Pg 1 – Author Page

OCTOBER 30, 2016 BY CRAIGI

Getting Started with Hobby Quadcopters and Drones

By Craig S. Issod © 2013-2016 (Updated October, 2016)

The Author Trying to Take Off in Various Ways

About the Author

By any method necessary, Craig has been attempting to leave the confines of Mother Earth since childhood. In his adult life, he first tried CB Radio with pirate channels, then Ham Radio and vast antenna arrays on his rooftop. Finally he found the promised land of Compuserve (1986), AOL (1988) and the Internet (1994).

Along the way, he developed and sold various alternative energy products, wrote technical manuals, obtained two patents and, along with his spouse of 40+ years, had three children. Craig founded the popular alternative energy web site Hearth.com and a newer hobby site, Droneflyers.com, which is the impetus for this ebook. He won't be happy until drones do some actual work for him and the rest of us.

What others are saying about this book (from Amazon Reviews)

"As a neophyte this helped me understand how to get started without being confusing. I felt that I have a friend to walk me through learning this new hobby/profession."

"Thanks for taking the time and putting this together. Very informative. Clear and concise advice and instruction. Easy for beginners to grasp and understand"

"I was impressed. His explanations were well written, Plain and simple.

You'll like it"

"Good book, informative, well written, and very helpful for the newbie. What more can I say. A must for those new to flying RC Quads."

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Pg 2 – Introduction

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Introduction

The last couple of years have brought an explosion in news reports regarding drones and other unmanned aerial vehicles. Although some of these reports focus on the military models (Predator, Skyhawk, etc.), the bigger news is the progress in smaller drones which can do a number of tasks – from photography and video to crop inspection to search and rescue. This Beginners' Guide focuses on consumer and hobby drones – those which you and I can buy and fly on a budget. Even those with higher aspirations need to start with the basics. This book provides a foundation for your drone education and much more.

What's it all about?

They go by many names – Quadcopters, Quadrotors, Personal Drones, Multirotors, UAV's and even "toys", but these amazing flying machines contain advanced technology and are about to transform our world and our lives in many ways. What's more, you and I and others who are hobbyists, photographers, pilots or just have interest in technology can participate in this revolution at a very reasonable cost.

Where are we now and where are we headed?

2013-2016 were years of explosive growth in the drone market and related technology, as costs have gone down and capabilities have gone up. In 2017 this is continuing with lower prices and more reliable flight systems. These advances were driven by lower prices for the important electronic components, which were in turn driven by the rise of hundreds of millions of smartphones and game machines. The same electronic components which power our phones and game consoles (accelerometers, gyroscopes, GPS) help keep a drone flying. Cameras are also getting smaller and less costly, again driven by the market for millions of them inside smartphones, tablets and computers.

Why fly a Drone?

Drones may have advanced greatly over the last couple of years – but what's in it for you? Here are just a few of the reasons you may want to take up this pursuit:

Aerial Photography and video

*H*ow would you like a picture of your house, the local valley and farms, the beach or your park from high above? Your drone allows you take pictures and videos as in the photograph below.

Another popular type of video is called FPV or First Person View. In this case, the drone has a camera which beams video back to a set of video goggles or a screen. This allow the operator to feel the sensation of flying and twisting through trees, down a path or over a stream.

Racing, Flips and Acrobatic Moves

Some pilots have the competitive spirit and like to push things to the limit. You can learn a number of fancy moves to impress yourself and your friends! Others enjoy the social aspect of hobbies. There are even events where you can fly your quadcopter in races, demonstrations or just for camaraderie.

Technical Aspects, Modification and Building

Do you enjoy technology, engineering, futuristic pursuits, inventing and expanding your general knowledge? This hobby will allow you to satisfy any level of these interests. Beginners might feel a sense of accomplishment by replacing a few small parts while others build their own quadcopters using custom parts – many of which they make or modify themselves. Others write and modify programs which improve the stability and other aspects of flight control. If you are part of the new "Maker" movement, you'll find many ways to improve the basic drones which you purchase or build.

Fun and Stress Relief

You will often find yourself laughing out loud as well as forgetting about all the troubles of the world as you build, fly or fix your personal drone.

Future Commercial and Non-Profit Uses

There are numerous other applications for drone technology. Some examples:
Building and roof inspection
Search and rescue and Public Safety
Mapping and crop inspection and spraying
Other uses are only limited by your imagination and the continued evolution of drone hardware and software. As with any such venture you need to start with a basic foundation of knowledge.

Blade 350QX Quadcopter – note the 4 propellers

When you are finished reading it, you should know more about the subject of drones than most of your peers and therefore be able to help others. Putting that knowledge to work, you will be able to buy and fly hobby and consumer level drones successfully.

Use of Terms and Basic Definitions

Throughout this book, we will use the term *drone*, *quad* and *quadcopter* interchangeably, drone being the common use of the news media while quadcopter is more descriptive of the current crop of consumer models. Not all drones are quadcopters (4 propeller) Some have 6 or 8 props or are winged. A more accurate name might be UAVs, which stands for "unmanned aerial vehicles". Some use the term *robotic* or *autonomous* in their descriptions, indicating the drone may have more advanced capabilities, such as flying a pre-programmed flight path without operator input or control.

Since this is a Newbies Guide, we will start with only a few definitions – a more complete glossary is at the end of the book.

Drone – a catch-all term used to describe any or all unmanned aerial vehicles.

Quadcopter (quad)– an aerial vehicle which uses four (4) propellers that provide all the lift and steering functions. Similar names are assigned to designs with 3-10 arms and propellers (tricopter, hexacopter, octocopter, multirotor, etc.)

Autonomous – not subject to control from outside, often used to describe a drone which follows a preset path using GPS or other means, as opposed to being actively steered by radio control.

For ease of description, most of our pictures and examples will use *quadcopter* or *quad* as the subject.

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Pg 3 – Basics of Operation

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Basics of Operation

It's Electric!

Why are the new vehicles so different from toy helicopters and planes? In a nutshell, it comes down to vast improvements in batteries, motors and in flight control hardware and software. The new breed of LiPo batteries (lithium polymer) have a higher power to weight ratio, meaning they can power heavier devices and keep them in the air longer. The same batteries also power the electronics and cameras your quadcopter will use.

The current crop of batteries are capable of keeping quadcopters aloft for periods from 5 to 25 minutes, quite an accomplishment when you consider some of these machines can travel

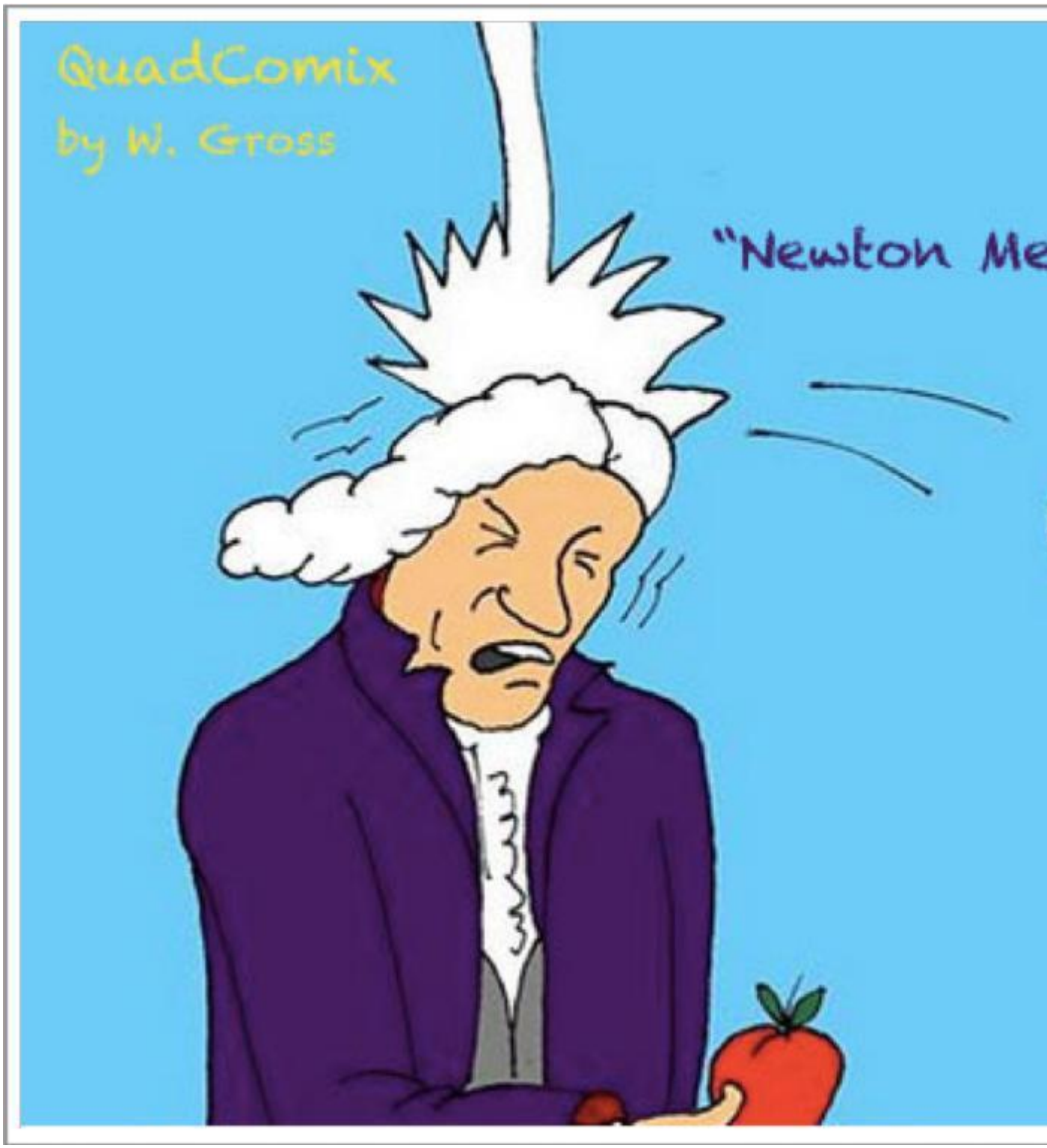
miles in that time. More advances are assured in the future, so specifications will continue to improve.

A quadcopter uses four propellers, two of them rotating clockwise and two counterclockwise. This creates a balanced effect, so that the quadcopter can hover with reasonable stability. The following diagrams and descriptions will help the newbie understand how the brains and brawn of these machines work in tandem to provide the magic of unmanned flight.

Aerodynamics of Quadcopters

Truth is they have no real aerodynamics! These are basically motors and propellers that can only fly with the help of their computer brains. Unlike a plane or even a regular helicopter, failure of an engine or part will invoke gravity without any glide ratio at all. Hobbyists have therefore been able to build quadcopters out of tupperware boxes (for landing in water), foam boards ($5 in frame costs), plastic wheels and other such materials.

It does help for quadcopters to be streamlined as wind will not have as much of an effect on them.

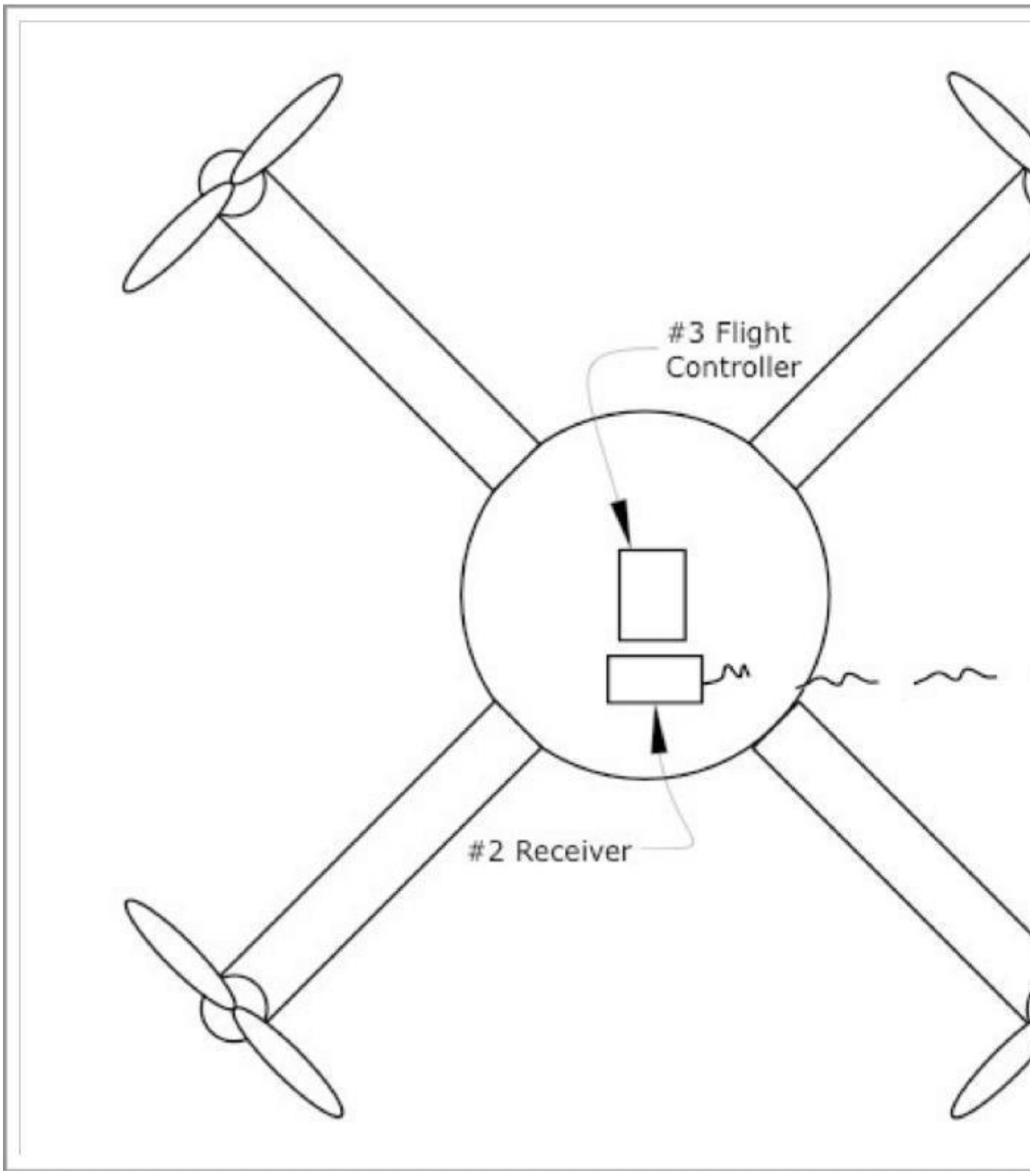


Like a Human (or robot)

It may help to consider the quadcopter as a robot, with the basic internal functions attempting to mimic those of your own body. The first steps in movement are your eyes, ears and other senses gathering input or instructions from the environment around you. With a quadcopter, this would be the instructions being given to the drone by the pilot or by a set of pre-programmed steps “listening” to many sensors in the drones flight control system (onboard

computers). In most cases the operator will be actively giving instructions to the flying quadcopter through the use of a radio control transmitter or a smartphone/tablet. You will notice that many discussions of quadcopters use the term “R/C” in them – which means “Radio Controlled”.

Item #1 below is the transmitter (TX – sometimes called a Remote), usually handheld, which is beaming the instructions to the drone. The part labeled #2 is the receiver – this is also a radio part and its function is to talk to your transmitter and hand over the instructions to item #3, the Flight Controller, which sends power to #4, the motors.



The flight controller (F/C) is the CPU (central processing unit) or brain of the quadcopter. Like a human brain, it has pathways for information both in and out. Here are the main inputs:

1. Power from the batteries

2. Instructions from your transmitter (usually in your hands).

3. Status reports from a number of tiny instruments (sensors) built into the quadcopter main circuit board. These may include gyroscopes for leveling, accelerometers to measure speed and direction, barometers and sonar for height control and GPS and compasses for determining your position on the earth. Simple quadcopters may only have gyroscopes, while very advanced models will have many or all of the above. Some recently released camera drones have added "Computer Vision" – the ability for the drone to see and recognize (and avoid or follow) objects!

Based on the combination of all these inputs, the Flight Controller (FC) makes decisions, most importantly exactly how much electrical power to apply to each of the four motors (#4 in the picture).

As an example, if you desire to fly forward, that requires the quadcopter to tilt in that direction – you should be familiar with this type of flight by having watched helicopters. By tiling forward, the propellers act to keep the vehicle in the air and to propel it forward simultaneously. In the case of a quadcopter, the command to move forward will put less power to the front two motors and more to the rear two, resulting in the machine leaning forward and being propelled in that direction. Side to side movement is accomplished in much the same way – the FC "brain" eases up on two propellers and powers the opposite two slightly stronger.

The comparison with your body is that the flight controller is the brain, the wires are the blood vessels and nerves, and the motors are your muscles, limbs and hands. Like your body, each system constantly gives feedback to the brain, resulting in amazing capabilities of movement.

Pg 4 – A Short History of Unmanned Flight

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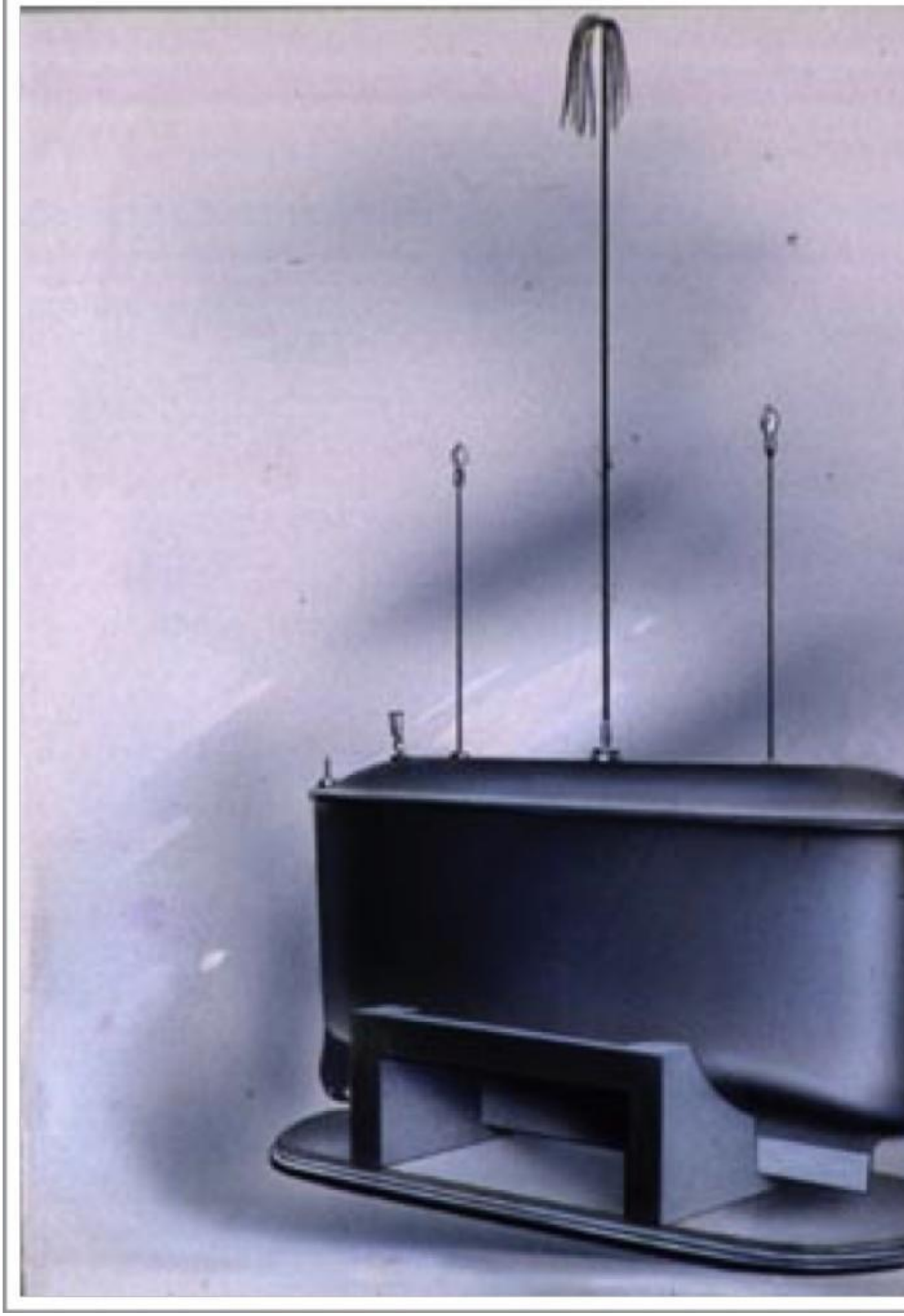
A Short History of Unmanned & Hobbyist Flight

The first demo of a Radio Controlled vehicle was in 1898, when N. Tesla showed a working R/C boat at an electrical expo at Madison Square Garden. He claimed the boat had a “borrowed mind” and obtained U.S. patent number 613,809 for various R/C schemes.



Tesla’s R/C Robotic Boat

Some hobbyists may remember building balsa wood airplanes many years ago. In fact, they remain quite popular today. It often took months to build these planes and the final results were quite impressive, but extremely fragile. Many were never flown – the completed plane with paint and decals graced many a man cave. Others installed small gas engines to drive the propellers and ran the planes in a circle, tethered to the ground with a rope. More daring hobbyists set up the planes so they would fly circles and land when they ran out of gas. Suffice it to say that one crash or bad landing often destroyed hundreds of hours of hard and meticulous work.

By the 1960’s, radio controlled wing surfaces and rudders were allowing better control of the aircraft and the invention of the transistor meant that radio and other electronic components could be made much smaller and lighter. At the same time, another method of flight became quite popular – model rocketry. These were quite sophisticated and able to travel thousands of feet into the sky. Some of the models featured one-shot film cameras, which provided a great addition to the hobby. Others carried payloads, including small animals. In fact, your friendly author has sent mice up 1,000 feet or more in padded capsules, with all returning safely to earth by parachute. The *Space Craze* bought on by America’s race to the moon, created a new generation of budding engineers and scientists.

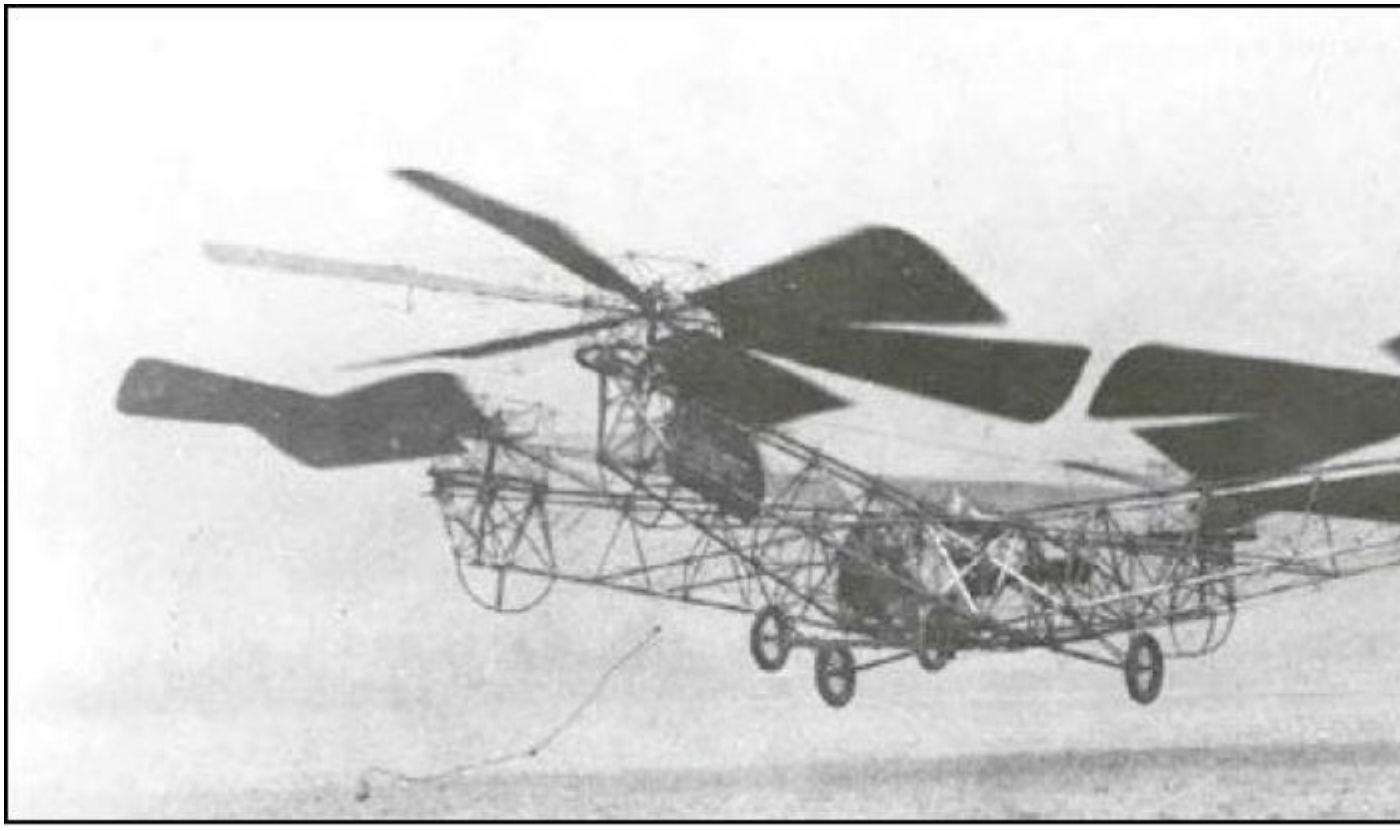
As mentioned earlier, it is the coming together of all the various electronic and electric technologies, from batteries to radios to advanced sensors, which now allows for much more sophisticated vehicles. Just as importantly, improvements in materials such as foam, carbon fiber and fiberglass have allowed for aerial vehicles which last more than a few flights. Some quadcopters can drop out of the sky from 100 feet and suffer little or no damage!

Whereas early models required skill and determination to build, fix and operate, some current models can be purchased and enjoyed by almost anyone – with some caveats (more on that later).

The First Quadcopter

The de Bothezat helicopter, also known as the Jerome-de Bothezat Flying Octopus, was an experimental quadrotor helicopter built for the United States Army Air Service by George de Bothezat in the early 1920s, and was said at the time to be the first successful helicopter. Although its four massive six-bladed rotors allowed the craft to successfully fly, it suffered from complexity, control difficulties, and high pilot workload, and was reportedly only capable of forwards flight in a favorable wind. The Army canceled the program in 1924, and the aircraft was scrapped.

The de Bothezat Helicopter



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Pg 5 – Buying a Quadcopter

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Buying a Quadcopter

Start Small and Learn

Whatever your goal, most newbies should start at the same place – with the purchase of micro or mini sized quadcopter (and possibly a good simulator) and hours of initial practice.

The toy drones you will learn to fly on are largely disposable – they work great and are loads of fun to fly, but the motors and other parts tend to wear quickly. The prices have come down so low that I often suggest buying 2 of the same model – that way you have an extra battery, 4 replacement motors and other extra parts. In many cases this costs less than stocking up on spare parts.

First Newbie Rule of Drones

You WILL crash your quadcopter many times while you are learning and repairs/replacements for a small quad are much less expensive than with a larger model.

Nanos vs. Micros vs. Minis vs. Full Size

Although there is no official definition of these size ranges, a rough grouping would go somewhat like this:

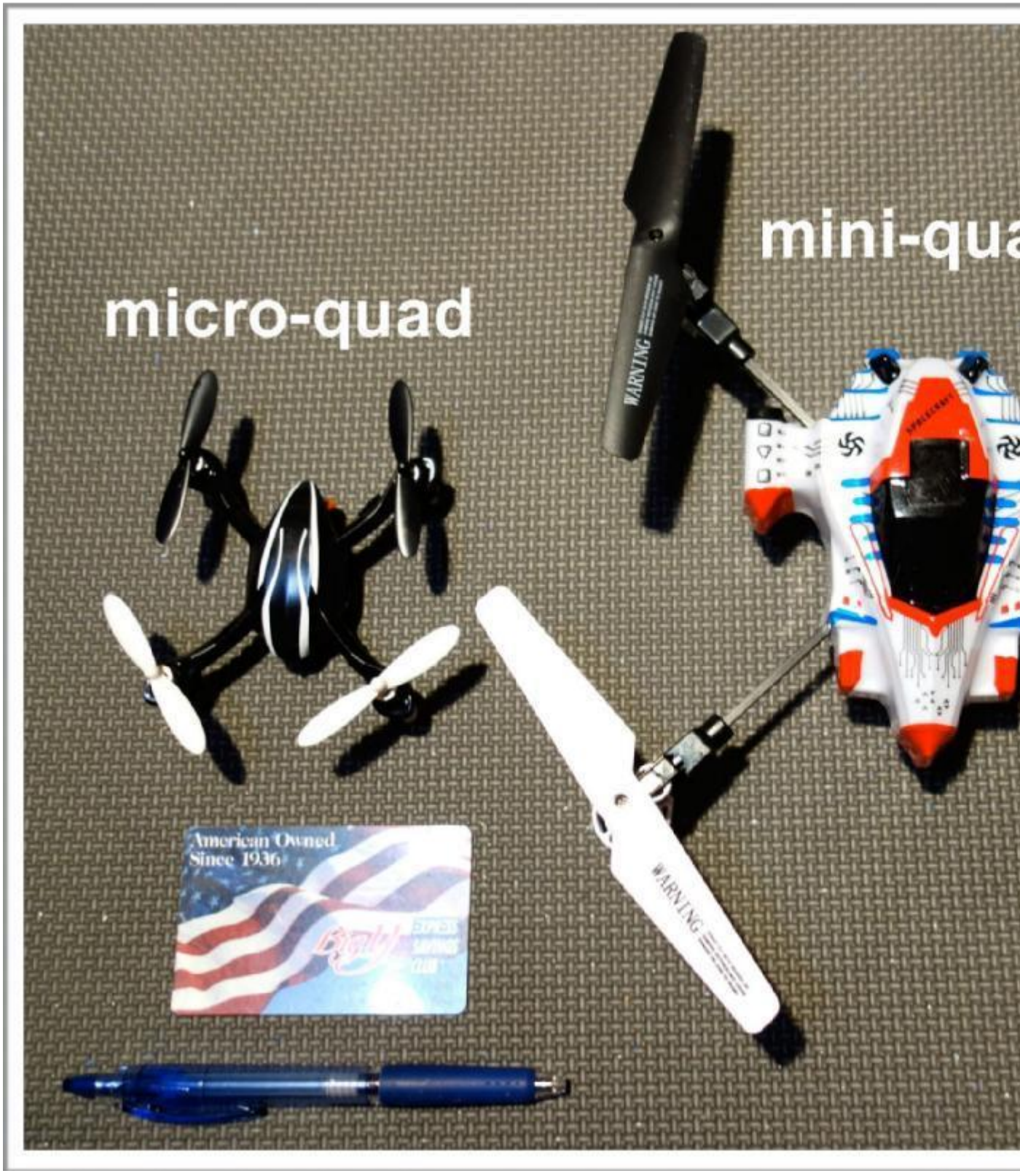
Nano drones/quadcopters – these are truly tiny – often not much bigger than a large coin (and much lighter in weight). Although a fun demonstration of technology, they are not suggested for beginners because of their poor flight characteristics. Examples include the Estes Proto X and WL Toys 272.

Micro drones/quadcopters – these fit into the palm of your hand and measure 3 to 4 inches diagonally motor to motor. Most of them are “direct drive”, which means the motors directly spin the propellers (no gears). Total weight is approx. 1.5-2.5 ounces (40-60 grams) with battery.

Mini drones/quadcopters – these are quite a bit larger and measure 8-10” diagonally motor to motor. Many of them use the same motors as the Micros, but use gearing to drive larger propellers. Total weight is usually approx. 3 ounces (80+- grams) with battery.

Full Size Quadcopters – are classified by weight rather than size, as the bigger motors and batteries and payloads are the most important parts of the system. Most larger quads are direct drive – that is, the brushless (higher quality) motors directly mount to the propellers. They weigh in at between 1 to 2.2 lb+ (1/2 to 1+ kg).

For newbies, either a **micro or a mini** will be a fine learning platform. Those who intend to learn indoors will probably be better off with the micro size.



Starting with Simulators

There are computer programs available which may help give you the feel of flying a quadcopter. These run the gamut from inexpensive smartphone or tablet apps to much more sophisticated PC and Mac software which can use a real R/C transmitter

connected to your computer via USB. Some examples of the genre and their capabilities are as follows:

Heli-X (www.heli-x.net) – This is a program which has numerous models of quadcopters built into it. A program such as this can really help you to learn to fly – and, although somewhat costly ($70-$180), are definitely worth the money for the serious pilot who wants to crash less in the real world. Note – a free trial is available, so be sure it works and suits your style before you make a purchase.

AeroSIM RC (http://www.aerosimrc.com) – This is another full-fledged simulator program with many models and modes built in.

IndoorHeliSim (Google Play Store) a free android app that is quadcopter only. This app simple, but effective and had various settings so you can get the feel as a beginner or a more advanced flyer.

FPV Freerider (http://fpv-freerider.itch.io/fpv-freerider) for Mac, PC and Linux – free demo and only $4.99 for the program. This simulator is aimed at those who want to do FPV racing or acro (acrobatic) flight.

NeXt Flight Simulator (http://www.rc-aerobatics.eu/cgm-rc-heli-simulator_e.html) – This full featured sim has dozens of helicopters and also a few popular quadcopters such as the Phantom.

DJI Phantom and other DJI Models – have a flight simulator built into the DJI Go App. You must, however, own the product in order to access this full featured simulator.

How much will this hobby cost?

This is somewhat variable depending on your wants, needs and budget. If you are happy with the smaller range of quadcopters, a year of fun can be had for the price of a couple fancy dinners out. On the other hand, if you are the proverbial fool who is easily parted with his/her money and buy a $1,500+ setup and instantly dunk it in the river while taking your first video (yes, it's done quite often), then it will set you back quite a bit more. Since this is a newbies book, let's set a starting budget of about $200 total for a couple small quads, extra batteries, accessories, modifications and repairs. If you decide to take a step up to much larger photo/video craft like a Phantom 3 the total will likely be triple that or more. A wider range would be from $200-$2,000 – depending on where you want to go with your 2nd or 3rd quadcopter.

Which model to buy first?

As in many other endeavors, not only is the brand and model of importance, but also the vendor (store, online site) you decide to purchase from. Some vendors are China or Hong Kong based and some offer very good prices and are reliable and honest.

However, a (USA-based) newbie should consider purchasing from a US based vendor (shipper) when possible for a number of reasons. First, communication with the foreign vendors can often be difficult – not so with your local hobby shop, Amazon (US shipped only) or the better US based sellers. Secondly, it can take weeks for shipments to arrive – no need to play the waiting game to save $5 or $10. Consider the return policy (defective product), parts availability and advice. Therefore, the author suggests one of the following vendors or types of vendors:

A local hobby shop – Unfortunately, many areas do not have shops that specializes in quadcopters – but, if you do, this may be the first place to look. Check to see if they have a friendly and knowledgeable staff and can answer your questions and concerns.

Online specialists or Big Retailers – there are a number of vendors who specialize in quadcopters. Some examples at the time of this writing:

Horizon Hobby – maker and distributor of the well regarded Blade products – known for good support after the sale.

Amazon and eBay also have nice selections – often sold through retailers who partner with them.

Banggood – a well known Chinese merchant, now had a USA Warehouse with quick shipping and low prices on toy quadcopters.

Quadcopters are popular all over the world. In fact, sales of this book are doing very well in the UK, France as well as elsewhere. Many people have no choice but to purchase from the Hong Kong and Chinese vendors – and there are some with very decent reputations. As of this writing, Banggood.com is one such vendor which seems to treat customers well. As always, look into the reputation of your chosen vendor. It will be easy to find discussions about the various suppliers on the online R/C forums.

About returns and refunds

It is rare for a new quadcopter to have factory defects – more likely, the customer takes it out the box, flies it into a couple walls and then claims it's broken. In other cases, the customer simply does not know how to calibrate or fly the drone. Many vendors do not accept returns of used quadcopters – as well they shouldn't – since most damage is often of the "you crashed it, you broke it" variety. However, for those cases where something is truly wrong out-of-the-box, the return policies of Amazon and other vendors (and even paypal payment) could come in handy. Using the Chinese vendors, very popular due to low pricing, usually means that you cannot

return the product even if defective in the box. Depending on the vendor, you may be able to get a replacement part for no charge.

Higher end vendors such as Horizon Hobby (Blade Quadcopters) and Traxxas have better customer service, return and warranty policies. However, you will pay more for their machines. It's up to you, the consumer, as to which makes most sense to you.

Don't be a Pioneer when Purchasing!

It's best to avoid newly introduced models of quadcopters, even from established companies. Reliability is often poor and parts are not immediately available. Models which have been on the market for a year or longer usually have been improved to deal with initial quality control problems. Go with the tried and true for your initial, and perhaps even your later, drone models.

W**ait before you get an expensive Camera Model**

Many of the toy quadcopters have upgraded models with photo and video capabilities. These will be tempting as many pilots foresee taking aerial shots. However, the best first quadcopter is a stripped-down model with no camera or extras. This will allow you to put your full concentration on flight and not think about "getting the shot". Beginners also have a tendency to crash and/or lose their first quadcopter(s) – so you will have the opportunity to buy a camera model soon enough!

Note: Some models, such as the Syma X5C, include a camera and are inexpensive enough for a first machine. Still, it's better to ignore the camera until you get the basic idea of how to fly.

Your Flying Grounds

Before choosing a model and size, consider your living and yard spaces and where you intend to take your first flights. If you picked this book up mid-winter in Maine, chances are that you are going to try to learn indoors! The same goes if you live in a small apartment – a micro quad will make a smaller space seem a little bit bigger, so they can be ideal for those who are a bit tight on space. Some other considerations to keep in mind are:

1. Wind resistance – micros, since they provide a smaller wind profile, are usually better in a breeze.

2. Visibility – as you improve you may have interest in flying your quad a bit further away from your person – a micro will quickly become a very small dot once it is more than about 40 feet away! Minis can be flown up to 200 feet away with some success.

Most flyers will eventually have at least one of both sizes, so you really can’t go wrong with this decision.

Note – although learning indoors is possible, your family is unlikely to take to you crashing into the good furniture. An open basement or garage provides a better starting place – even better would be to have a practice room with carpet or soft flooring!

Brand Names and Models

The following units are examples of good first quads.

Hubsan X4 -H107 (Micro – $25-$50) – buy the optional prop guard if you are just getting started. This is an improved newer version of the X4…the first version had some shortcomings.

Syma X11 – ($30) In-between a micro and mini size, this is becoming a new favorite of many for learning and messing around. It comes with propeller guards as standard. It uses gears to drive the props – so you will have to eventually replace both the gears and motors.

Syma X5C – ($50) – Mini-sized and perhaps the most popular starter quad in the middle size range. More expensive variations of this model have "FPV" where your smartphone mounts on the TX and can see what the quadcopter camera is pointing at. Most beginners would be better with the base model as this type of monitor can distract from actual flying.

Blade Nano QX (Micro – $80) – if you don't mind spending the money, this is a high quality and capable learning machine.

Dromida Ominus (Mini – $70) – a decent machine – a newer and more advanced design.

JJRC 1000 – ($35) Great starter drone somewhat in-between the micro and the mini size.

These, of course, are not the only quadcopters which would fit a beginner, but they should give most fledgling pilots a good place to start. The appendix contains both a list of manufacturers and a list of some of the quadcopters to consider in 2015. You can also find up-to-date reviews at droneflyers.com

How about the DJI Phantom or other larger models?

DJI Phantom models are very popular "flying cameras" for video and photography. We have included a chapter later in this book about the Phantoms…and also have published two additional books on the Phantom line. Budding pilots with little or no R/C and flying experience should probably start with some "toy grade" models as outlined in the following pages. If you want to "start big" you could consider a used or refurbished Phantom 1 or "new old stock" Phantom 2 model (approx. $340), but be sure you do your learning in a large open area. A GPS stabilized quadcopter such as the Phantom will actually be much easier to fly than many of the toy machines, but you will not learn as much about manual flying.

A very careful and conservative newbie who takes the time to carefully study the manuals, videos, etc. could probably skip the toy models and start with a Phantom – but in my experience this type of pilot is rare.

Note: More information on DJI models can be found later in this publication.

Are the Parrot Bebop and AR Drone for beginners?

These are mid-sized drones which are controlled from a smartphone or tablet computer. Both machines advertise full feature sets – however they operate differently than most of the quadcopters on the market and have a very short flying range (stock). In general we do not suggest any of the Parrot models for beginners (nor for more advanced pilots). The same goes for other models based on smartphone-only control. For proper flying of drones you need to "learn the sticks" of a standard R/C controller.

FAA Registration – Not needed for Toys (under 250 grams)

As of December, 2015 the FAA has requested that all drone pilots register and get a "tail number" which must be displayed on your equipment. This pertains only to larger and heavier quads – those over 250 grams. Registration is only $5 and can be done online at https://www.faa.gov/uas/registration/. Most beginner quadcopters are less than the 250 gram limit so no need to register yet!

About 3-4 Axis and 6 Axis Stability

Another consideration when choosing a first quadcopter is whether you want to learn in a more manual fashion or have help in the form of features which make flying and control easier. Although these terms sound technical, the summary is that 6-axis quadcopters will self-level when the operator takes their fingers off the right control stick. 3-4 axis models will continue in the direction they were going – even if that direction is a steep angle toward the ground. In general, a 6 axis quad will be easier to fly, but that may not be what you desire. As an example, if your interest in this hobby involves flying acrobatically, doing flips or racing pylons then you will need a lot of manual skills. The 3 or 4 Axis quad will force you to learn more about all the forces in motion. If you really want to learn some of the ropes, consider the 3-4 axis a better tool for the job – or, get one of each! One will build your confidence and the other will build your skill set. At the time of this writing, these are some popular starter quads and their number of axis:

3 or 4 Axis – Syma X1, WL Toys 929, HCW 553
6 Axis – Blade Nano QX (has a 4-axis mode also), Walkera QR Ladybird, WL Toys V202/212/222, Vitality H36, MJX X100, Hubsan X4 H107, JXD 388, Syma X5, X11

(Before buying, please confirm the above information with other users and the vendor.)

Certain models, such as many in the Blade line, have two or more modes – some which are 6-axis as well as a more manual mode which mimics 3 or 4-Axis.

Whether 3,4 or 6 axis, start with a model which you know is a good one for beginners. Use online reviews at Amazon or the advice of a good vendor for your final selection. Or, join our forums at droneflyers.com/talk and ask away!

Note – in 2016 , 3 and 4-Axis quadcopters are becoming less popular, since they are harder to fly. Most all larger quadcopters (Phantom, Blade, etc.) are 6 Axis and so the manual flight skills are not as important. However, those who want to be ahead of the pack in terms of piloting skills can still learn a lot from 3 and 4-Axis quads. Those looking to enter the racing and acrobatic parts of this hobby should definitely learn in this fashion. The knowledge gained will likely help you save your more expensive machine sometime in the future!

Spare Parts

It's best to buy a small supply of replacement parts along with your quadcopter . This will help you avoid disappointment when your propellers crack or your sole battery runs out! If possible, ask your supplier what parts they would suggest for a beginner. Examples include:

1. Purchase at least one or two additional batteries. Each battery will provide up to 10 minutes of flight time, but could take up to one hour to recharge.

2. Propellers – many of the kits come with a set of extra props – but some of the micros can go through them fairly quickly. You may want to order another couple sets.

3. Motors – it is likely that you will destroy a motor or two in the first few weeks of use. It does take good eyesight and some basic mechanical ability (some require solder, others plugs) to replace a motor on these quads. If you have what it takes, then order one of each (clockwise and CCW) motors or complete motor/arm assemblies.

Some models have motors which plug into the flight controller as opposed to being soldered on. These may be a good option for those who don't want to learn how to solder.

If you find that parts are not easily available, it may be good to change to a model where the vendors have plenty of spares. You don't want the lack of a $4 part to keep you grounded. Some quadcopters are so inexpensive that you can buy two – one to fly and one for spares, and still spend only $50 or so in total.

Quadcopters differ in how easy they are to repair (see section "DIY Drone Repair and Upkeep" later in this book). Many require basic soldering skills as well as nimble fingers and good eyesight to make a repair. Others may have plug-in motors and other components which are more modular and easier to replace.

FB Comments

Pg 6 – Flying a Quadcopter

OCTOBER 30, 2016 BY CRAIGI

Section 6 – Flying a Quadcopter

Preparing to Fly

It's an exciting day!

Your new quadcopter is unpacked and sitting on the table in front of you. The first order of business is going to be to charge up the batteries. Most of the low cost drones come with a USB cable that connects to the battery and provides the charge. Some come with a plug-in AC charger. Either way, get your batteries charged up ASAP so you can get your quad up and running. Note – do not charge the batteries up more than 3 days before you plan to fly as they lose some charge over time. Batteries which are not going to be used soon are best left in a less than fully charged state.

Your transmitter needs a couple batteries also – AA or AAA. Make sure you have these on hand.

While your batteries are charging, scan your owners manual as well as any online reviews of your quad model. Some of the manuals are quite poor in their translation from Chinese to English, so don't expect to understand every word. If you find a decent online review (such as on our droneflyers.com site), it will likely instruct you how to get started with your new toy.

Note: LiPo batteries should be charged on a fireproof surface – it is remotely possible for them to self ignite! Keep them away from loose papers and other combustibles and charge inside an ash tray, small bowl or similar container. PLEASE READ OUR SAFETY APPENDIX BEFORE CHARGING OR FLYING YOUR QUADCOPTER.

Becoming Familiar with your Transmitter

Most quads are sold with a transmitter (also called TX or Remote) which is set up as "mode 2". This means that the throttle is on the left while the right stick controls the pitch and roll (forward/backward and left/right) of the drone. A typical TX panel is shown below:

The left stick controls the speed of the propellers and therefore is set all the way back (down) before flying. The right stick should be centered for testing and most liftoffs. The small silver switches, two under the sticks and two toward the center, are for trimming the quadcopter so it hovers without drifting off to one direction or another.

Booting up your Drone

Caution – the spinning propellers on ALL quadcopters could cut or injure humans or pets! We'll discuss safety in more detail as we go along, but please take basic common sense precautions when using your new quadcopter and charging your LiPo batteries. Most importantly, avoid any situation where people or pets could come into contact with an operating quadcopter.

Read your owner's manual for full instructions on your particular models – here are the usual steps involved in booting a mini or micro drone.

1. Have transmitter ready and powered with the specified batteries (usually AA or AAA). Make certain that the throttle (left stick) is off (down fully toward you).

2. Insert quadcopter LiPo battery into quadcopter frame as shown in manual.

3. Connect battery leads – note, some batteries auto-connect when you insert them.

4. Immediately set the quad down on a flat and level surface. This step is especially important as many quads use their initial position as a reference for how straight and level they will fly. (certain newer models may not require this flat surface)

5. Turn on the transmitter – most will go through a series of beeps and then stop beeping. This indicates the transmitter is "bound" to your quadcopter. It is often necessary to move your throttle stick forward and backward once to arm (unlock) your quadcopter. A beep often indicates that the quad is armed and ready to fly. Certain models require other actions to arm them – this will be detailed in the owner's manual.

Your quadcopter is ready to fly – are you? Probably not, so let's go through a series of short checks so we don't run into many surprises.

NOTE: Some models use the opposite method of turning on – that is, you turn on the TX first and then install the battery and/or turn on the switch on your quadcopter. Check your manual for details on your model. Also, some newer models self-calibrate so do not need to be set on a level surface.

Testing your Quadcopter

The first-time pilot should continue slowly so that their craft (or the family cat) is not damaged too quickly. One testing technique involves weighting the quad down so it does not fly and then slowly checking all the transmitter functions. Here are a series of steps to do so:

1. Place a small weight, such as a wrench, etc. so that it holds your quad down (near the center) without being near the spinning propellers. Depending on the particular model, you may have to use a small piece of string, wire or a rubber band to hold the weight to the center of the quad

2. STAND BEHIND THE QUADCOPTER FACING IN THE SAME DIRECTION AS ITS NOSE. Slowly apply power to the propellers by pushing the left stick (throttle) forward. The propellers should spin up and increase in speed as you push the throttle up. Do not push the stick all the way forward, just enough to start getting the feel of the controls.

3. Once you are comfortable with the spinning props, test the basic functions of the right stick on your transmitter. This stick is normally centered – pushing forward on it should make the drone lean (with the weight on) in the forward direction of flight, while pulling back should do the opposite. Pushing the right stick to the left should make the quad lean left, while pushing it to the right should make it lean right.

An alternative method of testing is to use a small length of string or thin rope to tether your quadcopter to the ground. You can then test takeoff and basic stability while being sure the machine will not fly away and crash.

If all is well, your quad and you are ready to attempt flight…after a short technical break.

For Pilots, Nerds and other know-it-alls

The various directions in which an aircraft can moves each have distinct names – as do the usual flight controls which make the vehicle take these actions. The testing phase above describes two axis of movement, those being forward and backwards and left and right. The following definitions will apply:

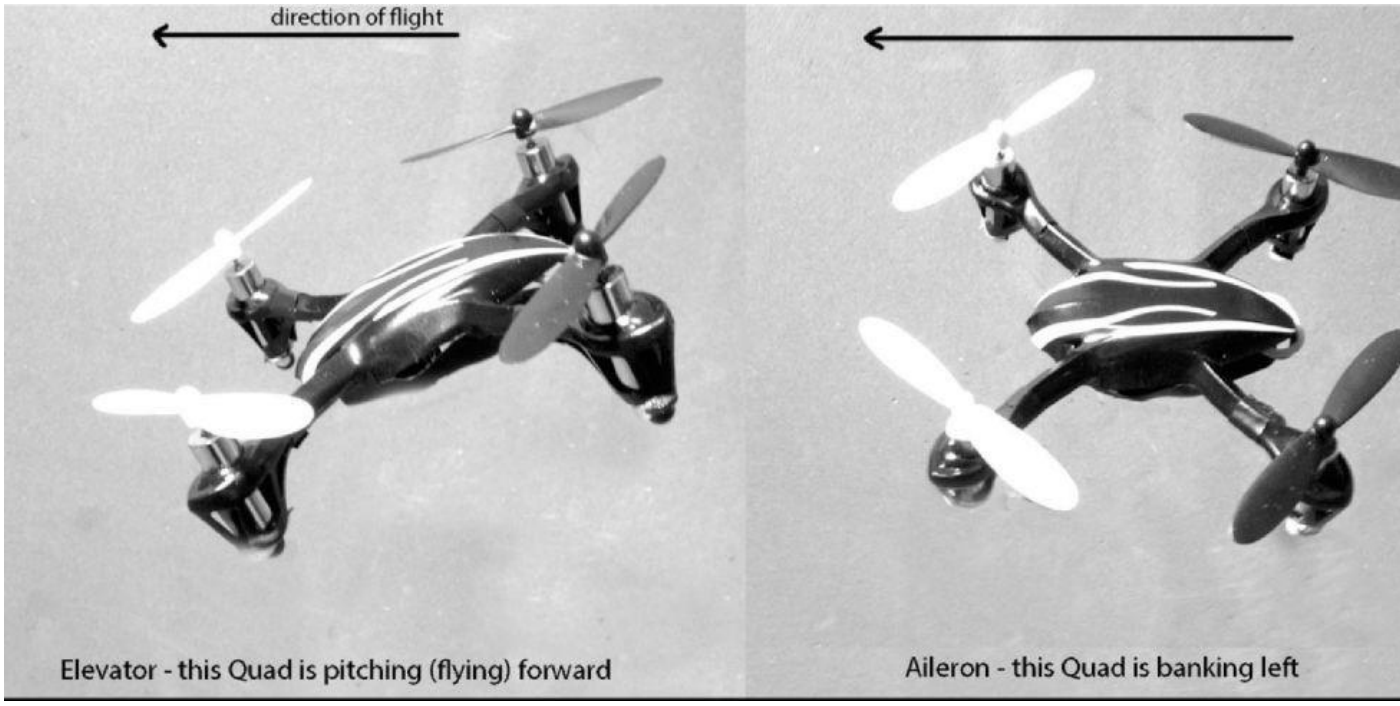
Pitch – this describes the angle of the quadcopter as relating to level, whether front to back or side to side.

Aileron – this is the flight control used to make the quadcopter lean left or right – the actual movement is called “roll” or “banking”.

Elevator – this is the flight control used to make the quad angle up or down when facing forward. Pitch is the term used to describe the effect of the elevator on the nose of the aerial vehicle.

Rudder – This describes the flight control which makes the quad rotate on its center axis – that is, stay level and spin on its center axis (as in dance pirouettes).

Since a quadcopter is computer controlled, there are no actual flaps as with a fixed wing aircraft. If your quadcopter were an airplane, the elevators would be the tail flaps and the ailerons the wing control surfaces. Instead, control is achieved by varying the exact amount of power to each of the rotors.



Whew! I'm glad that's over with – now let's get back to flying.

Lifting off and Hovering

Remove any weights which you may have used to hold your quad to the ground during testing. Ideally, you are outside over grass for your first flights as the inevitable crashes are unlikely to do as much damage.

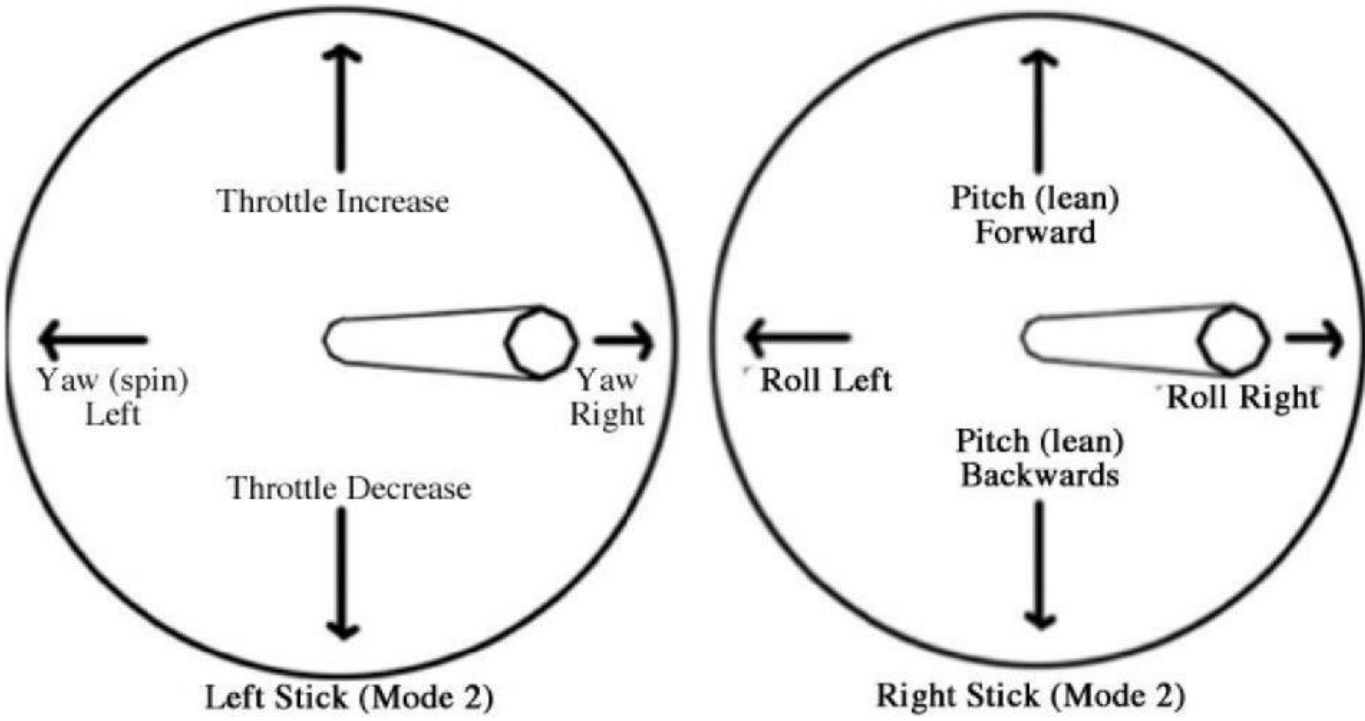
Next, while standing behind the quadcopter, slowly apply power to the throttle by moving it forward. Continue applying power until your machine lifts off the ground. It's best to initially raise the quad 2 to 3 feet off the ground, as they can be quite unstable when very close to floors, walls and ceilings. You want to get it high enough to be in "free air". Ideally, your quad will hover and not move too quickly in any direction. This indicates that your gyro is properly set. However, if you are practicing in a confined area, it could take some time to get the hang of hovering.

If your quadcopter seems erratic and moves quickly in any direction without your steering it, you should land it, disconnect the battery, and then reconnect it – making 100% certain that you are on a perfectly level surface. Then try again – you should not attempt to fly until you can hover within a small area – say about 6 X 6 feet. This may require small amounts of stick input from your right stick. If you are, as instructed, standing behind your quadcopter, the right stick should steer the quad as shown below.

The left stick is the throttle (up-down) AND, when moved left and right rotates the craft on its axis.

Depending on your level of coordination and previous experience with similar types of controls, it may take quite a few attempts before you are able to hover properly. Many of your first flights will be taking off and then landing quickly when you feel the quad is out of control. Don't fret – practice makes perfect and you will succeed after enough attempts. Take baby steps because attempts to fly far and fast will definitely result in losing or destroying your quadcopter.

Note: We have written a number of articles which you can find on our blog & forum at droneflyers.com

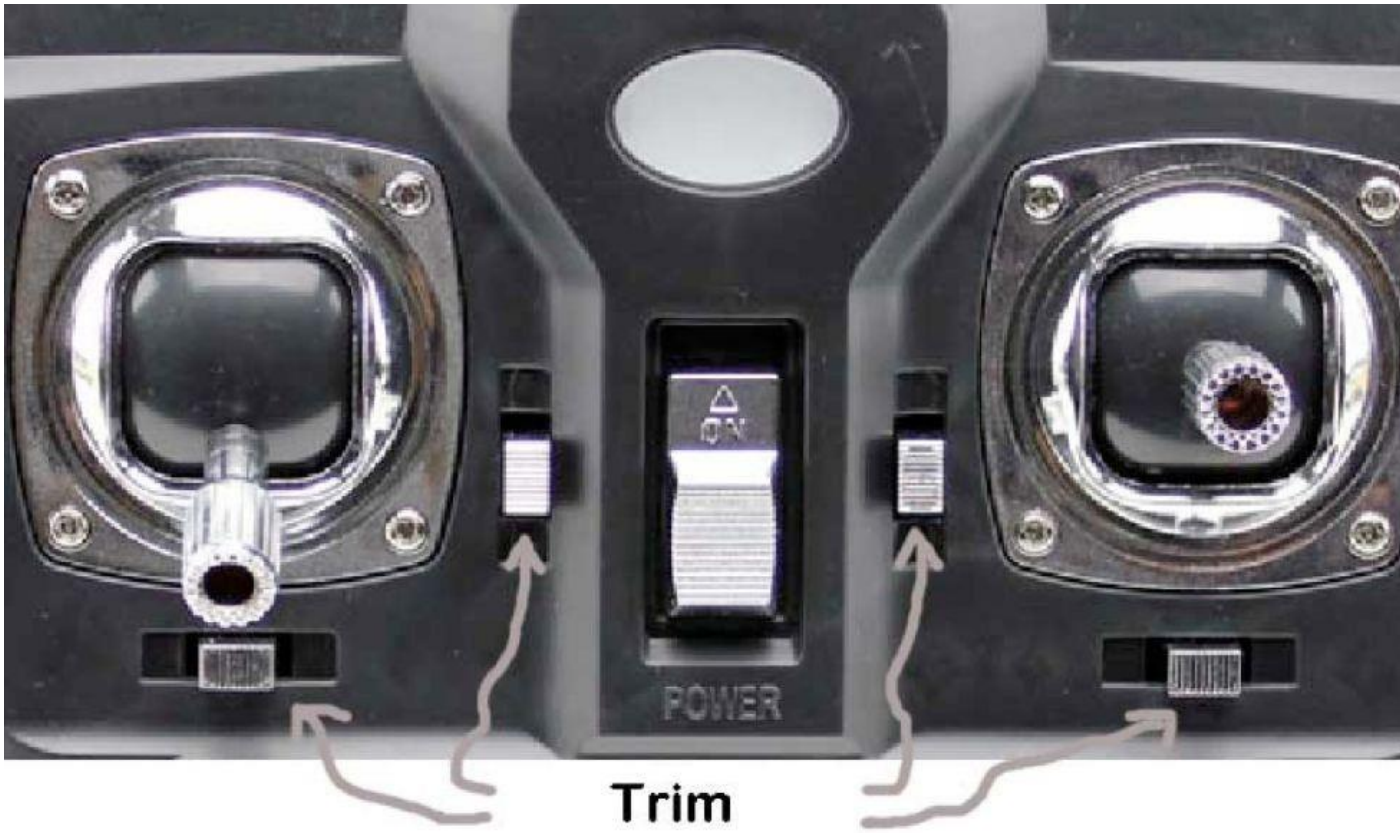


Youtube will also be a good source of videos about your specific model.

Trimming your Quadcopter

If your quadcopter seems to drift in the same direction constantly or spin on its axis, you may need to trim your transmitter slightly. Most transmitters have four switches which can be nudged in one direction or the other to help the quad hover in a more centered fashion. As one example, if the quadcopter tends to drift forward, the two middle switches could be pressed down a few clicks to favor the opposite direction. Note: do not use trim unless you are 100% sure that the quadcopter has been initialized (started) on a flat and level surface. Trim is only for making very small adjustments – if your drone is heading very quickly in one or another direction, it is likely the problem is elsewhere such as failing motors or stripped gears.

Read your manual regarding the trim buttons as they differ with various models.



The Next Steps

Once you can successfully hover, it's time to fly further away from the nest! This will familiarize you with the way your quadcopter responds to movement of your control sticks. Ideally you'll have an outdoor area at least 50 feet square for micro and mini quads. Your first exercise should be to fly your quad directly away from you – forward – by pushing the right stick slightly forward. Of course, you also have to keep the perfect amount of pressure on the left throttle stick – quadcopter flying is multitasking – you may also have to correct the course of the quadcopter to the left and right using the right stick (left/right movements).

Fly 10-20 feet forward and then pull slowly back on the right stick to bring the quad back toward you. As with hovering, this may take you some time to master – but don't give up! It's all a matter of training your brain and reflexes – similar to driving a car, which would be near impossible if you hadn't put in so many hours of repetition.

Landing your Drone

Unless you have an advanced model with automatic landing, you are going to have to learn the technique of gently lowering your machine back to the earth. One way or another, each takeoff means one landing – although many are what we call "unscheduled landings" (crashes). Landing can be harder than it seems, especially on 3 or 4-axis craft which must be perfectly level in order to avoid the propellers hitting the ground before the landing gear touches. Practice on a soft surface such as short-cut grass or carpet. Lift your quad a few feet off the ground and gain control

so that you hover under control – then slowly back down on the throttle until the drone nears the ground.

It's VERY important to cut the throttle 100% during crash or hard landings, as keeping power to the blades and motors when they strike grass or the ground may harm them. Most of the beginner quadcopters can drop from a few feet up (or even higher!) onto a soft surface with absolutely no damage – unless you keep the throttle on!

Next Steps in Flying

Once you are confident in the basics, you can start practicing other moves. Successful piloting of any aircraft or motor vehicle requires the ability to do a number of things at the same time. This will eventually come naturally, but you have to train your brain and your muscles first. Here are some of your first challenges:

1.Orientation – it's easier to fly your quadcopter when it faces the same direction as you do – but when it's facing you or another direction, the sticks will work differently – often in the opposite way as previously! Practice these moves so that you become more confident in your ability to control the craft no matter what the direction of flight.

2.Banking – many pilots find that learning how to fly loops or figure 8's is very instructive, as you can practice using more than one stick input at a time.

3.Spacial awareness – it's important to get a grasp on distances, directions, compass headings as well as wind and weather. Just as sailors and pilots know these things, so should anyone piloting a drone.

4.Bringing the quadcopter down from heights – is usually best done while moving it forward at the same time. Descending quickly into your own "prop wash" (air currents made by your propellers) can result in unstable flight.

Don't get discouraged – keep at it! Keep in mind that fancier drones have systems which actually make them easier to fly. Learning how to fly your toy drone should be considered *boot camp* and what you learn will come in handy later.

Continue to practice your landings until you are very confident that you can place your craft where you want it. Set up landing target zones around your practice area and try to land on them. Then, as you hone your skills, try to land in the center of the target.

Flying Patterns

Once you master taking off, hovering, landing and basic forward and backward flight, it's time to combine some of your moves. Watch some of the youtube videos on quadcopters and you will see experienced users doing banked turns and figure 8's. It

takes many hours of practice to master these turns and it won't happen if you are worried about crashing an expensive drone! Use a micro or mini drone with prop guards and fly outside over grass if possible. It won't matter how many times your machine hits the deck. Dust it off and try again.

Do you have the "Right Stuff"?

At some point it may become evident that the Air Force would probably not pick you as a candidate for their Top Gun flight school. Don't fret – all is not lost! If you find that manual flying is too difficult for you to master, you still have many options to enjoy the quadcopter hobby and pursuit. Many of the newer (and future) quadcopters have stabilization features and some can even be programmed for autonomous flight – that means they will take off, fly around a field by themselves, and then land within a few yards of their takeoff point!

The main thing to keep in mind if you are all thumbs, is to research and buy the proper machines for your capabilities and needs. Models such as the DJI Phantom have loads of intelligence programmed into them. More advanced models take some, but not all, of the piloting load off the operator.

Pg 7 – DIY Drone Repair and Upkeep

OCTOBER 30, 2016 BY CRAIGI

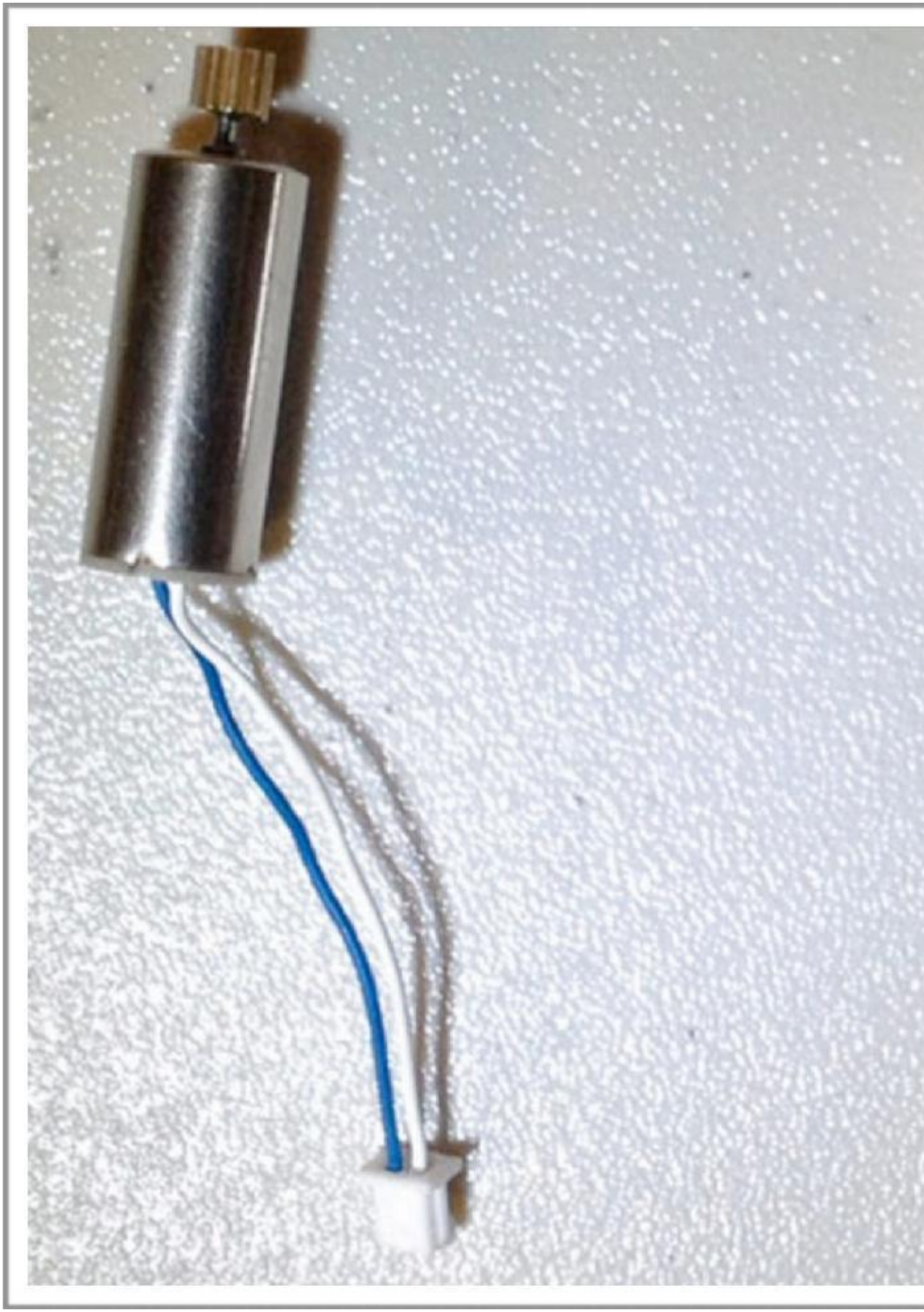
Section 7 -DIY Drone Repair and Upkeep

Even if you are all thumbs, there are some simple repairs that will help you get the most from your quadcopters. Here are some of the more common repairs and the basics needed to perform them.

Propeller Replacement – Propellers for small drones are very inexpensive, so you should replace them once they are bent or otherwise out of shape. Smaller quads have propellers which attach in one of two ways – the micros often have friction-fit (push on) props which only require a deft touch and small fingers to remove and replace. Some hobbyists claim that a small drop of a wood glue such as Elmer's helps them stay on better – yet is easily removed when it's time for replacement. Minis generally have a single phillips head screw holding the propeller to the drive shaft. For this and other repairs, your first tool purchase should be a set of tiny screwdrivers.

Motor Replacement – Motor replacement is a common task on small drones. Depending on your hobby skills, you may want to research your initial purchase to find out exactly how the motors are replaced on your particular quad of choice. Some are plug-in, while others require that you solder the new motor (motor comes with leads) to the main circuit board. It's often

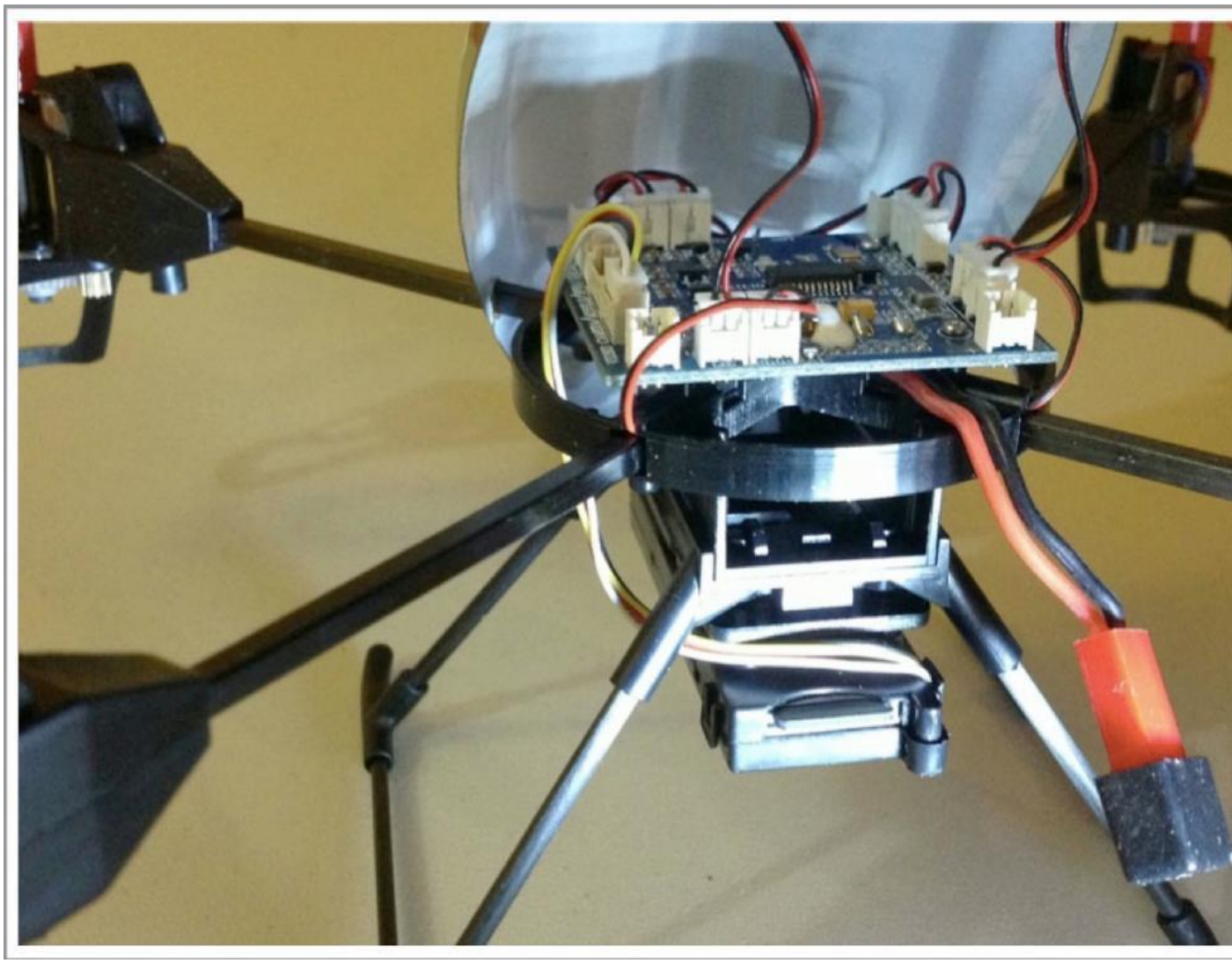
possible to take a shortcut and simply solder the new motor wires to the cutoffs of the old ones. Motor replacement sometimes requires disassembly of the booms (the cross pieces which hold the motors to the main body).



These motors use plugs so no soldering is required for replacement.

Boom or Shell Replacement

As shown in the photo below, the booms of most Mini quadcopters are press fitted into the main frame and also into the motor pods. The booms are very inexpensive, but you must be careful in your replacement work as it is possible to rip out the motor wires or harm other assemblies if you are too rough. If your motors have plugs, this process is easier – boom replacement on some models will require de-soldering and re-soldering of the motor wires to the main board.



The booms (cross pieces) push into the main round frame – wires run through the boom and are plugged into

Fix it or Sell It?

Other repairs can be done – in fact, you can get virtually any part for most quadcopters, including the main circuit boards. But there comes a time when the repair costs may be adding up. However, don't throw that quad in the trash yet! You can still recoup some of your cost by selling it for its parts content! For example, just your transmitter, which probably never sustained damage, could be worth $10 or so. Add to it some of the parts from your hulk, and you may be able to get $15 or more for what is left of your quadcopter. eBay and RCgroups.com are both places where you could consider selling your parts. Be sure to accurately describe your sale so your buyer and you remain happy after the transaction. Some hobbyists will give away their "hulks" to fellow hobbyists willing to pay the shipping and handling.

Repair and upkeep is a big part of the enjoyment for many people. However if flying is your only goal, the "use and sell or discard" route may fit your needs. As with all aircraft and mechanical devices, there is a certain cost per hour of operation. This holds true whether you decide to repair or to replace your mico and mini quadcopters.

Yet another parts strategy is to wait for a good discount sale and buy two of the same model quadcopter. This gains you an additional battery as well as a full complement of parts to fix one of the machines. Mini and micro quadcopters often are sold for as low as $20 each when on sale – so the cost for two would still be reasonable.

Tools of the Trade

If you enjoy repair and modification, the following tools and supplies should be the beginning of any basic drone tool collection:

1. Razor Blades, X-Acto knives, etc.

2. Electrical tape – various colors

3. Glue – some superglue as well as perhaps some other glues or epoxy. A hot glue gun can also be useful.

4. Mini and micro screwdrivers

5. Soldering Iron with small tip ($15-$20+) – if you intend to progress further in the hobby, pick up a more powerful one with interchangeable tips and variable heat. You can find bargain high-power models for about $40 including the tips. Pick up some solder for electronic use (usually rosin-core).

6. Digital Multimeter (voltage meter)

7. Good lighting for the work area as well as a magnifying glass on a stand for inspection of those tiny parts

8. Fastening odds and ends such as velcro, rubber bands and zip ties.

Chances are that some of these items are already sitting around your house or workshop. A nice kit could be put together for less than $50. Look for bargains both online and at the local dollar store.

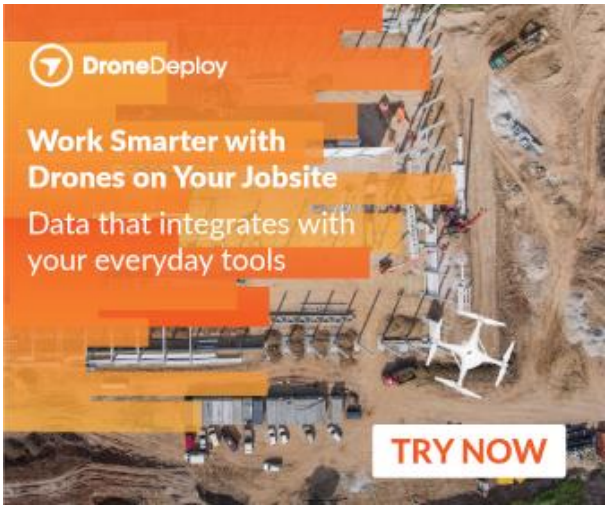
Pg 8 – A Primer on Aerial Photography and Video

OCTOBER 30, 2016 BY CRAIGI

Section 8 – A Primer on Aerial Photography and Video

The idea of taking pictures and videos aloft is enticing many to join this hobby. It can be tempting to pull out your credit card and buy that top-notch aerial photography platform early in your drone career, but I would caution against it. As mentioned previously, beginners are much less likely to crash, lose or otherwise harm their machines if they first get a solid foundation in the basics. Here are some definitions and hints, though, so you can know what the camera carrying options are.

First Person View (FPV), Aerial Photography (AP), App Driven Cameras



The simplest form of drone aerial photography is accomplished by flying around with a tiny camera – and retrieving the video or stills from a memory card once the quadcopter has landed. Mini-quadcopters with built in cameras and controls can be found for as little as $30 – however, the resulting pictures and video will not be of a high quality. In order to get higher quality images, you must step up to larger quadcopters as they are capable of greater stability (less wobble) and carrying better cameras. A shortcoming of the most basic method is that you don't see your footage until after you land and download the memory card to a computer.

First Person View (FPV) describes photography where you see what the drone is seeing, or at least a basic preview of it. The video is beamed back to a small monitor or to a set of special goggles the operator is wearing. This allows for much more precise control of the scenes being photographed.

App Driven FPV Camera Quadcopters w/Gimbal describes fancier video and photography machines such as those from DJI, Yuneec, Autel Robotics and others. These are what most serious aerial photographers will end up with after learning on lesser machines.

Camera types

Aerial cameras often take a beating, so beginners should not use a fragile consumer camera for this application. Here are some of the popular cameras and types used in hobbyist (sub-$1,000) Aerial Photography – approx. prices in ():

Included or Optional low-resolution quadcopter camera ($25) – These are included or optional with many well-known quadcopter brands. They are very light in weight and can be activated for photo or video from the included transmitter.

Keychain Cams ($12-$60) – These are very popular lightweight cameras sold as "keychain spy cameras" which many hobbyists affix to their quadcopters. The more expensive models have a higher resolution and wide angle lenses. The images from these can be very decent if

the quadcopter is stable and balanced and the lighting good (bright sunlight is not good for most of these cameras).

Mobius Sport Cam – ($65-$85) – A camera built specifically for the R/C market, this little wonder provides HD videos, stills (on a timer) and other great features for a low price. It can be lifted by some smaller quadcopters like the WL Toys v262, the HiSKY HM280, Skyartec Butterfly, etc.

GoPro and other Sport Cameras ($90-$400) – These are specially made for action – both shockproof and lightweight. Mid sized quadcopters (total weight up to 1000 grams or 2.2 lbs) are required to lift them, while the smaller keychain or similar models can be flown from minis and even micros.

The Parrot BeBop features a built-in front-facing camera which provides medium resolution images and FPV on a tablet or smartphone. Unlike most fixed cameras, the BeBop has fancy software and hardware which stabilizes the resulting video – making it similar to what is captured with a gimbal (camera stabilizer) carrying quadcopter.

The budding aerial photographer should spend some time on youtube and vimeo looking at various quadcopter videos and the platforms they were taken from. This will give you a good idea of what to expect out of your upcoming purchases.

Please note that true “hollywood style” aerial photography requires more expensive and heavier quadcopters along with better cameras. Some of the upscale models of drones even fly DLSR’s which weigh a couple pounds! Expect such systems to start at about $3,000 and quickly go upwards from there – putting them out of the range of most hobbyists and beginners. The price range of hobby range quadcopters and the associated features are below:

$50-$150 – A new generation of low-cost FPV models features are available – these have either built-in screens or use your smartphone as the monitor. Picture and video quality is poor.

$200 – $350 – larger toy or hobby grade models with brushless motors and Mobius and bargain FPV setup

$500 -$1500+ – Full size quadcopters (DJI, Yuneec, etc.) with dedicated or cameras and APV/FPV system installed. Most are driven by apps and use a tablet or smartphone for display and some control of features.

Hobbyists can put together systems in just about any price range from as low as $100. More detail on cameras, FPV and the proper quadcopters to fly them can be found in the section entitled More on **Aerial Photography and FPV** which follows later in this book.

Graduation Day

Congratulations! If you've gotten this far you are no longer a complete beginner – in fact, you probably know more about the subject than most of the general public! As with any graduation, this is a good time to reflect on both the past and the future. It's also time to make some decisions as to where you want to go in your drone career. Here are some possible paths to take to drone nirvana:

1.You enjoy the mini and micro quadcopters and want to continue to pursue this low cost and high value pursuit. This can also extend into small racing FPV machines and acrobatics.

2.You want to delve further into the hobby in terms of both the technical and learning aspects and the various sizes of quadcopters. You may want to be a full fledged "hacker" and start messing with the quadcopter programming.

3.You wish to fly larger quadcopters for photography/video, mapping, etc. but don't want to delve too deeply into the nuts and bolts.

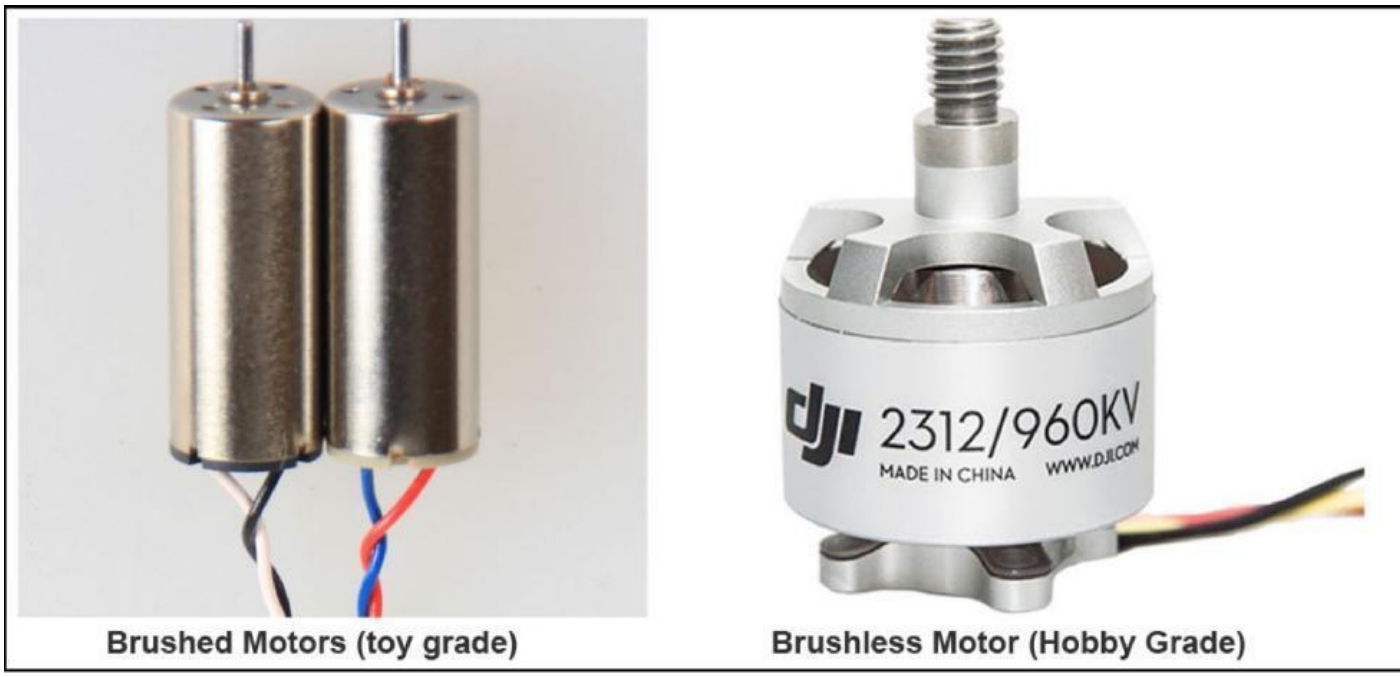
Since this is a newbies book, we won't go too far into all the technical details, but a basic introduction on how to step up follows.

Brushed vs. Brushless Motors

Most lower priced (toy grade) drones use small and inexpensive "brushed" motors which need to be replaced after only a few hours of use. They also are relatively inefficient and incapable of high speeds and large payloads. Higher performance quadcopter use "brushless" motors which provide a very long life, high efficiency and plenty of power.

Brushed motors have been common for over 100 years. They rely on "brushes", which are magnets that actually touch the spinning shaft of the motor. You may have seen small motors produce sparks when running – this is due to to the actual contact between the carbon brushes and the motor armature.

Newer brushless motors are more sophisticated and electronic means (ESC – or Electronic Speed Controller – usually external to the motor) to control the rotation. This is done without any physical part (like brushes) touching the motor shaft. The result is a longer lasting and more efficient system.



Brushed Motors (toy grade)

Brushless Motor (Hobby Grade)

Most racing and camera drones use brushless motors while the smaller and less costly (<$100) drones usually use the brushless type. When it's time to step up from your beginner models you will almost certainly want to shop for a brushless model. As of 2016 the prices have become quite reasonable with some starter brushless quadcopter as low as $110. Popular models in the lower price range include the HiSky HM280, JJRC X1 and the Eachine Racer 250.

Programmable R/C Transmitters

Advancing in this hobby requires at least a basic understanding of the standard R/C transmitters (TX) which are used with many larger and FPV quadcopters. Note the two types shown in the picture following:

The RTF (ready to fly) drones mentioned earlier in this book are sold with a TX which was specially designed and programmed to run only the particular quadcopter it was sold with. However, larger drones are sold without a TX or with a specially designed and/or modified model, so the budding hobbyist may need to learn about the various options.

Fair Warning – you may feel, at first, that you stepped back 20 years and are working with some ancient artifact of the computer revolution. As a rule, they are not user friendly – no color screen, no mice or touch screen, links, help files, or automatic setup wizards. Someday this will change, but for now you may have to join the club and slog your way through

learning these flight controllers if you want to enter the DIY (build, modification) part of the hobby.

The good news is that they are very powerful and flexible. A single model can store the profiles for many flying machines, so if the quad collection builds up you'll only need one or two of these transmitters. They also allow for dialing up-or-down on the flight characteristics of flying machines, so if you desire your quadcopter to be exceedingly tame, the settings can be changed easily.

R/C transmitters have from 4 to 9+ channels, meaning they can control that many different actions (switches, modes, flight surfaces, etc.) on the model you are flying. The beginning quadcopters mentioned earlier in the book are usually 4 channel – the channels controlling:

1.Throttle – how much power is being sent to the propellers

2. Elevators – this makes the quadcopter fly forward or backward by tilting it (pitch)

3. Ailerons – tilt the copter side to side and… (roll)

4. Rudder – this makes the quadcopter spin on its central axis (yaw)

Larger and fancier quadcopters may need more controls, although 5 or 6 channels are enough for most models. Prices range from as little as $50 to as much as $350+, although very decent models can be had for $50-$150. Brands include Turnigy, Walkera, Spektrum, JR, Futaba, FlySky and more.

Many purpose-built (photo/video) larger quadcopters come along with a matching TX (Remote), so those who are entering the Ready to Fly (RTF) market of larger Camera drones may be able to avoid having to program and bind these multi-model Transmitters to their new models. As an example, this modern Transmitter (now called a Remote) is included with the new DJI Phantom 3 and 4 quadcopters.


TapFly
Safe to Fly (GPS)
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Pg 9 – Your Next Quadcopter

OCTOBER 30, 2016 BY CRAIGI

Section 9 – Your Next Quadcopter

The drone market is rapidly changing and advancing. Many of the newer models come complete and Ready-to-Fly (RTF) so you will not have to concern yourself with learning about separate transmitters and receivers. However, if you decide to enter the DIY (build or customize your own) end of the hobby you will have to delve further into these. Even if you have no intention to DIY you should read the following for some basic information into how more modular drone models work.

Buying and Flying with a more advanced TX (Remote)

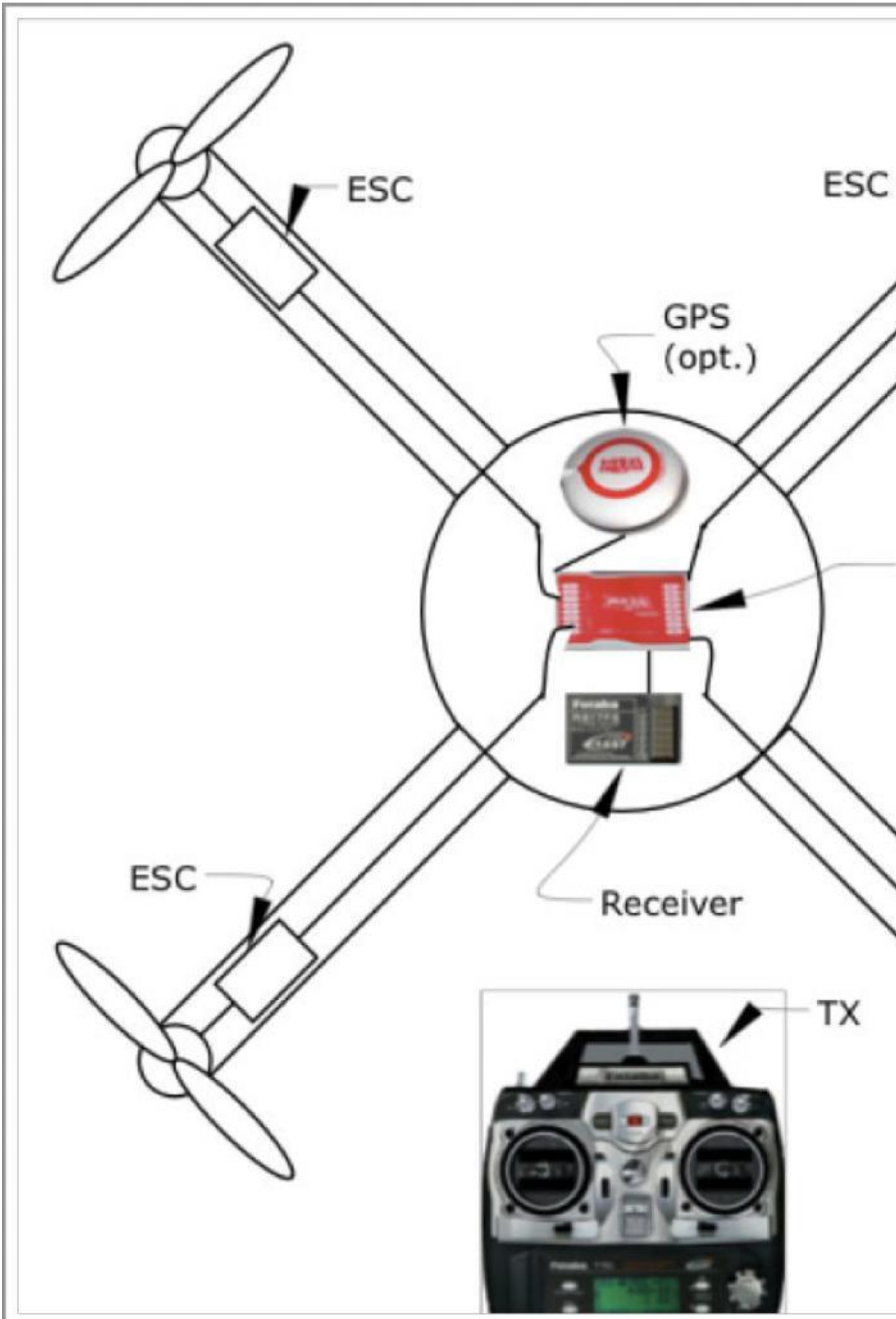
Various manufacturers produce generic R/C controllers. Brand names or types include Spektrum, Futaba, FrSky and Turnigy. Radios can cost as little as $50 or as much as $800+. A very popular current model is the FrSky Taranis which sells for approx. $250. The Turnigy 9X is a budget model which sells for about $70 and can operate most basic quadcopters. You'll want to have some idea of the models you wish to fly before choosing a generic TX. For example, if you are interested in quadcopter models from Blade (Horizon Hobby), these work only with the Spektrum (or clone) transmitters.

Some of the toy models mentioned earlier can actually *bind* (be paired and used with) these more advanced Transmitters. This is a good way to get started with learning how to adjust and program the radios.

Some Larger Drones are more Modular

At the beginning of the book, we covered the basics of how a quadcopter works. However, now that you may be advancing in the hobby, it will benefit you to learn about the various parts and how they function. This will help you with shopping and selection as well as with troubleshooting.

The following drawing shows a more advanced modular quadcopter, which has separate components onboard as opposed to the *all in one* design of the small circuit boards on mini and micro quads. This type of design allows you to select different receivers to mate with your TX – or, to select various brands and types of flight controllers and GPS add-ons.


ESC
ESC
GPS
(opt.)
ESC
Receiver
TX

Telemetry – Knowing what is happening aloft

Inexpensive and starter quads are essentially controlled in a one-way fashion – you provide the R/C control and "talk" to the drone, but it doesn't talk back to you. Telemetry is the science of having the vehicle provide real-time data back to you. This ranges from simple things such as the battery level, to more complex data such as wind speed, height above ground, vehicle speed and even the temperature of the motors. This is beamed back to you and shows as a overlay on the quadcopter view (FPV) or on a small display screen of your R/C Transmitter. Telemetry is a very important feature for advanced and more expensive quads, so you will want to educate yourself on the subject as you progress in the hobby.

Understanding the various components will make you a smarter shopper as you will be able to compare the various features and systems by brand name, compatibility, reputation and warranty. As we enter 2016 some of these systems are being combined into one main circuit board with ALL of the functions built-in. This is similar to what has occurred in other consumer electronics and is known by the acronym VLSI (very large scale integration). The advantage of this type of design is lower costs, easier service (switch main board) and better reliability.

Despite being advertised as such, many larger quads are not sold truly ready to fly – at least not to the consumer of average to low technical ability. There are some exceptions to that rule such as the Yuneec Q500 4K and the DJI Phantom 3 and 4 series. Even these models require various skills including piloting, upgrading software, understanding GPS and flight modes, etc.

These models can be described as major advances in Ready to Fly consumer quadcopters, as they include many advanced features for a relatively low price.

The DJI Phantom – The First Mass-Market Consumer Drone

The DJI Phantom series, first introduced at the beginning of 2013, represents a major milestone in the adoption of consumer level drones. This is a Quadcopter that,

just a few short years ago, would have been impossible to build. Similar vehicles were built before that time, but they were in kit form and required time, patience and mechanical skills. In addition, it is often hit or miss as to how well the homebuilt quads can perform aerial photography.

The Phantom series is sold RTF, or Ready to Fly, complete with transmitter, advanced navigation and software control and the ability to lift high quality cameras for video and still photography. As of this writing (2015), DJI offers a more advanced model called the Phantom 3. It is fully complete with camera, gimbal and controller and can take amazing video and still pictures right out of the box.

The Original Phantom 1 Quadcopter

Open the box and you see a quad that LOOKS like a consumer product! No bundles of wires strapped to exposed framing with cable ties, but a finished and sleek aerial vehicle that is ready to put into action.

The manufacturer, DJI Innovations, is solidly grounded in this business and is well regarded, making the purchase less of a gamble than a “here today, gone tomorrow” multirotor company. Newer and more capable DJI models (Phantom 3 and 4 series and Mavic Pro) sell from $500 to $1400 complete with the top end models sporting 4k video cameras and new collision avoidance technology.

The current DJI line appeals to virtually all levels of the multirotor market. While it should not be the first Quad you own, it could easily be the 2nd or 3rd machine you purchase once you learn the basics. The intelligent flight controls should help you avoid many common mistakes and the great videos which DJI has produced on the Phantom’s operation should put you into the pilots seat quite quickly.

As always, newer pilots should practice above a soft surface – tall grass, for example, and keep the Quad within a few yards until they understand its operation. The optional propeller guides are recommended for increased safety. Those who buy from a local retail shop may be able to get some lessons from the store personnel or team up with existing owners or a local flying club for tips and hands-on stick time. DJI has made a series of videos for the Phantom which should be watched by any prospective customer and owner.

DJI Phantom 3 Pro 4K Camera Quadcopter

All DJI Phantom models have GPS as well as a compass feature. These features can be used in various ways – the TX allows the pilot to turn various functions on or off.

DJI Phantoms are sold as “flying cameras” and that is primary mission of this size and type of quadcopter. If you want a “sport” or fun quadcopter to fly around your yard or a local small field – and don’t care much about photography and video – you should look elsewhere.

Summary – although not an inexpensive package, the Phantoms represent a major step in the world of RTF mid-sized multirotors. Steve Jobs said of the first Apple Macintosh Computers “These are the first computers worthy of criticism”. The Phantom fits into the same category and is likely to be the bellwether for what is to come in the future.

UPDATE: We have written a number of articles comparing all of the Phantom models at droneflyers.com.

As of the end of 2016, the Phantom 3 and 4 models are the most popular consumer video quadcopters. These models feature a camera and a stabilizing cradle (called a gimbal) which allows for amazingly smooth video.

Other brands have introduced similar packages for the hobbyist videographer. The Yuneec Typhoon Q500 4K (about $900 US) and Autel Robotics X-Star are two with decent reviews from users.

We have published 2 additional books detailing the DJI Phantom Quadcopters . All our eBooks are now free and published on or linked from our web site – Droneflyers.com

Note – these machines are purpose-built as flying cameras and are NOT the machines you want for learning, racing, hacking, etc.

More on Aerial Photography and FPV

Although some larger quads are used for aerobatics, racing and other pursuits, most hobbyists plan for photography to play a role in their more advanced machines. This section will discuss the equipment and costs related to aerial photography.

Earlier in this book we discussed cameras which are available stock on smaller (mini and micro) quadcopters. These cameras are fun learning tools, but have severe limitations when it comes to picture and video quality, range and other issues. Larger and more sophisticated quadcopters will give you more choices in camera, platforms, range and other options. Here are the basic options in terms of aerial photography drones.

1.Toy quadcopters with brushed motors and very small (included or strapped on) cameras. These will take very shaky video – useless for most applications. You will have little or no control over the camera settings, etc. – Prices for these setups range from $50 – $150 including camera.

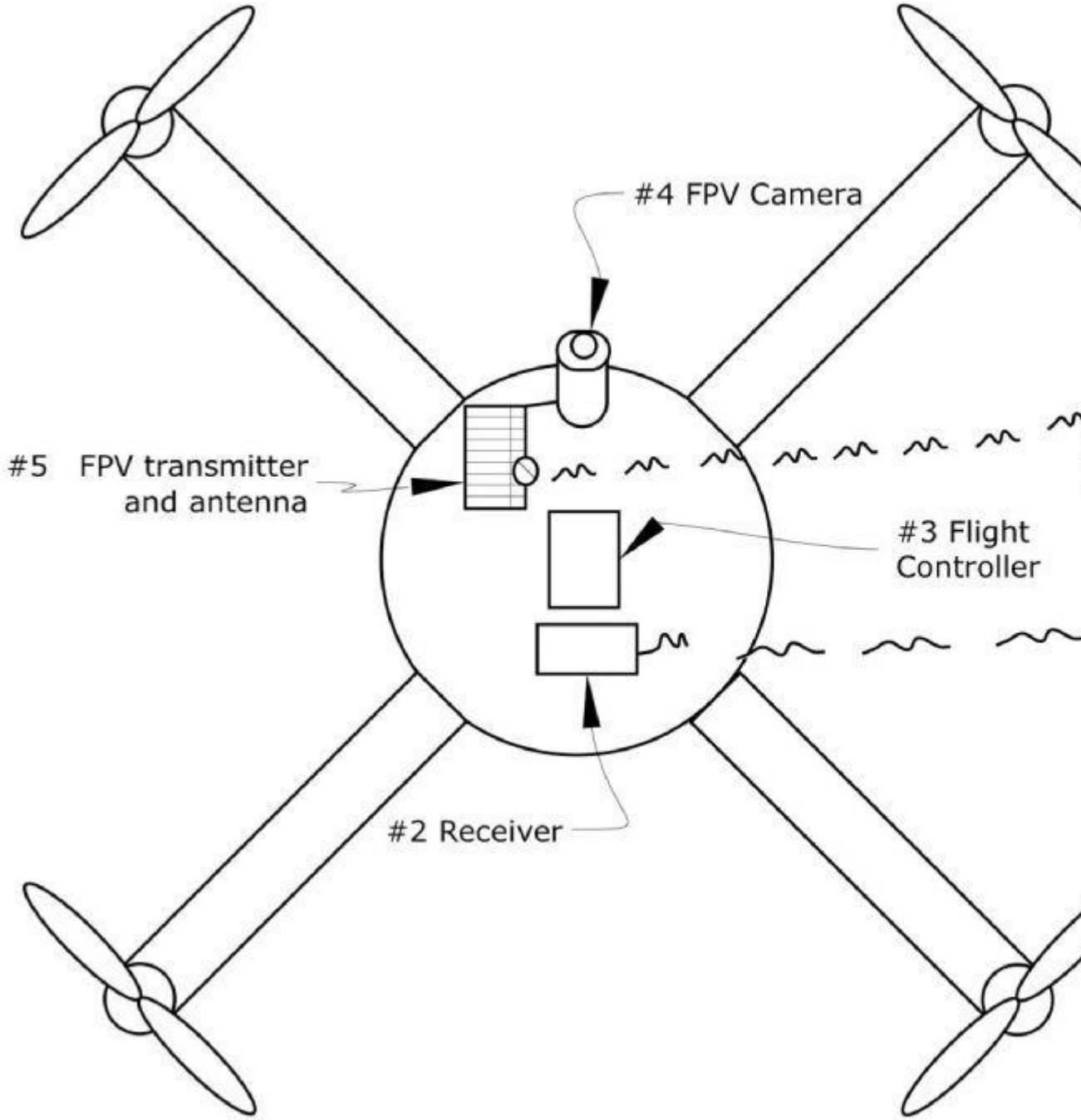
2.Larger quadcopters with brushed motors with GoPro or similar sports cameras (Runcam, Mobius) added on. This will give a better still picture quality and video can be reasonable in low wind situations. Prices are from $150-$300 (more with an expensive GoPro or similar brand). These models still do not have control of the camera tilt or stabilization, etc.

3.Purpose built Camera equipped Quadcopters with stabilizing gimbal – Popular brands include the DJI Phantom and the Yuneec Q500 4K. These machines are sold complete with a camera, stabilizer and and “app” that allows control of the camera from the ground. They take smooth video as well as decent still photographs.

4.FPV or Racing quadcopters which have a front mounted camera which is designed for seeing where you are going as opposed to photography.

Short Discussion of FPV Gear

First Person View (FPV) gear for drones will work differently than the purely digital cameras we are used to. These are often analog systems, and therefore use either a different (2nd) camera or an analog A/V output from your existing digital model. This output is coupled to a transmitter with its own antenna – and often needing its own battery. The video signal is then transmitted from the quad to your ground station and displayed on a small monitor on on the inside of specially designed googles. Many hobbyists prefer to keep the entire FPV system separate – with its own small cam. FPV does not require a high resolution, so the camera can be very small and light. These analog systems have less latency (lag) – but also less range than the fancier digital FPV systems now finding their way into the high end models.



In the diagram above, #4 through 6 are parts of the FPV system. They can be described as:

#4 – FPV Camera or Analog (usually composite) output from existing quadcopter camera (GoPro, Keychain Cam, etc.)

#5 FPV Transmitter and antenna – this takes the “TV Type” signal from the FPV Camera and broadcasts it to the ground.

#6 FPV Receiver and Monitor or Goggles – This receives the signal from your drone and then displays it on a connected monitor or goggles. In some cases, a smart phone or computer tablet acts as both the ground receiver and the monitor.

Some equipment and connections are not shown in the above diagram. These include the battery or power connection to the FPV camera and transmitter and connections for triggering the camera on or off from the ground TX. FPV gear setup can be quite technical – a full discussion is outside the range of this book. If you are not technical, it will probably be best to look for a unit sold RTF (ready to fly).

Here is one of our articles detailing how we put together a simple FPV setup.

Controlling Photography and Video Cameras Aloft

Simple toy quadcopters have video cameras which can be turned on or off by a button on the transmitter. However, since flight times are fairly short, many users simply turn the video camera on before takeoff and let it run for 6-8 minute duration of the flight. There is a separate control for the snapshot (still picture) function, but such shots are of very poor quality so it may be best just to use a frame from the video for any desired photos.

Larger systems work differently. Ready to Fly FPV systems like the Phantom 3or 4 and Yuneec Q500 4K have full control through a wireless connection to a smartphone or tablet, but many quads which carry cameras do not. In these cases, you have a couple choices.

Activate video before quadcopter takes off – again, since the flights are usually short, you can turn on your GoPro or other video camera and let it record the entire flight – then edit it later.

Use Camera with Interval Shooting – many cameras have a setting which is called Interval Shooting or Intervalometer – this allows programmed intervals at which the camera snaps a picture or takes a short video. As an example, a camera can be set to take one picture every 10 seconds for the entire duration of a flight. Only certain cameras have this feature, so check on your choice of cameras to confirm.

Rhode Island, USA

Aerial Picture of Stone Tower

Understand Flight Controllers (FC , F/C)

Flight Controllers, as mentioned previously, are the brains of a drone. They are created from a combination of hardware and software, much like modern computers, tablets and smartphones. As you progress in this hobby it may be important to understand the various F/C platforms available to control your drone.

Quadcopter flight controllers are of two basic types:

1. Open Source or Community based projects – these are designs which have been developed and shared and cost nothing to use or modify. The designs consist of both software and hardware. Examples of such projects include:

Openpilot

Ardupilot (APM, Pixihawk)

Multiwii

KKmulticopter

Although the software code and reference designs are usually free, you still have to buy the actual hardware (circuit boards) as those cost $$ to produce. Upgrading the flight controllers can be accomplished by downloading the newest code and connecting to the flight controller using a USB interface. This is not a task for non-techie beginners.

2. Commercially Developed systems – these are flight controllers developed (or heavily modified from open source) in-house and sold only with a specific model or range of models. Examples include:

Parrot AR Drone or BeBop F/C

Naza (DJI)

Wookong (DJI)

Dualsky (FC450, etc.)

With these flight controllers you are tied to the particular manufacturer in terms of upgrades and modifications.

Bare bones flight controllers – selling for as little as $15 – have the ability to manually fly a quadcopter, while more expensive models ($40-$200+) have advanced capabilities and modular expansion for features such as GPS, Barometers, Sonar, etc. which will help with autonomous (hands-off) flight. Those in the market for more advanced quadcopters should research the various flight controllers and options to make certain that they have the proper functions for their intended use.

Most newer consumer drones are based on advanced and commercially developed flight controllers. These are truly at the heart of the drone revolution and are starting to contain AI (artificial intelligence) as well as being capable of machine learning (getting smarter as they gain experience!). As a result, the next great drone advances are not likely to come from a garage workshop, but rather from years-long work involving millions of programmer-hours.

g 11 – Safety Issues and Basic Troubleshooting

JUNE 30, 2016 BY CRAIGI

Note – this is part of our free ebooks which you can find at this link.

Pg 11 – Safety Issues and Basic Troubleshooting

Please become familiar with the many safety issues which apply to this hobby. An outline of the major safety points is below:

Spinning Propellers can injure humans and animals – mid sized and larger quads could cause deep wounds or worse. Be cautious – do not fly near people and animals. Make certain you are familiar with the startup process (arming) of your quadcopters. Remove propellers when first testing new setups. Use a file or sandpaper to slightly dull the sharp edges of propellers.

Lipo Batteries can ignite as well as cause shocks. Do not charge batteries near combustible materials and do not charge unattended. Use special made LiPo batter charging sacks. Make certain there are smoke and CO detectors in the areas where you charge and store your batteries. Make certain that water and other fluids do not come into contact with your LiPo batteries. Make certain the wires and connectors cannot easily short circuit.

Be very careful when shipping – or traveling with – LiPo batteries. Inform the post office or your shipper so that your package doesn't cause a fire or other damage. DO NOT CHECK DRONE BATTERIES AS LUGGAGE WHEN TRAVELING BY AIR (GATE OR LUGGAGE CHECK). Read this article concerning travel with your drone.

Falling or Crashing larger quadcopters can injure or even kill. As stated before, do not fly over or near people, animals or moving vehicles. Use common sense in planning your flight path.

Keep a small fire extinguisher in your flying kit – and in your hobby room. An ABC extinguisher should be fine for most secondary fires.

Do not use GPS when flying indoors – erratic results could result in lost control.

Note – this is part of our free ebooks which you can find at this link.

The Drone Report – 2017 #1

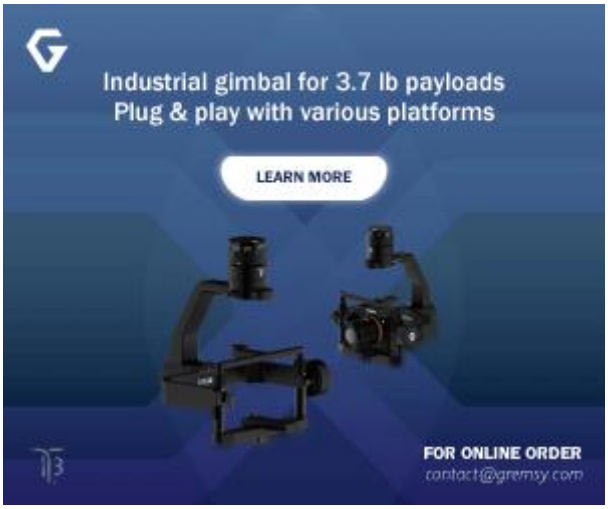
MARCH 15, 2017 BY CRAIGI

The Drone Report – 2017 #1

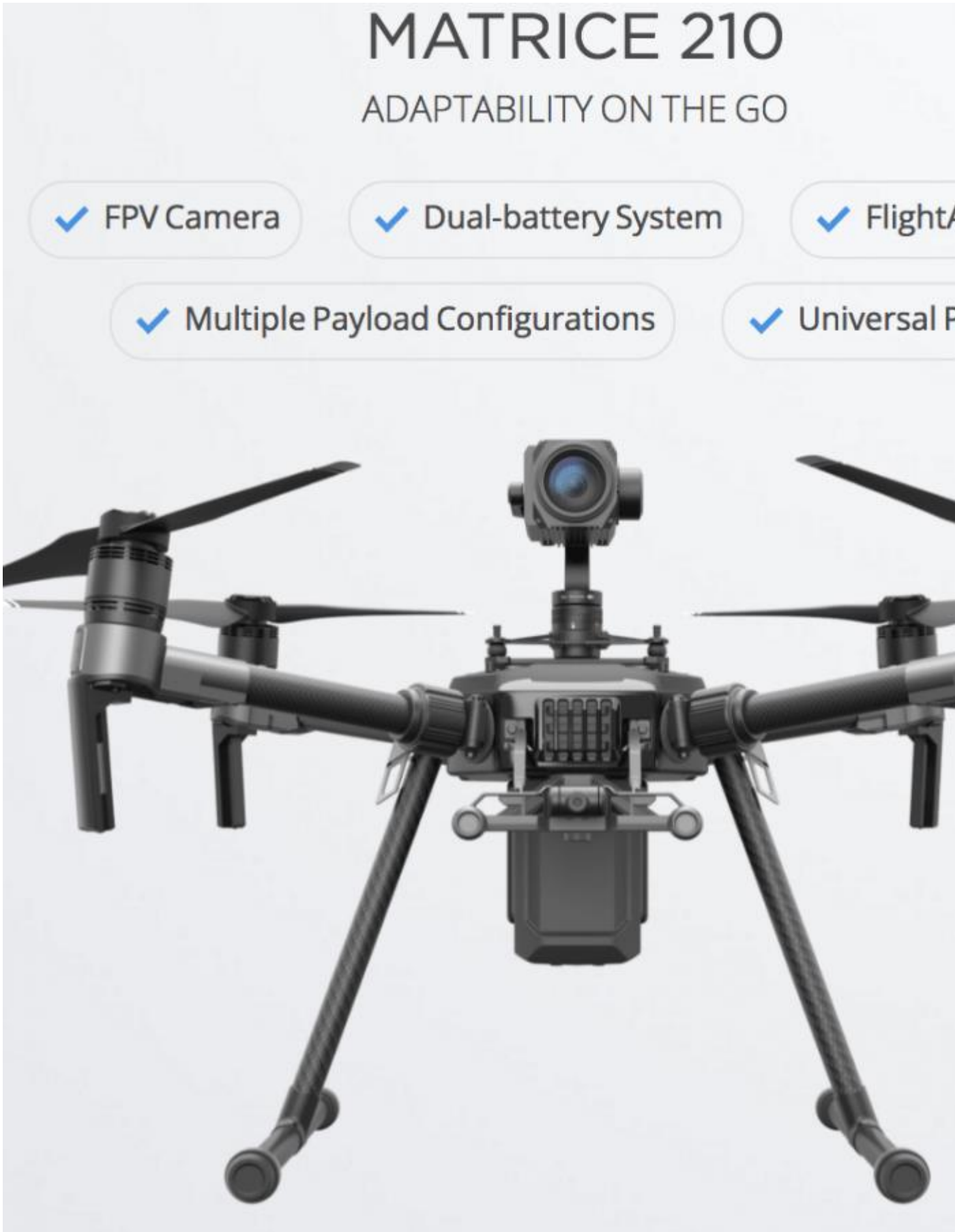
Introduction – this article will bring the reader up-to-date (mid-2017) in terms of most facets of the consumer drone (multirotor) business. Please consider it an "Executive Summary" and excuse the lack of detail on each of the many subjects involved. Note – this is also slanted toward the N. American Market.

Basic Index
Drone Hardware – Software – Services – Add-ons

Hardware Overview – 2017 is shaping up very differently than previous years. This is due, in part, to the "winning" of the Consumer Drone Wars by industry leader DJI. At this point we can dispense with the idea that other companies are going to hit the market with competitive products in most of DJI's price ranges. Here are the big stories involving Hardware (drones) within the civilian consumer camera drone market.



Consumer Models (<$2,000) – Supply has outpaced demand. Consumers are excited about upper-end models such as the DJI Mavic Pro and the (larger sensor) Phantom 4 Professional. Those who want other models have at least a a dozen to choose from – an example of the largest sellers on Amazon is at this link.



Higher end Commercial Drone Example – The DJI Matrice 200 is available in multiple

configurations

With the FAA now allowing commercial work, drone makers are starting to produce models designed for industrial or higher end commercial use. Models include the DJI Inspire 2 and the new DJI Matrice M200 series. Yuneec has announced beefed up models of their existing hexacopters which are also designed for heavier-duty use.

In terms of corporations which are succeeding in the business, the list is slim – here is our short take on the state of the major players:

DJI – Prospering – 2017 sales will likely double those of 2016, driven by the Mavic Pro which could sell a million+ units.
Parrot – Layoffs, sharp decline in sales, floundering
Yuneec – Layoffs reported – Treading Water – not gaining the market share they had hoped.
Autel Robotics – Layofsf reported – Reasonable sales volume but with high costs is unlikely to be able to keep up with the current speed of innovation in consumer Drones.
GoPro Karma (Failure to launch – unlikely to be news in the 2017 market). More and more layoffs reported.

As we mentioned in an earlier article, buyers seem willing to spend more on camera drones than in 2015/2016, but they want to get something very advanced (larger sensors, computer vision, portability, etc.) for their money. At the lower end, this means booming sales for models such as the DJI Mavic Pro (small size/weight) and the Phantom 4 Pro (larger sensor).

Software Overview – With a plethora of drones available, expanding the uses of consumer drones represents a great opportunity. A company called DroneDeploy seems to be leading the pack in terms of mapping software, but many other companies are entering the market. Less capable apps like Litchi are also popular but the relative size of the market is smaller – only a few companies will be able to sell enough $10 or $20 apps to continue development of sophisticated applications. Also, software producers can be easily co-opted by big drone makers such as DJI – who may include similar functionality in future software updates.

It is our opinion that only a select few larger opportunities (dronedeploy, etc.) exist on the software side of things in the consumer and light industrial space. Yet, as usual, dozens of firms are entering the segment. This points to the typical “gold rush” capitalist mentality where most firms are likely to fail while a few prosper.

The **Services Sector** would seem to provide quite a few opportunities for growth – after all, with 100’s of thousands of new aerial photography businesses being created, many are going to be in need of various services including:
1. Insurance, Extended Warranties and Repair
2. Cloud storage, processing and integration (related to the Software Category).
3. Education – at all levels, from initial operation to help with business operations.
4. JOBS – many sites have started to try and match pilots with job opportunities. A

partial list of these companies can be found at the following URL: http://www.dronepilotgroundschool.com/certified-drone-pilot-directory-list/
5. Drone Rental and other associated photography equipment and staffing.

As with many of the other categories, there is only room in the industry for "X" amount of any service…so there will likely be some head butting as companies compete for the same "space"…spaces which, in some cases, may not exist in the bullish case many of these companies imagine.

As an example, let's discuss the "find a drone job" type of site…of which new ones seem to be popping up almost daily. creating such a site is very easy. However, pilots (Part 107 qualified) have little idea of whether or not these sites will be able to deliver job opportunities. Pilots have been signing up but the other end of the equation – that is, actual paying jobs, do not appear to be populating these sites. Some have reverted to "playing the lottery" by taking unrequested pictures of Real Estate for Sale and then trying to sell the pictures afterwards to the listing Realtors. This type of scheme is unlikely to work out well in the long run.

I have also noticed that the prices for Real Estate Aerial Photography have generally started out very low – and seem to be headed lower. This makes some sense as there are likely hobbyists and spare-timers who are willing to do a job for much less than a full time pro. Many Real Estate firms have already hired contract or full time drone pilots who provide them with aerial photos at prices that would not entice more true "pros" to step out of bed in the morning.

This leaves a big question mark as to what the future of the lower end of aerial photography and video will be. Sure, there are some firms specializing in million dollar+ Real Estate which can make a reasonable fee – but most Real Estate is marketed on tiny budgets.

Of course, there are lots of additional types of jobs in addition to Real Estate. However, the point here is that the supply/demand curve is likely to be tilted toward consumers of these services…making it difficult for many to get steady work with their camera drones.

For now, the Services Sector belongs to the more experienced pilot with connections at the higher end of planning, multi-million dollar real estate, professional video creation, etc.

Others planning to make decent income taking pictures and video with their camera drones (under part #107) are going to have to get creative and innovative and start new markets such as working within a specific tourist trade (videos of water skiers, parasailing, etc. and similar efforts).

Education will always be needed – but the "cost of sales" is an important item to consider. Part 107 has provided a good jolt in terms of opportunity, but this too shall pass and educators will have to move on to additional courseware. Whether or not the public is ready to pay is somewhat in question – self study has become popular online and fewer students seem to be choosing in-person or custom tutoring and classes. Companies like DJI and Yuneec could definitely help in this department by keeping lists of educators for referral to their customer base.

Add-ons refers to hardware additions – everything from cases to ND filters and much more. The market for these items is relatively small (x percentage of relatively low sales of X model) so success in this market will go to companies that create multiple products and move quickly to bring them to market.

Summary – many of the industries' wishlists have been granted in 2016/2017. The FAA has started to help the industry and opened a path to light commercial uses. The technology available for consumer prices ($400-$2,000) has advanced – putting quality aerial photography into the budget of millions of potential buyers.

Most forecasts, including ours and the CTA, call for 2017 t0 be a good year for consumer drone sales. 2019 should see sales leveling out with slower growth or stagnation (or even a decrease) forecast for coming years. This seems even more certain if it's hard to find money making opportunities at the lower end of the camera drone marketplace. However, the market is always likely to surprise us – perhaps someone will come up with the "killer app" which allows a greater demand for Part 107 services. Here at Droneflyers.com we are experimenting with various tests and focus groups to see what types of aerial photography that the public desires. We'll be sure to note any successes and failures in a future report.

Thanks for reading – please leave your comments below.

Sincerely,

Droneflyers.com


AIRVŪZ
UNITED BY DRONE
AERIAL VIDEOS
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