An introductory guide for operating

# Radio Controlled Helicopters


- MICHAEL VOICHECK -

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# About the Author

The work in this guide was developed by Michael Voicheck, an R/C hobby enthusiast and high school technology teacher over the course of spring 2006 to fall 2007. His work involved developing a curriculum framework for R/C helicopter instruction which is to be used specifically for training Drexel students to become competent model helicopter pilots.

The guide is designed for an introduction to R/C helicopters with an emphasis on the specific equipment used in Drexel's Autonomous Systems Lab (DASL).

The information found in this book was formatted from a webpage to fit in this book. The web format is designed to provide quick easy reference material for students working at Drexel University in Philadelphia PA. It picks up where the book can not go and includes sample videos and the weblog of repairs to the various helicopters the lab owns and operates. The book format is more of a field guide.

Please note that the structure of the book is designed to get you through each step and most hurdles a new RC heli pilot will encounter. The sections about flying are last, because you should understand as much about the helicopter as possible before attempting to fly helis.

The web version of the book can be located at: http://prism2.mem.drexel.edu/~voicheck/

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# Introduction

Welcome to the wonderful world of radio controlled model helicopters. This hobby is a daily ritual for some, and a lazy Sunday activity for others. Your level of excitement or necessity will take you in your chosen path. You may find that your skills for flying R/C helicopters are a lot like riding a bike. Once you have them, you will not forget. You will however, become rusty if you take too long between flights.

Before you start or try to start flying, there are a number of exercises you can do to prepare yourself for becoming a competent R/C helicopter pilot. They are listed below:

1. Familiarize yourself with the helicopter parts
2. Practice heli flying on an R/C simulator
3. Become competent in flying model airplanes
4. Talk to an experienced R/C helicopter pilot

Obviously, the more of these you experience before attempting to fly an R/C heli, the more successful you will become. The author strongly recommends numbers 2 and 3 for having taught himself how to fly both, the concepts carry over from one to the next.

Take your time in completing flight level. The more thorough you are with your understanding of the helicopter and more time you spend logging time on the simulator and helicopter, the more competent of a pilot you will become. Being conservative in your flight training is ok. Eventually you will have to take a few steps which are going to make you feel uncomfortable. From an educator's point of view, when you're out of your comfort zone, you're learning.

Throughout the guide, you will see a few icons which are to draw your attention. Use this key to figure out what each icon means.

 Caution/Safety

 Repair/Maintenance

 Information

 Electric

 Take another look

Enough said… Let's get started!

# Safety

Safety is the most important aspect of this hobby. Improper use of an R/C helicopter or airplane can cause serious injury, even death. It can cause a lot of damage to you, someone else, or something else. Make sure you are following the Academy of Model Aeronautics, AMA, guidelines for operating a radio controlled model. Here are a few general tips of what to take into consideration every time you fly. It is imperative to make sure what you're doing while flying R/C aircraft is 100% safe.

## First Aid kit

You might not believe it, but a first aid kit is the most important part of your flight box. It may sound silly but it's true.

Accidents should you be ready for:

1. Burns
2. Cuts
3. Prop bites
4. Insect bites

An instant ice pack goes a long way. You should always have paper towels or napkins, and at least a bottle of water with you.

## Flying Site

Choose a site that is free from obstacles and void of people. The less populated the better. You'll want plenty of room, especially if you're new. You don't want to crash your aircraft into a car, person, or building. The best places to fly are ones where no one is going to bother you. Don't choose a site where you're going to be looking into the sun during any portions of the flight. It's not only bad for your eyes, but also bad practice. I'm pretty sure you're familiar with Murphy's Law. If it's a well known public place, check it out every time you fly.

## Equipment

Some of the quality of your flight training will come from the type of equipment you choose to learn how to fly on. It's been stated many times so take this information to heart; "Buy cheap, buy twice." You'll find that this information is true 75% of the time. If you're flying helicopters you will want quality equipment in them. It would be a shame to trash a $700 helicopter because you used cheap servos, and saved yourself $30. Most of the major brands will be more expensive, but carry warranties and are generally more reliable.

## Batteries

Although this topic is covered mainly in the flight training section, it is briefly mentioned here. Batteries need care and attention. Some batteries require more attention than others. Think of

your batteries as a love/hate relationship; the better off you treat them, the more likely they will perform for you, and visa versa. The most important thing to remember with batteries is following the manufacturers recommended directions for charging, discharging, storing, and disposing.

## Common Sense

Many people seem to lack this trait. If something doesn't "feel" right with the helicopter, something is probably wrong. If something seems wrong while flying, land the helicopter and find out what doesn't feel right. Stick to the common sense rule when attempting anything with R/C equipment.

For more information on national model aircraft regulations, check out the Academy of Model Aeronautics (AMA) website. The guidelines are spelled out very specifically for all members of the hobby.

# Helicopter Parts

There are many parts to the helicopter and they are all of equal importance. The JR Voyager CCPM kit is packaged with pre built components and requires approximately eight to twelve hours of work before it's first flight. As a general rule, your time will be split into thirds for each of these topics: assembly, electronics installation, and radio programming. Rushing through any of them could jeopardize your safety.

Shown below are the main parts which you need to associate yourself with.

## Main Rotor blades

The main rotor blades generate lift by spinning in a clockwise motion and pushing air downward. They move anywhere from +/-10 degrees pitch. For basic flying, we'll keep these numbers conservative. The higher in pitch the blades travel, the more lively the helicopter will fly. You don't need to know the exact degrees of pitch your blades are angled. Once you become more competent at flying, you will get a sense for the aircraft and know the sounds and feel for it. Keep in mind that the steeper the pitch, the harder the motor has to work, and the more lift you generate.

## Tail Rotor

The tail rotor counteracts the torque of the blades. It pushes air against that torque in a counter clockwise motion to stabilize the aircraft. The change in pitch of the tail rotor blades determines how fast the helicopter turns left and right. The pitch changes through servo movement inputs. The gyro also controls the pitch of the tail, but that's an automatic adjustment, and doesn't need your input.

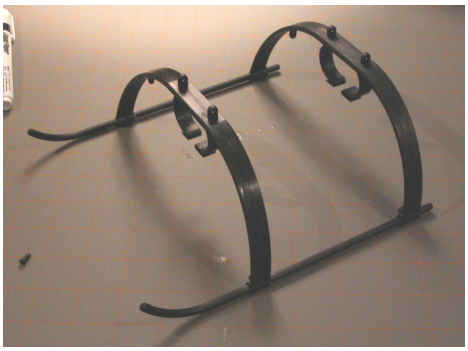
Check to make sure the belt that drives the tail rotor is taught before every flight. It seems to loosen in the warmer weather and humidity changes.

## Body

The body or frame of the helicopter holds everything together. All of the electronics are attached to it and it's important to make sure that it doesn't get damaged whether in storage or in flight. In-flight damage is called a crash. In-storage damage is called "hangar rash" and it is very common. Considering that the helicopter will spend most of it's life on a shelf choose a safe place for it to rest.

## Landing Gear

The landing gear is better known as the skids, and will not be used directly until you can competently hover the aircraft. It is however, used to attach the training gear, and provides clearance for the motor battery. The landing gear "gives" to provide a soft landing for the helicopter. It will eventually break after multiple hard landings.

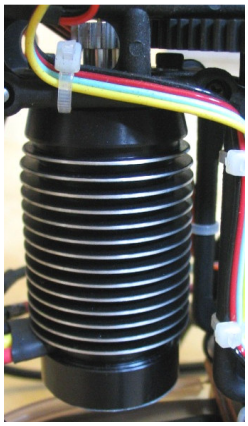


## Gyro

The gyro keeps the tail of the helicopter mostly stationary. When a gust of wind hit's the helicopter from the side, the gyro stabilizes the movement. It is connected between the rudder servo and the rudder spot on the receiver. Almost all gyros will need to be setup initially when you assemble the helicopter. Without the gyro, the helicopter has a very difficult time remaining stable in a hover.


## Motor

The JR Voyager belonging to Drexel for helicopter flight training is powered by a hacker C40 9L brushless inrunner motor. It can handle a lot of current, and it will fly the helicopter for over eighteen minutes. The motor has a pinion gear that drives the main gear and a tail rotor via a belt. It is approximately 1/3 more efficient than the standard brushed stock motor that comes with the helicopter. Notice that there are many cooling fins surrounding the motor because it will become warm during flight. Make sure to keep all electrical connections away from the motor.



The brushless motor is mounted securely using the supplied screws and a few drops of Loctite™or Threadlock™.

Setting the pinion/main gear mesh is critical because settings which are too loose or too tight will damage the heli. Place a piece of thin paper in the gear mesh before you tighten the motor screws. Once the paper is removed, your mesh should be correct. If it's too loose, try it again.

## ESC - Electronic Speed Control

The throttle control is handled by the ESC. It provides a smooth power distribution to the motor and accepts the LiPo style batteries in cut-off voltages and high current applications. The particular ESC in the Voyager trainer heli is a Hacker Master 40-O, meaning 40 amps max current, and "O" for omitting the BEC. BEC stands for battery eliminating circuit and it would power the servos from the flight pack. This ESC lacks that option, so it is necessary to use a separate 4.8V NiCad to power the servos.

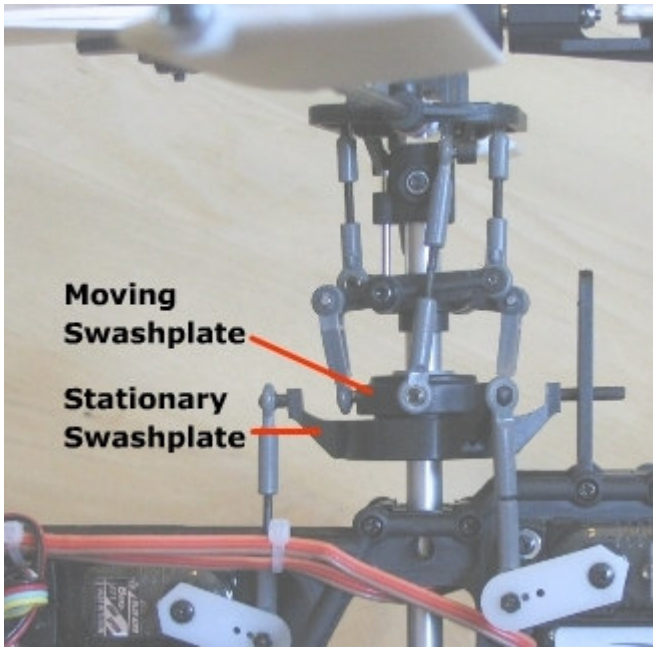

## Swashplate

The swashplates on the helicopter are the direct links between the servos and the control surfaces. There are two swashplates on every helicopter: moveable and stationary. See the section on aileron roll for more detail.

*Brief explanation:*

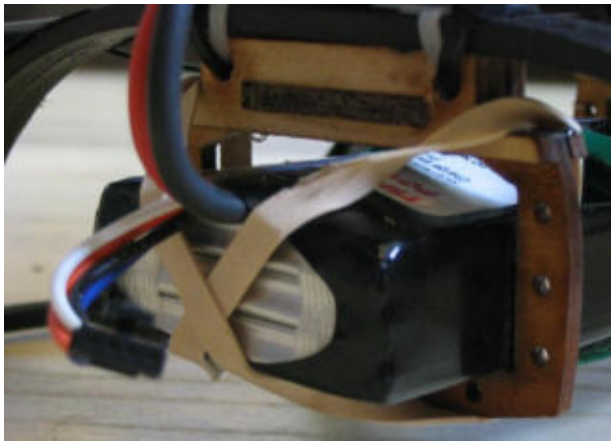
The bottom is the stationary, and the top is the moveable. The main shaft travels through the center of both, and it needs to be lubricated after every flying session.

You can see two of the servos that control the swashplate in the picture to the right. This is a CCPM swashplate so there is one more servo on the opposite side of the back servo.



## Motor Battery

The Drexel trainer helicopter gets it's motor power from a Thunder Power 6000mAh, (11.1V) Pro Lite battery. It is rated at 10-12C continuous discharge and can handle bursts of 18C or 108A. They are just under $200 a battery, so proper care is extremely important.



The battery is held in place using rubber bands for easy removal and vibration resistance.

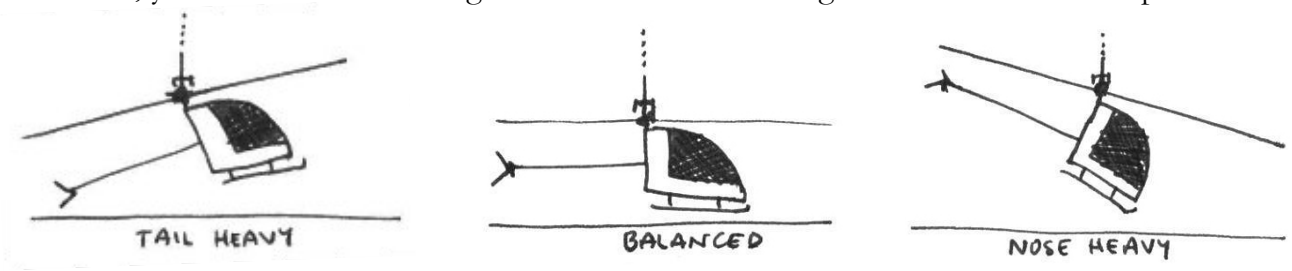
## Receiver & Receiver Battery

The receiver which interprets signals from the transmitter needs to be carefully attached the frame of the helicopter. In the picture shown, it is wrapped in foam rubber which was supplied with the receiver to prevent vibrations from destroying it.. It is then zip tied to the frame also holding the 4.8V NiCad receiver pack. The receiver power switch is placed behind receiver and the charging wire is routed towards the front and labeled. You don't want any wires dangling or any items loose so be careful that they are tucked away.


## Aircraft Balance

Although it's not a physical part of the aircraft, the balance point on the helicopter is an important component to smooth flying and a well trimmed aircraft.

The helicopter should be balanced by picking it up by the main rotor head and seeing if the nose or tail dips. The main battery can be moved slightly to adjust this; if the balance is really off center, you will have to rearrange the electronics. See images below for further explanation.



# Training Gear

To make your initial helicopter flying experiences easier, construct a set of training gear for your helicopter. You can purchase commercially available training gear but it's frowned upon because of cost. If you follow the two suggested methods, you can make your own training gear for fewer than five dollars. If you have some of the supplies, it will be even cheaper. Method 1 is recommended because the balls allow the helicopter to slide around more than the hula hoop does.

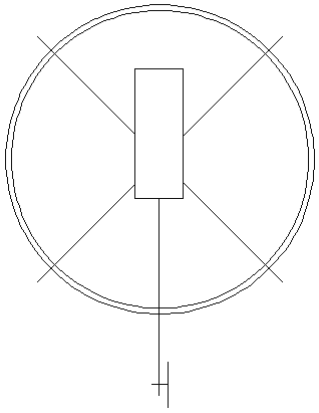
## Method 1 (balls and sticks)

Procure two 28-36" dowels with a diameter of 3/8" to 1/2", and four 3-4" diameter wiffle-ball style balls. You can purchase the dowels at a hardware store and usually find the wiffle-balls in packs at the dollar store. The ones used for the Voyager came in a pack of five. Use whatever materials you have available to you.

Rubber band the dowels together in the middle to form an "X" when they are spread apart. Spear the wiffle-balls with the dowel and attach them near the end of each dowel using a rubber band, or something similar. Do this on each end, and your training gear is finished

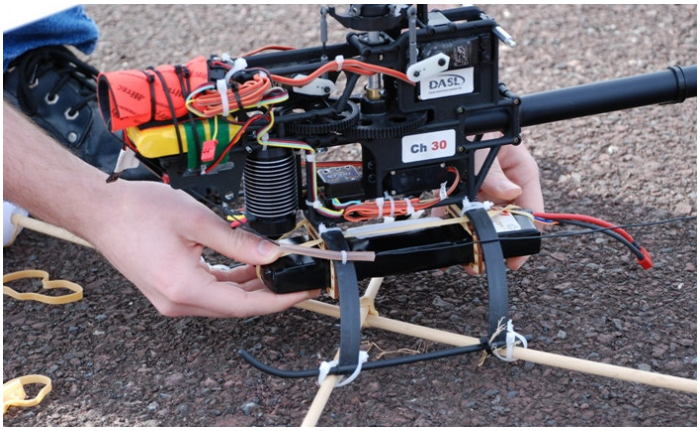
## Method 2 (hula hoop and sticks)

Just like method one, rubber band the dowels together in the middle to form the "X". Spread the dowels apart and attach them to the hula hoop using one or two of the following methods: string, zip ties, rubber bands, glue, or screws. It should look like an "X" circumscribed in a circle. Use the same mounting method as method 1.



## Attaching the gear

Mount the gear to the existing helicopter skids by adding the zip ties to hold the skids to the dowels. It is most effective if the zip ties crisscross over the dowel and skid. You should use two zip ties for each connection to the landing skids.




***Note***

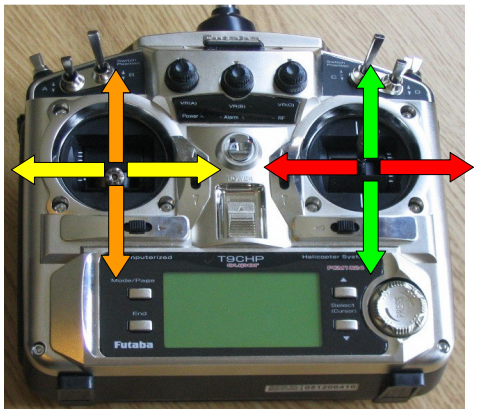
Training gear can come loose, and cause more of a problem than intended. Every so often a rubber band will come loose or rot and break, so keep an eye on them as your flight lessons progress. In addition to the rubber bands coming loose, keep your eyes on the zip ties working their way loose.

As you become more and more comfortable flying the helicopter, you can shorten the sticks two inches at a time. The helicopter will become livelier as you shed the weight of the training gear. Eventually you'll be flying without the training gear because you will master hovering the aircraft.

# Transmitter Setup

The transmitter will require a significant amount of initial setup to properly fly any helicopter. It should be setup by someone who knows radio controlled helis, or at least looked over by an experienced heli pilot once you have attempted the setup yourself. Most helicopters require a computer radio which mixes certain channels (servos) together. The trainer heli which you choose will dictate how much setup is required. Buying an off-the-shelf cheap Ready-To-Fly electric R/C helicopter package usually doesn't require any setup. This is especially true if you're flying a fixed pitch helicopter.

If you're unfamiliar with radio control model aircraft, it's hard to visualize the movements of the helicopter without knowing what's causing the movements.




The helicopter is flown using a transmitter, much like the one in the image to the right. There are two gimbals (sticks) on the transmitter; each has two axis of motion. The stick movements are interpreted into radio signals from the transmitter (known as Radio, or Tx) and sent to the receiver (indicated as, Rx) which sends the signals to the servos to create motion.

The Voyager helicopter you will be flying uses CCPM which stands for Cyclic Collective Pitch Mixing. This helicopter uses three servos to move the swashplate instead of just two. There are multiple types of CCPM, and the heli you will be flying uses three servos at 120 degrees to each other. This type of setup provides two major advantages. One, there is more torque applied to the helicopter swashplate than a two servo mix. Two, if one servo fails the helicopter is still semi-controllable.

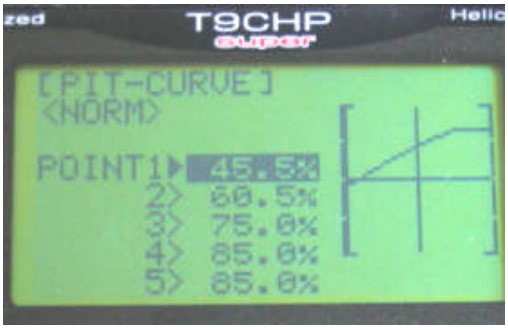
Note that channels 1, 2 & 6 are used as your CCPM channels for the Drexel helicopter. The signals are mixed in the Transmitter and sent to the receiver.

While operating your radio it's necessary to work with the antenna fully extended. The transmitter has a circuit that is designed to send a signal through that four foot long antenna. When it is collapsed, the circuit overloads and will eventually burn out. Most radios in this class have a range close to a mile.

The Futaba T9CHP transmitter you will be using has a large LCD screen on it for programming the helicopter. When you turn on the transmitter it should look very similar to this. The voltage may be different, but that's about it. You will also notice the timer, S1, S2 and MDL. These are all timers that you can setup to let yourself know how long you've been flying.


## Pitch Curve

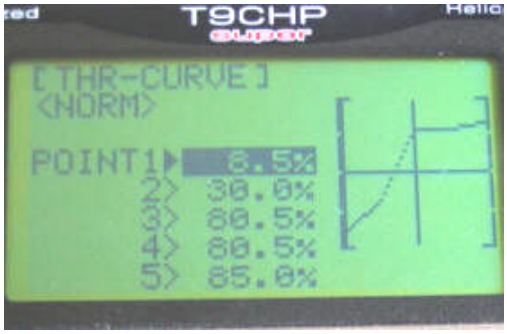
Setting up the pitch curve is not difficult but requires some planning. For our purposes the helicopter will be used for flight training only. As the collective/throttle stick moves upwards, we need a slow and smooth movement of the blades. The blades need to move to a high enough degree/pitch setting or the helicopter will not take off. Too much pitch and the blades will stall, and the helicopter will fall out of the sky.



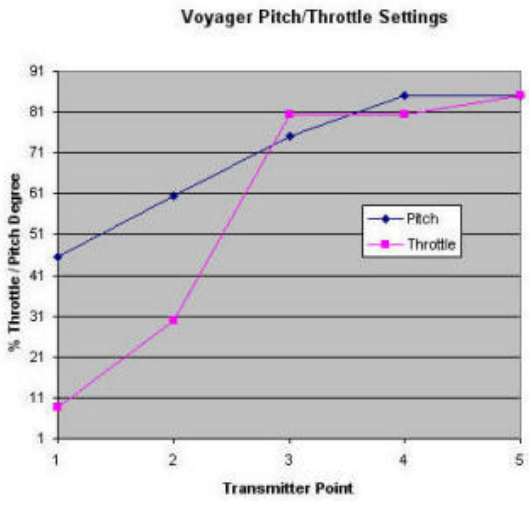

## Throttle Curve

The throttle curve is mixed with the pitch curve. Looking at both graphs at once lets you see how they interact with each other.

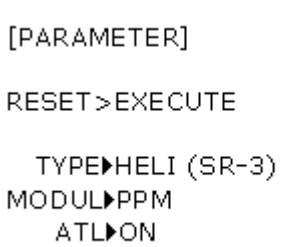
The throttle setting moves upwards quickly, and stays at a near constant level to achieve flight. These settings were put together for this helicopter to provide a beginner with solid hovering and basic flight experience. You'll notice when you advance the throttle on the transmitter, the helicopter's blades spin up quickly.




The graph to the right shows both the pitch and throttle on the same chart. There are numerous ways to set up your helicopter, but the current configuration seems to be the best for basic flight training.

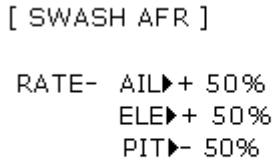


# JR Voyager CCPM Radio Settings

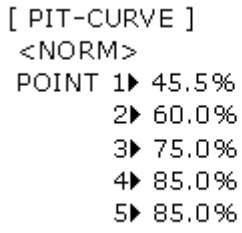



The parameter page makes specific adjustments to the type of rotorhead. SR-3 is the specific type of CCPM the Voyager utilizes. Check the radio manual for more information about CCPM mixing.

This receiver requires a PPM setup. If you switch the model from the SR-20 to the trainer heli, you're actually switching signal modes and need to cycle the on/off switch before the settings take hold.

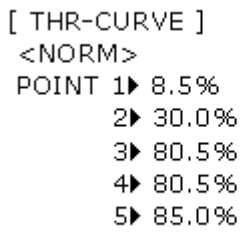



The swashplate has to be set to AFR. Then, setup the servos to move in the right direction by using the +/- sign.




The pitch curve is set for flight training, not aerobatic flight. These settings can be easily modified to vary the flight characteristics of the helicopter.


This is the servo reverse page. The current servo settings for the Voyager are shown. If the channel is highlighted, then it is reversed.




The motor is setup to start similar to the SR-20. A few clicks on the throttle/collective stick and the blades begin moving. The throttle curve is setup to maintain 80.5% of the maximum throttle setting around your hovering position. It took a while to figure out that these settings work the best. The rotorhead speed is not exceedingly high but can be adjusted using these settings.

# Holding the Transmitter

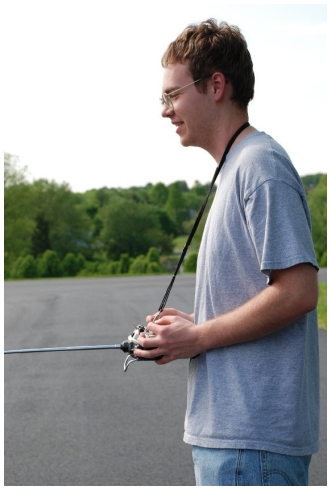
Most people, when they grab an R/C transmitter for the first time, put their fingers around the back of the transmitter and place only their thumbs on the gimbals. You can fly model aircraft this way, but it's not proper.

There's only one proper way to hold the transmitter and it won't feel natural unless you make a conscious effort to consistently hold it correctly. Flying aircraft using the following method will give you better control and a better feel for flying.

To properly hold the transmitter, place your pinkies behind the transmitter, ring fingers behind the far set of switches and middle fingers behind the dual rate switches. Place your pointer fingers on the far side of the stick and place your thumbs on top of the stick. Apply gentle pressure to the sides of the transmitter to relieve tension off your pinkies. See the photos for a better explanation. Once you become comfortable with this configuration, you will not want to fly any other way. See pictures below for holding the transmitter properly.



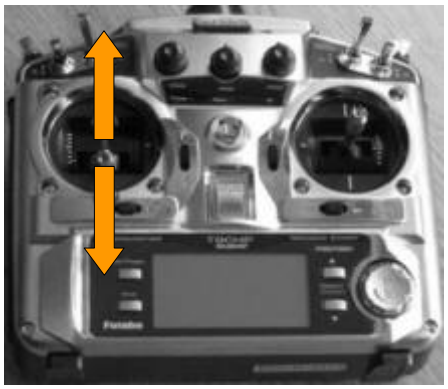
In the picture to the right, you see the student pilot holding the transmitter. The placement of his arms feels very natural. Notice that his wrists are not pulled back very far. He is using a neck strap to support the weight of the transmitter. If you choose to use a neck strap, do not alter the way you hold the transmitter. Keep your fingers in the correct spots.



It's very important to keep in mind that holding the transmitter should not be uncomfortable, or painful. This is true whether you are using the neck strap or holding the transmitter by itself.

# Axis of Motion

The helicopter has four axis of motion: up/down, turn left/right, roll left/right, and forward/backward. These are controlled using the sticks on the Transmitter. Here are the details for each:



## 1. Up/down "Pitch" or "collective" and Throttle

The up/down motion of the aircraft is caused by changing the pitch of the blades. Most model helicopters have adjustable pitch blades. Your engine/motor RPM should stay constant while flying and in order to gain/lose altitude your blade pitch changes.

*RC controls for Pitch*

If you want the helicopter to gain altitude, move the left stick upwards. The radio mixes the proper pitch to the blades, and power to the motor. They are known as the "pitch curve" and "throttle curve". These settings can be adjusted using graphs on the radio. They should be set by someone who knows helis, so don't adjust them unless you know what you're doing. A steep graph on the pitch curve could cause your blades to stall or motor to lag.

## 2. Turn left/right "Pirouette"

In order for the helicopter to maintain a steady fixed position in the air without turning, the tail rotor needs to develop enough thrust to counteract the torque of the heli. As the helicopter main blades spin faster, the tail rotor also spins equally as fast. They are connected by a belt drive system. If the tail rotor creates more thrust than needed, it turns in one direction. If the thrust decreases, it moves in the other direction.

*RC controls for Turn/Pirouette*

When you want to turn the nose of the helicopter to the left, push the left stick to the left. When you want the helicopter to turn right, push the left stick to the right. We call this "flying the nose" of the helicopter. You will see the pitch of the tail rotor blades change as you move the stick left and right. Once you become extremely proficient at heli flying, you'll want to mix your tail rotor pitch settings to your main blade RPM. It gets complicated so don't worry about it for now.

### 3. Roll left/right "aileron roll"

Below the main rotor, there are two sets of swashplates, stationary and moving. The stationary swashplate receives the movements from the servos and sends them to the moving swashplate. The helicopter rolls just like a real helicopter or real airplane. In order to roll, one side of the helicopter blades produce more lift than the other. The movement of the swashplate causes this imbalance. Once the helicopter blades initiate a small movement towards the direction of a roll, the helicopter will move in that direction, and keep moving in that direction. You have to counteract this motion to stop it.

*RC controls for aileron roll*

Move the right stick, left and right to move the helicopter left and right. Remember that the helicopter is facing away from you and it's in front of you. Only small movements are needed to move the helicopter.

### 4. Forward/backward "cyclic forward/backward"

The helicopter's forward backward movement is created the same way as the aileron movement. If the helicopter is going to move forward, there needs to be more lift generated by the rear blade of the helicopter. This is the opposite for moving backwards.

*RC controls for forward/backward*

To cause the helicopter to move forward, move the right stick forward. The nose of the helicopter will dip down, and the helicopter will begin moving forward. Recall that the helicopter will drift and you will need to stop the drift in order to get it to hover in one spot.

## Timer

The transmitter does not provide feedback of how much motor battery life is left for flying, so it's important to keep track of how long you have been in the air. In order to make this easier, the helicopter transmitter can be set up with a count down timer. The timer is activated by using one of the switches. Once you start the timer, it will not stop until you cycle the on/off switch on the Transmitter. If the counter gets down to zero, it beeps, and then begins counting upwards.

With the helicopter setup using the 6Ah packs, you should be getting eighteen minutes of flight time out of each battery before you notice a change in flight performance. At 21 minutes, the rotor head speed begins to sag and the helicopter usually cannot maintain altitude. You can usually tell when this happens by the change in sound accompanied by slow and sloppy flight characteristics.

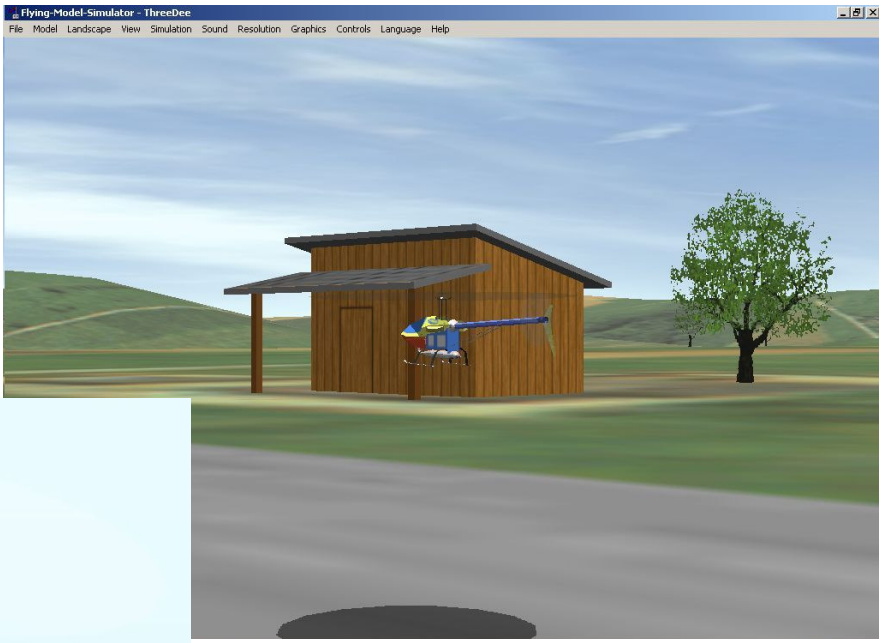
# Simulators

The simulator is an excellent tool for practicing R/C helicopter flying without any fear of crashing or wasting so much precious time and money. Although any good simulator will cost you between $150-250, it is well worth every penny. Simulators are highly underrated for radio controlled helicopter practice.

From the author's experience, it is much easier for someone to make the switch from simulator to R/C flying then to start with strictly with real R/C helicopters. Using a simulator, you gain an understanding of the controls and how the helicopter reacts. You get comfortable holding the transmitter for extended periods of time. You're able to experiment with different aircraft and the aircraft's settings/performance. The simulator also lets you trace paths, and play games like popping balloons and fly through aerial hoops.

The only major downside to the simulator involves the lack of sensory input. When you are outside with an R/C helicopter, standing in the grass on a hot day with wind and other significant distractions around you, it is a totally different feeling than staring at a computer while sitting in a chair. Despite this aspect, after logging time on the simulator, you're at least ten steps ahead of anyone without simulator experience.

The screenshots are taken from FMS, which is a free flight simulator available on the internet. Shown below is the ThreeDee, which is an advanced helicopter and the Hughes, which is much more stable. The simulator only comes with three helicopters, and you will need your own USB controller.




# Charging the Batteries

The helicopter has three batteries that you need to be concerned with: transmitter, receiver, and motor. All of them should be freshly charged before you begin each flying session. Without a fresh charge on the batteries the electronics will not perform at their peak levels. A low motor voltage will not allow the helicopter to leave the ground.

## NiCads

Nickel Cadmium batteries, or simply NiCad's, are easy to deal with, and don't require any specific care. You can charge them at almost any rate, let them get hot, discharge them at extreme levels, or leave them charging for days. They are extremely stable and take a lot of abuse. The transmitter comes stock with a 9.6V 600mAh NiCad battery. On a full charge, the transmitter battery will last approximately four flights before you need to recharge it. The receiver battery in the trainer heli has a capacity of 800-1000mAh, at 4.8V. This will safely last through three to six flights before needing a recharge. It's better to play it safe than to crash an aircraft because of negligence or ignorance.

To charge the receiver, and Transmitter, simply plug them into the wall charger supplied with your radio and let them charge for 12-15 hours. Make sure the red lights on the AC charger are on before you walk away. Waking up to find a dead battery because you forgot to switch the battery off first is a painful feeling. Start the charge before dinner so you're ready to fly first thing in the morning.

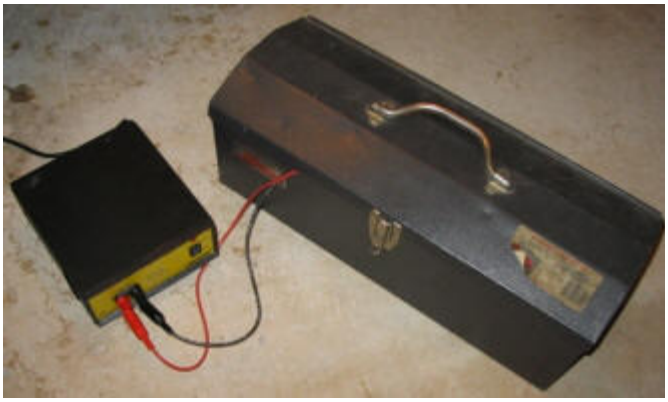
## LiPo's

Lithium Polymer batteries (LiPo's) need extreme care and should be handled only after reading through the paperwork which arrived with the batteries. Under no circumstance, should you ever plug a LiPo into a charger not designated for Lithium Polymer battery type. It will most likely explode or catch on fire. If you charge a LiPo higher than 1C, the battery will fail prematurely and it could cause it to catch fire. The "C" rating of a battery relates to its capacity.

The Voyager motor batteries have a 6000mAh or 6Ah capacity to them. They should be charged at 1C x 6A, or simply 6.00A. You should never fast charge a LiPo higher than its "C" rating. Knowing that the battery is to be charged at 1C, it should take approximately one hour to charge your battery.

## LiPo charging equipment

To charge the LiPo motor battery (6Ah), you will need a high current 12VDC source (above 10A), a closeable fireproof container, an open area such as a concrete floor, and the charger. Again, you can't be too safe with the handling of LiPo batteries.



In this setup, the battery and charger are both placed in the fireproof box because the leads are too short to allow the charger to remain outside the box. The box is not airtight because the charger needs fresh air to remain cool. The fan on the charger is noisy, so placing it in a closed box muffles it pretty well. The toolbox setup provides a nearly 100% safe way to charge the LiPo without any fear of fires.

**Every time you charge your LiPo in an unsafe location, you're taking a huge risk. These batteries are not to be taken for granted!**

## Charging LiPos using the Astroflight 109D

Connect the charger to the power supply. The charger will display the power supply voltage until you connect a battery. (Using the Astroflight charger)


Make sure that the dial is always at zero before you begin charging the batteries. Turn the dial on the charger all the way to the left (CCW). This dial controls the charge rate. As with any circuit, you can not set the current (charge rate) unless you have a load. Connect the battery to the charger and place the battery in the fireproof container. You will see the cycle start, but as long as you're current dial is not turned up, you're technically not charging the battery yet.

Before you close the lid and lock the container, check the voltage of the battery by using the

charger. The three cell pack you use should have a voltage between 11.1V - 12.75V. If the voltage you're reading is within these numbers proceed with charging.

If the voltage is very close to 12.60V (for example 12.55V) then your pack does not need to be charged and should be disconnected. Do not try to pack the battery full! Overcharging the battery is the straw that broke the camel's back.

If the pack voltage is below 11.1V it may not take a charge. LiPos need care and attention. If this occurs, charge the pack at 1A until it takes the charge.

If everything above checks out, slowly turn the current dial up to 5.90 - 6.00A and the charger will do the rest. It goes through three cycles to charge the battery. Once it's started and things are going smoothly, close the container and lock the lid.


During the charge cycle it will continuously display the current charge rate, pack voltage, time elapsed and how much charge it's restored into the battery to that point in time. Having a charger that displays this much information about the charge is very handy for diagnosing possible problems.


After the battery is charged, the charger will display a "CHRG Done" message. It will display the final pack voltage, total time elapsed until charge completes, and quantity of Amp-hours restored. This charger shuts off the fan and beeps, so you know to get the next battery going.


Cycle 1 : 3 minutes blind charge at the specified charge rate

Cycle 2 : charge at rate until a certain voltage is reached

Cycle 3 : on/off cycling of current charge until pack voltage peaks.

## Notes about charging:

1. Do not charge the battery until it has cooled down. Whether after a flight or from a warm vehicle, the battery must not be warm to the touch before initiating the charging cycle.

2. Use a high current power supply. A power supply rated for 10A should be the minimum size you use for charging a pack of this size.

3. Come up with a system to know which batteries have been charged and which batteries need charging. Something as simple as a shoebox with a note on the side that says "charged" or "discharged" batteries on it will work.

4. Use the Blinky every 4-5 charges but using it more frequently won't harm the batteries.

## Balancing LiPos using the Astroflight Blinky

The Astroflight Blinky can be used to help balance the lipo pack while charging. It helps each cell charge equally. The Blinky is used by plugging it into the balancing tab on the motor battery, and then charging the battery.

When you initially plug it into the balancing tab, the Blinky will light up as many lights as there are cells in the pack. After that initial light count, it will begin balancing the cells as they charge, and the light corresponding with the cell will light up--letting you know it's discharging that cell.

## Checking the Batteries

The batteries are the heart of the helicopter so you'll want to give them the attention they deserve. It is imperative that they are checked every so often for capacity and any good charger will let you know your battery capacity. Some of this can be noticed without the use of a charger. For instance, if the motor battery only lasts for ten minutes when you should be getting twenty, there's definitely a problem.

Check the pack after every flight, and especially after a crash. If the pack is swollen it is probably ruined. Do not use it. Immediately place it in a fireproof container and allow it to sit for half an hour. If it is still swollen, follow the proper procedures for disposing the battery.

# Takeoff & hovering placement

When you first start off learning how to fly helicopters you should stand 15-30ft behind, and 5-10 ft to the right or left of the helicopter. Always start your flights with the helicopter facing away from you in this position. It's a safe place to be, and it's something to get used to. With a nitro or gas powered helicopter this position gets you away from the noise and the fumes. There's also nothing directly in front or right and left of us for at least 100ft. If you look closely, you'll see the helicopter is only several inches to a couple feet off the ground, and the training gear is attached. Place your back to the sun and take note of any objects which could get in the way.



(the student pilot is standing in the proper location for flight training)

## Flying check list - for DASL trainer heli (JR Voyager)

1. Helicopter
2. Three (3) charged flight batteries (6000mAh LiPos)
3. Charged Transmitter (12.6V LiPo) and receiver (4.8V NiCad) battery
4. Transmitter
5. Training Gear
6. Zip Ties
7. Small set of tools (screwdriver, pliers, wire nips)
8. Small first aid kit (basic bandages and paper towels)
9. Rubber bands

You should come up with your own list that fits the needs for your flight training.

# Start Up Procedures

### Before you takeoff

1. Fully extend the transmitter antenna and turn on the transmitter.

2. Verify that the transmitter says "[06:VOYAGER!] Pac PPM" in the LCD screen on the Transmitter. If it doesn't, change the model. Follow the user guide for instructions on this.

3. Check the voltage; don't fly under 9.4V. Your transmitter will probably shut off and make the flight end violently.

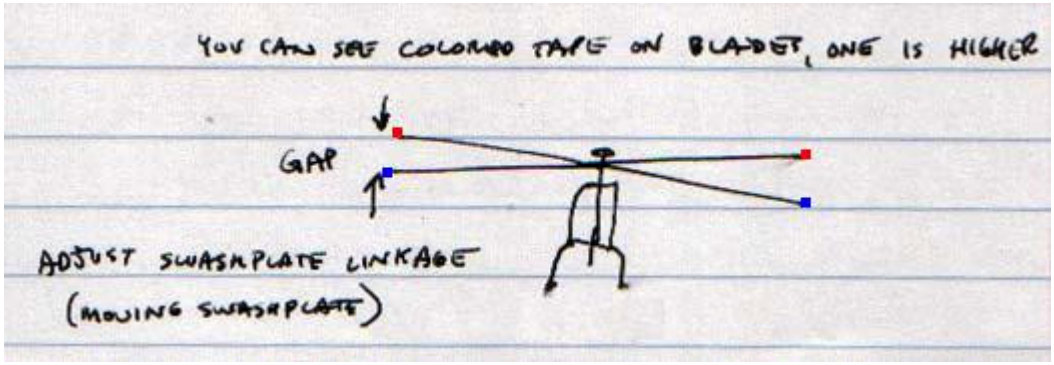
4. Check the voltage of the receiver battery. Once you have verified that it's good, apply power to the receiver using the switch (4.8V battery) and let the helicopter sit for a few seconds. This gives the gyro a few seconds to calibrate. Without this calibration, your helicopter may fly terribly. You will hear the tail servo move to a center position. The gyro is also very heat sensitive, so if you move the helicopter from a hot car to outside where it's cooler, give it time to stabilize. Move the sticks around to make sure that each servo moves the correct surface in the correct direction. Once you take off, you don't want your roll, pitch, or yaw to be backwards. This is especially important in the lab where people are sharing controllers. Assume your model will always be wrong, and you'll have a successful flight every time. Don't worry about the main motor spinning up yet because you haven't attached the motor battery.

5. Make sure the throttle stick is all the way down and plug in your fully charged motor battery. You should hear a series of beeps. Wait until they are finished and then proceed. If the beeps continue, you're accidentally programming the speed control. Locate the manual on the Reference Materials page for the speed control, and reprogram it. You're done flying for now. If this occurs, proceed to "shutdown procedures".

6. Grip the transmitter with the proper finger placement. Begin with the heli in the recommended takeoff position, and spin up the blades (give them power). The pitch/throttle stick (left stick, up and down) needs at least 1/3 throttle before you begin to lift off so don't worry about the heli jumping off the ground.

7. Once the helicopter blades are spinning, kneel down and check the rotor blade tracking. The blade tracking refers to the lines created by the spinning blades when viewed at eye level. You'll see two lines if they're off and one if they're on. They need to be close for training and perfectly aligned for aerobatic flight. If the helicopter is setup by an experienced heli pilot it shouldn't

need to make adjustments. If it's way off, stop the flight, shut down the helicopter, and make the necessary adjustments.




The view from the back of the helicopter

8. While the blades are spinning, check the control surface directions. If you've applied enough power, the helicopter won't take off or feel "light" on the training gear, but you will see if the control surface directions are set correctly. Don't doubt yourself, but double check this every time. Again, this is especially important when one transmitter is shared between multiple aircraft.

# Shutdown Procedures

### When you land

1. Pull the throttle/collective all the way down and wait until the blades stop spinning. You can help slow the blades down by pushing the right stick forward and to the right while the throttle/collective is down.

2. Unplug the motor battery first. That alleviates any major safety issues that could arise. A radio glitch could accidentally cause a main blade strike to the knee or knuckle. If you do get hit by a moving blade, it's probably your own fault, but that's why you have the first aid kit. By the way, getting hit by a moving propeller in the R/C world is called "prop bite" and is a common term used across the hobby.

3. Turn off the receiver battery, and then turn off the transmitter.

4. Make sure you take the time to complete these steps in the right order. Also, take the time to put the Transmitter antenna down carefully. Pull the antenna down from the middle not the top. These are easily breakable and are often tripped over when set down while fully extended. Just ask someone at the local flying field or in your lab.

5. Carefully move the helicopter to a safe location.

# Flight Level Ratings

The Flight Level rating system is designed to maximize your knowledge of the aircraft and provide quality flight training at the same time. A thorough understanding of the aircraft is vital not only to flying, but also to repairing and maintaining it too.

Each step of the process requires a decent amount of studying and hands-on training with the helicopter. Until you receive notice of passing a level, you should only focus on developing the skills associated with that level, and the previous levels. This rating system has been developed specifically for Drexel students but can apply to almost student pilot.

The names and colors represent your ability level. The new recruit doesn't have any boxes to be filled in. Once you get promoted past new recruit, you "receive" color boxes.

### New Recruit

Everyone starts out as a new recruit. The job of the recruit is to know what their objectives are and to be able to clearly state them.

Recruit's Objectives:

1. Learn as much as possible about R/C helicopters
2. Become an independent R/C helicopter pilot
3. Use the skills learned to further the good of the lab
4. Know how and why to properly hold transmitter
5. Spend at least 2 hours a week on R/C helicopter simulator.

The jump from recruit to corporal should be completed within a couple weeks.

### Corporal □□□□□□

Corporal's Objectives:

Helicopter Parts/Theory

1. Identify major parts of the helicopter and explain how they operate: rotorhead (pitch/degrees), swashplate (moving/stationary), tail rotor, batteries (motor, transmitter, receiver), Electronics locations (receiver, gyro, motor, servos, switch, ESC.

2. Log 2 hours on simulator for practice every week

Helicopter Flying

1. Explain controls of heli (four axis, sticks/gimbals, use Transmitter to help)
2. Proper location to stand when flight training
3. Know and follow start-up procedures (refer to startup section on flight training page.)
4. Knowledge of ground skirting and ability to properly control helicopter using the above conditions
5. Comfortable with ground skirting, and how the controls work with the helicopter

The jump from corporal to Sergeant should be completed within 1-3 flights

## Sergeant ☐☐☐☐☐☐

Sergeant's Objectives:

Helicopter Parts/Theory

1. Explain ground effect
2. Know what to check for before flying
3. Log 2 hours on simulator for practice every week

Helicopter Flying

1. Properly attach/remove training gear
2. Properly attach/remove motor battery
3. Hover within tolerance despite weather conditions [+/- 5' area, 0-2' altitude] (30sec)
4. Hover at higher altitude, 10-15ft. (60sec)

The jump from Sergeant to Lieutenant should take between 3-6 flights. Depending on the amount of simulator flying you put in, this could take as little as two flights. Expect to achieve this in five flights so you're not disappointed.

## Lieutenant ☐☐■☐☐☐

Lieutenant's Objectives:

Helicopter Parts/Theory

1. Explain how the gyro corrects the flight
2. Explain the startup and shutdown procedures
3. Log 2 hours on simulator for practice every week

Helicopter Flying

1. Hover within tolerance [+/- 1.5' area, 2' altitude] (30sec)
2. Demonstrate startup procedures properly
3. Hover over a designated spot, move safely to another one (20-30ft away), safely move to a hover, land, and repeat. (while keeping the tail facing the pilot.) [pilot should land within 5ft of spot, 2-4ft alt]
4. Standing in the center of a circle, fly the helicopter around you, keeping the tail facing the pilot, and keeping the helicopter at the same distance away from you [+/- 5' , 2-4' altitude]
5. Hover at altitude 15-20ft. (60sec)

## Captain ☐☐■■☐☐

Captain's Objectives:

Helicopter Parts/Theory

1. Explain blade tracking and how to correct it
2. Explain the swashplate's jobs and how they operate
3. Practice nose-in hover on simulator for 1-2 hours

Helicopter Flying

1. Hover over a designated spot, move safely to another one (20-30ft away), hover, and repeat. (while keeping the tail facing the pilot). The helicopter should not touch the ground in this exercise
2. Same as #1, but add the rudder to slowly "snake" the helicopter towards the direction of movement. The pilot should read through section on snaking.
3. Hover at altitude 20-25ft.
4. Begin nose-in ground skirting.
5. Hover the SR-20

## Colonel ☐🟨🟧🟥🟦☐

Colonel's Objectives:

Helicopter Parts/Theory

(none)

Helicopter Flying

1. Hover at altitude 25-30ft. (60 sec)
2. Take off, hover and accelerate into forward flight for 30-50ft, stop, bring heli back, and repeat. (5ft alt.)
3. Using trainer box as a safety guide, complete the following:
    a. Take off, and hover at altitude of 25-30ft.
    b. Move helicopter into forward flight, by following a left or right hand pattern
    c. Once helicopter returns from flight pattern, place it back where you started in a hover and repeat.
    d. Safely land.
4. Hover nose-in within tolerance despite weather conditions [+/- 5' area, 0-2' altitude] (30sec)
5. Take SR-20 to designated altitude, pass to ground station, take control back and land aircraft. (with safety pilot supervision)

## General ☐🟨🟧🟥🟦⬛

General's Objectives:

Helicopter Flying:

1. Complete the exercises in the Colonel ranking without the aid of the buddy box
2. Take SR-20 to designated altitude, pass to ground station, take control back and land aircraft. (without safety pilot supervision)
3. Receive certificate of completion signed by instructor

## Post General Operations…

At the point where you can comfortably operate all of the helicopters, it's time to progress past the flight level ratings. Post General Operations is your opportunity to spend time focusing on improving your flying habits to ultimately push yourself to a comfortable position of teaching other's to fly.

# Flying

Flying the helicopter for the first time, especially alone will be very intimidating. Following the list of flight skills below and not continuing until each one is mastered will almost ensure a success rate of 100%. Hopefully the mistakes you make along the way don't need correction with money and parts. The flight process is listed as follows: ground/skirting/ basic hovering, hovering, side stepping, piping, snaking, higher altitude hovering, and forward flight. Some other steps you don't need to cover for basic flight but will be addressed are: nose-in hover and autorotations. These shouldn't be attempted until you can safely complete all of the other steps.

## Ground Skirting/Hovering

With the training gear attached, keep applying power until the helicopter begins to feel light. You'll see the skids begin to drag on the ground. Keep adding power, but do this very slowly or the helicopter will take off and possibly fly away. Don't allow the heli to gain more than a few inches of altitude if at all for your first flights. The ground effect "where air is literally trapped underneath the heli in a bubble" makes this process a little tough, but get used to it. A fall from 1-2 inches is nothing compared to 2 feet or 20 feet. If you get nervous, you're doing fine. If you get too ambitious, you'll most likely crash the heli.

The helicopter may wander around, but do your best to keep it in one general area. Many people will tell you that "helicopter flying is like balancing on a ball." It's better said that helicopter flying is like "balancing on a ball floating in a stream." The stream is your air and the helicopter loves to wander.

Practice skirting the helicopter around with the training gear barely touching the ground. It takes time to become comfortable holding the transmitter and getting a feel for the aircraft, so don't become disheartened if this takes half a dozen flights.

If you can keep the helicopter over the same spot (+/- 18") you're doing very well. The conditions you fly in have a lot to do with how accurately you can hover the heli.

## Hovering

After two to four flights of skirting/floating the helicopter, it's time to hover the heli approximately one foot off the ground. At this point, it's easier to keep it in the same spot because the ground effect is much less noticeable. It's easier to damage the heli from this height so be careful. You'll need to "dance" on the left stick to keep the heli from rising and falling. This sport requires a lot of patience and honed reflexes. If you don't have either of these, take a few months off and work on them; they'll pay off in all aspects of your life.

*Note from the Author:*

"When I started learning how to fly R/C helicopters I spent hours hovering the helicopter in one spot, mainly because I was afraid to crash and I didn't have any money to repair it. After I was comfortable with 1-2ft, I moved to 3-4 feet and then 5-6ft, and then 10ft and higher. At that point, I had put a dozen hours on the helicopter and played it safe with my comfort level in hovering. It can be disorienting to see the bottom of the heli, so stay calm and use your newly honed hovering helicopter senses to better your flying skills."

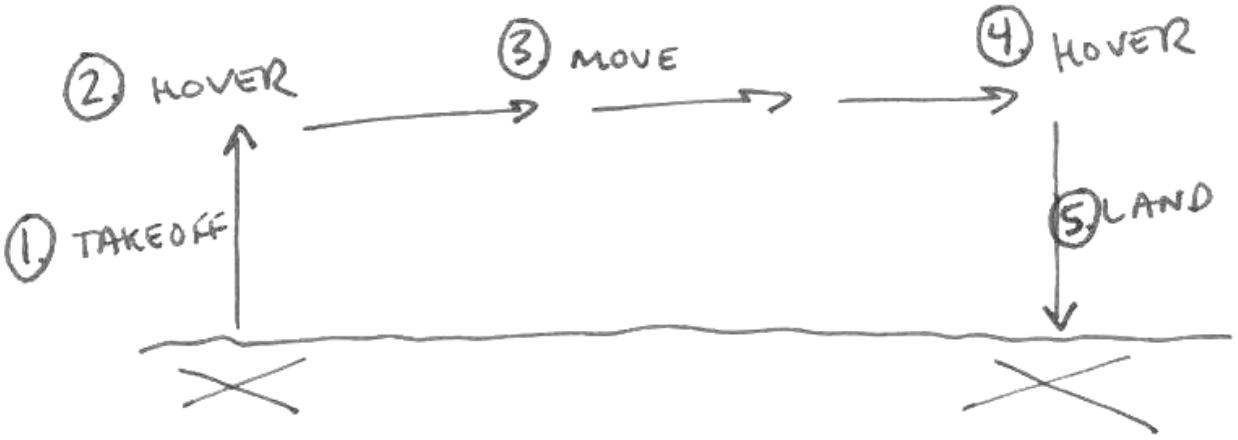
## Side Stepping

The next level is what is called side stepping. Move the helicopter from one spot to another specified spot all while keeping it facing directly away from me. You will takeoff, hover, move

to the spot, hover, and then land. This is really good practice and much harder than you may think.

Designate two spots on the ground by using hula hoops or large taped “X’s.” Sometimes you can find cracks in the sidewalk or pavement to use as a guide. Your spot landings will be tough at first, but eventually you’ll be able to hit near center every time.

Repeat the process over and over until you can travel between two, three, or four points, and land within the taped "X"s or hula hoops 80-90% of the time. When your comfort level increases, increase the speed in which you attempt the landings and maneuvers.



## Piping

Piping is a term for side stepping in the air. Instead of landing the helicopter when side stepping, you fly back and forth between two points without landing. This will hone your skills for stopping an accelerated sideways movement. It should look similar to a skateboarder in a wide half pipe. Once you get more and more comfortable with piping, you're ready to move on to the next step.

## Snaking

After you master side stepping and piping you will move on to "snaking." Snaking adds the yaw movement to the helicopter flight. While you're side stepping, point the nose of the helicopter slightly(10-45 degrees) in the direction of movement instead of keeping it perpendicular to your body. Move back and forth like you did before, but steer the helicopter more with the tail. Don't turn the helicopter more than 45 degrees off center. Always point the helicopter away from you immediately if you become disoriented during this exercise.

## Taking a Walk

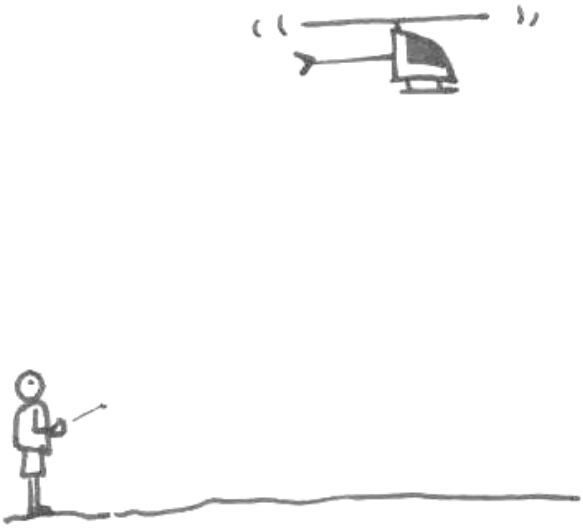
When you are comfortable enough with hovering, snaking, and piping, take a walk with the helicopter. Find a large field with plenty of room to wander around. Walk behind the helicopter at your normal safety distance but keep it flying. It can be relaxing as long as you don't trip on something while you're walking. So, be careful when you try this. You will find it may be difficult at first, but after a few minutes it is very helpful to see the helicopter in a different spot. Your flight training can get very boring, so mix it up by taking a walk.

## Higher altitude hovering

Once you become confident at all of the above steps, hovering at 5+ feet shouldn't be a problem. Take the helicopter up to eye level, and hover it there as best as you can. You should be able to stop all major movements of the helicopter using your skills at this point. Do not get disoriented when doing this.

After becoming comfortable with hovering the helicopter at eye level, take the helicopter to ten feet and perform the same procedures. Do not allow the helicopter to wander about, or to move backwards and get over your head. It's very poor practice to fly any model aircraft directly overhead.

When the helicopter gains altitude in a hover, it's pushing air out of the way to get there. When it loses altitude in a hover it's coming down in turbulent air which means a vertical descent does not look very good and can be scary when performed quickly. The helicopter will seem to just drop through the air no matter how much pitch you give it. To avoid this problem, it's better to slowly drift backwards/forwards or sideways until you set the helicopter down on the ground. You won't notice this in a slow hover ascent/descent. If you do find yourself sinking with no way out keep applying pitch. If this doesn't work, try applying forward or sideways motion to the helicopter. On a side note, a straight down crash is better than one where the helicopter tips over sideways.



## Nose-in Flight

Eventually you'll want to become very good at hovering "nose-in" where the helicopter is facing you. This is tough because everything is backwards, except your left stick, up/down. It's better to practice nose-in hover with the training gear on. Follow the basic steps you used to learn how to hover the helicopter while it was facing away from you. You can also practice nose in hover at a higher altitude, and if you get nervous, point the helicopter away from you and start over. This will work once you're extremely comfortable with forward flight.

## Moving along in your flight progress

Return the helicopter to the five foot mark and perform the steps above: hovering, side stepping, piping, snaking, taking a walk, and nose-in flight. If you can do all of these at five feet, you're ready to try it at ten feet. Once you can do this at ten feet, it's time to move to the next step which is forward flight.

# Forward Flight

Forward flight is difficult because the aircraft's orientation is constantly changing. The helicopter will fly much like an airplane when it is moving forward but will drift in many directions at once unlike an airplane. Forward flight is not recommended without the aid of an experienced R/C heli pilot!

One of the harder things to accommodate for while flying a helicopter in forward flight is the reduction of pitch settings because the helicopter needs less power when moving forward. The forward movement of the helicopter causes the blades to generate lift. Flight times are longer when the helicopter is kept moving.

Place the helicopter in a stable hover at 20-30ft altitude and 30-40ft in front of you. Make sure the helicopter is pointing away from you. Move the right stick forward to force the helicopter to start moving forward. Don't apply the stick movements sharply because the helicopter may lose altitude during this procedure. Once it gets about 70-80 ft in front of you, gently bank the helicopter to the left. The tail should follow the helicopter during this bank. If the tail doesn't follow the nose, use the left stick to turn it completely 90 degrees to the original position. The helicopter will continue in this direction until you tell it to turn again. Repeat the process for making a turn until the helicopter is back where it started. Remember, four lefts make a circle. Once you get back to where you started, hover the helicopter in place. If at any point in the flight you panic, point the tail towards yourself and put the helicopter in a hover.

Repeat this process for the left (counter clockwise) a few times, and then try it moving right (clockwise). You will eventually be able to keep the laps going and mix them together to make "figure eights." As you get more and more comfortable with your forward flight skills, begin to make different patterns in the air. You can also bring the helicopter lower and perform these exercises closer to the ground when you are ready.

Make sure that you don't fly the helicopter over your head in these steps. Once you're confident you're not going to crash it, take the training gear off and really have some fun.

# Progressing Further

After you become comfortable with forward flight, only time and perfect practice will make you better. Here are a few suggestions to make you a better heli pilot.

## Side Hovering

Practice different hovering positions. Hover the helicopter while it's facing left or right. The helicopter should be perpendicular to your body. The orientation is very difficult at first, but should be mastered. It can be easier to learn this while practicing forward flight.

## Autorotation

Practice autorotations with the helicopter. One switch on the heli can be dedicated to switching the motor to 0% throttle while still allowing full control over blade pitch. This allows you to simulate a motor failure. The helicopter will not maintain flight, but will land safely if you act immediately after a motor failure. Check the transmitter manual for more information. On setting this function.

You can try an autorotation in the air without landing the helicopter. After triggering the kill engine switch, pull the collective/throttle stick down to see how fast the helicopter descends. Flip the switch back to it's normal position and then quickly return the left stick to a normal position to stabilize the helicopter.

To perform an autorotation, hover the helicopter about 50ft above the ground with a slow forward speed. Flip the switch that kills the motor and bring the collective(left stick) all the way down to a negative blade pitch. The helicopter will nearly fall out of the sky, when it gets about fifteen to twenty feet above the ground start adding in your pitch to slow the helicopter's descent. Don't add all of it in too soon or you will crash the helicopter. At five feet you should increase your collective and set the helicopter down safely. You get one shot with this so make sure you're ready. Make sure the helicopter isn't moving forward while landing or it will tip over.

## Removing the training gear

At some point you will have to remove the training gear from the helicopter. This is a huge step because of how careful you must be when landing not to tip the aircraft over. Again, work your way to flying without training gear by removing two inches at a time from the trainer gear.

# After the Crash

### What to do when the bird goes down.

If you happen to experience a crash during your flight training, try not to become discouraged or turned off to the hobby. Most crashes occur because you were trying something you weren't capable of. Here's a quick list of things to do to get you back and flying as soon as possible.

1. Whether you're flying electric or nitro, the first thing to do in a crash is "kill" the engine. Upon impact, if the motor is trying to turn the blades it could burn out, over heat, or break more parts than necessary. So, turn the motor off.

2. Assuming you smashed in to mother earth and no one or nothing else was destroyed in the process, approach the helicopter in its saddened state. Look for smoke or fire before touching the helicopter. Follow standard shut down procedures.

3. Visually inspect the helicopter to make sure you can carry it. It may be in fifteen pieces, or it may be in three pieces. When you pick up the helicopter to carry it back, make sure you take all the parts with it.

4. When you get back to your bench, car, or takeoff area, grab a piece of paper and write down everything that looks broken. Most crashes are worse than you think. Upon further inspection you may find that there are many parts and pieces out of alignment or just plain missing.

5. Refer to the parts list in the manual that came with the helicopter and begin matching part numbers to pieces. It can help to make a spread sheet to keep track of these. Most parts aren't available at the local hobby store so head to the internet to find what you need. The JR helicopter parts are carried by Horizon Hobby, and are easily searchable under their part number search box.

6. Order the parts, wait until they arrive and then begin repairing. Use the manual to make sure all of the parts are put back in place correctly. You don't want to end up with fifty extra screws on the bench once the helicopter is rebuilt.

7. It's good practice to keep a "crash kit" on standby. A crash kit will include a set of main blades, a tail boom, landing gear, spindle shaft, and main shaft. Most crashes destroy these.

# Maintenance

There are a few parts of the helicopter which will need maintenance. It's important to keep all parts of the helicopter functioning properly for many reasons. You should perform a visual inspection of the aircraft before and after every flight. Take the fifteen seconds it requires because it will save you money and frustration in the long run. You may hear a strange nose or even see a part fall off while flying.

### Main Shaft

Every fifth or sixth flight, make sure to spread a small amount of oil on the main shaft near the swashplates.

### Tail Rotor

The tail rotor should be lubricated in the same fashion as the main rotor. Do not get the oil on the tail belt.

### Tail boom

The tail boom becomes loose and is pulled towards the airframe. It will also bend in a crash. When you have a rough landing, inspect the tail boom and make sure it's not bent. You will see a bend or fracture at the connection point.

### Loose bolts, screws

The helicopter has a lot of vibration and you will experience parts becoming loose if you're not checking for them. Where applicable, use Loctite® or Threadlock® to hold metal pieces in place. The manual will tell you where apply this.

***Notes from the Author:*** *A couple of lessons about maintenance*

1. While performing quick pirouettes flying my nitro helicopter without the canopy, my receiver pack became loose and began dangling from the helicopter in flight. Luckily, I responded quickly and immediately brought the helicopter down safely. I had been working on the helicopter that morning and in a rush I forgot/chose not to attach it properly.

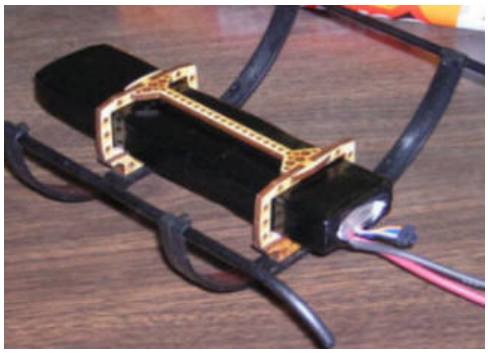
2. During a flight with my nitro helicopter, I was making really large figure eights and noticed a dip in the engine RPM while making left

turns. I chose not to land because in a hover, the engine sounded fine and it worked with right turns. After a few passes with the engine acting erratic, the engine finally quit. I tried to perform an autorotation to land it but the aircraft was too low with too much forward speed and I wrecked. The cause of crash was a rotted fuel line in a pre-assembled fuel tank. After calling and complaining about it, the company said it was routine maintenance to change the fuel line in the tank on regular basis. In my fifteen years of flying experience, mostly nitro, I have never seen fuel line rot occur in a fuel tank.

Jason's crash

Noah's crash

# Making a Replacement Battery Holder

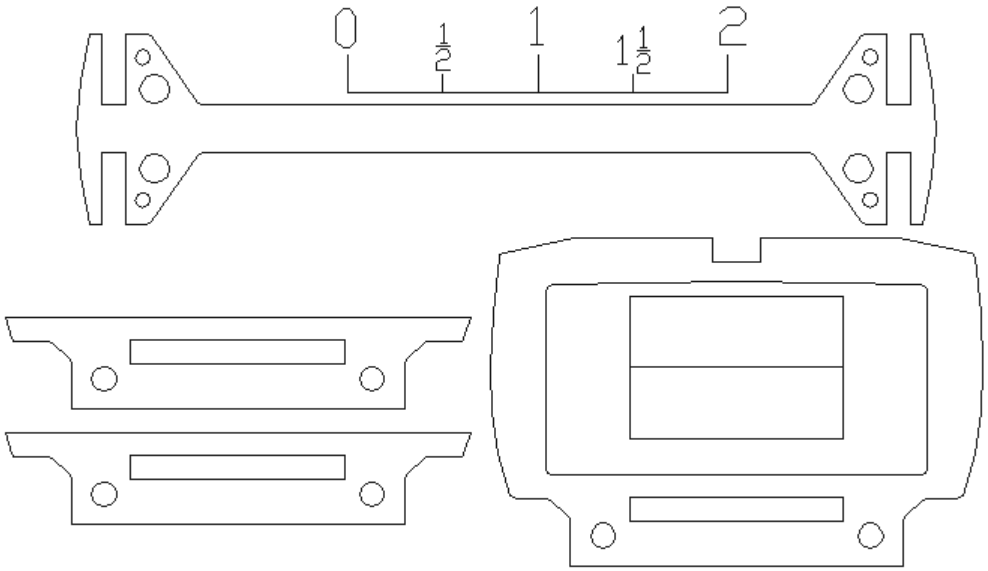


## Materials

1. Model aircraft ply, 1/8th in.
2. Epoxy, 5 minute
3. Zip ties, small
4. Drill bit, 3/16 in.

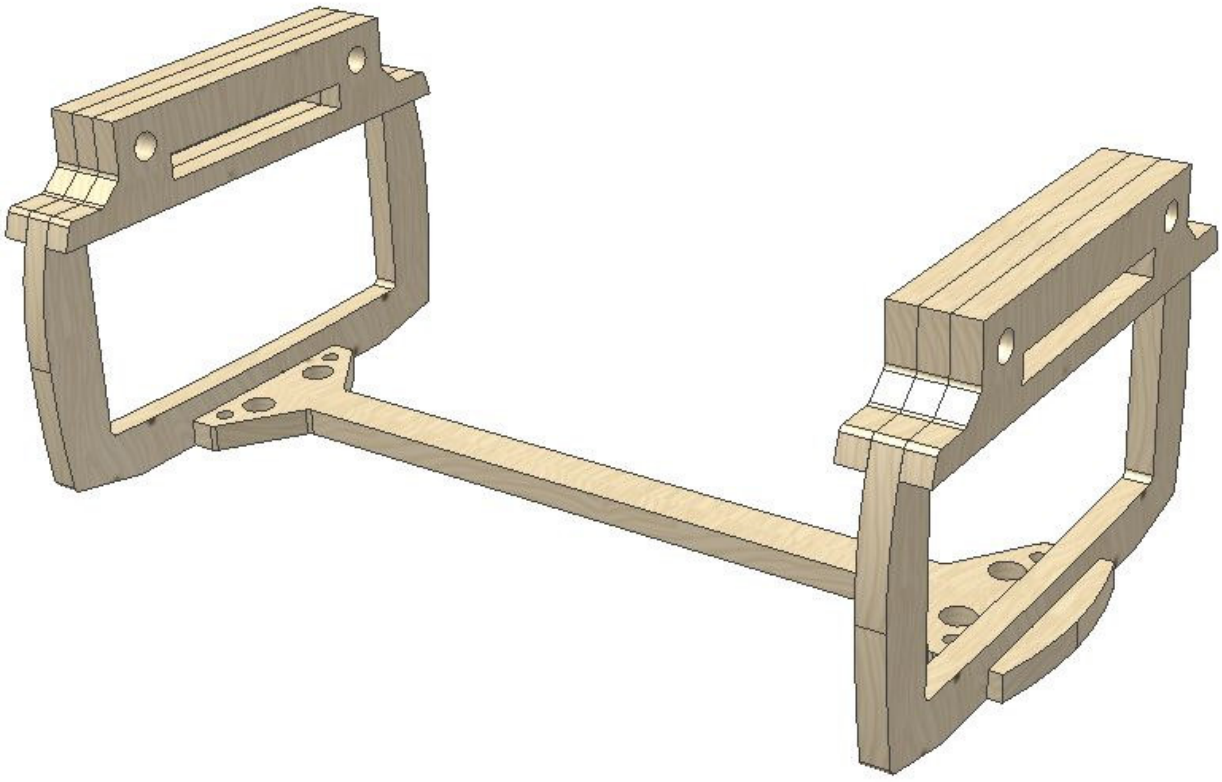
Shown below you will see the template for the battery holder. Photocopy this if the laser cut parts are unavailable. You can then transfer the template to the plywood by placing the photocopy, inked side down, on the wood and applying heat from an iron.

Once you have the template transferred to the wood, cut out the parts using a scroll saw, band saw or similar.



## Instructions

1. Cut out necessary parts or gather pre-cut lasered pieces.
2. Dry fit the components. Use the picture below as a guide.
3. Spread 5 minute epoxy on the parts, but not the bottom piece.
4. Allow time for epoxy to cure.
5. Drill out zip tie holes if they become filled with epoxy.
6. Attach battery holder to underside of helicopter using eight zip ties.
7. Use CA to glue in the bottom piece.



# Final Thoughts

As exciting as the hobby can be, it can also be very frustrating. Try not to become discouraged if you're not progressing as fast as you want. Some people will pick the concepts up faster than others. Being conservative in your flight progress is not a bad thing. The learning curve can be very steep especially if you have no one to turn to when you have questions.

1. Read as much as you can about the hobby. You'll get plenty of tips from the pros and ideas to keep you inspired.
2. Spend the money and buy a simulator; they really are totally underrated.
3. Be safe, smart, and as always "keep em' flying!"

### My two cents

Do not store the helicopter behind a door or in a high traffic area. Place it on a stable, strong shelf, out of the reach of anyone who does not know how to handle the helicopter. You can even place a "Please do not touch/handle" sign up to warn off others. A radio controlled helicopter is the coolest toy you can fly and put in your car.

# Notes