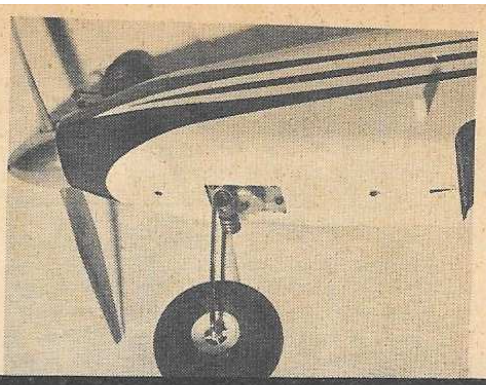
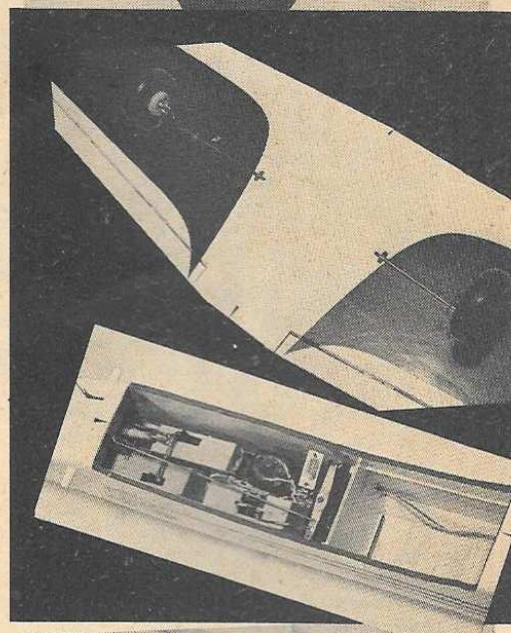
Tom A. Brett of St. Clair Shores, Mich., will be flying his Nimbus for the USA this year. Full size plans available from Hobby Helpers.





Tom Brett tells you about "NIMBUS-2"

his International entry

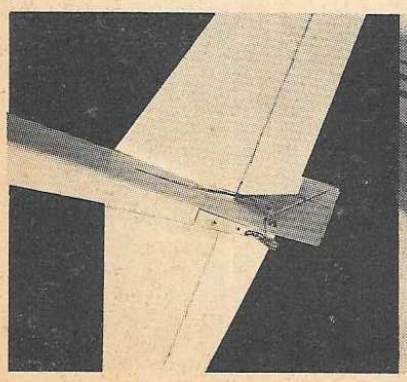
■ "Nimbus" represents a somewhat different approach to radio control Multi class aircraft design than some of the other more popular competition ships. My basic ground rules at the time I began planning went something like this: First I needed a ship that would compete in contest work with Ed Kazmirski's Orion. Second it would have to be sufficiently different so as to minimize the number of "is that a modified Orion" queries. With these fundamental principles and a few of my pet theories, tastes and building practices Nimbus began to take form.

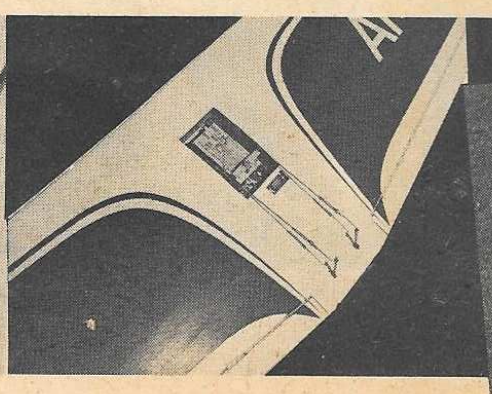
Since relayless equipment seemed unproven and far away in August 1960 the logical approach was to set her up for relay equipment. The installation indicated a ship of about 700 square inches to keep wing loadings around 22 to 23 oz./sq. ft. I might mention here that I prefer to fly at slightly higher wing loadings than generally used. I've found it easier to fly smoothly in windy weather. Maneuvers as well as landing approaches seem to be steadier in spite of the gusts.

To further insure smoothness of all maneuvers a larger than normal coupling was established. To improve steadiness of landing approach the percent of wing taper was increased over that of the Orion. The theory here being that a rolling moment caused by gusts producing air velocity across or against one wing panel, different than on the other, is proportional to each unit of area times its distance from the roll axis. Since a "board" wing has many unit areas at a great distance from the roll axis, as compared to a tapered wing that has fewer unit areas at the same distance, the total rolling force value is less.

After observing Bob Dunham's demonstration of near flawless flying at the 1960 Great Lakes Invitational Meet, trike landing gear was a must.

Having used a swept-back rudder hinge centerline for several years, because of the added elevator effect it has on spins and spirals, I tossed this in as a feature worth while. I had to resolve that whatever the rudder configuration might work out to be, I would have to concentrate its surface area as low as





Nimbus

possible, in order to reduce the aileron effect which opposes yaw when used above the roll axis.

At this point I get into the mystic consideration of off-set and down-thrust. I have never disputed the theories expressed by Charles Grant and backed vigorously by other authorities regarding the relationship of off-set and down-thrust to the center of lateral line. I do, however, doubt the practical desirability of complete elimination of off-set and down-thrust to the extent of letting it dictate the styling of a model. Admittedly, I have never built and flown a model with this configuration, but I have flown models many hours and still have to experience the realization that any of these ships show performance deficiencies that could be even indirectly attributable to 4° off-set and 4° down-thrust. The fact that there is a power loss due to this engine trimming is also acknowledged, but again, can this academic difference be noticed? The point is, I prefer to style what, in my opinion, is a pleasant appearing model, and feel free to allow other factors control the model configuration.

I have another theory that seems to differ from that of some authorities. I plan the basic relationships of balance, incidence, engine thrusts, etc., on the supposition that an aircraft in balanced flight has the mean chord line of the stab (providing it is of symmetrical section) flying at exact zero incidence to the relative wind through which it passes. This I figure to be true regardless of speed, attitude, wing loading.

On this basis it is easier to visualize that to support the weight of the model the wing must produce a lift force exactly

equal to that of the model, since no lift whatsoever is produced by the stab. If I chose to use a wing of a flat bottom airfoil section the amount of incidence relative to the stab chord line might be a minus value, due to its lifting qualities at a slightly less than zero angle of incidence. The exact amount is obviously affected by the average flat-out speed of the model, since lift is increased as speed is increased. The opposite extreme is the symmetrical airfoil wing. With this panel a zero decalage would never produce lift, regardless of speed, since the airflow over the top of the panel would be identical to that on the bottom. Point—as wing progresses from flat bottom airfoil section toward a symmetrical shape, more and more effective decalage is required. Without the aid of wind tunnel data and much complicated calculation a model designer is forced to use his best guess, based on eyperience, in order to determin the exact values of decalage. As near as I can tell Nimbus flies flat-out with the elevator in zero trim. My educatd guess of zero decalage for a modified 2415 airfoil must be very close to ideal. The competition Multi models of today are fast, as compared to models of 2 to 3 years ago, consequently the migration to near zero decalage settings.

Though it may seem a little out of place, I feel an explanation of how some symmetrical airfoil ships fly well at zero decalage settings is in order. The explanation is in the fact that a slight up elevator trim is required at "flat-out" to produce the required incidence, or a low stab, by its location in relation to the wing, falls in the wing down-wash, thus producing an effective decalage relationship.

The exact amount of down-thrust must be determined. To establish this figure, theoretically, is another problem that requires more time and effort than is worthwhile for the modeler. Consequently another educated guess based on the basic force balance is logical. This is the theory I follow.

As mentioned before, the stabilizer is presumed to fly at zero degrees incidence. Therefore, no forces act on it other than drag. Its mean chord becomes the reference line to which all other forces act, either parallel or perpendicular. The major forces involved and individually considered are: Lift, Center of Gravity, Weight, Total Fuselage and Wing Drag, Stabilizer and Fin Drag, and Thrust. Since center of gravity, by definition, is the center of the mass of an object (not necessarily the center of the area) and has no tendency to displace when the total object is rotated, it becomes the logical point to zero all moment couples about.

Now, an aircraft in straight flight should have no tendencies to deviate from its attitude or speed. The force couples acting to rotate the ship about its center of gravity must, therefore, cancel one another or a change of attitude or speed will result. I take a look at the side view profile of the design. Considering that the necessary balance point fore and aft should be back from the leading edge at the average mean chord station about 30 to 35%, a vertical line can be drawn representing its longitudinal location. Its vertical position is not so cut and dried. Location of the equipment, position and dihedral of the wing, position of the empannage, position and length of the gear, all have to be evaluated in order to select the exact spot, which I do as accurately as possible.

The lifting center is considered to be

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acting through the centroid of each wing panel. I spot this point, recognizing the dihedral effect, by projecting it onto the side view profile. The center of drag is located by approximation, considering all drag surfaces and spotting its location on the side view. The center of the empannage drag is similarly located. Lift acts vertically through the lift center, weight acts negatively to lift, but is of exactly the same value and concentrates at the center of gravity. Fuselage and wing drag act rearwardly, parallel to the stab, through the center of drag. Finally, the empannage drag acts rearward, parallel to the mean chord of the stab, but slightly higher than its center due to the fin effects.

Since the values of each of these forces is difficult to establish, I consider only their relative vectors. Primarily, I am concerned with their positional relationships. When setting up Nimbus, these relationships show, fore-to-aft, that engine, C.G., C.L., and C.D., fall pretty much in line with one another, indicating that little or no down-thrust would be required by their placement, but the center of empannage drag falls considerably higher, implying I have an unbalanced situation to combat. Since this drag is high, relative to the C.G., a rotation of the tail downward must be compensated by a force tending to cause the nose to go downward. I know now, that a down-thrust is required. Only an accurate estimate, based on this vector diagram can determine the amount; minus 4° (from the stab chord line) was my choice. Had the empannage center of drag lined up with the engine, C.G., C.L., and C.D., I would have had no down-thrust, or had it fallen below I would have added up-thrust.

The novice is confused by the many different airfoil sections he has to choose from on his first original .049 powered R/C Rudder job. The quantity makes him want to take up oil painting. Actually it is not that complicated. First of all, if he bought a 4" x 36" sheet of hard balsa about 3/16" thick and strapped it to his fuselage he could fly, probably well. Point is, airfoils, which are important to high performance aircraft, are highly exaggerated in their importance to the hobbyist. The pitfalls of home-brew airfoils are: sharp leading edges, because they cause abrupt, complete, and violent stalls when used in combination with thin sections (below 11 to 12%), and rearward cambers 35 to 50% on aircraft where wing loadings are 18 to 25 oz./sq. ft. The only advantage in going to thin sections with sharp leading edges can basically be boiled down to use on pylon racers where low drag and low wing loadings are desirable.

Stab and fin areas and placement only remain to be theorized. Stabilizer area should fall somewhere around 22 to 26% of the total wing area. Less than this amount will tend to allow the ship to wander; trim settings will be difficult to obtain and ineffective in establishing and holding attitudes of the aircraft. Larger stabs produce configurations that have difficulty in spinning. Fin area should be between 6 to 10% to produce the optimum in longitudinal stability.

At this point I start selecting equipment. I have been in the habit, when I begin layout work, to have accurate full size, 3-view drawings of servos, engine, receiver, battery packs or power supply, gas tank, electrical plugs, switches . . . everything that must be cleared or incorporated into the air frame. My equipment for Nimbus is: receiver. Bramco competition 10; servos, Bonner Duramites

tor everything but engine control, which uses the Hillcrest; gas tank, Veco 8 oz. clunk; engines, both K&B .45RC and Super-tigre .56RC; electrical plugs, 1 cannon 25 pin (for receiver), 1 cannon 9 pin (for aileron), and 1 home made 6 pin (for battery pack); 1 knife type slide switch DPDT (unidentified); a battery pack comprising a Hillcrest 6 pencell box (holding 1 Burgess activator for filament, 4 Burgess CD-6 nickel-cads for servo power and 1 Burgess activator to be used as a booster to effectively double the life of the "B" battery), and 2 sections of a Burgess K-45 (45v) taped side to side for "B" supply. All other hardware is home made, including adaptations of throttles on engines to permit action from beneath the cowl.

From here a design novelty begins. I begin juggling components, considering clearances, push rod locations, balance, accessibility, space and mountability. When all these are located efficiently as possible the line work begins. The airplane is literally designed around my installation. Considerable attention is given to envelop this equipment with the smallest practical fuselage possible. During such a process components usually get juggled, line work is modified until the optimum composite is finalized. I think study will show that Nimbus has no vacant areas. Each component has its own compartment or position and cannot be moved or relocated. I hope this does not prove to be a handicap to you readers who would like to build her utilizing other gear. I would suggest careful planning with the equipment layouts to insure that such deviation won't put you in a corner.

Once having enclosed the equipment, the styling of the model now progresses. I have already faired the nose to a point to reduce drag by the streamlining. I prefer to locate the stab sufficiently high so as to reduce as much as possible, down-wash air from the wing passing over its surface. Turbulent air cannot possibly do anything to aid smooth flying. Using an arbitrary figure for this wing and stab displacement of .50 (the ratio of displacement to average mean chord) and my coupling moment of 2.625, the stab was positioned. Considering the desired rudder hinge angle and surface concentration location, the remainder of the side view profile was styled.

Nimbus has been flown with two different wings. The original wing, flown at the '61 Nats, has both the leading and trailing edges tapered. It is constructed of two box section spars, shaped to beams of constant strength and utilizes the "Frise" ailerons of about 10.5% effective area. The open areas between the spars as well as the ailerons are spanned with silk over 5/16" cap stripped ribs. The new wing shown here was designed to compare the narrow 9% full span aileron system, first used by Lou Andrews, and flown at the '61 Nats by Harold deBolt and Ron Chapman, with the "Frise" aileron. Because of a nose heavy tendency that Nimbus has, the new wing was designed with its leading edge straight, all the taper being in the trailing edge. Finally, to produce a more efficient panel, this wing was fully sheeted with 3/32" contest balsa. The new wing weighed about 3 oz. more than the original wing, probably due to more paneling, even though the original incorporated more plywood. The construction advantage of the new wing really takes the pain out of building.

I feel that both wings operate effectively to fly Nimbus. The original version seemed to produce spins a trifle easier and rolled much faster than the new wing. The new wing seems to fly a little smother and a little faster, though the roll rate is substantially reduced. I found this quite difficult to become accustomed to after 500 flights with the original wing. This feature is an advantage, I believe, because it is easier to recover wings level from rolls, split "S's", Immelmanns, Cuban eights, etc. Ed Kazmirski flew Nimbus with the full span aileron wing just prior to the 1961 Great Lakes Invitational Meet last September and feels these ailerons produce a faster roll than his tastes prefer. So there you are. I believe after all is said and done that I favor the sheeted, single tapered, full span aileron wing over the double tapered, Frise aileron and silked panel wing.

Gear placement reminds me of another theory that displays its proof with Nimbus, and that has to do with main gear placement relative to C.G. Nimbus has never bounced on a landing, due to the C.G. being no less than 15% of the average mean chord ahead of the wheel contact point with the ground. Easy set downs, smooth and bounceless are assured by the complete robbing of incidence when 3-wheel contact puts the wing at a minus 1°.

Nimbus, as I built her, weighed out totally (less fuel) at slightly less than 7#. This is considered heavy in some circles. As a matter of fact, I feel it is a little heavy for some maneuvers. However, the advantage of high wing loadings are numerous, and it is too bad that there are no comparable weight engines available that would give her the power-to-weight ratio that would make her drive through loops like a 5# ship with a .45.

I will conclude this dissertation with a few construction peculiarities I have used. All of my push rods have washers soldered on their ends as keepers so there is no chance of vibration causing a disconnect. Trim adjustments need only be made on the first few flights. Re-soldering on the field to get another turn of aileron adjustment is a small price to pay for the ultimate of reliability. Wheels also have washers soldered to spindles as keepers. Have you ever ruined a winning flight at a contest because of losing a wheel? I have, but not since I began soldering wheel keepers. Every bolt used screws into metal or into "T" nuts.

The steerable nose gear shown is also home built, very similar to the "Atlas" nose gear produced by Don Steeb for $7.95, which should be a natural for Nimbus.

Building of the fuselage begins with gluing of all doubler sheeting and wing crutches to the side sheeting. On top of these are cemented the engine beam mounts, engine and steerable nose gear conduit, servo and bellcrank rails, and finally the beveled corner longerons. In essence, all the installation mounting provisions are installed before the top and bottom are added. From this point assembly and construction is conventional. All balsa wood used should be of the lightest attainable. There are no construction-wise deficient areas where hard balsa is required. However, the plans do show where some components could be from the harder material if light-all-the-way makes you squeamish.

If balances are established as recommended Nimbus should fly right off the table. Take care in building the wing flat and true and the fuselage straight, for as in all faster ships, a little warp or bow can give you a real frantic time on that first flight.