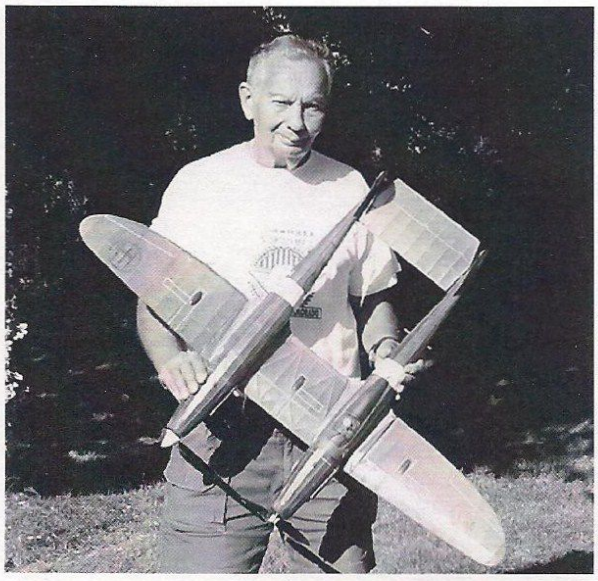
Twin fuselage scale models: the Reggiane Re 2005 Bifusoliero.

by Bill Henn, Harwich, MA, USA



The Bifusoliero project

During the next building season I decided to build a more competitive model for the Giant Scale Category. Best choice seemed to be a low-wing twin which would receive a total of 35 bonus points. During my search for a suitable subject, I came across information regarding an Italian project aircraft, the Reggiane Re2005 Bifusoliero. A 3-view drawing dated 24 December 1942, a memo by Reggiane engineer Nardi written in March-April 1943, and a photograph of a wooden factory model built by draftsman Bruno Belfiore are the only know documentary evidence. The design was supposed to have been conceived by engineer Marachini. Offered as a heavy single seat fighter with twin fuselages and the cockpit located in the left fuselage, it was to have been powered by two DB 605 engines. Unlike the twin fuselage Fiat G-58 contemporary, which used the main components of the single seat G-55, the Reggiane Bifusoliero would have been a largely new aircraft only formally related to the Re 2005 (for which see FFQ #5). An examination of the photograph of the wooden model and the 3-view indicates that the section of the fuselages behind the wing had been extended considerably. This leads me to believe that the aircraft was intended to be powered with the more powerful and heavier DB 603 engines as was the Reggiane Re 2006 and the Arado E-530. This subject had ideal proportions for a high performance twin motor rubber scale model. It was a very clean design with a longer and higher aspect wing than the Arado, long noses and long tail moments, as shown in the 3-view of Fig. 3. Truly an exciting project to which I gave my immediate attention!

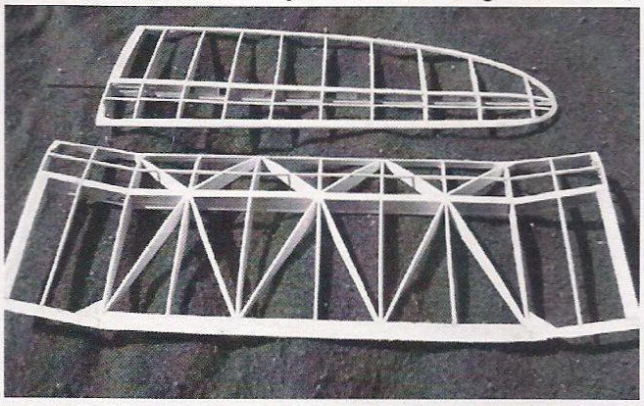


Fig. 1 Centre wing section with geodetic ribs and web-sheared I-beam spar. Removable elliptical tips.

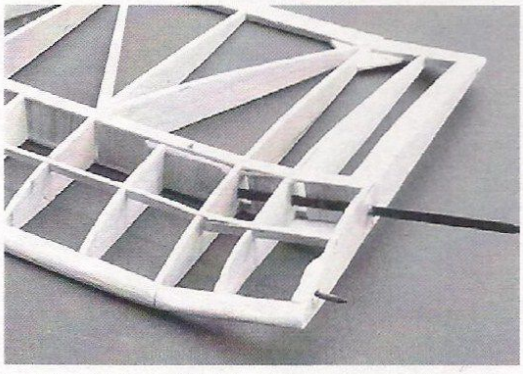


Fig. 2 Breakaway CF joiners in centre wing panel

Plan and construction

The plan was drawn in the same manner as that of the Arado, by filling in the 3-view with a marking pen and then enlarging it by section on 11" X 17" paper with a copy machine, finally tracing the outline on vellum. A wingspan of 43" was chosen so that the model would be eligible for the FAC Giant Scale Category. Construction was also done in the same manner, half shell on the fuselage and "I" beam wing main spar (Figs 1 and 2) with a full geodetic center section. Since the trailing edge of the wing was curved, it was laminated using three sections of

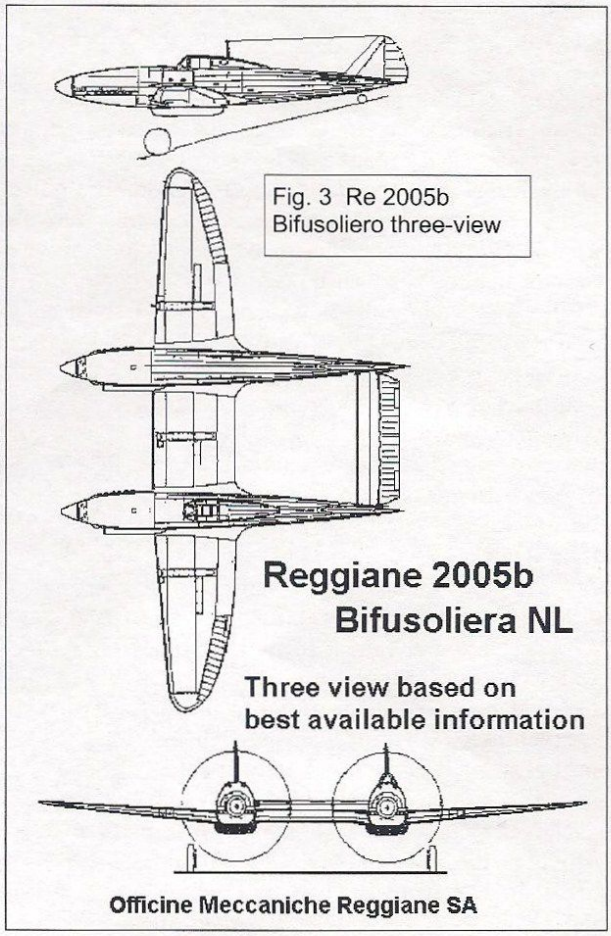
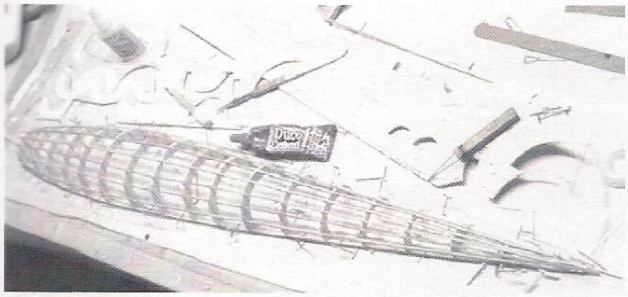


Fig. 3 Re 2005b Bifusoliero three-view



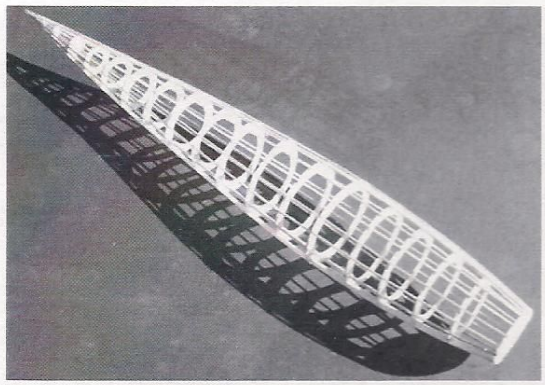


Fig. 4 Fuselage being constructed by the keel method, and Fig. 5 (right) completed fuselage with formers.

3/32" square, the outer sections soft balsa and the innermost spruce. (Airframe is shown in Figs 1 to 6) The wing and stabilizer sections and propellers and motors were identical to that of the Arado. The D/T was set up in the same manner with a rotating stabilizer actuated by a button timer (Fig. 10). The model was covered with Japanese tissue, white on the bottom chalked to light blue and green on the top, chalked to resemble the olive green color used on many of the Italian aircraft of the period. Several light coats of clear Krylon were sprayed on to fix the color and seal the tissue. The model was decorated with the squadron code of the 362 Squadron and the scarecrow insignia created by Lt. "Beppi" Biron for the 22nd Group. Complete model is shown in Figs 7 to 10.

Trimming and initial flying

During the initial test gliding procedure, with the model balanced but the propellers and motors removed, it was immediately evident that the Reggiane glided much better than the Arado. I believe this was because of the cleaner design, more efficient wing and lower wing loading.

Initial adjustments were 3 degrees positive incidence on the wing, zero on the stabilizer, zero rudder deflection and 3 degrees downthrust on each side with zero side thrust. On its maiden flight with low winds, I was pleasantly surprised to observe that it flew in the same manner as my Arado. All it needed was a little left rudder to get it to turn left under power and during the glide. The power and glide patterns did not change as the winds were increased with no other adjustments necessary. Another good flyer right off the board!

Prior to attending the 2005 FAC Nats, I spent some time at our local contest field testing both the Arado and the Reggiane. The Arado flew in the same manner as the previous season and the Reggiane flew even better. They both climbed to about the same altitude but the glide of the Reggiane was superior. The D/T saved it twice. On one flight the wind shifted and the model D/T'ed onto the top of a tree, 50-60 feet high. I drove home and got a 40 foot ladder and a 16 foot fiberglass pole. When I began to climb the ladder a few young RC'ers came by and took over. From the top of the ladder, one of them managed to poke the model free with little damage. I bought them a case of beer before I left. The Reggiane was not flown again until the July 2005 FAC Nats in Geneseo, NY. During one test flight at the Nats the model caught some good air and flew more than two minutes. With no help from thermals, it put in an official flight of 93 seconds. This put me in first place on the board by quite a few points so I put the Reggiane aside and started flying the Arado E-530, which was entered in Jumbo Scale. On its first flight the Arado flew for 83 seconds with about 90% turns. Next flight I packed in 100 more turns and tried for a max. Unfortunately a gust of wing caught the model and flipped it over on its back. The crash wiped out the left fuselage and ended the contest for the Arado. Luck was with me, however, because the 83 second flight was enough to keep it in first place. After this experience I was somewhat shy to fly the Reggiane anymore and decided to watch the score board and only fly it again if it was necessary to win. As it turned out the 93 second flight was good for first place.

The FAC Nats in July 2006 were equally successful, with the model winning the Giant Scale event for a second time, with a winning flight of 109 secs and good static points.

Considerations on other Twin designs

Entering only 4 events at the 2005 FAC Nats allowed me the time to observe others flying their twins. After watching Clive Gamble fly his impressive Westland Welkin in the WWII event, I began to have second thoughts about the limitations of certain conventional twins despite their obvious handicaps. The Welkin is an elegant aircraft, a very clean design, with a high aspect ratio wing and very slim nacelles and fuselage Although Clive's model had a wingspan of only about two inches less than my Arado, it had only half the weight. The fuselage and nacelles were built with laminated formers. Granted, the Welkin had a narrower chord than the Arado, but that results in proportionately less wing area being blanked out

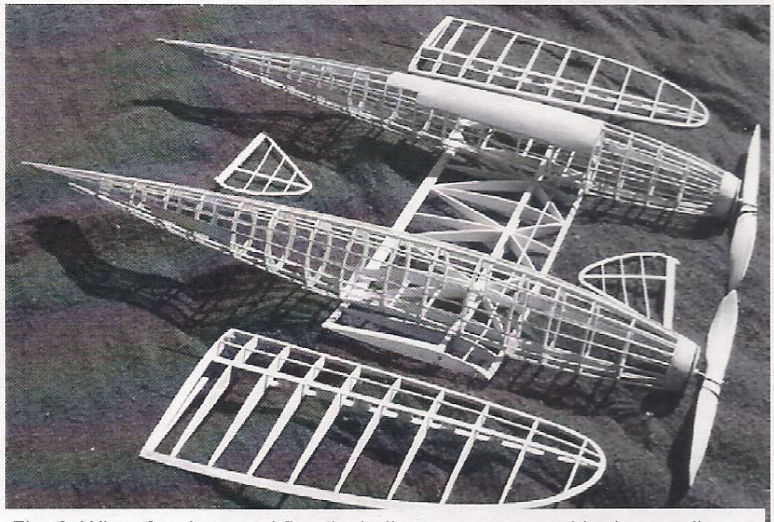


Fig. 6 Wing, fuselage and fins, including nose cone and both propellers, note opposite rotation of left propeller.

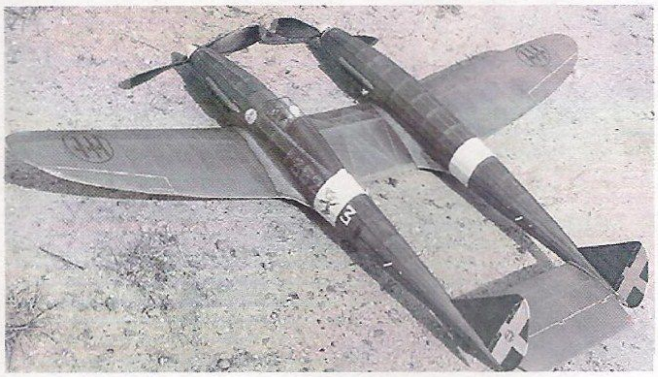


Fig 7 Completed model: rear left view, and below,

Fig. 9 Underside of model showing three-piece wing. Bill uses same propellers as in Arado 530, see FFQ#18.

by the slim fuselage and nacelles. With a lower wing loading, it can be assumed that the Welkin glided at a slower speed than my Arado, therefore reducing the drag of the two free-wheeling propellers. Judging by the difference in performance of my two twins, the length and chord of the wing are very important factors in the choice of any twin subject. Observe how much wing area is blanked out by the fuselage and nacelles of certain popular twins with relatively short, broad wings such as the Arado AR240, Mig-Dis and DH Hornet. It is true that the nacelles of such subjects can be built very lightly from the leading edge back because of the support of the wing. The fuselage can also be built very lightly because it is also supported by the wing and does not require the strength to withstand the torque of a motor. Just look at how slim the rear sections of the fuselages are in such subjects as the Mig-Dis and the Welkin, their only functions are to support adequately the stabilizer. These and similar subjects such as the Arado AR-240 and DH Hornet have the advantage of a very short nose that allows the use of larger diameter, more efficient props. Surprisingly, the length of the motor runs

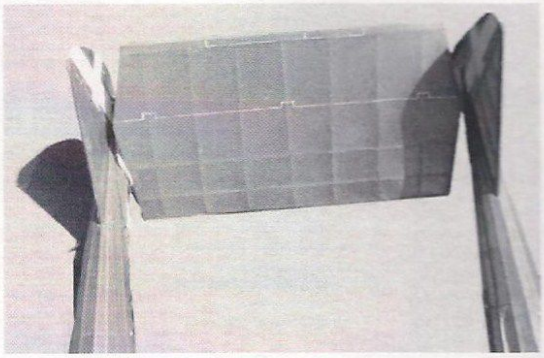


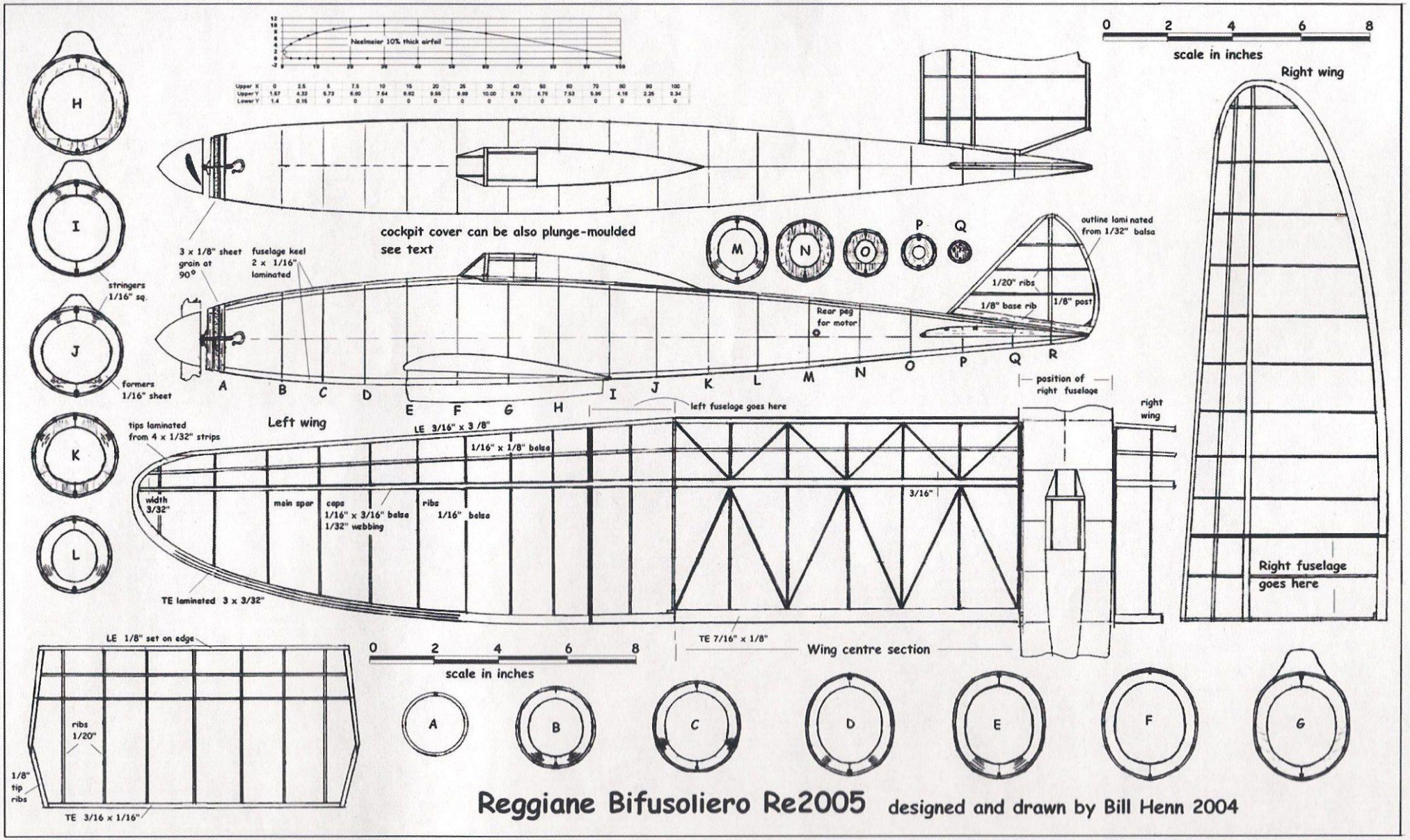
Fig. 10 Horizontal stab in the DT position. The stab position is controlled by conventional button timer.

were not all that bad on some of the conventional twins I observed despite the limitations of the short nacelles. It seems the use of extremely long motors, tight braiding and Dave Stotts "tube within a tube" rear peg (prevents bunching) allow almost all the turns to run out. Since only a short length of the motors in the nacelles are behind the CG, this will reduce or eliminate the need for ballast in the nose. Even if the motor bunches up at the rear after unwinding, the CG is not effected very much. There is no question as to whether scale subjects with twin fuselages have an advantage regarding the efficiency of the motors and drag. On the debit side, two long fuselages, strong enough to withstand the torque of the motors, will tend to be much heavier than a single fuselage and two nacelles. In addition, the center wing panel of a twin fuselage subject must be made very strong (and heavier) to withstand the stress of even a moderately rough landing when the nose of one fuselage contacts the ground before the nose of the other. The center section must also be resistant to torsional forces since the fuselages will lose the support of the stabilizer if a conventional DT is used.

Twins and tri-motors

The same reasoning can be applied to tri-motor subjects. Undoubtedly the motor in the fuselage will have a long run and, along with the two outboard motors, create a larger initial thrust than in twin engine models. However, such models will tend to be heavier than a conventional twin because the fuselage must be built strong enough to handle the torque of the motor and because of weight of the additional prop assembly. Furthermore, the nacelles on all the tri-motor subjects I have seen are even shorter than those on popular twins such as the DH Hornet, AR-240, etc. This will mean that the motors in the nacelles will run down much sooner than the motor in the center. The propellers will start to freewheel, creating significant drag which the motor in the fuselage will have to overcome. After the power mode ends, all three props will be freewheeling and the drag created will be greater than that of a subject with two props, adversely effecting the glide. This makes me doubt if the endurance of a tri-motor subject could equal that of a good twin.

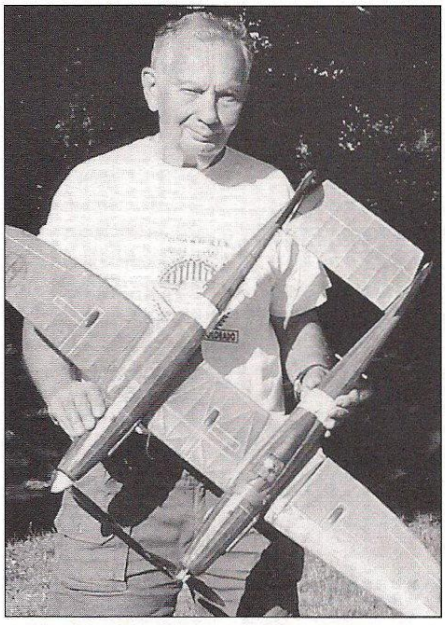
All things considered, it is apparent that twin fuselage subjects still have an edge over conventional twins and tri-motor subjects in regards to duration. The secret is to keep them light and select subjects that have long wings as compared to fuselage length. The fuselages should have enough separation to allow the use of optimum sized propellers. It is not an easy task finding suitable subjects unless project aircraft are also considered. Fortunately there are still quite a few of them out there, some of which have never been modeled, just waiting to be discovered♦.


Neelmeier 10% thick airfoil
Upper X 0 2.5 5 7.5 10 15 20 25 30 40 50 60 70 80 90 100
Upper Y 1.57 4.33 5.73 6.80 7.64 8.82 9.56 9.89 10.00 9.79 8.79 7.63 5.96 4.16 2.26 0.34
Lower Y 1.4 0.16 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 2 4 6 8
scale in inches
Right wing
cockpit cover can be also plunge-moulded
see text
3 x 1/8" sheet grain at 90°
fuselage keel 2 x 1/16" laminated
stringers 1/16" sq.
formers 1/16" sheet
outline laminated from 1/32" balsa
1/20" ribs
1/8" base rib
1/8" post
Rear peg for motor
A B C D E F G H I J K L M N O P Q R
position of right fuselage
left fuselage goes here
right wing
Left wing
tips laminated from 4 x 1/32" strips
LE 3/16" x 3/8"
1/16" x 1/8" balsa
width 3/32"
main spar
caps 1/16" x 3/16" balsa 1/32" webbing
ribs 1/16" balsa
3/16"
TE laminated 3 x 3/32"
Right fuselage goes here
TE 7/16" x 1/8"
Wing centre section
0 2 4 6 8
scale in inches
LE 1/8" set on edge
ribs 1/20"
1/8" tip ribs
TE 3/16 x 1/16"
Reggiane Bifusoliero Re2005 designed and drawn by Bill Henn 2004

Bill Henn

Two-Minute Twins: A Reality

Over the last three decades the popularity of scale models with two or more motors has been increasing along with their performance. According to the results of the first FAC Nationals published in the August-September, 1978 issue of *Max-Fax*, there were only two twins entered in FAC Scale. Dennis Norman's Tigercat flew for 30 seconds and placed 14th. Ralph Kuenz's Douglas A-26 flew for 32 seconds and placed 44th. A perusal of the Geneseo judged scale events over the last five years will indicate that many multi-engine models were entered with winning times often as high as 90 seconds or more. However, these times can be deceiving because they represent the longest of three flights. With three attempts, the chance of getting good air on at least one flight is quite high.



Author displays his Nats-winning Regianne RE-2005 'Bifusoliero'.

Contributed photo

This is not to say that multi engine models cannot be made to fly over 90 seconds or even more than two minutes without the aid of thermals. To perform this well a multi engine model would have to have a relatively small frontal area and a configuration that would allow a very long propeller hook to rear peg distance (long fuselage and nose moment) and would not restrict propeller size. In addition it would have to be built to an extremely low wing loading. This is extremely important with multi-engine models since they have so much drag because of the additional freewheeling propellers and increased frontal area. Heavy models must fly faster to stay in the air and drag increases exponentially as speed becomes greater. When calculating wing loading on multi engine scale models for the purpose of estimating endurance, the area wiped out by the extra fuselage or nacelles should be subtracted from total area and entered into the equation to obtain a true picture.

Very few subjects that have ever been flown on the contest circuit comply with all of the foregoing requirements. Some of those that come closest include the F-82 Twin Mustang, Focke Wulf FW-189 V6, Bestetti-Nardi BN-1 and a few project aircraft. They all have one thing in common: twin booms.

The F-82 has rather bulky fuselages but a smaller frontal area as compared to most twins with engines in wing nacelles. It also has a long nose moment which enables a rearward peg location and the use of long motors. In recent years many have been built and flown in FAC competition. Apparently they fly quite well, have won contests but, according to the results, have not dominated the competition. This may have been because they were too heavy or that their propeller/motor combinations limited duration. However, the F-82 appears to have considerable potential providing it could be built to a light wing loading and equipped with optimum propellers and motors. Such a model, built to minimum Jumbo Scale or maximum FAC Scale size and weighing less than 100 grams should be capable of 90-second flights.

For some reason scale modelers on both sides of the Atlantic have overlooked the interesting ground attack variant of the FW-189. The FW-189 V6 has an extremely small fuselage pod but is otherwise identical to the well-known observation version. The drag and extra weight of the glassed-in bulbous fuselage of the latter airplane severely limits endurance. The tiny fuselage and slender booms of the V6 create a very small frontal area. Because of the sweptback wing, it has a long nose moment. I built one from an enlarged and much revised Koutny plan of the observation variant. The large fuselage was eliminated and replaced by the tiny armored cupola of the V6. The model easily won Jumbo Scale at Geneseo in 2007 with a flight of 1:55. It may have had assistance from a mild thermal on that flight but the model flies consistently over 90 seconds in still air. The only significant problem with the subject is that the booms are so slim that the amount of rubber that can be installed is limited. Even though the booms on my model were built with wrapped formers, there was still insufficient room for the large motors that would be necessary for flights of two minutes or more. My favorite 6 x 1/8" x 20-gram motor would not fit so 4 strands of .155 weighing only about 13 grams was used instead.

The Bestetti-Nardi BN-1 is an obscure Italian twin boom experimental fighter. Veteran FACer Mark Fineman flew his 36" model at Geneseo this year to 2nd place in Jumbo with a flight of 1:27. This was only the third flight of the model which was still under development. Mark told me that his BN-1, built from his own plan, had flown 1:20 on an earlier flight and had to be fished out of a tree on the other. What is really remarkable is that the model weighed only 74 grams and was grossly underpowered. The two loops of 1/8" rubber used on each side only amounted to about 18% of the model weight. These motors were coupled to 8" diameter propellers with the blades cut from yogurt containers. Imagine what it could do with larger motors or built to Giant Scale size where it would have an aerodynamic advantage over the smaller version.

Certain project aircraft also have the potential for achieving long flights. My twin-boom Arado E-530 caught a thermal at Geneseo 2005 and won Jumbo with a flight of 3:15. It won again in 2006 without the aid of a thermal with a 90 second flight. The model has a 37 inch wingspan and weighs about 100 grams. The E-530 has a long nose moment and long propeller hook to rear peg distance but a rather skimpy wing and bulky twin booms. Two 15-gram motors using 6 strands of 1/8" rubber were used at Geneseo but longer motors should improve duration to over 90 seconds despite the relatively small wing and bulk of the booms.

There are a number of other project aircraft that appear to have even more potential including the ME609, Horkey Twin racer, Regianne RE2005 Bifusoliero and perhaps the ME409. I built a model of the RE2005 which won Giant

Two-Minute Twins: A Reality

Scale at Geneseo 2006 and 2007 by a comfortable margin with 93 and 109 second flights. The RE2005 Bifusoliero is a twin fuselage version of the elegant WWII single engine Italian fighter. It has long slim booms, a long nose moment and a generous wing. The model has a wingspan of 43 inches and weighs 108 grams. Using two 15-gram motors, 6 x 1/8", and propellers with a diameter of 10" and 11" pitch, it is capable of consistent flights of more than 90 seconds without the aid of thermals. Months after the contest, while testing it in early morning still air and using 20 gram motors, the model put in three flights of about 1:50. What was impressive was that the motors were only wound to 2000 turns. The 20 gram 6 strand motors are similar to those used in some P-30s but twice as long. P-30 flyers commonly wind these 10-gram motors to 1100 or more turns so it is obvious that the motors in my RE2005 could have taken a few hundred more turns. I have been using the same motors in several other competition models for years, winding them to 2100 turns and have never broken one, another indication that the motors were not fully wound and the model could have flown longer.

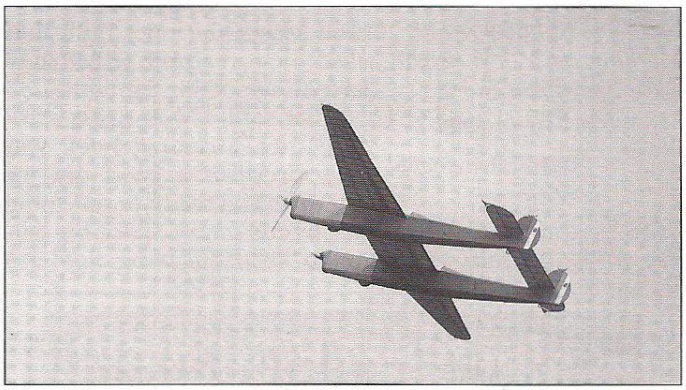
The twin fuselage ME609 has proportions similar to the RE2005 but a narrower wing. Nevertheless it should also be a great flyer. The ME409 has an extremely high aspect wing and might also be worth consideration if built to about a 50 inch wingspan. The futuristic but little known Horkey is a different matter altogether. The fuselages are very long but the subject has a rather small, sweptback wing which results in a nose moment that is actually so long that rear ballast would be necessary. Of course the wing could be moved forward but then the model would not agree with the 3-view. However it could take extremely long motors running all the way back to the tail. With an optimum propeller/rubber combination, motor runs over 90 seconds could be possible with two minute flights within easy reach.

Czech scale champ Lubimor Koutny has created 1/20th scale plans for the Horkey, ME 609 and BN-1 which could be enlarged to comply with the dimensions of the various FAC scale categories. Koutny also has plans for the single engine ME209 which could be used as a basis for drawing plans for the ME409, the twin fuselage version.

Of all the aforementioned subjects, the Bestetti-Nardi BN-1 appears to have the most endurance potential primarily because it could be built to a very light wing loading. A check of the 3-view and photos from the internet of the actual airplane will indicate that it has very slim booms with flat sides, easily replicated without the need for a multitude of stringers. The long nose moment will allow a rearward placement of the motor peg. Even the blue color of the prototype could be reproduced using only blue tissue without the added weight of colored dope. If Fineman could build a 36" wingspan Jumbo Scale to only 74 grams, it should not be difficult to build a sufficiently robust 43" wingspan Giant Scale model to considerably less than 100 grams. Such a model would be a real floater and, using the same 20 gram motors and propellers as my 108 gram RE2005, should be capable of longer flights, likely over two minutes.

Despite this impressive endurance potential, the BN-1 might have a difficult time competing against some of the other aforementioned models because of the FAC method of scoring. Flight times between 90 and 120 seconds only receive ¼ point per second and anything over two minutes doesn't count. Since the BN-1 has a shoulder wing, it only garners 30 bonus points while the others are all low wingers which are awarded 35 points. The extra 5 points may make a big difference in final scores.

The decision as to which of these subjects would be the best choice for serious competition is quite difficult. The Horkey is an intriguing, exotic design but stability is an unknown factor. It appears to have great potential but there is a possibility that it might be harder to trim and less stable. The asthetically pleasing BN-1 certainly would be a good choice but would have the 5 bonus point disadvantage. The RE2005 Bifusoliero may have less appeal but has proven itself with two consecutive first places at Geneseo. Besides, it is extremely easy to trim and a very stable and predictable flyer. Another advantage is that it can be easily decorated without the use of an airbrush to apply multiple coats of colored dope. A very lightweight and full scale finish can be achieved simply by darkening ordinary Japanese green tissue with olive green chalk and then finishing with a few dust coats of Krylon clear acrylic paint right out of the pressurized can. The model's extremely light, knock-off outer wing panels contribute to stability and durability and the DT helps to prevent loss.



Mark Fineman's gorgeous Bestetti-Nardi on the wing in Connecticut.

Contributed photo

A Giant Scale BN-1 is very high on my building list. Mark Fineman was gracious enough to send me a copy of his plan, already enlarged to 43" wingspan. Measurements indicated that it had the same nose moment and propeller hook to rear peg distance as compared to my Regianne Bifusoliero. Therefore the same motors and propellers can be used. Since the BN-1 could be made considerably lighter, performance should be greater. A comparison the plan with the Koutny BN-1 plan indicated that the Fineman plan is much more true to scale. It will soon be published in a commercial magazine and be available to everyone. The enlarged plan sent to me needs few revisions over the smaller one but I will add a dethermalizer, light weight knock off outer wing panels and a different stabilizer section. It would fun to build two sets of propeller assemblies, a pair of freewheelers for scale competition and a pair of folders for sport flying. I always wondered how a high performance twin could fly without the drag of two freewheeling propellers.

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