



**LEFT: The author's first attempt to build an RC Autogyro. The rotor is three bladed.**

**BELOW, LEFT: The first version with two contra rotating rotors on one axle. This version performed the first real flight.**

# RC AUTOGYRO SUPER LIBELLE

By Helmut Meyer

**Designed for .19 to .25 engines, this Autogyro is a definite change of pace for sport flying enthusiasts. The Super Libelle is easy to fly and will always cause a sensation wherever you take it. If the wind is strong enough, the Autogyro can be landed nearly vertical even with full throttle.**



<b>SUPER LIBELLE</b>	
Designed By: Helmut Meyer	
<b>TYPE AIRCRAFT</b>	
R/C Autogyro (Experimental)	
<b>ROTOR DIAMETER</b>	
Upper 37.4" — Lower 32.68"	
<b>ROTOR CHORD</b>	
3 7/8 Inches	
<b>TOTAL ROTOR AREA</b>	
221.8 Square Inches	
<b>ROTOR LOCATION</b>	
2 Rotors Above Fuselage	
<b>ROTOR AIRFOIL</b>	
Flat Bottom (20%)	
<b>ROTOR PLANFORM</b>	
Constant Chord	
<b>DIHEDRAL, EACH TIP</b>	
1 1/2" Lower Rotor	
1-3/16" Upper Rotor	
<b>O.A. FUSELAGE LENGTH</b>	
34 3/8 Inches	
<b>RADIO COMPARTMENT AREA</b>	
(L) 6 3/4" X (W) 2 3/8" X (H) 3"	
<b>STABILIZER SPAN</b>	
18 1/2 Inches	
<b>STABILIZER CHORD (incl. elev.)</b>	
4 3/8" (Avg.)	
<b>STABILIZER AREA</b>	
77.43 Square Inches	
<b>STAB AIRFOIL SECTION</b>	
Flat	
<b>STABILIZER LOCATION</b>	
Mid-Fuselage	
<b>VERTICAL FIN HEIGHT</b>	
4 3/4 Inches	
<b>VERTICAL FIN WIDTH (incl. rudder)</b>	
5-5/16" (Avg.)	
<b>REC. ENGINE SIZE</b>	
.19 — .25	
<b>FUEL TANK SIZE</b>	
4 — 6 Ounce	
<b>LANDING GEAR</b>	
Conventional	
<b>REC. NO. OF CHANNELS</b>	
3	
<b>CONTROL FUNCTIONS</b>	
Rudder, Elevator & Throttle	
<b>BASIC MATERIALS USED IN CONSTRUCTION</b>	
Fuselage	Balsa, Ply & Pine
Rotor	Balsa, Ply & Pine
Empennage	Balsa
Weight Ready-To-Fly	51 Oz.

**The final version of the RC  
Autogyro as featured in this  
article — The “Super Libelle”.**

**T**he autogyro, sometimes also called gyroplane, is an intermediate stage between an airplane and a helicopter and was developed more than 50 years ago by the Spanish engineer, Don Juan de la Cierva. Later the helicopter replaced the autogyro almost completely and today only few specimens are flying, such as the Benson Gyrocopter.

Cierva replaced the fixed wing of the conventional plane by 2 or more rotor blades to obtain extremely low airspeeds and very steep climb and descent angles. Contrary to the helicopter, the rotor of the autogyro is not connected to the engine, but driven automatically by the airstream passing through the rotor disc. The engine of the autogyro drives a conventional prop to reach the necessary forward speed so that the airstream will turn the rotor. Therefore, the complicated power line to the rotor and the tail rotor of the helicopter is not necessary. The whole design of the autogyro is much simpler than the helicopter, but the flight characteristics are also different. The autogyro cannot make vertical take-offs and landings or fly backwards or sideways or hover. The autogyro can only fly very slowly and can perform very short take-offs and landings. If the wind is strong enough, the autogyro can barely reach any speed over ground and landings with full throttled engine are then nearly vertical.



The building and flying of this radio controlled autogyro will present no problems, there are no more difficulties than with a conventional radio controlled plane, but this type of model will always cause a sensation and serves as a basis for further individual developments.

When I started to develop a radio controlled autogyro, it seemed to be a simple job, because the construction is relatively simple and the rigid rotor (without controlled blade positions) should cause no major problems. The first model was built in a short time and the maiden flight took place. But this first flight was a great disappointment, immediately after launch the autogyro started to fly a roll and I had to collect the pieces of the rotor blades and think about the reasons for this disaster. Further test flights of modified versions ended with the same result, so I studied the literature about autogyros to find the reason of this unstable flight. I found the following reason:

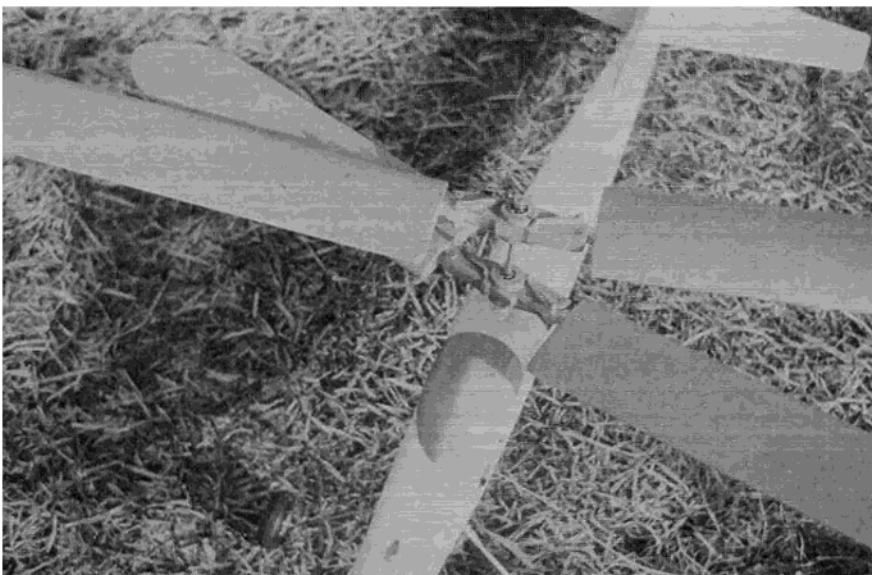
When a rotor blade during its rotation happens to be moving forward, or in the same direction the model moves, this blade has a speed equal to the rotation speed *plus* the model's forward speed. The other rotor blade has a speed equal to the rotational speed *minus* the forward speed. The first blade moving at a higher speed obviously produces more lift than the second blade with the result that the center of lift of the rotor during forward flight (which is necessary to turn the rotor) is outside the centerline and causes the tendency to fly steep turns or rolls.

Some tests with a rotor mounted off the centerline and with a seesaw-type rotor caused a lot of building time, but no real flight could be obtained. So I tried to install two contra-rotating rotors on one axle to compensate for the shifted center of lift of the first rotor with an opposite shifted center of lift of the second rotor, which rotates in the opposite direction.

The test flight of this twin rotor version was the first success and showed that this could be the right way to approach a radio controlled autogyro. Some modifications had to be made to find the right location of the Center of Gravity, to develop a practical rotor design and to find the best angle of the rotor axle. A lot of test flights (and repairs) had to be performed to come to this final design, called “Super Libelle”. A 3-channel radio was used to control elevator, rudder and



**The Super Libelle in flight.**



engine throttle and no difficulties were found in controlling this autogyro. Some words should be said about the engine used. Because the engine gives the control to make the model hover, go up and down and fly slowly and fast more than the elevator, the engine throttle is more important than on conventional models. Only an engine which is able to run steady on all throttle positions should be used.

### CONSTRUCTION

**Fuselage:** Cut two sidewalls from 1/8" medium balsa, tape them together and sand until they are alike. Glue the forward and aft doubler to the inner sides. The forward doubler is 1/16" plywood, while the aft is 1/16" balsa. The grain of both should be vertical. After sanding the doublers to the size of the sidewalls, mark the location of the formers F2 and F3 and glue the 3/16" square balsa stringers to the top side and beside the former location mark. Cut the balsa blocks 3/8" x 1/2", the reinforcements made of 3/16" balsa, and the servo trays (size in accordance to the servos to be used) to size and glue them to the position shown on the plan. The landing gear supports R1 and R2, made of 1/8" and 1/16" beech-plywood, are the next parts to be glued properly to the inner side of the sidewalls. Former 1, to which the engine is flange-mounted, has to be cut from 1/4" plywood and inserts for the engine mounting bolts have to be fixed. Cut formers F2 and F3 from 1/8" hard balsa and cut the balsa block for the fuselage end from 3/8" medium balsa. Glue formers F2 and F3 to one sidewall and, when dry, glue the second sidewall, former F1, and the end block in place. The 3/8" x 3/4" pine block is now glued on top of the fuselage beside former 1. The front bottom, made from 3/32" plywood, 1/8" balsa, and 1/8" plywood, has to be glued in place and then the holes for the landing gear are to be drilled from the top side. Now the 3/8" triangular stock hard balsa, or spruce, reinforcement between former 2 and the bottom can be glued in place and also the 3/8" balsa cover on top beside former 2. Cut the 3/8" balsa block to size and glue it to the top. After drying, sand the top of the fuselage to a plane surface and glue the top cover of 3/16" plywood and 3/16" balsa to the top. Install the elevator linkage (Graupner-Cirrus control horn) in the rear part of the fuselage after the necessary cut-outs are made and make sure that the brass tube is properly aligned and the linkage runs free. Temporarily mount the servos and install the pushrods. When this is done, the aft part of the bottom, made of 1/8" balsa, can be glued in place.

The hatch for the fuel tank compartment has to be made from 3/8" and 1/8" balsa and 1/16" plywood. The hatch for the radio compartment is similar and made of 1/8" balsa and 1/16" plywood. To hold the hatches in place, small

screws and metal plates are used. Sand the nearly finished fuselage carefully to the shape shown on the plan and trim the canopy to the right size.

The landing gear, made of two lengths of  $1/8$ " music wire, has to be bent to the shape shown on the plan and, afterwards, bound with copper wire and soldered together. The  $2\frac{1}{4}$ " wheels are fixed with collars. The tail skid of  $1/16$ " music wire has to be bent as shown on the plan and fixed with epoxy in grooves at the outside of the sidewalls. The rotor axle of  $7/32$ " straight music wire, together with the fixed mounted collar, has to be epoxied into the fuselage and then the lower support of  $1/8$ " plywood can be mounted in place. The correct location and alignment of this axle, perpendicular to the deck, is important.

The fin is a framework of  $3/16$ " balsa strips covered on both sides with  $1/16$ " balsa sheet. The rudder is made from  $1/4$ " balsa, sanded to shape and connected with two nylon hinges to the fin. The completed fin has to be glued to the top of the fuselage.

**Elevator:** The flying tail can be easily glued together on the plan. The framework is made of  $1/4$ " balsa. One half has two permanently mounted  $3/32$ " music wires, while the second half consists of two aluminum tubes of  $3/32$ " inside diameter which fit to the  $3/32$ " music wires. The distance between the wires and tubes must be in accordance to the linkage, mounted to the fuselage. To avoid the difficult exact drilling of holes into the framework to install the wires and tubes, it is much better to make these struts out of three thin pieces of balsa, glued together as shown on the plan and epoxy the wires and tubes between them. In order to hold the two halves of the flying tail together, the aluminum tubes should be slotted at the end with a thin bladed saw and pressed together to hold the wires in place during flight. After sanding to the shape shown in the cross section of the plan, the elevator halves can be covered with Mono-Kote or a similar material. Because the "Super Libelle" has the tendency to be tail heavy, the elevator should be made from soft balsa.

**Rotor:** First, the hubs have to be manufactured - - - pine blocks;  $3/8$ " x  $3/8$ ", and coverplates of  $1/8$ " plywood are the main parts. The dimensions and assembly steps are shown and explained on the plan. The ball bearing assemblies are epoxied in plywood discs of bearing thickness. A simple jig, as shown on the plan, guarantees the necessary accuracy of the ball bearing installation. To avoid any loosening of the hub parts during flight,  $1/8$ " O.D. aluminum rivets, made of tubing, have to be mounted as shown on the plan. The hubs for the lower and upper rotor are the same. The blade connectors have to be made from the same  $3/8$ " square pine



blocks used for the hubs and pine blocks 3/8" x 7/32" x 3/4" long have to be glued to the first ones. After shaping to the dimensions shown on the plan, the 1/8" diameter beech dowels are glued into the drilled holes.

The four blade connectors have the same dimensions, but require different shaping of the blade sides for the upper and lower rotors. A good fit to the hubs is very important.

The first step in making the rotor blades is to glue the leading edge of 3/16" x 3/8" balsa and the ribs, made of 1/8" balsa and 1/8" plywood to the 1/16" balsa blade bottom. The next step is the installation of the blade connectors and the 3/16" x 3/16" pine reinforcements to the first rib. The blade connectors should exactly match the cut-outs of the ribs and be glued carefully in place. After shaping, or sanding, the upper side of the leading edge to the height and direction of the ribs, the blade can be covered with 1/16" balsa sheet. All blade joints can be done with white glue. The lower tip of the blade has to be sanded to shape and the gap between the lower and upper sheet at the end of the rotor blade has to be covered with 1/16" balsa. After sanding the blades to the shape as shown on the plan (a template is very useful), the two blades have to be fixed to the hub with rubber bands and balanced carefully. To make the balancing easier, the balsa sheets for the blades should be selected carefully in order to have the same weight. Small corrections can be done by sanding the heavier blade, while larger corrections have to be made by epoxying lead to the lighter blade. The balanced rotor blades can then be covered with MonoKote or similar material.

To install the rotors on the axle, two distance tubes and two wheel collars are needed, the dimensions of the distance tubes are shown on the plan. To prevent any shifting of the wheel collars on the axle during flight, small grooves at the location of the collar fixing screws should be ground to the axle.

#### **FINISH**

The surfaces not covered by MonoKote need a finish in the manner which is usual for engine driven models. More important is the right location of the Center of Gravity. After the installation of the engine and the radio equipment, the location of the C.G. has to be checked and corrected as necessary. To make the C.G. check easier, two small holes can be drilled into the fuselage at the C.G. position shown on the plan, to allow for holding the autogyro with two wires. To correct the C.G. location, lead has to be added until the fuselage underside is in the horizontal position.

#### **FLYING**

First the autorotation of the two

contra-rotating rotors has to be checked, by holding the autogyro nose high into the wind. The rotors must start spinning very rapidly without vibration and should have enough clearance between the fin and between each other. If it is a calm day, you have to run with the model to start the autorotation, an angle of nearly 30° between rotor and the horizontal makes the autorotation easier. When the rotor check is performed without problems, the engine can be started and the carburetor needle positioned carefully. The engine should run steady in all throttle positions and should reach 10,000-11,000 rpms with a 9/4 prop at full speed. The hand launch is the recommended take-off method for this autogyro and it is important that the rotors are spinning rapidly enough before launch. When the rotors are running fast enough, the model should be released in the normal flight direction similar to a free flight model. After launch, the flight direction has to be controlled by small movements of the rudder and the turns should be wide until you are familiar with this type of model. Ascent and descent have to be controlled by engine throttle, since the elevator is only effective at full forward speed. Do not try to dive the autogyro at full engine speed! If you want to land the "Super Libelle", throttle the engine and land with the engine running, this gives a softer landing than with a dead stick.

I am certain, this unusual concept of R/C flying will fascinate you and I wish you many happy landings. □