Selecting Your First ARF Trainer
By Frank Granelli

IT HAS BEEN a long, but hopefully educational and not too difficult, road to this point. In the preceding "From the Ground Up" installments, Bob Aberle covered what an airborne radio-control system is, how to choose one, how to install one, and how to keep one working well. He also covered electric motors, batteries, and the basics of electric-powered RC flight. The articles before those detailed the mysteries of the modern glow engine in all its incarnations.

Although it resembles a basic RC trainer, the Piper Cub has a big wing with ailerons near the wingtips, causing adverse yaw. Narrow landing gear results in poor ground handling. Mark Lanterman photo and aircraft.

If, at times, it seems that there is more information than you really want, it is because the "From the Ground Up" concept is to present everything that a new RC pilot will need to know in the first few *years*. It is hoped that learning the technical aspects of model aviation from these articles or from fellow pilots might be more fun—and less expensive—than being educated by "Fractured Balsa University." With this in mind, let's move on.

At this point we have an engine and a radio system. Nice, but we need something to house these items. It would be convenient if this housing for the engine and radio were also able to lift the assembly off of the ground.

There *is* such a structure, and we call it the airframe, the model, the airplane, or other less-polite names when all is not working well. Whatever it is called, the airframe is the next topic. Specifically, I will be discussing ARF and RTF aircraft.

Yes, there are many other types of model airplanes. Some are built from wood kits—assembled one stick at a time—and then covered. Some consist of fiberglass fuselages and Styrofoam (foam) wing cores with balsa sheeting. Some are built straight from plans. In that process, the builder cuts the wood into all the pieces of a kit and then starts the assembly. Last, there are modelers who design their own aircraft, draw the plans, create the kit, and then build it. Future "From the Ground Up" installments will detail all of these airplanes.

The following articles will cover the types of airframes available and which are best suited to learning the basics of RC flight. Along the way I will include some thoughts about how to modify RTF and ARF airframes to improve performance and durability. Proper balancing is important, as is building the airframe straight and true.

Sport aircraft such as this Sig Four-Star 60, with its symmetrical airfoil, are somewhat gentle but fly faster and respond quickly. They are designed for aerobatic flight regimes—not basic training chores.

RTF and ARF appearances are usually predetermined, but there are some ways in which even beginning pilots can make minor changes to the looks to set their aircraft apart from all the others. Radio setup can be optimized on many models—even on some RTF airframes.

The sheer number of ARF and RTF aircraft is astounding. There are Scale models that replicate full-scale airplanes and competition models meant for aerobatic-performance contests. There are basic trainers, biplanes, second aircraft, sport models, 3-D performers, and some that defy any logical description.

All of those accomplish their design tasks far better than their compatriots of just 20 years ago. But new RC pilots will usually find it best to begin with a "basic trainer"-type aircraft.

Why begin with a good basic trainer design? It is possible to learn RC piloting on any type of model, but sport or Scale aircraft react quickly to control inputs, leaving less time for the new pilot to plan the *next* control inputs. Also, takeoff, in-flight, and landing speeds can be higher with the more reactive models.

Sport and Scale airplanes demand more from the pilot than most basic trainers. In addition, their higher airspeeds and quicker control responses mean that this "more from the pilot" must happen more quickly. This requirement that the pilot be "further ahead of the airplane" makes learning to fly RC with a sport airplane more difficult and time consuming.

There are so many excellent sport ARF designs that make great advanced trainers or second models that many new pilots want to use them as their basic trainers. This is possible, but sport aircraft have certain drawbacks in that capacity.

Slower, yet honest and responsive, basic trainers such as

Hangar 9's RTF Alpha 60 can take a new pilot from starting out to solo flight in just weeks. Notice the flat-bottom wing.

Although high-wing advanced trainers such as the Midwest Aerobat, which is shown, may resemble basic trainers and even have similar wing loadings (the weight each square foot of wing area must support), their design criteria are different, as are their wings' airfoils.

The Aerobat and its cousins, which include Hobbico's Avistar, Hobby Lobby's Bonnie 20, and Hangar 9's Arrow, feature symmetrical (or semisymmetrical) wing airfoils that have less lift than equivalent flat-bottom trainer airfoils. I will explain *why* shortly. A symmetrical wing is curved equally on the top and bottom, and a semisymmetrical wing is curved on the bottom but more so on the top.

The symmetrical wing allows for easy inverted flight, Outside Loops (loops with the airplane upside-down, performed using down-elevator), faster aileron response, and good Snap Roll/Spin performance. But landing speeds are higher and the symmetrical-airfoil wing is more responsive, making these second aircraft sensitive to control inputs.

The symmetrical airfoil actually has slightly less air drag than an equivalent flat-bottom wing. This means that the aircraft gains more airspeed than a basic trainer if the student pilot lets the nose drop in a turn. Aerobatic trainers will not "balloon" as much (raise the nose and climb) in this situation as basic trainers would. That is a plus for them.

Hobbico's NexSTAR keeps flying even at 6 mph. This RTF basic trainer features high-lift wing devices, flaps to control airspeed, and three-axis flight-stabilizing system. It also comes with a PC-based flight simulator.

However, the increasingly rapid descent in the turn usually causes the new pilot to input substantial up-elevator, causing the aircraft to rocket upward or tighten the radius of the turn. Learning to make level turns is the first step in becoming an RC pilot, and aerobatic trainers make that more difficult.

These second airplanes are designed to take a *newly soloed pilot* beyond basic flight and into the exciting world of aerobatic flying—not to be the best basic trainer.

Some Scale aircraft would seem to be ideal basic trainers and do use flat-bottom airfoils, but they are better suited as second models. The Piper Cub, for instance, is extremely short coupled; the tail is close to the wing, given its wing's large span and width (wing chord). Without perfectly set aileron differential, one aileron moves upward much farther than the other moves downward, and the Cub needs coordinated rudder/aileron input to make proper turns. Coordinated turns and aileron differential can be daunting for most new RC pilots and is seldom necessary in a basic trainer.

The Cub's short fuselage and narrow landing gear make ground handling troublesome for new pilots. Its light wing loading and large wingspan compound landing difficulties because the aircraft tends to land on the main gear and keep the tail up. This usually means that the wing drops to one side, pulling the aircraft off in that direction, or the model ends up on its back.

SuperStar EP, offered in RTF and ARF format, is three- or four-channel, electric-powered basic trainer that handles and performs like a glow-powered aircraft. Flight times can reach seven minutes.

Yes, a new pilot can begin on a Cub or similar Scale model, but learning is easier on a basic trainer that is designed expressly for teaching RC piloting.

A good basic trainer has several design features to ease this learning process. Most important is that the wing usually has a flat bottom and a curved, or airfoil-shaped, top section.

As far as I know, only one basic trainer—Hobbico's Hobbistar 60—uses a semisymmetrical airfoil, and its wing is made overly large to compensate. Without delving into total eye-numbing detail about why an aircraft flies, this type of wing produces more lift than a similar symmetrical wing with equal airfoil shapes on both sides.

HobbyZone's Firebird Commander RTF electric-powered basic trainer teaches absolute basics of RC flight and seldom requires an instructor. It is ideal for sampling RC flight before making a full commitment.

The air flowing over the curved top section of a flat-bottom wing must move faster to cover the longer, curved distance than the air flowing over the straight bottom. According to Daniel Bernoulli's theorem of gaseous density, the faster a given amount of gas moves, the less dense it must become if all other conditions remain the same.

If the air above the wing has reduced density, the pressure it exerts on the wing's top is lower. This means that there is a "low-pressure" area above the wing. The wing tends to move upward into the low-pressure area, taking the rest of the aircraft with it.

But then how does an aircraft with a fully symmetrical wing fly? Daniel Bernoulli is on vacation where this wing is concerned, but, fortunately for all sport and Aerobatics pilots, Sir Isaac Newton remains in the house.

High-performance advanced trainers can also be electric-powered, such as Hobby Lobby's Bonnie 20, shown temporarily on floats. With proper motor and batteries, it can fly for as long as 16 minutes.

If the wing is pointed upward to the airflow even a few degrees—called a positive angle of attack—much of the air striking the wing's LE is redirected downward. But Sir Newton demands that for every action (here the redirection downward) there is an equal and opposite reaction. Therefore, the wing is "pushed" upward, creating lift.

This is all a *gross oversimplification* of why an aircraft flies. There is still much debate about this subject even after 102 years. However, this basic explanation serves to illustrate *why* a flat-bottom wing has more lift per square foot than a symmetrical airfoil.

Of course, Newton's law also affects the flat-bottom airfoil--maybe even to a greater degree than it does a fully symmetrical wing. But Bernoulli and Newton work together on a flat-bottom wing, generating that extra lift.

Extra lift means slower takeoff and landing speeds, lower stall speeds (the speed at which the wing stops producing lift and begins resembling an anvil), fewer bad habits such as snap stalls in tight turns, and generally an all-round more rewarding learning experience.

Midwest Aero-Star 40, with flat-bottom and extra large wing, is one of the prototypical 40-size trainers that many RC pilots use to earn their wings.

It helps if the wing is placed on top of the fuselage (a high-wing configuration) and has some positive dihedral; the wing is bent in the middle so that the wingtips are higher than the center-section. The fuselage below the high wing imparts a slight pendulum effect—but every bit counts in a good trainer. The dihedral reinforces this pendulum effect.

Combining these two features helps to create an aircraft that will tend to stay in wings-level flight during straight flight and loops. They also help the pilot recover the aircraft from most turns. Fewer pilot corrections are therefore required in all of these flight regimes.

Dihedral has other effects, but some are not so beneficial. It allows the rudder to be used to bank and turn the aircraft better, but too much results in a model that requires continuous aileron input to remain in a banked attitude. This is bad because it teaches a new RC pilot bad habits. On the other hand, a reasonable amount of dihedral, such as the three inches on Hangar 9's Alpha 60 RTF which is shown, adds a great deal to a trainer's teaching abilities.

Basic trainers are not necessarily boring. The Lanier Explorer 40 performs simple rolls after completing three consecutive loops.

Power-plant selection is also important when studying a basic trainer. As far as I know, all RTF basic trainers that are powered by engines are two-stroke designs; these include Hobbico's NexSTAR, which is shown. If the pilot prefers to use a four-stroke engine, he or she must select an ARF.

There are also a few electric-powered basic trainers. Some, such as Hobbico's SuperStar EP Select, which is shown, are complete, four-channel RTFs. Others, such as Horizon Hobby's HobbyZone Firebird Commander, also shown, are basic, two-channel RTFs.

Engine-powered ARF basic trainers such as Midwest's Aero-Star 40 and Lanier's Explorer 40, which are both shown, offer the new RC pilot choices of radio system and engines that are unavailable in RTF models. However, this luxury comes at the cost of additional assembly work that could require basic model-building skills. RTFs require only that the new pilot be vaguely familiar with which end of the screwdriver points toward the work.

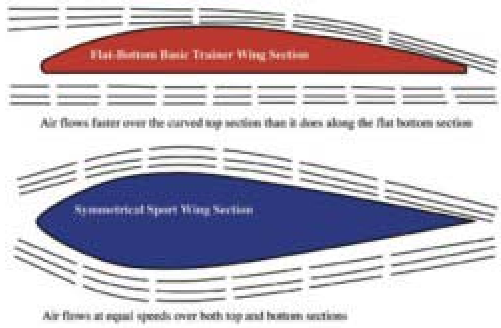
Midwest Aerobat is outstanding flier with semisymmetrical wing. Twin aileron servos allow computer transmitter to use ailerons as flaperons for extra lift, speed reduction, and amazing attitude changes when coupled to elevator.

The amount and type of assembly work involved in ARFs and RTFs (it's hard to call preparing those models for flight "building") is all that separates the two. As you can see in the photos, they look almost identical. And the two types do fly the same since there are few airframe-performance differences. There are performance differences, however, if the pilot equips an ARF with more powerful engines/motors and more capable radio systems than are usually found in an RTF.

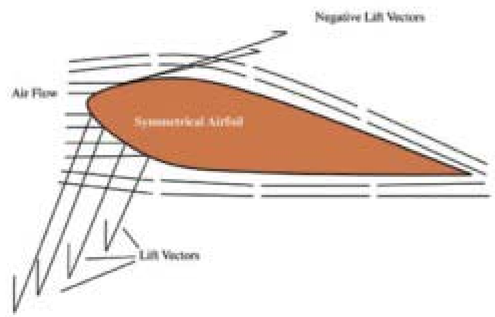
With the exceptions of the Hobbico NexSTAR powered by the O.S. Max .46 Fxi engine, the HobbiStar 60 Mk III using the O.S. Max .60 LA engine, and the Hangar 9 Alpha 60 equipped with the Evolution .61 engine, all RTF glow-powered aircraft currently use .40 cu. in. power plants. No matter how good a .40 might be, and all of today's engines are good, a hot .46 offers more performance.

HobbiStar 60 Mk III uses slightly semisymmetrical airfoil, but its overly large 875-square-inch wing area makes up for any missing lift. Its airfoil does improve inverted flight performance. Photo courtesy Ron Farkas.

Except for the Hangar 9 Extra Easy 2 with the five-channel JR XF-421 computer radio system, all RTF basic trainers use analog four-channel radio systems for control. The NexSTAR does have an installed flight-stabilization system, which is similar to an autopilot but without direction control, but its transmitter remains a good four-channel analog system.



Since air must travel a longer distance over the curved top of a flat-bottom wing in the same amount of time, it must move faster than the air below the wing. The faster the air moves, the lower the density.



Top and bottom, air moves the same speed over the symmetrical airfoil. Therefore, the wing must be pointed up to have any lift. Total lift is less than with a flat-bottom wing, but the symmetrical wing can fly equally well upright or inverted.

Whether a pilot chooses an RTF or an ARF airframe as a basic trainer is his or her choice. Both offer excellent aircraft and performance. But as good as these aircraft are, there is always room for improvement and for pilot individuality.

Next month I'll build an RTF trainer and make a few easy improvements. Following that, I'll look at the ARF world and show you how to make these fine aircraft look different and perform better.

Until next time, you can review many of these aircraft on Sport Aviator, *MA's* online magazine, at www.masportaviator.com. ***MA***