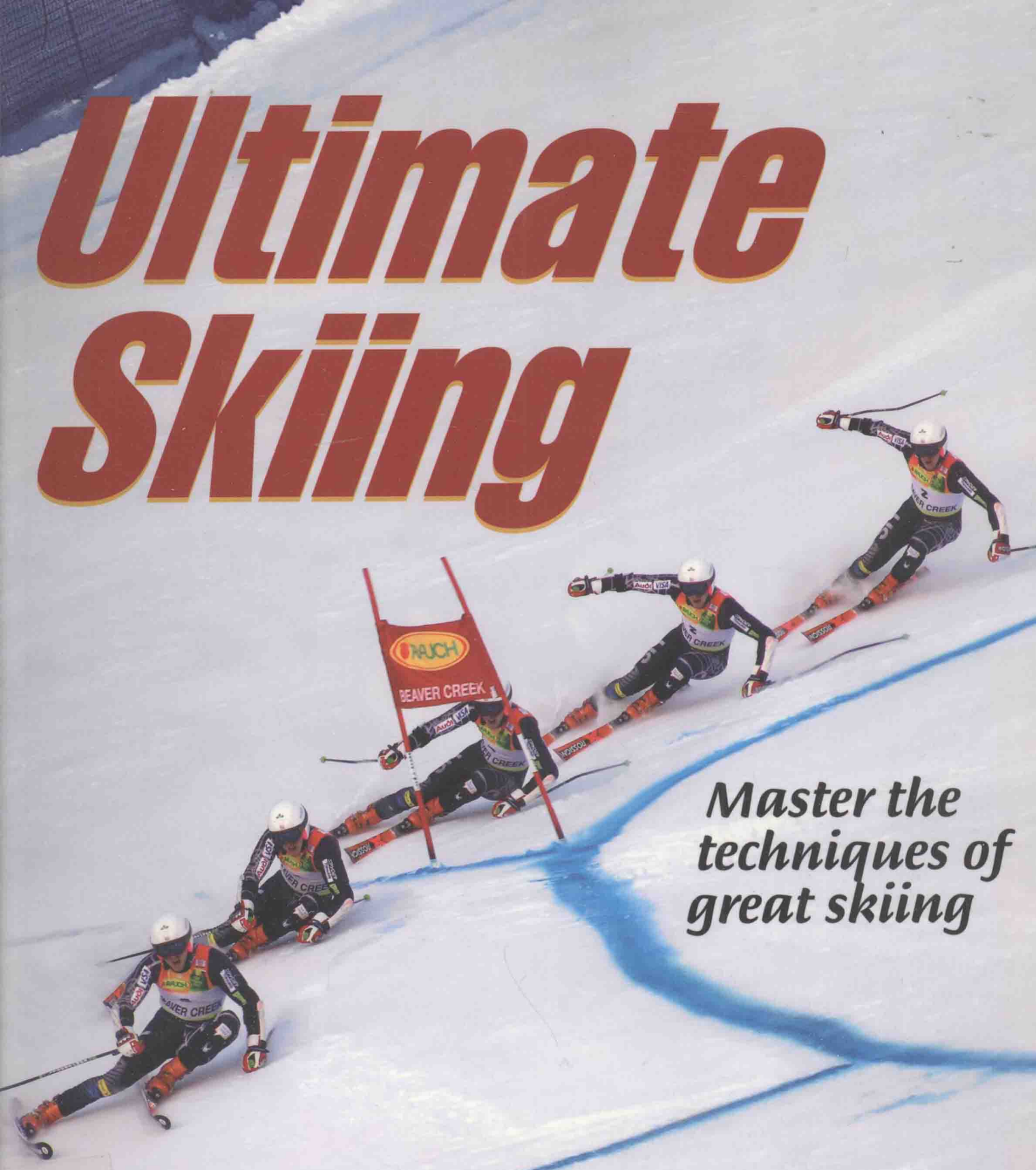
Ultimate Skiing



Master the techniques of great skiing

Ron LeMaster

Author of the acclaimed book *The Skier's Edge*

Ultimate Skiing

Ron LeMaster

Human Kinetics

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This book is dedicated to Curt Chase.

Preface

In 1998 I wrote a book called *The Skier's Edge.* It was published just as the ski world was discovering what have come to be known as shaped skis. Since then, the sport has gone through something of a revolution. Our skis are now cut with an accentuated hourglass shape whose curvature has a radius that is typically 60 percent smaller than their predecessors, and are roughly 15 percent shorter. As a result, everyone skis better. New skiers learn faster, experienced skiers tackle more difficult terrain and snow conditions, and people ski at higher levels later into their lives. As Warren Miller might say, shaped skis are the best thing to happen to the sport since stretch pants.

The new equipment has caused the ski teaching and coaching community to reconsider just about everything we thought we knew about how to ski and how to teach skiing. Most of what we thought we knew, we still think we know. But there are some things that I, for one, have either changed my mind about or have come to realize I didn't have quite right. I've been asked many times if I would write a second edition of *The Skier's Edge* that addresses these changes, and this book is, in part, that second edition. The core topics are still here, but the material has been revised and augmented to identify the changes brought by shaped skis and explain why they've occurred. There are six new chapters, four of which are in a new section on tactics and techniques for specific types of advanced skiing: ice, moguls, powder, and steeps. Not only has ski technology improved in the last 11 years, but so has photographic technology, and almost every photo in the book is new.

Although many new techniques of lasting value have emerged during the shaped ski revolution, none were invented by me or any other technical analyst. Rather, the best skiers retooled their skiing to take advantage of the new gear. What I've found is that, with few exceptions, the best skiers still make the same movements they always have. This shouldn't be surprising. After all, neither the laws of physics nor the structure of the human body has changed—only our skis. What have changed in ski technique, in many cases, are the relative amplitudes of some movements, how often they're made, and their timing relative to each other and the phases of the turn. These changes, and how the new skis have brought them about, are discussed in detail in this book.

I believe that most changes in ski technique aren't deliberately invented by anyone. I think they evolve in a Darwinian fashion, emerging from the feet of talented skiers all over the world in response to changes in the skiing environment. What works survives. And what changes in the skiing environment is, for the most part, our equipment.

In the preface to *The Skier's Edge,* I wrote that Vic Braden, the noted tennis coach, once told me that every great coach he had known understood the physics of his sport and of human movement. If you're an avid skier, you are, for the most part, your own coach. You improve by watching better skiers, talking with your friends, picking up tips here and there, and, maybe, reading books like this one. But chances are you don't have the understanding of the sport that Braden (and I) would think you need to be the best coach you can be, and therefore the best skier you can be.

This book will help you ski better by becoming that coach: the one who understands the sport well enough to analyze, evaluate, and modify what you are doing. This book explains how the skis, the snow, and you, the skier, work together to make skiing happen, including the basic mechanics of the sport, the movements you make to take advantage of and control these mechanics, and how you can apply them out on the mountain in the real world of skiing.

You don't need formal training in physics or kinesiology to be a good coach or a skier, and I don't intend to provide that. The mechanics of skiing are pretty simple and I hope to explain them in terms of everyday experience and what you feel when you ski. If I have done my job, you should, as you read, come to understand the more technical material by thinking, *So* that's *what I feel when I make a turn!* This touches on an issue at the heart of coaching and skiing. As coaches and instructors, we often confuse what we teach with how we teach it. And as skiers, we often confuse what we feel with what we actually do. My objective is to untangle that confusion so you know what is fact and what is feeling—so you know what the goal is and what you need to do to reach it.

Of course you need more than an academic understanding of skiing to coach yourself toward better performance. You need images, visual and visceral, that you can absorb and emulate when you're out on the slopes. With this in mind, I supply photographs and photomontages, picked for their ability to expose certain techniques and convey particular concepts, of some of the best skiers in the world, and descriptions of what you should feel when you pull off a specific movement. Many of the images show World Cup athletes in competition. These athletes are, in my opinion, the best skiers in the world, technically speaking. They don't get judged on style, only on how effectively they handle challenging situations. People who've skied on slopes that have been prepared for World Cup races know how formidable they are. The snow is like formica, many of the pitches are precipitous, and the courses are *fast.* Skiers who look pretty darned good on the double-diamonds back home are instantly transformed into hackers by these race hills. In short, there's no doubt that someone who can win on the World Cup must be doing it right. There are also many photos of expert skiers whose technique is exemplary and deserves emulation. Finally, I've included images of skiers exhibiting particular common problems. Many of the photos are relevant to more than one topic, or chapter, in the book, so I occasionally point you to photos in other parts of the book that are good examples of the topic at hand.

Once you understand how skiing and ski technique work and have read about how good technique is supposed to feel, you need to practice. By that I don't mean just going out and making turns. I mean directed, focused execution of specific movements so that your body, not just your brain, learns what to do and how it feels. To this end, I've included exercises, drills, and cues to help direct your training.

The book is organized in three parts. Part I, comprising chapters 1 through 3, explains the basic mechanics of skiing, including how skis do their job. These aren't complicated. Unless you have novocaine in your bloodstream, you already know the mechanics of skiing by how they feel. Skiing is a sport of big, tangible forces, and when skiing feels good, it's the effects of those forces on your body that you feel. Once you understand how what you feel corresponds to the mechanics of skiing, everything about the sport will make more sense.

Part II, chapters 4 through 10, details the movements we make to work with the forces of skiing—why we make them and how. This is *technique:* the collection of movements we make with our bodies to summon up the right forces, and to get these

forces to act in the right place at the right time. Part II also includes a chapter on boots. Every movement you make to control your skis works through your boots, and they must set up right if you're going to ski your best. If 20 pages on boots (chapter 10) sounds like overkill, think again. They are the most personal and important part of your equipment, and you can only ski as well as your boots let you.

Part III, chapters 11 through 14, examines real-world skiing in specific types of terrain and snow that are the bread and butter of advanced and expert skiing: ice, moguls, powder, and steeps. In these environments, the tactics you choose are as important as (and largely determine) the techniques you employ. We'll take a good look at both.

I mentioned that one of the reasons I wrote this book is because of the changes that have occurred with the new generation of skis. Another reason is that, over the past 10 years, I have had the good fortune of working with and learning from a good many knowledgable, gifted, and generous people. They have given me opportunities to learn that I could have only dreamed of; they have shared their knowledge and wisdom and disagreed constructively with me when it's mattered. I want to pass on what I've learned.

Most of all, I wrote this book to help you enjoy skiing more by skiing better.

Acknowledgments

This book has been made immeasurably better by the help, encouragement, and support of many people.

I'm indebted to the many great ski technicians whose books have taught me so much over the years. I have especially been influenced by Georges Joubert, James Major, and Olle Larsson. Their approach to analyzing skiing and their groundbreaking photomontages have been a model and inspiration.

I want to thank all of the skiers who gave me so many hours of their time and talent to ski for the noncompetition photos in the book. Their ability to demonstrate good skiing has made the job of writing about it much easier.

Megan Harvey and Ron Kipp gave me great detailed feedback on many of the topics on techniques, and Kurt Fahrenbach was instrumental in ironing out a few key points. Thanks to Don Daigle for reminding me of something I said and adding something to it.

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For their careful review and advice on the physical mechanics sections, my thanks go to Juris Vagners, Chris Brown, and especially John Howe, who spent hours with me on the phone talking about how skis function.

Noah Finkelstein and Noah Podolefsky were a great help, over many burgers and beers, in clarifying the presentation of the physical mechanics of skiing. I want to thank them and my other former colleagues in the physics education research community at the the University of Colorado, where I learned something about how people learn.

Greg Hoffman at Ski Boot Fitting in Vail, Colorado, and Denny Hanson of Apex Sports Group in Boulder helped refine the material on boots. Greg and I have had some great discussions about boot fitting over the last few years, from which I've learned much.

I am grateful to the Rossignol Ski Company, and Jason Newell in particular, for their generous support over the years.

Richard Rokos of the University of Colorado Ski Team deserves special thanks for being there at a moment's notice when I needed help with photo shoots.

Without the help and advice on publishing from my old friend Paul Fargis, I'm not sure I would have undertaken this project in the first place. And without the ongoing help and encouragement of Mandy Eastin-Allen and Laurel Plotzke, my editors at Human Kinetics, I'm not sure I would have persevered to its completion. More than anyone, though, I want to thank Rick Kahl, a great editor and a good friend, who always answered the phone when I had yet another question about skiing or writing.

For many years, Dee Byrne of the Vail Ski and Snowboard School has made me feel a welcome part of the family of Vail ski pros. Dee, along with her colleagues Carol Levine and Brian Blackstock, has provided me access to the staff of the ski and snowboard school, who, by listening to my presentations and then asking me

hard questions and telling me what they know, have helped me understand skiing better and improve my ability to express myself.

It's hard to put into words the special place Carol Levine and Curt Chase have had in the development of this book. Whenever I've needed help understanding something or just wanted to talk skiing with someone who cares about it as much as I do, they've been there for a lift ride, a glass of scotch, or just a phone call.

Finally, I want to thank the dedicated staff and athletes of the U.S. Ski Team. I'm especially indebted to Jesse Hunt, Finn Gundersen, Andy Walshe, and Phil McNichol. All have taught me a great deal and given me the opportunity to watch and analyze the best skiers in the world, and thus made this book possible.

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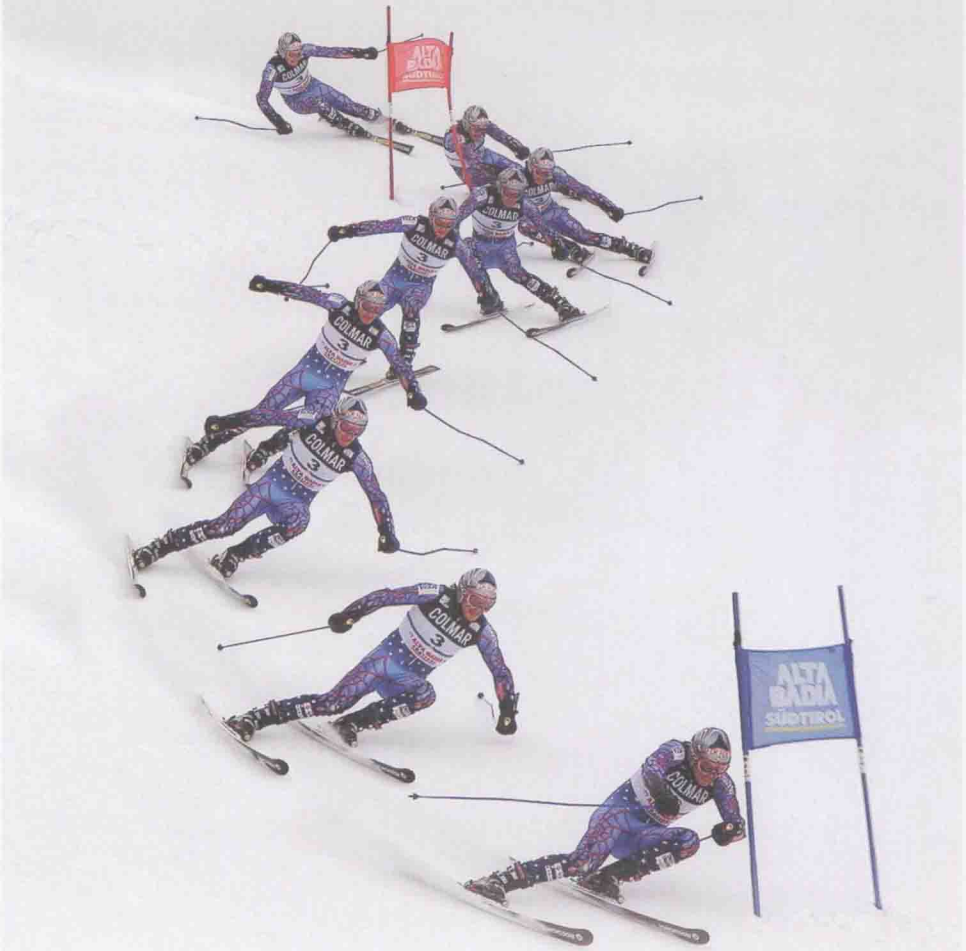

PART I

Fundamentals:

Skiing From the Snow Up

Years ago I read an article about a well-known race-car driver that changed the way I think about skiing. The driver said that everything he did behind the wheel was motivated and judged by its effect on the four patches of contact his tires made with the pavement.

Since then I've come to believe that every element of ski technique can ultimately be evaluated in terms of how it affects our interaction with the snow. If we want to turn or slow down, we need the snow to push on us in a particular way, which means manipulating our skis in ways that extract the force from the snow that provides that push and aligning our bodies to balance against it. Where our skis meet the snow is where the rubber meets the road, so to speak.

The gravitational pull of the earth and the push of the snow are what make skiing happen. Because of these forces, our skis are designed the way they are, and we move our bodies the way we do. Once you understand the forces, everything else about skiing makes more sense. That's what part I is about: the simple, basic forces of skiing, how modern skis are designed to work with these forces to shape and carve turns, and how we work with the forces to produce the incredible variety of turns that make skiing so much fun.

CHAPTER 1

Skiing Mechanics

Skiing is a sensual sport. We love what we feel when we ski. We love what we feel when we see another skier make a great turn. And what is it that we feel? Forces. The same forces that Sir Isaac Newton definitively characterized with his three elegant laws of motion. The forces that govern the movements of the planets and the balls on a pool table are the same forces that make skis turn and that make skiing feel so good.

1. An object that's not moving won't move unless something else exerts a force on it, and an object that's moving will continue to move at the same speed, in the same direction, unless something else exerts a force on it. For example, in skiing, gravity makes you move by pulling you down the hill. When the hill flattens out, friction between the skis and the snow and the air pushing against your body slow you down.

2. The magnitude of the change in an object's motion caused by a force is proportional to the size of the force and is inversely proportional to the object's mass. The direction of the change in the object's motion is the direction in which the force acts on the object. For instance, a gust of wind affects you more than the same gust affects a skier heavier than you. If the wind blows straight up the hill, it slows you down.

3. Forces always occur in pairs. Whenever one object exerts a force on a second object, the second object exerts a force of the same size on the first object, in exactly the opposite direction. When you pole across a flat on skis, you exert a force on the snow with your poles. The snow reacts by pushing back on you, providing the force that makes you move forward.

The basic mechanics of skiing aren't merely abstract concepts; they are the concrete forces that make skiing happen, and you feel them when you ski. In this chapter we discuss these basic physical mechanics because understanding them helps your skiing in a couple of ways. The techniques of the sport, covered in part II, have their basis in these physical mechanics, so fully understanding the techniques requires some understanding of the mechanics. Furthermore, the vocabulary of physical mechanics gives us the clearest, most objective way to talk about skiing with each other.

Forces, Pressure, and Momentum

In his famous *Lectures on Physics,* the late Nobel laureate and legendary physics professor Richard Feynman said, "Newton's laws . . . say pay attention to the forces. If an object is [changing speed or direction], some agency is at work; find it" (vol. I, ch. 9, p. 3). Skiing is all about changing speed and direction, which means changing momentum. So if we want to understand the mechanics of skiing, to follow Feynman's suggestion, we need to search for and understand the forces affecting the skier's momentum.

To start, we divide the forces in skiing into two categories: internal and external forces. Internal forces are those that skiers generate with their muscles. They're used to align segments of the body, manipulate the skis and poles, and push against the snow to get a desired reaction from it. Edging the ski by twisting the leg inward is an example of using an internal force to manipulate the ski. Turning the upper body down the hill at the end of a turn is an alignment movement created by internal forces. A quick extension to unweight the skis uses internal forces to push the skis downward against the snow. In contrast, external forces act on the skier from outside the body. Gravity, friction between the skis and snow, and wind resistance are some (but not all) of the external forces that can change a skier's motion. Gravity, the primal external force of interaction between your body and the earth, gives you momentum. Then, using your skis, you impress your momentum on the snow to evoke forces that make you turn or slow down.

Sometimes it's easier to think in terms of the pressure between your skis and the snow, rather than the force, so you'll see the term *pressure* occasionally in this book. Simply put, pressure is force spread over an area. When you're standing on skis in deep powder, you apply no less force to the snow than when you're standing in that snow without skis. But because you exert less force on each square inch of snow, you don't sink as far as when you're on foot. In contrast, if a person weighing twice as much as you comes along on a pair of skis the same size, that person will sink farther into the snow because twice as much pressure is being put on the snow. Controlling pressure and controlling force, then, often amount to the same thing for skiers.

Momentum is one of those cosmic fundamental properties of the universe that's a little hard to define. Isaac Newton called it a "quantity of motion"—the product of an object's mass and its velocity. The concept of momentum is more easily understood by observing its effects. Momentum is that property of a moving object that makes the object resist slowing down or changing direction. It's the property your car has when you're driving that keeps the car moving at the same speed until you hit the brakes or wind resistance and friction slow it down, and keeps it going in a straight line until you turn the wheel. Once you're moving on skis, you have momentum. Your momentum keeps you going at the same speed and in the same direction until an external force pushes on you. That last sentence is very important. You, the skier, only change direction or speed when an outside force acts on you. This is, essentially, Newton's first law of motion. (Exactly how your momentum changes when you're acted on by outside forces is the subject of Newton's second law, $F = ma$, where F is the sum of all outside forces, m is your mass, and a is your resulting acceleration.)

Forces and momentum have two key attributes: magnitude and direction. Gravity, for example, acts toward the center of earth. A T-bar exerts a force on you in the direction of its attachment to the cable. Throughout this book, we'll use arrows to represent forces and momentum. An arrow's length will correspond to the relative

Hermann Maier

In the late 1990s, Hermann Maier of Austria single-handedly raised the level of competition on the men's circuit with a combination of technical skill, physical power, and aggressive line.

Interestingly, his career has in many ways been defined not by his 54 victories (second only to Ingemar Stenmark on the men's side of the World Cup), his 14 overall and individual-discipline World Cup titles, and his numerous Olympic and World Championship medals, but by two crashes. The first was a spectacular fall he took in a downhill training run at the 1998 Nagano Olympics. Photographer Carl Yarbrough caught Maier flying directly at him through the air, nearly upside down with nothing but blue sky behind him, grimacing in anticipation of what was sure to be a very painful landing. A lead picture in *Sports Illustrated* the next week, Yarbrough's shot made Maier an instant worldwide sports celebrity. Maier's response to this terrible crash? He won the Olympic super G and giant slalom races that week.

It was another crash, this one off the slopes, that has defined Maier's career in more fundamental ways. He was struck by a car in August 2001 while riding a motorcycle. The injuries to his right leg were so severe that doctors seriously considered amputating it, but instead performed extensive reconstructive surgery. This time, *Sports Illustrated* led with a two-page spread of Maier's X-rays. Many gave him little chance of ever skiing again, let alone competing at the highest level.

Maier responded to the smashed leg with a year and a half of relentless rehab. Not only did he return to World Cup competition, but he also amazed everyone by winning the second race he entered—the super G at Kitzbühel, Austria, one of the most demanding hills in the world. The next season he stunned the skiing world again by winning his fourth overall World Cup and fifth super G crown. All this on a right leg he claimed was so numb that he couldn't feel the front of his boot. Although Hermann Maier is probably nearing the end of his career, he continues to be successful, particularly in super G. When he does retire, he will leave a legacy not only as an excellent skier, but as a person who rises above adversity.

magnitude of the force or momentum, and the arrow's direction will correspond to the direction in which the force or momentum acts. The force of gravity acting on something can be represented by an arrow pointing toward the center of the earth. If one thing weighs twice as much as another, the magnitude of the gravitational force on it will be twice as big, and so the arrow would be twice as long. A skier's momentum can be shown by an arrow pointing in the direction the skier is traveling, its length proportional to the skier's speed and weight. If two skiers of the same weight are going at different speeds, the magnitudes of their momentums will be different, and so the arrows representing them will be of different lengths. Similarly, the momentums of skiers of different weights going the same speed will have different magnitudes. The exact lengths of the arrows we use aren't important, as long as the relative lengths of the arrows used in the same picture reflect the relative magnitudes of the forces and momentums they represent.

Slowing down corresponds to a decrease in the magnitude of your momentum. This happens only if you meet with a force acting at least partially in opposition to your direction of travel. You turn when your momentum's direction changes, not its magnitude, and this happens only if a force pushes on you from the side. Figure 1.1 shows how these effects can be isolated or can happen at the same time, depending on the direction in which an external force acts on you.

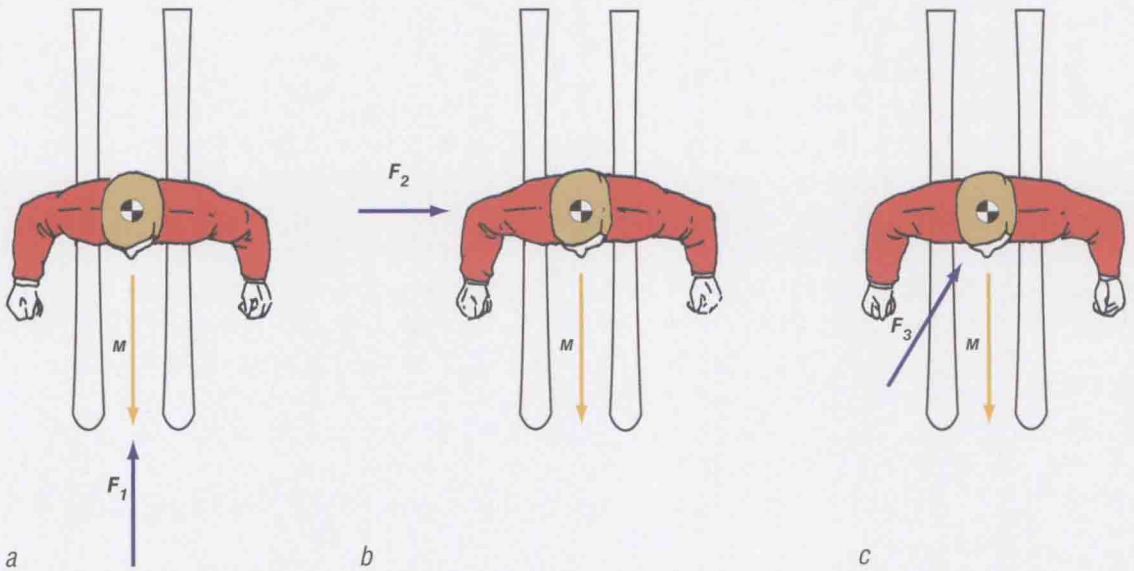

FIGURE 1.1 *(a)* The force, F_1, reduces the magnitude of the skier's momentum, *M*, because F_1 directly opposes it. *(b)* F_2, because it acts perpendicular to *M*, changes the direction of the skier's momentum, but not its magnitude. *(c)* F_3 both slows and turns the skier because it acts from both the front and the side.

The Skier's Center of Gravity

As we've seen, your direction and the speed at which you're going changes only when an outside force acts on you. So, at the most fundamental level, ski technique is about managing forces, particularly gravity and the force from the snow, which we'll explore shortly. To understand how to manage these forces, we first need to understand how they affect a skier's motion, and for that we rely on the concept of the skier's center of gravity.