Learning to Fly Helicopters

Second Edition

R. Randall Padfield

Mc Graw Hill Education

Learning to Fly Helicopters

About the Author

R. Randall Padfield, formerly editor-in-chief of AIN Publications for 14 years and now chief operating officer, has some 9,000 hours of flight time, most of it in helicopters, and is the author of four books on aviation. He holds an Airline Transport Pilot certificate for helicopters and airplanes, flew U.S. Air Force rescue helicopters in Iceland and Alaska and civil offshore helicopters to North Sea oil platforms, and for a short time served as copilot for Donald Trump, flying a VIP-configured AS332 Super Puma. A graduate of the U.S. Air Force Academy, Mr. Padfield holds a master's degree in engineering management from UCLA and received the National Business Aviation Association's Gold Wing Award for reporting excellence in 1998.

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To my ever-loving, always patient, cleverly creative, frequently funny, and thankfully forgiving wife, Moira; our three happy, intelligent, amazing, and much-loved children, Heitha, Dirk, and Tommy, and their spouses, Richard and Dawn; and our clever, spunky, and fun-loving grandchildren, Richie, Nia, Lila, Liam, and Coral, all of whom are showing signs of outdoing their parents and grandparents.

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Foreword

Charles Lindbergh and I both flew out of Roosevelt Field in Garden City on New York's Long Island. He did it famously in 1927, and I in utter anonymity some 30 years later. Still, my flight—albeit as a passenger—was also noteworthy since it occurred after the field had become, sadly, the Roosevelt Field Mall and thus may have been among the last flights from the hallowed aviation place.

As you've surely guessed, my aircraft was a helicopter, a classic Bell 47 that my uncle, a friend of helicopter pioneer Frank Piasecki, had sponsored for a brief appearance at the mall. A wide-eyed kid going aloft for the first time, I distinctly recall my surprise at not so much ascending, as I had expected, but rather seeing the ground fall away below me. I knew immediately that this was something special.

Ever since I have marveled at the helicopter's unique properties, but they remained largely theoretical as I went on to fly aircraft whose wings were fixed solidly in place, and to write and edit stories about the same.

Then one day in 1980 a manuscript arrived unbidden at the magazine I was then editing that described in riveting detail an environment, a set of circumstances, a discovery—all to the extreme—that had tested helicopters and their crews to the limits. The story focused on the Alexander Kielland, a five-legged, semi-submersible drilling rig that had capsized after one of its legs broke off during a furious storm in the North Sea shortly before night. Despite a desperate response by helicopter crews in harrowing conditions, their bravery could not alter the catastrophe, which ultimately claimed 123 lives.

The story's author was one of those responding pilots, an expert rotary-wing aviator, and, as it turned out, a writer of the highest order as well. That was my first encounter with Randy Padfield and, fortunately, we've had many since, as we've traveled parallel paths in publishing.

Over the years, I have come to admire Randy's special ability to convey both the technical and practical aspects of rotary-wing flight, as is well demonstrated within the pages that follow. Anyone truly interested in mastering these extraordinary flying machines—no simple thing, as two of my sons can attest—would be well served to spend some time taking in what an aviator who achieved that level years ago has to give.

And before long you, too, might be pulling collective and watching your old world fall away.

William Garvey
Editor-in-Chief
Business & Commercial Aviation
Ridgefield, Connecticut

for her; to Amy Laboda, a freelance writer for *Aviation International News* and former editor of *Aviation for Women* magazine, who provided contacts with three helicopter pilots she knows; and to Stacy Sheard, one of Amy's contacts, who connected me with three more pilots. Believe me, networking in the helicopter industry really works!

I am also thankful to Laura McColm of the Bristow Academy and Daniel Jones of Hillsboro Aviation, who provided much of the current information about helicopter flight training that appears in Chap. 13.

More special thanks to my two longtime bosses, Jim Holahan, founding editor of *Aviation International News*, and Wilson Leach, founding publisher, now managing director and full owner of the business and my current boss. Jim took a chance on me, hiring a professional helicopter pilot/freelance writer to be news editor of what then was primarily a business aviation publication, at a time when I really needed the job. Wilson took another chance when he offered me the position of editor-in-chief when Jim retired.

I also want to thank Bridget Thoreson, my editorial coordinator at McGraw-Hill Education, publisher of this book, for encouraging me to do this second edition and for patiently helping me step by step through the process; and Sapna Rastogi, project manager at Cenveo Publisher Services, for patiently guiding me through the page proof process and allowing me to use Dropbox instead of the company's FTP site to move materials back and forth.

And I must also gratefully thank all the helicopter manufacturers who provided many photographs and much information about their aircraft for this book and its first edition: AgustaWestland, Bell Helicopter Textron, Boeing Helicopters, Enstrom Helicopter Corporation, Erickson Air-Crane, Eurocopter, Kaman Aerospace, MD Helicopters, Robinson Helicopter Company, and Sikorsky Aircraft Company; and also Bristow Academy and Hillsboro Aviation.

Finally, as I did in the first edition of *Learning to Fly Helicopters*, I wish to thank again my parents, Ralph and Clara Anne Padfield, although this time posthumously. My father, a World War II naval aviator, meticulously prepared the drawings for the first edition and I have kept all of them in this one. He and my mother also read the original manuscript of the first edition for clarity, accuracy, readability, and errors. Thank you, Mom and Dad. I miss you both.

R. Randall Padfield

Acknowledgments

I would like to thank my dear wife, Moira, for her many hours of help in the preparation of this second edition of *Learning to Fly Helicopters*, for her reasoned advice, for accepting my absence while I worked on the book during nights and weekends, and for doing even more of her fair share of household tasks than she normally does, while she still maintained her private practice as a psychotherapist for children and adolescents.

I offer special thanks to three longtime friends and to my first helicopter flight instructor:

- Matt Thurber, one of my coworkers and a key editor at *Aviation International News*, who wrote the section on glass cockpits and aviation apps for Chap. 11, "Aircraft Systems," and proofread my section on turbine engines in the same chapter.
- Bill Garvey, editor of *Business & Commercial Aviation* magazine and an accomplished airplane driver, who agreed to write the Foreword to this second edition and encouraged his two sons, Michael and James, to provide their career stories as helicopter pilots. When Bill was editor at *Professional Pilot* magazine many years ago, he bought and published my first paid story as a writer.
- Ron Bower, who took me along on one leg of his first, record-breaking, round-the-world flight in a Bell 206 JetRanger, provided his career story for Chap. 17, "Employment Opportunities," and offered some inspiring "Words of Wisdom for Aspiring Pilots," which forms the basis of Chap. 24, "Postflight," the last chapter in this book.
- Gale Stouse, posthumously, my first helicopter flight instructor during primary training at Fort Wolters in Mineral Wells, Texas. Mr. Stouse, a former World War II Navy fighter pilot and also an early member of the Blue Angels flight demonstration squadron (formed in 1946), had more flying knowledge than I could ever acquire and was the best flight instructor I've ever known. Much of what you'll find in this book I learned from him.

I am extremely grateful to all 17 helicopter pilots who provided their career stories for Chap. 17. I am especially grateful to Tom Dolan, a former New York City Police pilot I've never met in person, who eagerly offered me his story and provided contacts with six more pilots; to Carol Lynn, owner of Sky River Helicopters in New Jersey (whom I also have not met), who put me in contact with three flight instructors who had worked

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Introduction

A couple of surprising things happened to me as I worked on this updated edition of *Learning to Fly Helicopters*. First, I realized I had stopped flying professionally 20 years ago in 1992, the same year the first edition of this book was published. However, I did continue to fly privately in my own 1946 Taylorcraft BC-12D, a small, two-seat airplane, and I started flying with test and demonstration pilots in new and upgraded helicopters so I could write pilot reports about the aircraft for *Aviation International News* (*AIN*). In effect, I went from being a full-time pilot and a part-time writer to being a full-time writer and a part-time pilot.

But more surprising to me was that I really fell in love again with helicopters. Not that I had ever lost my fondness for them, but after almost 20 years in Air Force and civilian helicopter cockpits, I had felt a need to pursue something else.

So, after leaving my job with Helikopter Service in Norway and returning to the United States in 1989, I added a multiengine airplane class rating to my Airline Transport Pilot certificate. My intended goal was to fly airplanes professionally. However, I quickly learned that I did not have enough fixed-wing time to get a job flying airplanes that paid enough to keep my family afloat. My best option was to return to helicopters, which I reluctantly did. I flew for Trump Air until I was laid off, then worked as sales manager for Carson Helicopters until I was unfortunately, but rightfully, fired for not being good enough at that job. Meanwhile, I was freelancing for a few aviation magazines and had started writing books, which I quickly learned is no more than a side income for most authors. So when Jim Holahan, *AIN*'s editor-in-chief at the time, offered me a full-time position as an editor, I hesitated less than 24 hours before I gratefully accepted it. I knew nothing about editing, but I could write and was eager to learn how to become a good editor.

Now, 20 years later, I find writing about aviation, and flying occasionally, a perfectly satisfying occupation (Fig. 1), although I would like to fly more often than I do. But I know what it takes for me to feel safe and competent in the cockpit—to fly like a professional pilot even when I'm flying for fun. While I eagerly accept any stick time I can get with other pilots, I do not have the time to concentrate on being the professional aviator I once was. But enough about me already.

Because you have picked up this book and maybe even bought it, I suspect you are wondering what it is like to fly a helicopter. Before I tell you, allow me to explain some things about *Learning to Fly Helicopters*.

Figure 1 Doing pilot reports for AIN Publications has allowed me to pursue my favorite avocations: flying helicopters and writing. In May 2009, Leo Meslin (right), a Bell Helicopter experimental test pilot, took me on a demonstration flight in a Bell 429 at Bell Helicopter's assembly facility in Mirabel, Quebec. My report on this light, twin-engine helicopter appeared in the July 2009 issue of *Aviation International News*. Photo by Yves Beaulieu (www.beaulieuphoto.com).

What This Book Is Not

If you found *Learning to Fly Helicopters* on Amazon, you might have read some or all of the 20 comments about the first edition, and maybe some more comments about this edition. Then you already know that most of the first edition's comments were quite positive (13 five-star ratings), some were moderately positive (5 four-star ratings), one was average (a three-star), and one other was quite negative (a one-star). I have also received more than a dozen letters in the mail from readers. These letter writers were all complimentary, and most also asked for advice, which I tried to provide as best I could.

I'd like to address that single, one-star commenter on Amazon, who wrote the following: "I strongly urge anyone who has any rotary-wing time not to buy this book. It is completely introductory in nature. The only usefulness might be for someone before they undergo rotary-wing training to gain an understanding of what a rotary-wing training program is about.... If you're looking for supplemental information, I would suggest *The Art and Science of Flying Helicopters*. ... But *Learning to Fly Helicopters* does not offer anything new."

The first and last sentences hurt, but I am heartened by the fact that the majority of readers who commented on Amazon apparently don't feel the same way. I agree with the unhappy reader's suggestion that *The Art and Science of Flying Helicopters* is an excellent follow-on to this book. In fact, I know its author, test pilot Shawn Coyle. I much admire all that he knows about this subject that I do not. (He also provided his career story for Chap. 17, "Employment Opportunities.")

But I do believe my book is more than "completely introductory in nature," that it has usefulness for people both before and after they have started flight training, and that it does offer "something new" in the quite small universe of books about how to fly helicopters. Based on their comments, as many as 18 of the other readers (the five- and four-star raters) apparently feel this way, too. I also think my book can be helpful to spouses, significant others, family members, and friends who want to know more about what their budding helicopter pilot is getting him- or herself into.

As much as I dared to, I have tried to enliven this book with my own experiences, thoughts, joys, fears, mistakes, misunderstandings, foibles, and failures, so that the reader can hopefully learn and profit from my time as a student and as a full-time, professional helicopter pilot. I've tried to write the book as if you and I were casually talking together about flying and in a way that one does not need to be an aeronautical engineer to understand what is being discussed. I could not write that way if I wanted to. I've been to enough conferences and lectures by engineers and PhDs—really smart people, believe me—to know that beyond a certain point I often don't understand a word they're saying. Yet I managed to fly almost 9,000 hours in helicopters without killing or injuring myself and anyone else or breaking anything significant, although I did have some close calls.

Another thing this book is not is a reworded example of the FAA's *Rotorcraft Flying Handbook*, nor is it the FAA's *Pilot's Encyclopedia of Aeronautical Knowledge*. To be sure, you must get both of these books and study them carefully, if you are to become a proficient pilot, whether you fly for fun or money. They are thorough, as they should be, and the latest editions are huge improvements over earlier ones. My hope is that *Learning to Fly Helicopters* will help you to better understand much of the information that is in the *Rotorcraft Flying Handbook* and maybe a few things in the *Encyclopedia*.

Finally, this second edition of *Learning to Fly Helicopters* includes additions to many of the previous chapters and several new chapters. It also has been slightly reorganized with information in Part 1 relevant to all student helicopter pilots, both those who plan to fly only privately and those who want to become professional pilots. Part 2 holds information that is tailored more for budding professional helicopter pilots, but I think many private pilots will find value in this part, as well.

What This Book Is

This book is about what it's like to learn to fly helicopters and what it's like to fly them as a professional pilot. And what is that exactly? It starts with a feeling. A feeling that must be experienced to be understood. The best I can do is identify other experiences that create similar feelings, experiences you're more likely to have had, and hope you'll get the idea.

It's a feeling you get when playing football. You go out for a long pass. You're running full speed down the field and hear your name called out. You look over your shoulder and there's the ball—right there—floating toward you. You reach out in front of you, your legs pumping as fast as they can go, and the ball just settles right into your fingers as if it were weightless. You grasp the ball, cradle it to your side, and feel like you could run on forever.

Or you're playing baseball. The pitcher throws and before the ball is halfway to the plate you know it's the kind of pitch you like. You time it just right and swing

hard and smooth. The bat meets the ball full on, a loud satisfying "thunk." As the bat coils around your body, you watch the ball sail straight out over the pitcher's head in a perfect 45-degree arc and it sails on and on and on.

It's a feeling, a hands-eyes-and-feet coordination thing. The kind of feeling a gymnast gets on the balance beam. The kind of feeling an airplane pilot gets when he squeaks on a landing in a tail dragger. The kind of feeling a skier gets coming down a slope covered in new powder. The kind of feeling everyone gets when they learn to ride a bicycle without training wheels.

That's what it's like to fly a helicopter.

You won't get the feeling riding as a passenger in a helicopter. You won't get it the first time you fly a helicopter or even the second or the third. When you're learning, you'll be concentrating too much on the basics to get the feeling. You have to master the basics before the feeling comes. Be patient. It will come with time.

When you get the feeling, you'll know it. The helicopter will no longer feel like an alien machine trying to kill you at every turn. You won't think of it as thousands of individual parts flying together in loose formation while they try to beat the air into submission. You won't think of it as the "inherently unstable" ugly duckling of the aviation industry. When you get the feeling, the helicopter will become your magic carpet.

This book can't give you the feeling. No book can. What this book can do is pave the way so that you'll get the feeling sooner.

Helicopters are fascinating, complicated machines. They're not easy to fly and they're not easy to understand. You have a lot of study and work and practice ahead of you if you are to become a helicopter pilot. Believe me, it's worth the time, effort, and money.

Once you get the feeling, you'll never want to let it go.

For several of my pilot reports on various helicopters, previously published in *Aviation International News*, and a selection of images from this book, please visit www.mhprofessional.com/helicopters.

For links to more pilot reports and to contact me directly, go to "R. Randall Padfield" on Facebook.

PART 1

Essentials for Students and Private Helicopter Pilots

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CHAPTER 1

Helicopter Myths

If God had wanted man to fly, he would have given him O.D. fire-resistant skin and pockets with zippers.

Unknown United States Army helicopter pilot, referring to the olive drab–colored Nomex flight suits worn by military pilots

Admit it. Deep down one thing you've always wanted to do is fly a helicopter. Ever since you saw your first helicopter hovering over the ground, you've wondered what it's like to be a real "hover lover." But something has always held you back.

Maybe it's that number one horror story about helicopters: If the engine stops, down you go, with all the glide ratio of a brick. Even twin-engine helicopters aren't safe, you've heard. And what about strong winds? Aren't they a problem for those fragile-looking whirlybirds? Most people will tell you no one in their right mind would really want to fly such unsafe aircraft. Why, you'd be risking your life every time you went up!

Hold on a minute. Let's clear up these things right from the start. First of all, let me assure you that all the horror stories about helicopters are just that—stories. The truth is helicopters and their pilots suffer from an image problem. Because of this and a general lack of knowledge about rotary-wing aircraft, a number of misunderstandings about helicopters, myths, if you will, have grown up over the years.

I've talked with many people—passengers, nonpassengers, even experienced airplane pilots—and I've found that a few subjects are brought up time and time again (Fig. 1-1). Let's look at them one at a time.

Myth #1: If a Helicopter's Engine Quits, You're a Goner

The film and television industries perpetuate this myth by constantly showing helicopters spinning madly out of control whenever the pilot so much as scratches his nose... not to mention when the movie villain does something mysterious, but obviously foul, to the hero's machine. For an apprehensive viewer with little or no mechanical or aeronautical knowledge, it's easy to believe that it doesn't take much to make a helicopter fall out of the sky.

On the other hand, some people with some mechanical and aeronautical knowledge, even many fixed-wing pilots, hold fast to this myth. They reason that rotary-wing aircraft have glide ratios not much better than bricks or anvils. Therefore, when its engine stops, a single-engine helicopter is doomed to descend at such a high rate that a crash is inevitable.

Myth #1: If a helicopter's engine quits, you're a goner.

Myth #2: Helicopters need two engines: one for the big propeller on the top and one for the little propeller in the back.

Myth #3: Helicopters are too fragile to fly in strong winds.

Myth #4: A flight in a helicopter is always bumpier than a flight in an airplane.

Myth #5: Helicopter pilots are different from other people.

FIGURE 1-1 The five myths about helicopters.

An object's glide ratio is the relationship between the distance it will travel unpowered over the ground compared to the height that it started gliding from; gliders are made to glide and therefore have good glide ratios; small airplanes usually have fair glide ratios and supersonic jet aircraft have relatively poor glide ratios; bricks, anvils, and rocks obviously don't glide very far so they have extremely poor glide ratios (Fig. 1-2).

Helicopters don't have the best of glide ratios, but as long as the rotor blades keep turning, helicopters can do something airplanes can't do. And it's even better than gliding. It's called *autorotation.*

The fact is: You have a better chance of survival after a complete power failure in a helicopter than you do after a complete power failure in an airplane.

Helicopters can autorotate because they have rotating wings (rotor blades) instead of fixed wings. Think of the rotor blades on top of a helicopter as a fan. When you switch on a fan, an electric motor turns the fan's blades and the blades create a small breeze.

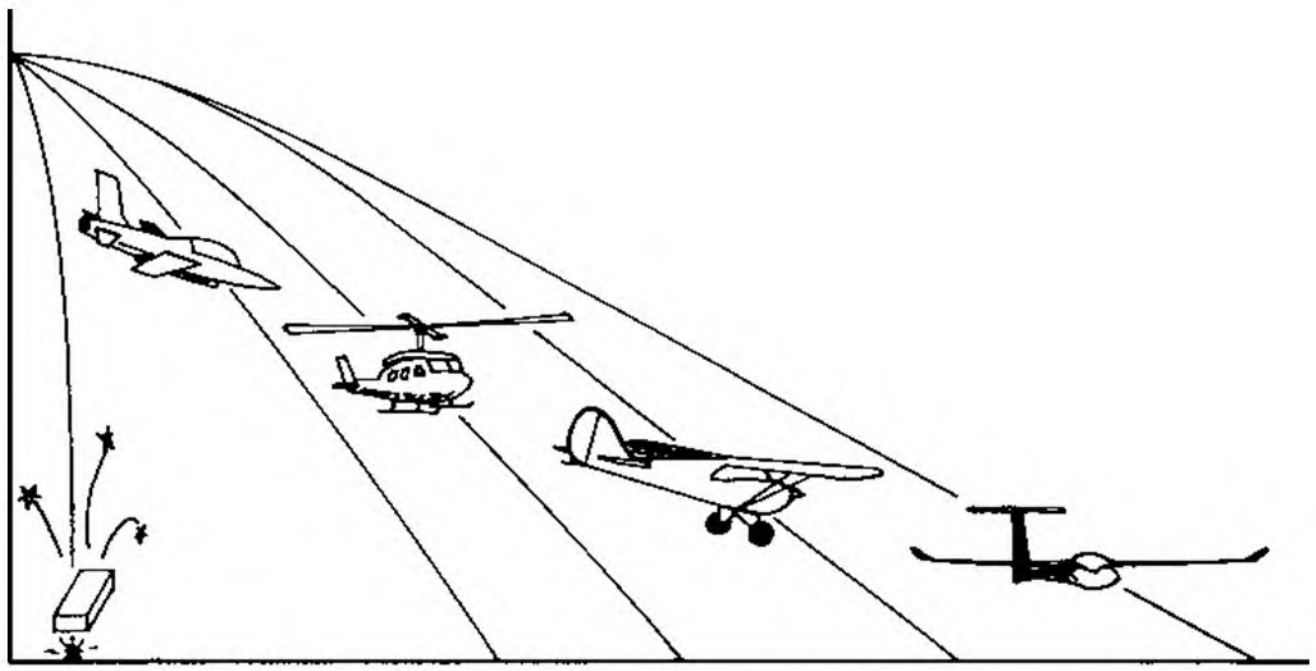

FIGURE 1-2 Relative glide ratios of several objects. A helicopter in autorotation has a better glide ratio than a supersonic jet aircraft.

The opposite of a fan is a windmill, or wind turbine. A windmill uses breezes and winds to drive pumps, generators, and other machinery. Air moves the blades of a windmill to drive the machinery, whereas, the motor in a fan turns its blades in order to move the air.

The amazing helicopter can act like either a fan or a windmill.

Most of the time, a helicopter acts like a fan. The engine turns the rotor blades, the rotor blades create lift, and the helicopter flies. But if the engine stops, the air flowing past the rotor blades, the *relative wind,* causes the blades to turn like a windmill. This allows a helicopter to make a controlled descent and landing.

What happens when the engine fails in a single-engine helicopter? (We'll get to twin-engine helicopters in Myth #2.)

The first event is the immediate and automatic disconnection of the engine from the rotor system by a freewheeling unit in the main transmission (Fig. 1-3). The effect is similar to when you stop pedalling a bicycle when going downhill. Because of your momentum and the pull of gravity, the bicycle's wheels continue to turn even though the "engine" (meaning you, the cyclist) has stopped pedalling. You might even pick up speed as you coast down the hill.

A flying helicopter is also subject to the force of gravity and it will continue "downhill" with its rotor blades "coasting" because of the effect of the relative wind turning them like a big windmill.

The net result is that helicopters do not glide like bricks, they do not fall from the sky like anvils, and they do not spin around like whirling dervishes when the engine fails. What they do is autorotate.

Although a helicopter in autorotation will descend at a faster-than-normal rate, helicopter pilots are trained to handle this event. As the helicopter nears the ground, the pilot manipulates the controls so that the momentum generated by the turning rotors during the descent is converted into lift. Some helicopters have so much energy that they can actually hover over the ground for a few seconds at the bottom of the autorotation.

The amount of lift available is dependent upon the weight of the helicopter, the temperature, the air pressure, and the surface wind. However, even under the most unfavorable conditions, a skilled pilot can usually still make a safe autorotative landing—no damage and no injuries—into an area not much larger than the helicopter itself (Fig. 1-4).

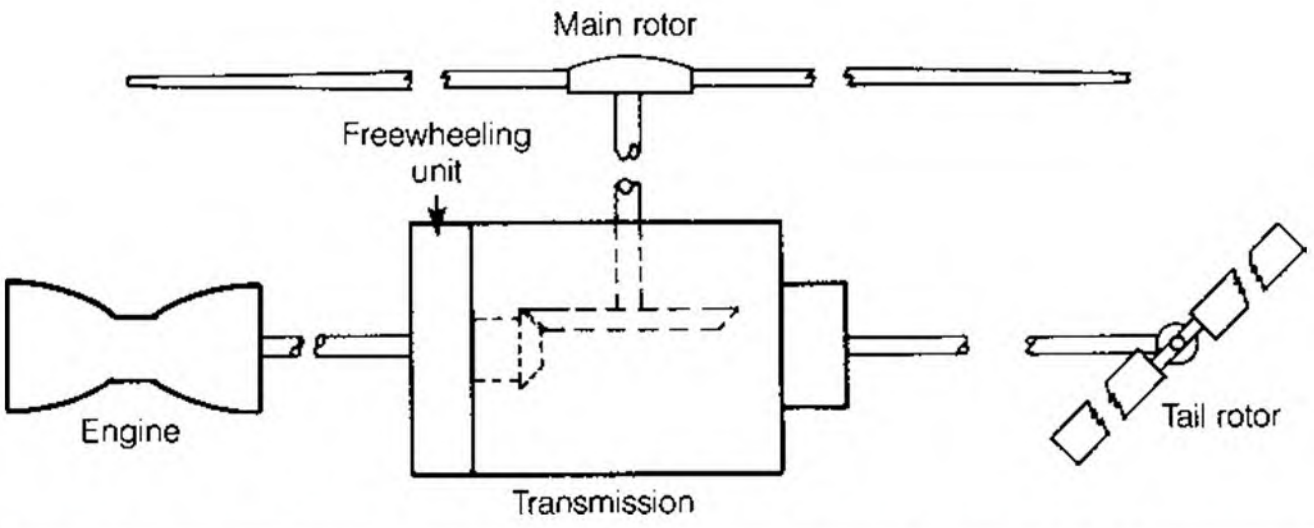

Figure 1-3 Simple schematic of a single-engine helicopter. The engine is coupled to the transmission via a freewheeling unit. In the event of an engine failure, the freewheeling unit automatically disconnects the engine from the transmission so that the main and tail rotors are free to autorotate.

Figure 1-4 At the hands of a skilled pilot, a helicopter can make an engine-out landing into an area not much larger than the helicopter itself: Schweizer 300. (*Source*: Schweizer Aircraft Corporation)

The ability to safely land in a small area is the main advantage an unpowered helicopter has over an unpowered airplane, but there are other advantages, too.

When a small, piston-engine airplane loses all engine power, its electrical generators and hydraulic pumps stop, as well (newer airplanes and airliners have backups); however, because the generators and pumps in a helicopter are connected to the main transmission, as long as the rotor blades are turning, so are the generators and pumps.

This means that the helicopter pilot can use the same equipment during autorotation that he has available in powered flight: radios, navigation aids, autopilot system, and the like. An unpowered airplane, on the other hand, would be reduced to battery power alone, which usually means that some electrical consumers are lost. Small airplanes do not have hydraulically boosted controls, but the loss of total hydraulic power in a large airplane is a serious emergency. This would happen if an airplane had a total engine failure.

So, you can see that autorotation is a very handy thing for the helicopter pilot to have.

Myth #2: Helicopters Need Two Engines—One for the Big Propeller on the Top and One for the Little Propeller in the Back

Can you figure out one of the fallacies in this statement from the preceding explanation?

Think of a single-engine helicopter. It has a main rotor on the top, the "big propeller" (but don't ever call it that), and a tail rotor in the back, the "little propeller" (ditto), and it has but one engine; therefore, something else besides a second engine must make the little propeller—excuse me, the tail rotor—in the back go around.

That something is the same in both single- and twin-engine helicopters, and even three-engine helicopters (yes, there are some, the AgustaWestland AW101, for example).

For comparison, an automobile has one engine. The engine turns the gears in the transmission and the transmission transfers the power to the wheels. In a normal two-wheel drive car, there is one engine powering two wheels.

What if you decided you wanted a more powerful car? You could, of course, take out the engine and install a bigger one. But, for the sake of this analogy, let's say that you decide to add another engine and connect it directly to the transmission.

Now you would have a car with two engines powering two wheels through a single transmission. If one engine were to stop, you could continue tooling on down the highway because you would still have power to both wheels from the engine that's still working.

A twin-engine helicopter is similar to that hypothetical twin-engine car, except that the transmission of the helicopter drives the main rotor and the tail rotor, instead of two wheels (Fig. 1-5). Each engine has a freewheeling unit so that if one engine fails, it will not slow down the transmission and make it harder for the other engine to keep the rotors turning.

The reason a "standard" helicopter has a tail rotor is to counteract the torque of the main rotor. Without an antitorque device to counteract the rotation of the main rotor, the fuselage of the helicopter would rotate in the opposite direction. Other ways of counteracting torque include the tandem rotors of the Boeing 234 Chinook or blowing pressurized air out vents in the tailboom like the MD Helicopters NOTAR (NO TAil Rotor), but we won't get into them just yet.

Why two engines? The obvious reason is to increase safety. Even though aircraft engines rarely fail, they can theoretically stop at any time, and the ability to continue flight on the remaining engine gives the pilot of a twin-engine helicopter more options (Fig. 1-6). The pilot of a single-engine helicopter has only one option available if the engine fails: autorotation. As discussed earlier, this is a very good thing to have, but it does mean the flight will end sooner than planned.

Numerous minor things can plague engines: partial failures of the control mechanism, stuck throttles, hiccups in the fuel system, and environmental factors, such as icing, heavy rain, and salt water spray, which although not always serious, can be cause

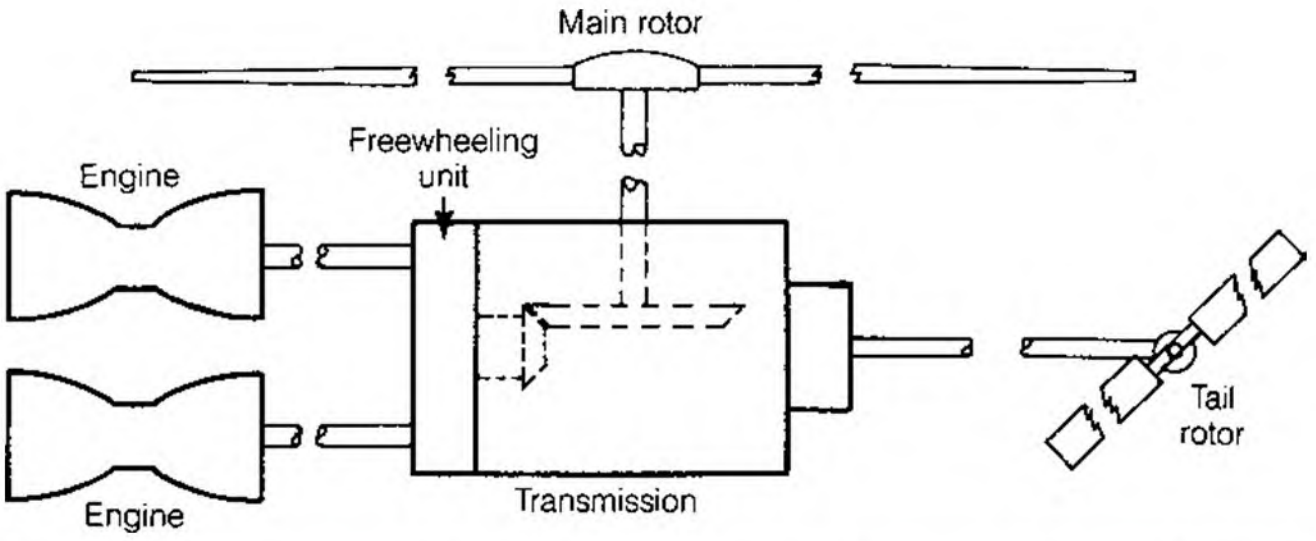

Figure 1-5 Simple schematic of a twin-engine helicopter. The transmission is powered by two engines that each have their own freewheeling gear. If one engine fails, the other engine can still provide power to main and tail rotors via the transmission.