

Ground School and Flight Training

Marymoor R/C Club, Redmond, WA
AMA Charter 1610



Version Information

Version	Author	Date	Description
.5	Eric	3/27/2015	First Draft
.6	Brian	15-Apr	Second Draft
1	Eric, John and Brian	5/4/2015	First Version for release
1.1	Eric	5/4/2015	Comments from Steve Guty, Doug, Ian
1.2	Eric	5/10/2015	Edits for sections
1.3	Brian	5/24/2015	Misc. Edits, photos, and added content
1.4	Brian Kelly	5/3/2016	FAA registration, recommend electric. Edits and sequence for clarification
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1.6	Brian Kelly	4/19/2017	Misc edits, repaired links, to prepare for website update
1.7	Brian Kelly	4/26/2017	Corrections and misc edits
1.8	Brian Kelly	9/28/2017	Updated Proficiency Check and misc edits

A safe, inspiring, and educational training experience

1. **Any Time of year: Come to the field and ask around for someone to teach you to fly**
2. **Summer Training Program:**
 - FREE – Run by club volunteers
 - Your first lesson on the club trainer
 - After this, you must provide your own airplane and transmitter, and apply for memberships (free if 18 or under, see following slides)
 - Tuesdays 5 PM to sunset (weather permitting), from approximately first week in May through last week in August.
 - For new student pilots or for returning pilots that need to brush up on their flying skills
 - Minimum age depends on aptitude and motivation of the individual student – usually at least 10 years old.
- Instructor and student each hold a transmitter, and the two are connected by a “buddy box” connector cord so the **instructor can always assure safe flying**
- ***BEFORE YOUR BUY ANYTHING, READ SECTION 2, Selecting your training airplane and radio***

Disclaimers

MAR/C provides advice. After you gain solo flight privileges, *only you* are responsible for your model aircraft readiness, your actions, and abilities

Any instructions provided by the manufacturers of equipment such as but not limited to aircraft, radio controls, batteries, motors or engines and anything installed in your airplane have precedence over any advice provided by instructors, this document, or the mar-c website..

Flying and teaching techniques vary widely in our hobby, and vary from one instructor to another.

The goal of this document is to encourage some standardization and provide a practical minimum amount of knowledge.

Contents

- [Section 1: Getting Started, Field Rules and Safety](#)
- [Section 2: Selecting your training airplane and radio](#)
- [Section 3: How Training Works](#)
- [Section 4: How planes fly](#)
- [Section 5: Flying Lessons!!](#) (Flight Instruction and Flying Technique)
- [Section 6: Radios and ESC's](#)

Section 1

Getting Started, Field Rules and Safety

3 Things to Do Right Away

Note: **You may come the first time to training without doing these**

1. **Get your AMA NUMBER - FREE if under 18**

Academy of Model Aeronautics <http://www.modelaircraft.org>

Provides liability insurance (required by King County)


AMA will send you your membership *number* in several days

2. **Apply for MAR/C membership on our website (you need your AMA membership *number* before doing this) FREE if under 18**

Preparation Checklist

- Visit the field anytime, talk to members, see the planes
(optional, but recommended)
- AMA membership
- MAR/C membership (apply as soon as you have AMA number)
- Read sections 1-4 and Phase 1 of section 5
- Purchase your plane and transmitter ***AFTER*** reading section 2
- Read instructions for your plane, charger, and batteries
- Assemble your plane according to the instructions
- Come to training night with your batteries recently charged

Do these
as soon
as possible




MARYMOOR R/C CLUB
Redmond, Washington. AMA Charter #1610



AMA
SINCE 1936

HOME NEWS SAFETY EVENTS GALLERY LINKS GUIDE FORUMS

Flight Training Program

Marymoor R/C Club Flight Training



ABOUT US
MEMBERSHIP
PROFICIENCY CHECK
AIRFIELD
WEATHER STATION
RULES
FLIGHT TRAINING
CONTACTS
MAPS
DOCUMENTS
AMA EVENT CALENDAR
VIDEOS

Our goal is for all students to enjoy a safe and inspiring training experience. The information here can be a bit intimidating at first. Rest assured that we are enthused about helping you, as we have done for many, many new fliers. We will introduce knowledge to the student at their own pace. We want every student to succeed. After all, flying is a lot more fun when we have new friends to share it with!

- AMA membership (<http://www.modelaircraft.org>) and MAR/C membership are both required.
- MAR/C membership is "provisional" (yellow badge) until the student passes a flight proficiency test and gains the privilege to solo.
- MAR/C conducts a flight training program each year for new student pilots or for returning pilots that need to brush up on their flying skills:
 - Tuesdays 5 PM to sunset (weather permitting), first Tuesday in May through the last Tuesday in August.
 - A new pilot may fly a MAR/C owned trainer with an instructor for one flight prior to joining the training program.
 - We provide a "buddy box" and cord to connect the student and instructor's transmitters.
- The club currently supports **Spektrum** and **Futaba** brands.
- If the student owns a transmitter of some other brand, they must invest in their own buddy box (e.g. a second transmitter) of the same brand, and the connecting cord.
- Both the primary transmitter and the "buddy box" transmitter must be of a similar vintage and be able to use the same type of cord and connections.
 - Direct any questions that you may have to Flight Training Manager **Doug Hales at (425) 392-2212** or **Mike Powell at (425) 883-2465**.
- Alternatively, you could arrange privately with a willing club member to teach you to fly at any time of the year. When the student is ready to graduate from "provisional" to "full" membership, the student must pass the flight proficiency test with a club board member, in the same manner as the training program.

Before purchasing your own airplane and other equipment, ***please*** read **sections 1-3 of the MAR/C Ground School 2017 PDF or PowerPoint.**

Contact one of the above MAR/C contacts if you have any questions. Also, please **come visit the field** and talk to other pilots, to see the equipment in use and get a feel for the size and capabilities of different kinds of trainers. You can do this any time, but Tuesday training evenings are the best opportunity. Deciding what to buy based only on website and advertisements usually results in disappointment. Buying from swap meets is also risky unless you know exactly what you need.

What is training like?

A MAR/C tech inspector will check your airplane to ensure that it has been assembled correctly and is flight worthy according to the pre-flight checklist found in the MAR/C Ground School 2017 [PDF](#) or [PowerPoint](#). Most deficiencies identified by the tech inspector can be corrected quickly at the airfield.

Student pilots will fly with different MAR/C instructors during training. The instructor's "buddy box" transmitter will be connected to the student's transmitter with a special cord. The instructor can fly the airplane and take control from the student instantly at any time.

Learning Tools on our Website

<http://www.mar-c.org/training>

Join AMA

Use the Ground School!!!

- Easy reading
- What to buy and not to buy
- Lesson material for each phase of your flight lessons
- Guardians and Students – read section 1 now

Safety

Propellers can cause Significant Injury

- Before plugging in the battery of an Electric Aircraft, ensure that:
 - **Transmitter ON**
 - Throttle is at idle
 - Throttle Cut switch is in “cut” position
 - Airplane switch (if so equipped) if OFF
 - Hands and arms are away from the propeller
- When starting Glow or Gas engines, ensure that:
 - **Transmitter is ON**
 - the Aircraft is restrained
 - no one is standing to the side or in front of the prop in case the prop comes loose.
- Ensure your propeller nut remains tight.
 - Wooden props especially tend to loosen with time
 - Gas and glow engines can “kick back” during start attempts and suddenly loosen the prop nut

Safety: LiPo Batteries

- LiPo batteries can catch fire if not treated properly.
- Always charge batteries in a fire-proof container like a flower pot or a Lipo bag. Never charge inside a car.
- Read all the warning material that comes with your charger and battery. Charge at the recommended current or “C” rate.
- Always fly one flight only with a fully and freshly charged battery
- Never run the battery all the way down. This will damage the battery. Make sure at least 25% is left. Use the battery checker after each flight to learn how many minutes of flight the battery is good for. Use count-down timer to limit the time of every flight.
- Do not store your batteries for more than a few days fully charged. This will limit their life.
- Understand your charger. When charging a battery ensure that you have the polarity on the battery correct before charging. Red goes to red and black goes to black.
- Consider investing in a good charger that can tell you how many milli-amp-hours (maH) are put in each time a battery is charged. Compare this to the rated maH of the battery



Charger connections

FIRE SAFETY



Ceramic Flower Pot, or LiPo Safe Bag

Battery Checker



A Rule for Real Aircraft we can Learn From

Federal Aviation Administration (FAA) 91.3, Responsibility and authority of the pilot in command:

(a) The pilot in command of an aircraft is **directly responsible for**, and is the final authority as to, the operation of that aircraft.

Rules enhance fun and cooperation, and ensure that we keep our field.

1. Marymoor R/C Club: [Field Operating Rules](#)
2. Academy of Model Aeronautics: [AMA Document 105 - Safety Code](#)
3. US Federal (FAA) rules for flying RC aircraft
 - Read “Know before you Fly” to understand WHERE and when it is legal to fly:
<http://knowbeforeyoufly.org>

A few of our Field Rules

- Flyers less than 12 years of age and all Provisional Category (yellow badge) members must fly under the supervision of a fully qualified MAR/C member
- Fly from a fenced pilot station only
- No flying over the pits (anywhere behind the fenced pilot stations)
- Takeoffs and hand launches from the runway only
- Callouts make for safe flying – see signs at each flying station
- All injuries and accidents need to be reported.

Read the full set of MAR/C rules on the GIANT sign upon entering the pit area.

Section 2

Selecting your training airplane and radio

Recommended Airplanes

Available at Redmond Hobby Town (along with good advice)



E-Flite Apprentice



Park-Zone Sport Cub

- **Electric power is strongly recommended for training**
- Wheels large enough to take off from grass (2 ½ inches diameter). Apprentice airplanes need upgraded wheels
- High Wing with dihedral
- Ailerons required for our program
- Nose wheel or tail wheel landing gear are OK. Tail wheel is better on our grass field and more durable.

Selecting a Transmitter

- MAR/C Training program provides the “buddy box” transmitter.
- You must own a **Spektrum** or **Futaba** brand transmitter to be compatible with the club buddy boxes, or you must provide your own buddy box
- A simple transmitter might be supplied with a “Ready to Fly” (RTF) model like the Apprentice
- Better ones with more channels are a good investment if you are sure you will stick with the hobby
- Protect the switches and sticks by storing it in a case or a plastic box with padding



Power Options

- Electric Motor (strongly recommended for training)
 - Must understand safe charging and storage of Lithium-Polymer (LiPo) batteries.
- Internal combustion “gas” engines (not recommended)
 - Traditional “Glow” model airplane engine
 - New small gasoline ignition engines
 - Require different field equipment than electric
 - More difficult to achieve reliable operation
 - Must have a sound check inspection – 90db is the limit

Electric Power Support Equipment

- Arrive at training with 3 fully charged batteries, or 2 fully charged batteries and a charger.
- Recommended:
 - Battery checker for checking the charge status of a battery before and after the flight
 - A charger that can tell you about health of the battery (upgrade from the one supplied with an Apprentice)

Section 3

How Summer Tuesday Night Training Works

Your First Day of Training

- A little check-in paperwork
- Our Tech Inspectors check out your airplane before it flies.
- Meet an instructor.
- Learn about the “Buddy Box” system that connects two transmitters so that your instructor can ensure safe flying
- Your first flight using the club trainer, or your own airplane



Your Own Plane -

- After your introductory flight on the club trainer, you will be expected to have your own equipment:
 - **Plane**
 - **Transmitter**
 - **Extra batteries and/or charger if electric**
 - **Appropriate ground equipment for your plane**
- Before coming to the field with your plane, assemble it to the best of your ability. Follow instructions carefully.
- Before flying any new plane, a MAR/C Tech Inspector will examine your plane using the checklist on the next pages

- Intentionally left blank

Before flying, a MAR/C Tech Inspector will check your plane using this checklist

MARC PREFLIGHT CHECKLIST

Pilot Name _____

Aircraft Description _____ Power: Nitro ___ Electric ___ Glider ___

General: Radio Brand _____ Freq: 2.4GHz _____ 72MHz _____ Channel _____

1. Transmitter is in Imbound (if required) _____
2. Aircraft power is OFF _____
3. Check flight battery: 4c/5volts, 5c/6volts. Elec. Based on motor requirements. _____

ENGINE AREA:

1. Engine / Motor are secure in mount. _____
2. Muffler, accessories, prop are secure and installed correctly. _____
3. Check prop for damage. _____
4. Was prop balanced prior to installing? _____
5. Check nose wheel installation for security. (if required) _____
6. For nitro power check firewall and nose area for fuel proofing. _____
7. For nitro power check fuel tank installation, tank security, secure fill and feed line's: _____
8. If cowl is used check for secure installation. _____

ELECTRONIC INSTALLATION:

1. Are servos mounted correctly, rubber mount, grommet flange against mounting surface. _____
2. Check that wires are routed to preclude hang up on servo arm motion. _____
3. Are all mounting screws tight? Is control arm screw tight? _____
4. Check that control rods are secure with supports to prevent flexing. _____
5. Attachment of control rods to servo is secure and non binding. _____
6. Receiver is secured and isolated from vibration. _____
7. Check that antenna are installed correctly for the selected receiver. _____
8. Check that battery is secured and is isolated from vibration. _____
9. For electric need to verify that battery is not damaged/puffed, that hold down is adequate to prevent movement in flight, and correct connection to motor/ESC. _____
10. Check that all clevises have "safety" tubing to prevent opening in flight. _____

TAIL AREA :

1. Check fin and stabilizer for solid mounting. _____
2. Pull test fin to rudder hinges and stabilizer to elevator hinges. _____
3. Check rudder and elevator control horn and clevises for secure mounting. _____
4. If required check tail wheel for secure mounting and non-binding steering. _____

WING:

1. Check for damage, warps, center section reinforcement and/or wing joiner for two piece wing. _____
2. Pull test aileron hinges, check control linkage , control horn security and clevises. _____
3. Check wing mounting for secure attachment hold down; dowels or bolt hold down. _____
4. Before installing WING, insure required AMA identification data is applied. (Gen rule 6) _____
5. Install Wing: prefer nylon bolts or minimum of 10 new rubber bands. _____
6. Visually check overall alignment of wing, fin, and stabilizer. _____

Before flying, a MAR/C Tech Inspector will check your plane using this checklist (page 2)

BALANCE:

1. Check CG; fuel tank empty, use main SPAR if location is unknown. Correct as required. _____
2. Insure battery is installed when checking CG for electrics. _____
3. Note: For low wing aircraft, turn model over to check CG. _____
4. If possible check lateral balance. _____

POWER ON CHECKS:

CHECK FREQUENCY BOARD TO ENSURE YOUR CHANNEL IS AVAILABLE (72 MHz) PRIOR TO
POWER ON CHECKS. PLACE MEMBERSHIP CARD IN CORRECT SLOT. FOR 2.4 GHz PLACE CARD
IN ANY OPEN SLOT ON 2.4 GHz BOARD.

1. If the aircraft is electric powered, tie down and insure that throttle stick is in idle position. _____
2. Turn on transmitter: check battery is 10 volts min. (Maybe lower voltage on some 2.4) _____
3. Check that control surfaces move in correct direction and throttle idle to full is correct. _____
4. Check that control throw is sufficient for flight. _____
5. Check that the control surface is trimmed to the primary flight surface. _____
6. NOTE: For electrics motor should be turning during range check. _____
7. Perform radio "range" check: for 72 MHz, one section of antenna out @90 to 100 ft. _____
8. Range check for Spektrum: enter range mode (press and hold bind button) @ 90 ft. _____
9. TIE DOWN AIRCRAFT PRIOR TO ANY ENGINE OPERATION/ADJUSTMENT. _____
10. Start engine, perform power test/idle test, LOW trim shut off. _____
11. For electrics check whether ESC is set to "hard brake" or "free-wheeling". _____
12. If required, set up "buddy box" to insure compatibility with primary transmitter. _____
13. If required and if available perform 90db test. _____

INFORM FLIGHT SCHEDULER AND FLIGHT INSTRUCTOR OF ANY DISCREPANCIES NOTED:

INSPECTORS NAME _____ DATE _____

Early Flights

- When you begin your flights, your instructor will walk you through a pre-flight inspection or ask you about your inspection.
- Instructor will taxi your aircraft.
- Instructor will take-off and depart the runway.
- Once your aircraft is trimmed the instructor will turn the aircraft over to you

Training Expectations

- Every Tuesday evening check out your logbook and a buddy box.
- Get your name on the instructor waiting list
- Meet with your instructor
 - Ask questions!
 - Instructor will ask about your progress. Tell them what phase you are working on (see section 5)
 - Make a plan for the upcoming flight
- After each flight, get your name on the list to be assigned to the next available instructor. You will likely fly with a different instructor each flight
- Return the logbook and buddy box after your last flight of the evening

When are you Done?

- A solo flight and quiz, when you are ready. See end of section 5 for details.
- Most solo near the end of the summer.
- After you pass, you are a “Youth”, or “Full” (adult) member, and may fly by yourself without buddy box and instructor.
- However, pilots less than 12 years of age must be supervised by an adult, full club member
- Use of computer RC simulators is highly encouraged. Students learn faster, especially in the early stages.
 - [Great Planes Real Flight v. 7](#)
 - [Horizon Hobbies Phoenix R/C flight sim](#)
 - For Mac computers, [Aerofly RC7](#)
- Good pilots never stop learning!

Section 4

How the planes fly

Controls, Aerodynamics, and Stability

- Elevator, Rudder, Aileron
- Wing planform
- Lift and Wing Design
- Wing section (airfoil)
- Tail group (empennage)
- Center of lift, center of gravity
- Characteristics of a “speed stable” airplane

Ailerons, Elevators, and Rudder

Control *Roll*, *Pitch*, and *Yaw*

Ailerons

- Roll, left and right

Elevators

- Pitch, up and down)

Rudder

- Yaw, left and right

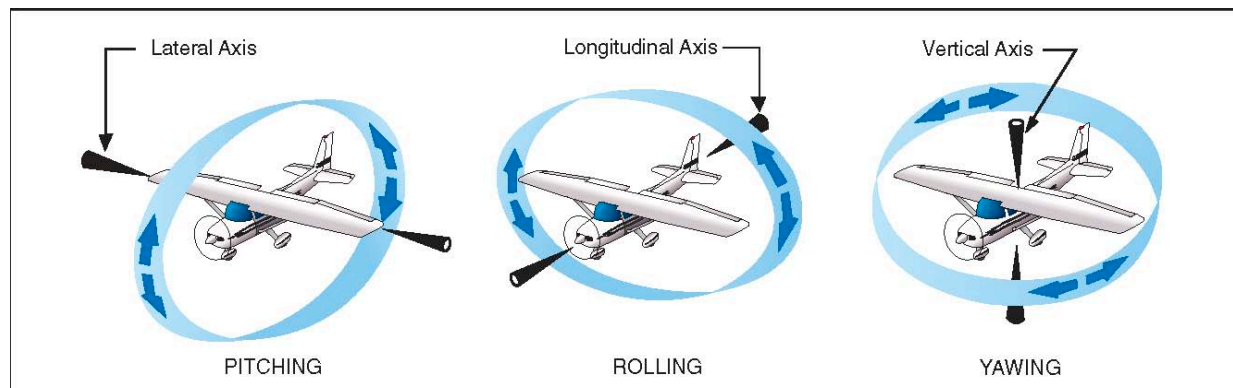
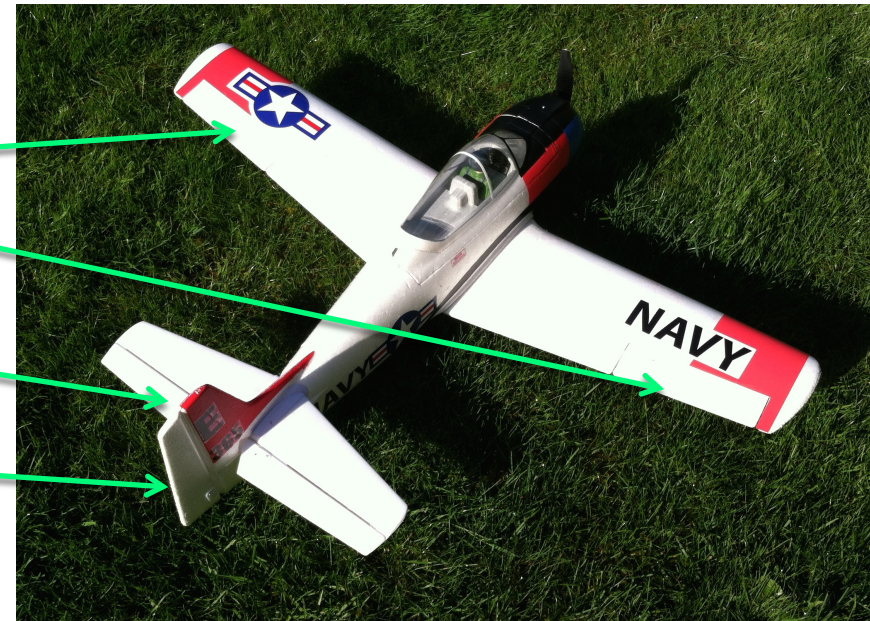
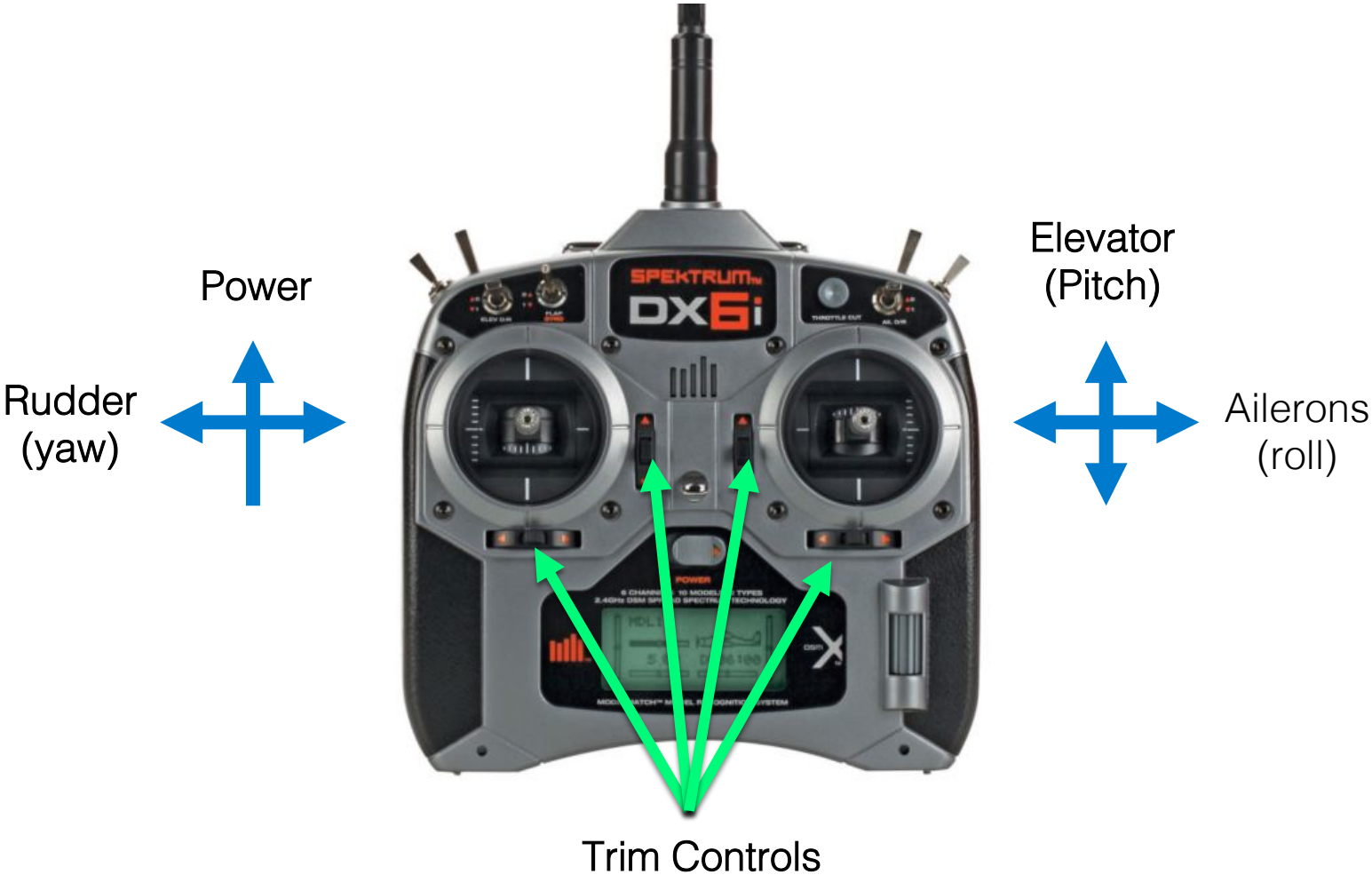


Figure 3-9. Axes of an airplane.

Radio Controls

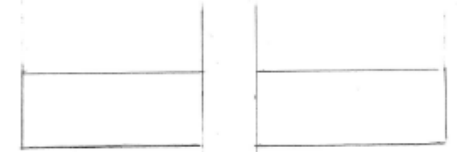


Wing Planform

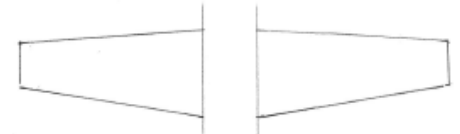
- Rectangular (best for trainers)
- Tapered
- Elliptical
- Swept
- Delta

WING PLANFORM

RECTANGULAR



TAPERED



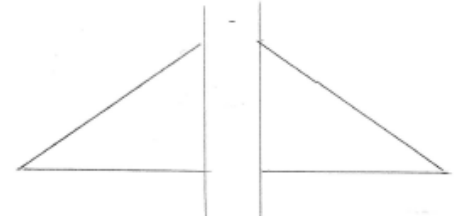
ELLIPTICAL



SWEPT



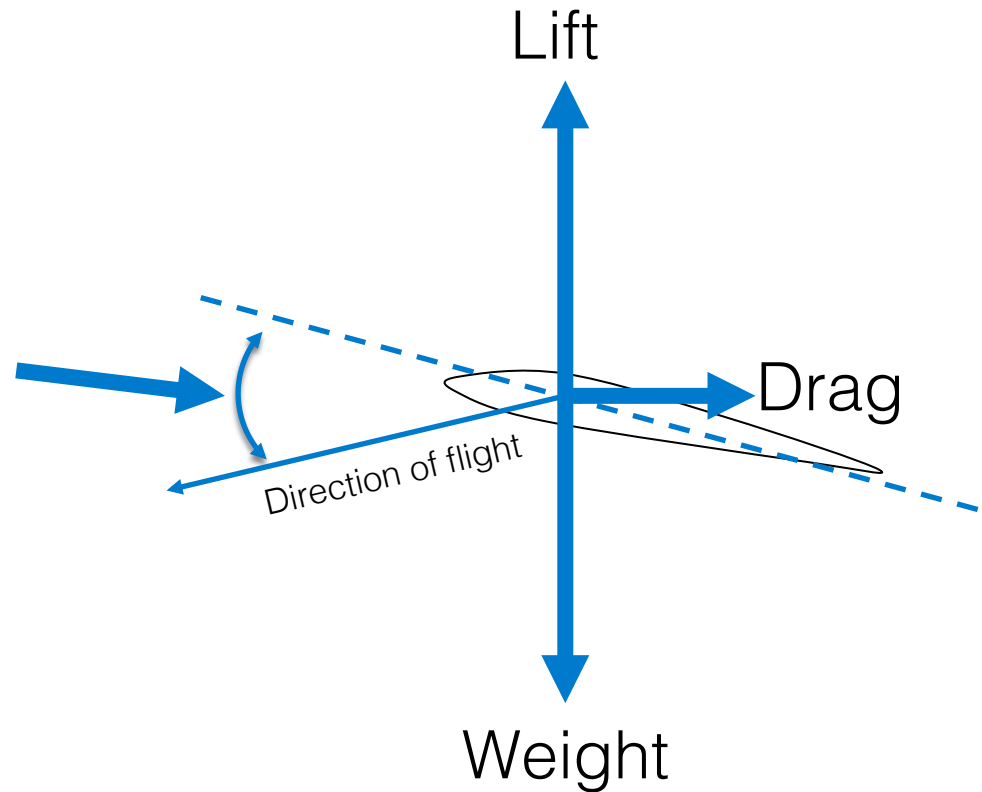
DELTA



Lift

Lift comes from:

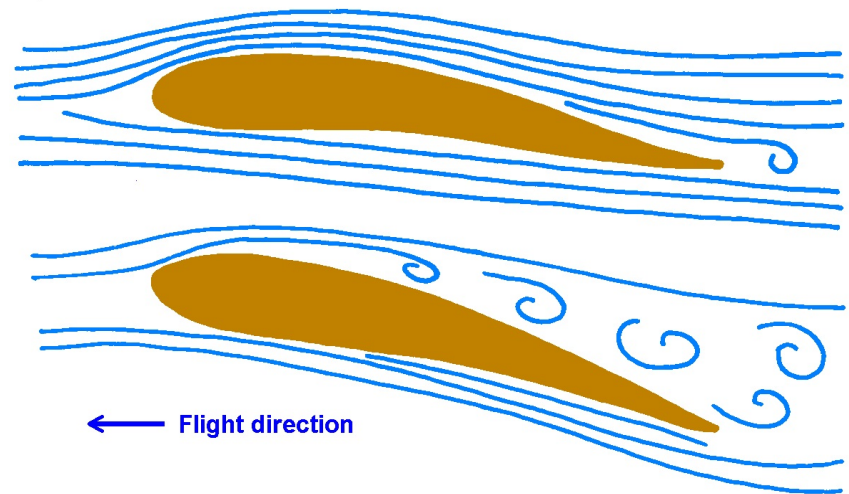
- Angle of Attack
- Wing Area
- Airfoil Shape
- Airspeed



In level flight, $Lift = Weight$

Lift is greatly reduced when the Wing Stalls

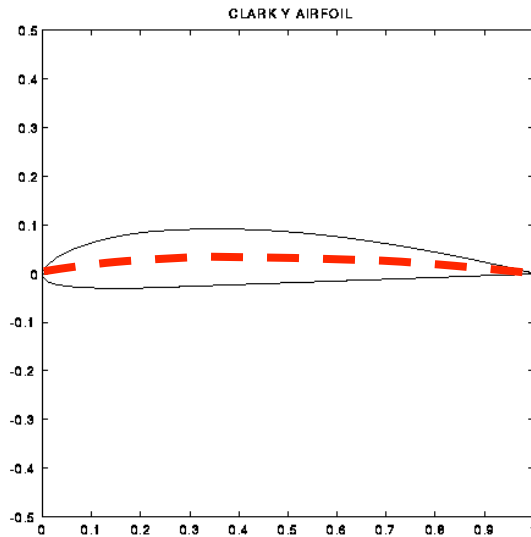
- Stall can occur when:
 - Too slow
 - Pulling too much up elevator
 - Steep bank angle
 - Any combination of these three
- Occurs at *critical angle of attack*, about 15 degrees
- Trainers have gentle stall characteristics. The warbird you want to fly someday might not.
- One wing can stall before the other, resulting in a sharp roll, and if it continues, a spin. A good trainer won't do this.



Airfoil Shapes

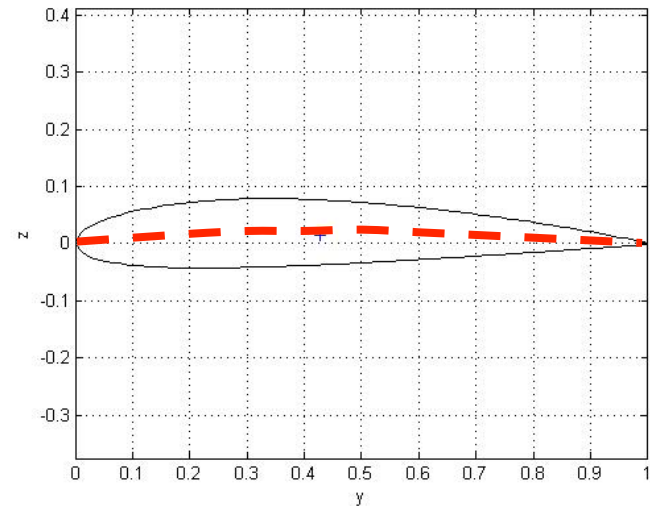
Flat bottom airfoil

- much camber (mid-line is curved)
- Often used on trainers and Cubs
- Good at low speeds



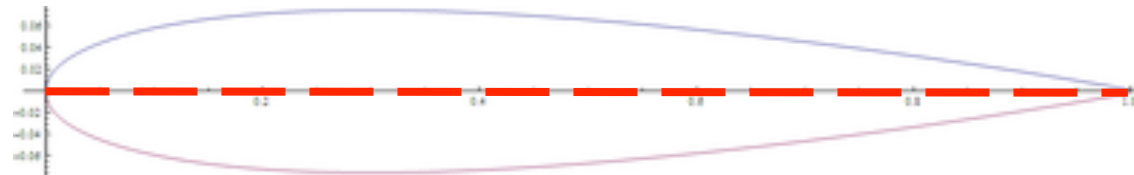
“Semi-symmetrical” airfoil

- has some camber
- sometimes used on trainers
- Good all-around airfoil



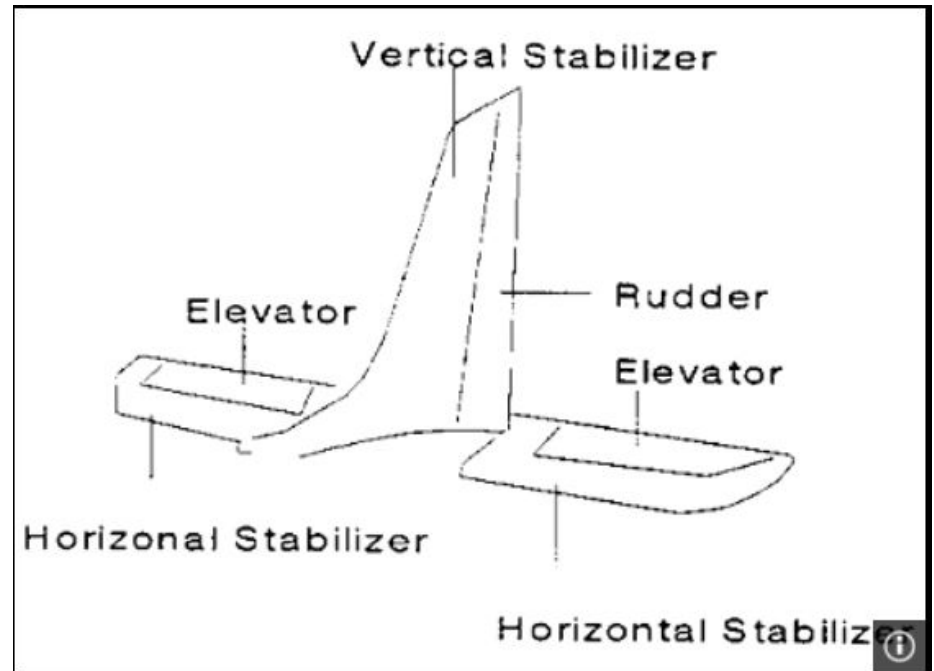
Symmetrical wing

- Zero camber - mid line is straight
- Used on aerobatic airplanes



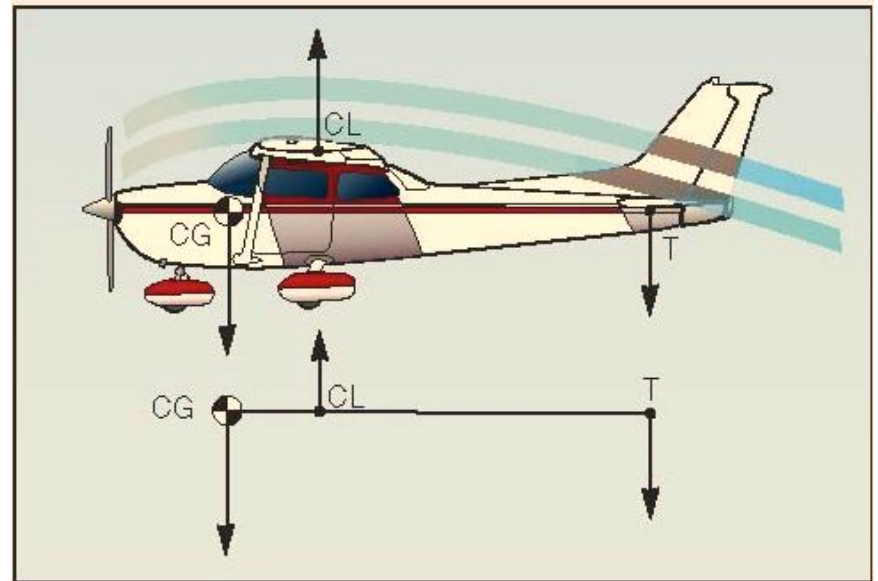
Empennage (The tail Group)

- Large tail surfaces, longer aft fuselage, and relatively small elevator and rudder result in a smoother, more stable airplane.



Balance and Pitch Stability

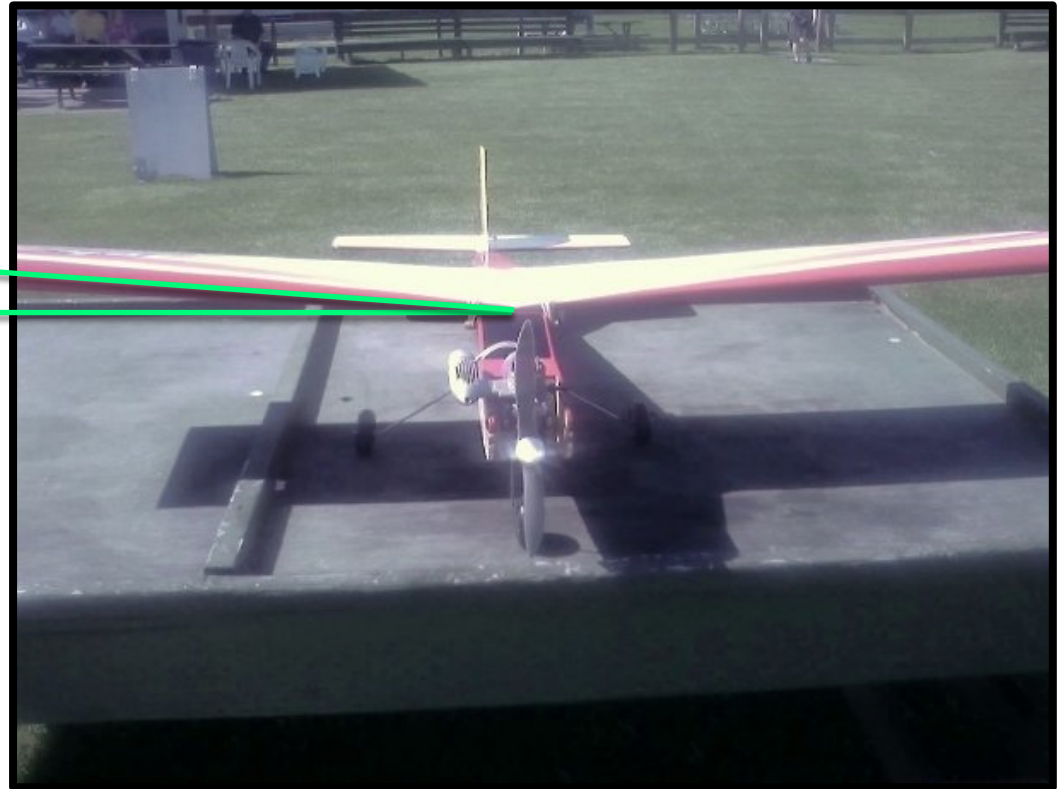
- A stable trainer type airplane will have the balance point, or center of gravity (CG) ahead of the center of lift.
- ALWAYS make sure your model balances at the point recommended by the manufacturer.



Roll Stability

- Dihedral effect helps to right the airplane in roll, making it easier to fly

Dihedral angle



- A zero dihedral high wing airplane will still have some dihedral effect
- Swept wings have dihedral effect
- Aerobatic airplanes usually have zero dihedral so they also fly well upside down

Section 5

Flying Lessons!!

(Flight Instruction and Flying Techniques)

MAR/C
R/C FLIGHT TRAINING
STUDENT
LOGBOOK

Student Name _____

AMA# _____ FAA# _____

Phone Number _____

Training Log used by Your Instructor

STUDENT NAME: _____ MAR/C FLIGHT TRAINING LOG

D = Demonstrated P = Practiced X = Proficient

Phase 1 – Pre Flight and Taxi

PHASE 1 - PRE-FLIGHT AND TAXI

Pre-flight inspection by student															
Before Takeoff Checklist - B A T T C *															
Taxi															
Callouts															

Phase 2 – Basic Orientation and Pattern

PHASE 2 - BASIC ORIENTATION and PATTERN

Trim for Level Flight															
L-R Wing Rock flying toward pilot															
Level Turns, High Oval Pattern															
Climbing Turns (by adding power)															
Descending Turns (by reducing power)															
Rectangular High Pattern															
Rectangular Low Pattern															
Figure 8's (introduction)															

Phase 3 – Approach and Landing

PHASE 3 - APPROACH AND LANDING

Slow Flight, Stall, and Recovery															
Trim at approach speed															
Demo appch pattern visual cues - Left															
Demo appch pattern visual cues - Right															
Stabilized Approach															
Go-Around - controlled, straight ahead															
Flare and Touchdown from Left															
Flare and Touchdown from Right															
Approach in Crosswind															
Dead Stick Landing															

Phase 4 – Takeoff

PHASE 4 - TAKEOFF

Straight line on takeoff roll															
Controlled rotation and liftoff															
Straight ahead climb															
Takeoff in Crosswind															

Phase 5 – Advanced Orientation

PHASE 5 - ADVANCED ORIENTATION

Figure 8's with good altitude control															
Demo ways to regain orientation															
Loop															
Immelman turn & Half Cuban-eight															
Roll															

Flight Number >>

DATE

INSTRUCTOR INITIALS

* B A T T C : Battery (transmitter), Antenna position, Trim, Timer ready, Controls

Phase 1

Pre-Flight and Taxi

- Pre-Flight Inspection
- Before Takeoff Checklist
- Taxi
- Callouts

Pre-Flight Checklist

Before before powering up on every flight, you, the student, should check at least the following:

- Radio installation secure (before you close up the plane)
- Wing secured with proper number of rubber bands
- Control surfaces secure: Linkages, hinges, and servos
- Engine & Prop: secure, prop not damaged
- Electric: Recently charged and fully charged battery, well secured in the plane
- Gas or Glow: Check fuel hoses secure, tank full
- Do a range check, before a model's first flight, or if any part of the radio installation has changed

Note: This checklist is not the same as the much more comprehensive pre-flight inspection checklist that we use before the first flight of your airplane with the training program. This checklist is a shorter version for you to use before every flight

Before Takeoff Checklist

This habit will save your airplane someday

After the plane is powered up, but before taking off:

Battery (*transmitter battery “in the green”*)

Antenna (*transmitter antenna placement
– NOT pointed at the airplane*)

Trimms – *set correctly*

Timer – *ready to be started, right amount*

Controls – *Check operation and DIRECTION!*

Do Controls check for both student and instructor



Phase 1

Tell Other Pilots What you Intend using Standard Callouts

- “Coming out on the left” (or right)
- “Taking off Left to Right” (or Right to Left)
- “On the Field” and “Clear of the field” (for a person)
- “Airplane on the Field” (stuck or engine quit)
- “Touch and Go from the Left” (or Right)
- “Low pass from the Left” (or Right)
- “Landing from the Left” (or Right)
- “Field Clear” (after you or your plane is off the runway)”
- “Deadstick, Deadstick” (engine failed, need immediate landing)

Phase 2

Flight Pattern and Basic Orientation

- Trim for level flight
- L-R Wing Rock Flying Towards Pilot
- Level Turns, High Oval Pattern
- Climbing Turns (by adding power)
- Descending Turns (by reducing power)
- Rectangular Pattern
- Figure 8's (introduction)

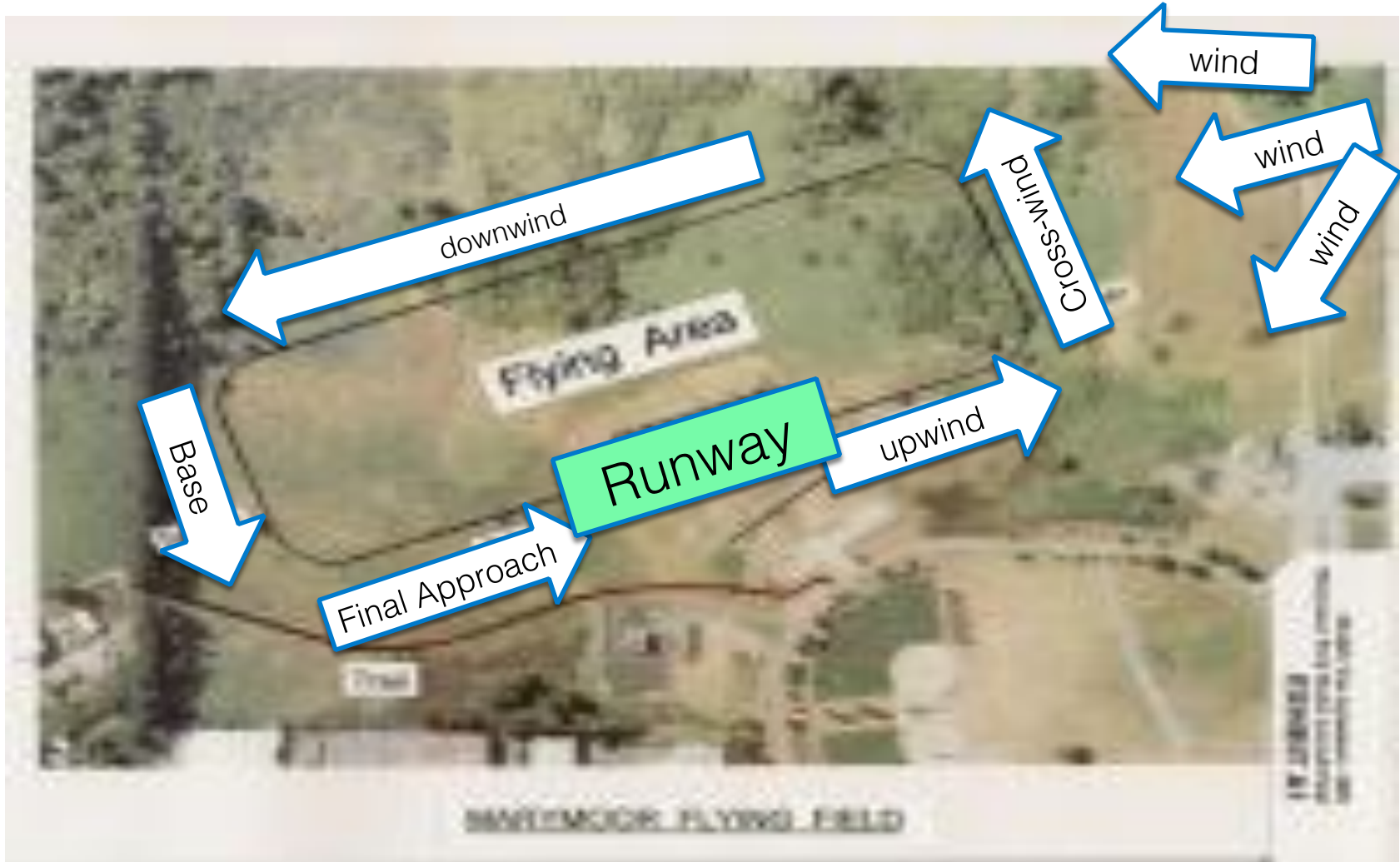
Trimming

- On your first flight, you and your instructor will *trim* your plane in level flight by adjusting the trim controls until the airplane flies straight hands off
- This makes the airplane MUCH easier to fly.
- **Airplane should be trimmed at about 1/3 to 1/2 throttle for a relaxed pace, a longer flight, and consistent handling during approach and landing.**

Orientation

- Left and Right will seem reversed when the airplane is coming toward you
- What can you do to learn to deal with this?
 - Turn your back to the plane and look over your shoulder
 - Wiggle the wings Left and Right with aileron when the plane is flying toward you on the upwind leg
 - Talk while you fly, i.e. “I’m now turning LEFT, I’m now rolling RIGHT to stop the turn”, etc.

The Flight Pattern



Level Turns

- On your first flights, you will work on flying the pattern, with four 90° turns, or two 180° turns
- An airplane does NOT turn like a boat or car. Holding the ailerons too long will result in the plane rolling over onto it's back
- To initiate a turn, “poke” in some aileron for less than a second (think “one potato”) to establish a 30-45 degree bank angle, then return the ailerons to neutral.
- As soon as the bank angle is established and ailerons are at neutral:
 - Ease back on the stick (up elevator) to compensate for altitude loss that will result from the bank angle.
 - A good trainer will hold the bank angle, and pulling on the stick will feel like the airplane “carves” a nice, level flight turn.
- When the airplane has turned enough, you must stop the turn by applying opposite aileron (with a “one potato” poke) to level the wings. Remember to stop the elevator input too.

Climbing and Descending Turns

- Climb by adding some power. The airplane will climb in a controlled way
- Descend by reducing power. The airplane will descend without gaining a lot of speed.
- Try descending using NO power. Be a glider.
- Using only elevator to do climbs and descents will result in big changes to speed, which will in turn cause changes in pitch.

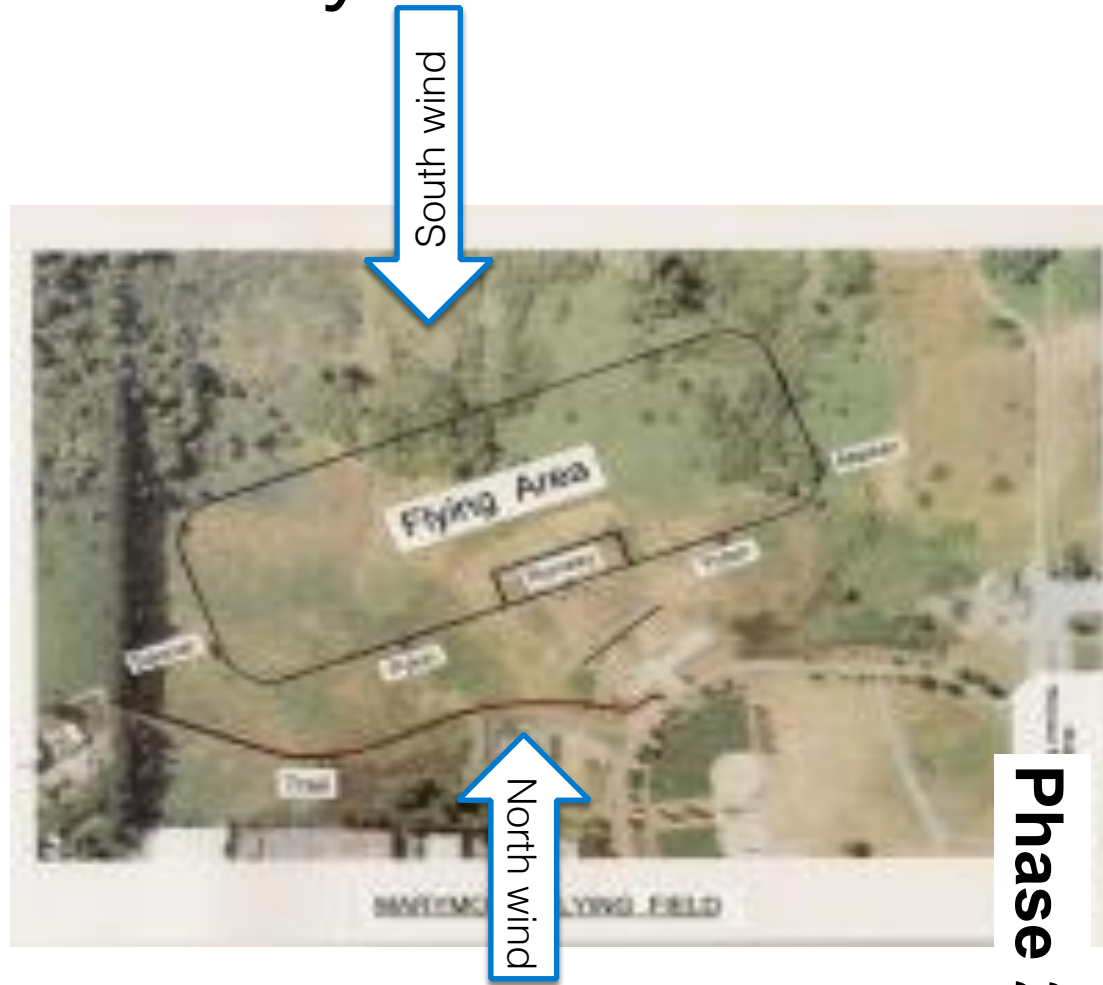
Figure 8's

- Fly in a gentle circle in front of you, focusing on altitude control.
- When the airplane is pointed at you, reverse your roll angle to enter the other circle, and so on.
- This maneuver improves your skills best if the cross-over is done with the airplane pointed at you



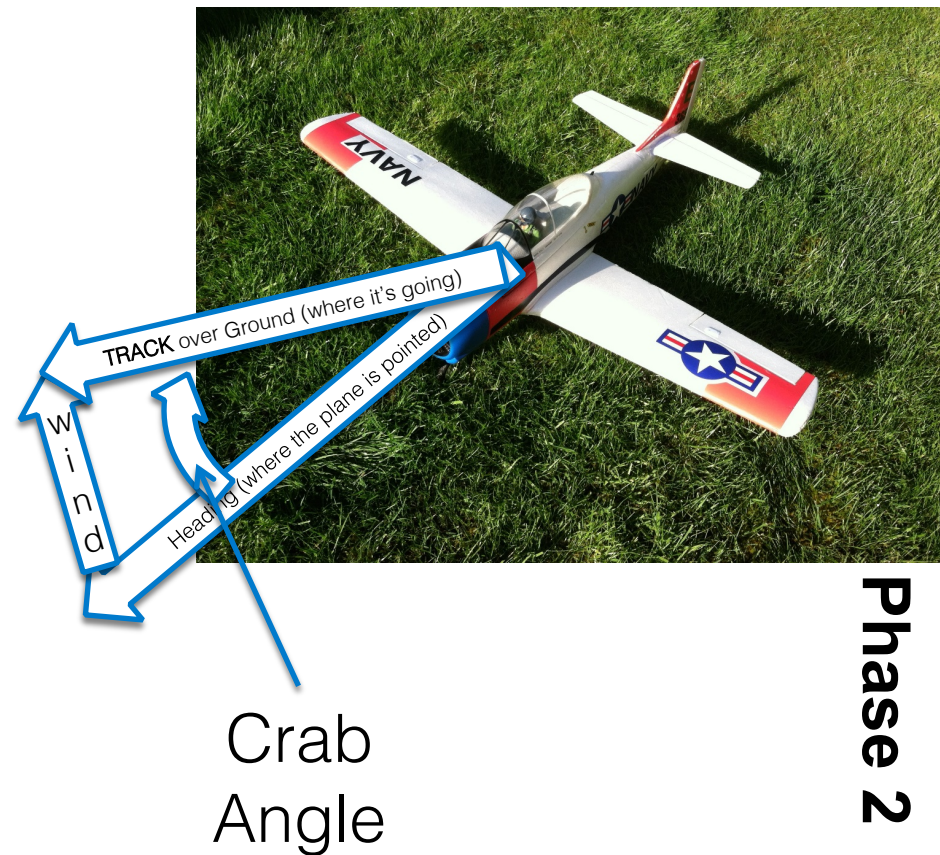
Wind at Marymoor

- Usually on nice days the wind is from the right (West)
- But we can have crosswinds, coming from behind us (north winds) in fair weather. If the weather is poor or changing to poor, we often have south winds, resulting in crosswind coming toward us.
- Check our our personal weather station! (link on the website)



Crab Angle

- In wind, where the airplane is *pointed* is not where the airplane is *going*.
- The pilot does not need to hold rudder to maintain a crab angle.
- Simply make a turn to fly on the *heading* that results in the desired *track* over the ground.
- The airplane does not “feel” the wind. It is simply flying in a body of air that is moving with respect to the ground.



Flying the Pattern in Wind

- Judge the start of your turns. The legs of the pattern last longer or shorter depending on wind direction.
- Judge the end of your turns. Turn a little further, or a little less far to anticipate the crab angle for the leg you are flying into
- Crosswind and base legs might just become 180 degree turns when the wind is behind the airplane.
- While flying the longer upwind or downwind legs, watch to see if the airplane is drifting off course. If so, make a gentle turn to increase or decrease your crab angle.
- The same technique applies on final approach

Phase 3

Approach and Landing

- Slow flight, stall, and recovery
- Trim at approach speed
- Instructor demo approach pattern visual cues – left
- Instructor demo approach pattern visual cues – right
- Stabilized approach
- Go-Around – controlled, straight ahead
- Flare and touchdown from Left
- Flare and touchdown from Right
- Approach in crosswind
- Dead Stick Landing

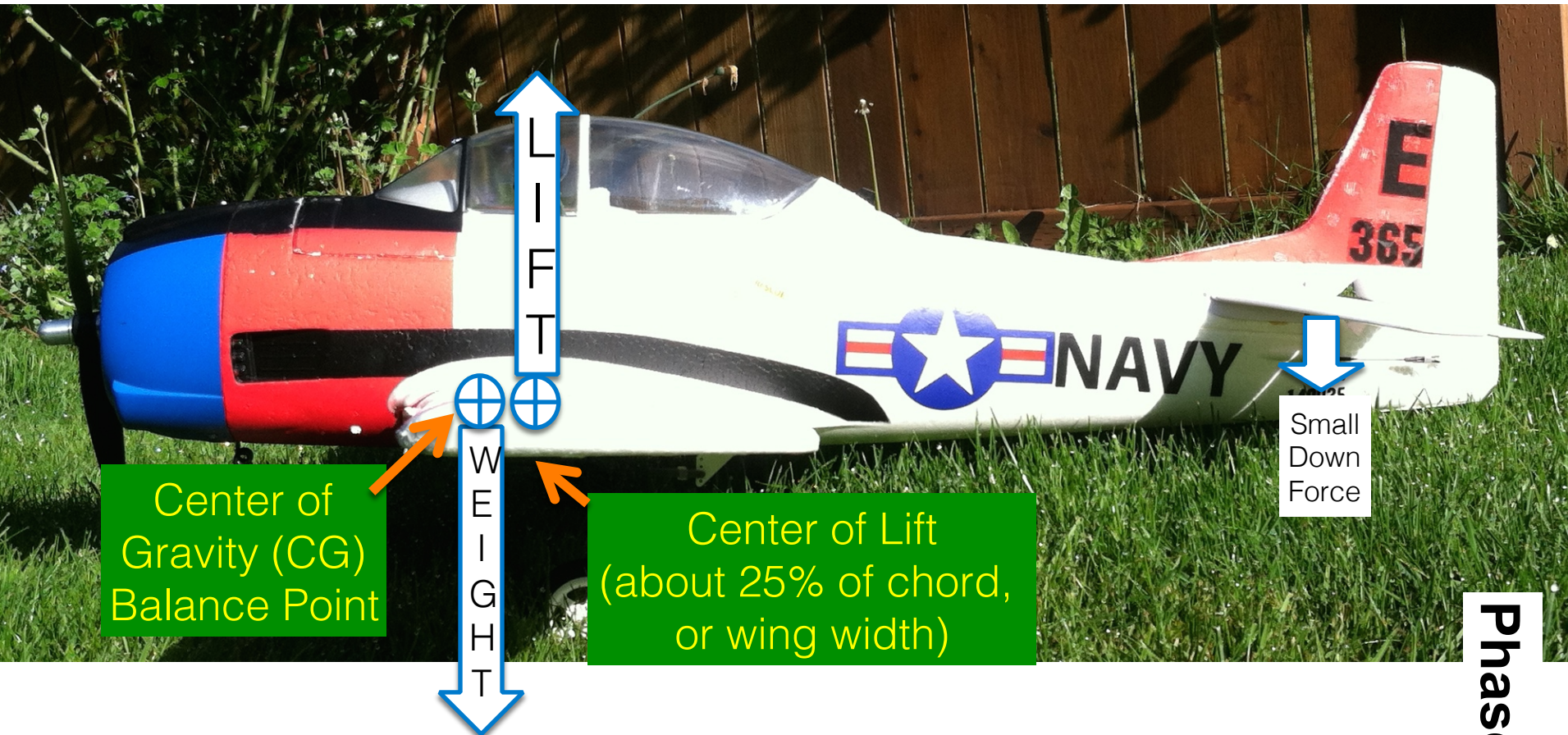
Slow Flight

- After you've mastered flying the pattern at a level altitude, learning how to fly the airplane very slowly will teach you about how pitch and power control speed and altitude
- Throttle back, and as the airplane tries to descend, counter that with some up elevator. Now your plane is flying slowly, while you hold elevator to keep altitude
- Try flying the pattern slowly. Turns will be tighter so you can use less bank angle. Whenever the plane tries to descend, smoothly add a little power while you hold the elevator. Reduce power smoothly if it tries to climb.
- Try this at different throttle settings to see how slow you can go and still maintain control of the airplane
- As you get good at this, you may find that using rudder to turn will be more effective, since the ailerons will be less effective due to slower airflow over the wings
- Don't worry, your instructor will make sure you don't stall, or recover if you do stall.

Stalls

- See the Wing Stall explained in Section 4
- As you slow further in slow flight by pulling back on the elevator and reducing throttle even more, you can get the angle of attack so high that the wing cannot “hang on” to the air anymore.
- The air is meeting the wing at the critical angle of attack.
- Lift will reduce and drag will increase
- Most trainers will just “mush ahead”, but with poor control because of low airspeed over the control surfaces.
- To recover, relax the elevator input and smoothly add power
- If one wing stalls first, the airplane will roll abruptly. In this case relax the elevator and input rudder or aileron to level the wings. Check for wing warps after you land.

Centers of Lift and Gravity



- Center of gravity must be ahead of the center of lift for the airplane to be stable in pitch (and speed)

The CG and Pitch Trim Determine the Speed the Airplane “wants” to Fly

- If the airplane is trimmed while flying fast at high throttle, then during approach at low throttle, it will try to fly fast by nosing down
- If the airplane is trimmed while flying slower, then it will want to fly at a better speed when on approach
- Trim elevator in level flight at $1/3$ to $1/2$ throttle to give a relaxed speed:
 - Slowing down increases your precious flight time
 - Gives you more time to think ahead of the plane, and correct for mistakes
 - Produces a comfortable and consistent approach speed
- This works well for stable trainers and scale airplanes with cambered airfoils and CG ahead of the center of lift.
- CG further aft and symmetrical wing sections on aerobatic airplanes enable them to be trimmed the same at all speeds. Throttle and elevator are used to control speed and altitude on final approach. This is a different technique that experienced flyers are comfortable with.

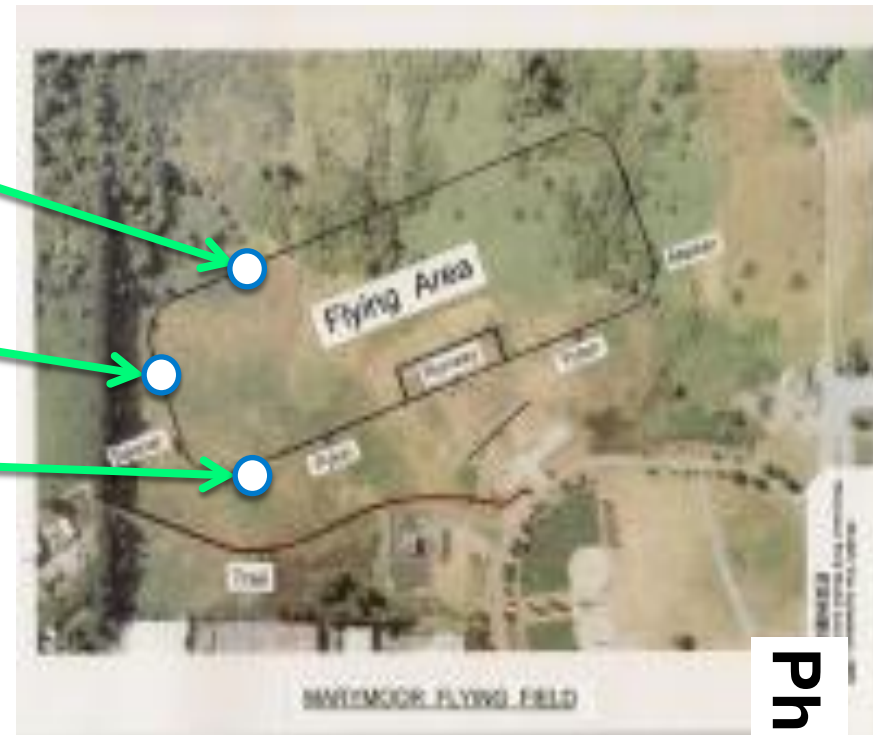
Getting Ready for Landings

- Thinking Ahead of the Plane

- Think WHERE you want the plane to be in 10, 20, and 30 seconds from now.
- What STATE you want the airplane to be in 10, 20, and 30 seconds from now, i.e. high and fast or low and slow?
- Make a plan in your head to get you there

Low Pattern – Getting Ready for Landings

- Reduce power a little on late downwind, starting at the same altitude and location every time. Consistency is key here.
- Turn to the base leg and level the wings
- Make another power reduction. Keep a little daylight between your airplane and the trees.
- Turn onto final. Ensure the right landmarks are behind the airplane, so that it approaches the runway on centerline. If you turn too late, just continue the turn until you get to the centerline. Don't rush or increase the bank angle!
- Fly straight at yourself (initially), shallow descent, relaxed speed.
- At about 10 feet high, do a missed approach (“Go-around”). Smoothly add power and climb to that same altitude and repeat the process



○ Power Reductions
(for approach from your left)

Approach Pattern Visual Cues

- From the Left
 - Base leg just above the tree line
 - Turn final just before the gap in the trees where you can see the apartment buildings. This will line you up right over the checkerboard
- From the Right:
 - Judge the height of the base leg from your experience approaching from the left
 - Turn final so that you are above the checkerboard

The Stabilized Approach

Key to a Good Landing

A stabilized approach is:

- Flying in a straight line, wings level, toward the landing zone, parallel to the runway centerline. Your airplane appears above the checkerboard boundary marker.
- Descending steadily toward the landing zone – your airplane appears a bit below the top of the trees
- Make shallow turns to stay on the centerline. (more about crosswinds later)
- When landing from the left, you want the plane to be about 1/3 of a tree below the top of the tree line on Final Approach



Phase 3

The Stabilized Approach

Key to a Good Landing

(continued)



- If low, add a little power. If high, reduce power
- Changing altitude with elevator at this point will de-stabilize the approach, and you will find yourself “hunting” up and down with elevator.
- If you trimmed your plane earlier to fly at a relaxed pace (about 1/3 throttle), the airplane will tend to seek a nice steady not-too-fast approach speed, and not much elevator will be needed.

The Missed Approach or Go-Around

- You will practice many go-arounds before learning to land
- go-arounds also prepare you for takeoff skills
- If the approach is un-stabilized, the landing will be lousy too!
- Go-around if the approach doesn't look stable
- **Go-arounds are free. Bad landings are expensive!**
- **Full scale pilots train the same way.**

Executing the Go-Around

- During the approach, don't stare only at the plane. This can cause you to forget where the plane is with respect to the runway while you focus on control.
- Quickly glance at the runway end now and then to enhance your awareness of the overall situation.
- Know where on the approach (height and position) you will decide to continue to land, or go-around
- Then....to go-around,
 - Smoothly but promptly add about $\frac{1}{2}$ power.
(Since you are slow (at approach speed) DON'T add full power rapidly. A rapid roll to the left might be the result.)
 - Fly the airplane
 - establish a shallow, steady climb
 - make it go straight on the runway heading

The Touchdown (Finally!!)

- If your approach has been stable, continue the glide
- Glance at the ground quickly as the plane crosses the runway threshold to orient yourself
- Cut the power to idle at the runway threshold, if it is not there already
- When the plane is 2-3 feet above the runway, raise the nose slightly, just enough to slow the descent
- As the plane slows, it will descend again. Raise the nose a little once more, and wait for it to touch down.
- Don't forget to steer the plane with rudder after touching down!

Recovering from a bad Landing

- If you flare too high and the plane is nose up and losing speed, add power and go-around to avoid a stall
- If you bounce a little, and the nose is up less than about 15 degrees, just hold it there and wait for the next touchdown
- If you bounce a lot – if the nose goes up, add some power and go-around to avoid a stall
- Flare and touchdown are difficult if you fly the approach too fast or too slow. This is why we trimmed the elevator for lower speeds earlier.

Approach and Landing in Crosswind

- RC flying techniques based on full scale flying are described in articles and online requiring use of rudder and opposite aileron to produce a “forward slip” to counter the crosswind while keeping the fuselage parallel to the runway. For landing on narrow, paved runways with larger planes, these techniques might be necessary – but they are difficult to master.
- At Marymoor, we have a huge, wide, grass runway. You still want the discipline to land on the centerline, but an easier technique can be used.
- Simply make small turns (with no special use of rudder) during the approach to achieve a **crab angle** (see slide in Phase 2) that results in the airplane following an imaginary extended runway centerline.
- In the flare and touchdown.
 - Very close to the ground, the airplane flies into the “boundary layer”, and the wind decreases.
 - Grass is tolerant to the airplane landing a little sideways, so don’t worry about a crab angle
 - Hold aileron into the wind after touchdown to counter the wind “picking up” the upwind wing
- In high winds, flying a somewhat faster approach might help provide needed control, and some margin to stall in case a gust comes from behind and robs your airspeed (known as windshear)

Phase 4 - Takeoff

- Straight line on takeoff roll
- Controlled rotation and liftoff
- Straight ahead climb
- Takeoff in crosswind

Instructors Note!

- Experience shows we have the most training accidents and damaged airplanes doing takeoffs.
- Takeoff is best taught *after* the student has practiced go-arounds in Phase 3.
- If the student over-rotates, or rotates while steering with a rudder input, the instructor may not have enough time to save the plane.
- Teaching go-arounds first ensures that the student knows how to smoothly pitch up, and fly a straight-ahead climb in wind

Straight Takeoff Roll

- Get lined up. Use the middle of the runway
- Hold about 1/3 UP elevator
- Smoothly advance power to $\frac{1}{2}$ or more
- Steer straight with the rudder – think ahead, and be smooth. The plane may want to turn left due to propeller effects, or it may try to turn into the wind.
- If the airplane steers badly, ABORT the takeoff (throttle immediately to idle).

- Never hastily pull the airplane into the air.
- Never pull into the air with a large rudder input present. The immediate snap roll will ruin your day!

Takeoff Rotation

- The airplane will rise when it's ready, with enough speed, if you are holding some UP elevator. If it doesn't add a little more gradually.
- When the plane lifts off, immediately relax the UP elevator and set a shallow climb to build speed
- The airplane may want to turn left. Don't let it!
 - With a crosswind, this can become a downwind turn and stall close to the ground. Force it to fly straight, just like full scale pilots do.
- Climb out straight and steady. Build speed. When settled, start your turn to the crosswind leg

Taking off in Wind

- Take off into the wind! If others are not, make your callouts clear and loud.
- Steer with rudder, but be ready for the plane to weathercock into the wind during the takeoff roll
- For crosswinds, hold some aileron into the wind during your takeoff roll.
- Be ready for the wind to “pick up” your upwind wing, and correct for it.
- After liftoff, ease out the aileron, but gently make a small turn into the wind until you achieve a crab angle so that the airplane flies the runway centerline.
- ***NEVER lift off with a large rudder deflection. This will likely cause an immediate snap roll.***
- ***If it doesn't look good and straight on the ground, abort the takeoff roll.***

Phase 5

Advanced Orientation

- Figure 8's (again)
- Instructor demonstrate ways to regain orientation
- Loop
- Immelman Turn
- Roll

Figure 8's

- Fly in a gentle circle in front of you, focusing on altitude control.
- When the airplane is pointed at you, reverse your roll angle to enter the other circle, and so on.
- This maneuver improves your skills best if the cross-over is done with the airplane pointed at you

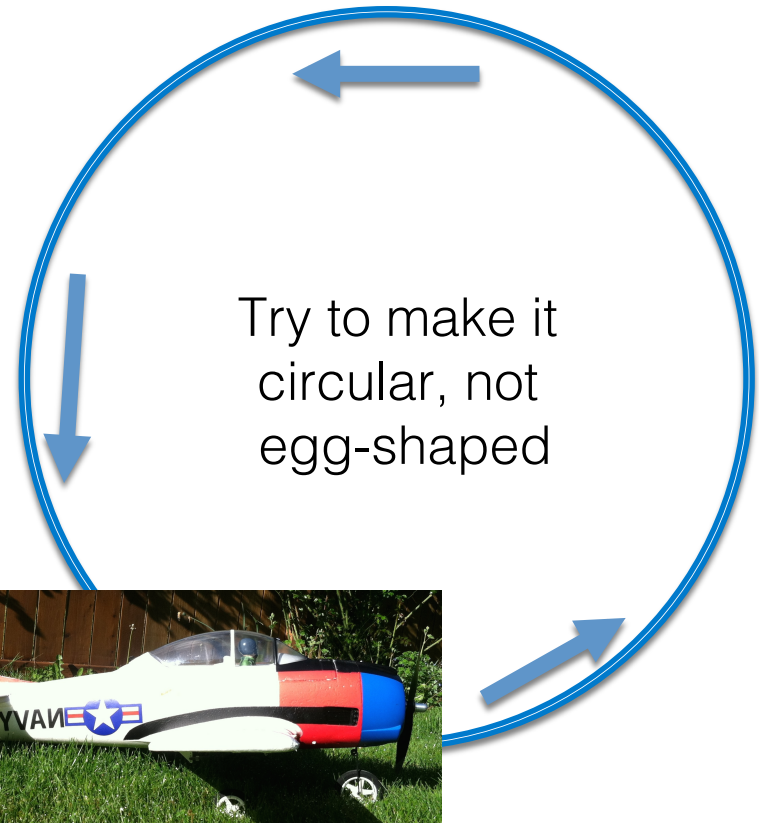


How to Prevent loss of Orientation, and Regain Orientation

- Prevent loss of orientation:
 - Think ahead. Plan where you want the airplane to be in 15 seconds.
 - NEVER fly directly overhead or behind yourself
 - Always remember where you just were a second ago and what you were doing.
 - If the plane is getting too small, don't wait – take action to fly back to you.
- Is it coming or going? Rolled left or right?
 - When the silhouette confuses you, making a roll input will help

Loop

- Fly straight with wings level and plenty of speed and power
- Pitch up smoothly and apply full power
- At the top of the loop, pull power back to idle so you don't get too fast coming down
- Continue pitching smoothly
- Add the power back in at the bottom



Immelman* Turn



Roll
Upright



- Enter just like the loop
- At the top of the loop, neutralize elevator.
- Then roll upright



* Named for Max Immelman, German WWI ace

Half Cuban Eight

Learn to roll first when recovering from a dive

- Just like the Immelman, but,
- Neutralize elevator a bit later - on a straight 45° down line
- Roll upright
- Pull out of the dive



Pull up



Roll Upright



Phase 5

Roll



Level Flight



- Nose up
- Then, Neutralize Elevator



- Full Aileron
- Roll all the way around



Recovery From Extreme Attitudes

- Later in your lessons you will learn to recover from from very steep climbs or dives, and very steep bank angles, even upside down.
- When you are surprised by an extreme *attitude*, your objective is fix the problem with the smallest loss in *altitude*, i.e. don't hit the ground!
- Nose high: push elevator nose down to prevent the stall
- Nose low: Reduce power to avoid building too much speed, and pull out of the dive with elevator. Pulling too hard or too suddenly can cause a stall.
- High bank angle or upside down: Roll to **level the wings first**, then correct any dive with elevator. Do not pull elevator until the wings are nearly level.
- Memorize what Pitch, Roll, and Yaw are so you and you instructor can communicate effectively.

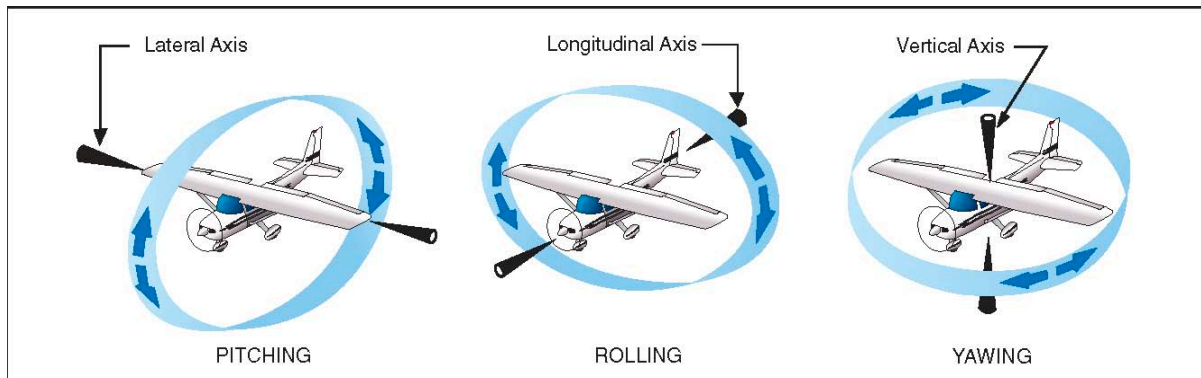


Figure 3-9. Axes of an airplane.

Flying in Gusty Weather

- Gust means that the wind speed and/or direction change rapidly
- Wind is usually stronger higher up
- Gusts may be stronger nearer the ground where the wind whips around obstacles
- Try not to fight every gust too hard. It is possible that the next gust will put the plane back in the direction you want.
- If your trainer has artificial stabilization modes like “Beginner”, “Intermediate”, and “Advanced”, choosing the Intermediate mode will help the airplane fight some of the gusts for you.

Recovery from mishaps

- Mental – don't worry everyone does it! You will learn, and fly again.
- Repair – You can fix almost anything if you are determined, and ask for help and advice.
- Ask your instructor to teach you dead stick (power lost) landings
- If your airplane goes down:
 - Put your throttle to idle immediately to avoid damage to the ESC, or to an engine.
 - Other pilots at the field are likely to see where it went down. Get someone to go with you. The tall grass and vegetation make finding the plane difficult. Wear long pants. There are nettles out there!
 - Take your transmitter with you so you can wiggle the controls and make a little noise. At Marymoor, putting a beeper in your plane is a really good idea.

Skills to Refine before your Solo Check Flight

- Thinking ahead of the plane
- Awareness of boundaries
- Smooth flying for all skills
- The stabilized approach – Key to good landings
- Approach and landings from both directions
- Smooth Go-Around with control of your heading
- Touch down where you planned to
- Flying in Wind
- Figure 8's with good altitude control
- Simple aerobatics and recovery from extreme attitudes

Proficiency Check Flight

- You will fly multiple instructors during training. When you are ready to fly solo, you will fly with two instructors for two flights. These flights will be done without a buddy box.
- In each flight you will be required to:
 - Demonstrate a before start check of your model
 - Taxi
 - Demonstrate a pre-takeoff check
 - Make appropriate callouts
 - Takeoff and climb out straight ahead
 - Fly a rectangular pattern in level flight
 - Do a stall, and recovery with minimum loss of altitude
 - Fly a figure eight showing good altitude control
 - Fly a stabilized approach and a missed approach from both left and right
 - Fly an approach into the wind, and land

MAR/C Proficiency Check Quiz

Page 1 of 2

1. Name the national organization that guides and self-regulates flying models.
2. Name the federal agency with legal authority that regulates flying models.
3. What information should you to have marked inside or on your model?
4. Under the FAA sUAS (Small Unmanned Aircraft System) program, what altitude should you not exceed?
5. How far must you be from an airport when you fly?
6. When performing a pre-flight (before start) inspection what are you going to inspect?
7. In addition to the pre-flight (before start) check, what is your before-takeoff checklist?
8. How many pilots are allowed to fly at any one time at the Marymoor Field?
9. Are you allowed to fly behind the pilot stations with your model?

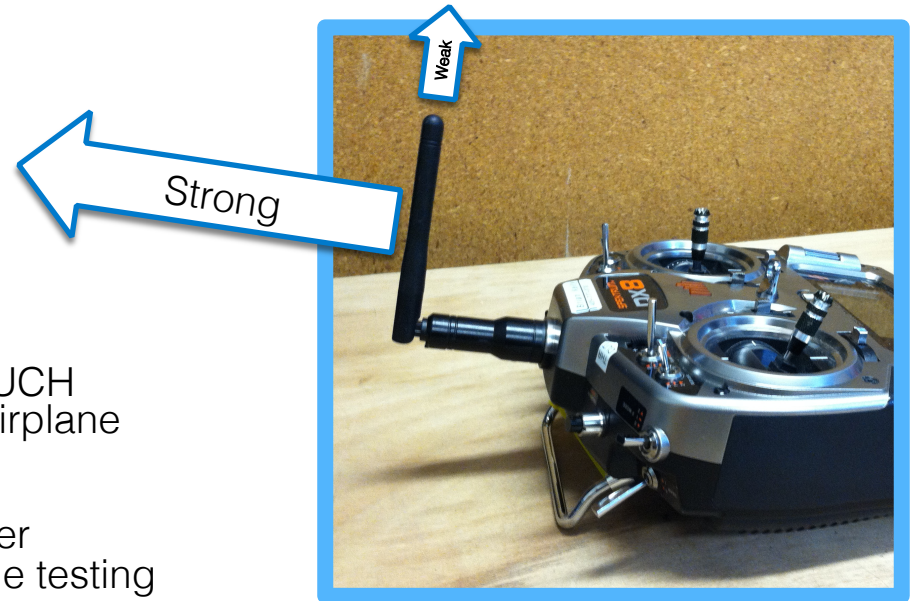
MAR/C Proficiency Check Quiz

10. Can you explain the markers that define the Marymoor flying boundaries?
11. What park areas are just outside our boundaries? Why must we stay inside the boundaries?
12. When flying, what callouts are you expected to make?
13. When are you allowed to fly a low pass over the landing area?
14. Before plugging in a battery on an electrically powered aircraft:
 - a. The throttle lever on the transmitter should be where?
 - b. The T_____ C__ switch on the transmitter (if available) should be set to I n _____
 - c. The switch on the airplane for the ESC (if available) should be _____ ,
or the safety plug (if installed) should be un – p l _____.
15.
 - a. Before starting a gas or glow powered aircraft, it must be R e _____ e d.
 - b. An electric S_____ should be used to start the engine.
 - c. If starting by hand, a chicken S t _ _ _ must be used to start the engine.
16. Lithium polymer batteries can be a _____ hazard. They should be charged and stored in a _____
- proof container, such as a _____. They should be charged only by LiPo capable
chargers at the correct charge _____ for that battery.
17. What airplanes must pass a 90 db noise measurement?

Section 6

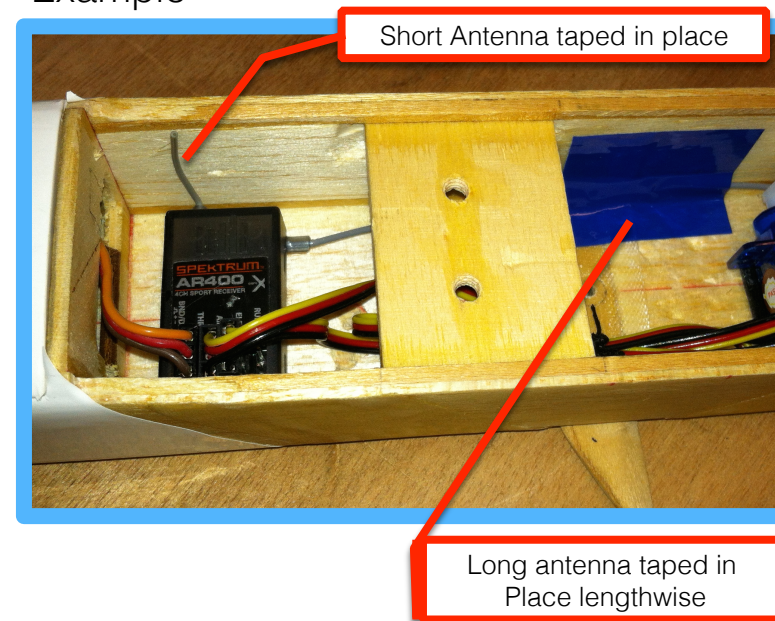
Radios and Electronic Speed Controls

Radio Antennas



- Transmitter - Correct Antenna Orientation
 - The signal from the SIDE of the antenna is MUCH STRONGER. “Pointing” the antenna at the airplane sends the WEAKEST signal.
 - For older 72 MHZ radios extend the transmitter antenna to it’s full length before flying or range testing the aircraft.
- Receiver – Correct Antenna Installation
 - The 2.4 Ghz antenna needs to be placed inside the model away from moving parts and wires
 - 2.4 Ghz antennae MUST be oriented 90 perpendicular to each other, and as far apart as wiring allows. Read your radio manual.
 - An older 72 Mhz antenna will be a long wire that will run the length of the model. Do not cut the length or tie in a large loop at the back of the model.
- Above all – READ your radio manual instructions

Example



Setting the controls for You

- Stick Forces
- Dual Rates
- “Expo”
- Aileron to Rudder mix
- Throttle cut



Stick Forces

- Stick forces on many transmitters are adjustable. Read your manual
- Increasing forces can help a lot with over-controlling early in the learning process
- One professional RC flight school even puts custom, stronger springs in their transmitters
- Control forces and Dual Rates are the first things to adjust if your instructor feels you are over-controlling.

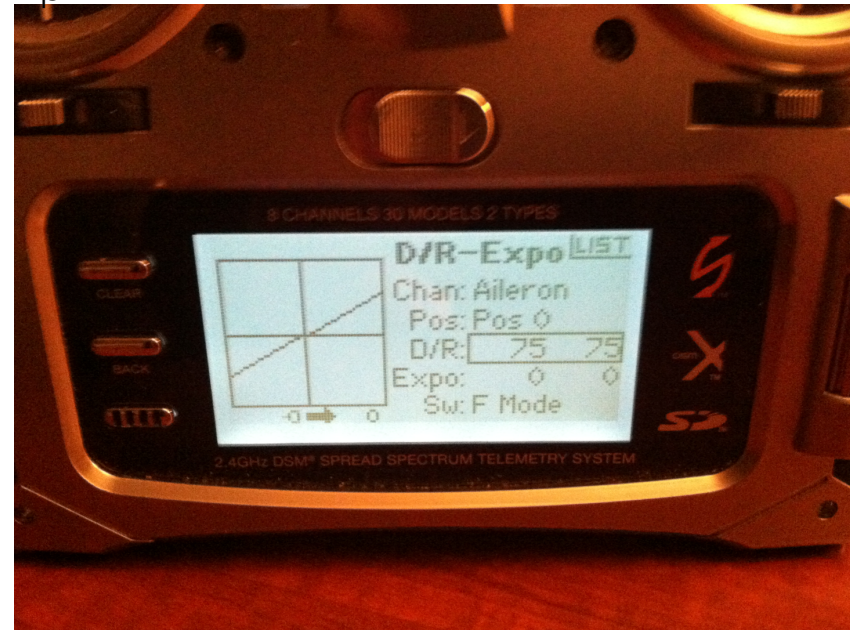


Dual Rates

- Sets up switches on the transmitter so you can select more or less control throw for Aileron, Elevator, and Rudder
- Generally start with the control throws recommended for your airplane
- For any first flight, it's a good idea to have options. Take off in low rates to begin with
- Rates too high, or too low can cause problems

- Even many simple transmitter may have a dual rate switch

Example of a programmable “computer” radio screen showing dual rate setup.



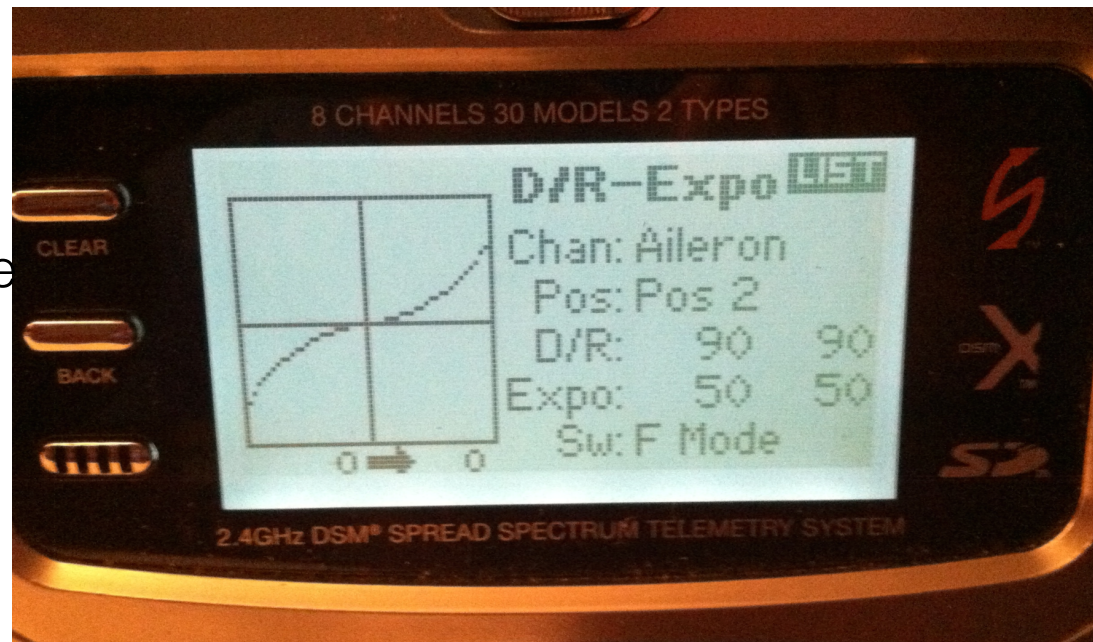
“Expo” (Exponential)

Expo can “soften” the response around neutral and help prevent over-controlling

- Mostly used for high performance 3D airplanes that would be difficult to control around neutral because of their very high control throws (rates)
- Can be used as you prefer for a trainer (not too much though – probably 30% or less)
- Not available on “simple” transmitters

- Expo is NOT the first choice to make an airplane handle nicer – adjust the throws (rates) first
- Too much Expo can cause difficult handling
- Expo the wrong way can be disastrous!
- Good” expo is a positive number on Spektrum and JR
- Good” expo is a negative number for Futaba! (Read your Manual to be sure)

Compare this curve to the straight line one the previous slide



Aileron-to-Rudder Mix

- Most radios (not the cheapest ones) can do this
- Causes rudder to move also when the right stick commands ailerons
- Setting the “gain” at 50%, so that rudder moves about half way when the ailerons are fully deflected, is about right for most trainers.
- Gives most trainers a smoother and more predictable response to a roll (aileron) command from the pilot.
- Make SURE that rudder moves Right for a Right aileron command (and similar for Left)
- SHOW THIS to your instructor before you fly
- You can put the mix on a switch so that you can take off normally, and then try the mix for the first time when at a safe altitude. And turn the mix off again if you don't like it.

Propeller Safety Features

Glow and Gas Engines

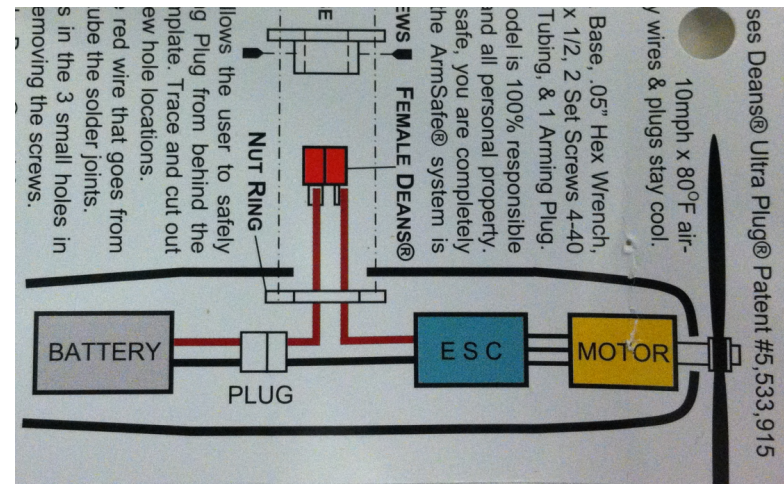
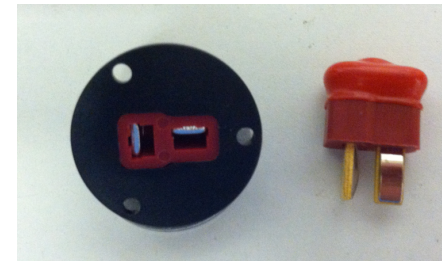
- Throttle Cut function enables a switch to tell the transmitter to send zero (or less) throttle no matter where the throttle stick is. Read the manual for your transmitter to program it.



- Used to stop “glow” or gas engines

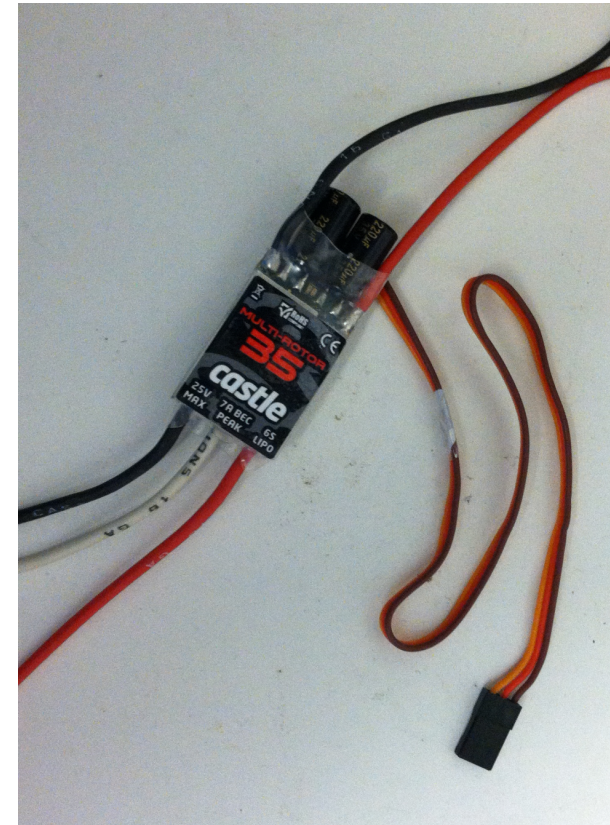
Electric Power

- Use Throttle Cut function if your transmitter has it. Assign the function to a switch that you won't bump in flight
- Use an ESC switch, if your ESC has one
- Or install a safety plug on the airplane like this one:



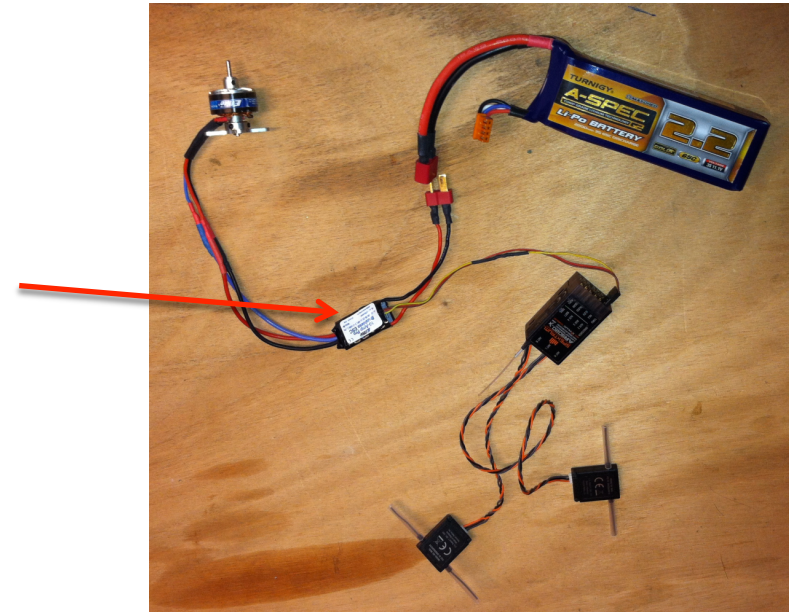
The Electronic Speed Controller (ESC)

- The ESC takes commands from your radio receiver, and tells the electric motor how fast to run by turning the power on and off very fast.
- It also powers your radio receiver, (larger planes often use a BEC and separate battery)
- If your propeller is ever blocked for any reason, like if the airplane noses over or runs into tall grass, immediately pull your throttle stick to idle to avoid damaging the ESC
- ESC's usually have safety features to prevent them coming ON when plugged in – but don't rely on that alone. Make sure your stick is at idle before plugging in
 - ALWAYS read the instructions for your ESC. There are differences between brands!



Battery Power for the Receiver and Servos

- Power to the receiver (and the servos) can come from either:
 - The ESC on an electric airplane, if that ESC has a BEC (Battery Eliminator Circuit) or
 - A separate battery, for gas and glow airplanes
- A separate battery for radio is sometimes also used on larger electric airplanes, to ensure control of the airplane even if the motor battery dies or if the ESC fails



Electric Motor and Prop

- The right prop is determined by the airplane size, motor size and type, battery, and ESC.
- The wrong prop diameter or pitch can cause excessive electrical current and damage the ESC or battery
- Use eCalc or other online tools, or a current meter to determine the right prop. If you don't know for your airplane, don't guess.



Section 7

Choosing, and getting help with your next
airplane

Get ready for your Next Airplane

- Fly with your trainer until you feel you have mastered it
- Pay special attention to stabilized approaches
- Get proficient with simple aerobatics

Choosing your 2nd Airplane

- Ask other pilots for their advice
- Choose a low-wing with some dihedral, or a high wing with less dihedral than your trainer
- Choose a slightly faster and more aerobatic airplane
- Park-zone T-28 is a good candidate
- Feel free to try a tailwheel airplane. Steering will be more challenging on takeoff, but the landing gear will be more robust.
- Avoid retractable landing gear. It is more fragile and more expensive. At this stage, you can still expect hard landings.
- 3D aerobatic planes, fighters, and ducted fans are good choices for the 3rd or 4th airplane

Get help before you fly the next new airplane

- Ask other pilots to look over the plane before first flight
- Consider having a more experienced pilot do the first flight to get the plane trimmed properly

Web resources

- Aerodynamics
- Building technique (you-tube)
- How to fix an ARF (look for you-tube help)
- YouTubes of stalls, downwind turns, classic stall-spin turning to final

Links

- [AMA Safety Code](#)
- [Know before you fly](#)
- [AMA](#)

Future topics

- Building from kits, plans, or scratch
- Assembling ARF's
- Hobby shop sessions - covering, hinging, radio installation, etc.
- Preflight, range checks
- First flight assistance, trimming
- In what ways will your second and third airplane fly differently
- What you should and shouldn't choose
- Wing Loading — what is it and why should I care
- Cubic loading, Reynolds number, other advanced topics
- Basic programming for a better flying airplane
- About wings and airfoils - different uses and characteristics
- Pushrods and control linkage geometry