
Newport News Park Radio Control Club, Inc.

# Pilot Training Program

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# Foreword

This booklet is used as a guide for instructors and students of the Newport News Park Radio Control Club (NNPRCC). 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 should 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, a mechanics check list and glossary.

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 R/C 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.

# Section 1: Introduction

## Program Objectives

As you were learning to fly, you probably noticed that the instructors at NNPRCC were usually busy, especially during evenings and weekend flying. There probably never seemed to be an abundance of instructors. For this reason, we encourage newly proficient fliers to consider becoming club instructors.

In this text, you will learn how you can become an R/C 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 NNPRCC 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 as many approaches to learning R/C flying as there are instructors; however, the basic procedures remain constant. The instruction methods contained in this publication are rather simplistic, yet have been proven over years and normally work well. Both students and instructors are encouraged to submit recommended improvements to the club. This helps to ensure that the program evolves to meet the changing needs of our organization.

The goal of the NNPRCC 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 phases of part-task flight training (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 these four basic phases. 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 phase 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

While not mandatory, a "buddy box" is the preferred NNPRCC method of instructing new R/C students with no prior experience. Buddy box instruction provides for a level of safety through direct and timely flight corrections by the instructor. It also affords the instructor an opportunity to demonstrate to the student correct execution of a particular maneuver. However, depending upon your flying skills and the experience level of the student, there are several acceptable alternatives available (e.g, Spektrum's Sensor Assisted Flight Envelope or SAFE). Flight instructors should discuss various approaches to flight training with their student and determine the best fit.

Experienced instructors can assist most students through the early stages of learning without the use of a buddy box as long as they keep the airplane high enough (i.e., "two mistakes high"). However, as the student begins takeoff and landing training, the flight instructor should set realistic expectations with the student and explain that his/her brand-new airplane will more than likely take a few hits. Absent a buddy box, there is little that the instructor can do to avert some disasters other than command "GO AROUND!" This is why ground schooling students prior to this phase of training is absolutely mandatory. A thorough

discussion with your student is not only a wise exercise in expectation management, but perhaps more important, it is a good standard of practice for risk mitigation and safety of flight operations.

If the instructor and the student decide to use a buddy box, it is imperative that the instructor establish clear transfer of aircraft control procedures (i.e., “I have it…”). The student must understand when he/she is or is not in control of the aircraft.

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 phase of training. If in doubt about whether a student is ready to move on to the next level, it is recommended that you continue with the current phase of training until the student has developed sufficient proficiency and confidence. What you do not want to do is push a student beyond their limits and in the end frustrate the process, maybe irreparably.

Be assertive with your control of the master transmitter. Especially when first starting; you should be ready to take control of the plane at the first sign of mistakes. While this may frustrate some students, you must be totally comfortable with control of the airplane. Example: The student is on approach to the runway and begins to drift towards the pit area. In this situation, if a verbal correction is insufficient and the student does not respond, the instructor should take control of the aircraft.

**IMPORTANT SAFETY NOTE**: Where appropriate, ensure that the buddy box is properly matched to the student’s transmitter before each and every flight. Often a buddy box is used on multiple models with the potential for reversed servo controls and/or misaligned flight trims.

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. And always… always end the training session on a positive note. No matter how poorly your student performs, always end the training session with something positive. Example: Stanley Student, that was the

best job binding your model I have ever seen! Never mind that he crashed six times. His ground-ops were perfect!

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. And 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 plane's trims. Practice getting the trims back to normal while controlling the plane in the air.

Encourage students to keep their left hand on the throttle/rudder control. Initially students will be predominantly using their right hand. Urge them to keep both hands on both controls. This is building good habit patterns for other phases of flight such as approach and landings.

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

The instructor must review all requirements and operating rules with new students which should address commonly asked R/C questions, AMA and club membership rules, Trust and FAA registration, 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 divide R/C flying instruction into four basic phases. In any form of teaching, it is good to limit the number of things a student must learn at any one time – R/C flying is no exception. This is known as part-task training, a building block approach to learning.

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

## 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 thoroughly by the instructor, have had at least one trim flight and depending on whether a buddy box is to be used, properly configured. 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 as they understand it. There are several alternatives to almost every phase of flying. Good instructors recognize that their own approach and techniques are not necessarily the only (and in some cases the best…) way of doing something.

Example: How do you handle the left/right problem? Beginners have a common problem when it comes to mastering turns. After entering a turn, they tend to forget which way they are turning and use 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 technique is to have the student to orient his body with the plane. 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. With 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. The important thing is to avoid the student becoming too mechanical with the throttle. All too quickly it becomes a two-position switch – full-on or idle. The result is throttle-bursting with the student chasing the plane around the pattern.

How much control surface deflection – control authority - do you want initially? Since students have a natural tendency to over control, many instructors like to set up trainers to be somewhat docile, minimizing control surface motion, possibly with dual rates. This means initially the student begins with a lower rate control authority and as they advance, transition to a higher rate. However, some instructors prefer to start right from the beginning in high-rate. The justification for this approach is: first, it teaches the student more precise control; second, on windy days reduced control authority may not be sufficient to respond to abrupt changes in attitudes; and third, as the instructor, you need the plane to be responsive enough to avoid an accident.

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 use of rudder in coordinated turns is not recommended until successful completion of the four phases of instruction.

## Wind Limitations

What is the wind limitation? Most students can learn more easily on calm days. But since we live in southeastern Virginia, 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 or so flights, recommend limiting your instruction to when the wind is blowing less than 5 miles per hour steady state. The maximum wind for safe operations is basically determined by the model and the pilot's proficiency. Both should be carefully considered. Generally, though, as the student progresses, encourage them to fly on windier days.

Having said this, it is important to exercise caution on days when a significant crosswind exists. The geography of our club field makes crosswind operations especially challenging when the crosswind is from the southwest. The tall pine trees behind the parking lot will with southwestern winds blowing across and around club buildings to have a tendency to create turbulence and unexpected wind shears.

High wing trainers with their generous dihedral do not handle crosswinds very well. Although flying in crosswinds is not overly difficult, takeoff, landing and ground handling can 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 2: 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 really get 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 will ask an instructor. This section of the program is devoted to handling the most common questions and student problems. 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 R/C Questions

Most beginners to the hobby tend to have the same set of questions. Below is a summary of common questions with 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 will have multiple 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 or actuate the throttle.

A good beginner's radio configuration has a minimum of 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, these sticks spring back to the center (neutral) control position. The throttle stick stays where you place it, from idle to full throttle.

Bear 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.

## Common 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 servo will come out backwards (left aileron comes out to be right aileron, for example). The feature servo reversing 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. Recommend see owner's manual for specific instructions.

**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 60-70 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. See prior discussion on control authority.

**Exponential** – This is another feature not included on every radio. This feature will allow you to control the sensitivity of the controls around the neutral point. A positive exponential will make the aircraft more responsive around neutral whereas a negative exponential will do the opposite. Exponential is a nice feature since you can adjust the responsiveness of airplane while still maintaining full control throw. Exponential control on rudder and nose gear steering is especially helpful in controlling some aircraft on takeoff.

**Mixing** – This feature allows for one control to automatically actuate another. For example: some transmitter radios can be adjusted to automatically provide some rudder movement in response to an aileron command (to make for a smoother turn). Note: this is an advanced feature and not recommended for new R/C students.

**Trainer System(s)** – Today complete trainer systems come in various forms to include flight simulation on your home computer. The instructor should discuss the various trainer

packages commercially available with the student to inform his purchase and shape his training expectations. If the decision is made to use a buddy box, make sure the student purchases compatible equipment.

## Common Student Questions

*How long can they fly?* – All depends… Normally speaking most electric powered R/C trainer aircraft can fly eight to ten minutes on a single battery. Some longer (E-Flite AeroScout 15 minutes on a 2200mAh battery!).

*What happens if the engine quits?* – Most commercially marketed R/C airplanes will glide quite well hands off. For most fliers, a plane can be safely landed even if the engine quits. The altitude and attitude of the airplane at the time of the engine failure will have a lot to do with a successful outcome. The higher the plane, the more time the pilot will have to plan the landing. (Note: landings without power are called dead-stick landings.)

*How far away can the airplane fly?* – Today's transmitters and receivers are good for line-of-sight. The FAA also requires all R/C aircraft to be operated within line-of-sight. That said, if your aircraft goes lost-link for some reason, depending upon the battery and weather conditions, it could go a long way. This is why the FAA requires a registration number prominently displayed on each model. NNPRCC also recommends you include your name, AMA and telephone numbers on your model.

*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, our flying field is located in close proximity to the Newport News/ Williamsburg Airport and we have a flight altitude

*Is it hard to learn to fly an R/C aircraft?* – This is a tough question to answer. Everyone has a different aptitude level for learning R/C. This much is certain. R/C 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 number 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 R/C 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 couple of weeks, weather permitting sufficient continuity of training. Others may take a little more time. In the end, most succeed!

*What is the best size 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. 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 at NPRCC – 3-7 MPH.

*What's the hardest part of flying?* – Approach and landing, and takeoffs.

*How much wind can there be?* – Depends on the model and pilot's experience. Generally, 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

5-10 MPH. 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 have a natural tendency to right itself after a turn. Dihedral also contributes to the aircraft's dynamic stability.

**Flat-Bottom or Semi-Symmetrical Wing** – Flat bottom wings are best for stability, which is helpful when learning. However, planes with flat bottom wings do not handle burbling and gusting winds very well. Flat bottom wing designs perform poorly when it comes to aerobatics. Once you do learn to fly, you will eventually want to learn how to do some 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. "Foam" type airplanes (EPP, EPO, EPS, etc.) are quite resilient, easy to repair and the models are well designed with the novice pilot in mind.

**Recommended trainers (RTF):**

- E-Flite S2 Cub (SAFE select)

- E-Flite AeroScout (SAFE select and AS3X)
- E-Flite Apprentice (SAFE select)
- E-Flite Carbon Cub (SAFE select)

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)?* – No – not to start. For a newcomer to the hobby, especially someone with no aviation background, this can quickly become an exercise in frustration.

## Pre-flight Inspections and Airworthiness

NNPRCC requires members (students or experienced pilots) who are attempting for the first time to construct an R/C model (e.g., ARF, kit, etc.), to have their aircraft inspected by a qualified instructor prior to flight. Most almost-ready-to-fly models tend to be rather easy, requiring little more than final assembly while kits can be much more challenging. Additionally, correctly installing radios and engines/motors can be somewhat difficult, even for ARF airplanes.

For these reasons, we insist that all beginners have their planes checked for air-worthiness prior to flight. 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), improper control surface deflection, controls that bind, not placing foam rubber around the receiver for padding, not properly gluing wing halves (on ARFs), 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 ask that some things be changed before further help will be given.

Appendix B includes a complete Mechanics Check List for new planes and can be used as an aid to determine air worthiness. 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.

# Section 3: Teaching Turns and Level Flight

The objective of this phase 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.

At this point that the training airplane should have had a trim flight and any necessary control surface adjustments have been made. The student should have 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, the student has been taught how to safely start and operate the engine/motor and is familiar with the safety and operating rules of the NNPRCC.

The time it takes the student to master this phase of flight training 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 phase 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. R/C 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 training 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 to ensure that all control surfaces are moving freely and in the proper direction. Before takeoff, on gas powered aircraft, 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. Be cautious that the student does not become too mechanical. Emphasize smooth coordinated control inputs.

Begin turn instructions by getting the plane into a good turning position. You'll need to make it as simple as possible for the beginner's first few tries. Begin at a safe altitude and by aiming the plane toward one of the near corners of the field. Always have them turn the plane in a direction away from the pit/building area.

It is quite likely that the beginner will over-control, so if not using an aircraft with SAFE technology, be prepared to take immediate action (e.g., buddy box). Once controlled flight has been regained, try again.

If using a buddy box, 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 your 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 greater 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 steeper 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 over bank, use a lot of up elevator, and level out quickly. While their turns may look rather well, you should insist that they turn smoothly. 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 the next phase of 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 may be related to how much offset thrust (thrust line) the plane has (possibly too much right thrust?). Though it may be possible (probably not desirable for any number of reasons), some of this tendency can be removed by changing the thrust alignment

and eliminating some asymmetric thrust. It is probably just easier and safer to use aileron and elevator as required, and accept that left and right turns may require different control pressures.

What about planes that don't have ailerons? – Though you don't see them as much anymore, 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 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 your student progresses, be sure they can handle the airplane at any throttle setting.

**Wind and Turning** – Recommend that the wind will be calm during the first few flights. However, do not consider the student competent with turns until they have flown under windier conditions – 5-10 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 approach and landing, 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 downthrust (asymmetric

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 should anticipate reducing elevator back-pressure. 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 to mastering turns when 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 increase the bank angle with the aileron or not use 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 phase? – Generally speaking, when the student can keep the airplane in the air for a whole flight with no coaching from you. 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 4: Teaching How to Set and Hold Headings

The objective of this phase 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 has truly mastered turns, this phase should be relatively easy to master. You can begin stressing the importance of being able to set and hold headings even during phase one, turns. 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 phase one, the beginner may be able to keep the plane in the air, but the plane may be flying the pilot to some extent.

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 initial 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 turns 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. This is the reason why you should keep the student from turning too radically. While radical (very hard) turns may be easy for the student to master, when it comes to setting headings, hard abrupt turns are very difficult to exit in a predictable manner and lead to over- controlling.

**Free-form Turns** – Once the student has mastered figure eights 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 that 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. Only now have the student adjust the lobes of the eight so the airplane is turning to pass directly in front of themselves on a heading away from where they are standing. 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 planes attitude at the completion of the previous turn.

They must always be ready to apply these minor corrections in order to hold headings. The amount of crab required to hold a steady heading will be readily apparent. The eventual goal of this practice is to make perfectly shaped figure eights with the crossover right in the middle of the flying field.

The next step with the figure eight is to reverse the turns (right turns on the left side and left urns on the right) so the airplane is flying directly at the student. This maneuver forces the student to practice the all-important skills of flying the airplane while it is flying directly at him, albeit at altitude. Again, stress the importance of flying the aircraft to the desired position in the sky. The student should be controlling the

airplane, not the other way around. 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 takeoff. As the throttle is increased, the plane becomes more responsive, simulating how an over-powered plane will behave during takeoff. This is also a good place to explain the effects of proper trim.

**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 phase? – When the student has demonstrated the ability to control the airplane and 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 some precision – then they are ready to progress to phase three, landing the airplane.

# Section 5: 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.

**Engine/Motor Reliability** – This step requires a great deal of throttle changing.

Before starting this phase, it would be wise to confirm that your student's engine or

(electric) motor will maintain idle, go from idle to full, and in general, perform without stopping or hesitating at all throttle settings (gas).

**Is the student ready to land?** – If all phases of training up to this point have been mastered, landing will simply be an extension of what the student already knows. However, if they are having problems with approach and landing, it should be taken as a signal that further practice with turns and turns to headings may be 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 (may) stall. Note: most commercial trainers are almost stall proof. Depending on battery location, they may not 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 the prior phase, the beginner was flying with some precision. They were capable of flying 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 the student repeat this process (still at altitude), 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 coordinate 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 off 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 is the increase and decrease of the throttle.

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 (buddy box ops) 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 feet 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 good landing begins with a good approach, begins with a good base turn to final, begins with a good downwind. The instructor must explain how one directly impacts the other, and how the student should begin planning for a landing on downwind. An accurate analysis of winds and how to adjust the approach and landing for the winds is imperative.

The student must first position the airplane on a solid downwind at the appropriate altitude with a ground track adjusted for any pattern winds so as to arrive at the desired perch or point at which he begins his 180 degree turn to final. During this turn to final or base leg, he needs to understand that the nose of the plane should maintain a slightly downward attitude throughout the turn to final approach (especially if the throttle is at idle). Once the airplane rolls out on final, the glide path is controlled with small smooth pitch adjustments. Airspeed, especially to adjust for the effects of a headwind, is controlled with small deliberate throttle adjustments. The goal is a stable well controlled final approach to the runway threshold. Once

over the threshold, if the throttle is not already at idle, reduce to idle now. As the airplane starts to settle to the runway, slowly increase pitch. The great paradox of landings is that to achieve a good landing, the pilot tries to keep the airplane from landing. Continue to increase back pressure on the elevator until the main wheels touch down. The instructor must emphasize that it isn't over yet. The student must continue "flying" the airplane on the runway making any rudder inputs as necessary to control the rollout and then taxi back to runway exit.

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.

It is absolutely critical that instructors teach student when and how to go around. Instill in your students that it is far better to abort an approach than try to save a bad landing. Just add power and go around. Set up for another approach and landing, adjust appropriately, and try again.

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 6: Teaching How to Takeoff

The objective is to get students to the point where they can taxi and take off. Remind the student that while practicing takeoffs 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 pit area).

One way for the beginner to set tracking (at home) is to let the plane role 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 asymmetric thrust force also known as "P-factor" will normally pull the plane to the left. They should anticipate the use of right rudder as required. 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.

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 a gradual climb at full throttle. As the plane rises, the student must be ready to make minor corrections to adjust for winds and turbulence. Always have the student make the first turn away from the pit

area! Once the plane has reached a safe altitude, the throttle may be reduced and maneuver as desired. Students tend to be so nervous during the first few takeoffs that they forget to reduce the power. Instructors should demonstrate a takeoff prior to the students first attempt.

Beginners have problems in three areas. First, they have problems with rudder control and P-factor. Tail draggers are particularly challenging for new pilots (ground-loops…). This can be very dangerous if the plane wanders off in the direction of the pit area. Be sure to let them know that just because they started the takeoff roll does not mean they have to takeoff. If anything looks wrong or they feel panic for any reason, have them abort! By the way, this is why the high-speed practice runs are so very important. During these runs, the beginner does not expect to takeoff and becomes familiar with high-speed abort procedures for his airplane.

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 for too long. Either way, this can result in a too high nose attitude and possible stall.

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 and velocity, 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 is after landing have the student taxi back, takeoff and land again. As they gain proficiency, have them apply throttle as soon as the plane touches down, performing a touch and go.

When have they completed this phase? – 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 solo.

# Section 7: Important Things a Beginner Must Know

The instructor needs to include discussions on just what new R/C pilots needs to be aware of as they continue to learn to fly.

*Solo flight – when?* The whole point of R/C flight training is to get the beginner to the point where they no longer need the constant attention of an instructor. Once the student has successfully completed preflight instruction, the four phases of flight training and has earned an NNPRCC solo certification, they are ready to go it alone, safely. However, the student needs to understand that the solo clearance is really just a learner's permit. The instructor should advise caution and encourage the student to acknowledge their limits – go slowly while building experience.

*Discipline*. It is important that students have proper expectations established at the beginning of their flight training. 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 electronic babysitters. The instruction process should proceed from phase to phase, with each prior phase of training 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 maneuvers will prepare the beginner to react more instinctively when the time comes for aerobatic instruction. The first priority is to develop the skills to become a competent and responsible pilot.

*Safety! Safety! Safety!* Safety is everyone's responsibility. The objective of R/C flying is to have fun, but we must acknowledge the associated risks. Membership in NNPRCC is a privilege, one that should be appreciated and guarded carefully. The quickest way for us all to lose this privilege for someone through carelessness or negligence to cause a serious accident that we simply cannot recover from. It is incumbent upon us all that we be our brother's keeper and be constantly vigilant.

Unfortunately, our hobby can be a dangerous. As R/C flyers, we must all treat the hobby with respect and acknowledge the potential risks. There are numerous examples of what one flyer may think is safe and acceptable, and another does not. But rules are rules. You may question rules but not break them. While a public correction is not pleasant and can be embarrassing for all involved, it is better than allowing someone to operate their aircraft contrary to club rules. Do not be afraid to question any operations by anyone at the field that are not compliant with our NNPRCC operating rules and safety standards.

No responsible flyer will intentionally do something to cause an accident. It is normally when a flyer makes the unintentional mistake that accidents 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 inform beginners, and remind experienced pilots, as to why we consider these rules so very important.

**Safety in the Pit Area** – While most of these rules may seem to be common sense, unfortunately sometimes common sense isn't so common. People become distracted and make mistakes.

Hold on to your plane whenever the engine is running – NEVER, repeat NEVER let go of an airplane with the engine running until it is on the flight line and ready for taxi. Always keep it under complete control. And always treat an airplane with the engine running as if the transmitter is going to fail at any moment. We highly recommend the use of the hard stands in the pit area for engine/motor tests to ensure that the airplane cannot move until the flyer is ready to carry it out to the flight line. If your aircraft is too large for a hard stand, either solicit another pilot's assistance or use some restraining device (e.g., PVC aircraft restraining cradles). Always position your body to one side of the airplane while starting and running the engine/motor. 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/motor is directly in line with the prop. If the propeller is fractured in any

way, an injury can occur if the propeller shatters. Once the engine/motor is started, ALWAYS stand behind the airplane.

NEVER taxi in the pit area. Taxiing is only allowed on the flight line or runway.

For gas powered engines: 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. Do not reach over or around the propeller to adjust the needle valve. 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.

Limit engine run ups in the pit area. Never run your engine above idle speed in front of a structure or a group of spectators. As a courtesy to other flyers, NEVER break in an engine in or near the pit area.

## Priorities in Flying

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

1. Dead-stick landings – When an airplane's engine/motor fails, the airplane is going to come down no matter what. The flyer with the dead-stick must yell "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/motor has the highest priority. ALL other flyers must give way (including any that have already called their landing).

2. Runway access – Whenever a person needs to retrieve an airplane from the runway, they MUST announce their intentions - call (very loudly) "RUNWAY ACCESS!" While this person has the right of way, they must coordinate access first with other airborne pilots.

While ANYONE is on the field, no takeoffs, landings or low passes are allowed. Before walking onto the runway, make sure all pilots currently flying have acknowledge your access declaration. 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 "RUNWAY CLEAR!" When retrieving your plane, be expeditious – be sure to take the shortest route on and off the runway.

3. Call landing – The first flyer that calls a landing has priority. Do not attempt to hurry a takeoff to beat an airplane that is landing. If your engine/motor stalls, an airplane may be sitting in the middle of the runway while another is trying to land!

4. Takeoff – takeoff has the lowest priority. A flyer may have to wait for several minutes while other pilots land and retrieve their airplanes.

5. **Call Takeoffs and Landings** – Keep all airborne pilots informed of your intentions. Someone may have called a landing without you 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 all pilots' announced intentions so that they know you have heard them as well.

Be sure you know the current direction of traffic. Winds have a bad habit of constantly changing direction at NNPRCC. Be aware, announce your intentions and coordinate direction of flight with any airborne pilots. Make sure all can hear and no one is surprised.

DO NOT ATTEMPT TO FLY BY YOURSELF – If a new R/C pilot, "Novice", has not been cleared for solo by an instructor, NNPRCC requires an 'Experienced' pilot to be present and in a position to provide guidance if necessary. Bear in mind that your model airplane is not the only thing at risk! When in doubt, ask for help! – No matter what the concern or question, if you do not understand what you should do, seek help from an experienced pilot.

## The Basics of Engine Tuning (gas and nitro engines)

This short discussion provides the most basic considerations when making adjustments a new gas or nitro engine. While there are many potential problems that can cause similar symptoms, and while each flyer has his own way of doing things, the below should acquaint you with time proven ways of handling the most common problems.

A good running engine is a student pilot's best friend! Nothing is more frustrating than trying to learn how to fly with a poorly performing engine. It is difficult to get much quality stick time if the engine is constantly quitting in the air. And for approach and landings it is MANDATORY that the engine responds properly. If the engine dies close to the ground, the results can be disastrous.

A leading cause of poor engine performance has to do with how the fuel tank is mounted in the airplane  Position Nitro fuel tanks so that approximately 1/3 of the tank is above the centerline of the needle valve.

Kinks in fuel lines MUST be eliminated. ANY kink or sharp bend will limit fuel draw. Be sure to drill fuel line holes in the firewall large enough for your fuel lines. If you have to force a 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 fuel and muffler pressure lines as short as possible for optimal fuel flow.

New Nitro engines are notorious for going through glow plugs quickly. This is predominantly because new engines are 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 for air leaks and loose head bolts. Loose head bolts and air leaks will cause premature engine failure due to a lean condition and overheating.

Carburetors must be secured to the engine so that no air can infiltrate the bottom of the carburetor seal. If you remove your carburetor for cleaning, be sure to tighten IAW the manufacturer's instructions Most carburetors have a rubber seal or gasket that must be

compressed properly as the carburetor hold down screws are tightened. Similarly, crankcase bolts must also be tight, as must be the engine mounting screws.

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 in a new engine mounted to your airplane, many flyers prefer to perform the break in procedure on a test stand. Recommend eliminating the break-in instructions. Engines should be broken in IAW manufacturer's instructions.

## Charging 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.

## NNPRCC Volunteer Instructors

If interested in becoming an instructor please contact the Director of Flight Training, any NNPRCC instructor or club officer. Phone numbers available on the NNPRCC web site (http://www.newportnewsrc.org/).

# Appendix A - Student Solo Flight Checklist

Student's Name & AMA #: _____

1. NNPRCC Operations and Safety Rules
2. Assemble and Test Aircraft
3. Airplane and Transmitter Familiarity
4. Battery Installation and Binding
5. Engine/motor Operations
6. Perform Flight Maneuvers:
    - Start & Taxi
    - Take-off & Trim Aircraft
    - Rectangle Pattern (hold altitude & heading)
    - Figure Eight
    - Slow Flight and Stalls
7. Landing
    - Go-Round or Aborted Landing
    - Landing
8. Taxi and Take-off

(Continued on next page.)

**Flight Check:**

1. Start, Taxi and Take-off

2. Right Hand Pattern and Landing

3. Left Hand Pattern and Landing

4. Dead Stick Landing

5. Secure Equipment

I certify that this student is qualified for unsupervised solo flight and authorized to wear an Experienced pilot's badge.

INSTRUCTOR: _____

DATE: _____

**Notes**:

The instructor will date and sign-off each task as proficiency is demonstrated in that task. If instructors change or training is suspended for some period, then proficiency should be demonstrated prior to resuming training with a new instructor.

Some instructors may require the student to perform tasks in addition to the ones listed above, this checklist serves as a minimum program of instruction.

An NNPRCC instructor is a volunteer and should not expected to provide anything more than instruction and his time. Instructors will perform an initial inspection on the student's airplane model for safety and airworthiness.

New members to our club will be issued "Novice" badges. They will not receive "Experienced" badges until they complete the flight check portion of the above program and are cleared by an instructor for solo.

# Appendix B - Mechanic's Checklist

**POWER PLANT**

- PROPELLER
  - Propeller nut tight
  - Spinner on tight
  - Propeller balanced
- ENGINE
  - Hold down bolts tight
  - Head bolts tight
  - Carburetor secure
  - Glow plug tight
- FUEL SYSTEM
  - Lines connected properly
  - Line routing, bends, kinks
  - Tank mounting
  - Clunk free

**CONTROL OPERATION**

- FUSELAGE CONTROLS
  - Throttle control free
  - Servos mounted securely and tight
  - Servo hardware tight

- Servo pushrods clear of mechanical interference

- LANDING GEAR
  - Main Gear and Nose Gear hardware tight
  - Wheels free and collars tight
- RECEIVER
  - Check all receiver plugs for proper seating
  - Check antenna routing
  - Check receiver overall crash protection
- BATTERY AND SWITCH
  - Check switch mounting (opposite muffler side of fuse)
  - Check wire leads for routing and binding and proper hook-up
  - Check battery crash protection
  - Check battery voltage
- EMPENNAGE: VERTICAL STAB
  - Check all glue joints for rigidity where joined to fuselage
  - Check rudder hinges Check rudder control horn
- EMPENNAGE: HORIZONTAL STAB
  - Check all glue joints for rigidity where joined to fuselage Check elevator hinges
  - Check elevator control horn
- WING CONTROL SURFACES
  - Check aileron hinges
  - Check aileron control horns

- WING ALIGNMENT
  - Check wings center section joint
  - Check wings for warp
- TRANSMITTER
  - Check transmitter batteries
  - Set all trim controls on center
- RUDDER AND NOSE GEAR
  - Check rudder for correct direction (also check nose gear if tricycle gear)
  - Check for proper throw
  - Check all hardware for tightness (especially nose gear control horn on shaft)
- ELEVATOR
  - Check for correct direction (change transmitter switch if necessary)
  - Check for proper throw
  - Check all hardware for tightness
- AILERON
  - Check for correct direction (change transmitter switch if necessary)
  - 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
- THROTTLE
  - Check for correct direction

- Check for proper throw.
- Trim down-carb barrel closed.
- Trim up-carb open to fast idle.
- **Throttle control with ENGINE OFF for these checks**:
  - Throttle full up-carb barrel full open.
  - Throttle servo should not be stalled at either extreme.
  - Listen for servo buzz at full open and full closed positions.
- Check all hardware for tightness
- There should not be any metal-to-metal contact in the throttle linkage as this can transmit interference back to the receiver.

**BUDDY BOX OPERATION**

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

**RANGE CHECK**

- Range check transmitter with antenna collapsed and distance of 100 feet.
- Check also operation of buddy box through transmitter at the range check.

# Appendix C - Glossary of Radio Control 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 aileron is moved upward and the left aileron downward, and vice versa for a left roll or turn.

**AMA** – The Academy of Model Aeronautics. 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 that are 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: Most CA glues will attack Styrofoam.

**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.

**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 unpowered flight (glide) when the engine quits running.

**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.

**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 take-off and landing speed. Flaps are often found on scale models, but usually not on basic trainers.

**Flare** – The point during the landing approach in which 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 all 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 whereby 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 do 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 to be used 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 channel number your radio broadcasts on.

**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** – Momentary radio problem that never happens unless you are over trees or a swamp.

**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.

**Hit (or to be hit)** – 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.

**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.

**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.

**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 these two numbers, for instance 10 – 6. The first number is the prop's length, 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″.

**Re-Kitting Your Airplane** – Changing your finished model back into a kit, as a result of "stuffing it in."

**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 perceives music 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 is the roll movement. This is used to bank or turn the airplane. Many aircraft are not equipped with ailerons and the Roll and Yaw motions are controlled by the rudder. This is one reason why most trainer aircraft have a larger amount of dihedral.

**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. The radio device which does 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.

**Shot Down** – A "hit" that results in a crash landing. Sometimes caused by radios miles away.

**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** – First unassisted flight that results in a controlled landing.

**Spinner** – The nose cone which covers the hub of the propeller.

**Sport Airplane** – A model which possesses 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.

**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 situation is not fun when you are only a few feet off the runway trying to land.

**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.

**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** – The non-moving surface that is 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.

**Z-Bend** – A simple Z-shaped bend in the wire end of a pushrod, which is used to attach the pushrod to a servo output arm.

**Z-Bend Pliers** – An inexpensive plier type tool used for easily making perfect Z-bends.