do the maneuvers. Sensitive controls are of little value in trying to perform smooth and graceful maneuvers. For this reason I usually set the rudder throw up so that full rudder is just the right amount for the slow and four point roll. The elevator is set up so that full throw is just enough to do reliable spins. And the ailerons are adjusted so that full throw produces just enough roll for the vertical parts of the Top Hat. No differential is used.

Of course, in addition to having a good airplane which has been properly trimmed out, competition flying also requires a lot of the right sort of practice. One of the problems with contest flying is that you are never warmed up when it is your turn to fly. Either it's the first flight of the day for you or it's been at least a couple of hours since the last one in the previous round. In an effort to take care of this problem, I've developed a method of practicing which I think is really the right way of preparing for a contest. I call it, as you might guess, practicing cold. All it means is that when I go out to practice, I concentrate on trying to make the first flight a good one. In a sense, I practice flying well without practice. As a result, I usually limit my practice sessions to one or sometimes two flights. If I do fly a second flight, it's usually to try the pattern in a different direction relative to the wind. It may sound as though I don't practice much, but actually I do – it's just that I don't do much of it at one time. I'd much prefer to fly once every day than a couple of dozen times on the weekend. In this way, I think the condition in contest flying of having to fly without being warmed up is simulated to a certain extent in practice. If you can develop the ability to make your first flight a good one, then you'll have the rest of the fellows at a contest trying to catch you instead of you trying to catch them. Moreover, I think this type of practicing tends to result in a lot more consistency in one's flying.

Flying one flight after another in practice, is, in my opinion, of little value in preparation for a contest. However, it is good in the begining when you are trying to get used to an airplane or to learn how to do the maneuvers. Although, once you've attained a fair level of proficiency, I think it's a good idea to restrict your preparation for contests to practicing cold.

Well, that's about it. I've covered everything from the design of the Mach 1 to practicing with the Mach 1. Should you decide to build the Mach 1, I hope you will enjoy its many fine flying characteristics. ■

VTO

(Continued from page 9)

Pete Sotich and VTO tell the story of the West – now let the results speak:

COUPE d'HIVER WEST

1st Jr.	Andrew Bennett	Ann Arbor	242
2nd Jr.	George Bennett	Ann Arbor	197
1st Sr.	Keith Gordey	Chicago	284
2nd Sr.	David Lyjack	Ann Arbor	159
1st Open	William Bennett	Ann Arbor	413
2nd Open	J.T. Watters	Battle Creek	378
3rd Open	M. Richardson	Dayton	367
4th Open	D. Goodwin (Sotich)	England	314

COUPE d'HIVER PARIS

1	G. Gastaldo	Italy	357
2	A. Merritte	France	330 + 359
3	B. Boutiller	France	330 + 267
4	J. O'Donnell	G.B.	330 + 85
7	R. Garrigou ('72 winner)	France	319
11	P. Chaussebourg	France	310
15	T. Medley (Tubbs)	U.S.A.	301
19	F. Monts (O'Donnell)	U.S.A.	298
59	D. Linstrum (Chaussebourg)	U.S.A.	221
72	D. Linstrum (Goodwin)	U.S.A.	198
100	D. Goodwin	G.B.	144