Notes for the
2008 MCRCS Flight School Program

Open House

Open House Topic 1 – Introduction to RC Flight

What is Radio Controlled Flight?

A radio-controlled model is a real airplane:
- It obeys the same laws of aerodynamics that govern its full-scale counterpart.
- All the same controls are active.

But you fly it from the ground:
- You hold a radio transmitter in hour hands.
- It has a lever, knob, button, or switch for every flight control.

Flying a model is at least as challenging as a full-scale airplane because:
- You do it from a distance.
- Your orientation changes as the airplane turns.
- The ground is just as hard.

What Powers These Airplanes?

Glow engines:
- These are real internal-combustion engines, some generating several horsepower.
- They run on an alcohol-based fuel.
- They have glow plugs, rather than spark plugs, simplifying the ignition.
- They come in both two-cycle and four-cycle versions

Gasoline engines:
- These are often the same engines that power weed eaters.
- They run on gasoline, rather than glow fuel.
- They generate even more power.
- Most gasoline model engines are two-cycle engines.

Electric motors:
- They are powered by batteries.
- Big ones can generate as much power as the biggest gasoline engines.
- They're clean and very easy to start.

Modern batteries aren’t much heavier than fuel.
Batteries for big models can get very expensive.

What Controls Them?

Basic transmitter controls are on one or two joy sticks.
A sport radio will have at least one joystick for pitch and directional control.
A second joystick usually controls throttle and rudder.
You won’t need more than the four functions on the joysticks at first.

Additional controls may be in the form of knobs and switches:
You can control things like landing gear, flaps, lights, and a bomb release.
You can also change functionality, like control sensitivity.

Trim tabs or switches let you modify control settings.
You can trim a model to fly “hands off”.
The four joystick channels will have trims.

How Big are These Models?

Serious small models start at about a pound in weight and two feet in wingspan.
These are generally relatively inexpensive.
They can be every bit as exciting to fly as the big models.
They can be flown in a small area.
They are more affected by wind.
They’re less likely to impress your friends.

The average model at our club flying field probably weighs 5-10 pounds.
These need a large, relatively secluded field.
They are easy to see at a distance and the apparent speed is relatively low.
They can usually take off from the grass.
You’ll get the respect of your friends with a model of this size.

Giant scale refers to models with a wingspan of 80 inches, or at least a quarter scale.
We have a lot of these at our club.
On the ground, they’re really impressive.
In the air, they’re relatively docile and unaffected by the wind.
They require special knowledge and building practices to ensure safety.
Your friends will really take notice of a giant scale model.

Bigger models exist.
Generally, models are limited to 55 pounds.
Our club members have a 16-foot wingspan Jenny and a 12-foot span B-17.
Special permits allow larger models, be we don’t have any.
In Europe, they fly really large models, some exceeding 300 pounds.

The military has even bigger Remote Piloted Vehicles (RPVs)
These models will scare your friends.

How Hard is it to Build a Model?

Some come completely ready to fly.
They’re built and covered.
The radio is installed and tested.
They’re reasonably sized, some as large as five pounds.

Almost Ready to Fly (ARF) models are very popular.
They’re mostly built and covered.
Expect to spend 10-20 hours finishing an ARF model.
You generally have to glue wing-halves together, mount the engine, and install the radio.

Kits can take more time.
Some are literally a set of plans and a box of wood.
They can take a few hundred hours to complete.
Building is part of the enjoyment.
You can really customize the model.
You don’t save any money by building from a kit.
Build an ARF first.

How Much does it Cost?

As sports go, it’s relatively inexpensive.
Electronics are cheap
ARFs are cheap
Crashes don’t usually do that much damage.

A good basic trainer with radio will cost between $200 and $500.
Electric trainers don’t require much additional equipment.
Spare parts are usually available.
The radio equipment can be used in your next airplane.

Some things are a good investment:
A computer radio is easier to set up and allows advanced adjustments.
A transmitter with a buddy-box connection minimizes your chances of a serious crash.

You can spend as much, or as little, as you want:
One good transmitter is enough.
A few flight packs (receivers and servos) will let you have several airplanes.
Many serious flyers spend less that $500 per year on the sport.
Of course, some addicts (none of us) have $30,000 models in the air.

Open House Topic 2 – Simulated Flight

Flight Stations

Participants will have attended the Intro to RC Flight session and have a rudimentary idea of what it's all about. The objective of the simulated flight session is to give participants a taste of the sport and motivate them to explore it further.

Let each student attempt:

- Straight & level flight
- Pattern turns
- Loop
- Roll
- Immelman/Split S
- Landing

Open House Topic 3 – Getting Into the Sport

Why Do We Do It?

You can own a scale model for a very small fraction of the cost of a full-scale airplane.
- You can store it in your basement.
- You can work on it yourself.
- It's your airplane to be proud of.

Flying models is at least as much fun as full-scale.
- You get the same sense of exhilaration when you take off, land, or perform a maneuver.
- You do maneuvers you'd never do in a full-scale airplane.

You'll meet lots of people with similar interests.
- There's never a shortage of things to talk about.
- The conversation is never boring.

If you're really serious, you can make a living in the field.
- A substantial commercial infrastructure supports the sport.
- Some flyers have applied their skills for the military flying UAVs.

In the end, we do it because we love it:
- The building.
- The flying.
- The camaraderie.

Join the Academy of Model Aeronautics (AMA)

Membership has its advantages:
- A monthly magazine that's not all fluff.
- A lobbying organization to promote and protect the sport.
- $2,500,000 of liability insurance, should the worst happen.
- It's required to join a club.

It's not very expensive:
- Full adult membership is $58 per year.
- Junior (under 18) membership is $1 per year (Yes, that's a one — with magazine it's $15).

Join our Club

A club has a field.
- The field is designed for flying, not for parking cars or growing grass.
- It's big enough that you can fly almost any model you want.

A club has members.
- These are people who, like you, are aviation enthusiasts.
- They love to talk about aviation and the RC sport.
- They have been in the sport for a long time and know how to do things that confuse you.

A club has designated instructors.
- Instructors not only love to fly, they love to teach.
- The fact that they’re designated means their peers find them competent to teach.
- The can give you tips and pointers you may not figure out by yourself.
- They will save your plane from almost certain destruction.

A club has activities.
- Building contests
- Flying contests
- Aerial combat contests
- Family picnics
- Charity events
- Airshows

Ground School

Ground School Topic 1 — Airplanes and Flight

Parts of an Airplane

Fuselage – Main “Body”

Wing – Produces Lift and holds ailerons

Empennage – Tail group (fin, rudder, stab and elevator)

Fin – Fixed vertical piece that holds rudder

Horizontal stabilizer – Fixed horizontal piece that holds elevator

Rudder – Moveable control surface for yaw control

Elevator – Moveable control surface for pitch control

Ailerons – Moveable control surfaces for roll control

Lift

Wings provide lift when air flows across their surfaces.
- The wings and tail provide the lift required to balance weight.
- Wings change the direction of airflow producing lift, drag, and downwash.

Drag

Drag is a downside of creating lift – You can’t have lift without it.

Engine thrust overcomes drag.

Drag can be reduced by streamlining
- Wheel pants
- Cowling around engine
- Smooth surface
- No supporting struts, wires, etc.
- Good flying technique reduces drag too

Thrust

Thrust is needed to balance weight and drag, and…
- It also influences rate of climb
- The pilot controls thrust with throttle

A power source is needed to cause forward motion
- Gravity works as a power source too.

Axes and Flight Controls

The direction of plane is controlled about 3 axes:
- Pitch (lateral)
- Yaw (vertical)
- Roll (longitudinal)

The pilot moves control surfaces to change lift-balance:
- Ailerons asymmetrically change the wing’s lift to cause roll
- Rudder changes the fin’s sideways lift to produce yaw left or right
- Elevator changes the stabilizer’s lift to result in pitch up or down

Elevator controls pitch
- Pilot controls airspeed by changing pitch/angle of attack
- Holds plane in turn when banked
- Adjusts angle of attack to compensate for changing forces (i.e., when banking or inverted)

Rudder controls yaw
- On some models it can be used for turning if no ailerons;
- On others, use of the rudder will just cause the airplane to fly sideways.

Ailerons control roll
- Turning is done by rolling (banking)
- Ailerons move in opposite directions
- The aileron moving down increases lift on that side
- The opposite aileron, moving up, decreases lift.

Using Lift to Turn

You can turn an airplane by lifting it sideways, that is tilting it and pulling up, but…
- Since some of the lift goes sideways, you need to add lift to counter the weight, and…
- More lift means more drag means more thrust!

Aerodynamic Stall

A stall doesn’t mean that the engine quits.
- The engine can quit and the plane won’t stall.
- In a stall, the wing quits flying (generating lift).

A stall is a loss of lift caused by too great an angle of attack.
- Speed decreases as angle of attack increases.
- Prior to a stall, lift still balances weight.

Above a critical angle of attack, a full stall occurs:
- Airflow changes from smooth to burbling, turbulent stream
- Lift drops sharply – no longer balances weight
- Plane loses altitude and the pilot may lose control

Ground School Topic 2 — Radio Control

The Basics of Radio Control Systems

All radio systems have a few things in common:
- A transmitter to send signals from the ground.
- A receiver in the model, to recognize those signals.
- Actuators (e.g., servos) to take action on those signals.
- Batteries to power the components.

Radios control systems come in many forms
- Toy radio systems come from discount department stores and electronics retailers.
- Sport radios are generally available from hobby shops and Internet retailers.
- Complex radios are generally purchased on the Internet.

A toy radio is usually included with a toy.
- It costs almost nothing and is worth what it costs.
- Its controls are probably non-standard.
- Skills developed on a toy radio may not transfer to a better system.
- The components of a toy radio usually can't be transferred to a new airplane.

A sport radio system is a good choice for a beginner:
- It will cost between $130 and $180, including all necessary components.
- Its controls are standard; skills developed on it will transfer to better systems.
- It probably has an internal computer, offering some programmability.
- It can be recycled in model after model.
- It may be all the radio you'll ever need.

A complex radio system is for later on:
- It will cost between $300 and $3,000.
- It can control more functions (i.e., channels)
- Its internal computer offers significant programmability and a good display.
- It will impress your friends, even if your flying doesn't.

Transmitters

Basic controls are on one or two joy sticks.
- A sport radio will have at least one joystick for pitch and directional control.
- A second joystick usually controls throttle and rudder.
- You won't need more than the four functions on the joysticks at first.

Additional controls may be in the form of knobs and switches:
- You can control things like landing gear, flaps, lights, and a bomb release.
- You can also change functionality, like control sensitivity.

Trim tabs or switches let you modify control settings.
- You can trim a model to fly "hands off".
- The four joystick channels will have trims.
- Mechanical trims are adjusted by sliding them.
- Computer trims are adjusted by discrete clicks.

A computer radio offers additional functionality and doesn't have to cost much more.
- A computer radio system will cost $20-$30 more than a non-computer radio.
- It will contain a model memory so you can set it up for several different airplanes.
- It will allow you to adjust control sensitivity through "exponential" and "dual rates."
- It will remember your trim settings form model to model.
- It should include a timer to warn you when it's time to land.

Buddy box support is important, especially if you value your first model.
- A buddy box is a second transmitter connected to yours by a trainer cord.
- Your instructor will hold one transmitter; you will hold the other.
- When (not "if") you screw up, your instructor can take over immediately.

A radio system can use AM, FM, PCM, or Spread Spectrum.
- AM is somewhat more prone to interference and should be avoided.
- There's disagreement whether FM or PCM is better.
- Spread Spectrum is new and quickly replacing all other types. (Buy one of these.)

Receivers

Receivers are very small and go in the airplane.
- The largest weigh only an ounce or two.

Channel is a term that refers to both frequency and function (two different things)
- A frequency channel is a slot in the radio spectrum, like a radio station.
- There are 50 good frequency channels near 72 MHz and several others elsewhere.
- A function channel is a slot in your receiver, where you plug in a servo to move a surface.
- Typical receivers will support between 2 and 14 functional channels.

Servos

A servo is an actuator that translates a signal from the receiver into a physical position.
- It contains a motor and a gear train to accomplish this.
- Its output comes in the form of a rotating arm.
- It is proportional, in that the servo movement is in proportion to the stick movement.

Servos come in a variety of shapes and sizes.
- Large servos weigh more, offer more thrust, and are for larger models.
- Small servos are lighter, offer less thrust, and are for small models.
- Fast servos offer expert flyers instantaneous response.

Slim servos fit in tight spaces, like thin wings.
Retract servos offer two positions and a lot of thrust.

Gear trains are made of several types of material:
Plastic or nylon is inexpensive, accurate, and fragile.
Metal is expensive and less accurate, but tough.
Composite materials are accurate and fairly tough.

Servos may be analog or digital.
Digital servos are more powerful, and more responsive.
Analog servos are less expensive and take less power.
Either will work on your first airplane.

Batteries

Alkaline batteries are not rechargeable:
They're what you put in your flashlights.
You find them in low-end radios.

Nickel cadmium (NiCad) batteries are rechargeable:
Better radios usually come with NiCad transmitter batteries and flight packs.
Most radio systems that come with rechargeable batteries also come with a charger.

Connecting Things Up

The battery connects to the receiver.
Usually it connects through a switch harness, so you can turn it off.
Generally, you just connect the plugs.

The servos plug into the receiver.
The slot you plug it into determines which transmitter control it responds to.
You can get extension cables if the cord is not long enough.

The servos connect to the surfaces by pushrods.
These go from the servo arm to the control horn on the control surface.
They can be metal rods, wooden sticks, or flexible plastic rods in guide tubes.

Frequency Control

Your radio frequency separates your signals from those of other flyers:
Two radios cannot share the same frequency; interference will result.
Interfering with a channel in use will likely result in a loss of control followed by a crash.

The frequency board ensures that only one flyer is on a channel at a time.
There is one clip for each frequency.
You must get the clip matching your frequency before you turn your transmitter on.
If the clip is missing, someone is probably using the frequency.

Keep the clip only for as long as you are flying.
- Your transmitter should be in the impound while you are not flying.
- You should take the clip when you're ready to fly.
- You should return your transmitter to the impound and your clip to the board when you're done.

These rules don't apply to spread spectrum systems.
- Spread spectrum technology doesn't rely on frequency to separate signals.
- Spread spectrum systems can't interfere with one another or conventional radio systems.
- You don't need to impound your spread spectrum system or get a clip to fly.
- Most of us wish all our radios used spread spectrum.

Ground School Topic 3 — Electric Motors

Electric motors are not just for toys

Electric motors come in a wide range of sizes:
- Small motors weighing a fraction of an ounce can power airplanes as light as an ounce or two.
- Large motors can generate enough power to fly the largest model you'll ever want.

Electric motors come in different designs

A brushed motor is most conventional.
- Direct current from the battery is switched by a commutator.
- Carbon "brushes" connect the power to the commutator.
- Speed is controlled by an electronic speed control that pulses power to the motor.
- Brushed motors are generally inexpensive.

A brushless motor has no mechanical switching circuit
- Direct current is converted to three-phase power by a speed control.
- Brushless motors don't generate electrical noise and generally don't wear out.
- Brushless motors make more efficient use of power.
- Brushless motors and their speed controls cost more than brushed setups.

An in-runner is a conventional electric motor with the stator coils on the outside.
- The magnets are on the armature inside the stator coils and rotate.
- In-runner motors re capable of high speeds.

An out-runner or rotating-can motor has the magnets on the outside.
- The case of the motor rotates, requiring some extra care in installation.
- The larger diameter of the rotating portion results in higher torque.
- Higher torque allows the use of a larger propeller.
- Out-runners are very popular on larger models.

Electronic Speed Controls

Brushed and Brushless motors require different speed controls.
- A brushed controller just limits the amount of power to the motor.
- A brushless motor must supply three-phase power at the right frequency.

A brushed speed control can be rather simple.
- The most basic is a simple on-off switch.
- A variable resistor will work, but inefficiently as unused power is wasted as heat.
- An electronic speed control switches power on and off at high frequency.
- The amount of power supplied is varied by pulse width.

A brushless speed control supplies three phase power.
- It must sense the speed of the motor, which varies with load.
- There are both sensored and sensorless approaches to sensing motor speed.
- The control must vary the frequency and amplitude of the three-phase electricity it supplies.
- Brushless controls are more complex and thus more expensive.

A speed control may also contain a battery eliminator circuit (BEC)
- This provides power to the receiver through the throttle channel.
- No separate receiver battery is required.
- Be careful to ensure the BEC will handle all of your servos (see its specifications).

Choosing a motor

Motor power is rated in watts:
- One horsepower is equivalent to 760 watts.

Power requirements are determined by watts per pound.
- A trainer needs 50-75 watts per pound.
- A sport model needs 100 watts per pound.
- A 3-D aerobatic model needs at least 150 watts per pound.
- A 5-pound trainer, for example, would need 250-375 watts.

The propeller length is determined by the size of the model.
- Longer propellers are more efficient than short ones.
- They have to clear the ground by about 2 inches.
- A scale model will require a specific length to match scale.

For efficient power, several things must match:
- The motor-battery combination must spin the propeller fast enough to achieve the desired pitch speed.
- The motor must not overheat.
- The battery current limit must not be exceeded.
- The speed control current and voltage limits must not be exceeded.
- The motor must run in its efficient range.

Computer software simplifies the evaluation.
- Moto-Calc and Electri-Calc are the current favorites.
- They come with an inventory of motor, prop, and battery specifications.
- By specifying the characteristics of the model, they will recommend several motors.

Motors can be geared.
- Gear boxes reduce speed and increase torque so motors can turn larger propellers.
- Small airplanes with small propellers usually do not need gear boxes.
- Outrunners usually do not need gear boxes.
- Gear boxes make noise and require maintenance.

Batteries

Serious electric models won't use alkaline batteries to power the motor:
- They can't produce high current.
- They can't be recharged.

Nickel cadmium (NiCad) batteries are a well developed technology:
- They can produce really high current.
- They can be recharged.
- For most applications, they are quite heavy.

Nickel metal hydride (NiMH) batteries cost a bit more:
- They can produce high current.
- They can be recharged.
- They're lighter than NiCads, by a factor of about 2.

Lithium (LiPo) batteries are the most expensive:
- They can produce high current.
- They can be recharged.
- They're lighter than NiCads, by a factor of about 4.
- They need a special charger and special care, as they can catch fire.

A battery charger should be matched to your batteries and your needs:
- It must be appropriate for your particular battery chemistry (NiCad, NiMh, or LiPo).
- Different chargers offer different charge rates.
- NiCads and NiMH batteries can charge in 20 minutes.
- LiPo batteries typically take an hour to charge.
- LiPo chargers are typically computerized and cost more (about $120).

Many chargers only accept 12 volt DC input.
- They connect directly to your car battery.
- To plug into the wall, you'll also need a power supply.
- 150 watt power supplies cost about $80

Connecting the Motor to the Battery

If you buy a plug-and-fly system,
- You'll plug the battery into the ESC.
- The ESC will probably contain an on/off switch.
- You'll plug the ESC into the receiver; its BEC will power the receiver.
- You'll plug the motor into the speed control.

Otherwise,
- The battery should have a connector on it.
- You'll have to solder a matching connector to the ESC.

You'll have to solder a few more connectors between the ESC and the motor.
Then you can plug things together.

If your ESC doesn't have a BEC,
You'll either have to plug in a separate receiver battery or
You can connect an universal BEC (UBEC) to the batter, which will power the receiver.

And while you're doing this, make sure you get the polarity right.
Reversed polarity will burn out the ESC instantly.

Safety Considerations with Electric Motors

A stalled motor draws lots of current.
A motor stalls when something (like the ground) keeps the motor from turning.
Some ESCs have current limiters.
If your ESC doesn't have a current limiter, your circuit needs a fuse.

Electric motors are every bit as powerful as their fuel-based cousins.
Propellers, especially on larger motors, can inflict a serious cut.
Fuel-powered propellers stop when they hit something.
When electric-powered propellers hit something, they just try harder to cut through it.
Electric propellers are thin and sharp.

Unanticipated motor starts are the big danger in electric models.
Treat every motor as if it might start at any time.
Be aware that the ESC switch does not isolate the motor from the battery.
Large models (over 200 watts) should have a safety interlock.

Ground School Topic 4 — Engines

Parts of an Engine

Crankcase

The housing that forms the basic platform for all the parts to work together.

Cylinder Head and Glow Plug

Initially lighted by a starting battery to provide an ignition source for the fuel/air mixture.
After engine start, the heat of combustion and the chemical reactions caused by some fuel additives causes the glow plug to remain lighted.

Carburetor and Needle Valve

Introduces the fuel and air mixture into the crankcase so that it can then enter the cylinder to be burned.
The needle valve allows adjustments to the fuel/air mixture.

Muffler

Connects to the cylinder at the exhaust port
Reduces noise by smoothing out the pulses of combustion.

Cylinder and liner

A hollow cylinder in which a piston travels up and down.
Is usually lined.

Piston

A metal “slug” that travels within the cylinder.
The piston compresses a mixture of air and fuel and converts it to usable power when the mixture ignites

Crankshaft

A rotating shaft that is connected to the piston by way of the connecting rod.
The up and down motion of the piston is converted to a rotating motion by the crankshaft.
The crankshaft has the propeller attached to its end thereby making use of the power developed by the piston.

Bearings

Hold the crankshaft in position.
Minimize friction as the crankshaft rotates.

Engine Size and Number of Cycles

Engine size is typically measured in cubic inches or a fraction thereof.

Displacement, in simple terms, means the internal size of the cylinder.
For example a “40” size engine is .40 cubic inches of displacement.

A “60” size engine measures .60 cubic inches of displacement.
Typical engine sizes for trainer aircraft are in the .40 to .60 range
Generally, the larger the displacement, the more power is created.

Most engines for model airplane use are considered either “2 cycle” or “4 cycle”.
More accurately, this means the engine incorporates either 2 strokes per cycle or 4 strokes per cycle
The strokes refer to number of piston movements (either up or down) to accomplish the action of ingesting the air and fuel, compressing it, producing power and then exhausting the burned gasses.

The 4 stroke/cycle engine draws in the air and fuel on a down stoke of the piston.
As the piston travels on the up stroke it compresses the mixture and ignition occurs.
The resulting down stroke of the piston is the power stroke.
Lastly, the burned gasses are exhausted on the next upstroke of the piston.
These 4 strokes result in two complete revolutions of the crankshaft and propeller.

The 2 stroke/cycle engine draws in the air and fuel through and compresses it on a single up stroke. When the mixture is ignited, power is produced and the exhaust gases pushed out on a single down stroke.
These two strokes result in one complete revolution of the crankshaft and the propeller.

Considerations in Choosing an Engine

Most airplane manufacturers will recommend an appropriate engine size for their model.
They will give you recommendations for size for a 2 stroke and 4 stroke engines and maybe even electric motor sizes.

Generally, 2 stroke engines produce more power at higher revolutions per minute (RPM) than a 4 stroke engine of the same size.
On the other hand, 4 stroke engines have more torque and swing larger props.
Airplane manufacturers usually recommend a larger 4 stroke engine than the 2 stroke recommendation for a particular airplane.

Most people find the sound of a 4 stroke engine more pleasing and realistic than the 2 stroke engine.
This is because the power stroke of the 4 stroke engine occurs once every 2 revolutions rather than every revolution making the sound produced by combustion at a lower frequency (or pitch).
It seems more pleasing to the ear.

Fuel

Glow fuel is a blend of:
Alcohol (methanol),

some nitromethane to enhance the ignition and idle characteristics, and
a lubricant.
The lubricant is usually castor oil or a synthetic oil or a combination

Some folks use regular gasoline in engines designed for it, chainsaw engines for example.
These are usually used in what we call giant scale models.
The gas is also mixed with a lubricant similar to that used in the glow fuel.

When using gasoline, fuel tanks and fuel tubing and fittings need to be compatible with the gas.
Gas is more volatile than glow fuel so caution is paramount.

As with any fuel, common sense safety practices are important with model airplane fuel.

Ground School Topic 5 — Your First Model

Selecting Your First Model

Your first model should be a trainer:
- It should have the wing on top for stability.
- It should have a flat-bottomed airfoil.
- It shouldn't be too fast for its size.
- It should be easy to repair.

Should it be fuel or electric powered?
- Both fly the about the same, although electric is quieter and provides fewer auditory cues.
- Electric is cleaner and requires less support equipment.
- Fuel engine concepts are more readily scaled to larger models.
- More instructors are familiar with fuel than electric, although this is changing.

How big should it be?
- Small models appear to fly faster and are more affected by the wind.
- Big models are easier to fly, but harder to fix.
- A .40-sized fuel-powered model makes a good trainer, especially at mid-day when it's windy.

Your first model should probably be an ARF (Almost Ready to Fly):
- ARFs actually cost less to build than do basic kits.
- ARFs take 10 hours; trainer kits take 40 to 60 hours.
- You don't want to become too attached to your first model.
- You'll get plenty of building experience putting your ARF back together.

Assembling an ARF

Start by reading the instructions:
- Yes, the English is bad, but is your Polish better?
- The sequence of construction is important because some items get buried.
- When the instructions fail, consult a club member. (You joined a club, right?)

Use the right glue.
- CA glues are fast, but can be unreliable (although the finger-to-finger bond never fails)
- Five-minute epoxy is good for most joints of an ARF
- Be aware that glue fumes can be toxic – use a fan.

Most ARF hinges are CA hinges
- CA works really well in this application.
- You place all the hinges in the slots and center them.
- Then you put a few drops of CA on them – Viola! Instant hinge.

Control horns give you something to connect the pushrods to.
- They should be placed so the holes are exactly over the pivot points.

Pushrods connect servos to control surfaces.
- There are several types; follow the instructions for you r ARF.
- They should include some mechanism for adjusting their lengths.
- They should be supported so they don’t waste motion by flexing.

In a fuel-powered model, wiring is simple:
- Each servo has a factory-installed plug and an assigned slot on the receiver.
- One slot is the primary directionality servo (rudder or aileron).
- One slot is for the elevator.
- One slot is for the throttle servo or speed control.
- One slot is for the rudder
- The battery plugs into the switch harness and the harness into a spare slot.

In an electric model, wiring is only a bit more complicated.
- The ESC/BEC replaces the throttle servo and comes with its own switch.
- The switch harness is eliminated.
- You may have to solder a power connector to the ESC/BEC.
- This important connection is no place for a cold solder joint.
- Soldering connectors to batteries is tricky; choose a battery with a connector installed.

Makes sure all the controls move in the proper direction.
- This is usually done in the transmitter.
- Even instructors will crash if the movements are reversed.

Get the throws right.
- Throw refers to the range of motion of a surface; the instructions say what it should be.
- Too much throw will make the airplane uncontrollable; so will too little.
- Adjust throws by the position on the control horns, or the adjustment in your computer radio.

Don’t forget to balance the airplane.
- The instructions tell you where to hold the model to see if it sits level.
- If it tips forward, it’s nose heavy; if it tips aft, it’s tail heavy.
- Nose-heavy models fly poorly; tail-heavy models fly once.

Flight Day

Flight Day Field Orientation

Layout of the Field

Every field is divided into a runway, a flight line, and a pit area.
- The flight line is between the pit and the runway.
- All flying takes place over or behind the runway.
- Airplanes are assembled and stored but not started in the pit.
- Engines are started on the flight line.
- Spectators are not allowed on the flight line.

The landing direction is generally determined by the wind.
- We land into the wind, when it's possible.
- If the wind is across the runway or can't be determined, those present agree on a direction.

Takeoffs are generally in the same direction as landings.
- The exception is that cross-field takeoffs are allowed by agreement.
- Cross-field takeoffs cannot be toward the flight line.

The traffic pattern is rectangular or oval in shape.
- The close side is over the runway.
- The distant side is away from the runway.

Takeoffs to the right result in a <u>left pattern.</u>
- A left pattern contains all left turns.
- This keeps the pattern away from the flight line.

Takeoffs to the left result in a <u>right pattern</u>.
- A right pattern contains all right turns.

Never fly over the flight line.
- Not only is it considered unsafe and bad form, at least one person will yell at you.

Rules of the Field

Get a frequency clip before you turn your transmitter on.
- This ensures you won't "shoot someone else down" with radio interference.
- Spread spectrum radios do not need clips.

Don't exceed the established maximum number of planes in the air at one time.
- At our field, the maximum number is five.
- It's pretty rare that this is a problem.

Announce your intentions loudly so others can hear you. Yell:
“Taking off” before you taxi onto the field.
“Landing” on your downwind leg of the pattern.
“On the field” before you walk onto the runway.
“Clear” when you walk back off the runway.

Stand in the designated pilot locations while you’re flying.
At our field, these are the black mats.

A spotter is a good idea, especially if it’s busy.
A spotter is like an instructor, without the instruction.
A spotter tells you where the traffic is.

Safety Rules and Procedures

Don’t smoke on the flight line.
Some members use gasoline in their models and that stuff burns pretty readily.

Don’t fly over the flight line.
It makes the guys who are flying really nervous.
It makes the guys who aren’t flying really mad.

Don’t fly by yourself until you have been approved to solo.
That’s why we have instructors.
You’re less likely to over-fly the flight line after you’ve soloed.

Treat every engine/motor as if it can start at any time.
Propellers are tougher than fingers.
Gas, glow, and electric motors have all started unexpected in the past and will in the future.