Getting Started with Drones and Model Airplanes

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by Patrick Sherman

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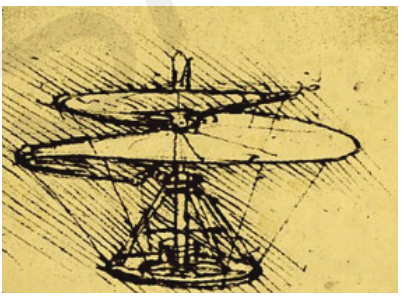
Foreword

Although we often think of aviation as arriving on the scene towards the end of the industrial revolution, man's dream of taking flight and soaring with the birds has existed for centuries, perhaps even millennia.

Uncrewed aviation, or what hobbyists refer to as model aviation, predates crewed aviation by several decades. In the fifteenth century, Leonardo da Vinci made the first real studies of flight and had over 200 drawings and sketches that illustrated his theories on flight, most of which were ornithopters—machines that flap their wings, like birds.



Leonardo da Vinci lived centuries before the development of technologies (such as the internal combustion engine) that would have made his imaginings practical. He nevertheless made sketches and built models of flying machines, including this helicopter, that presaged the era of human flight.

In 1878, the Wright brothers' father, Bishop Wright, brought home a rubber band powered toy helicopter designed by the French aeronautical experimenter Alphonse Pénaud. The Wright brothers flew the toy helicopter until it broke, then rebuilt and redesigned the model multiple times as they gained a better understanding of aeronautical design and the theory of flight.

On December 17, 1903, the Wright brothers' experimentation in model aviation resulted in man's first successful powered aircraft flight in the 1903 Wright Flyer with Orville Wright at the controls. In the decades that followed, model aircraft have time and again been employed to prove new aeronautical designs, new flying techniques, and new theories in aerospace science.

Model aviation has not only aided in the development and advancement in aeronautical design and related aviation equipment but has also been instrumental in developing the knowledge, skills, and abilities of thousands of aviators, engineers, mechanics, technicians, and scientist enjoined in the emergent field of aeronautics and aerospace science.

Among the most prominent of these stories is that of Neil Armstrong. Few people on the planet don't recognize Neil Armstrong as an astronaut and commander of the Apollo Lunar Module, *Eagle*, and as the first man to step on the surface of the Moon. However, fewer individuals know that Neil's interest in aviation was spurred by his involvement in model aviation in his youth and during his formative years at Purdue University.

When asked how big of a role aeromodelling played in Neil's endeavors, Neil's brother Dean said, "Enormous!" And, perhaps Neil said it best in his letter to AMA Executive Director John Worth, "My model building and flying activities significantly contributed to my interest in aeronautics and was a primary force in directing my education toward aeronautical engineering."

This is by no means an isolated anecdote. Similar stories are told thousands of times over by aviators, engineers, and aviation career professionals around the country, and it is very much true in my own case. My interest in aviation was stimulated by my father's recounts of his experience as a Flying Fortress B-17 pilot during World War II, and it began in earnest when I flew my first control line model airplane at 6 years old.

This simple beginning led to receiving my first pilot's license upon graduation from high school, followed by a 27-year career in the military, 36 years in civil aviation, and a life-long involvement in the hobby culminating in being elected as president of the Academy of Model Aeronautics.

Model aviation is a hobby that touches the hearts and minds of individuals across the spectrum of life's journey. It's an educational tool in the development of life skills for our youth, it provides a wholesome and productive activity for young adults, it brings families together providing an active and unifying endeavor, and it becomes a social outlet and a therapeutic activity well into the golden years of the aeromodelling enthusiast.

Model aviation also provides a competition platform ranging from local fun flies and sporting events to regional and national competition leading to world-class international competition that climax in podium-level standings in world championship events under the banner of the Fédération Aéronautique Internationale. For more than a hundred years, competition has been the driving force behind innovation and new technologies within the aeromodelling pursuit and has directly translated into advancements in full-scale aviation.

I've known Patrick Sherman for a decade and have worked with him directly in training new entrants into both the uncrewed and crewed aviation arenas. He's a true professional, an ardent educator, and a consummate creator of innovative and effective educational materials. I think you'll find this book to be a treasure trove of concepts and ideas aimed at assisting the novice in getting involved in remote piloting, aeromodelling, and full-scale aviation. Enjoy the read.

Richard Hanson, President
Academy of Model Aeronautics

Preface

You'll figure this out for yourself eventually, so I'm just going to come right out and say it: I am going to deliberately withhold more information than I end up sharing with you. This may not sound like an especially compelling reason to keep reading. However, if you take a moment to consider why I'm making this choice, you might actually agree with me.

I have always believed that the greatest tragedy of the human condition is that we are unable to share wisdom as easily as we are able to share knowledge. If you want to understand how an internal combustion engine works or the history of the British Isles between the Fall of the Roman Empire and the Norman Conquest, I've got some good news for you: We've spent the past several thousand years perfecting techniques that allow us to take what one person knows and instill it in another person.

From the microprocessor to the locomotive and from crop rotation to high-rise architecture, every significant human accomplishment has been built upon understanding what our ancestors understood and then improving on it. This capacity to create and share knowledge—which I would describe as the characteristic that most distinguishes humans from every other life form that we have encountered so far—has enabled our greatest achievements.

However, despite this extraordinary capability, it seems that each new generation must discover wisdom for itself, by trial and error. We can teach people about genetic engineering and orbital mechanics, but as any parent will tell you, we can't teach people that actions have consequences. We can't teach them that bullies are cowards or that thinking about a problem is no substitute for doing the work. It seems that each of us must learn these lessons for ourselves through lived experience—and then watch as the next generation painfully learns those same lessons.

I am not going to propose a solution to this problem: I'll leave that to the philosophers and theologians. I'm just a pilot, these issues are well above my pay grade. Nevertheless, my recognition of this problem has informed the knowledge that I will seek to share with you across these pages. I have taken my best guess about what you need to know as a person who is getting started with drones and model airplanes and eschewed everything that doesn't fulfill that mandate.

Nearly every single sentence you will read between the covers of this book could be expanded upon with a more thorough and comprehensive explanation, each of those explanations could then be expanded upon, as well, again and again, until this book became an encyclopedia. If I were to delve more deeply, however, as a novice I believe you would have trouble distinguishing between those things you need to understand *right now* and those things you can discover for yourself throughout your own journey in aviation.

If a career spent writing has taught me anything, it's that what you don't say is often as important as what you do say. Too much information can be overwhelming, confusing, and ultimately result in less knowledge being meaningfully transmitted to the reader. That's my theory, anyway. You can let me know how it works out for you.

Remember that the only true source of wisdom is experience—and experience is a hard teacher because it gives the test first and the lesson second. My goal, based on my own experience and the insight of many colleagues, is to guide you as to what experiences you should seek out, and those you should seek to avoid.

In keeping with the idea of trying to share wisdom and not just knowledge, I would like to suggest that almost everything you will read in this book has the goal of providing you with *context* for the learning you will do after you are finished reading it. I always tell my students that my goal is not to teach you the rules and the facts: You can look those up for yourself on the Internet in a few seconds. My goal is to teach you how to *think* about the rules and the facts and where to find them when the need arises.

7

Spaces and Places: Choosing Where to Fly

Your choice of flying sites will be driven by two key considerations: first and foremost, safety, and second, what you hope to accomplish by flying. The first point is non-negotiable, but the second offers as many possibilities as there are combinations of remote pilots and aircraft—and that's a lot of possibilities. Since we can't conceivably cover all of them, we'll look at the general characteristics of different types of flying sites and explore procedures that will allow us to operate safely at each of them.

Two steps must be taken before flying in any location—verifying the airspace and assessing the environment.

FIRST THINGS FIRST

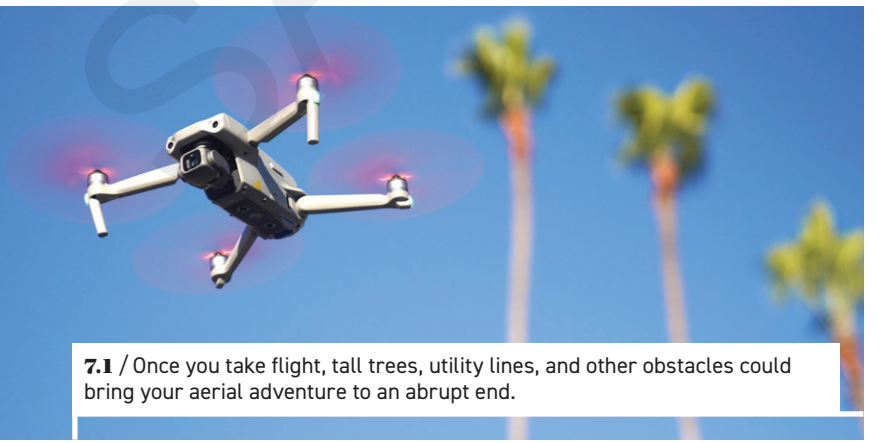
We looked extensively at the question of airspace in Chapter 2, but by way of a quick review—or in case you're jumping around in the book like I would—the two kinds of airspace are ***controlled*** and ***uncontrolled***. You can use the FAA's ***B4UFly app*** to figure out which one you're in, and either answer requires some additional work. If you're in controlled airspace, you'll need authorization before you can fly from the ***Low-Altitude Authorization and Notification Capability (LAANC)*** system. If you're in uncontrolled airspace, you'll need to verify that no airports are in the vicinity that could cause crewed aircraft to be operating at low altitude.

Hopefully, all that sounds familiar—if not, go back and read (or re-read) Chapter 2. You really need to know this stuff—especially airspace—or you're just asking for trouble. With this kind of trouble, the best-case scenario is an unpleasant interaction with representatives of the law enforcement community or the Federal Aviation Administration (FAA). The worst-case scenario is that you cause an incident, or worse yet, you hurt somebody, which will result in an *even more* unpleasant interaction with law enforcement or the FAA.

Next up, you need to assess the local environment before every flight. This basically means looking around and noticing anything that could pose a threat to your aircraft or that your aircraft could harm. Bear in mind that your aircraft will be spending most of its time in the sky, so you definitely need to look up, and maybe in a way that you never have before in your entire life.

Notice the location of tall trees, overhead utilities or other obstacles that might pose a collision risk for your aircraft (Figure 7.1). You also need to ensure that there is sufficient space for your aircraft to take off and, most especially, to *land*. Remember the old-timey wisdom from our friends in crewed aviation: Takeoffs are optional, landings are mandatory.

There have been a few instances where I have forgotten this all-important rule while flying drones. Their remarkable stability and collision-avoidance capabilities have allowed me to launch from a narrow patch of ground where it was impossible for me to safely



7.1 / Once you take flight, tall trees, utility lines, and other obstacles could bring your aerial adventure to an abrupt end.

set the aircraft back down again. A few mad scrambles to identify an alternative landing site with my machine's battery running low broke me of that habit. Hopefully this is a lesson you can learn from my experience, rather than your own.

With fixed-wing aircraft, this is perhaps an even more important consideration. Especially as a new pilot, you are likely going to need far more open space to set up an approach and land than you will require to take off in the first place. The sky is infinite—it's really hard to miss once you are in the air. Space on the ground is finite. Even a football field can suddenly look small when you're trying to corral an aircraft and get it back on the ground in one piece.

Of greater importance is to study your prospective flying site for things that your aircraft could harm. Again, as we've discussed previously, you should always assume that your aircraft may stop working at any moment. All electrical and mechanical systems will fail, it's only a matter of when. Rotorcraft will most likely drop straight down to the ground at their present location, although they could spiral off in some random direction depending on the exact nature of the malfunction. Fixed-wing aircraft will most likely continue in their current direction of travel and begin descending with increasing speed. However, if the control surfaces get stuck in the middle of a maneuver, it could pitch, roll, or stall into the ground. And, of course, if the propeller(s) are still turning, the risk of severe lacerations is added on top of getting whacked by a two-pound object falling from 400 feet.

"Prepare for the unknown, the unexpected, and inconceivable . . . After 50 years of flying, I'm still learning every time I fly."

– Gene Cernan, American Astronaut

So, the key to finding a safe place to fly is to find somewhere that nothing—people, vulnerable property, or moving vehicles—will ever be underneath your aircraft that could suffer harm if it comes down out-of-control. Hitting dirt is fine. Hitting grass is fine. Hitting pavement is fine. Hitting a group of second graders on a field trip is *not* fine.

FLY COURTEOUSLY

Something else to think about while you are considering a prospective flying site is how your operations will affect not only the physical safety of others but also their enjoyment of the outdoor space. If someone is sitting cross-legged like the Buddha, waiting in silence to greet the rising sun, the buzzing sound of your propellers is likely not going to enhance their inner calm.

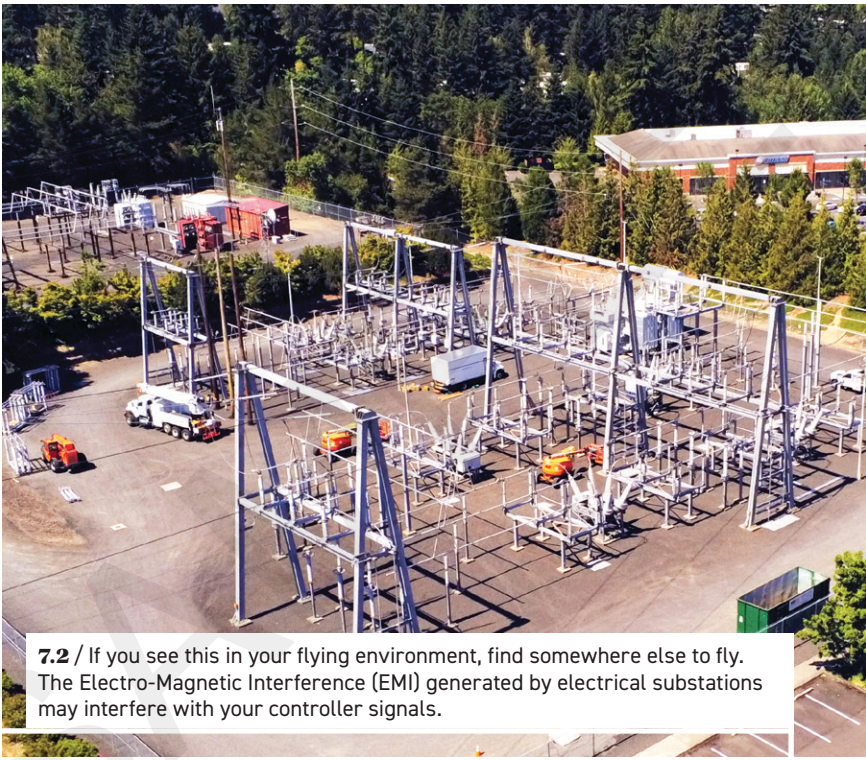
It's not against any rule to fly under these circumstances, but it is extremely rude. You should always consider the impact your operations will have on other people—to include whether it will disturb or annoy them. Not only is this simply polite, but being a good neighbor reduces the likelihood that the locals will take up a petition to ban flying in the area. Remember, every time you go flying, you are representing not only yourself—but also me and millions of other remote pilots. Enlightened self-interest is a real thing.

Another part of your environmental assessment is to anticipate what may change in the future. Just because it's an empty field right now doesn't mean that it will still be an empty field half an hour from now. Are there soccer goals at either end of the field? Maybe a team will show up to practice or to play a game. Are there walking paths and signs reminding dog owners to clean up after their pets? Your quiet field could soon be overrun by dogs who are just going to *love* chasing your flying machine. That makes for a tricky landing—believe me!

Assessing the weather is another key factor you should keep in mind while surveying an environment before flying. Hopefully you did this before you left home, either by checking the local weather forecast or just looking out the window. This assessment should continue once you arrive at the field. In particular, look at the tops of any trees in the vicinity. Their movement, or lack of movement, can give you a hint about the wind you are likely to encounter once your machine is aloft. Also, keep in mind that the weather can change during a day of flying. Dark clouds on the horizon may indicate that it's time to cut your expedition short.

Finally, you should also be alert for any potential sources of ***electromagnetic interference (EMI)*** or ***radio frequency***

interference (RFI) in your vicinity. As we learned in Chapter 5, these can be generated by sources like electrical substations or high-tension power lines and unusual concentrations of radio transmissions occurring on the same frequencies used by your aircraft's controller. These are relatively rare, but it only takes one to ruin your whole day (Figure 7.2).



7.2 / If you see this in your flying environment, find somewhere else to fly. The Electro-Magnetic Interference (EMI) generated by electrical substations may interfere with your controller signals.

FIXED-WING FIELDS

If you're flying fixed-wing, most likely your only goal is to successfully guide your machine through the air—as opposed to flying a drone, which could involve capturing interesting photos or video of something other than an open field. For this reason, selecting a fixed-wing flying site is a pretty straight-forward process: You need a large, open space with few obstacles and no people around. The less experience you have, the more space you will need.

Fortunately, 2,500 such sites already exist across the country that have been prepared for this specific purpose—flying fields affiliated with the ***Academy of Model Aeronautics (AMA)*** (Figure 7.3). Use the "Club Finder" on its website to locate one near you. These will have prepared runways, shelters, and other specialized facilities and, most important of all, they are inhabited by people who are acutely aware of the hazards involved in flying model airplanes. Indeed, as a new pilot, you will likely find that they are a terrific source of help and advice, as we discussed in Chapter 6 (Figure 7.4).

7.3 / Flying fields chartered by the Academy of Model Aeronautics (AMA) frequently offer facilities such as runways and taxiways for the launch and recovery of model airplanes.

7.4 / AMA fields also offer shelters, restrooms, and electricity for re-charging your batteries between flights, along with plenty of experienced and friendly remote pilots.

If a local AMA field isn't an option, you'll need to find a space that provides as many of the same amenities as possible: lots of open ground where people are scarce, at a minimum. Athletic fields—while not in use, of course—can be a good choice. One of my personal favorites, located only about 10 minutes from my home, is a large community park with two vast fields, each large enough to host three soccer matches simultaneously. Dogs are prohibited on the fields, and because there are beautiful, well-maintained trails that meander through the trees all around, the fields themselves aren't especially popular with the walkers and joggers. Also, it's located in uncontrolled airspace, and there are no airports in the vicinity (Figure 7.5). A quick internet search may also yield flying fields within your local area that may or may not be associated with AMA.

7.5 / A public park almost ideally suited for remote piloting operations is located just a few miles from my house, and I couldn't ask for better. Maybe I'll see you out there some time.

The park near my home is about as good a place as you could hope to find for flying fixed-wing aircraft apart from an actual AMA flying field or other local model aircraft club, and I'm far from alone in using it for that purpose. I've made several friends among the remote pilots and onlookers I've met while flying there.

Getting Started with

Drones and Model Airplanes

Written for a beginning remote pilot, *Getting Started with Drones and Model Airplanes* will help you understand how these marvelous machines work and how to fly them safely. Explaining complex subjects in simple language with pictures and diagrams that make them easy to understand, the author will guide you through buying a drone or model airplane, registering your aircraft with the Federal Aviation Administration, completing the testing and certification process, and learning how to safely operate your aircraft in and around the busiest and most complex airspace in the world. You will learn:

- The rules that apply if you are flying for fun or flying to make money.
- Fundamental principles of aerodynamics.
- How to maneuver a drone or model airplane using a two-stick controller.
- How to identify the different parts inside a drone or model airplane.
- The importance of flying safely.
- Simple techniques for evaluating a new flying site and taking great aerial photographs.

Whether you are learning how to fly remote aircraft, taking the first step on the road toward commercial drone operations, or getting your feet wet with aviation-related subjects, this book will get you headed in the right direction.

Patrick Sherman is a pioneer in the drone industry. A professor at Embry-Riddle Aeronautical University specializing in sUAS, Patrick was honored as the "Drone Instructor of the Year" by the Association for Uncrewed Vehicle Systems International (AUVSI) and is a Trusted Operator Program (TOP) Level 3 Remote Pilot Instructor (RPI).

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