

Flying board: within everyone's reach

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Design

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Project summary

Amateur airplane model builders have to constantly change aircraft in order to improve their skills. I decided to design an airplane that could be adapted to the ever-increasing skills of model builders. I will explain the different characteristics of my airplane through the design, testing and construction phases.

Project report

Aircraft modelling is a widespread hobby almost everywhere in the world. It is easy to find remote control airplanes both in Europe and America. Although anyone can enjoy flying model airplanes, it is a very expensive hobby. Although buying a single model isn't expensive, changing aircraft as your piloting skills improve can become quite costly.

Model builders can spend huge amounts of money going from beginner's models that are easy to fly to more involved models. This is where I came up with the idea to design a multifunctional remote control airplane known as the "Flying Board".

My approach

I asked myself what I could do to lower the costs associated with constantly changing models. That's when I got the idea of designing a device with variable flight characteristics, depending on the pilot's skill level. That way, a person interested in aircraft modelling could buy a single airplane and modify it in just a few minutes. The buyer could transform the plane's flight characteristics, turning the simplest model into an aerobatic model.

Desired characteristics

The following are the flight characteristics of models currently on the market. Since planes for beginners are relatively uniform, the characteristics are easy to identify. Advanced models, however, have a wide range of characteristics. For purposes of comparison, I chose aerobatic models that most resemble training aircraft (slow flying but very aerobatic). The following table of characteristics is based on these types of models.

<u>Characteristics</u>	<u>Beginner's model</u>	<u>Advanced model</u>
Stall speed ¹	Less than 20 km/hr.	Less than 25 km/hr.
Air speed	Up to 75 km/hr.	Up to 100 km/hr.
Stability	Very stable in all axes (positive stability)	Neutral
Spin angular velocity	180°/sec.	720°/sec.
Dihedral angle (angle between wing and horizon)	4°	0° to 1°
Power/weight ratio (HP/kg) ²	Approx. 0.5	Approx. 0.8

¹ Minimum air speed in still air

² Based on Carl Goldberg's Eagle II and Thunder Tiger's Fun Tiger G-200

Airplane performance

Using this data, I designed an airplane that could go from a beginner's model to an advanced model in a few seconds. The basic model is an aerobatic aircraft with a very thick symmetrical profile,³ making it slow flying but aggressive thanks to the oversized control surfaces (used to control the plane). The wing span is shorter than the length of the body, allowing for greater stability. There is considerable distance between the wheels for greater stability on all ground surfaces. I opted for a ½-in. thick flat fuselage because it is very lightweight and easy to build. The dihedral angle is only 1°, for neutral stability, and there is no engine power limitation, allowing for a ratio of 0.8 (HP/kg). For slow, stable flight (beginner's model), the dihedral angle has to be increased. Since the wing cannot be changed, the only solution is to add a removable wing portion with a very wide angle to increase wing surface and stability. Then, the centre of gravity has to be moved forward⁴ (from 37% of the wing chord to 30%) to increase stability during pitching. This way, like in aerobatic flight, a light weight is applied to the tail to push back the centre of gravity. The weight can be removed for more stable flight, causing the centre of gravity to move forward again. Finally, the deflection angle of the flight control surface⁵ has to be decreased by nearly 50% to reduce the sensitivity of the controls. These changes will transform an aerobatic aircraft into a very stable model for beginners.

³ Side view of the wing. The thicker it is, the slower the flight. If it is symmetrical, the airplane can do aerobatics.

⁴ Point at which the model could be balanced on a needle.

⁵ The angle at which the flight control surfaces move. The greater the angle, the more sensitive the aircraft in flight.

Building a prototype

I started with the fuselage, made entirely of balsa (a very lightweight wood). Since the fuselage is flat, this step was fast and easy.

Then, I built the tail assembly and all the control surfaces out of ¼-in. thick balsa dowels. As I mentioned earlier, the flight control surfaces are disproportionate because they are approximately 300% larger than on a normal training airplane. When in aerobatic mode, the control surface is used to maximum potential. When in slow-flying and stable mode, however, the potential is diminished.

The wing is practically hollow, with two longerons made of beech and the rest made of balsa to make it as lightweight as possible. I used the smallest possible number of ribs to reduce weight.

The wing additions are constructed exactly like the wing, except that they have a flat profile (for very slow flight). They each have three ribs, which increases the wing span by 9.5 in. from 46.5 to 56 in. This has a considerable impact on flight performance. The attachments are made of 1/8-in. steel rods that slide into the wingtip. The entire assembly is fastened with tape and can easily be removed.

The covering is made of blue, red and black Monokote.⁶ These contrasting colours make it easier to see the model in the sky.

⁶ Brand name

The 0.46-cu. in. OS⁶ engine drives a propeller with a 12-in. diameter and 4-in. pitch at 12 000 rpm. The engine runs on a 6-oz. tank of fuel (methanol, oil and nitromethane), providing considerable thrust at low speed.

Electronics

The airplane was specially designed to accommodate all types of remote controls and servomechanisms. In order to decrease costs, I opted for a JR receiver and standard servos. All the electronic components (e.g. receiver, battery, servomechanisms) used to control the aircraft are inserted in the wing and are readily accessible.

The remote control device can be programmed to increase flight performance, if desired. For example, the exponential function makes the controls very sensitive when all the flight control surfaces are in use, but sensitivity can be reduced as needed, making aerobatic flight a bit easier.

Performance analysis

The airplane seems to fulfill all the functions assigned at the outset. It is convertible and can be used by anyone. In easy-flight mode, the aircraft is simple to operate and offers no surprises for beginners. In aerobatic flight mode, it is extremely sensitive and manoeuvrable. It is a real pleasure to fly.

I was forced to modify my plans several times because the flat fuselage had too much flexion. To avoid starting over, I fortified both sides near the wings using 1/16-in. balsa wood, a simple but effective solution.

Conclusion

I think that convertible scale models like my airplane have a promising future, and will open up the world of aircraft modelling to a greater number people, at a lower cost. In

the next version of the Flying Board, the dimensions will be increased for greater stability and the engine power will be increased. In addition, a conventional fuselage will be used to increase structural resistance, and a removable wing will facilitate transportation. I hope that that the world of airplane modelling will be open to convertible aircraft in order to make this hobby more affordable for the general population.