Pilot Training Program

Revision 2
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This booklet is a guide for instructors of the North Dallas R/C Club, and their students. It primarily applies to how to teach beginners to fly R/C. However, there is a large amount of information that is good for all R/C pilots, not just instructors.

Instructors - please read this thoroughly, and re-read it every so often so that as a club we maintain consistency in our instruction of student pilots. At the back of this document is a useful set of appendices including a Solo Flight Check List, Field Equipment List, Mechanics Check List, Field Rules and a Glossary of Terms.

Just because you're good at something does not necessarily mean you can teach it. Some of the best fliers freely admit that they do not have the patience to teach beginners. Additionally, teaching requires an ability to see things through the eyes of the beginner, and to modify your discussion accordingly. Not everyone is cut out for this. It is the intention of this text to teach experienced fliers how to teach RC flying. While it will be most useful to beginning instructors and their students, even fliers who have been teaching for some time should find many points helpful.

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SECTION I

INTRODUCTION

Program Objectives

Surely as you were learning to fly, you noticed that the instructors at your flying field were very busy, especially during evening and weekend flying. There probably never seemed to be an abundance of instructors, even during designated instruction times. For this reason, many newly proficient fliers should consider becoming instructors.

In this text, we will show you how you can become an RC flight instructor. While there are many ways you can give back to your club, instructing for a flying season is one of the most rewarding ways.

The objectives of the NDRCC Pilot Training Program are as follows:

- Promote model aviation
- Retain newcomers to the club
- Maintain a high level of club membership
- Improve Safety
- Achieve a uniform and high quality standard of instruction
- Ensure a sufficient quantity of qualified instructors and assistants

There are many ways to teach RC flying, and no two instructors will totally agree on how every concept along the way should be related. The methods shown are rather simplistic, yet they have been proven over years of instruction and have always worked well. Both students and instructors are encouraged to submit improvements to the club. This helps to ensure that the program evolves to meet the changing needs of our organization.

The goal of the instruction program is to get each student to the point where they can fly safely by themselves. While you may also wish to assist your students with learning aerobatics as well, this text only addresses basic flight. This teaching method consists of **four steps** (or progression levels) a student must achieve to get to the point where they can begin flying on their own. This makes it very easy to teach, since you can organize every technique needed for flying into four basic steps. It also helps you limit the number of things beginners must master as they learn how to fly. While you can eventually mix and match certain techniques described during each step to match your own teaching preferences, we recommend that you thoroughly understand the entire process before you begin changing anything.

Special notes for beginning instructors

Insist on using a buddy box. While experienced instructors may be able to teach without a buddy box, as you begin instructing you will be amazed at how many precarious attitudes beginners will get their airplanes into. Depending on your flying skills, some of these attitudes will not be comfortable to you. It is difficult enough to right a wandering airplane with the buddy box. Doing so after a transmitter is passed can be much more difficult, especially when the plane is close to the ground, as it is when taking off and landing.

Experienced instructors can easily help students with the early stages of learning how to fly (steps one and two) without using the buddy box. As long as we keep the airplane high enough, the plane should never be in danger. However, as the student begins taking off and landing, you must make it very clear that there will be little the instructor can do to save the plane when it gets close to the ground. More than likely the plane will be dumped (and damaged) several times before take offs and landings are mastered. As long as the student understands this, you can work with them. However, if they show any signals (during steps one and two) that they may blame you for the plane's damage, you should delay teaching them to take off and land until the student accepts this risk.

With the buddy box, you have total control of when you retake control. Conversely, when sharing a transmitter, the student must give you the transmitter before you can retake control. As the student progresses, they may protest when you ask to retake control. They may (incorrectly) feel they are still in total control even though you know better. By the time they finally acknowledge that they are in trouble, it may be too late for you to save the airplane. Make it very clear at the start that if the student protests when you ask to retake control, that you will stop helping them.

You control the pace. Students tend to get a little anxious. You will eventually develop a feel for when a student has progressed enough to move on to each new step. Until then, take it slow. If in doubt about whether a student is ready to move on, keep on the current step until you are absolutely sure.

Be assertive with your control of the master transmitter. Especially when first starting, be ready to take control of the plane at the first sign of mistakes. While this may frustrate students to some extent, you must be totally comfortable with the control of the airplane. There may be times, for example, when a student is coming close to the flight line. They may be flying just fine, but you will have to take control of the plane to avoid the flight line boundary.

Patience is the key. Students will have difficulty with things you (now) find easy. This can be frustrating. If you show your frustration, the student will soon lose confidence. You must constantly encourage beginners, stressing positive accomplishments to build on.

Be on the lookout for new ways to do things. Believe it or not, the best way to thoroughly learn something is to teach it! You will be amazed at how many things you learn from a student's questions. They really force you to think through many things that you may now take for granted. In order to explain anything, you really have to thoroughly understand it. For questions you can't answer, look for another experienced instructor to help.

Be sure you can fly out of trim airplanes. If you have never taken a new plane off by yourself, you shouldn't take a student's plane up for the first time. To get ready to fly a plane for the first time, practice this. Get your plane in the air and have an instructor intentionally throw off one or more of your planes trims. Practice getting the trims back to normal while controlling the plane in the air.

Keep their left hand on the stick. Through the first two steps of learning to fly, students will be predominantly using only their right hand. You will eventually notice that they tend to let their left hand stray away from the left stick. Urge them to keep both hands on the sticks. As they begin landing and taking off (in steps three and four), their left hand will be needed, and it will be easier if they are comfortable with their left hand on the stick.

Watch for the student's saturation point. We all have a limit to how much new information we can absorb in a given period of time. Keep in mind that your student will be concentrating very hard during practice sessions (especially on their first few flights). There will come a point when they simply cannot take any more without a break. One common symptom of this will be that the student has been doing just fine for about eight to ten minutes of flying. Suddenly, the student starts making mistakes (usually silly mistakes) not normally made. The student may not even understand why they are doing so poorly and begin to get frustrated. As the instructor, you must be able to recognize when the student has had enough. Tell the student they need a break and land the plane.

Two steps forward, one step back. You must remember that your students will have problems along the way to learning how to fly. At times, things you thought your students understood will seem to be difficult again (especially after long non-flying periods). This can be frustrating for instructors so you'll have to show your patience when faced with this problem. One way to minimize the problem is to do a review of what the student currently knows at the beginning of each flying session. You can review on the ground, reinforcing the student's knowledge as well as begin the practice flying by having the student do seemingly simple maneuvers they already know. This also helps you begin a more complicated (and new) topic on a positive note. However, even with reviews, you must be on the lookout for times when the student needs to take the one step back before they can move forward.

The approach

Section two is devoted to requirements for new students. This chapter includes the most commonly asked RC questions, AMA and club membership rules, a presentation on what makes the best trainer airplane, a discussion of safety, aircraft assembly and control setup and the basics of engine tuning. While these presentations are, for the most part, directed to the beginner, we urge you to read them to help with your ability to relate these important topics to beginners at the field. You can also copy this information and give it directly to students.

When it comes to actually teaching, we break teaching RC flying into four basic steps. In any form of teaching it is good to limit the number of things a student must learn - and RC flying is no exception.

1. **Teaching how to master turns and level flight**
2. **Teaching how to set and hold headings**
3. **Teaching how to land**
4. **Teaching how to take off**

While this may sound overly simplistic, think about it. To get to the point where you are flying by yourself, every technique you master fits into one of these four steps!

Assumptions

Before taking a student up for the first time, there are several things that must be explained. For example, the student should know the basics of aerodynamics and flight, the stick controls on the transmitter (ailerons, elevator, throttle, and rudder) and the function of each control. The student's airplane must be checked out by a pre-flight instructor, have had at least one trim flight and be properly configured to operate with the buddy box. These pre-requisites are covered in detail in section two and appendix C of this manual.

Flying preferences

Instructors tend to teach what they know in the same fashion that they know it. There are several alternatives to almost every important function of flying. Good instructors recognize that their own ways are not the only (and in some cases not the best) ways of doing everything.

How do you handle the left/right problem? Beginners have a common problem when it comes to mastering turning. After entering a turn, they tend to forget which way they are turning and give the wrong aileron to exit the turn (sending the plane deeper into the turn). There are several ways you can help the beginner with this problem. But first, ***establish with the student that right and left commands always refer to the position of the joystick, not the plane.*** This greatly simplifies the learning process for the student.

One teaching aid is to ask the student to turn his body to face the plane's heading. If the student is looking in the same direction as the plane is flying, it will help him remember which way the plane is turning. Another method is to have the student keep repeating (out loud) from the beginning of the turn

which way he is moving the stick. A useful rule of thumb for beginners is to instruct them to push the aileron stick in the direction of the low wing when the plane is flying toward them. Using any of these methods, the beginner will eventually become comfortable turning and not need the crutch. The preference is to get them to stand in a stationary position when flying and get them to keep saying out loud the direction they are turning.

What throttle setting do you use? Try to keep the throttle setting just high enough for the plane to maintain "hands off" level flight in the air. This ensures smooth docile performance and minimizes the student's natural tendency to over control. It also helps them make level turns. You will eventually need to have the student practice at all throttle settings from idle through full throttle.

How much control surface motion do you want? Since students have a natural tendency to over control, many instructors like to set up trainers to be very docile, minimizing control surface motion (possibly with dual rates). This means the beginner must move the sticks quite a bit to cause a reaction from the plane. However, the preferred setup is to keep the plane rather responsive for three reasons. First, the student must eventually learn the precise control motions needed with sensitive control surfaces (on this airplane or their next one). Second, on windy days minimal control may not be enough to cause sufficient response from the airplane in certain attitudes. Third, as the instructor, you need the plane to be responsive enough to get out of precarious attitudes.

When do you teach rudder-coordinated turns? It is generally best to teach people to fly without ever manipulating the rudder stick (except for steering on the ground). Most RC airplanes, and especially trainer planes, turn quite nicely with only a combination of aileron and elevator. While rudder coordinated turns make for nicer looking turns, and rudder is helpful when landing in a crosswind, try to keep turning as simple for beginners to master as possible. The addition of rudder coordinated turns should follow successful completion of the first four steps of instruction.

Final approach, one turn or two? If teaching realistic flying, the RC pilot will make two turns during the final approach. One turn will bring them ninety degrees to the runway and the other will bring them right on the middle of the runway. To simplify this, have students make one (180 degree) sweeping turn during final approach.

What is the wind limitation? Most students can learn more easily on calm days. But, if we waited for perfectly calm days, we'd never fly! However, there comes a point when the wind is blowing so hard that it will be impossible for the beginner to control the plane. For the student's first ten flights or so, we recommend limiting your instruction to when the wind is blowing under 10 miles per hour. As the student progresses, let them fly on windier days. Remember that your student has not truly mastered flying until they can fly with winds around 10-12 mph.

Having said this, it is important to ***exercise caution on days when a significant crosswind exists***. High wing trainers with their generous dihedral do not handle crosswinds very well. Although flying is not particularly difficult, the ground handling may be hazardous to the plane's health! The student's first attempts at landings and takeoffs should be restricted to days where the winds are primarily parallel to the runway. Teaching crosswind handling should be reserved for advanced students only. Each instructor will have a different comfort level with handling high wing trainers in a crosswind. If you do not feel comfortable flying under these conditions, by all means, ask your students to wait for a better day.

SECTION II

PRE-FLIGHT INSTRUCTION

Instructors tend to get the brunt of questions from people just thinking about getting into the hobby. Once someone has begun learning to fly, instructors are bombarded with questions related to all facets of this hobby. Even once a student has learned to fly, if they have questions (especially about aerobatics), they ask an instructor. This section of the program is devoted to handling the most common questions and problems from a beginner. Though as an experienced pilot you already know much of what is presented in this section, this presentation should help you with your ability to relate what you know to beginners. Also, much of this section can be simply copied and given to beginners with questions.

Common RC questions: Most beginners to the hobby tend to have the same set of questions as they enter into the RC airplane hobby. So we'll begin by giving a summary of these questions and supply brief answers.

How does the radio control system work? As with any kind of radio, a transmitter (held by the flyer) is used to send signals to the receiver (in the airplane). Both are powered by (usually rechargeable) batteries. The radio system can have several channels. Each channel is used to control one airplane function. Servos (one for each channel) are used to cause the actual motion within the airplane to make control surfaces move.

A good beginner's radio configuration has four channels. These channels control ailerons, elevator, rudder, and throttle. Two sticks (like computer game joysticks) on the transmitter give the pilot command of these four controls. With the most common radio setup mode, the right stick is used to control aileron (left/right) and elevator (up/down). The left stick is used to control rudder (left/right) and throttle (idle through full throttle). Like a computer game joystick, the aileron, elevator, and rudder sticks are spring loaded…when you let go, they return to the center (neutral) control position. The throttle stick stays where you place it, from idle to full throttle.

Keep in mind that radio control systems can have more than four channels. Other controls for these channels include retractable landing gear, flaps, and even smoke systems. For now, you should concentrate on the four basic controls. Leave the fancy stuff for when you have mastered the hobby.

Within the airplane, servos receive signals from the radio's receiver whenever either of the transmitter sticks is moved. The servos respond according to the motions of the transmitter sticks and cause the control surfaces of the airplane to move in sync with stick movements (through mechanical linkages). **Instructors:** If an interested person at the flying field has questions about radio systems, be sure to show them on your own airplane.

Other radio terminology:

Trim controls - It is not possible to perfectly set each servo and control surface prior to a model's first flight. Say for example, the plane tends to climb in a hands off condition. The elevator trim control will give the flyer the ability to trim in some down elevator without affecting the joystick for the elevator. In essence, trim controls allow the flyer to set the radio so that the plane will fly straight and level with hands off the radio. ALL radios come with trim controls for the four basic channels. It is advisable to perform mechanical adjustments to the control linkages such that the plane flies nearly hands off with all trims set in the neutral position. This is a trial and error process that may take several flights. The effort pays off though since trim buttons are easily bumped out of position inadvertently and it can be difficult to estimate the settings if they aren't close to the neutral position.

By the way, this is another reason that beginners should seek help. It is highly unlikely that a new airplane will behave perfectly with regard to trim settings. A plane that is not trimmed properly can be

very difficult to fly (even for an experienced flier). For a beginner, it may be impossible to fly. During the new plane's first flight, the instructor will trim your airplane, and advise you on the procedure to mechanically adjust the control linkages to be centrally positioned.

Servo reversing - It is sometimes inconvenient (if not impossible) to mount the servos in a way to properly control the control surface. In many cases, the control motion will end up backwards (a left aileron command results in right aileron movement, for example). The servo reversing feature allows you to mount the servos in the most convenient manner, and if one or another comes out backwards, the servo reversing switch for that servo (in the transmitter) can be turned on. Servo reversing is a standard feature on most radios sold today.

Dual rates - Though not included on every radio, this feature allows you to change the responsiveness of your airplane's control surfaces (usually this feature only applies to ailerons and elevator). On high rates, your servos will move full travel and the plane will be quite responsive. On low rates, your servos may only move about 40-60 percent of their total travels. This is a nice feature for beginners, since you can reduce the responsiveness of the airplane, making it easier to fly.

Mixing - This feature allows you to have one control automatically invoke another. For example, the radio can be adjusted to automatically give some aileron movement in response to a rudder command (to make for a smoother turn). While this is a nice for feature experienced flyers, it doesn't help beginners learn to fly. Don't go out of your way to find a radio with this feature for your first radio.

RF Style - This refers to **AM** versus **FM-PPM** versus **FM-PCM** versus **Spread Spectrum** - Generally speaking, the most reliable (and most expensive) radio style is FM-PCM (stands for frequency modulation - pulse coded modulation). Next in reliability and price comes FM-PPM (frequency modulation – pulse phase modulation). Finally comes AM (amplitude modulation). All of these typically operate on the 72Mhz frequency band, although some park-flier ARFs may use the 27Mhz band. The newest style on the market is called “Spread Spectrum”, and operates on the 2.4Ghz frequency band. You may see these referred to simply as “SS” or just 2.4Ghz. They are a bit better than the FM-PCM type, and are more immune to interference. Though almost all of these radio styles are highly reliable, we recommend that beginners purchase an FM-PPM, FM-PCM or 2.4Ghz radio.

Trainer system – Commonly referred to as a “buddy box”. This feature allows the safest manner of flight instruction. We devote an entire discussion later in this set of questions to the trainer system. Please refer to this information. For now, just remember a beginner should not buy a radio that is not set up to accommodate a buddy box.

How many airplanes can fly at a time? – Looking at just the 72Mhz band for now, the FCC has allotted 50 frequencies to model aviation. These frequencies are given numbers, ranging from 11 to 60. In theory, this means that fifty planes could be flying at the same time! However, the likelihood of that many flyers showing up at the same flying field without duplicating frequencies is low. Also, when more than four or five planes are in the air at the same time, it can be quite distracting to the flyers (mid-air collisions, although rare, do happen). For this reason, the NDRCC normally limits the number of planes that can be in the air at the same time to 4. On exceptionally busy days, we allow 5 airplanes up at a time but only if each pilot has a dedicated spotter. The role of the spotter is to keep track of other aircraft in the air on behalf of the pilot, paying particular attention to take off and landing activity on the runway. Note that if one flyer turns his transmitter on when another on the same frequency is flying, the pilot of the plane in the air may lose control of the plane. This is why we require frequency control at the field. **Instructors:** be sure your students understand the rules of frequency control. ***Anyone that causes a crash by failure to follow frequency control procedures is financially liable for their actions.***

How long can they fly? - Depending on the size of the engine and the size of the fuel tank, the range of flight time can be from about 10 minutes to well over 20 minutes. One common recommendation for a .40-sized engine is about a six ounce fuel tank. This will allow about a 10-12 minute flight.

What happens if the engine quits? - Most planes designed for beginners will glide quite well. In the hands of an experienced flier, a plane can be safely landed even if the engine quits. Of course the altitude and attitude of the airplane at the time of the engine failure has a lot to do with how difficult it is to safely land the airplane. The higher the plane, the more time the pilot will have to plan the landing. (Landings without power are called dead-stick landings.)

How far away can the airplane fly? - The rule of thumb is if you can see it clearly, you have control of it! Generally speaking, your radio will have control of the airplane for distances of close to a mile. The higher the plane, the greater the range. However, since the farther away the plane is, the smaller it appears, most pilots will not be able to truly "fly" the plane when it's only a speck in the sky.

How fast do they go? - This depends on the style of airplane as well as the size of the engine. Trainers will fly at speeds of about 20-60 miles per hour, depending on the maneuver. More aerobatic sport planes can reach speeds of well over 90 MPH. Pylon racers designed for speed can go as fast as 150 MPH.

How high can they go? - As high as you can see them. Again, if you can see it, you have control of it! However, flying fields that are located in close proximity to airports usually have some height limitations. **Instructors**: Be sure to relate any rules related to height and position when flying.

Is flying an RC airplane like flying a full-scale airplane? - In essence, yes. You'll have the same basic controls a pilot has on a full-scale airplane. However, full scale pilots that have learned to fly RC airplanes say there is quite a difference in actual flying technique. They say an RC airplane responds much faster than a full-scale airplane. They also say that learning to fly RC can be awkward, since there is no seat-of-the-pants "feel" for the plane's maneuvers. RC flying requires much more hand/eye coordination since you must respond to what you see rather than what you can feel.

Is it hard to learn to fly? - This is a tough question to answer. Everyone has a different aptitude level for learning RC. This much is certain. RC flying is hard enough to learn that you will not want to try to learn by yourself. You are not likely to meet anyone who learned by themselves that did not go through several airplanes (or at least several crashes) in the process! Fixing airplanes is not nearly as much fun as flying. If you want to learn to fly with the least amount of problems and expense, join the club and work with one of our instructors. He'll flight test and trim your plane, take off and land for you, give you pointers, and stand close by, ready to take control if you get into trouble in the air. While we can't promise that your plane will never crash, you will have a much better chance of keeping your plane in one piece with an instructor than without one.

How long does it take to learn to fly? - Like the previous question, this is tough to answer. It depends upon the student's aptitude. It also depends on how often you practice. The more often you practice the shorter the time it will take to master. You know the saying, "If you don't use it, you lose it!" It truly applies to RC flying. If you only fly once a week, it may take quite a long time. You'll be struggling to remember what was learned in the last session. Some people solo (fly by themselves for an entire flight) in as little as two weeks of practice (every day for several flights). Others might take the whole flying season to learn to fly. Yet others may take more than one flying season. With a good instructor, even the learning stage is fun and rewarding. So this period should seem to go quite quickly, regardless of how long it takes.

What is the best size plane for learning? - Generally speaking, the smaller the airplane, the less expensive it will be. Unfortunately, the smaller the airplane, the less stable it is and the worse it handles in the wind. Here are the approximate engine sizes as well as the approximate wingspan and weight of several standard classes of RC airplane.

Engine	Wingspan	Weight
.049 (1/2-A)	35-40"	1-2 lbs
.20	40-45"	2-3 lbs
.40	50-55"	4-5 lbs
.60	60-65"	6-8 lbs
.90	70-75"	9-10 lbs
1.20	80-85"	10-12 lbs

Keep in mind that all size RC airplanes perform nicely on calm days. We recommend starting with an airplane large enough to handle our typical wind conditions. This means a .40 or .60 size airframe.

What's the hardest part of flying? – Take Off and Landing. Your instructor will first teach you how to keep the plane in the air, making simple turns. Then you'll progress to flying figure eight patterns. Once you can keep the plane in the air by yourself without any problems, you'll learn to land. Finally, once you have mastered all other phases of flying, you'll learn how to taxi and take off.

How much wind can there be? - Experienced flyers can fly (sport planes) in winds well over 20 MPH. However, the more wind, the harder (and scarier) it is to fly. Beginners won't want to fly in winds much over 8-10 MPH until they have mastered the first step of learning how to fly. Crosswinds may be particularly difficult for the beginner and your instructor may ask you to wait for a better day.

What about flight simulators? – The flight simulator software available today is very realistic and an excellent investment for beginners. The student can log many times the number of flight hours on the simulator than is possible at the field in a given period of time. This investment is virtually guaranteed to rapidly improve your hand/eye coordination and accelerate your learning curve. The use of this tool may shave weeks or months off of the time it would ordinarily take to achieve solo certification.

What makes a good trainer plane? - Here are some qualities that contribute to making a good trainer plane:

- **High wing design** - You'll notice that all trainer recommendations we give are high wing airplanes. This is the most stable design (even for full-scale airplanes). Since the body of the fuselage is below the wing, the plane will nave a natural tendency to right itself after a turn.

- **Flat bottom or semi-symmetrical wing** - Flat bottom wings are best for stability, which is helpful when learning. However, planes with flat bottom wings are not very maneuverable. Once you do learn to fly, you will eventually want to learn how to do some aerobatics. Flat bottom wing designs perform poorly when it comes to aerobatics. Semi-symmetrical wings have a slight curvature to the bottom of the wing. They are not quite as stable as flat bottom wings, but they do allow moderate aerobatics.

- **Rugged design** - It’s almost a guarantee that your first plane will get knocked around quite a bit. You'll want to be sure that it can take some minor bumps and bruises. But be careful here! When a plane is designed to be rugged, it usually sacrifices some of its flying characteristics. There are a number of planes on the market that claim to be almost indestructible, and they almost are, but they sacrifice good flying characteristics to be able to make this claim.

Planes that make good trainers and that we have successfully taught people to fly with:

- SIG Kadet LT 40 (ARF and Kit)
- Thunder Tiger Trainer 40 (ARF) and Tiger Trainer 60 (ARF)

- Hobbico Superstar 40 (ARF) and Superstar 60 (ARF)
- Hobbico NexSTAR or NexSTAR EP
- Avistar (ARF)
- Carl Goldberg Eagle II (ARF and Kit)
- Hangar 9 Solo Series (ARF)
- Hangar 9 Easy Fly .40 (VRTF)
- Great Planes Trainer 40 (Kit)

All these planes are very stable, don't tip stall, can fly very slowly, respond uniformly to controls, and have fairly light wing loading.

Should I build a plane from a kit or buy an ARF (almost ready to fly)? - This is totally up to you. If you enjoy working with your hands, by all means, build your own airplane. You can save a little money (but not much) and you'll have the satisfaction of flying something you built yourself. Also, you'll have the plans to the airplane in case you have to do some repairs after a crash.

On the other hand, if you don't enjoy building, or you wish to get in the air as quickly as possible, there are several excellent flying ARF airplanes on the market (some of which we highly recommend). Keep in mind that, even with an ARF, there is still some work to do. While the wing halves, fuselage, and tail section are complete, you do have to finish the final assembly, mount the engine, and install the radio.

Most ARFs come with excellent instructions (since they assume beginners are purchasing them), and you can be in the air in about 10-12 hours of building time. The VRTF (virtually ready to fly) designs can be assembled in as little as two hours with no special tools.

Plane and engine size - 40 size trainers offer the best compromise in stable flight and economy. If cost is not a concern, 60 size trainers tend to be substantially more stable than 40 size trainers (especially in higher winds). The difference in total price between a 40 and 60-size setup is typically less than $100.

When it comes to engines, you should buy a product with a proven track record of reliability and ease of use. Talk to experienced flyers at your field to get recommendations. OS, Thunder Tiger and SuperTigre engines are among the most common name brand engines at our field. All have excellent reputations and most of our experienced pilots will be very familiar with the initial setup and operation.

As far as power, select an engine that is in the middle or top end of the recommended range for the airframe. As a general rule, it is best to err slightly on the overpowered side. As you begin taking off, a good strong engine makes the procedure much easier. If your plane barely has the power to get off the ground, taking off can be quite a challenge. This extra power is also very handy when practicing approaches and for gaining altitude fast. Additionally, once you have learned to fly, a good strong engine will be needed for your next (sport) airplane.

How much do they cost? - This is also a tough question to answer based on the size of the airplane and how many extras you want to buy. For a .40-sized airplane, here are some basic guidelines for costs. Note that this configuration assumes that you wish to keep the cost down

ARF (almost ready to fly) plane:	$125.00
.40 sized engine (medium class):	$90.00
4 Channel FM radio (with cord):	$175.00
Flight box accessories (fuel, etc.):	$60.00

Approximate startup cost:	$450.00

While this may sound expensive, this is a one-time cost. Your radio, engine, and flight box can be used over and over for other airplanes. Don't forget that you need to join the AMA as well as the NDRCC club in order to fly at the field.

What is the trainer system? (IMPORTANT!!) - Imagine you've just built your airplane and you bring it out to the field for the first time. You get together with an instructor and he test flies your airplane and trims it out. Now it is going to be your turn. Your instructor takes off again and gets the plane up to a safe altitude and hands you the transmitter. If you're like most beginners, you'll have the plane on its back almost immediately (beginners have the tendency to over-control the plane). Your instructor quickly grabs the transmitter back from you and rights the plane. Then he gives you back the transmitter. You get about 3 more seconds of practice before he has to grab the transmitter again.

***This passing back and forth of the transmitter is very cumbersome, error prone, and downright scary*.** In the beginning, when you are just trying to keep the plane in the air, passing the transmitter will suffice. But as you get better, and you begin to do maneuvers closer to the ground (like takeoffs and landings), you'll want a more fail-safe method of instructor control. Typically called a buddy box, the trainer system allows you to connect a slave transmitter with the master transmitter via a cable. Once set up properly, the instructor will take the master transmitter and give you the slave transmitter. He'll get the plane in the air and when ready, he'll simply press a button and you'll have control. If you get into trouble, he releases the button and he has control again. No more passing transmitters. The trainer system will dramatically improve your odds of learning how to fly without crashing even once (especially as you begin taking off and landing).

Unfortunately, you have to have both a master and a slave transmitter. Most beginners do not want to buy a second complete radio system just to get the slave transmitter. Most pilots will not let you borrow their transmitters to be used as a slave (the servo reversing switches may have to be changed which can cause major problems when they go back to flying their own airplane). Fortunately, NDRCC maintains buddy boxes at the field. We currently have Futaba, Hitec, JR/Spektrum and Airtronics-compatible buddy boxes and cords available to work with students.

Note that the trainer system connector port is not equipped with all radios. Most older AM style radios, for example, do NOT come with this port and those that do typically are not compatible with our modern FM systems. ***You should plan on buying a current model Futaba, Hitec, JR/Spektrum or Airtronics FM or 2.4 Ghz transmitter to ensure that your radio will operate with our training equipment.*** If you prefer to purchase any other brand of radio system, plan on purchasing your own buddy box and trainer cord as well.

Pre-flight inspections - Beginners to RC flying vary dramatically when it comes to building skills. Some are building their very first flying model and find it quite challenging while others may have built other types of flying models and find it rather easy. The kind of airplane has a lot to do with how difficult it is to get into flying condition. ARF's tend to be rather easy, requiring little more than final assembly while kits can be much more challenging. Additionally, correctly installing radios and engines can be somewhat difficult, even for ARF airplanes.

For these reasons, we insist that all beginners have their planes checked for airworthiness prior to starting flight training. Instructors will check for problems that need to be corrected. Common mistakes that must be corrected before the plane can be flown include having servos activate control surfaces in the incorrect directions (easily fixed by using servo reversing), not placing foam rubber around the receiver for padding, not properly gluing wing halves (on ARF's), not correctly gluing hinges, and improper center of gravity point. Keep in mind that these are but a few of the many things that can cause an airplane to crash, and the instructor must be on the lookout for many more.

Additionally, there may be things an instructor finds that may not cause the airplane to fail (yet) but should be repaired in the near future. For example, certain control surface hardware (clevises, control horns, and linkages) works better than others. An instructor may be willing to help a beginner today, but also ask that some things be changed before further help will be given.

Appendix C includes a complete Mechanics Check List for new planes. Encourage students to go over the check list with their plane at home before bringing it to the field. This will minimize the amount of time spent at the field going over the plane for the first time. Review the Mechanics Check List with the student at the beginning of each flying day. In particular, ensure that the engine can be completely stopped by means of the throttle trim. Do not allow any plane to be flown that is not airworthy in every regard.

IMPORTANT SAFETY NOTE: Be sure that the buddy box is properly matched to the student's transmitter before each and every flight. We often share buddy boxes among multiple students on any given day and the potential for reversed servo controls and/or misaligned flight trims should be assumed to be present at any time.

SECTION III

STEP ONE: TEACHING TURNS AND LEVEL FLIGHT

The objective is to get the student to a point where they can keep the airplane in the air with no help from you. Though the plane may still be "flying the student" to some extent at the end of this step, at least they should be to the point that you are not constantly fearing for the airplane as they fly.

We assume at this point that the training airplane has had a trim flight and any necessary control surface adjustments have been made. We also assume that the student has completed the pre-flight instruction section and understands the basics of aerodynamics and flight, including knowledge of the influence each control surface has on the airplane. Finally, we assume that the student has been taught how to safely start and operate the engine and is familiar with NDRCC safety rules.

The time it takes the student to master step one varies dramatically. Believe it or not, some students do so on their very first flight. But it usually takes longer. Regardless of how long it takes, students should not get the feeling that they are in a race to see how long it takes to master any step of flying.

When it comes to time, many beginners think they should master flying their very first time out. When they don't, or whenever they don't feel they are progressing fast enough, they tend to get down on themselves, especially if another beginner seems to be progressing faster. Part of your job will be to keep them from getting discouraged. Make it clear that everyone picks up the hobby at a different pace. Relate the problems you had when you learned to fly. Be sure they are having fun. (If it's fun, who cares how long it takes?) Tell them if they push too hard, the problems they are having only get worse.

Begin on the ground by explaining the basics of turning. Explain that turning is basically a three step procedure:

1) bank with the ailerons,
2) maintain the turn with up elevator
3) level out with the opposite aileron.

Demonstrate turning with hand movements as well as on the stick of the transmitter. Explain that even trainer planes tend to be quite responsive and that only a little motion of stick will be sufficient to maneuver the plane. While the student cannot really get a feel for flying while on the ground, you must prepare them for what to expect in the air. What about the rudder? - If the plane has ailerons, we recommend having the student ignore the rudder when turning for a while. RC airplanes, and especially trainers, turn quite nicely with a simple combination of aileron and elevator. While you may eventually wish to teach the beginner rudder coordinated turns, this tends to substantially complicate the learning process, especially early on. If you intend to teach rudder coordinated turns, wait until the student is well along in step two before you introduce this more complicated turning method.

Demonstrate proper safety practices each time you take the student's plane to the runway. Always perform a final system check with the engine running to ensure that all control surfaces are moving freely and in the proper direction. Before takeoff, advance the throttle briefly to the full position to ensure that the engine is cleared and will not stumble upon acceleration in the takeoff roll.

On the student's first flight, begin by demonstrating a turn. Try to get the plane in an attitude where the student can see both the plane and the transmitter to see the small amount of control you are giving (hold up the transmitter to show them). After entering the turn, stress how important it is to maintain the turn with up elevator. Also demonstrate how a trainer airplane tends to self correct, meaning minor

aileron corrections may be required to hold the bank angle. Finally demonstrate exiting a turn with opposite aileron control. You may want to demonstrate this in both directions, stressing the three step nature of turning - bank with aileron - hold the turn with up elevator - straighten with opposite aileron.

The beginner's first few attempts - We're assuming you're using the buddy box. Always announce to the student whenever you give control or retake control of the plane. Begin by getting the plane into a perfect turning position. You'll need to make it as simple as possible for the beginner's first few tries. Begin at a safe altitude by aiming the plane toward one of the near corners of the field (left or right). This way, soon after the student takes control (by your holding the trainer button on the master transmitter), they will immediately begin the turn. Always have them turn the plane in a direction away from the pits (turning right on your left side and turning left on your right side).

It is quite likely that the beginner will immediately roll the plane over on its back, so be ready for anything as you give them control! Again, you decide when to take over. For the student's first few attempts, you will probably have to retake control soon after you push the trainer button. Don't be afraid of hurting feelings by retaking control! As soon as the student is in trouble and you retake control, right the problem and set the plane up again for another turn.

As the instructor, ***you set the rules for when you retake control***. Early on, tell students that there will be times when they may be in control of the airplane, yet you may still retake control. The first time has to do with the flight line. If it even appears that the student might eventually cross it and fly over the pits, you must retake control. While it is possible that the student may have been able to continue flying without crossing the flight line, you should not take any chances where safety is concerned, especially on the student's first few flights. Second, ***set an altitude limitation***. While learning how to turn, students tend to lose altitude in each turn they make. When the plane descends past a certain altitude, you should retake control, even though they may be doing rather well (this also gives them the goal of keeping the airplane above your cut-off point). Third, ***set a distance limitation***. If the plane gets so far away that it becomes difficult to see, you should retake control. You may also want to set a similar rule based on your own comfort level. Tell the student that if they get the plane into an attitude you don't feel comfortable with, you'll retake control. This may not be caused by a problem or mistake on their part; you simply don't want the plane to get into an attitude from which you cannot recover!

Though you have explained the three steps to turning on the ground and the student may have seemed to understand quite well, when in the air, the student will probably have problems remembering these three seemingly simple steps. Also, they will not be able to give the correct amount of aileron and elevator to make good turns. For these reasons, you will probably have to talk them through their first few turns. Don't be afraid to talk to the student while they fly (though be careful to stick to the point so as not to get them confused). Here is an example conversation (though very one-sided) you might have with a student on their first few turning attempts. At this point, you have just set the plane up for the student to make a gradual left turn when you push the trainer button to give the student control of the plane.

> *"OK. I've set you up to make a nice gentle left turn. Give a little left aileron to get the turn started and be ready to bring in up elevator. See that left wingtip drop. That's it. Not too much now or you'll have to give some right. That's it. You'll need some up elevator now. Waited just a little too long to bring in the up. See that nose drop a bit. Hold the turn with the up. Nose is still dropping. You need more up. That's it. Hold the turn until you're heading back toward the runway. Good. Remember, you're turning left. Be ready to straighten with right. OK. Begin to straighten. Not too much now or you'll over-control. Good. Now let's try a right turn..."*

Be careful with how much talking you do. Stick to the main points of the step. In this case, bank with aileron, hold the turn with up, and straighten with opposite aileron. Save any discussions that are not directly related to the subject at hand until the plane is on the ground.

That brings up a good point. After each flight, be sure to review the flight with the student. Stress those areas where progress has been made and be sure to offer praise. For those things the student is having problems with, you now have the student's full attention and can offer advice and constructive criticisms.

One more point about talking to students as they fly. While it's good to talk to help them get comfortable with a new flying technique, you'll want to be sure that the student is not just mimicking your instructions and confirm that the student truly understands the maneuver you are teaching. Once they are following your instructions and turning quite well, keep your mouth shut for a while and just watch them fly. If they continue to do well, they truly understand the maneuver you have been teaching.

If the student is having problems making turns (as most will), concentrate on each step independently. Begin by making sure they can give the correct amount of aileron control to get the desired bank angle. Beginners have the tendency to give too much control, rolling the plane to a very severe bank angle. You'll probably have to keep stressing how little stick control they need to give. Make sure they understand the relationship of bank angle to the plane's tendency to lose altitude. The more bank angle, the more the tendency to lose altitude quickly.

Once they can set the correct bank angle, concentrate on having them maintain the turn with the elevator. Make sure they are making gradual, level turns, neither gaining nor losing altitude (though gaining is always better than losing). Stress the relationship of bank angle to elevator. The more severe the bank angle, the more up elevator required to hold altitude (and the tighter the turn). Also stress that it is important to begin giving up elevator as soon as they see the wingtip begin to drop to the desired bank angle. Beginners tend to wait too long, and the plane loses altitude before entering the turn. This is somewhat difficult to master, because if they pull in up too early, the plane will simply climb (eventually stalling). Beginners also have the tendency of forgetting which way is up. The elevator stick may seem backwards to a person who has never been exposed to any form of flying. Stress that it's just like a full-scale aircraft, pulling back on the stick makes the plane go up. If they hold the transmitter more horizontally, it may help them remember this.

As they progress further in this step, stress the importance of maintaining the bank angle with aileron control throughout the turn, especially if they're flying a very self correcting trainer plane with a flat bottom wing and a lot of dihedral. Have them practice this by making full 360-degree turns. Have them fly the plane in a full gradual circle. Even a plane that is not very self-correcting will require minor adjustments of aileron to maintain the correct bank angle. Once they master the 360 turn in one direction, have them practice it in the other. Also, once they can perform one 360-degree turn, have them continue the turn several times, making several 360-degree turns consecutively. This practice forces the beginner to maintain a gradual turn for a long period of time.

Finally, have them concentrate on exiting the turn by applying opposite aileron until the plane is flying level again. The most common problem here is that the beginner forgets which way the plane is turning and they attempt to straighten by applying the wrong aileron direction to exit. This, of course, sends the plane into an even sharper turn. ***As the instructor, you must be prepared for this mistake every time the beginner ends a turn! The lower to the ground the airplane is, the more important it is that you be ready.***

There are several things you can do to help the student with this problem. One way (that many experienced fliers do not like) is to have the student physically turn with the plane. If they are facing the same direction as the airplane, it will be easier to determine which way to exit the turn. Another way is to have the student keep saying (out loud) which way they are turning throughout the turn. They will then know which way to exit the turn. Another common problem for beginners exiting turns is they

continue to hold the up elevator too long. This of course, will make the airplane climb at the end of the turn, and possibly cause a stall. They must practice until they can exit the turn at the same vertical attitude as entered.

Another problem to watch for is the student's tendency to turn much too severely. They bank hard, pull in a lot of up, and level out quickly. While their turns may look rather well, you must force them to turn gradually. When they turn so radically, it will be difficult (if not impossible) for them to come out of the turn on a predictable heading, which will be very important in step two to flying. If the beginner is having problems, it doesn't hurt to point out that turning gradually is the most difficult way to turn. Though they must master gradual turns, once they do, they can look forward to learning the Split-S and Immelmann turns, which are much easier turns to perform.

From the very start, be sure that the student practices left and right turns equally. With no intervention from you, most students will fall into the habit of making turns in only one direction. Most beginners tend to favor left turns. Force them to practice turns in both directions. Many students find it more difficult to make right turns. They may complain that the wingtip drops more quickly and more severely (along with the nose of the plane) when making right turns. They also complain that the plane tends to fall further into the turn while holding the turn with up elevator. This is related to how much engine thrust the plane has (possibly too much right thrust). Though some of this tendency can be removed by removing some right thrust, it also makes an excellent time to stress how small corrections must be made with ailerons during each turn. It also makes a good time to have them practice full 360-degree turns in both directions.

What about planes that don't have ailerons? - Though you don't see them as much any more, there are trainer planes that have only rudder, elevator, and throttle. Believe it or not, these planes fly quite similarly to planes with ailerons. As you apply rudder, the wingtip will still drop. You still hold the turn with up elevator. And you still exit by applying the opposite rudder. You will notice, however, that the nose of rudder controlled airplanes tends to drop more severely in turns. Be sure you've practiced flying a rudder-controlled airplane before you try to help someone for the first time. It takes some getting used to.

Throttle setting - Most model airplanes are overpowered, including trainers. This means you usually won't need full throttle to keep the plane in the air. As you know, planes tend to be much more responsive at full throttle. For most of our practice flying, keep the throttle at a setting that ensures docile performance. As the beginner progresses, be sure they can handle the airplane at any throttle setting.

Wind and turning - Ideally, the wind will be calm during the beginners first few flights. However, do not consider the student competent with this first step until they have flown in wind of at least 8 – 10 miles per hour. They will find that wind presents its own problems to turning smoothly. It will appear that the plane will be sluggish when turning into the wind, while quite responsive when turning in a direction with the wind. This of course, means that different stick control amounts will be necessary with every turn. The best advice is to tell beginners to fly what they see. If they give a little aileron control and the plane does not respond, they simply have to give more. Getting the student used to this idea early is very helpful. As we start slowing the airplane down for landing practice, this tendency for response to become sluggish will be compounded.

Ballooning tendencies - Many trainers have the tendency to climb with speed, especially trainers with flat bottom wing design. The faster they go, the more they want to climb. While some of this tendency can be overcome with engine down-thrust, engine speed is only one factor that influences the plane's speed. As a beginner makes their first few turns, it is likely that the plane will lose altitude. As it loses altitude it picks up speed. When the beginner exits the turn, the plane will have the natural tendency to climb, due to the increased speed. We call this tendency ballooning, since the plane resembles a hot air balloon as it rises for no apparent reason. Be ready to explain this tendency. To avoid it, the beginner must make level turns. If the plane does not lose altitude in a turn, it will not pick up speed, and it will not climb at the completion of the turn.

The beginner will also notice a tendency for ballooning whenever the airplane is turned into a high wind. To the airplane, it is just as if airspeed increased by the wind speed. The plane will tend to rise. This can be corrected (to some extent) by applying down elevator as the plane comes into the wind. Try not to let the student get too bogged down with trying to overcome ballooning. Though it may seem like the plane is doing something wrong, it is just a natural tendency for trainer planes. Try to have them accept the fact that trainers tend to balloon. Tell them that their next airplane (probably a sportier plane) will not have this tendency. Demonstrate this on your own sport airplane.

You know they're getting close when - One signal that the student is getting close to the completion of this step is that they begin to complain that the airplane always seems to climb. Be sure to praise them at this point! They have overcome their tendency to lose altitude in every turn. Now it will be a relatively simple matter of flattening out their turns. They can bank slightly more severely with the aileron or not give quite as much up elevator to hold the turn.

When the plane gets too high, simply have them cut the throttle a few notches and continue flying. Eventually the plane will descend. Once a comfortable altitude is reached, have them increase the throttle a little and concentrate on making more level turns. It is best to have students control the decent of the plane by themselves (instead of retaking control) since it provides an excellent opportunity for the student to practice manipulating the throttle.

When are they finished with this step? - Generally speaking, when the student can keep the airplane in the air for a whole flight with no coaching from you, they have mastered this step. Be sure, however, that the student can turn left and right equally well. It is quite common that a student becomes much more comfortable with one way or the other, and ends up constantly setting up the plane to turn in the comfortable direction. Force them to practice turning in the direction they feel least comfortable with!

SECTION IV

STEP TWO: TEACHING HOW TO SET AND HOLD HEADINGS

The objective is to get the student to the point where they can fly the plane under complete control at all times while in the air.

If the student truly mastered the first step to flying, this step should be relatively easy to master. You can begin stressing the importance of being able to set and hold headings even during step one. As they begin to make level turns (even after their first successful attempt), stress how important it is to come out of the turn in a predictable direction. This will be very important during the setup and final approach for landing!

Setting headings - By setting a heading, we mean the student must be able to exit each turn in a predictable manner. By holding a heading, we mean the student must be able to keep the plane flying in the headed direction (without wandering) for as long a period as required. Again, at the completion of step one, the beginner may be able to keep the plane in the air, but the plane may be flying the pilot to some extent. The beginner may still be reacting to the airplane instead of making the airplane react to stick movements.

Explain that the key to setting precise headings is knowing when to begin exiting the turn with the opposite aileron. The smoother and more gradual the turn the easier this will be. At what point opposite aileron must be applied depends on the severity of the turn. The more gradual the turn, the sooner the (equally gradual) opposite aileron is applied, and the easier it is to smoothly exit the turn on the desired heading. As mentioned in part one, beginners tend to turn much too severely, making it very difficult to exit turns precisely.

To practice, begin by making the student fly figure-eights. The best pattern consists of left turns on the left side and right turns on the right side. This gives the student practice at setting up landing approaches from both sides of the field. Begin to stress the importance of flying much more precisely. Since we fly on a rectangular shaped flying field, use each corner of the field as the target heading after completion of each turn. The student is told to maintain each turn until the desired heading is reached. They should then execute a ¼ turn to set up a diagonal vector to the next corner. While the first few attempts will not be perfect, this practice forces the beginner to think about exiting the turn at the proper heading very early in the turning process.

Figure-eights are excellent for heading setting practice because you (the instructor) can easily monitor the beginner's progress. You will be able to tell if the student is catching on or still having problems. As long as the student has truly mastered step one and can consistently make smooth level turns, the two most common problems a beginner has at this stage is one, exiting too early, or two, exiting too late. If exiting too early, the student must turn again to eventually get the heading they want. If exiting too late, the student will overshoot the desired heading and have to turn back. Both of these problems lead to over controlling the airplane. Talking the student through the first few turns can help with each of these problems.

If they have either of these two problems, stress the importance of being able to begin exiting the turn slightly before the desired heading is reached. ***The more gradual the turn, the easier exiting should be.*** By the way, this is the reason we said during step one that you should keep the student from turning too radically. While radical (very severe) turns may be easy for the student to master, when it comes to setting headings, radical turns are very difficult to exit in a predictable manner and lead to over-controlling.

Free Form Turns - Once the student has mastered figure eight's have them practice free form turns. Based on the position of the airplane at a given time, call the turn you wish them to make. For example, if you say "45 degrees right", expect the student to veer off to the right on a new heading 45 degrees from the start. If you say "180 degrees left", expect a complete turn to the left. This practice forces the beginner to fly the plane in new and different attitudes, and commonly turns up trouble spots (attitudes and positions in the sky with which the student is not yet comfortable). We all had trouble spots as we began flying (even some experienced fliers still have some trouble spots). For those areas the beginner has trouble with, give more practice. But at the completion of this practice, the beginner should be able to control the plane in almost any position in the sky!

Trim Settings - This is about the point in the training when you should introduce the student to setting transmitter trims while flying. They have pretty much mastered the ability to keep the plane in the air when the plane is perfectly trimmed. Give the student some practice with an out of trim airplane. On the slave transmitter, reach over and throw the aileron or elevator trim slightly off center. The beginner will be forced to determine what is wrong and correct the trim problem. Once you have started doing this with a beginner, repeat trim setting practice on the first flight of each practice session.

Holding headings and flying with precision - Once the student has mastered figure-eights and free form turns, you must stress the importance of being able to hold a heading. Even the most stable airplanes tend to wander from set headings based on wind direction and velocity. The student must be able to keep the plane going in a given direction. This must be mastered before they will be able to land. (During the final approach, the beginner must be able to hold the plane right on the middle of the runway all the way to the ground!)

For practice, once again begin with the figure-eight. They must practice making minor corrections as the plane tends to wander from its desired heading. Stress that the direction and amount of wandering will vary almost every time, based on wind speed, wind direction, and the plane's attitude at the completion of the previous turn. They must always be ready to apply these minor corrections in order to hold headings. The eventual goal of this practice is to make perfectly shaped figure-eights with the crossover right in the middle of the flying field. Once mastered, the student can truly fly the airplane with a great deal of precision.

Next, have the student fly a pattern that takes them right down the middle of the runway (still quite high of course). One way to do this is have them fly a long oval shape with the upwind side of the oval right on the middle of the runway. Have them practice holding the heading on the runway for the entire length of the flying field.

What about throttle settings? - Most of the practice to this point has been at one throttle setting. As stated during step one, most students find it easier to fly with a throttle setting that is just strong enough to keep the plane in the air, making for a docile flying airplane. However, before progressing to step three, you should direct the student to practice flying the plane at different throttle settings. When they decrease the throttle, the plane will become less responsive, simulating how a slightly under-powered plane will respond just after take off. As the throttle is increased, the plane becomes more responsive, simulating how an over-powered plane will behave during takeoff.

A note about rudder-coordinated turns - Most trainers will turn quite nicely without rudder control. In fact, the influence of rudder may make it quite difficult for the beginner to master turning. They may not even notice any difference if the rudder control surface is small. For this reason, we usually omit rudder-coordinated turns from basic flight training. It is often best to wait until the student has their first sport airplane when the rudder will have more of an impact on the quality of turning.

When are they finished with this step? - When the beginner has mastered the ability to fly the plane under complete control at all times, when they can fly the airplane in virtually any attitude, when they have gotten all of the left/right, up/down mistakes out of their system - and when they can set and hold headings, flying with precision - then they are ready to progress to step three, landing the airplane.

SECTION V

STEP THREE: TEACHING HOW TO LAND

The objective is to get the student to the point where they can make consistent approaches from both directions and land safely. This is a good time to explain to the student the risks associated with learning to land. The plane will be flying very close to the ground and at slow airspeeds. In the event that the student gets the plane into trouble, there may be very little that the instructor can do to save the plane, even on the buddy box.

A note about engine reliability - This step requires a great deal of throttle changing. Before starting this step, it would be wise to confirm that your student's engine will maintain idle, go from idle to full, and in general, perform without stopping or stuttering at all throttle settings.

Are they ready to land? - If all steps to this point have been truly mastered, landing will simply be an extension of what the student already knows. However, if they are having problems with this step, it should be taken as a signal that further practice (especially with step two) is needed.

Teaching slow flight characteristics - Before the beginner can begin learning how to land, they must understand how the plane responds at slower speeds. With the plane rather high, have them reduce the throttle to just above idle and fly the figure eight pattern. Have them take note of how the ailerons respond more sluggishly. Also have them note how, at idle, it is impossible to keep the plane from losing altitude (especially in the turns). Most importantly, have them note how if they try to maintain altitude by pulling back further with up elevator, the plane will eventually stall.

As they continue to lose altitude in their figure eight pattern, eventually have them kick the throttle back up to regain altitude. Have them repeat this several times. Be sure they can still maintain control even at slow speeds (especially holding a heading into the wind). Be sure they know at what point the plane will stall. And be sure they know what tends to happen during a stall. Fortunately, most trainers are very stable in a stall and no radical controls will be required to recover (though you may wish to explain that more aerobatic airplanes may not be so forgiving when they stall).

In step two, we had the beginner flying with precision. We had them flying right down the middle of the runway (in an oval pattern). The goal was to hold the heading all the way from one end of the field to the other. Now have them repeat this practice (still up high), but this time have them reduce the throttle for each pass down the middle of the runway. Again, be sure they can hold the heading for the length of the field at idle. Have them increase the throttle at the end of each pass. Be sure to make them practice this from each direction.

During the actual approach the beginner must begin letting the plane come closer to the ground. But first have them practice the approach pattern up high. Teach a symmetrical approach pattern. That is, the same basic pattern should be used from either side of the field (left or right). This also makes it quite easy to practice from both directions.

If there is little traffic at the field, and you secure permission from any other flyers, you can use a modified figure eight pattern for teaching approaches. Starting with the plane flying right down the middle of the field from right to left, have the student veer off to the right (at about 45 degrees) shortly after the plane passes by. Have them hold this heading until the plane has made sufficient room to make a left final approach turn. The student will then begin a long sweeping left turn with the goal being to end the turn with the plane perfectly aligned with the middle of the runway. At this point they cut the throttle to just above idle and hold the heading just until the plane passes by. The student then increases the throttle and veers of to the left (at about 45 degrees). The heading is held until enough room is made for a right approach turn. The student will then begin the long sweeping right turn to line up with the middle of the runway. This is repeated over and over again. As the student gains

proficiency, the throttle is cut earlier and the plane is allowed to come closer to the ground. While all of this may sound a little difficult, if the student has truly mastered setting and holding headings, believe it or not, this is actually rather easy! All we are really adding at this stage is the increase and decrease of the throttle.

SAFETY NOTE: Low level modified Figure Eight patterns should only be flown on Tuesday evenings, the designated training night, unless there are no other pilots present on the flight line. At all other times, the basic flight pattern rules remain in effect. We don't want to be teaching our students to violate basic club safety rules!

Though it is rather difficult to explain, the student must understand that the nose of the plane must maintain a slightly downward attitude throughout the final approach turn (especially if the throttle is cut). This is how we cause the plane to maintain airspeed as it comes to the ground. The windier it is, the more important this point (and the more severe the downward attitude). While some pilots try to counteract the wind with higher throttle settings, the decent of the airplane allows much finer control of airspeed than throttle. ***If the nose of the plane balloons up at the end of the final approach turn, the plane will eventually stall.*** It will be impossible to maintain airspeed, and if very close to the ground, could result in disaster. As the student is practicing approaches up high, have them pay particular attention to the nose of the airplane.

Once the student has progressed to the point where they can consistently align the plane with the runway and bring the plane to within twenty to thirty feet of the ground, they are finally ready to land. Once again, remember that beginners tend to rush this. You must determine when they are ready. If anything, a little more practice than necessary won't hurt. Also, remember to be aligning your master transmitter throttle setting to their transmitter, so you'll be ready to take over at any moment!

Explain to the student that landing (if done right) is really nothing more than letting the airplane drift to the ground. Done properly, the student will not be having to force down elevator into the approach to get the plane to come down. It will do so naturally because of the low (idle) throttle setting. During the last twenty to thirty foot of decent, the beginner must keep the wingtips nice and level. The student has to be ready with sharp, precise corrections to keep the plane on the center of the runway. The natural tendency of the plane at idle will be to descend, so if the proper heading is maintained, it is a relatively simple matter of waiting until the plane comes to the ground. When the plane drifts down to within about 1-2 feet above the ground, explain that they should gently pull back on the up elevator to cause the plane to flare out. Of course, you should demonstrate the landing procedure prior to having the beginner do it.

A beginner's first few landings tend to be a little rough. Beginners tend to panic when low to the ground. They forget which way to turn, especially if minor aileron corrections are necessary. Tell them to remember that if approaching from the right, right is your friend, meaning if they panic, giving right aileron will take the plane in the direction away from the pits. If approaching from the left, left is your friend. Dumping the plane is always better than flying into the pits.

Practice, practice, practice. Though a beginner's first successful landing is a great confidence builder, do not let him think he has mastered landing just because he has done it once. As with taking off, every landing will be different so be sure to practice landings over and over again - in several directions and in different wind conditions.

What about dead sticks? - Sooner or later, we all have to land without power. One obvious way to practice this to simply cut throttle and pretend the engine is no longer running. At first, have the plane in a nice approach position so the beginner can land with relative ease. As you continue practicing, get the plane into more precarious conditions when you cut throttle. Even if you just have the student tell you what they would do if the engine quits in a given position may be good enough. In any case, be sure the student is prepared.

SECTION VI

STEP FOUR: TEACHING HOW TO TAKE OFF

The objective is to get students to the point where they can taxi and take off. Remind the student that while practicing takeoffs, the plane will be very close to the ground, and there may be little that the instructor can do to save the plane if he gets into trouble. Make it very clear at this point to the student that proceeding to this next level involves risk.

Setting the plane's ground tracking - Experienced pilots can taxi and take off even if the plane is not perfectly tracking on the ground. In fact, if you've had a hard landing or two during training, it is likely that you may not have realigned the plane's ground tracking for the sake of saving some time. You may have simply held in some corrective rudder (coupled with nose or tail wheel) during the taxi run. However a beginner will not be able to handle a plane on the ground that does not track straight. Before you turn the plane over to the student to take off, be sure the plane is tracking straight, and after every hard landing from this point on, be sure to check the tracking before the next takeoff. **This is very important!** In the hands of an inexperienced pilot, a plane that is not ground tracking properly can be very dangerous indeed (especially if the plane veers toward the pits).

One way for the beginner to set tracking (at home) is to let the plane roll down a shallow grade (with the radio on). Many suburban driveways are perfectly graded for this. With the rudder stick neutral, let the plane roll down the grade and watch for left/right tendencies. Be sure to tell the beginner not to adjust for tracking with the rudder's trim (this will, of course, affect flight trim). Adjustments must be made mechanically, within the airplane.

Taxiing and making the takeoff run can be quite difficult to master. First of all, if they have a four channel system with rudder attached to steering on the left stick, they will probably find it awkward to precisely use their left hand. They will also find it difficult to control throttle and rudder independently. Begin by making them get comfortable with the left stick without the engine running.

Once they can move one control without the other, explain the plane's ground handling characteristics. You've been doing a lot of taxing with their airplane to this point, and while different airplanes can have dramatically different ground handling characteristics (tail dragger vs. tricycle gear, for example), you should be able to help them understand how responsive their plane will be on the ground.

Be sure to explain the plane's natural tendency to accelerate quickly as soon as it begins moving. As they develop a feel for what it takes to get the plane moving, they will make the plane move smoother. But first and foremost, be sure they keep the plane moving slowly - be sure to be ready to retake control as soon as the plane gets moving too quickly. As for steering with left and right, it may take quite a bit of practice, since it must be done with the left hand. Also, the same left/right problem they had in the air when the plane is coming toward them may recur.

Take off practice - Once they can handle the plane well on the ground, have them head the plane into the wind and practice some high-speed takeoff runs. Don't let them take off quite yet. As soon as the plane builds up speed, have them cut the throttle. **Remind the student that the engine torque will normally pull the plane to the left.** Force them to see how little rudder it takes to make the plane respond at high ground speeds. Beginners have a tendency to over control with rudder their first few times, so be ready to retake control at all times (keeping your master transmitter set to idle). By this point, the student should be quite comfortable with handling the plane on the ground. But you'll still want to make it as easy as possible for his first few takeoffs. Explain that taking off is just a matter of building up flying speed heading into the wind while holding a little right rudder. Once flying speed is reached, he must apply just a small amount of up elevator (though some well-trimmed planes may actually lift off by themselves). Once the plane comes off the ground, the nose will be pointed up slightly and the student can release the up elevator and the right rudder. If the plane is properly

trimmed, the plane will continue its gradual climb at full throttle until it reaches a comfortable altitude and can be turned. As the plane rises, the student must be ready to make minor corrections to hold the plane's heading directly into the wind (with aileron and rudder) and to maintain a gradual ascent (with elevator). ***Always have the student make the first turn away from the pit area!*** Once the plane has reached a safe altitude, the throttle can be reduced. Beginners tend to be so nervous during the first few takeoffs that they forget to reduce the throttle. Of course, you should demonstrate taking off prior to having them do it.

If other traffic allows it, position the student so that he can takeoff in a direction directly away from him. Walk him out to the middle of the runway if necessary. (Once he masters this, the student will still have to learn how to take the plane off in different directions while standing at the pilot's station.) As the student increases throttle for takeoff be sure to increase the master transmitter's throttle setting in the event you must retake control.

Beginners have problems in three areas. First, they have problems holding the plane in the ***proper heading*** with the rudder while the plane is on the ground. This can be very dangerous if the plane wanders off in the direction of the pits. Be sure to let them know that just because they started the takeoff roll does not mean they have to take off. If anything looks wrong or they feel panic for any reason, have them cut the throttle! By the way, this is why the high-speed practice runs are so very important. During these runs, the beginner does not expect to take off and will be cutting the throttle every time. With this experience, they will be much more likely to cut the throttle at the first signs of problems during actual takeoff runs.

Second, when taking off in winds over about 5 mph and especially with a crosswind, beginners have trouble holding the ***wingtips level*** after the plane lifts off. Since the plane is not moving very fast at this point, it may respond rather sluggishly. The beginner must be ready with firm, accurate aileron and rudder control. When taking off in any kind of cross wind, be sure to make them predict which way the wind will tend to blow the plane as it lifts off the ground. This way, they will be ready to apply the opposite aileron.

Third, beginners tend to apply ***too much up elevator*** to get the plane off the ground. Or they hold the elevator in too long. Either way, the plane will have the tendency to stall soon after liftoff.

Practice, practice, practice. Many beginners think they have mastered takeoffs with their first successful one, regardless of how scary it was. However, you must stress that each takeoff will be different, and it will take many takeoffs to become fully proficient. Wind direction, wind speed, and rudder sensitivity will make for a few nerve-wracking moments. As soon as the student has successfully taken off, instruct him to relax, fly a full circuit around the field and set up to land. Have the student do it again - and again - and again. If all practice is done on a nice calm day, be sure you are with them the first few times they take off on windy days.

One excellent way to practice landing (and taking off) is with touch and go's. After landing (without killing the engine), have the beginner taxi back, take off, and land again. As they gain proficiency, have them reapply throttle as soon as the plane touches down, performing a true touch and go.

When have they completed this step? - When you are confident that they are in complete control on the ground. When you have seen them make a mistake and know enough to cut the throttle (they recognize when to abort takeoffs). When they can repeat the takeoff roll time and time again regardless of wind conditions. When they can maintain the takeoff heading in a nice gradual climb over and over again - then they are ready to take their solo certification test.

SECTION VII

IMPORTANT THINGS A BEGINNER MUST KNOW

Here we include discussions that beginners need to be aware of as they learn to fly. These presentations are made directly to the beginner, so feel free to copy and distribute this information to your students.

When can I fly by myself? The whole point of RC training is to get the beginner to the point where they no longer need the constant help of an instructor. Once you have successfully completed the pre-flight instruction, the four steps of the training program and have earned your solo certificate you should be ready. You must understand, however, that this training will not by any means transform you into an expert pilot! The practice you receive in training is done with close supervision. In the real world, there will be no instructor there to take control when things go wrong. ***You can quickly and unexpectedly get your plane into rather precarious situations from which you may not recover.*** This knowledge should inspire you to be quite cautious for a while.

A few words on discipline. It is important that students have proper expectations set up front for the approach to flight instruction. Flight training can be very enjoyable and rewarding, for both the student and the instructor. But the instruction must be taken seriously in order to be effective. Instructors should not simply be baby sitters tied to a child by an electronic umbilical cord. The instruction process should proceed from step to step, with each prior step being mastered before moving on to the next. ***The student should not be sidetracked by attempting loops, rolls and other aerobatic maneuvers prior to achieving solo certification status*.** Repetitive practice of the basic training maneuvers will prepare you to react more instinctively when the time comes for aerobatic instruction. The first priority is to develop your skills to become an independent, competent, responsible pilot.

Safety! Safety! Safety! The time we spend at the flying field is intended to be fun, right? From the time we pull into the parking lot until the time we pack up to leave, the only thing on our minds is to enjoy the time away from our troubles. Nobody likes going out to the field only to be bombarded with a bunch of rules and regulations. And of course, no one likes to be yelled at for doing something wrong. We all want to go about the business of having fun.

Unfortunately, our hobby can be a dangerous one. As flyers, we must all treat the hobby with respect and acknowledge the potential for danger. There are numerous times when what one flyer thinks is safe and acceptable will be totally rejected by other flyers on the flight line. We've all heard and seen what happens when a fellow flyer steps out of line. It isn't a pretty sight.

Truly, no intelligent flyer will intentionally do something to cause an accident. It is only when one flyer or another makes an unintentional mistake that accidents can occur. While beginners bear the brunt of the silliest mistakes, even experienced pilots have been guilty of unwittingly breaking safety-related rules. This section contains several safety-related guidelines and explains the reasoning behind each rule so as to enlighten beginners as to why we consider them so very important.

Safety around the transmitter impound stand - Mistakes made around the frequency stand can be costly. Many an airplane has gone out-of-control because these simple and basic rules are not followed. An out-of-control airplane can end up anywhere.

Impound your transmitter - Before you arrive at the field, be sure that your transmitter power switch is turned OFF. Upon arrival at the flying field, ***double check that the transmitter is off*** and immediately place it in the impound stand. While doing this, check to see if anyone else is on your frequency. If there is, find out who each flyer is and alert them to the fact that you are on their frequency. As other flyers enter the flying field, check to see if they are on your frequency.

Keep your transmitter in the impound area while you're not flying - This serves two purposes. First, you will be forced to walk over to get your transmitter whenever you wish to fly, keeping you from fiddling with your aircraft when you haven't pinned your frequency. Second, and more importantly, ***if someone who is on your frequency crashes, you can easily prove that your radio was off at the time of the crash***. Together with the suspicious pilot, you can walk to check the status of your transmitter. On the other hand, if you store the transmitter close to your airplane, he can easily accuse you of having your transmitter on while he was flying.

NEVER turn on your transmitter without pinning your frequency - Before you are allowed to turn on your transmitter, you must place your club membership card in the appropriate frequency slot at the transmitter stand. This gives you control of the frequency and no one else on your frequency can turn on their transmitter. ***Never remove another member's card from the frequency slot!*** If another pilot has forgotten to remove their card, find them and ask them to remove it.

We all know what will happen if someone on your frequency is flying when you turn on your transmitter. There may be times, however, when you're tempted to temporarily turn your transmitter on when setting up or tearing down. Maybe you want to move the throttle setting. Or you just want to run the fuel out of the engine. ***NEVER give in to this temptation.*** If you do, you may be paying for someone's broken airplane.

Always use your NDRCC Membership Card - We've seen a variety of devices used as frequency pins. AMA cards, driver's licenses and even college ID cards have been known to appear in these slots. ***The only acceptable frequency pin markers are current NDRCC club membership cards.***

Transmitter identification - You should have a red 72 MHz flag AND your frequency number attached to your transmitter antenna in large enough characters that a person can see it without having to ask. This helps each pilot determine who else is on their frequency (does not apply to 2.4Ghz).

Remove your membership card every time you finish flying - As a courtesy to other flyers, unpin your frequency as soon as you are finished flying. You should do this as soon as you impound your transmitter. Especially on crowded days, this keeps people from having to track down pinned frequencies that are not being used. If you get in the habit of impounding your transmitter and removing your frequency pin every time you finish a flight, you'll never leave the flying field with your frequency pinned. After you leave, if your pin is still in the frequency slot, you will cause another pilot a great deal of grief while they try to figure out who has the frequency pinned.

Don't hog the frequency - As a courtesy to other flyers, every time you finish a flight, check to make sure that no one else is waiting for your frequency before you fly again. **Be Extra Careful!** - As a flyer, you must be VERY careful whenever you turn your transmitter on. If your frequency is pinned, and you cannot find the owner of the pin, ask EVERYONE in the pit area. Another possible explanation for your frequency being pinned is that the pilot may have crashed before you arrived and is looking for his plane in the cornfield (possibly with his transmitter still on!)

Safety in the pit area - Now let's address the matter of being safe in the pits. While most of these rules may seem to be nothing more than common sense, you'd be surprised at the number of pilots who break these rules.

Hold on to your plane whenever the engine is running - NEVER, repeat NEVER let go of an airplane with its engine running until it is on the flight line and ready for taxi out. Always keep it under complete control. And ***always treat an airplane with the engine running as if the radio is going to fail at any moment.*** We highly recommend the use of hold-down devices that ensure that the airplane cannot move until the flyer is ready to carry it out to the flight line. It is a good idea to place your flight box in front of your airplane's propeller while starting the engine. If you somehow lose your grip on the plane, the flight box could save someone from serious injury. Always position your body to one side of the airplane while starting and running the engine. ***Do not stand or kneel in front of an airplane with a moving propeller!*** A propeller rotating at 10,000 to 20,000 RPM carries a great deal of centrifugal

force. The most dangerous position to be in near a running engine is directly in line with the prop. A piece of dirt attached to the prop during a hard landing will usually be thrown from the prop. Or, if the propeller is fractured in any way, an injury could occur if the propeller shatters. Once the engine is started, ALWAYS stand behind the airplane.

NEVER taxi in the pit area. Along the same lines, when you are ready to bring your airplane out to the flight line, carry it out. NEVER taxi out to the flight line! In the same manner, after landing, carry your airplane back to the pit area.

Make needle valve adjustments from behind the airplane. Once your engine is running, if adjustments must be made to the needle valve, be sure to get yourself into a convenient and safe position from which to make the adjustments. If you are behind the airplane, you can easily hang on to it with one hand while you adjust the needle valve with the other.

Use a glove, chicken stick, or electric starter. Especially for beginners just getting started with RC, until you really get to know your engine, exercise extra caution when starting your engine. A flooded engine can really bite you if you use your bare finger to start it.

No engine run ups or breaking in new engines near the pits. Never run your engine above idle speed in front of the shelter. As a courtesy to other flyers, NEVER break in an engine near the pit area. If you must do it at the flying field, move down 50 yards or more to the north or south of the pit area. From there, the noise in the pit area won't be excessive.

Priorities in flying. Here we list the basic rights of way for the flying field in the order of most importance. These rules apply from the time you enter the flight line until the time you carry your airplane back to the pit area.

1) **Dead stick landings** - When an airplane's engine dies, the airplane is going to come down no matter what. ***The flyer with the dead stick must call out ``DEAD STICK!'' immediately.*** Anyone on the field must know an airplane is coming down in order to stay out of its way. A flyer with a dead engine has the highest priority. ALL other flyers must give the right of way (including any that have already called their landing).

2) **A person on the field** - Whenever a person goes onto the field to retrieve an airplane***, they MUST call (very loudly) ``ON THE FIELD!''*** This person has the right to safely retrieve their airplane. While ANYONE is on the field, no take offs, landings, or low passes are allowed. The only exception to this rule is a dead stick landing. Once the person exits the runway area***, they must alert all flyers with the call ``FIELD'S CLEAR!''*** If you are the person retrieving your plane, be sure to take the shortest route off the field to help others who may wish to land.

3) **A flyer calling a landing** - The first flyer that calls a landing has the right to land. Do not attempt to hurry a takeoff to beat an airplane that is landing. If your engine stalls, an airplane will be sitting in the middle of the runway while another airplane lands!

4) **A flyer ready to take off** - Notice that take offs get the lowest priority. At times a flyer may have to wait for several minutes while other pilots land and retrieve their airplanes.

Fly in control - Beginners will naturally want to keep trying new things in order to improve. However, all flyers must fly within their abilities, especially when the field is crowded. Save your new maneuvers for a day when the field is less populated, or get an instructor to help.

Call your take offs and landings - The more informed you can keep other pilots, the safer flyer you'll be. Some one may have called a landing without your hearing it. If you call your landing loudly, another flyer will be sure to alert you that someone else has already called their landing. Acknowledge other pilots announced intentions so that they know you have heard them as well.

Be sure you know which way everyone is taking off and landing. Especially on calm days, flyers have a tendency of taking off in both directions. Watch to be sure you know which way everyone is taking off and landing. If in doubt, ask! If it is a perfectly calm day everyone should be taking off and landing toward the South. Whenever there is a crosswind, take offs and landings must be into the prevalent wind direction most aligned with the runway.

If you need help, DO NOT FLY BY YOURSELF - Beginners have a tendency to prematurely think they are ready to fly by themselves. Maybe you've had one or two solos and are feeling pretty brave. NEVER fly by yourself unless you've had your instructor's OK to do so. Keep in mind that your airplane is not the only thing at risk!

When in doubt, ask for help! - No matter what the rule, if you do not understand what you should do, ask an experienced flyer for help.

The Basics of Engine Tuning - In this short discussion, we will give the most basic considerations when making adjustments on your new engine. While there are many potential problems that can cause similar symptoms, and while each flyer has his own way of doing things, we will do our best to acquaint you with proven ways of handling the most common problems a beginner faces.

A good running engine is a novice flyer's best friend! Nothing is more frustrating than trying to learn how to fly with a poorly performing engine. You can't get much quality stick time if your engine is constantly quitting in the air. And, when you eventually begin setting up for landings, it will be MANDATORY that the engine responds properly. If the engine dies close to the ground, the results can be disastrous.

The biggest cause of a poor running engine has to do with how the fuel tank is mounted in the airplane. As the instructions that come with your airplane and engine say, the fuel tank should be mounted at the same level as the engine's carburetor. Ideally, the middle of your fuel tank will be 3/8 inch above the engine drive shaft when viewed from the side.

Kinks in the fuel line MUST be eliminated. ANY kink or sharp bend will limit fuel draw. Be sure you drill the fuel line holes in the firewall large enough for your fuel lines. If you have to force the fuel line through the hole, the hole is not big enough! Be sure the ”clunk" line within the tank can extend to the bottom of the tank without closing off the clunk. If this line is too long, the clunk hole may be pressed against the back of the tank. Keep the fuel line and muffler line as short as possible so as not to impede fuel flow.

New engines are notorious for going through glow plugs quickly. This is predominantly because new engines are commonly run quite rich to ensure a good break-in. However, as you begin leaning out your new engine to gain performance, the glow plug problem should go away. If it does not, check your head bolts. Loose head bolts will cause also cause premature wear to your glow plug.

Your carburetor must be connected to the engine so that no air can leak from the bottom of the carburetor seal. If you remove your carburetor for cleaning, be sure to seal the bottom properly before tightening. Most carburetors have a rubber seal that must be compressed before the carburetor hold down screws can be tightened. In the same way, the crankcase bolts must also be tight, as must be the engine mounting screws.

No matter what the engine manufacturer says, it is ALWAYS best to break in a new engine. Breaking in will ensure that internal engine parts wear into position properly, while not under a great deal of load. While you can break a new engine in while it is mounted to your airplane, many flyers like to perform the break in procedure on a test stand.

Either way, keep the engine running crackling rich during the first stages of the break in procedure. At full throttle, keep the needle valve well open to ensure that the engine never comes close to peaking

out. As the fuel tank empties, be ready to stop the engine to keep it from leaning out. We recommend running about two to three tanks of fuel through the engine in this manner.

The second step to breaking in a new engine is to begin leaning it out. Refuel the tank, start the engine again and slowly turn in (Clockwise) the high-end needle valve. As you do, the engine will begin to accelerate. Don't peak it out yet. Just get it running faster, a little at a time. As you do this, manipulating the throttle to let the engine run at various throttle settings for 10-20 seconds at a time. Repeat this until the entire tank is empty.

Finally, the engine is ready to peak out. Refuel the tank and start the engine again. With the engine running, continue turning the needle valve in (clockwise) until the engine peaks. To tell if it has peaked, lightly squeeze the fuel line. If the engine accelerates more, go another click of the needle valve in. Squeeze the fuel line again. Continue until the engine has peaked. THEN BACK OFF ABOUT TWO TO THREE CLICKS of the needle valve (making it slightly richer). Keep in mind that any engine will have the tendency to lean out in the air. Backing off a little on the ground will keep the engine from becoming too lean in the air.

We cannot stress enough the importance of keeping a new engine running on the rich side. Admittedly, there are times when an airplane (even a trainer) is somewhat underpowered and the engine must be peaked out to its maximum before the plane can even be flown. However, in most cases, there is ABSOLUTELY NO REASON to peak out an engine to the max, even after break in. For example, if you are flying a 40 size Avistar with an OS46FX, your plane is highly overpowered. The engine could be running quite rich and still pull the plane nicely. If your plane is overpowered, why not run the engine a little rich to ensure that the engine properly breaks in? This way, when you're ready for your first hot low wing plane (like an Ultrasport), your engine will still have something left to give. REPEAT AFTER ME: A rich running engine will last forever - a lean running engine will soon wear out!

Tuning the engine's low end (idle). Most high performance model airplane engines have two needle valves. The needle valve we have been talking about to this point is the high-end needle valve. This needle valve controls the high throttle setting and functions basically the same for ALL model airplane engines. Turning it in (clockwise) leans the engine and turning it out (Counter Clockwise) richens the engine.

However, the low-end needle valve may vary from one engine to the next. For most ABC style engines, like the OS46FX, the low-end needle valve functions the same as the high-end needle valve. Turning it in (clockwise) leans the low end and turning it out (counterclockwise) richens the low end.

Keep in mind however, that certain carburetor configurations (such as single-needle air-bleed) are just the opposite. The LA series of the OS engine is one example. Before you can adjust your engine's low end, you MUST know which way is which! (Consult your owner's manual or ask an experienced flyer),

As with the high-end needle valve, you begin peaking out your low end from the rich side. The idle position should be set so that the carburetor is open to about 5-10 percent of maximum. If the engine crackles and dies, lean the low-end needle valve about a quarter turn and try again. When the engine will run at idle, quickly advance the throttle and listen. At this point, probably the engine will crackle up to its maximum speed. This indicates that the low end is still too rich. Lean out the low-end needle valve by about 1/8 of a turn and try again. If you go too far, and the engine's low end needle valve setting is too lean, the engine will bog down and possibly die when you try to advance the throttle.

Be aware that you may be fooled at this point. Since an engine consumes fuel at a very slow rate when at idle, if you are too quick to make changes, the engine may be under the influence of the last idle adjustment as you increase the throttle. Repeat the throttle advance and slow down several times to confirm the setting. If in question, squeeze the fuel line slightly to force the engine to use up the

residual fuel. Eventually, by repeating the above procedure, the engine will respond quickly and accurately to your every throttle command.

What if nothing works? - Though the techniques given here should handle 90% of all engine problems, there are possible problems that can affect an engine's performance which have nothing to do with tuning. If you find that no matter what you do, you cannot get the engine to run properly, by all means, ask for help. Surely one of the experienced flyers in the pit area will be more than willing to help you.

Charging your batteries – Failure to properly charge transmitter and receiver batteries is arguably the most frequent cause of crashes due to mechanical failures (as opposed to pilot error). Make sure you read and follow the manufacturer's instructions on battery charging faithfully and to the letter. Typically, NiCd battery packs should be charged for 24 hours continuously at slow rate for the first charge. The charging unit supplied with your radio is specifically designed to provide this slow charging rate. Thereafter, always charge your batteries between 14 and 16 hours continuously at slow rate the night before you intend to fly your plane. Quick field charging is acceptable if performed on the way to the field or upon arrival at the field. ***If you do not have a quick field charger, and forget to properly charge your batteries on the night before – do not expect to fly your plane! You should not fly if the battery packs are not fully charged.***

The **North Dallas R/C Club** has volunteer instructors.

If you need help learning to fly, or are interested in being an Instructor, please contact the Training Committee Chairman Jim Williams or any NDRCC officer.

Phone numbers available on the NDRCC application and newsletter or website at:

http://www.ndrcc.com/

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Updated to Revision 1.1a by Tom Beach of the M.A.R.S. club in Pittsburgh with NDRCC permission February, 2009.

Updated to Revision 1.2 by NDRCC, March 2009.

North Dallas Radio Control Club

Student Solo Flight Check List

Student Name _____ AMA #_____

1. Field Safety Rules. _____

2. Impound Area and Frequency Control. _____

3. Assemble and Test Aircraft. _____

4. Start engine and tune. _____

5. Perform Flight Maneuvers:
   - A. Start & Taxi _____
   - B. Take off & Trim Aircraft _____
   - C. Rectangle Pattern (hold altitude & heading) _____
   - D. Horizontal Figure Eight _____
   - E. Landing _____
   - F. Go-Round or Aborted Landing _____
   - G. Landing _____
   - H. Taxi Back and Shutdown _____
   - I. Secure Equipment _____

(Receiver & transmitter off, antenna down, transmitter in impound, pin removed from board)

Instructor:

Observe Student for SAFE operation - Was student aware of wind direction and did he/she compensate for it? Was student aware of position of the sun and did he/she avoid flying into its glare? Was student aware of other aircraft in the air and other pilots on the flight line? Was the student confident and in control of his aircraft at all times?

I certify that this student is qualified for unsupervised solo flight

_____ _____
INSTRUCTOR DATE

Appendix B
Field Equipment

The equipment required to get a trainer off the ground can be very inexpensive. There are a few basic items that will suffice to get a beginner into the air and learning to fly but there are other items that can be added to make the job a lot easier.

MINIMUM EQUIPMENT

NAME	DESCRIPTION
Glow Plug Driver	Clip on battery for supplying power to glow plug
Chicken Stick	Stick used for flipping the prop to start the engine
Fuel	Fuel mixture recommended by engine manufacturer
Fuel Bulb	Rubber bulb used to transfer fuel to model tank
4-Way Wrench	Combination wrench with sizes to fit glow plug, prop nut, etc.
Tool Box	Any box suitable for carrying the other equipment

These items should cost about $60. This can vary depending on the brand of the items where the items are purchased. An assortment of screwdrivers, pliers, and Allen wrenches may also be needed to perform field maintenance.

OPTIMUM EQUIPMENT

NAME	DESCRIPTION
Starter	Battery powered motor for starting model engine
Glow Plug Connector	Clip on battery connector for supplying power to glow plug
Power Panel	Power distribution panel for distributing power from a field battery to starter, glow plug connector, etc.
Field Battery	Small 12 volt wet or gel cell battery
Fuel	Fuel mixture recommended by engine manufacturer
Fuel Pump	Electric pump used to transfer fuel to model tank
4-Way Wrench	Combination wrench with sizes to fit glow plug, prop nut, etc.
Field Box	Tool box specifically designed for carrying model field equipment

These items will cost about $200. The cost will vary depending on the brand of the items and where the items are purchased. Field box kits are available for a wide range of prices but, can be built from readily available materials. An assortment of screwdrivers, pliers, nut drivers, and Allen wrenches is also desirable to perform field maintenance.

Appendix C
Mechanics Check List

POWER PLANT

1. PROPELLER
- o Propeller nut tight
- o Spinner on tight
- o Propeller balanced

2. ENGINE
- o Hold down bolts tight
- o Head bolts tight
- o Carburetor secure
- o Glow plug tight
- o Note: carburetor operation will be checked during the “CONTROL OPERATION”.

3. FUEL SYSTEM
- o Lines connected properly
- o Line routing, bends, kinks
- o Tank mounting
- o Clunk free

FUSELAGE

1. CONTROLS
- o Throttle control free
- o Servos mounted securely and tight
- o Servo hardware tight
- o Servo pushrods clear of mechanical interference

2. LANDING GEAR
- o Main Gear and Nose Gear Hardware tight
- o Wheels free and collars tight

3. RECEIVER
- o Check all receiver plugs for proper seating
- o Check antenna routing
- o Check receiver overall crash protection

4. BATTERY AND SWITCH
- o Check switch mounting (opposite muffler side of fuse).
- o Check wire leads for routing and binding and proper hook-up
- o Check battery crash protection
- o Check battery voltage

EMPENNAGE

1. VERTICAL STAB
- o Check all glue joints for rigidity where joined to fuse
- o Check rudder hinges
- o Check rudder control horn
- o Rudder throw will be checked and set under “CONTROL OPERATION”.

2. HORIZONTAL STAB
- o Check all glue joints for rigidity where joined to fuse
- o Check elevator hinges
- o Check elevator control horn
- o Elevator throw will be checked and set under “CONTROL OPERATION”.

WING

1. CONTROL SURFACES
- o Check aileron hinges
- o Check aileron control horns
- o Aileron operation will be checked and set under “CONTROL OPERATION”.

2. WING ALIGNMENT
- o Check wings center section joint
- o Check wings for warp

CONTROL OPERATION

1. TRANSMITTER
- o Check for card in frequency slot on transmitter impound before operating transmitter
- o Check transmitter voltage meter for proper operating voltage
- o Check for proper flags on transmitter
- o Set all trim controls on center

2. RUDDER AND NOSE GEAR
- o Check rudder for correct direction (check also nose gear if tricycle gear) (change transmitter switch if necessary)
- o Check for proper throw
- o Check all hardware for tightness (especially nose gear control horn on shaft)

3. ELEVATOR
- o Check for correct direction (change transmitter switch if necessary)
- o Check for proper throw
- o Check all hardware for tightness

4. AILERON
- o Check for correct direction (change transmitter switch if necessary)
- o Check for proper throw

- Check all hardware for tightness and check aileron control shaft from pushrod connection through trailing edge bearings to connection on aileron. There should be no "slop" in the system.
- Check for symmetry in neutral position.
- Check all hardware for tightness

5. THROTTLE

- Check for correct direction (change transmitter switch if necessary)
- Check for proper throw. Trim down-carb barrel closed. Trim up-carb open to fast idle. Throttle control off for these checks. Throttle full up-carb barrel full open.
- Check all hardware for tightness

BUDDY BOX OPERATION

1. TRIM

- Set all transmitter and buddy box trim to neutral or center position.
- Ensure that the buddy box power switch is OFF.

2. OPERATION

- Check buddy box for proper tracking with main transmitter for Rudder, Elevator, Aileron, and throttle.
- Correct buddy box as necessary to track with main transmitter.

3. RANGE CHECK

- Range check transmitter with antenna collapsed and distance of 200 feet.
- Check also operation of buddy box through transmitter at the range check.

Appendix D
Glossary of R/C Terms

ABC / Non-Ringed - These letters stand for aluminum, brass and chrome or a composite such as nickel. These engines have an aluminum piston and a chrome or composite coated brass cylinder sleeve which allows them to be more efficient for higher performance. They have no piston ring and rely on a very tight piston/cylinder fit to obtain a piston/cylinder seal. New ABC engines are normally hard to turn over by hand. Because of the tight fit, it is very important that the engine is broken in properly.

Adjustable Travel Volume (ATV) - ATV allows you to preset the maximum travel of a servo to either side from its neutral position. Such settings help tailor control action to suit your flying or driving style.

Adverse Yaw - The tendency of an airplane to yaw in the opposite direction of the roll. For instance, when right aileron is applied, the airplane yaws to the left, thus opposing the turn. Adverse yaw is common in trainer type airplanes having flat bottom wings. It is most noticeable at slow speeds and high angles of attack, such as during takeoffs and when stretching a landing approach. Caused by the unequal drag of the upward and downward deflection of the ailerons, this undesirable trait can be minimized by setting up the ailerons with Differential Throw or by coordinating the turns, using the aileron and rudder controls simultaneously. (See Differential Throw.)

Ailerons - Hinged control surfaces located on the trailing edge of the wing, one on each side, which provide control of the airplane about the roll axis. The control direction is often confusing to first time modelers. For a right roll or turn, the right hand aileron is moved upward and the left hand aileron downward, and vice versa for a left roll or turn.

AMA - The Academy Of Model Aeronautics. This is the official national body for model aviation in the United States. AMA sanctions more than a thousand model competitions throughout the country each year, and certifies official model flying records on a national and international level.

Angle of Attack - The angle that the wing penetrates the air. As the angle of attack increases so does lift and drag, up to a point.

ARF - A prefabricated model - Almost Ready to Fly.

Battery Eliminator Circuitry (BEC) - A circuit that eliminates the need for a receiver battery, usually in electric R/C airplanes.

BB - These letters usually designate a ball-bearing supported crankshaft in an R/C engine. This makes the engine run smoother and last longer.

Buddy Box - Two similar transmitters wired together with a "trainer cord." This is most useful when learning to fly -- it's the same as having dual controls. The instructor can take control by using the "trainer switch" on his transmitter.

Boring Holes in the Sky - Having fun flying an R/C airplane, without any predetermined flight pattern.

CA (Abbreviation for "Cyanoacrylate") - An instant type glue that is available in various viscosity (Thin, Medium, Thick, and Gel). These glues are ideal for the assembly of wood airplanes and other materials. Note: Some CA glues will attack Styrofoam unless specifically marked as “Foam Safe”.

Carburetor - The part of the engine which controls the speed or throttle setting and lean/rich mixture via setting of the needle valve.

CG ("Center of Gravity") - For modeling purposes, this is usually considered the point at which the airplane balances fore to aft. This point is critical in regards to how the airplane reacts in the air. A tail heavy plane will be very snappy but generally very unstable and susceptible to more frequent stalls. If the airplane is nose heavy, it will tend to track better and be less sensitive to control inputs, but will generally drop its nose when the throttle is reduced to idle. This makes the plane more difficult to land since it takes more effort to hold the nose up. A nose heavy airplane will have to come in faster to land safely.

Charge Jack - The plug receptacle of the switch harness into which the charger is plugged to charge the airborne battery. An expanded scale voltmeter (ESV) can also be plugged into it to check battery voltage between flights. It is advisable to mount the charge jack in an accessible area of the fuselage so an ESV can be used without removing the wing.

Charger - Device used to recharge batteries, usually supplied with the radio if NiCd batteries are included.

Chicken Stick - A hand-held stick used to "flip start" a model airplane engine.

Clevis – A coupler shaped like the letter “U” that connects the control surface to the pushrod or servo arm.

Clunk - A weighted fuel pick-up used in a fuel tank to assure the intake line is always in fuel.

Dead Stick - A term used to describe non-powered flight (glide) when the engine quits running.

Control Horn – A short, arm-like lever at the base of a control surface of an airplane which is attached to the servo arm through various linkages.

Differential Throw - Ailerons that are set up to deflect more in the upward direction than downward are said to have Differential Throw. The purpose is to counteract Adverse Yaw.

Dihedral - The V-shaped bend in the wing. Typically, more dihedral causes more aerodynamic stability in an airplane, and causes the rudder to control both the roll and yaw axis. This is why some trainers and sailplanes require only 3 channels of radio control--i.e. having no ailerons.

Direct Servo Control (DSC) - This radio feature permits you to check servo operation without broadcasting a radio signal. A cable connects the transmitter to the receiver. Direct servo control is very useful for on-the-ground control checks.

Ding - Minor dent or damage to the structure. Also, a nick in a prop. Dinged props must be replaced.

Down Thrust - Downward angle of the engine relative to the centerline of the airplane. Down thrust helps overcome the normal climbing tendency of flat bottom wings.

Electric Starter - A hand-held electric motor used for starting a model airplane engine. Usually powered by a 12-volt battery.

Electronic Speed Control (ESC) - Electronic speed controls replace the mechanical speed control and servo providing enhanced power efficiency and precision in an electric R/C airplane. In addition, they are lighter which improves the performance of some electric models. This may also include a BEC.

Elevator - Hinged control surface located at the trailing edge of the horizontal stabilizer, which provides control of the airplane about the pitch axis and causes the airplane to climb or dive. The correct direction of control is to pull the transmitter elevator control stick back, toward the bottom of the transmitter, to move the elevator upward, which causes the airplane to climb, and vice versa to dive.

Endpoint Adjustment - This radio feature adjusts the length of servo travel in one direction (a single channel will have adjustments for two endpoints). If your plane rolls faster one way than the other, endpoint adjustments can correct the problem.

Epoxy - A two-part resin/hardener glue that is extremely strong. It is generally available in 6, 15 and 30- minute formulas. Used for critical points in the aircraft where high strength is necessary.

Expanded Scale Voltmeter (ESV) - Device used to read the battery voltage of the on-board battery pack or transmitter battery pack.

Field Charger - A fast battery charger designed to work from a 12-volt power source, such as a car battery.

Flaps - Hinged control surface located at the trailing edge of the wing inboard of the ailerons. The flaps are lowered to produce more aerodynamic lift from the wing, allowing a slower takeoff and landing speed. Flaps are often found on scale models, but usually not on basic trainers.

Flare - The point during the landing approach where the pilot gives an increased amount of up elevator to smooth the touchdown of the airplane.

Flight Box - A special box used to hold and transport equipment used at the flying field.

Flight Pack (or Airborne pack) - All of the radio equipment installed in the airplane, i.e., Receiver, Servos, Battery, and Switch Harness.

Flutter - A phenomenon where the elevator or aileron control surface begins to oscillate violently in flight. This can sometimes cause the surface to break away from the aircraft and cause a crash. There are many reasons for this, but the most common are excessive hinge gap or excessive "slop" in the pushrod connections and control horns. If you ever hear a low-pitched buzzing sound, reduce throttle and land immediately.

Four Stroke (Four Cycle) - Although a 4-stroke engine has less power than a 2-stroke engine of comparable size, there are advantages to 4-stroke engines. They may not require a muffler and are often quieter than most 2-strokes are with a muffler. They can swing a bigger prop than the same size 2-stroke engine. This is an asset in the large, slow flying aerobatic and scale models where 4-stroke engines are usually mounted. Lastly, the fuel economy is better.

Frequency Control - The FCC has allowed the 72MHz band for R/C aircraft operations. This band is divided up into many different channels in which you can choose a radio system. You should be aware that certain areas have frequencies in which there is pager interference. This is why it is always a wise move to check with your local hobby shop to find out any channels that may be troublesome in the area you wish to fly.

Frequency Module - A frequency module plugs into the transmitter and enables you to change the frequency and thus channel number of your radio broadcast.

Fuel Overflow Line (Vent) - The fuel line is either open to atmospheric pressure or attaches to the muffler pressure nipple to pressurize the fuel tank for better fuel flow to the engine. This is the line through which the fuel will overflow when the tank is full.

Fuel Pick Up-Line - The fuel line in the fuel tank through which fuel travels to the carburetor. Typically a flexible tube with a weight or "Clunk" on the end which allows it to follow the fuel with changes in aircraft attitude. This is the line through which the tank is filled.

Fuselage - The body of an airplane.

Glitch - Sudden radio interference which causes your model to fly in an erratic manner. Most often caused by someone turning on a radio that is on your frequency, but can be caused by other radio sources miles away. Also referred to as a “hit”. In a worse case it can result in the airplane crashing, usually referred to as being “Shot Down”.

Glow Plug - The heat source for igniting the fuel/air mixture in the engine. When starting the engine a battery is used to heat the filament. After the engine is running, the battery can be removed. The wire filament inside the plug is kept hot by the "explosions" in the engine's cylinder. (See next heading and "Idle Bar" Plug.)

Glow Plug Clip/Battery - A 1.2-volt battery, which is connected to the glow plug on a model airplane engine for starting. The battery is removed once the engine is running steadily.

Grease-In - A very smooth, gentle landing without a hint of a bounce.

Horizontal Stabilizer - The horizontal tail surface at the back of the fuselage which provides aerodynamic pitch stability to the airplane.

Idle Bar Plug - This type of glow plug has a "bar" across the tip to help prevent raw fuel from being splashed onto the glow element. Too much raw fuel will cool the plug and prevent it from igniting the fuel/air mixture. An idle bar is a help in obtaining a low idle speed.

Lateral Balance - The left-right or side-to-side balance of an airplane. An airplane that is laterally balanced will track better through loops and other maneuvers.

Leading Edge (LE) - The very front edge of the wing or stabilizer. This is the edge that hits the air first.

Mixing (Coupling) - Two radio control channels can be coupled together so that they move together when only one control channel is activated. Many 1/4 scale models require a combination of aileron and rudder to turn. Mixing does this electronically at the transmitter. V-tailed models, where the two halves of the V-tail must move not only together but independently, are another use of control mixing.

Muffler - A device attached to the exhaust stack of the engine to reduce noise and increase back pressure which helps low speed performance. Note: Most R/C Clubs require the use of mufflers.

Muffler Baffle - A restrictor plate inside the muffler which reduces engine noise. This plate can be removed to increase power, but only if there are no noise restrictions where you fly.

Needle Valve - Adjustment on a carburetor used to set proper fuel/air mixture. Some carburetors have separate needle adjustments for low and high throttle. Typically, turning the needle clockwise (screwing in) leans the mixture (less fuel), and vice versa. However, there are a few exceptions--refer to the engine manufacturer's instructions.

NiCd - Nickel Cadmium battery. Rechargeable batteries which are typically used as power for radio transmitters and receivers.

Nitro - Nitromethane, a fuel additive that increases a model engine's ability to idle low and improves high speed performance. Ideal nitro content varies from engine to engine. Refer to the engine manufacturer's instructions for best results. Nitro content in fuel is indicated by the percent of the fuel.

Ni-Starter - A self-contained battery and glow plug clip, used when starting the engine. (See Glow Plug Clip.)

One-Point Landing (or a figure 9) - Synonymous with "stuffing it in". Something we hope you never do. Usually results in re-kitting your airplane.

Peak Charger - A peak charger automatically shuts off when your battery is fully charged. This means longer run times for your vehicle. Peak chargers are nearly foolproof, if you forget to turn it off, the charger does it for you. No more overcharged batteries.

Pitch Axis - The airplane axis controlled by the elevator. Pitch is illustrated by holding the airplane at each wingtip. Raising or lowering the nose is the pitch movement. This is how the climb or dive is controlled.

Power Panel - 12-volt distribution panel that provides correct voltage for accessories like glow-plug clips, fuel pumps and electric starters. Usually mounted on a field box and connected to a 12-volt battery.

Programmable or Computer Radios - These high-tech radios are not inexpensive but allow a full set of programmable transmitter features like multiple plane memory, preprogrammed maneuvers (rolls, loops, etc. at the touch of one button) and much more.

Prop Pitch - Props are designated by two numbers, for instance 10 - 6. The first number is the prop's diameter, 10". The second number is the pitch or angle of the blades. The 6 represents the distance the propeller will move forward in one revolution, in this case 6".

Pushrod – The rod that runs from the servo output arm to the control horn. This often has a clevis on each end for attachment to the Servo arm or Control horn.

Receiver (RX) - The radio unit in the airplane which receives the transmitter signal and relays the control to the servos. This is somewhat similar to the radio you may have in your family automobile, except the radio in the airplane perceives commands from the transmitter, while the radio in your car receives a signal from the radio station.

Roll Axis - The airplane axis controlled by the ailerons. Roll is illustrated by holding the airplane by the nose and tail, dropping either wingtip to simulate the roll movement. This is used to bank or turn the airplane. Some aircraft are not equipped with ailerons and the Roll and Yaw motions are controlled by the rudder.

Rudder - Hinged control surface located at the trailing edge of the vertical stabilizer, which provides control of the airplane about the Yaw axis and causes the airplane to Yaw left or right. Left rudder movement causes the airplane to Yaw left, and right rudder movement causes it to Yaw right.

Servo - The electro-mechanical device which moves the control surfaces or throttle of the airplane according to commands from the receiver. These devices actually perform the physical work inside the airplane.

Servo Output Arm - The removable arm or wheel which bolts to the output shaft of a servo and connects to the pushrod.

Servo Reversing - This radio feature allows you to install the servos where they can give the best pushrod routing without concern about the direction of servo rotation. When your installation is complete, turn on your radio and check each channel. If a channel operates opposite of its intended direction, a simple flick of a switch corrects the problem.

Slop - Unwanted, excessive free movement in a control system. Often caused by a hole in a servo arm or control horn that is too big for the pushrod wire or clevis pin. This condition allows the control surface to move without transmitter stick movement. (See Flutter.)

Solo - Your first totally unassisted flight that results in a controlled landing.

Spinner - The nose cone which covers the hub of the propeller.

Sport Airplane - A model possessing some attributes of many of the specialty airplanes and are best for general flying as they are the most versatile and durable.

Stall - What happens when the angle of attack is too great to generate lift regardless of airspeed. (Every airfoil has an angle of attack at which it generates maximum lift -- the airfoil will stall beyond this angle).

Tachometer - An optical sensor designed specifically to count light impulses through a turning propeller and read out the engine RPM. (**Safety note:** Should be read from behind the prop.)

Tip Stall - The outboard end of one wing (the tip) stops developing lift, causing the plane to roll suddenly in the direction of the stalled wing. (This is most likely to occur at low speed during landing or take off.)

Trainer Airplane - A model designed to be inherently stable and fly at low speeds, to give first-time modelers time to think and react as they learn to fly.

Trainer System - This effective method of training allows two transmitters to be connected by means of a trainer cord. The instructor can pass control over to the student's transmitter so that he can fly. If the student gets into trouble, the instructor can regain control instantly. (See Buddy box)

Trailing Edge (TE) - The rearmost edge of the wing or stabilizer.

Transmitter (TX) - The hand-held radio controller. This is the unit that sends out the commands that you input.

Touch-And-Go - Landing and taking off without a pause. Often confused with a good bounce.

Vertical Fin – This is the non-moving surface perpendicular to the horizontal stabilizer and provides yaw stability. This is the surface to which the rudder attaches.

Washout - An intentional twist in the wing, causing the wing tips to have a lower angle of attack than the wing root. In other words, the trailing edge is higher than the leading edge at the wing tips. Washout helps prevent tip stalls.

Wheel Collar - A small, round retaining device used to keep wheels from sliding off an axle.

Wing - The main lifting surface of an airplane.

Wing Loading - This is the amount of weight per square foot that has to be overcome to provide lift. It is normally expressed in ounces per square foot. This specification can be easily calculated as follows: If you know the square inches of the wing, simply divide by 144 to obtain square feet. Divide the total weight (in ounces) of the airplane by the wing area (in square feet). This information is valuable when deciding on which airplane to build next. Planes with high wing loading numbers must fly faster to stay in the air. These are generally "performance" airplanes. Conversely, planes with lower numbers do not need as much air flowing around the wing to keep it flying. Gliders and trainer airplanes fall into this category because slow, efficient flight is desirable.

Wing Root - The centerline of the wing, where the left and right wing panels are joined.

Y-Harness - Two servos can be plugged into one channel with a Y-harness. The two servos will then operate simultaneously. It is most often used in areas where the strength of one servo is not adequate.

Yaw Axis - The airplane axis controlled by the rudder. Yaw is illustrated by hanging the airplane level by a wire located at the center of gravity. Left or right movement of the nose is the Yaw movement.