Model Airplane Secrets

Basic to Advanced Strategies

On Model Building

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INTRODUCTION

The Joy of Flight

You've always had that dream. You know the one, you take a step and all of a sudden you're soaring above the clouds. Ever since childhood, the mysteries of the deep blue sky above have attracted you. You wanted to be an astronaut, a pilot, anything to get you *up there*, where you'd have limitless freedom to bank and turn and glide above the static world below.

But, sadly, life got in the way of your flying dreams. Somehow, at some point, the line of people destined to become pilots diverged from your own. How and why this happened is a personal tale, but it doesn't mean those dreams must be lost forever (and if you did end up becoming a professional flyer – well done!).

Thousands of people take up flying each year, but they attend no courses, enter no cockpit, and don't even visit an airport. Still they get the sensation of freedom, the command of controls, the satisfaction of a great landing on a blustery day.

Welcome to the world of model airplanes.

When most people think of model airplanes, they envision a nice tidy box with pieces to be put together like a puzzle, the final product being a cute little plane to set on a shelf to be admired but not touched. While this certainly describes one type of model airplane, it's another category altogether that we'll focus on in this book.

We'll discuss something that's more a passion than just a simple hobby. The type of model airplanes in which we're interested can have wingspans of up to 20 feet, can reach speeds up to 200 miles per hour, and can travel as far as the eye can see. These are serious planes for serious hobbyist.

The great thing about model airplanes is that there is something for everyone. You can choose a simple plane, perfect for a child or novice flyer, or build one from the ground up and get involved in some serious competition. Prices for model planes vary from $30 for an off-the-shelf model to thousands of dollars for a one-of-a-kind creation.

People of all ages can enjoy this exciting hobby. If you're looking for something new and different, something exciting and fun, then model airplanes could very well be the answer. As you'll discover in this book, there are hundreds upon hundreds of incredible models from which to choose, each with unique characteristics.

Each with its own special thrill.

Because of the hobby's great diversity (and the wonder of flying), you'll have a blast getting started and quickly become hooked! And this is a social pastime--there are many clubs where you can meet other model plane enthusiasts, plus get the opportunity to watch experts at work.

Convinced? Well then, you've got a lot to learn. So sit back, tighten your seatbelt, and put your hand on the throttle--it's time for lift off!

In The Beginning….

A Frenchman, Alphonse Penaud, is generally credited with the first public demonstration of a model airplane. His rubber-powered model plane "Planophore", made its public appearance in Paris in 1871 and flew 131 feet.

He had first worked on rubber powered helicopters before turning to fixed wing aircraft and he is credited as an early inspiration by the Wright brothers who went on to develop the first powered aircraft after their father gave them a toy helicopter based on Penaud's designs.

The Wright brothers Kitty Hawk

The famous Wright brothers flight with the *Kitty Hawk* in 1903 generated some interest in modeling and a model club was formed in New York in 1907.

Although the designs of these initial planes were very basic--they were generally constructed out of materials like bamboo, pine, spruce, basswood, and tissue paper--they offered a means for plane enthusiasts to enjoy traversing their own little piece of blue sky.

Meanwhile, back in the full-scale world, the 1920's and 1930's became what was called the "Golden Age of Air Racing." During the Great Depression people participated in air races for a chance to win thousands of dollars. This incentive inspired many inventive souls to build race planes in the hope of winning the big prizes; everyone needed the money in those days.

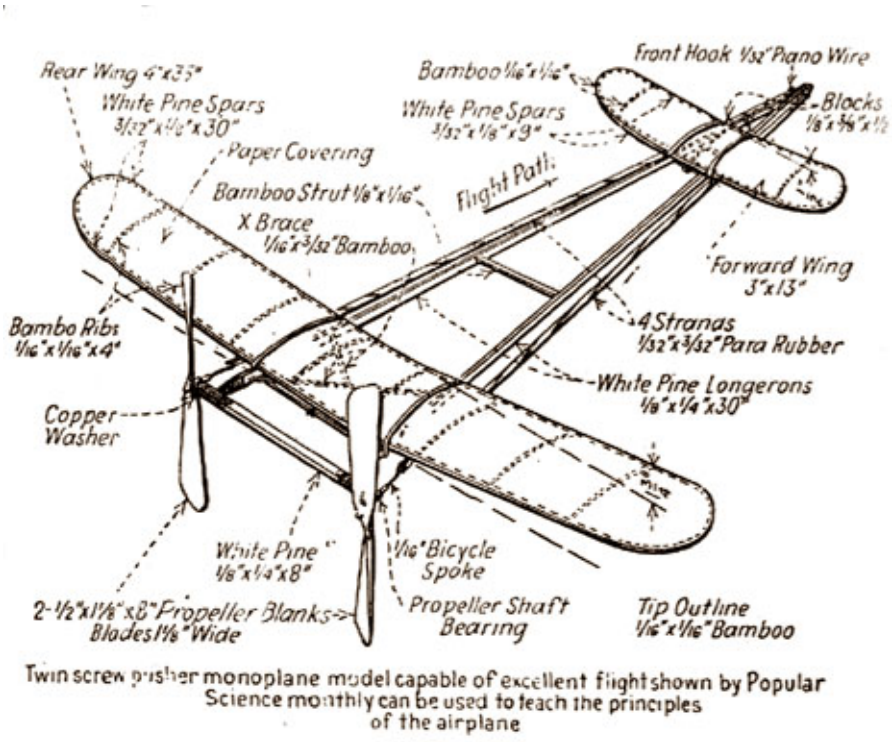
With big financial incentives the competing designs soon turned into serious racing planes capable of clocking amazing speeds. As air racing became more popular, the enthusiasts vying for the big prize began to include entrepreneurs, aircraft companies, members of the military, and even some ordinary folk.

The Granville brothers of Massachusetts, for instance, began building a two-seater biplane called the Gee Bee Model A. It was a tremendous success. Following up on their groundbreaking creation, Granville Brothers Aviation continued the quest and built the Gee

Bee series of aircraft which became among the best-known (and some say most dangerous) race planes of that era. One one occasion, making $16,000 in prize money against a cost for building the airplane of $5,000.

The Gee Bee racer – all engine in the pursuit of speed. No wonder it was considered difficult to fly.

Coupled with this enthusiasm for air races, it was Charles Lindbergh's flight across the Atlantic to Paris in 1927 which really fired the public imagination with several thousand model kit manufacturers springing up in the year following his flight.



Twin screw pusher monoplane model capable of excellent flight shown by Popular Science monthly can be used to teach the principles of the airplane

An early twin-pusher model – it remains a very successful design.

Today the world of do-it-yourself aviation is stronger than ever, though the desire to build one's own flying machine is usually sublimated into a passion for model airplanes. You'll find thousands of clubs around the country, and hundreds of model planes from which to choose. There are, however, different niches from which to choose: many people involved with model planes simply want something small and easy; others go all-out, looking for the maximum in power and speed.

How did all this begin? Radio-controlled flight, usually referred to as RC, was largely developed by people with interests in both flying and amateur radio, like two early pioneers

named Clinton DeSoto and Ross Hull, who flew gliders in the first public exhibition of RC flight.

About 1933 the first gasoline powered engines were developed for model airplanes. Although this made the model more realistic it also created the problem of preventing your model with its expensive engine simply flying off over the horizon. It was Clinton deSoto who first envisaged radio as the solution to this problem. At that time radio was in its infancy. It is difficult to believe in this day and age when there is so much computing and communicating capability wrapped up in the form of a mobile phone that the simplest radio set up achievable at that time to operate a single channel weighed in at 5 lbs (2.3kg). The 'model' airplane developed to carry this little lot had a wing span of 18 ft and had a total weight of 20 lbs! With continuous development and help from his colleague, Russ Hull, from the developing radio world the weight of the radio equipment was progressively reduced.

Two other names must be mentioned in conjunction with the origins of RC: the twin brothers Bill and Walter Good. Walter had an enormous passion for model airplanes while Bill understood radio transmission, and together in 1937 they built the first RC model plane. That first plane was given the name "Guff," had an 8-foot wingspan, and weighed 8.5 lbs.

For the 'Guff', two radio frequencies were used: one to control the elevator and the other, the plane's rudder (we'll go over these terms soon). The servo was mounted on the tail surface, and an outlet and extra-long extension cord was used for the transmitter.

Just as the Kitty Hawk was the beginning of something wonderful for flying, the Guff was considered a huge step in the history of model planes. You can still see it on display today at the Smithsonian National Air and Space Museum in Washington.

As you'll learn in this book, radio-controlled planes have come a long way. While some people use them as toys for amusement, others are serious competitors. If you're interested in model planes, you can choose anything from a high-wing mounted trainer to sailplanes to jet powered models of modern military aircraft. The sky's the limit!

In addition to model choices, you also have a huge selection of price ranges. When you start

looking at all the components you can add, it gets really exciting. So, as you can imagine, the world of model planes can be a bit overwhelming. That's what this book is for - to help guide you through the whole process, from buying to flying.

GETTING STARTED

Now that you have a little background on model planes, you'll want to figure out what it takes to get started--to make sure this is truly the right venture for you. There are many initial considerations with model airplanes--here we'll go over the basics so that you'll know what to expect.

Cost

The cost of your hobby can be whatever you decide to make it. The principles of flight remain the same whether you make paper airplanes from cast off copy paper or the most complex, technical models. All the same, before you do anything else, it's wise to determine your budget--and then stick with it. For instance, if your really strapped for cash you can find sites on the web which show you how to build models from paper and cardboard, or you could buy a nice fun plane for as little as $100--or spend $1,000 or more for just the basic equipment of a high-end version. Know in advance where you'll fall on the scale.

Packages are available that come with all the equipment needed--these often start around $250 for a beginner, and head into the thousands for those involved in competitions. (If you want to race, there will be costs associated with travel and entry fees.)

This can be an expensive sport, and can get out of hand if you allow it to, so it's best to understand the financial aspects of model airplanes before you go out to buy. Yet keep in mind that you do not have to spend a lot of money to enjoy model airplanes; if you pay attention and give it your all, you'll have a blast no matter how much you spend. Don't forget that everything you learn with a low cost model will save you money when you move on to something more expensive.

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A B-17 model. An indication of what you can achieve. Good to dream about but best to keep your dreams in check as a beginner

Trainer RC

Radio-controlled model airplanes are controlled by a radio system that consists of a transmitter (the box that remains with you on the ground), a receiver, receiver battery, and servos. The majority of radio systems are sold with everything needed, which often includes a rechargeable battery pack. It's best to seek the assistance of a professional instructor when learning to fly your model (for reasons we'll explore shortly). One advantage of learning with an instructor is that he or she can teach you on what is called a buddy system.

This system is similar to those found in driving-school cars. The instructor has controls just as the student does. In RC buddy systems the instructor will start out controlling the plane with his controls, then gradually allow you to take over. However, if the instructor sees you're about to get into difficulties, he or she can quickly take over, saving you both cost and embarrassment which usually come in equal quantities when your model makes unplanned contact with the ground!

Trainer planes generally use a radio with four channels. One controls the throttle, one the elevator, one is for the rudder, and the fourth is for the ailerons. More on this to follow….

Engines

When you hear about the size of a model airplane, it will usually refer to the size of engine needed to power it (measured in cubic inches). Typically models will be described as a size 20 (which needs a .20 to .36 engine), 40 (.40 to .53) or 60 (.60 to .75). These sizes refer to the capacity in cubic inches, e.g. 0.36 cu in, of the most popular 2-stroke glow engines in use and will be adjusted if you change to a different type of engine.

Typically, trainer planes have .40 to .53 engines, because the size of model powered by engines of this capacity offer good stability, the engine gives adequate power for windy conditions, and affordability. Yet some trainers are larger and have engines in the 60 category. The bigger size gives greater stability and easier visibility after take off.

Just as model airplanes come with various engine sizes, they also have a range of power sources. For instance, an electric motor is powered by a battery while glow and gas engines run from tanks of their respective fuels. Sailplanes or gliders, on the other hand, have neither engine nor fuel and fly on naturally occurring air currents, though some use electric motors to attain greater heights.

The most popular choice of engine is usually the two-stroke glow engine. After many years development these are reliable and economical and are considered a good choice for beginners. The lower cost versions are built with brass bushings to support the crankshaft. (We'll get into engines in depth a little later.)

A more advanced version would have the crank shaft supported by a ball bearing race instead of the brass bushing. This type is often identified as a **BB** engine. The ball bearings create less friction with the crankshaft and the engine therefore produces more power and has a longer life. The only drawback is that the ball bearing type of engine is more expensive to produce and will cost more to buy.

Another option is the four-stroke glow engine. Though not quite as powerful as the two-

stroke engines, and a little bit more expensive, with the four-stroke you do benefit from more torque. This enables these engines to drive bigger propellers, uses less fuel, and produce a sound nearer to that of a real airplane.

Power, Speed, and Distance

Another important factor, especially if you plan to race, is the power source. As we've already discussed, a radio-controlled model airplane will often be powered with a two-stroke engine that burns a mixture of methanol/nitro-methane/oil, known as glow fuel. However, there are also four-stroke engines, quiet electric engines, and others as well. The method of power will determine your maximum speed.

Airplanes suitable for beginners generally max at about 25 miles per hour and land at speeds between 12 and 15 mph. Yet if you choose a modified type of plane, a customized job, you can reach speeds up to 200 mph--amazing for a model, right!? Just go and look at this video for an example:

http://www.hugi.is/hahradi/bigboxes.php?box_id=51208&f_id=1277

As for distance, the radio-controlled models on the market today will go about one mile. Just remember--you have to maintain control of the plane, which means you have to be able to see it. Therefore, even if you're flying a plane with a six-foot wingspan, once it's half a mile to one mile away, depending on visibility, it will be nearly impossible to see and to have full control.

Adhesives

"Glue" has moved on a lot in recent times and you will use a range of different adhesives depending on the materials and the requirement. Here's some basic information.

Cyanoacrylates. Commonly known as CA (hardly surprising, really) in the modeling world and 'Instant' or 'Super' glues to everyone else. Good for wood, plastic, metal, glass, ceramic, fabric, rubber, fiberglass, carbon fiber or combinations. CA comes in different thicknesses or viscosity. Thinnest are excellent for gluing balsa as the very thin glue can be applied to the edge of the join and will penetrate both the join and the surrounding balsa wood to create a strong bond. The downside of this very thin viscosity is that it cures or 'goes off' very quickly, literally in seconds. To speed up curing even more there is another product called an accelerator which will cure the top surface of the adhesive instantly and then progressively cure the remainder.

CA debonders

Sometimes CA 'superglues' are just too good and you end up glued to your own model. Debonders can remove cured CA glues from skin, work surfaces, most plastics, and model finishes.

Epoxy resins

Epoxy resins come as two part adhesives, one part resin and one part hardener that have to be mixed to become active. Vibration resistant and fuel proof, epoxy is perfect for fire wall and engine mount installations, for attaching bulkheads and formers in epoxy glass fuselages. Like CA the curing time can be adjusted according to the ratio of the mixture you make up. Since epoxies cure by an exothermic chemical reaction, (that means they give off heat) and heat can speed the cure of epoxy, mixing large amounts can mean it hardens and becomes unworkable before you have had the chance to use it.

Finishing resin

Finishing resin is a light weight two part epoxy laminating / finishing type resin used when fiber-glassing. It can also be used to seal all engine and fuel tank areas. It is absolutely the best for sheeting foam wing panels. It will bond to itself and does not get brittle with age. Finishing resin can also be used to seal and prepare all types of wood projects for painting. Finishing resin will penetrate into porous wood, so several applications may be required to fill and level the surface.

Clear or Canopy glue

Don't go spoiling your beautiful model by using inappropriate glue on the clear Perspex canopies and windscreens when there are special canopy glues available. They're actually just another type of glue for plastics and vinyl with the advantage that they dry clear and transparent.

Field Equipment

After you've purchased your model airplane, you'll need what is called "flight line equipment." This includes things such as fuel, a fuel pump, equipment for starting the engine, and so on. Typically this field equipment (with the exception of fuel) will be only a one-time purchase.

The glow fuel has a percentage rating that indicates its nitro-methane content. For a trainer plane you want between 10% and 15%. Be sure to use quality fuel with a blend of synthetic lubricants and castor oil, as this will protect your engine. People often go with a cheap fuel, thinking they are saving money, only to find the moisture in the fuel causes rusting, ruining their equipment.

Other field equipment commonly required include a power panel, 12-volt field battery, DC battery charger, glow plug clip, glow plugs, and propellers. If you bought your airplane RTF then you may well not need this equipment as everything will be supplied in the box. If you build your airplane from a kit then you will probably find that you will accumulate most of these tools and equipment as you go along. Then you just need a convenient box to put them all in.

Tools

Whether a beginner or an advanced flyer, you'll always need to keep a few things around to help you keep your model airplane in top working condition. Among them: masking tape, pliers, sandpaper, a cordless drill, T-pins, a hobby knife, and a variety of screwdrivers. Keeping these in a handy travel kit handy will allow you to take care of problems that develop in the field.

Other things to keep around include covering, an adhesive backed fabric or plastic; pushrods to link the radio-system servos to movable parts of the model; a control horn; hinges; foam rubber; wheel collars; wheels; wing seating tape; spinner; fuel tank; tubing; filters; an engine mount; and various engine accessories.

Of course, these things add up which is why it is always worth keeping components from your old models. One day you will be able to reuse them.

Those "'Oh dear!..." moments

Unfortunately, crashes happen. Bad ones can do significant damage to the airplane and your wallet, so they're best avoided if at all possible. While we'll help you learn how to fly safely and with confidence, which will head off most crashes, they will still happen. So understand that routine maintenance and repairs, fixing (and sometimes trashing) planes and replacing parts as you go, is just a normal part of the game, and is to be expected. Remember, there is no such thing as a mistake, only a lesson to be learned.

TYPES OF AIRPLANES

There are many different types of model airplanes, so this chapter is dedicating to outlining the major types--we'll also give some examples associated with a few of the categories. Armed with this information, you'll have a much better idea of your options when you're ready to buy. (There are also numerous types of engines, which will be discussed in-depth in a subsequent chapter.)

Static Airplane Models

Just like the flying variety, static models can vary from the cheap and cheerful to the deadly serious with the choice of size, cost and the quality of the finished model being entirely your own choice. The most common variety to be found is the plastic model found in most toy shops and it is this type of model which is often the introduction to the hobby for many who go on to become serious aeromodellers.

If my own experience is anything to go by, your early efforts of gluing and snapping the parts together will probably be rather messy and taking the next step of painting and finishing with the stick-on markings known as decals can often be delayed. But eventually it is the realization that careful preparation and handling and, above all, patience learned from assembling these models that will have most effect on the quality of your finished model and will be the foundation of your later success.

The parts for these kits are made by the process of injection moulding where molten plastic is forced into pre-prepared moulds where it sets. This allows great accuracy of details and finishes which are machined into the moulds – even down to lines of rivets and other small details of the full size aircraft on which the model is based. Painting and finishing in the colours actually used then enables the modeler to produce a very high quality representation of the original, accurate in every detail and frequently put on the bookshelf or in a display cabinet.

The popularity of such models dropped rather over the last twenty years, perhaps as a result of computers and flight simulation games which took the attention of young aviation

enthusiasts. Today, interest is returning again.

Of course, models can be made from any material. Aircraft models carved from mahogany are a common display item. However, these represent the skill of the carver rather than that of the owner and tend to be a visual representation rather than an accurate scale model. It is a very accomplished modeler who is able to begin from scratch in any material and build an accurate model.

Lets not forget that static models often serve a serious purpose. Scale models are built by airplane manufacturers to test their theories and new production types in wind tunnels, data is collected and then actually used to determine the design of full-scale planes. However, for the collector, the static airplane is a model requiring construction, gluing, painting, snapping, decal application, and so on.

What are the benefits of choosing to build a static model? Well, it requires you to develop the skills and patience necessary for model construction, and thus is a great learning tool. When the model is complete, you'll have something of which to be proud. Usually, these planes come in scales of 1/144, 1/72, 1/48, and 1/32, (1/32 means the model is 32 times smaller in every detail than the original) although there are a few odd scales sold on the market.

Flying Models

The use of flying models is often referred to as "aero-modeling", whether it is for fun or competition. The flying model plane may frequently be designed and built according to exactly the same principles that apply to a full-sized airplane. So the construction of this type of plane can be considerably more difficult. This is not always the case. The strength of materials does not change in scale. So for example a wing can be cut and shaped from foam for a model because the strength of the foam is sufficient for the greatly reduced weight of the model - but this would be impossible for a full sized airplane.

The key to model airplane construction is lightness. So flying model planes will normally be made mostly from a very light wood like balsa and covered with a skin covering – or whole sections such as the wing illustration may be formed out of a strong, light material such as foam. In the early days, and still to be found today, the covering was a tissue paper skin painted with dope. Surprisingly, when the dope dries and hardens, it shrinks the tissue paper over the frame of the airplane, making a very light but strong construction with a hard, though rather delicate finish. These days, modern technology offers greater strength and robustness with very thin and light plastic materials. Traditionally, the fuselage is built up of longerons and formers along with ribs and spars for the tail and wing surfaces. In the more sophisticated models these may be made from solid sheets of thin ply or increasingly these days from very strong, lightweight composite materials.

Models can be powered with many different types of engines, though, because the builder is trying to produce a model as faithful to the original, full-sized airplane as possible, a balance must be struck between the power required and the size, sound, and appearance of the engine (which may have to be disguised).

Kits Versus Pre-builts

Until just a few years ago, models were only sold in kits. You opened the box to discover a bunch of parts, plans, hardware, and an instruction manual. The kits on the market today are the same. Many people enjoy building kits and going through the entire process of putting the plane together.

However, not everyone enjoys spending weeks or months building a plane when their main interest is to fly one. If this is your preference then choose a pre-built plane, which is also a great option for beginners.

The best and most obvious characteristic of the pre-built model airplane is that everything comes factory assembled. You know the plane is built well and you don't have to spend too much time putting it together. For those who want *some* assembly experience, there are models sold in varying degrees of completeness. Pre-built planes include the following types:

RTF

RTF is the acronym for “Ready to Fly”, which means that very soon after taking everything out of the box you can have the plane in the air. You’ll have very few things to assemble. Or, you can also find what are called “true RTF’s”, pre-built kits where *everything* is assembled, including the radio gear and engine.

ARF

This is the acronym for “Almost Ready to Fly”, a type of model airplane that is just that - not complete, but almost. After some hours of assembly, which varies with the kit, the plane will be ready to go.

Typically, this type of pre-built comes with the wing halves, tail fins, and fuselage completely assembled and covered. Therefore all you have to do is fit those sections together, install the radio gear and power plant, attach the landing gear, add a few small pieces of hardware, and you’re finished.

If you decide to buy a kit to build yourself then you may well have the choice of pre-built wings or building the wings yourself. As a beginner it is preferable to pay the small extra cost and buy the pre-built wings. These are usually a moulded foam core with a thin wooden veneer. These are more robust and much less likely to be badly damaged in an accident.

More Acronyms: Free Flight and Control Line

FF - This is the acronym for Free Flight, which is a type of model airplane designed and built in such as way that the plane can fly without any kind of attachment to the ground. It may be a glider or even powered, though fitting an engine to an airplane over which you have very limited control is hardly sensible as the early pioneers discovered. A free flight glider on a successful flight may have such good flying conditions that it continues to climb in thermals and can easily be lost. To prevent this they can be fitted with a de-thermaliser. This is a mechanism which, after a fixed period of time, will lift the elevators so that the aerodynamics of the glider are badly affected. This will bring the model floating gently to earth, hopefully still in sight of the owner so that it can be easily recovered.

C/L - Also known as Control Line, this plane is made to be flown with the use of wires attached to a control handle held by the operator. Typically, two lines lead from the control handle to the inboard wing tip of the plane to a mechanism that translates the handle movement to the airplane elevator, allowing maneuvers to be performed along the airplane pitch axis. In simple terms you can only adjust the height of the plane but in practice you can fly the model in the complete hemisphere centred on you. This poses some unique and exciting challenges for the flyer, especially in competition with others. Of course, it also avoids the cost of RC equipment so may be an option you can explore.

Another variation of the C/L plane is the RTP, or Round-The-Pole plane which was developed in the early stages of electric motors and provides power to the model through a low voltage cable which also serves as a tether connected to a rotating bearing on top of a pole.

Gliders and Sailplanes

Glider model planes are usually launched by hand, or with an elastic bungee that catapults them into the air. Obviously, to fly successfully without an engine, the glider must be flown when conditions are right, so the plane can get the required lift. A warm, still day, when warm thermal columns of air are rising through the atmosphere, is ideal.

The original gliders, before the development of radio control, were free flight models. In good flying conditions with warm air rising in thermals up from the earth's surface, a model glider without any means of control can easily disappear for ever – together with the hours and hours of labour the builder has put into it. To have some chance of recovering a model the 'de-thermaliser' described before was developed.

Lift can also be found when a steady breeze blows against a hill and is forced upwards over the top. Flying in such conditions is called "slope soaring," and provided the wind keeps

blowing, the flyer can keep the glider in the air for a long time. For example, slope soaring proficiency tests include a requirement to keep a glider airborne for eight hours.

RC slope soarers can be launched from the top of the hill and flown into the wind to gain altitude and then circled back, both to stay within range of your transmitter and to return to the point over the hill crest, where they can ride the wave again. The challenging aspect of flying a glider or sailplane is that lift cannot be seen, but only deduced from the reaction of the plane. Mastering this technique requires patience and skill.

Toy Planes

Another option for model airplanes are the toy RC models. Although intended for children they can also be great fun for adults. With these more basic flyers everyone can learn the joy of having control of a flying model airplane.

The majority of these planes are sold in RTF form including the radio gear, batteries, and a rechargeable motor battery. The nice thing about choosing a toy plane is that in addition to being affordable, most are virtually indestructible.

There's nothing like the sight of a little boy or girl's eyes as he or she opens up a package to discover a model airplane. They make excellent and uncommonly instructive birthday and Christmas gifts--as well as "just because" gifts. There are many different models you can consider, including the following:

- **Cox E-Z Flyer** – Great introductory plane for young flyers. Designed with twin engines to control direction and altitude.

• **Sky Hunter** – This Delta-wing style is an RTF that is easy to operate and extremely durable.

• **Air Phantom** – Simple, yet very robust that is literally crash proof

• **Stealth Bomber** – RTF that features twin 15,000 RPM electric motors, as well as Thrust Vector steering capability

These toys are all in the $30-$70 price range and all claim to be very robust and crash proof. So you might consider putting out that sort of money just to try the whole idea and before you commit either more money or time. Just bear in mind that they are all 'stand alone' products. Some of them use unusual control mechanisms and it is unlikely that you will be able to re-use the component parts such as the radio equipment for other models. And don't get into the crashing habit! The model you build yourself is going to be a lot more delicate than these.

Radio-Controlled

The radio-controlled plane, also called RC, is controlled using a radio link. For this type of plane, your equipment consists of a transmitter you operate, and the airborne unit in the model, which consists of a receiver and one or more servos depending on the number of mechanisms you want to control. Your transmitter will need a channel for each servo. In the next chapter, we'll take a look at some of the technical elements in detail.

The electric RC airplane is very popular, being the next step up from the RC toys we talked about earlier. It is more realistic but retains the convenience of the electric motor and gives you a quick and easy way to learn powered radio-controlled flying. Electric RC planes are affordable, and you can find them at most hobby shops in a number of fun, exciting styles and colors.

These planes are super easy in that you literally open the box, remove all the parts, put the plane together, and in a matter of minutes, you can be working with a trainer to fly. For people just starting out, the electric RC plane is an excellent choice. Yet there are many different options, and while this type of plane is easy, you should think about a few things before making your final decision.

First, the majority of electric RC planes are designed for the novice flyer. Therefore, when choosing your first plane, look for models that have a high wing design--they're the best planes to learn on, due to high levels of stability. Also, go with the RTF models, allowing you to get airborne fast and without high levels of aggravation.

Look for a plane pre-finished with a four-channel radio gear that you will be able to re-use with later models. There are cheaper models available with less than 4 channels but these will not be suitable for use when you move on to more advanced models – and you will therefore have to buy the radio equipment all over again. So you will be trading cost saving now for more expenditure later.

Look for one with a rechargeable motor battery-pack, and preferably one with spare props. Finding an electric RC plane with spare parts included makes it much easier to keep flying. It keeps you from grinding to a halt when some original part is broken, usually just as things

were getting exciting. If the kit has no spare parts, you'll want to ensure the parts on the plane are easy to find and affordable.

It is very useful to buy a second motor battery, so while you're out flying your plane, the backup can be charging and ready to go whenever you need it. Although electric RC planes have been around for years, only in the past few years have they become truly popular. The principal reason for this is that with advancing technology, we now see the batteries and other equipment such as motors, gearboxes, receivers and servo becoming smaller and lighter, thus enabling better performance from the plane and longer flight times. If you have to travel any distance to your flying site then only getting 5 or 6 minutes of flight time from a single battery charge is pretty frustrating – though the knocking knees and sweaty palms resulting from your early flights may well make it seem like an eternity!

When this type of plane first came out, the motor battery packs were large and therefore, too heavy. Today however, everything you need to get your plane off the ground is not just small but extremely lightweight. Because of this, these planes can be flown at slower speeds, making them excellent starters for the novice.

Electric motors are also environmentally sound and much more acceptable close to residential areas. The electric RC plane does not pollute the air with the fumes a gasoline or glow powered plane puts out, and the level of noise is dramatically lower. But don't forget to dispose responsibly of any unwanted batteries. The bottom line: an electric RC plane is an outstanding way to have good, clean fun without the possibility of complaints from anyone bothered by fumes or noise. Some examples include the following:

Freedom Flyer – Great as a trainer plane or for a more advanced sport-flying plane. This particular model works well for aerobatics and with the four-channel aileron option, it maneuvers with ease.

J3 Piper Club – Although of a simpler style, this two-channel plane is a great starter choice.

Glow or Gasoline Fueled Radio-Controlled

Next comes the glow or gas powered radio-controlled plane. So we've now added a fuelled engine that you might have to buy separately, plus RC equipment that you might have to assemble separately plus the possibility of your building your model from a kit – so the potential for hazards both in building and flying have increased considerably. In truth, these days you can purchase an RTF or ARF gas plane that is both affordable and easy to fly and these days you can progress to this stage while avoiding most of the traditional risks. For example, a multi-channel gas plane can be an excellent training plane--many come with software and a simulator to help you get started.

To choose the one right for you, start by determining if you to fly a realistic scale model or non-scale. This is largely a matter of personal preference.

For training, you again want to go with a high-wing design, usually around 40 in size. This type of plane would normally use a .40 or .46 cubic inch glow-plug engine. For the non-scale options, there are many classic high-wing patterns to consider. Some may require engine and radio installation, as well as some finishing assembly.

When choosing a glow or gas radio-controlled plane, understand that by going this route (instead of buying an electric RC plane), you could be limiting yourself to flying at a model airplane flying club. This will be the case unless you have land, know of someone who has land, or live in the country where vacant land is easily accessible--with the owner's

permission, of course!

This type of plane also requires more pieces of field equipment, due to the engine. You will need to deal with the transport and storage of fuel and fuel filling equipment and these can be major fire risks both at home as well as at the flying field so ensure that you find out about all the relevant regulations. Many of the essential items may be borrowed from fellow flying enthusiasts, particularly if you belong to a club. Without doubt, a gas radio-controlled airplane is exciting. Although not for everyone, some people swear by them. Some representative examples include the following:

NexStar – Loaded with all kinds of exciting features, this plane can be learned quickly and flown safely. Considered a full RTF, this is a nice introduction model.
Wingspan: 68.75 in (1740mm)
Length: 56 in (1420mm)
Wing Area: 722 sq in (46dm2)
Wing Loading: 21 oz/sq ft (62g/dm2)
Weight: 6.5 lb (2930g)
Radio: 4 channel
Engine: glow 0.46

Nitro Airstrike – Completely RTF, this plane is ready to go and can be flown in a matter of minutes. Flat bottom airfoil.
Fuselage length: 21"
Wingspan: 61"
Wing area: 686.25"
Wing Loading: 17.82-oz/sq.foot
Weight: 5.lbs. 5oz
Radio: 4 channel
Engine glow 0.40 – 0.59
(electric version of this plane is also available)

RADIO CONTROL

Aeromodelling would be a whole lot duller without the spark that radio control brings to the hobby. After all, it is the ability to put you in control of the plane which makes it so exciting. So many of us would love to be pilots, to fly aloft among those fluffy clouds but are prevented from doing so by so many different reasons. Yet model airplanes bring that excitement within reach and radio control is what brings the control into our hands. So we should spend a little time trying to understand how that control comes about.

For most of us it is and will remain a mystery. All we will need to know is to buy the boxes, connect up the wires the way the manual says and away we go. But for those who are interested then here goes with some basic technical stuff.

Transmitter

These typically have four to six channels. Of those, at least four would be used for "proportional," meaning they control devices or surfaces that move proportionally to the movements of your control sticks. The other two channels may be used as on/off features to help retract landing gears, turn on lamps, to work the air brakes, and so on.

Typically, the transmitter will have a dual rate facility. With that you can change the maximum throw angle of the control surfaces while the plane is being flown (i.e. it changes the physical distance the servo arm will move). In other words, when the plane is in flight, you can choose exponential movement, depending on the type of model airplane you have. This helps you control the plane.

Many of the transmitter models on the market today have a servo-reversing feature to facilitate linkage assembly. Others have channel mixing, which allows you to make V-tail and flying wing configurations including flaperons (a type of control surface that combines flaps and ailerons into one) and elevons (combining elevators and ailerons). You can even buy a transmitter with memory and a microprocessor, allowing you to save the settings and configurations for several different planes.

The transmitter works by sending data to the receiver, which then generates a radio

frequency carrier (the receiver is tuned to find the transmitter's carrier frequency). With the use of crystals, this sending and receiving of frequencies is highly accurate. The receiver detects data from the modulated carrier, decodes it, then instructs the appropriate servo to move according to the user input.

Receiver

You'll find receivers come in all shapes, sizes, and weights. Some work for long-distance flying, some for safe programming, some for miniature planes, and so on. As you'll discover below, you'll determine the type of receiver you need based on your plane and the type of flying you do.

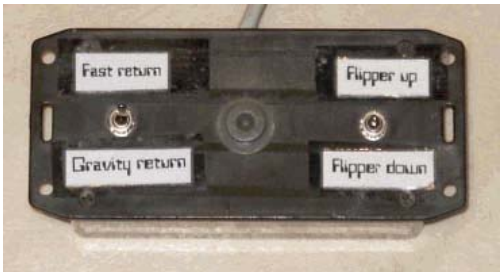
Servo

A servo is a small motor wired to the receiver in the airplane. The receiver decodes the signals from the transmitter and instructs the servo to move a certain amount. This movement is transmitted to the aircraft's control surfaces--usually by the pushrods connecting them to the servo.

As you can see from the picture, servos are usually small black-box type devices.

Buddy Box

Some flyers use what is known as a "buddy box." This allows you to use two compatible transmitters connected by a cable. In most cases the buddy box is used for training purposes: the instructor has one of the transmitters and you have the other.



You control the plane only if the instructor is holding down the push button on his transmitter. The benefit of this is obvious. If you get in trouble during takeoff, flight, or landing, the instructor simply releases the push button, giving him or her complete control over the plane.

Frequency

Radio controls use several frequency bands, which vary depending on the country in which you live. These bands are then divided into several different channels. Thus you need to know the bands for your country in order to adjust your equipment properly. Your local hobby shop will advise you on this when you're starting.

The channel you are using is also the most important issue when you go to your club flying site. There will be strict rules governing the channels in use by each flyer to prevent two flyers using the same frequency at the same time. You will often find coloured ribbons tied to transmitter aerials and may even have your transmitter taken from you by a central control office until you are ready to fly. Pay real attention to the local rules wherever you fly. There is no quicker way to lose a friend than to switch your transmitter on to his frequency while he is flying.

PPM System – PPM is the acronym for Pulse Position Modulation, an older style designed for encoding and decoding. This particular system has a data frame with synchronizing pulse, which is then followed by a series of shorter pulses equal to the number of channels.

The transmitter encoder circuit reads each of the potentiometer's values, along with switch position, sequentially. The values are then converted to a pulse width, which corresponds to the appropriate servo position. For instance, a control in neutral position produces a pulse of 1.5mS, which in the end position could be 1 or 2mS, according to how the control was moved.

The advantages of choosing a PPM system: it's not as expensive as your other options; you can use different brands of transmitters and receivers without any problem; the transmission is fast for operating quick servos; and the transmission range end is shown by the servo

when starting to glitch.

However, there are also negative considerations. For example, this is a simple system and is incapable of detecting errors, and the receiver cannot see any difference between valid and invalid pulses from the servo. For range boundaries, the pulses generally become shorter or longer due to noise, servos can glitch (a situation often caused by an incorrect antenna orientation), and short glitches often go unnoticed until it is too late to correct a problem with the plane.

PCM System – PCM is the acronym for Pulse Code Modulation, a digital scheme for transmitting analog data. The signals in PCM are binary; that is, there are only two possible states, represented by logic 1 (high) and logic 0 (low). This is true no matter how complex the analog waveform happens to be. Using PCM, it is possible to digitize all forms of analog data, including the telemetry used in RC for model airplanes. For this option, the position of the switches, pots, and joysticks, initially analogue voltages, are digitized with an AD converter to 8 or 10 bits (8 to 10 servo would equate to 80 to 100 bits).

This system has a 16-32 checksum per frame, synchronization sequences, and failsafe values. For a complete frame, a bit number of 100 to 160 is then required. The PCM uses two primary systems, one being a very long starting pulse that cannot ever be mistaken for data, and the second is a half-bit pulse that also makes it impossible to mistake data.

The advantages of using a PCM system is that even if your model airplane is a good distance away, the servos' movements are transmitted without glitch. In addition, servos are not damaged by pulses that are too short or too long, something that can happen with the PPM system.

The downfall of this system is that it is much more costly; it is sensitive to interference from adjacent channels, which means you must be very careful when flying close to other radio emissions; determining the transmission quality is hard, as there is a lack of warning signs for trouble; and control issues that occur slowly are only noticed when the connection fails, possibly leading to a bad crash of the plane.

IPD – This is the acronym for Intelligent Pulse Decoding. For this, the receiver uses a processor capable of analyzing incoming signals, which it checks for validity. Similar to the PCM system, the IPD also filters out invalid signals. With an IPD, the receiver never turns off the dirty signal whenever field strength begins to decline.

Instead, the tolerance level is widened, which means control is not as precise as the field strength becomes worse or the quality of the transmission simply deteriorates. You will notice an approaching range limitation by the way the plane behaves, unlike the PCM system that simply stops, causing you to lose control.

Furthermore, anytime there is an insufficient signal for the receiver, a failsafe condition occurs, so the controlling servo can choose a pre-selected safe position. Keep in mind that the signal from this system is only considered valid when the length is between 890 and 2350 µsec.

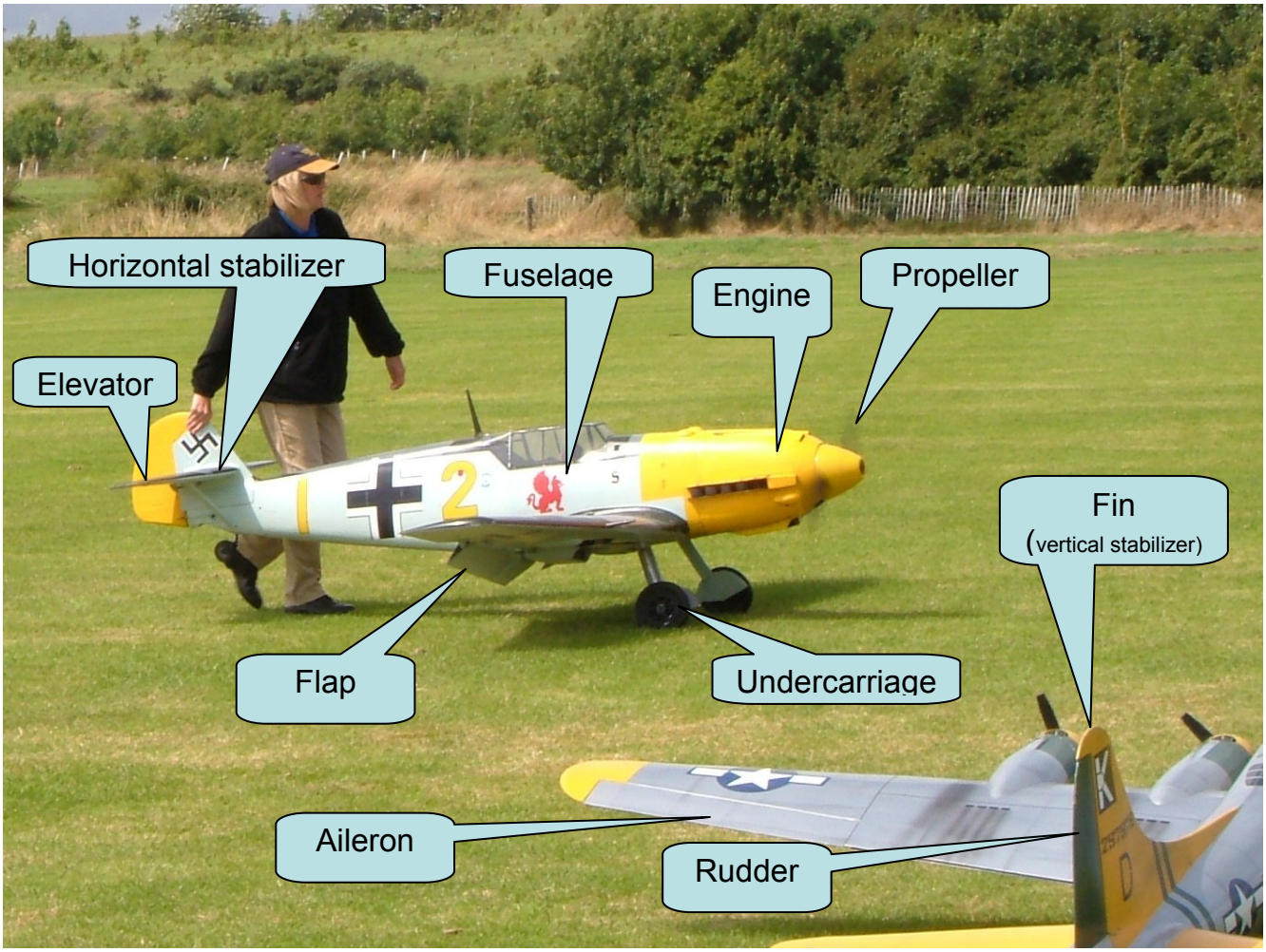
Another benefit to choosing the IPD system is that the receiver can take the signal and analyze it, thus adjusting it automatically to coordinate with the current quality of the reception or field strength. Because of this, the possibility of interference is greatly reduced and you are aware of problems over a longer timeframe, allowing you more time to make corrections.

DSR System – DSR is the acronym for Digital Signature Recognition, which is used for most dual conversion FM receivers. This system is designed with a special Stabilization System, claiming to provide optimal protection against crashes. The receivers are capable of blocking interference by memorizing the transmitter's distinct signal frame, and thus rejecting anything else.

If you are bemused by this chapter then take comfort that you are not alone. You probably don't need to know the majority of this stuff. Just take advice from your local hobby shop and club members.

MODEL PLANE ANATOMY

To be a successful flyer, you need to understand your plane. Just as a good doctor knows the anatomy of the human body, you should understand each part of the plane and how they work together.



AILERON - Hinged control surface located on the back of the wing, furthest from the fuselage. When the servo moves the aileron via the pushrods, the plane is capable of turning and rolling.

ELEVATOR - This hinged control surface is connected to the back of the trailing edge of the horizontal stabilizer (the part of the tail parallel with the ground at takeoff). When the elevator is moved, the plane dives or climbs.

ENGINE - This is a mechanical device providing power to the airplane so it can fly. It uses battery power or internal combustion. For RC model airplanes, there are two primary choices of internal combustion engines -- glow, which burns nitromethane fuel or gasoline that burns a mixture of gas and oil. Both engines types come in two and four-stroke designs.

FLAP - The flap is a control surface on the wing, closer to the fuselage than the aileron, which moves up or down, increasing drag or lift.

FUSELAGE(fuze) - Long, narrow body of the airplane

GLOW PLUG - Initially heated by battery power, this part of the glow engine provides the ignition source for the glow fuel and then retains the heat required to continue to do so after the battery is disconnected. The difference between this and a gasoline engine is that, for the gas option, a spark plug is used for ignition which then requires an additional electrical system.

HORIZONTAL STABILIZER - The horizontal portion of the tail that controls the plane's up and down movement, and to which the elevator is attached

LANDING GEAR – The structure and wheels that support the plane on the ground as it takes off and lands. The two primary types of landing gear are the tail-dragger, with two wheels under the wing and a skid under the tail; and the tricycle, with two wheels under the wings and one under the nose.

PROPELLER - The rotating device located on the nose of the plane, which is designed to convert engine power into thrust. Propellers, along with Bernouli's principle, propel (what else) the plane through the air by creating a disparity in the air pressure between the surfaces

of the blades. The thrust of a propeller depends in large part on the volume of air it accelerates, to what extent this volume is accelerated, and the relative density of the air.

These factors depend, in turn, on the diameter of the propeller and the RPM and torque of the engine, which is responsible for turning the prop. The aerodynamic design of the propeller also influences its performance. Model plane propellers are commonly made from wood or specially molded nylon or reinforced plastic.

PUSHRODS - Rods connecting the servos to moveable parts of the plane.

SERVO - This component converts the incoming radio signal into physical movement in the airplane, moving the pushrods connected to the flying control surfaces, such as the rudder, elevator, and ailerons of the plane.

TAIL - The part of the airplane located on the rear of the fuselage, which includes both vertical and horizontal stabilizers.

VERTICAL STABILIZER - The vertical stabilizer, or fin, is the portion of the tail that provides side-to-side stability. It is perpendicular to the ground at takeoff.

IN FOCUS: MODEL AIRPLANE ENGINES

There are numerous options when it comes to engines. Rapid technology advances mean you'll find exotic new models on the market every few years. However, as you'll see in this chapter, determining the best engine for you does not have to be an overwhelming task.

Some airplane engines are more expensive than others. But, as with all things technical, prices always fall, and you get more 'bang for your buck' every year. Engines are now quieter, more reliable, better performing, and produce less fumes--and this trend is likely to continue.

Types of Engines

If you're just starting out with model airplanes and want to use a glow or gas-powered trainer, then I would recommend you use a two-cycle glow engine. This is a basic engine, and just about anyone at the flying field will be able to assist you if you run into problems or if you have any questions. Electric-powered, on the other hand, is more expensive, although easier to manage as long as its working but harder to fix when it is not and gas tends to be for the larger models.

Two-Cycle Glow

The fuel/air mixture of a glow engine is ignited at the top of the compression cycle by the glow plug. This is made hot when starting the engine by passing an electric current through it from a battery so that it glows in the same way as a light bulb. Once running, the battery is disconnected and the glow plug keeps on glowing from the heat created in the engine cylinder by the combustion of the fuel. If it stops for any reason there is no way to re-start the engine because the glow plug cools down and there is no ignition source. As a result the engine is simple, light and efficient.

The two-cycle glow engine is the most popular type for model airplanes. It is affordable, but also powerful and more importantly, reliable. You can turn high revs per minute (RPM), so if you're going with a propeller-driven plane, and you want speed and rpm then this is the best choice.

Some model jets are actually driven by propeller engines hidden in the bodywork and with the airflow directed past them by a duct looking like the jet engine intake. This is a neat solution to keeping down the cost or complexity of a model jet by avoiding the high cost of model jet engines. Remember that a ducted-fan airplane depends on high fan RPM to get enough thrust. The two-cycle engine is the only one capable of producing high enough RPM for this task.

Four-Cycle Glow

The difference between the 2-stroke and 4-stroke engine is something for another day. Sufficient to say that the four-cycle engine has much more torque than the two-cycle, and turns at lower RPM. If you have a model airplane that needs stronger vertical climbs and requires consistent airspeeds, the four-cycle is a better choice. This type of engine is highly reliable, but also more complex. Until you become skilled, it may be more difficult for you to maintain yourself.

The four-cycle glow engine became more popular during the 1980s. Since that time, it has become a great choice for RC model airplanes. When this type of engine first came out, it was advertised as producing realistic airplane noise. Although this is a little bit over the top, they do produce a better sound.

The four-cycle engine is more fuel efficient than the two-cycle, so you'll get more flight time from a single tank of fuel. With the exception of airplanes that need high RPM, I would recommend the four-cycle glow engine. The only real drawback is the higher price.

Two and Four-Cycle Gas

Years ago, the large model airplanes were often powered by engines converted from use in

weed eaters and chainsaws. Today, manufacturers have understood the need for an engine that can handle larger planes, and come up with both two and four-cycle gas engines intended for the modeling community.

The good thing about these engines is that gasoline is much less expensive than glow fuel, so you can enjoy flying your larger model plane without worrying so much about the cost. Most expert flyers will tell you that the two-cycle gas engine sounds the most realistic of all engines, which is a big selling point for enthusiasts. For some reason, a realistic noise from your model makes flying more fun.

Like the models it powers, this engine is large and heavy, with a bigger prop. Thus it is capable of doing serious damage, and therefore must always be respected and treated with caution.

Diesel

Although we're not sure why, the diesel engine is simply not a popular choice for model airplanes. There are numerous benefits that argue for a diesel engine over other types, yet you'll rarely, if ever, see one on the flying field.

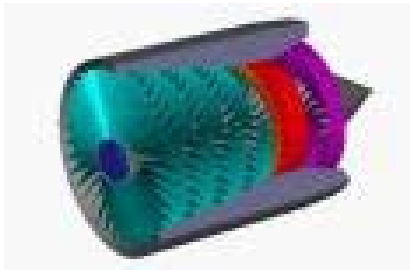
One advantage: just as with diesel engines in cars they produce more torque at low rpm and can therefore push large propellers far better. In addition, this type of engine requires no battery or glow driver. The problem usually lies in trying to find them. Unfortunately, when you do find a diesel engine for RC model airplanes, they tend to be expensive.

The biggest drawback, other than cost? When you get out to the field, if you should run into a problem, chances are there won't be anyone there knowledgeable enough to provide assistance. Some flyers are trying hard to increase the popularity of the diesel engine, but this will probably not happen overnight.

Wankel

The Wankel engine requires more space than is available here to explain how it works. But it is smooth and can achieve high rpm because the pistons do not go up and down as in most other internal combustion engines. Instead there is a single, almost triangular, piston that rotates within a housing. The technical difficulty with all Wankels is that the tips of the rotating piston tend to wear because of the high speed at which they sweep the chamber wall. The only Wankel engine designed and produced for model airplanes is a .30 version. Manufactured by a company called O.S. Max, the performance is reportedly very good. The only complaint about the Wankel engine from flyers is that it consumes too much fuel making it a trade off—you can have high performance but at the expense of high fuel consumption and cost.

Gas Turbine



If you're a beginner then it may be some time before you need concern yourself with gas turbine 'jet' engines. When shopping around for a gas turbine engine for your model airplane, keep in mind that this particular type of engine is miniature in size. However, do not let the size fool you – they are extremely powerful and they produce lots of noise just like the real thing. While the gas turbine engine is expensive, it is a popular choice for scale jets , and very fast airplanes.

Pulse Jet

Pulse jet is another extremely powerful and loud engine, for flyers who feel the need for great speed. One thing to remember with this engine: there's no way to throttle it.

Probably the most important thing to keep in mind is that, because the pulse jet engine can be highly dangerous if not handled properly, many flying fields and clubs have banned them.

Therefore if you want a pulse jet engine, you need to check around first to see if you can

even fly your plane anywhere close.

Multi-Cylinder

Reflecting the advances we have already talked about in miniaturization of radio and electronics, and driven by modelers desire for realism, engine manufacturers are now producing scale versions of pretty well every type of internal combustion engine. These include "horizontally opposed," "radials," "Inline," and "V". Their characteristics mirror those of the full size engines and they will usually produce less vibration when compared to a single cylinder engine of the same size. The downside is that they are less powerful as the additional machinery is bound to absorb some of the power produced.

How to Choose

I hope this section has given you a better understanding of the different engines people use for model airplanes. As a beginner I would suggest that you simply go with the engine that comes with or is recommended for your first kit. But when the time comes for you to branch out and start making your own decisions then here are some helpful guidelines.

Top Rated

Most flyers will choose the engine rated at the top of the manufacturer's recommended range. For instance, if you have a model plane kit that recommends .25 to .40, then go with an engine that is rated .40 to .45. (There is an exception to this rule: for 1/2A kits, you would go with a .10 or .15.)

As mentioned, a four-stroke engine does not produce the same level of power as a two-stroke engine. Therefore, a good rule to follow if you want to substitute a four-stroke in place of a two-stroke is that with a two-stroke, you'll only need about 66-75% the size you will with a four-stroke engine.

In this case, if you have a model airplane designed to run with a .45 two-stroke, you could instead go with a .60 four-stroke. On the other hand, if the recommendation is a .90 four-stroke, you could choose a .60 two-stroke. Because the four-stroke engine is more fuel efficient, the tank size for these swaps would remain constant.

Reliability

Choose a reputable brand. Normally, as long as you stick with a name brand, you'll find a good one for your particular needs. The key is to go with quality, even if it means spending a little more. Although you'll find some "generic" engines that appear to be identical except for the brand name, we recommend you go with the known brand. A good engine may well last you through several models. An imposter will probably not.

Tuned Mufflers

The next tip is to not use tuned mufflers, which are usually referred to as "tuned pipes." The cost of a tuned system will push your engine up into the realm of the next-size-larger engines.

Rather than go with a tuned system and set yourself up for problems, why not just go with an engine one size up? If you already have your engine, you can buy a pipe, especially if the larger engine does not fit the airframe.

Of course, there are always exceptions to every rule. In this case, there will be slight advantages in competition flying. Yet if you love a plane with speed, remember that this comes from RPM. Therefore, an engine will not get much more speed from a tuned pipe. You will notice improvement in climb, as well as hovering, power, but when it comes to speed, look at the engine's RPM rating.

Fuel

Most glow engines will come with a manufacturers recommendation for fuel/oil mix with a type and percentage of oil specified. This is probably applicable to running in the engine and you should comply with the manufacturers recommendation. But only buy a small quantity of the recommended fuel – enough to run in the engine. If you then want to change the oil type and percentage based on other advice from your club colleagues you will not be stuck with a gallon of unwanted fuel.

AERODYNAMICS - THE BASICS

This section will discuss some of the basics you need to know to fly a model airplane. Everything that flies, big or small, man-made or natural, is bound by the laws of aerodynamics and it will help you to understand why your model flies and why it flies the way it does if you know something about aerodynamics. Don't forget that much early development in aerospace came about because the designers and engineers involved tried out their theories with models. As a modeler, most of your expertise will come from practice as theirs did but this material will provide you with a good starting point about the theory.

General

For an airplane to fly, it must be able to conquer gravity, which happens when the lift is greater than the plane's weight. This cannot be accomplished with the plane sitting still, of course, so thrust is used, which is a force directed backwards.

With thrust provided by the engine or propeller, the wing is moved forward through the air, thus generating lift. The thrust must be greater than the drag created by the shape of the airplane for the airplane to move forwards. Drag is the resistance of air to a body moving through it. Therefore, if thrust and lift are greater than gravity and drag, the plane will fly.

In other words, when the specially-shaped wing of the airplane moves forward, air lifts it. If the plane is traveling too slowly and does not produce the required lift, it will stall and fall. Therefore, the speed of the plane must be produced by an engine or propeller. The entire time the plane is moving forward, the wing is lifting, even if it's in a turn, upside down, doing aerobatic maneuvers, or inverted.

The plane is turned using the rudder and/or ailerons. A turn using just rudder is inefficient because the wings stay level and the plane yaws through the air. A turn using ailerons is more efficient as the ailerons move up on one side and down on the other thereby lifting one

wing and dropping the other and the plane flies neatly around the turn.

To get the plane to go up, you use the elevator. As the elevator surface angles upwards, air hits it in a way that blows the tail down and the nose up. When the plane goes up, it will begin to slow down unless additional engine power is applied and, again, if it slows down too much, it will stall.

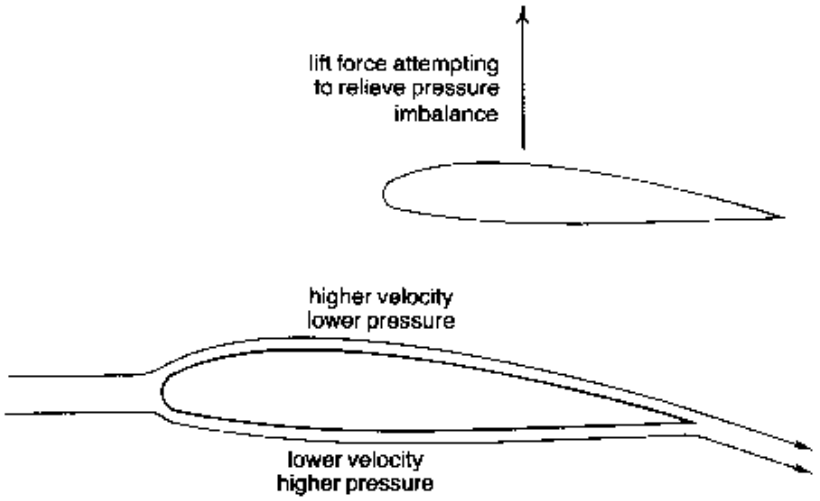
Airfoil

The airfoil is a section taken through the wing at any point along its span. The span is the distance from one wingtip to the other. To develop lift at low speeds, and to provide a stable airplane that returns easily to horizontal flight, a flat-bottom airfoil is needed. This is obviously very beneficial for beginners just getting started with flying model planes. If they do nothing the model will return to level flight and right side up.

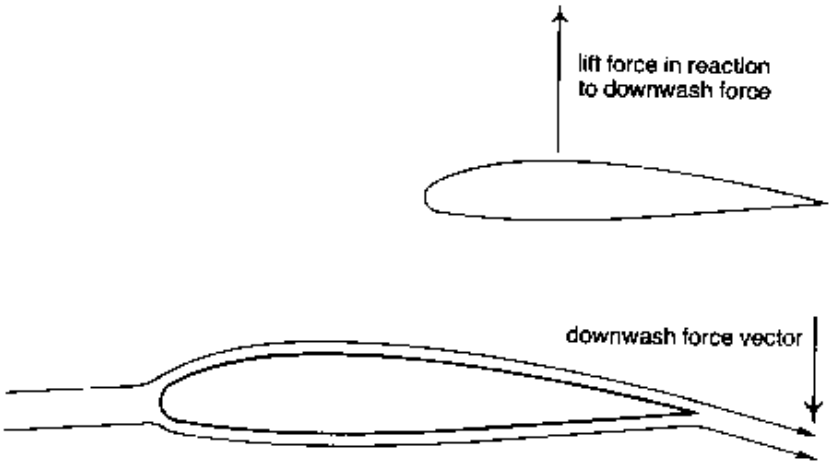
A wing with an airfoil section shaped the same on top and bottom will produce lift equally, regardless if upside down or right side up. So the orientation of the wing in the air depends entirely on the control inputs of the pilot. The symmetrical airfoil is recommended for advanced flyers. There is also the semi-symmetrical airfoil, which is a combination of the two and is used by both intermediate and advanced flyers.

We've talked about 'lift' but what is it? There are two explanations for lift which even the experts are not agreed upon. The two theories were proposed by two very famous scientists, Bernoulli and Newton, so there is probably some truth in both.

The diagram below shows air flowing past an airfoil, i.e. a wing. The airflow over the top of the wing has a higher velocity than the airflow under the wing. Experiments have proved that this creates a lower pressure on top of the wing. A basic rule in physics states that when an imbalance exists, a force will result tending to relieve that imbalance. Therefore, to relieve the imbalance there is a force from the higher pressure to the lower pressure and this is called lift. This is Bernoulli's explanation.



Newton's laws state that for every action there is an equal and opposite reaction and the alternative explanation is as follows.



The airfoil shape of the wing causes the flow of air to be deflected downwards – and this is the importance of the airfoil shape of the wing which causes this deflection which is necessary for either of our two scientist's theories to hold good. Therefore there must be a reaction in the opposite direction which is equal in force to the force of the downwash – and this is lift.

Whichever one is right, or maybe a combination, you can see that the shape of the wing is critical as is its position on the airplane and that its surface is maintained in a smooth condition so as not to disrupt the intended airflow. All of these things are critical for your model just as they are for full size airplanes.

Dihedral

If the wings of your model sweep upwards from the fuselage, then it has 'dihedral'. This helps increase stability while decreasing aerobatic ability.

Anhedral

Anhedral is the opposite of Dihedral and is when the wing sweeps downwards from the fuselage. This is much less common.

Landing Gear Location

To make takeoffs and landings easier, especially for someone just starting out, tricycle undercarriage comprising two wing wheels and a nose wheel is used.

Wing Specs (Area, Loading, Lift, and Thickness)

The wing area is the wing surface available to create lift.

Wing loading is the mass of the airplane divided by the wing area. This is generally measured in ounces per square foot. Typically, beginners want a light wing load to make controlling the plane easier.

Wing location means wing placement, and falls within two primary categories, the high-wing design and the low-wing design. With the high-wing, the model plane's weight is suspended under the wing, so when the plane tilts, the weight of the plane tends to push it back toward a level position. The plane has more natural stability, making it easier to handle and thus a good choice for beginners.

On the other hand, with the low-wing model, the main weight of the fuselage is above the wing, which tends to make the airplane less stable. Because of this, the low wing design would be used for advanced flyers who are interested in performing aerobatic maneuvers such as rolls and loops.

The thickness of the wing is measured from top to bottom and determines the amount of drag created. Because they are thicker and harder to push through the air, thick wings create more drag, which causes slower speeds and gentler stalls, making this style good for beginners.

A thinner wing produces far less drag, meaning high speeds and sudden stalls are both possible. Typically you see the thin wing used by people who enjoy performing aerobatic maneuvers, or who are involved in racing their model airplanes.

Flying

When it comes to flying then exactly the same considerations apply to your model as to any full sized airplane. When you unleash your model into the skies you have to be responsible for anything that may happen as a consequence. Safety is the most important concern when flying model airplanes.

More important than size, speed, height, model, and engine, is the safety of you, the people around you, and the plane itself. Much of the knowledge required for safe flying arises from practice and common sense, but nonetheless, in the name of leaving no stone unturned, we've dedicated much of this chapter on flying technique to safety considerations.

Pre-flight

To fly safe and smart, you should take follow the same steps every time you get ready to fly. Keeping to a good preflight routine will protect you from many major problems.

Frequency

Put simply, always check that your model control surfaces are responding and working in the correct direction in response to control inputs you put into your transmitter. To put it technically, always use your receiver to analyze the data stream, so it will automatically check for positive or negative shift, a valid number of pulses, a valid frame length, and valid pulse widths. If the frame is damaged, the system will invoke three specific levels for correcting the problem, as well as trying to restore data.

If data fails for 50 consecutive tries, the failsafe mode will be enabled, setting the servos to the last good frame to your preset options. In addition, receivers include extensive flight data that reports capabilities via the computer, although the most critical data would be read directly by the receiver.

You certainly don't need to worry about this sort of complexity at the early stage of your flying career. But as remarked at the beginning – check your model is working properly. By the time you'll need it, you'll already have learned the details from your experience or your colleagues

Co-Pilot

There are some models available with this additional feature which you might consider if you are concerned about your flying ability. The equipment works by monitoring your airplane's relationship to the ground's horizon using four infrared temperature sensors. During flight, the co-pilot senses any changes in altitude relative to the horizon.

Corrective signals are then sent to the aileron and elevator servos to keep the plane level. If you have an extra, unused channel, then you can turn the co-pilot on and off, adjusting sensitivity from the ground.

Weight and Balance

For RTF kits, you don't need to worry much about the weight and balance in the beginning. However, you should always check the balance before each flight. If the airplane is not

balanced, it will likely crash. Planes, whether model or full size passenger jets, all have a center of gravity.

This has a direct impact on the plane's balance. As a general rule, the center of gravity is about one-third of the way back from the front edge of the wing (and two-thirds of the "wing-chord" forward from the trailing edge). To test, place the tips of your index fingers under the wing tip, about one-third of the way back toward the trailing edge.

Then, very carefully, lift the model airplane up, balancing it on your fingers. If the balance is good, the plane will be level, with the nose pointing straight, or just a bit downward. If the plane's tail is pointing downward, then you have a balance problem and should not fly the plane until it is fixed.

Before adjusting it, think of what might have caused it. If you tested your model before leaving home and it was OK but now it isn't then what might be the cause? A loose screw or piece of material which has moved around during transit can be enough to affect the CG. If you now adjust it back to balance by adding another weight then you may have left a loose item inside your model which will surely come back to haunt you when it moves again during a flying manoeuvre. If you do need to adjust, add weight to the nose, something like fishing shots, plasticine, or even modeling clay. Add just a little at a time, checking the center of gravity after each addition. (Or, you can move the engine more toward the front.) If you do not want to crash and ruin your plane, this is a crucial step.

Following the Manual

For your full pre-flight check, always refer to the manufacturer's recommendations. At first, this will take time, but as you do it over and over, you'll soon have the entire process memorized. This step is essential when flying model airplanes.

Some of the things you'll be checking include the following: looking at the wings to make sure they are fastened securely; making sure the control surfaces move correctly and freely; and ensuring that the engine operation and radio gear are okay.

Getting Airborne

Other important safety considerations have to do with the flying process itself.

Test Glide

Although not all flyers will perform a test glide, you might want to consider this. The test glide is designed to assess the glide characteristics of the plane, so you know what to expect if the engine should unexpectedly run down. To do this, you want to work over a long area of grass, so if something happens, the model airplane will not be seriously damaged.

For the pre-flight check, turn the transmitter on first, followed by the receiver switch. Then, pull the transmitter antenna out so that it's completely extended. Next, make sure the rudder or elevator is working properly, moving in the correct way then centre it in a neutral position.

Now hold your airplane facing away from you, at head level and into the wind. Very gently launch the plane from your hand, making sure it is level or pointed slightly downwards. If the plane is right and ready to fly, it will gently glide to the ground after a short, smooth flight.

Powered Flight

Once you've checked everything for the flight, the plane will then be launched, which can be done in one of two ways. First, you can perform a hand launch, which is just like the Glide Test listed above, or, if your model is able, you can have it take off from the ground, from a runway.

Once the plane is out of your hand or off the ground, you want to hold your transmitter with both hands and put your thumbs on the sticks. Ensure that you have gained enough height to be able to maneuver safely. Next, bank the model airplane gently, so you become accustomed to the way it will behave under your touch. The elevator is used to control altitude as needed. Keep your movement very smooth, gradual, and slow and avoid moving the sticks to the maximum positions.

Obviously, if there are people around, you want to keep the plane a safe distance from them

(and high above them). Make sure to never let the plane get too far out of your sight. Finally, always keep the transmitter antenna pointing up at a 45-degree angle or more.

Trimming the Plane

The word “trimming” refers to the adjusting of your airplane controls during a flight so that the plane flies straight and level without you making any control inputs. Sometimes a model airplane will want to veer in one direction or another because of the motor’s torque or perhaps some distortion or construction defect is affecting the aerodynamics. This may not be critical but you’ll need to learn about this characteristic of your plane, and fast, so you can fly it properly.

The small trim tabs located on the transmitter are used to fine-tune the controls, and these may vary from one transmitter model to another. Once the trim tab has been moved, allow your model plane to fly on its own for about 10 seconds to check that it is flying straight and level, and then, if necessary, you can make further small adjustments until you get it right.

Taking Off

The way you take off will depend on a number of things. For example, if your model plane is designed with an undercarriage and you’re flying from a flat, smooth surface, then you would do better taking off from the ground instead of using a hand launch. To do this, you go through all of your pre-flight checks and then set the plane on the “tarmac,” facing into the wind.

Next, stand directly behind the plane. Turn the engine on to full power, allowing the airplane to accelerate while on the ground. If necessary, use the rudder to keep the plane headed straight down the runway. Just as with a full size plane, the model will gain speed and eventually lift off the ground.

Landing

The most important thing to know about landing a model airplane is that it must land into the wind. Think back to the section on lift and you can see that wind is effectively free lift that is available for you without using engine power. To bring your plane in, start by lining it up with the place where you want it to land, either grass or a runway. Then reduce the power, without turning the engine completely off. Use the rudder to keep the plane in a straight line, allowing it to glide down to the ground gently.

Some model airplanes have an elevator control. In this case, you can adjust the height, but if your plane doesn't have this feature, don't worry--the engine will do the same thing if you power up briefly to help slow the descent down. Otherwise, it's best to use the elevator to pop the nose up lightly as you touch down--this drains excess speed from the plane.

If you're uncomfortable with landing, turn the engine back on to full power. Then, circle around and try again, lining up again with the runway or grass. Remember that even the experts make mistakes and have missed approaches, and you'll do far better to circle three, four, or five times than to crash your plane. However, you want to make sure the battery does not die prior to landing, or the plane could end up somewhere you do not want it to go.

Above and Beyond

When first getting started, you'll quickly discover that you have much to learn. With a lot of practice, the following tips will help you understand flying better and quicker.

Balance

Before you fly, make sure the balance point is where it's supposed to be. If you've built the airplane yourself, you may need to add lead weights to the nose or tail to help balance the plane, so that the center of gravity is where the plans indicate that it should be. An 'out of the box' model should already be properly balanced by the manufacturer – but it's always worth checking.

Field

When flying, you need lots of open space, a large field or preferably the flying field of your local model club where you know the activity is approved. Most model planes must be flown in approved areas that are open and unobstructed. Therefore, a model plane, especially a large one, should never be flown down a residential street or from a backyard. Regulations vary from country to country so check on the situation in your own area before you go flying.

Flying Direction

Because you're not sitting in the cockpit of your model facing the direction of travel it is easy to become confused about which control input you need to use to turn your model in the direction you want. If your model airplane is flying directly toward you, the control movements you make will produce plane movements that appear to be opposite to those you intend. The side movements are completely reversed in this situation. The key is to turn your body a little to envision left or right from the plane's viewpoint. This way, you'll not get confused about how to turn your plane.

Gentle Turns

Before you try to land your plane, we recommend you practice some gentle turns when high in the air. By doing the turns high, you'll have lots of altitude available to correct problems if they develop and you can safely develop a better understanding of how your plane will respond to your controls. Now, if the plane begins to stall, simply give it a little down elevator and you'll have no problem bringing it under control.

Ground Roll

If you take off from a ground roll, allow the plane to get up enough speed on the ground prior to giving it the "up" signal. The goal is to make the plane climb at a small angle using wing lift, rather than trying to drag it abruptly into the air on engine power, which can cause you to lose speed and stall.

High Turns

After take off, never try to turn until you know the model airplane is high enough. Generally, you should climb straight ahead before making very gentle turns.

Landing Spot

Avoid trying to land in a particular spot. Instead, allow the model airplane to glide to the ground, its nose pointed straight ahead. Remember to use a large field, especially for a first flight, so that you'll have a better chance for a successful takeoff and landing.

Launch

If you plan to hand launch your model plane, be sure you never throw it angled up. Instead, it should be thrown hard--but not too hard--with the nose pointed straight ahead. You want it in a nice stable flying position while you get your hands back on the transmitter box.

Lift off

When the plane starts to take off, give it just a little bit of up elevator. Typically you see beginners make the mistake of climbing too steeply, which causes the plane to slow down, stall, and crash. A gradual climb, as stated before, is much better. So go light on the up elevator.

Washout

Washout is the desirable and intentional warp seen in the wing near the wing tip. Typically, the warp would be at the outer 20% of the wing. Washout is good because it helps the outer parts of the wing fly straight during the start of a stall. In other words, the plane will stall straight ahead rather than rolling to the side or back.

Yet you want to ensure the wing is not warped more than the intended washout. To check for

warping, you can attach the wings to the plane and then set the plane on a table. Step back to look at the rear of the plane at eye level. You want to be able to see just a little of the bottom of the entire wing and it should be symmetrical on both sides. If you see more, then you can go through the testing process to see if your plane is still controllable and try to 'trim out' the defect as described under 'Trimming', but your model will never be as efficient or controllable as it could be. If the defect is too extreme to trim out then you must remove the warp prior to flying.

Field Safety

You should keep a first-aid kit handy on the field, just in case. Additionally, you may want to wear eye protection (even when working on building a kit). A small fire extinguisher is advisable, as is hearing protection. Most importantly, never rush yourself when it comes to getting your plane up in the air.

You would be amazed at how many flyers get in too much of a hurry and, without thinking, reach through a whirling propeller to adjust the needle valve. Many people have lost fingers this way.

Next, never point your plane in the direction of people in the pits. While this might sound like common sense, you would again be surprised at how many people do this. The plane should always be pointed away from people and toward the flight line. Stay oriented. It is easy to swivel around several times as you watch your plane and lose track of the location of the flight line and pits.

Then make sure the engine can be completely shut down using the transmitter. This requires you to set the throttle linkage up properly so the throttle is able to go below a high idle.

It is important to remind yourself that each time an adjustment is made mechanically to the throttle, you need to ensure the plane is being held very securely. Many modelers make up restraining yokes they can dig into the ground with two padded forks sticking upwards either side of the fuselage and just in front of the horizontal stabilizers. That way they can roll the model so the stabilizers are up against the padded forks and the model cannot move any

further forward while they have both hands available for any adjustments or tests they need to make. The alternative, of course, is a helpful friend.

Next you want to start the engine, making doubly sure the throttle is working as it should, and that you can shut the engine down with the transmitter, the way it is intended to be done.

After you have started the engine and the propeller is spinning around, move behind it whenever possible. You never know when your restraining forks – or your friend – may fail in their task. It has been known.

Another important flying tip: you should get into the habit of pulling back on the throttle immediately anytime you run into problems – and get the nose down. Remember, you don't need engine power for your model to fly – you have tested that your model will glide – but you do need flying speed and you wont get that with the nose pointed upwards. Obviously, if the plane is flying at a slower speed, you'll have more time to determine and fix the problem.

Final Tips

Additional tips that will help you become an excellent flyer:

- If your model airplane is coming toward you, your turns will be back to front. When first starting out, you'll be unaccustomed to the opposite configurations but, over time, it will all fall into place.

- If at any time your airplane is not doing what you want, cut the engine. In most cases this simple step will reduce the possibility of any serious damage.

- Make sure the <u>all</u> the radio gear batteries are fully charged prior to flying. Just one dead battery will cause a problem.

- When flying model airplanes, every flyer needs to leave his or her pride at the door. This is a hobby of focus; when a person becomes proud, mistakes happen that can lead to disaster. Remember, the people at clubs, and your instructor, will help you and answer questions--all you have to do is ask. All of them were beginners just like you at

one time. It is perfectly fine to be the beginner.

- Be smart, use common sense, and most of all, have fun.

10 QUESTIONS AND ANSWERS

The flying of model airplanes is a remarkable hobby that offers tremendous challenges and unsurpassed amounts of pure fun. In this chapter, we'll look at some of the most common questions asked by people interested in getting involved with this unique pastime.

How Do I Start?

This is probably the number one question. The best way is to locate RC enthusiasts in your area. You can check with local hobby stores, look in the yellow pages, or scout around on the Internet. Using a search engine such as Google.com, type in "RC club," or "RC flying fields," followed by the state city in which you live. Look for the national association for your country. They will usually have a comprehensive list of clubs in your country.

Once you locate a club, schedule a time to meet with the owner and other members and ask to watch them flying. You'll probably be surprised at just how friendly and encouraging these people are--common flyer traits which should make you all the more excited about becoming one.

How Much Does It Cost?

The next question we usually hear. Remember that you yourself control the expense. If you fall in love with the hobby, you can go completely overboard. However, just as with most leisure activities, you can generally adjust for your budgetary constraints.

Although the startup can seem a little high, remember that these are only one-time fees. After you have your plane, engine, and so on, the ongoing costs are very affordable, unless you want something bigger, faster, and better every year.

Otherwise, the engine and radio controller will last for years if cared for properly.

You can learn an enormous amount about aerodynamics by building paper and card models for almost no cost – and power them with rubber bands.

The RC toy planes described earlier came in around the $40 to $70 range.

For a typical glow or gas powered RC trainer startup package, you can expect to pay the following (in US dollars):

Equipment	**Cost**
Mid-Size RC Trainer Model Kit	$100
.40 Cu. In. 2-Stroke Engine	$130
4-Channel Radio System	$200
Accessories, glue etc.	$55
Fuel plus Basic Fuel Equipment	$40
TOTAL STARTUP	**$525**

How Far Will It Go?

Many people are initially interested in how far model airplanes can fly. This of course depends on the model and most importantly on the size of the fuel tank, but for most of the current RC planes, you can fly between one and two miles. Even so, controllers rarely do so--simply because the plane will fly out of sight, making it impossible to control.

Think of it this way: a model airplane with a wingspan of six feet will all but disappear around half a mile away. Therefore, you'll find most flyers keep their planes--at a max--somewhere between 200 and 300 yards distant, so they have full control.

How Fast Will It Fly?

A standard trainer plane typically hits max speed somewhere around 60 miles per hour. However, if you want to purchase a more advanced stunt plane, then speeds of 80 to 100 miles per hour are realistic. Some racing models can reach 140, 160, or even upwards of 200 miles per hour!

Can I teach myself, or do I need an instructor?

Although some people successfully teach themselves to fly model airplanes, we highly recommend you work with a professional trainer. It takes time and patience to learn to fly, something you'll not master overnight. An instructor can guide you through the proper steps slowly and correctly--so you'll be able to enjoy flying and not worry about crashing the airplane.

A recent development is the availability of flight training simulators so that you can practice on your computer just like a video game. But it must be the proper software for RC training purposes – and for the specific model you intend to use. Be aware that the common flight simulator video games are no use for this purpose. Some models kits even include the relevant software.

With or without the advantage of software training, go with a qualified and reputable training instructor. This is extremely important, because the first time you take control of the RC plane, you'll probably feel overwhelmed, especially since most airplanes have a mind of their own.

An instructor will help you maneuver, and handle unexpected turns or trims and you will have the confidence of knowing that they are properly approved by the club or the national association.

Everyone make mistakes the first time they take the controls. Don't panic and don't beat yourself up over it. Instead, listen

to the instructor, learning from what he does. Remember--learning to fly a radio-controlled model is not impossible, or even exceedingly difficult, but it is unlike anything you've done before, so it does take time.

The key to success at this hobby is to pay attention and listen carefully to the instructor. Even if you feel nervous or awkward, if you keep your mind on the task at hand, it won't be long before you completely understand the ways of flight.

How Hard Will It Be to Build?

As mentioned earlier, you can build your own model airplane, and the process is not difficult. Most RTF or ARTF kits involve easy-to-follow steps that take anything from a few minutes to a few hours to get through. Building a full kit plane is a little more challenging but still not terribly hard.

Just be sure you check the package to understand what it contains. You'll generally be required to purchase things like glue, radio, engine, wheels, covering material, and fuel tank separately, but not always. To make the process of building your model airplane easier and quicker, start with a flat building board, one that you can push pins into and large enough to build one-half the wing at a time.

Then you'll need a modeling knife with sharp blades, a razor saw, a small screwdriver, T-pins, needle nose pliers, a drill and twist drill bits, a soldering iron with rosin-core solder, a sanding block, various grades of sandpaper, and a heat sealing iron.

What Should I Look for in My First Plane?

In the beginning you want a trainer model airplane. Although this is not necessarily the prettiest plane on the market, it is built specifically for those learning to fly for all the reasons already discussed.

Always choose a high-wing plane for your first model; they are much more forgiving of pilot error. As you build up skill and confidence with the trainer plane, then comes the fun part of going out and buying other planes you've researched for weeks.

What's the Best Kind of Radio?

People always want to know what kind of radio to choose. This choice can be a little daunting at first because there are so many choices, ranging from a very basic model to one that is completely over-the-top. However, when first getting started, you don't need the fanciest radio system available.

Instead, we recommend you go with a basic, four-channel radio system that is specifically designed for beginner flyers with a trainer, or sport, RC plane. The result will be a good quality system that is dependable and easy to learn. After working this one for a little while, you'll soon have the necessary skill and confidence to move up to a more sophisticated model.

Do I Need a License?

People always ask if a license is required to fly a model airplane. The answer to that question is no. Yet you'll be required to abide by some strict regulations that are enforced by your national government. For example in the USA the Federal Communication Commission (FCC) is involved with the flying of model airplanes (and their radio devices), just as they are with full-size passenger planes.

If It Stalls Out, Will My Plane Crash?

Most people think that once a model airplane engine stops, the flyer no longer has any control over the plane. In truth, although the plane's engine is not working, the radio system is still perfectly functional, as it is powered by the on-board battery. Therefore, when this situation occurs, all you need to do is glide the plane in for a safe landing. With some models you can even restart the engine.


Members of the Large Model Association of the UK
with their twin engined scale models of the DC3

HAPPY LANDINGS!

As you have learned in this book, building and flying a model airplane involves learning and practicing new skills. It is an exhilarating experience that men and women of almost any age can enjoy. The reasons people love it are many and varied: some fly planes to get away from a hectic day at the office, or at school, while others simply enjoy a good challenge--and being around like-minded people.

Flying model airplanes is not difficult, but it is a learned skill. By working with a reputable instructor, you'll soon be on your way to becoming an expert flyer. We're confident the information provided in this book will start you down the runway toward an amazing hobby you'll absolutely love.

Once you've decided on the model plane you want and have located an instructor, the fun begins. The greatest thing about flying planes is the fine balance of skill, challenge, and risk. And every time you conquer a challenge there are new horizons to aim for. You'll watch your skill level improve quickly and, before long, you'll probably be involved with a fantastic model airplane club where you can have great fun with people just like yourself and be building fantastic models yourself.

Remember, there are tons of additional resources available at your local library, bookstore, or on the Internet. Therefore, while we have done our best to provide you with a broad view of the hobby, you have many ways to find the answers to any questions we didn't answer. Do your homework, and the sky's the limit!

Thank you for allowing us to introduce you to the world of model airplanes. We truly wish you much success, and years of safe fun. Blue skies forever!