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HOW TO  
LAND  
A  
PLANE

MARK VANHOENACKER



## *HOW TO LAND A PLANE*

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**Important Notice:** If you have opened this book because you find yourself in the sky, in the cockpit of a plane that you do not know how to fly, there's no need to stand on ceremony—please skip right ahead to Chapter 2, “Aviate, Navigate, Communicate.” You can return to this introduction at a more convenient time (say, after touchdown).

**Less Important Notice:** I know you've got a lot on your plate right now and I don't wish to distract from the task at hand. But I can't help mentioning that I'm a huge fan of photographs taken from airplanes. Sunsets, cloudscapes, shining wings—whatever you manage to capture up there, if you think it's beautiful, then I would love to see it. Feel free to send me a picture, via the website [skyfaring.com](http://skyfaring.com).

# Introduction

I spent a lot of my childhood dreaming of becoming a pilot. I saved my money to buy model airplanes, I begged my parents to take me to air shows, and whenever we flew somewhere on vacation I pressed my nose to the window with an ever-firmer love of flight.

Today I'm a 44-year-old pilot who flies the Boeing 787 Dreamliner. On most workdays (and work nights) I still carry a bit of that childhood joy with me across continents and oceans, above the most beautiful formations of cloud and the gathered lights of cities, under more stars than I could ever have imagined I would see.

Like many pilots, flight attendants and devoted fans of the window seat, my love for flying feels simultaneously planet-sized and deeply personal. In flight we move like mere dots through the new immensity of the sky, we see our homes so small and far below us on the unfamiliar enormity of the earth, and yet even as flying makes us feel so tiny, it uplifts us. What else does that? I'm never surprised when I hear people describe flying as an almost religious experience, nor when I encounter wings and elevated perspectives in sacred images and stories that far predate the Wright brothers.

For those of us who love flying, and who want to share what we love, I think it's important to describe flight in such high-reaching terms. At least sometimes. Otherwise, whether as pilots or as passengers, we might forget how humbling and inspiring flight can be.

But there's another way to think about the wonder of flight.

We might briefly, and perhaps counterintuitively, set aside all that soaring language (of which Exhibit A is surely the word "soaring" itself).

We might instead approach flight through its most impersonal and mundane details, where God (or the devil, depending on which version of the expression we're partial to) is said to reside. We might remind ourselves that airplanes, like delivery vans and supertankers and lawnmowers, are machines that people design, build, and drive across the world for almost entirely practical purposes.

Reencountering the airplane as "just" a machine reminds us that flying, however remarkable, is "just" a skill—a set of skills, to be precise, that are taught, tested, and regulated like any other (albeit far more rigorously than most). These skills are challenging, certainly, but they are not romantic. On the contrary, they're unusually down-to-earth. Many remain stubbornly physical, even in the most computerized modern airliner. Yet it's from these skills that the transcendence of flight is dutifully and safely assembled, many thousands of times each day.

In this short volume, I'd like to describe some of these skills—specifically, those needed to land a plane.

Why focus on the landing? While it's true that takeoffs are great fun—they benefit from the exhilaration, and the acceleration, that accompany any great beginning—landings offer more opportunities to describe a number of different skills that pilots need. Most pilots would agree that landing is more challenging than taking off, and it's arguably a more useful talent (no one has to take off, after all).

It's also the case that landings, at least to me, are more momentous than takeoffs. I find that's especially true when I'm



flying as a passenger. I love to listen to music while in the window seat, and, for as long as I can remember, it's been the landing that has demanded the best song. A landing is nothing less than how we move from the skies of our planet to its surface. It's how we (a flying species at last) come home.

But I promised to set aside the lofty words, didn't I? And anyway, it's almost time for you to take the controls.

Close your eyes, then, and imagine a plane high in the blue. Any plane at all.

You are going to land this plane. I hope that you'll enjoy doing so. I hope, too, that the experience will leave you with a new understanding of flight, and of why so many pilots—myself included—believe that we really do have the best job on Earth.

Before we start, a few caveats. My goal in these pages is to guide you on a flight of imagination—one that's as technically accurate as possible. Needless to say, however, this book cannot substitute in any way for professional flight training. "I do not intend to be taken literally," wrote Squadron Leader Nigel Tangye about the title of his classic 1938 text, *Teach Yourself to Fly*. Instead I encourage—as Squadron Leader Tangye did—any sufficiently interested reader to hurry to their nearest airport, where your "baptism of the air" may be attained for as little as five shillings (a figure that only a killjoy would adjust for inflation).

The main reason that no book can substitute for professional flight training, of course, is that flying is a physical skill you can only learn in an actual airplane, in the sky, with a steely-eyed instructor sitting next to you.

Another, less appreciated reason is that planes differ vastly from one another. Certain principles apply to all aircraft, of course. There's a beauty to these universals, and they are the

perfect window onto both how flight works and why it's so amazing. Beyond these, though, even the more general systems and procedures that I describe won't cover *all* aircraft.

On the subject of beauty, the aircraft I'm going to refer to most often in these pages is the Boeing 747. The most iconic airliner in history, the 747 changed the way many people thought not just about flying, but about the world itself. It entirely captured my imagination as a child, and the opportunity to fly it for 11 years was one of the great joys of my life. So it seems right to give it pride of place here.

Finally, in order to focus on the fundamentals of flight during our brief time together, I've thought it best to make a few unrealistic assumptions. Sorry to say, then, that your plane has no automatic flight systems. If such wonders were to be available (they're not as easy to spot as the inflatable autopilot doll in *Airplane!*, a film that just about every pilot loves, and that you'll have a number of hopefully happy opportunities to recall in the pages to come), then you should consider jumping ahead to the "communicate" section of Chapter 2.

Looking on the bright side, though, when you take control of your aircraft, it's cruising at an altitude that is free of mountains, adverse weather conditions, and other aircraft. You are in level and unaccelerated flight, and your aircraft (aside from the aforementioned automatic flight systems) is functioning normally.



## Chapter 1

# Settling In



*Figure 1*

Hello! Welcome! Honestly, you look surprisingly calm. That's great to see.

So, this is the cockpit. Have a seat on the left—you're now the captain, after all, and that's the captain's seat. First of all, I have to ask, what do you think of the view? The world-surveying, forward-facing panorama that a cockpit offers is reason enough to become a pilot. You really are in the best seat in the house.

Fasten your seat belt, which pilots must wear whenever they are sitting down. In addition to the usual belt which goes across

your lap, there may be shoulder straps or harnesses, as well as what's delicately termed a "crotch strap."

Now, in the spirit of a gentlemanly skipper I once flew with ("Priorities, young Mark, priorities!"), order yourself a cup of tea.

I'm joking about the tea, but only a little. One reason I prefer flying to driving is that when you're driving, whether on a busy highway or a winding country lane, if you were to let go of the wheel you'd probably be only a few seconds away from disaster. Airplanes are different. They are designed to be stable. If a pilot briefly took his or her hands off the controls, a plane would simply carry on doing whatever it had been doing before. For an untrained pilot, "Do nothing" is my first bit of counsel.

So, by all means, have some tea (at the very least it will help you relax). And then, when you're ready, take a good look around the cockpit. There's almost certainly a bewildering array of buttons, levers, and switches, and, depending on how modern your aircraft is, lots of digital screens. But for routine flight—including a routine landing—I promise you that a cockpit isn't as complicated as it looks.

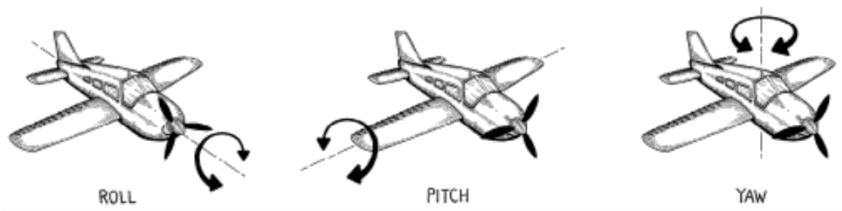
Let's start by dividing what's in front of you into **controls** and **instruments**. To give a familiar example, in a car you can add power by using a control (the accelerator pedal), and you can monitor the result on an instrument (the speedometer). It's the same in a plane. The controls allow you to manipulate the aircraft and its systems, while the instruments give you information about the results of your inputs, as well as about the aircraft's ever-changing relationship to the outside world.

## The Controls

The first widebody airliner I learned to fly was the Boeing 747. Compared to many airplanes, it's both enormous, and enormously

complicated. Yet one of my 747 instructors was fond of saying to me, again and again, “Mark, it’s just a big Cessna.” What he meant was that, while technology changes, the basics of flying don’t. So, what are those basics?

A good place to start is with the famous **three axes** along which a plane can be controlled, as shown here:



*Figure 2*

Think of a line running through the nose of the plane, down the middle and out the tail. As painful as it is for me to compare the majestic 747 to a rotisserie chicken, you could imagine that the plane is on a spit. A plane can rotate from side to side along this axis. That’s **roll**.

Add another line, running (roughly) between the wingtips. A plane can rotate along that axis, too, tipping its nose and tail upwards or downwards, as if they were the opposite ends of a seesaw. That’s **pitch**.

Finally, imagine a vertical line running through the plane from the sky to the earth. A plane can rotate around that, just as if it were on a turntable. That’s **yaw**.

A pilot has controls at his or her fingertips (and toe tips) to rotate a plane along each of these three axes.

Let’s start with roll. In front of you is something that vaguely resembles the bottom half of a steering wheel. That’s the **control**

**wheel** (Figure 3). When rotated, it maneuvers panels on the wings that essentially make one wing work better or worse than the other. The temporarily improved wing rises, the other one falls, and the aircraft rolls around its skewer-style nose-to-tail axis. From a window seat behind the wing, it's easy to see how neatly the plane rolls in response to even very small movements of the panels on the wings—a testament to how much air is flowing over them, and how fast. Rolling can also be called **banking**, and it's basically how planes turn in the sky.



*Figure 3*

Why do planes turn like this? While it's not a perfect analogy, you might think about how racetracks are often banked or inclined, especially on the curves. Indeed, some racetrack bank angles are just as steep as the bank angles typically used by a turning aircraft. (Another reason why I like the racetrack analogy: the holding patterns that planes sometimes enter when waiting to land are racetrack-shaped, with precisely drawn curves the planes must bank around . . .) You could also think about those little model airplanes you see in toy shops, which are tethered to the ceiling and race around and around in a little circle. Those planes

are always turning, and always banking.

Next is pitch—the seesaw-like motion that raises or lowers the angle of the nose in relation to the horizon. Unlike a car’s steering wheel, the control wheel also moves forward and backward on the **control column**, to which it’s attached (the terms **yoke**, control wheel, and control column may be used somewhat interchangeably for the combined assembly). The forward-backward motion of the control column moves either the entire horizontal part of the tail, or panels that form part of it. The horizontal part of the tail is basically a mini-wing, and manipulating it so that it works better or worse forces the tail down or up, which in turn changes the pitch (or **pitch attitude**) of the whole aircraft.

If you push forward on the controls, the nose will lower and (in the most general terms) the aircraft will descend. Pull back, however, and the nose will rise, and the aircraft may climb. My favorite summary (which is adapted from *Father Ted*—a British TV show from the nineties—and which I couldn’t help but quote in my first book, *Skyfaring*): “Push the control column forward, cows get bigger. Pull back, cows get smaller.”

On some planes, instead of a control wheel and column, you’ll have a stick right in front of you that performs the same functions. On certain aircraft, including most Airbus jets, you’ll see a sidestick controller off to one side—an incredibly expensive joystick, essentially, that processes pilot inputs in a high-tech manner that’s far removed from the basics we’re discussing here.

So that’s roll and pitch. What about yaw? In front of your feet are **rudder pedals**. These pedals have a number of functions. Both in flight and on the ground, they control the vertical panel or panels on the tail fin of the aircraft, while on the ground the pedals are typically also used to steer the aircraft via its wheels, as

well as to brake, or indeed to steer by applying the brakes. In flight, the effect of the rudder pedals is to yaw, or rotate, the aircraft—again, as if it were on a turntable.

Perhaps you're wondering here why planes don't just yaw to turn, instead of rolling. Planes can indeed turn simply by yawing, but for a variety of reasons it's less effective. To go back to the racetrack analogy, if a curve wasn't banked, a car going too fast around it would skid off, right? If you simply yaw a plane, then it, too, will "skid" in the direction it was originally traveling.

In fact, the most efficient, polished aerial turns require both banking and a bit of rudder. In a small, basic plane—the kind you might take lessons in—your instructor will drill this coordination of roll and yaw into you from Day One. In airliners, the coordination is typically automated. For today's limited purposes, on most modern aircraft it's probably simplest to not use the rudder pedals when turning in flight. Just don't think of them as anything like the pedals in a car, which they definitely are not.

The other important control you need to find is the power.

The importance of the engine (or engines) might seem obvious. But this is a good excuse to talk about the famous **four forces** (Figure 4) that, along with the famous three axes we just discussed, are something every aspiring pilot learns about on the first day of ground school.



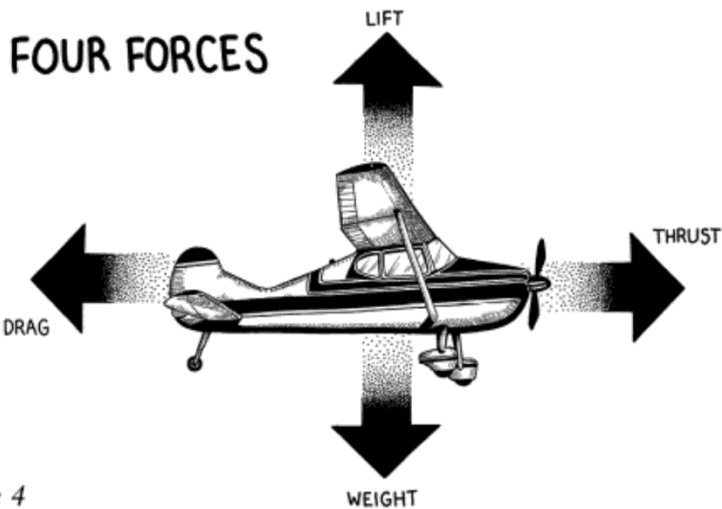


Figure 4

The plane creates **lift**, primarily from the wings. Sometimes my friends ask me how planes fly. What they usually mean is “How does a wing work?” There are a couple of different ways of explaining it, not all of which, frankly, are very satisfying or intuitive. Perhaps the best answer is the simplest one, and that was given long ago by Wolfgang Langewiesche, one of history’s greatest author-aviators. In *Stick and Rudder*, first published in 1944, he wrote: “The wing keeps the airplane up by pushing the air down.” That venerable statement grows even more remarkable, as another pilot I know is fond of pointing out, when you see a 450-ton 747 rise into the sky. For thousands of miles and a dozen or more hours, over deserts and mountain ranges and entire oceans, its vast, shining wings are pushing and pushing against nothing more than the invisible air. Lift, then, primarily overcomes the **weight** of the airplane and of everything it’s carrying into the heavens—you, your breakfast tray, this little book. It even lifts the wings themselves (which is kind of meta and best not thought