DRONING ON AND ON: A PRIMER

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Abstract - *Everything you knew about drones a year ago has changed. On Aug 29, 2016 the Federal Aviation Administration (FAA) released their rules for flying unmanned aircraft systems (UAS); also known as drones. The rules are codified by 14 Code of Federal Regulations (CFR) Parts 101 and 107. Part 101 addresses model aircraft and recreational drones. Part 107 specifies commercial drone use and provides rules to ensure our National Airspace System remains safe. This paper will answer questions about drone use. For example:*

- *What constitutes commercial drone use?*
- *What other requirements must be met to fly a drone?*
- *What are the operational rules?*
- *What else should I know?*

THE FAA AND DRONES

Drones are available in increasing numbers. They are a great production tool and provide amazing results. Many of us want to fly them, and do so safely, but do not realize that while it is easy to buy a drone it does not mean you can fly it anytime, in any place, for any purpose.

The FAA is committed to providing the safest, most efficient aerospace system in the world. They are charged with integrating unmanned aircraft systems (UAS) into our National Airspace System. The FAA's "Know Before You Fly" educational campaign provides information needed to fly safely and responsibly in the United States [1]. For example, if you want to fly a commercial drone, you must follow the FAA's set of operational rules, known as Part 107, mentioned above.

Drones come in all shapes, sizes, and configurations, and are typically the means to deliver a payload to a desired destination. The most common payload is a camera capable of shooting video and stills. While drones differ slightly from one manufacturer to another, they are typically made of the same set of core subsystems. Broadly speaking, these include the body, a power supply, an onboard computer (with GPS and sensors), flight controls, plus a communications transceiver and antenna.

For many, flying a drone is not just part of our work, it is a passion. So it is no surprise that many drone pilots own more than one drone. For example, I own two small drones meant for recreational flying, while I fly a third at Radio Free Asia. One personal drone is the Syma X5C. When flying, it is not as stable as higher costing drones but it does come with a 2-megapixel camera suitable for experimenting with cinematography and photography. After reading the X5C operations manual and a few hours of flight time, any neophyte can be comfortable with this drone.

The other personal drone is the Estes Proto X Nano. Like the Syma X5C, it is very reasonably priced and is a good starter drone. Thankfully it arrived with extra propellers since my first mistake was to fly it into a wall. I'm more careful with it these days.

The term 'drone' is broad. Drone is used to describe Unmanned Aircraft Systems (UAS), small Unmanned Air Systems (sUAS), quadcopters (4 motors), Unmanned Aerial Vehicles (UAV), and several other names that are all aircraft without a human pilot on broad.

Everything we knew about drones changed on Aug 29, 2016 when the FAA released its final rules for flying drones. In these rules, the FAA specified safety regulations for non-recreational use of drones weighing less than 55 lbs. [1]. This also meant those who fly for commercial use, or fly as a part of their business, must follow these regulations.

In the four months after, the FAA reported more than 30,000 applications to become certified remote pilots and that 16,000 had already taken the exam. With 90 percent of those applicants passing the airman knowledge test (AKT) in order to become certified commercial drone pilots, the FAA finished 2016 on a strong note [2].

FIRST THINGS

Owning a drone can be fun and rewarding, but before you plunk down money, it helps for you to answer some questions regarding a drone. Take some time for serious thought and answer these questions before choosing a drone:

- Which suits your needs and your budget best?
- Do you need automated flying?
- How precise does your positioning need to be?
- How long do you need your drone to fly? As an example, my experience with the Phantom 4 is that each battery is good for approximately 20 minutes of flight though they are rated for up to 28-minutes each.
- Some drones can use different cameras, so what are your needs? As we know, better cameras usually drive up the price.
- How far do you need your drone to fly while maintaining safe operations and at what altitude?
- How is the data between your control system and drone handled? The options are Wi-Fi, Bluetooth, and in some cases, you can have a tether between your controller and the drone.

- Are you going to be flying exclusively outdoors, indoors, or both? If you need a drone to withstand near-gale winds, expect to pay more.
- What level of object avoidance do you need?

Recreation Versus Commercial Use

The average recreational pilot flies their personal drone and can continue to do so with limited intervention from the FAA but it is important to know the law. When you fly a drone in the United States, it is ultimately your responsibility to know the rules and follow them. The best place to start is at the FAA's website, www.FAA.gov. When you intend to fly a drone for personal use, the FAA provides the following guidelines [3]:

- You do not need FAA permission to fly your drone for fun or recreation, but you must always fly safely.
- The new FAA regulations from last summer do not apply to model aircraft operated in accordance with 14 CFR Part 101 Subpart E, Model Aircraft and are not affected by all rules and regulations covering 14 CRR Part 107 for commercial drones.

Here are a few specifics that classify you as a recreational flier instead of a commercial drone user [3]:

- You are flying for fun.
- You are not flying the drone for a company, business, or government.
- You are not flying for pay, either directly or indirectly.

Before you fly for recreation, you must [4]:

- Be at least 13 years old. If the owner is less than 13, a person 13 or older must register the drone as needed.
- Be a U.S. citizen or legal permanent resident. Visiting foreign nationals must register their drone upon arrival in the United States. Online registration serves as a certificate of ownership.
- Register your drone if it weighs more than 0.55 lbs. and less than 55 lbs. [1]. The cost is $5 and is valid for 3-years. Registering online is easily accomplished at the FAA's site. To register, you only need a valid Email address, a credit or debit card to pay the registration fee, and a physical address and a mailing address, only if it's different from your physical address.
- Once you receive the FAA registration number, mark your drone with this number. A simple label or sticker will suffice. Ensure the number can be found on the drone without having to use a tool to find it.
- Read and understand all FAA safety guidelines.

As a recreational flier, you do need to follow these important operating rules [4]:

- Fly at, or below, 400 feet.
- Keep your drone in sight.
- Never fly near other aircraft or airports. Manned aircraft always take priority over unmanned aircraft.
- Never fly over people.
- Never fly over stadiums or sporting events.
- Never fly near emergency response teams.
- Never fly under the influence of drugs or alcohol.
- Be aware of the classes of airspace and their limitations; ignorance is no excuse. Through the FAA you can be subject to civil and criminal penalties if you meet the criteria to register a drone but fail to do so.

Here are the specifics that classify you as a commercial drone pilot:

- You receive some type of compensation for flying a drone.
- Using a drone is part of your work.
- You are flying for a government agency or entity. For example, if you are working for the fire department, police or other emergency services, this is commercial use.
- If you are an educator teaching the use of drones as part of your curriculum.

There are many ways to be classified as a commercial drone user. If in doubt, start by visiting the FAA's website and if needed, contact the FAA for clarification.

With the popularity of drone use, it is no surprise many industries unrelated to broadcasting are already using them in ways previously unknown. Some of those uses include:

- Cinematography
- Photography
- Selling photos or videos taken from a drone.
- Providing contract services, such as transmitter tower inspections.
- Monitoring the progress of a company's work.
- Real Estate
- Law enforcement and disaster relief.
- Reconnaissance and search-and-rescue.
- Civil Engineering
- Oil and gas pipeline inspections
- Construction
- Agriculture
- Forestry and fisheries
- Mining

As you can see, the drone has many commercial uses and made growth in various industries. The list continues to grow.

Commercial Pilot Certification

As you already read, the FAA's "Know Before You Fly" campaign is an excellent source for all drone pilots. It

emphasizes the need to fly drones safely and responsibly. If you want to fly your drone commercially, you must follow the FAA's Part 107 operational rules. In addition to the rules mention earlier for recreational drone flying, here are the FAA's guidelines and minimum requirements you must meet before you receive a Remote Pilot Certificate and fly a commercial drone [5]:

- Be at least 16 years old.
- Read, speak, write, and understand English. Exceptions can be made by the FAA if you are unable to meet one of these requirements for a medical reason.
- Be physically and mentally able to safely operate a drone.
- You must successfully pass the FAA's Aeronautical Knowledge Test (AKT) at an FAA-approved knowledge testing center. Once you pass the AKT, you will be vetted by the Transportation Safety Administration (TSA). While I believe this is more of a formality for the average American, it only makes sense they ensure drones are not placed in the wrong hands.
- Much like a recreational drone, a commercial drone must be more than .55 lbs. and less than 55 lbs. Your drone must be registered with the FAA and have that number posted on the drone.

There are occasions when the FAA will not accept an online registration application for a commercial drone and you must submit a paper registration application. Here are a few of the reasons [6]:

- Your drone is 55 pounds or greater.
- You want to qualify a drone for operation outside the United States.
- You hold title to a drone in trust.
- The drone's owner uses a voting trust to meet U.S. Citizenship requirements.

What follows is the standard list of operating rules. Most of these can be waived by the FAA [7]:

- Only operate in Class G airspace without approval from the local air traffic control (ATC). Drones are never allowed to fly in Class A airspace. Since you are a commercial drone pilot, contact the affected ATC by using the FAA's online notification portal if you plan to operate in Class B, Class C, Class D, and Class E airspace. See the FAA Sectional Chart in advance to identify the class of airspace you plan to use.
- The remote pilot in command (PIC) must always maintain a visual line-of-sight (VLOS) of the drone unaided by any device other than corrective lenses. As an alternative, VLOS can be maintained by someone assigned to the flight crew as a visual observer (VO). By the way, the PIC is the final authority on-site and responsible for the flight operations.
- A PIC can only fly one drone at a time. The same limitation applies to a VO.
- No one may act as a PIC or as a member of a flight crew when they have a physical or mental condition that would interfere with the safe operation of a drone.
- The PIC must be able to maintain a minimum visibility of 3 miles from your control station.
- When flying near clouds, you must stay at least 500 feet below the cloud base and no closer than 2000 feet laterally from the clouds.
- You must fly at or below 400 feet no matter the class of airspace used and no higher than 400 feet above a building or other structure.
- You can only fly during the day. The actual day begins 30 minutes before sunrise and ends 30 minutes after sunset. If you fly during either 30-minute period, your drone must use anti-collision lighting.
- You can fly no faster than 100 mph (160.9 km/h or 87 knots).
- Must always yield the right-of-way to manned aircraft.
- You cannot fly your drone over people other than those participating in the operation.
- Must not pilot your drone from a moving vehicle unless the operation is over a sparsely populated area.
- A first-person view (FPV) camera does not satisfy the FAA's see-and-avoid requirement where a drone pilot must do all they can to see-and-avoid other aircraft. FPV can be used as long as the see-and-avoid requirement is satisfied in other ways.
- You are prohibited from carrying hazardous materials with a drone. Likewise, any operation deemed careless or reckless is prohibited too.
- A drone can carry a load if the object is securely attached and does not adversely affect the flight characteristics or controllability of the aircraft. Transportation of property for compensation is allowed only when (1) the aircraft, including its attached systems, payload and cargo weigh less than 55 pounds total; (2) the flight is conducted within visual line of sight and not from a moving vehicle or aircraft; (3) the flight occurs within the borders of a State.

Again, most restrictions above are waivable through the FAA as long as you can demonstrate your flight operations can be conducted safely under the terms of the waiver. When applying to the FAA for a Certificate of Waiver, the FAA recommends submitting it at least 90-days before the waiver is needed to allow sufficient processing time. Anything less will not likely allow the FAA enough time to review and approve your request [8].

In addition to the commercial use characteristics above, a PIC must hold the FAA's Remote Pilot Airman Certificate with a small UAS rating, or be under the direct supervision of someone holding a valid certificate. This is awarded after successfully passing the FAA's Airman Knowledge Test (AKT) mentioned earlier.

Now let's review the AKT. It is a multiple choice exam. Each question is answered by selecting only one response. Each question is independent and therefore does not influence the response to any other questions. The test demonstrates your knowledge of aeronautical skills, rules and laws. All the information needed for this is available for free at the FAA's website [9].

If a structured course suits you more, classes for the AKT are available through some schools, universities and even the Academy of Model Aeronautics (AMA). The AKT must be taken at an FAA approved testing center and costs $150. Visit the FAA's website to find the by-state list of approved commercial test centers in the United States. Do not stress too much about failing the test because you can retest in 14 days [10].

The test is comprised of 60 questions though there were actually 62 the day I took the AKT. I believe the 2 extra questions were sample questions the FAA was using for data analysis and they neither added, nor detracted, from the test's final overall score. You are given 2 hours to take the exam and you must receive a score of 70 or greater to pass. The AKT is controlled by the FAA so ensure you bring government issued identification to the test like a driver's license, passport, or alien identification card along with an acceptable method of payment.

The AKT covers many areas of importance to a remote pilot. Some of the information needed for the AKT is found within these pages, but you should visit the FAA's website and find their comprehensive list of study references. Here is a broad list of subjects on the AKT:

- Regulations relating to small unmanned aircraft systems (sUAS)
- National airspace classifications
- Weather and effects on aircraft. You will also need to know how to read a routine aviation weather report (METAR) and a terminal aerodrome forecast (TAF).
- Small unmanned aircraft loading and center of balance.
- Handling emergencies
- Crew Resource Management (CRM)
- Radio communications
- Aircraft performance
- Physiological effect of drugs and alcohol
- Aeronautical Decision Making (ADM)
- Airport operations
- Maintenance and preflight inspection procedures

It can all seem a bit overwhelming but remain patient and give yourself enough time to study all the material before calling the FAA Testing Center to schedule the AKT. There really is no rush especially when you want to pass the AKT the first time you take it.

Here are a few FAA regulations you will have to become familiar with, or outright read. The FAA's Remote Pilot – Small Unmanned Aircraft Systems Study Guide (FAA-G-8082-22) which is an excellent place to start. Other extremely useful references are the Pilot Handbook of Aeronautical Knowledge (FAA-H-8083-25B) and the Remote Pilot Knowledge Test Guide (FAA-G-8082-20). Remember, all of these, and so much more, are available from the FAA for free [11].

Upon successful completion of the AKT and certification by the FAA, you are good for 24-months until you have to recertify your aeronautical knowledge again. How exactly the FAA plans to recertify commercial drone pilots is yet to be determined but it will be on the FAA's website when the procedure is finalized.

VOLUNTARY GUIDELINES AND PRACTICES

There are other matters to consider before your first or next drone flight. Privacy is an important issue to most Americans. When practicing with my Syma X5C on my lawn, I always leave the camera cable disconnected should anyone question whether there has been a privacy violation. All I need to do is land the X5C and show them the disconnected cable and empty mini SD card slot.

The FAA has issued voluntary guidelines for neighborly drone use which helps balance the rights of drone users and the rights of others. The FAA's goal was to develop and communicate best practices, accountability, and transparency regarding drones and the use of the National Airspace System (NAS). Here are their guidelines [12]:

- Tell others you'll be taking pictures or video of them when possible before you actually do it. Post signs in and around your launch site as needed.
- If you think someone has an expectation of privacy, don't violate that privacy unless you have a very good reason.
- Do not fly over another person's property without permission if you can easily avoid it.
- Do not gather personal data without reason.
- If someone asks you to delete their personal data, do it.
- If someone brings up concerns about privacy, security, or safety, hear them out.
- Do not use your drone to harass anyone.

GOVERNMENT AND EDUCATIONAL FLYING

If your work requires you operate a drone for a government agency, a publicly funded university, or for first responders, you very likely have two options [13]:

- Follow the FAA's Part 107 small UAS rules. Therefore you adhere to all the same rules, laws and operating guidelines used by commercial fliers, or
- You can apply for a blanket public Certificate of Authorization (COA) which allows you to fly at or below 400 feet in Class G airspace nationwide. The COA requires self-certification of the pilot and lets them obtain emergency COAs under special circumstances. By the way, COA's for public flight operations are only available to federal and state government agencies, law

enforcement, and public colleges and universities. Public aircraft operations must be conducted for a governmental function. The FAA thoroughly evaluates each COA application to determine the safety of the proposal. While the average COA application takes just under 60 days to process, it can be expedited in emergency and life-threatening situations.

Starting in May 2016, the FAA allowed the use of drones by students in accredited education institutions as part of their coursework. Students only need follow the guidelines for recreational use of model aircraft, provided the drone is also operated within local safety guidelines and those of a nationwide community-based organization like the Academy of Model Aeronautics (AMA). A drone can also be operated for demonstration purposes at community-sponsored events, provided the drone pilot does not receive any compensation related to the operation of the aircraft [14].

Students can learn how to design, construct and operate small unmanned aircraft under 55 lbs. as part of science, technology and aviation-related coursework, or for other educational purposes like that in television, film and photography courses. According to the FAA these fall under recreational use; schools and students should follow the same protocols as a recreational flier. As a finer clarification, this only applies to accredited educational institutions and does not apply to research which would likely connect flight operations to a faculty members' professional duties and compensation. The same applies to a course instructor; they can only provide very limited support to a student flying a drone when the emphasis on the lesson is not flying a drone but concentrating on other skills like aircraft construction or design.

DRONE MAKERS

If you really do not plan on flying more than 15-20 minutes at a time and do not need to fly in adverse conditions, consider lower costing consumer drones, or prosumer drones in order to keep your budget under control. The more you need your drone to do, the higher the cost. Realize too that when it comes to video recording, not every camera on every drone is the same. If you really need to use GoPro's Hero4 then you need to ensure your platform will accept and support that camera.

Drones are available in many sizes, shapes and even different colors. The Syma X5C mentioned comes in two colors, white and red. This is not a drone I recommend even for prosumer media work; although it is a good practice drone. I purchased the red version to help with visibility but this also added another 10% to the price. The X5C comes with front and rear anti-collision LEDs to help with low-light flying, and the 2 megapixel camera shoots stills and high definition video from the always-forward-pointing camera. While it takes approximately 1.5 hours to charge a battery, it will only give you approximately 7 minutes of normal flying time. I have been able to get 10-12 minutes of flight by unplugging the camera's cable from the drone. Being less than 0.55 lbs. this drone does not require FAA registration [15]. This gave me another reason to buy it. The X5C is still available online as of early 2017 for less than $50 but with better models coming to market all the time, the X5C will be replaced soon, if not already. If you just want some experience with a drone without the need for FAA registration and you are fine with an ultra-small drone, the Fast Lane Radio Control FLX Nano Drone is a good option. Like the FLX Nano drone, if you want something else that is low-budget, I recommend the Estes Proto X Nano. It is approximately double the price of the FLX Nano but beware, like the Nano, the small size of both can still be a disadvantage.

When it comes to commercial drones the price jumps dramatically. DJI, which I believe is the best known name in drones, makes consumer models like the Mavic Pro and the Phantom 4 which can be purchased for approximately $1,000 and still have uses in broadcasting. Their position in the consumer market is likely the strongest of all companies since they seem to dominate all news and press at this level. If your budget allows a better quality drone, consider the DJI Inspire 1 and Inspire 2 since they are specifically made for capturing high definition (HD) video [16]. There are also optional Zenmuse cameras and professional gimbals from Ronin available for both Inspire models. Again, once you take the leap-of-faith to better drones, expect to pay a higher price.

One drone used by many professionals is the xFold™ Travel which is designed for multiple applications, from DSLR and FLIR cameras, to a variety of sensors and payloads you can personalize to your needs. With a flight time of approximately 40 minutes this brings extended production in a single launch. With the additional cost comes smoother footage due to an anti-vibration mechanism and multiple axis, gyro stabilized camera gimbals. The Travel comes configured with 8 motors/propellers (X8) with the option to configure it with 12 motors/propellers (X12). If a motor fails while in flight, the Travel will maintain its altitude and rotate around the stopped motor. The beauty of this is it still lets you fly safely back to your launch site. With the Travel, you also have the option of a dual operator set up, gimbal system, a travel case and Lithium Polymer (LiPo) batteries. The ready-to-fly price of the Travel starts at just over $10,000. With the higher price comes the higher reliability many of us demand. Understandably no broadcaster wants to be covering a major event and have their drone crash and injure an innocent bystander [17]. Besides the Travel, xFold™ also offers the heavy lift Dragon, the Cinema, and the SPY models.

Another well know manufacturer in the world of professional drones is Yuneec. Their current models included the Breeze, the Typhoon H and Typhoon 4K, and their high-end professional platform, the Tornado H920. The Tornado is a hexacopter (X8) providing a 360° view below without anything obstructing the camera's view. The

Tornado H920 is reasonably priced at just over $3000 and offers stability and retractable landing gear. While I have yet to fly any Yuneec drones, the Breeze seems very comparable to the DJI Phantom 3 in technical specifications and pricing [18].

Autel Robotics also warrants a mention here. While their X-Star Premium quadcopter (X4) is easy to fly, it comes with a 4K camera and 3-axis gimbal, takes Ultra HD video and 12-MP stills. DJI filed a lawsuit against Autel at the end of 2016 claiming copyright infringement [19]. While still for sale under $1,000, the X-Star, in its bright orange color, makes it a good choice when you must rely on your visual line of site in order to fly this drone a long distance. It comes with dual GPS, the Starpoint Positioning System, and SecureFly to help keep the drone stable [20].

Shotover also produces professional drones and sells the super heavy-lift cinema drone, the U1. With the U1, it is possible to carry an increased variety of camera and lens configurations for cinematography including the 6K RED Weapon, ARRI Alexa Mini, Phantom Flex4K and Sony F55 cameras and the Canon 17-120mm, Fujinon 85-300 and Optimo 28-76 lenses. Without a doubt, this is not a cheap solution but when you expect the very best, this is one choice [21]. By the way, one production house that uses the U1, Flying Glass from the United Kingdome, can be hired to fly their Shotover U1, and other drones to get the videos and photos you want without the overhead of buying a drone and training a staff. Some of the Flying Glass' clients include National Geographic and the BBC [22].

Drone Vault from France manufactures drones too. They specialize in the manufacture, integration and sale of drones for professionals. With their Janus 360 (X8) you can shoot 360° video. The Janus 360 is one of the first drones for virtual reality productions carrying 10 GoPro cameras with an option for 12 cameras. The pricing starts around $20,000. Besides shooting 4K live video, the Janus 360 provides approximately 15 minutes of flight time and can shoot up to 150GB of still images per flight [23].

There are other drone manufacturers that warrant a mention but we will refer to only one more before we end this section. Freefly Systems is based in Washington where they design and manufacture drones and compatible accessories used in photography and cinematography. Their drones, like the Alta 6 and Alta 8, offer top and bottom mounting of cameras and have foldable booms that reduce the Alta's footprint to half its size for shipping around the globe to where ever it is needed. Starting at around $11,000, the Alta 6 might suit your budget [24]. By the way, Freefly also has their CineStar line of heavy-lift drones available as a hexacopter (X6) and as an octocopter (X8). The CineStar 6 starts at around $10,000 too while the CineStar 8 pricing begins at just over $15,000.

The choices are seemingly endless so there is much research that needs to be done before anyone buys their first drone. Remember, buying any drone is only the first step in the entire process. Throw in training, certifications, insurance and you soon find that initial cost for the drone was just the beginning. In the long run it should pay off in photos and video where you provide a new perspective and a view of the world you would never have shot otherwise. If you are not ready to buy yet, consider renting a drone or hire a contractor to fly their drone for your project.

DRONE USERS

In the broadcast industry, major networks are already using drones. In a story from August 2016 about drones used by ABC News, Good Morning America's Maria Stephanopoulos told Sally French of TheDroneGirl.Com, "At ABC News, we love sending drones to places we can't access. In my opinion, drones provide the most compelling images when they're used as Steadicams, jibs and helicopters" [25]. ABC News' videos show the DJI Phantom 4 in use for much of their newsgathering.

During the same timeframe CNN announced the launch of its own drone operations called CNN Aerial Imagery and Reporting, otherwise known as CNN AIR. CNN AIR is the network's drone unit comprised of full-time pilot operators tasked with incorporating aerial footage and stills in to all of CNN's networks [26].

Sinclair Broadcast Group reported that by the end of 2017 they will have as many as 80 trained and FAA-certified drone pilots in 40 markets. Sinclair's drone fleet is made of DJI's Inspire 1 drones and once released for sale this year, the Inspire 2. As part of Sinclair's policy, they always have two operators for each drone; one to pilot the drone and the other to concentrate on shooting videos and stills [27].

The DJI Phantom 4 is currently part of Radio Free Asia's production toolbox. In 2014, a Phantom 2 Vision Plus was donated for use in Hong Kong to cover the massive demonstrations of the Umbrella Revolution. Its use was short-lived because in one of its early flights, the Phantom 2 inexplicably crashed breaking off the camera. When deemed too expensive to repair at the time, it was removed from use as our production tool. Since, replacement part prices have dropped and as of this writing, the Phantom 2 is being repaired for use this year. In hindsight, it may have been a fortuitous crash as the operators who received the drone were not aware of the legal limitations for using it in a major city like Hong Kong.

Obviously, drone-based newsgathering will continue to grow domestically and internationally.

GOT DRONE; NOW WHAT?

Once you have your drone, your work has only begun. Register the drone through the FAA's website and get the Remote Pilot's Certification as mentioned previous. Follow the user manual and fly safely. You must train with the drone in advance so you are very familiar with it when the time comes to fly for an event. First, practice these flying techniques with your GPS activated [28]:

- Fly your drone up and down.

- Fly forwards and backwards.
- Make circles; fly 360° around a point-of-interest while maintaining your camera shot. If you prefer, fly squares or triangles. The more you fly the greater your skill.
- Now fly figure eights. Here are 3 of many great ways to train yourself using this flight pattern: (1) fly around your point-of-interest and maintain your camera shot; (2) fly with the camera pointed only in the direction the drone flies; (3) and point the camera outwards from the center of each circle.

Now turn off the GPS; you will notice that a simple task like hovering becomes more difficult. If you are like me, you will notice right away that when the drone is pointing right at you, every movement of your joysticks must be reversed. Only through practice can you become comfortable and prevent panic from ruining your flight. I try flying at least one hour weekly to continually sharpen my skills.

INSURANCE

Whether you fly a drone for personal pleasure or business, you should have drone insurance. Insurance for your drone is like any policy you maintain for your home and auto. If you get into an accident the insurance will cover liability and any damages to the limits of the policy.

For anyone on a low budget, one for drone insurance is to use Verifly. It lets you to buy drone insurance on-demand for recreational and commercial flights. For the moment, Verifly is the only company offering drone insurance on an as-needed basis. Due to the costs and the ease of activating its drone insurance, Verifly is best suited for small companies flying only a few times a year. Available for Android and iOS mobile devices, Verifly provides $1 million of drone liability insurance for a 1/4 mile area around you. Verifly insurance starts at approximately $10 an hour and is good for any drone less than 15lbs. Once you open Verifly's mobile app, select your flight area to see the price, click again for instant approval, and then click one more time for on-the-spot proof of insurance. After your purchase, Verifly lets you forward the insurance certificate to any email address. You can also show the policy certificate to anyone directly from your phone. Check the Verifly website for coverage in the United States since they do cover drone flights in all 50 States except in Illinois and New York [29].

Even the safest fliers experience problems flying their drone. Sometimes a drone simply malfunctions in spite of regular inspections and meticulous maintenance. With insurance you are ready for the worse, should it ever happen.

PLANNING AND PRE-FLIGHT CHECKLISTS

Now we get into the nitty gritty of preparing for flight operations. Good video comes from even better planning ensure you do your best to achieve outstanding results. We all plan our work day, vacations, and careers without having an itemized list. When it comes to drones, a pre-planning and pre-flight checklist is a must. While the following is not an all-inclusive list, I have tried to address all the important items to help you prepare for any situation wherever you fly a drone [30]:

- Keep your drone, controller and camera up to date with all software and firmware updates. Install and test these well before your next scheduled event.
- Perform preventative maintenance before and after every flight.
- Develop, conduct, and document preflight inspections, to include specific aircraft and control station system checks. This helps guarantee your drone is prepared for safe operation.
- Things come loose. Consider marking a line on exposed nuts and screws; if one comes undone, you should catch it before it wreaks havoc.
- Create and use any additional checklists to ensure you are ready to fly before you depart for the flight operations site.
- Use a flight log, or log book, to document your flying and site conditions. This information could be important especially if you crash or have a serious accident.
- Know your camera, controller, and UAV inside and out. Read the entire manual; not just the quick start guide.
- Keep spare parts with you for most any problems. For example, always have spare batteries, a spare mobile device should the primary fail, extra propellers and propeller guards, and spare cables.
- Practice regularly, especially on-location a day or two before your event. This is also your chance to do a site survey. Be sure to identify and review locations of all hazards and obstacles; get to know the area. Walk the entire site. If you cannot physically visit the site, try Google Maps and their Browse Street View function.
- Know the objective of your event and ask questions.
- Will you be flying in Class G airspace? If you are not sure, check the FAA's Sectional Charts. These are available at the FAA's website for free and can quickly tell you what class of airspace you will be using and will provide contact numbers for the local air traffic control center.
- Contact local authorities and provide a courtesy briefing on your flight plans. This can go a long way in overcoming potential obstacles and encourage their support.
- Always get permission to operate on private property. Better yet, make sure you get that in writing since oral agreements can be tougher to prove in a court of law.
- Have you added the right accessories to your drone for the event? Some possibilities are camera filters, camera lighting and anti-collision lights, leg extenders, foldable legs, and sturdy carrying case.

- Consider joining an owner's group or forum specific to your drone. They are a great source for troubleshooting advice.
- Drinking and droning do not mix. Wait at least 8-12 hours from the end of your last drink to when you fly. Put another way, wait the necessary time before you go bottle-to-throttle.
- Always pack a copy of your Remote Pilot Certificate and proof of insurance with your drone.

A Checklist For When You Fly

You have successfully preformed all pre-planning and completed your pre-flight checklist. You are now ready to go on location. To ensure a safe and successful event, follow these steps [31]:

- Attach the strap to the controller if you carry it while flying; make this a mandatory part of your personal on-site checklist. This may seem like a minor thing but can be huge if you drop your controller.
- Calibrate your drone before flying. This will help when using the drone's GPS and promote a safe return to home (RTH) if needed.
- The FAA airworthiness certification is not required but the PIC must conduct a preflight check of the drone to ensure it is in a condition for safe operation.
- Follow all FAA rules and regulations, including all local rules and regulations.
- Fly no higher than 400 feet above ground level (AGL).
- Know the weather forecast for your event location on the day of your flight. If you must fly in extreme cold, keep your batteries warm before using them. One suggestion is to microwave two bags of rice and then place them in a cooler to keep your batteries warm.
- Will it be windy? The Phantom 4 is good in winds up to about 19 knots (22 mph or 35 km/h) [32]. You can buy an anemometer through most broadcast supply and other online stores. There are also mobile apps and attachments available for use with a mobile device.
- Will it be sunny? The greatest problem flying in bright sunlight is glare reflecting off the controller's monitor. While ultra-bright monitors are available, some creative shading with cardboard or plastic can go a long way to help you get the perfect shot.
- Do not fly at night.
- Do not fly when it's cloudy. The FAA rules state you must remain at least 500 feet below the cloud base and you cannot fly closer than 2000 feet laterally to clouds [33].
- If possible, post caution signs in and around your active flight area so others know what you are doing.
- Continue to ask questions of local authorities and others as needed.
- Have someone scan the sky for other aircraft. When sweeping the sky, look for 1-second at a particular spot and then look at another.
- Use mobile apps like the FAA's B4UFly, Hover, Agrible's Pocket Drone Plan and drone specific mobile apps, like DJI's GO.

Safety

Before you fly, it goes without saying that you must plan for safety and maximize all opportunities to avoid an accident. Some of these are repeated from earlier, but they warrant inclusion in this list:

- Know your drone's average flight time for the fuel or battery used.
- Plan your flight operations so you return the drone to your launch site when you have reached approximately 80% of the drone's maximum flight time.
- You are insured and have proof of insurance, right?
- Be aware of all obstacles that may prevent a successful return to your launch site.
- Never fly directly over buildings, streets, or people. If you are flying over a building as part of your flight plan, get permission before you launch your drone.
- What is your alternate plan if weather or other problems pop up?
- Speaking of weather, do not fly in rain or snow. Only fly if the winds are less than 15 knots.
- What is underneath your drone during the flight? This must be considered when planning your flight. If there is nothing but water beneath the drone, fly with care. If you have a malfunction at any point, are you putting people or property at risk? These are all part of the responsibilities as the PIC.

Drone Accidents

In spite of all your best efforts, accidents can happen. As the remote PIC, you must know what to do when an incident occurs. The FAA only needs notification of certain drone accidents and even provides an accident report page for Part 107 pilots on their website with an online form that can be filled out and submitted right away. The FAA requires an accident report no later than 10 days after an incident [34]. Before any report is submitted, the accident must meet specific standards. It must result in a serious injury, loss of consciousness, or damage to any property.

A serious injury is one that qualifies as Level 3 or higher on the Abbreviated Injury Scale (AIS) of the Association for the Advancement of Automotive Medicine (AAAM). While it may seem cruel to assign a rating to an injury, this scoring system provides a systematic way for medical professionals to grade the severity of an injury. Injuries are ranked from 1-6 with Level 1 being minor and a Level 6 being life threatening. Consider it a 'serious injury' if anyone requires hospitalization. As a guideline, the FAA's

threshold for a serious injury generally begins at Level 3. Leave this determination to the emergency medical professionals responding to the incident [35].

When there is damage to personal property, no accident report is needed when the cost of repair, including materials and labor, is equal to or less than $500 or when the fair market value of the property is equal to or less than, $500 when there is a total loss. As an example, your $400 drone crashes into a tree and the drone is a total loss. As long as there is no monetary damage to the tree, this incident does not need to be reported to the FAA. If in doubt, I recommend you report it to the FAA.

TIME TO LAND

Drones are great production tools which produce amazing results. They range from inexpensive to high quality cinematography platforms. We are finding them everywhere too, from real estate to mining operations. While easy to buy and seemingly easy to fly, there are inherent dangers. They do require an investment of time to practice flying maneuvers, and in the long run, pilots need to develop skills to use them. Many, like Enrique Iglesias in 2015, learned the hard way things can and will go wrong with drones. Even the best drone pilots run into problems during flights. With proper education, training, certification, and following checklists, we will minimize the potential for drone disasters and keep the skies safe for us all.

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