Third Edition

The Complete Encyclopedia of Skiing

The indispensable reference for instructors and all serious skiers!

Bob Barnes

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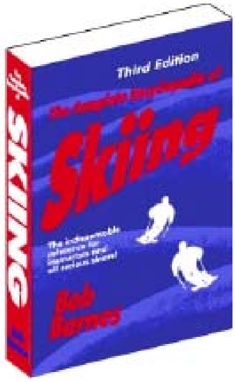

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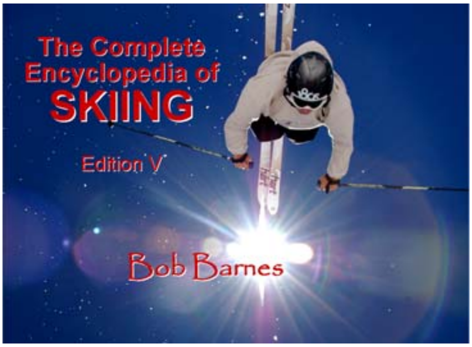

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Written, illustrated, and edited by

Bob Barnes

The Snowline Press
Silverthorne, Colorado

The Complete Encyclopedia of Skiing

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Silverthorne, Colorado

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—Acknowledgments—

In the two decades now that I have taught skiing, I have been extraordinarily privileged to encounter many dedicated and accomplished ski instructors and experts in all walks of life, without whom this book would not have been possible. They have been my teachers, mentors, friends, and inspiration. I could never list all those who have contributed, knowingly or otherwise.

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In addition, many thousands of students have taught me with their questions, their skiing, and their patient willingness to act as guinea pigs, whether they knew it or not!

Finally, I want to thank my parents, Ann and Forrest Barnes, for their support and for not going through the roof twenty years ago when I drove my rusty Ford Econoline van to Colorado to live in it and teach skiing, when I should have been in school . . . .

Mom and Dad, this book is dedicated to you.

"From the very beginning be simple and clear in your thoughts as well as your words."

—Georges Joubert

Preface to the Third Edition

SILVERTHORNE, COLORADO
OCTOBER 11, 1998

This third edition of *The Complete Encyclopedia of Skiing* represents a total overhaul of the previous edition. The seven years that have passed since *Edition Two* have brought not only the inevitable evolution of my own thinking, but also an explosion of new equipment and ideas. Deep-sidecut "shaped" skis have redefined the boundaries of technique, and brought a few new terms in the process. Snowboarding has matured, and other alternative equipment has entered the scene. And a new generation of skiers, riders, and racers has introduced a new lingo for snow sports.

Today's deep-sidecut skis bring the reality of carved turns to even casual skiers—*if* they use them properly. Never has the reward for clear understanding and effective education been greater. The art of ski instruction grows increasingly scientific as instructors must keep pace with technique grounded in the objective world of biomechanics and with teaching methodology drawing ever more from the fields of education theory and psychology. Today's effective instructors are dedicated professionals combining athleticism and passion with a working knowledge of many diverse fields.

While no single work could ever hope to provide exhaustive coverage of all the specialized fields relevant to skiing and ski teaching, I have tried to include here at least an overview of most of the concepts. In my own journey through the various levels of PSIA certification and in my quest to become a better skier and instructor, I have often been frustrated by the lack of pertinent reference materials. Most information is either too specialized and technical, too simple or inaccurate, or outdated. Where can you look to find information about contemporary ski technique, historical influences, biomechanics, and education theory, all in one place? If it applies to skiing, I hope you can find it in this book.

As in prior editions, I have tried to emphasize areas that seem to present the most confusion or controversy. I have greatly expanded the sections dealing with biomechanics—forces, accelerations, and the Laws of Motion. I've addressed the concept of *frames of reference,* the misunderstanding of which accounts for very many fruitless arguments about motion and forces, centrifugal and otherwise. Without getting overly technical, I have tried to describe the basic concepts of mechanics that apply to skiing and that ski instructors do deal with, whether we want to or not. I believe that understanding these things switches on light bulbs that make us better teachers.

Some will argue that ski instructors have no need for knowledge of basic mechanics, that physics can only complicate a ski lesson. I disagree. Surely, the best ski lessons are paragons of simplicity. And simple lessons are rarely built with the laws of physics—but they are always built *on* them. Simplicity cannot arise from ignorance! "Everything should be made as simple as possible," as Albert Einstein said, "but not simpler." Discussion of natural laws rarely makes the substance of a good lesson, but those laws form its only possible foundation. Newton's *laws of motion* govern our sport of motion absolutely, so it is naive to think that we can teach effectively without knowing the laws. In the words of Aldous Huxley, "facts do not cease to exist because they are ignored." Lessons not grounded in basic understanding are not simple—they are simply confusing!

Of course, like so many athletic but uninformed skiers who don't realize their techniques are fundamentally flawed, instructors whose teaching suffers from a lack of understanding usually don't realize it either! Students lacking a technical background get confused—but they rarely know why. Students who *have* a technical background do not get confused—they quickly recognize the instructor's flawed understanding and then often distrust everything else he or she says, valid or not. And instructors who don't know, but don't know they don't know, naively assume that they *do* know. If you don't know this stuff, trust me—your lessons and quite possibly your own skiing will improve if you make the effort to learn it.

Just remember this rule for simple lessons: laws of physics need to be *obeyed*—not *discussed*!

> "We can be absolutely certain only about things we do not understand."
>
> —Eric Hoffer, *The True Believer*

I have also added information about learning theory and developmental psychology, that I hope instructors will find useful. Researching "teaching models," I was pleased to discover that our own *ATS Teaching Model* is deeply rooted in established principles of education theory.

I have enlarged sections dealing with contemporary technique, including PSIA's Center Line™ Skiing Model and the phenomenon of "shaped" skis. With such controversial issues as the definition and validity of "steering" and the descriptions of various "rotary mechanisms," I have tried to stick with common sense and to ensure that nothing violates natural laws, normal non-ski-instructor use, or original definitions of the terms. ("*Fulcrum turn*" comes to mind—a term whose use varies so much that I would prefer to dispense with it altogether in favor of "independent leg steering" or Georges Joubert's elegantly simple expression "foot steering.")

Much controversy arises too, not from misunderstanding of the details, but from differing views of the "big picture." *What is GOOD SKIING, anyway?* If we don't agree on what a good turn *is,* then we certainly won't agree on the technique of producing one either. Why do so many racers "disagree" with so many ski instructors? Could it be that racers make turns to get through the course as fast as possible, while most ski instructors think of turns as a means to control speed? These are diametrically opposed concepts of turns! Once ski instructors accept that, just like turns everywhere else, turns on skis are ways to control *line,* not *speed,* much of the confusion vanishes!

Such a "paradigm shift" does not come easily, but if our profession is to shed its growing reputation for teaching lifeless, defensive, skidded turns, it is one we must all make! The near universal "wisdom" that we make turns to control speed is perhaps the most limiting thought in all skiing.

In this light, I have reluctantly introduced a couple of new terms myself. While there are already more than enough words out there, and I have no desire to add to the jargon of *"skibonics,"* (my other new term), I think *"positive"* and *"negative" movements* describe an important concept. Positive movements are the soul of good turns, the essence of performance skiing; negative movements, which define the defensive turns of so many skiers at all levels—including many instructors, are the plague of perpetual mediocrity.

Many will disagree with some of my definitions. That's O.K. At the very least, please recognize that my concept of good skiing forms the basis for my descriptions of the techniques and tactics involved. If you don't agree with my definitions, remember that we may be coming from different places to start with. If we are, I hope my perspective will provide at least another way of looking at skiing.

I welcome any comments and suggestions for the next edition of *The Complete Encyclopedia of Skiing.* If you find an important concept that I should add, please let me know. Typographic errors, lack of clarity, and all factual inaccuracies are, of course, my fault—but please point them out to me. You can reach me at the addresses on the copyright page, or look me up on hill!

See you on the slopes!

Bob Barnes

"If you would be a real seeker after truth, it is necessary that at least once in your life you doubt, as far as possible, all things.

—René Descartes, *Principles of Philosophy*

"It's not whether you get knocked down, it's whether you get up."

—Vince Lombardi

"Who dares to teach must never cease to learn."
—John Cotton Dana

—Introduction—

Colorful but often confusing, the language of snow skiing reflects the richness of the sport. Skiing is a technical sport. Students of physics and biomechanics have devoted volumes to analyzing the movements and forces involved. Skiing is a mental sport. The wealth of knowledge about learning and sports psychology has contributed its share to the ski-teacher's lexicon. And skiing is steeped in history. Evolving over many years, in diverse countries, the sport owes much of its sophistication and language to the great skiers, teachers, and technicians of the past and present.

If I cannot explain something in less than one minute, then I really don't understand it well enough myself!

This complexity has inspired a language rich in concepts, lingo, and unfortunately, jargon and confusion. I hope to sort through some of these words and concepts, to identify and clarify some of the confusion. As ski teachers and devotees of the sport, we must understand the concepts of skiing and teaching, including the relevant fields of biomechanics, kinesiology, psychology, and teaching theory, and we should appreciate the historical influences on our sport. It is not necessary to understand all these things just to make a turn, of course. But it is essential to grasp these concepts accurately in order to effectively teach. It is not possible to impart a clear, concise, appreciation of a concept to a student unless one's own understanding is comprehensive. It has been said that if I cannot explain something in less than a minute, then I don't understand it myself! As instructors we owe it to our students—and to ourselves—to strive for ever deeper understanding.

There is much to gain through communication and sharing of knowledge among instructors. Many in our profession insist that instructors refrain from using technical terms even among themselves. But there is an efficiency when specific words represent specific concepts. It is far briefer to say "wedge christie" than to describe all the mechanical details of this maneuver each time I refer to it. The problem arises only when the other person does not use the term the same way I do. Ski instructors are notorious for arguing about poorly understood concepts, using words that mean different things to different *people, and turning what could have been a valuable discussion into a semantic argument. When a word is not clearly defined, it is best not to use it. I hope that better understanding of the terminology will lead to a better understanding of the concepts and so provide the foundation for improved communication.*

With the diverse origins of the words and concepts, there are often several expressions that describe the same thing, albeit sometimes with different shades of meaning. More confusing, some expressions can have a variety of meanings. Ask two instructors to compare "inclination," "angulation," and "banking," for example, and you are likely to get an argument, not an answer. Still worse, many technical terms are often blatantly misused or the concepts misunderstood. If we are to focus on the content of a discussion without getting lost in the semantics, it would help if there were one and only one "thing" per name and one and only one name per "thing."

The ideal:
One name per thing, one thing per name?

We will never reach this goal—nor should we! I would not want to "sterilize" the language and eliminate the historical color of the sport.

What follows is a collection of terms all related to the teaching of skiing. Some expressions are common; some are obscure. Represented are the fields of mechanics, education, and sports psychology, as well as lingo specific to skiing. Some rarely heard expressions are included for their historical interest or amusement value. I have tried to determine the most common usage of each term and to eliminate contradictions between technical "ski-specific" definitions and common dictionary usage.

I hope that these definitions and discussions will clarify the understanding of instructors—not confuse and overwhelm students! In teaching lessons we must "keep it simple, stupid" (the KISS Principle). We must remember that students come to us for fun and to improve their skiing; rarely are they interested in technical analysis of the mechanics of skiing. Even more rarely can such a discussion actually improve someone's turns. We must heed the advice of Horst Abraham from his days at the Austrian Academy:

> *All this will enable you to see clearly as a teacher, but don't forget that for the student, all the contemplations are reduced to just one simple thing: "Turn both feet."*[1]

Thus, with this list of terminology my intent is to clarify the language of skiing; it will fail if it only increases the jargon. The definitions represent my own understanding and opinions. I do not pretend to believe that everyone will agree with all of them; nor do I suggest that any of these definitions are "official" PSIA definitions. I do hope that this work will be useful and will at the very least stimulate thought and further discussion.

"After all, when you come right down to it, how many people speak the same language even when they speak the same language?"

—Russell Hoban,
The Lion of Boaz-Jachin and Jachin-Boaz

"We shall never understand one another until we reduce the language to seven words."

—Kahlil Gibran, *Sand and Foam*

"When *I* use a word," Humpty Dumpty said in rather a scornful tone, "it means just what I choose it to mean—neither more nor less."

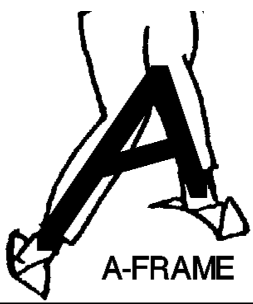
"The question is," said Alice, "whether you *can* make words mean so many different things."

"The question is," said Humpty Dumpty, "which is to be master—that's all."

—Lewis Carroll, *Through the Looking-Glass*

A

A-Frame An a-frame is a "knock-kneed" stance (knees closer together than the feet) that often indicates insufficient inside leg activity, or a need for canting or boot adjustment. While a-frames occasionally appear in good skiing as skiers momentarily increase knee angulation and edging of the outside skis, a chronic a-frame may indicate a serious problem with either technique or equipment.



Ski boots can cause a-frames. Poorly fitting or poorly adjusted boots, improper cants, or boots with worn soles can force a skier to struggle for enough edge angle. A visit to a qualified boot fitter, orthotist, or podiatrist may solve the problem.

If equipment is not at fault, a persistent a-frame may signify insufficient activity of the inside leg or rotary forces originating in the upper body instead of the legs ("*rotation*"). Modern skiing demands active steering of the legs. You can clearly see this activity, as most top skiers pull their inside knee away from their outside knee (to the inside of the turn), keeping the shins roughly parallel and the knees apart. This inside leg action promotes unrestricted activity of the outside leg. If not actively cleared away, the inside knee can interfere with the outside leg, reducing the skier's edge control and steering control throughout the turn.

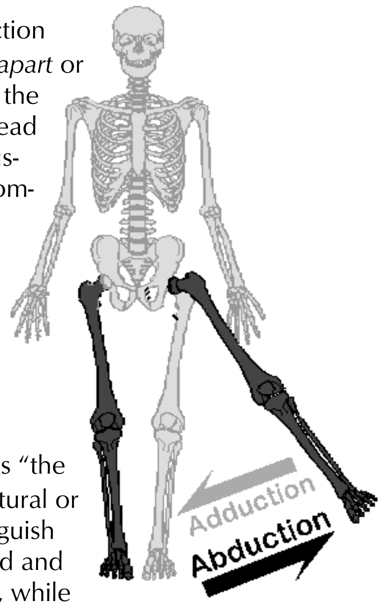
A skier who uses rotation of the upper body to initiate a turn will often have an a-frame stance at the turn completion. Rotating the upper body usually pulls the hips around and out over the skis. Having lost hip angles, the skier may try to compensate by using strong angles in the outside knee, causing an a-frame.

And there are other problems with an a-frame stance. It is biomechanically weak, as it puts the outside knee in a vulnerable position. An a-frame makes it difficult to release the edges of both skis simultaneously during initiation of a parallel turn. Strive to develop stability and discipline of the upper body, activity of both legs throughout the turn, and good, functional alignment of the upper and lower body.

Read also the discussion of **Alignment**.

Abduction In biomechanics, abduction refers to movement of limbs or body parts *apart* or away from a central axis. Raising an arm to the side, spreading the fingers, and doing a spread eagle off a mogul all involve abduction. Muscles that cause abduction are *abductors.* Compare with **adduction,** which is limb movement together or toward the central axis. (Remember: "add" means to bring together; ab- means "away" or "apart.")

In the legs, abduction is a weaker movement than adduction.



Ability The dictionary defines ability as "the quality of being able to do something; a natural or acquired skill or talent."[2] In skiing we distinguish between abilities and *skills.* Skills are learned and generally relate to a specific task or activity, while abilities involve both learned and innate components, and are more general in scope. We speak, for example, of athletic *ability*, but of a *skilled* skier or tennis player. Someone with great natural athletic ability has the raw material to become a good skier with practice to develop the skills. In a lesson, it is the skills of skiing that we strive to develop. Success at most things, and certainly at skiing, is a result of combinations of both abilities and skills.

See also **Aptitude**, **Skills**, **Balance**.

Abraham, Horst Born in Austria, Horst Abraham is a former director of the Vail Ski School in Colorado. As Educational Chairman of the Professional Ski Instructors of America (PSIA) in the 1970's and early 1980's, Abraham was instrumental in developing the humanistic American Teaching Method (ATM). His published works include *Skiing Right*[3] and *ATM Teaching Concepts.*[4]

Absorption Absorption refers to movements of the body to smooth out the sometimes dramatic changes in pressure that occur on the skis due to turning and to moguls, "washboards," compressions, and other terrain irregularities. Most absorption movements take place in the legs as they flex and extend like the shock absorbers of a car. These movements may be passive (see **Reploiment**), or active (see **Avalement**). Also see **Retraction.**

Abstem An abstem is simply a *downstem*—a slipping or brushing out of the tail of the downhill ski. While any downstem could be called an abstem, some people use the term specifically to describe an unintentional tail washout at the end of a turn, often due to excessive forward pressure on the skis, upper body rotation, or "over-initiation" of the turn.

Historically, when the "Arlberg Technique" ruled the slopes, abstem had a very specific meaning that encompassed the upper body as well as the skis. Arlberg technique used strong rotation of the torso and arms to propel the skier into and through the turn, preceded by a counter-rotation windup movement. *"Abstemmen"* referred to this windup, also known as "counterswing." Fred Iselin, in *The New Invitation to Skiing* (1947)[5] defined abstem as "the windup which precedes a turn. Refers specifically to pulling back of [the] uphill shoulder and stemming of [the] downhill ski, with accompanying shifts in weight."

Accelerated Frame of Reference Hold onto your seats—we aren't going anywhere!

All motion is relative—things only move or stand still compared with other things. To analyze motion, forces, and acceleration, we must first define a frame of reference, the "stationary" point or object to which other motion is relative. In skiing, the "accelerated frame of reference" is the *skier's* point of view, in which we experience motion, force, and acceleration relative to ourselves and our own motion. The skier himself is the "stationary" reference point.

The common alternative to the accelerated frame of reference is an *inertial* frame of reference. Here, the snow, trees, race gates, and so on stand still, and forces push the skier around through turns and speed changes. From this perspective, centrifugal "force" doesn't exist (if we are turning, the real forces are those that push us into the turn). You might think that *this* is the "normal" frame of reference, but it really isn't!

Agreement on a frame of reference must underlie any discussion of the mechanics and techniques of skiing.

In a real sense, when we ski we stay in one place—that is to say, "*here*" (are we *ever* anywhere else?). This frame of reference ("here") moves with us—we never leave it—and our feet, skis, hips, arms, and other parts move around relative to each other. Perhaps this idea is clearer if you imagine skiing with your eyes closed. You will have no real sense of speed, merely of its effects (inertial and centrifugal force), and of your body's movements relative to itself. This is an accelerated frame of reference.

From the skier's accelerated frame of reference, *centrifugal* and other *inertial forces* are real forces that the skier must balance against. Since we never move or accelerate (we're always "here"), any forces acting on us must always cancel each other out (add up to zero). Our "task"—the goal of ski technique—is to maintain this balance, as we move fore-and-aft and lean in against centrifugal force.

Wow! Is this merely a pointless digression into philosophy? Hardly—agreement on the frame of reference must underlie any discussion of the mechanics and techniques of skiing, especially when describing forces, motion, and acceleration. As all motion is relative, it depends absolutely upon the frame of reference. From a stationary observer's (inertial) frame of reference, a skier is never in balance when turning, because turns (acceleration) can only be caused by *un*balanced forces. "Centrifugal force" is not a real force from this frame of reference—it is merely an effect the skier feels, but it has nothing to do with causing turns. But from the skier's accelerated frame of reference, the skier *is* (we hope) in balance. Centrifugal force *is* a real force pushing sideways, that the skier resists and leans against in order to remain in balance.

It may seem odd to say that we stand still while the mountains and trees move around us—but is this not our normal way of describing experiences?

It may seem odd to say that we stand still while the mountains and trees move around us when we ski. Think about it though—isn't this our normal way of experiencing and describing things? When we drive a car, or sleep on an airplane, we don't move much either. We stay (usually) right in our seats. Only to a "stationary" observer on the ground are we moving sixty—or six hundred—miles per hour. When we say things like "at 100 mph the trees went by in a blur," we are describing the experience from an accelerated frame of reference. Do those trees really move? And when an instructor says to "keep your head still"—do you *really* want to leave it behind?

Most analysis of ski technique assumes the accelerated frame of reference. Cross-over/under moves, stepping "uphill" (while skiing downhill), "fore/aft" and "up/down" movements, and any discussion of balance and centrifugal force, all make sense only relative to the skier's accelerated frame of reference. And many fruitless arguments occur (is centrifugal force real or not?) where the real point of contention is contrasting frames of reference.

See **Frame of Reference** and **Inertial Frame of Reference**.

Acceleration

Acceleration denotes simply a change in motion. It is the result of some external force pushing or pulling on an object. Do not confuse this simple physicist's definition with the common use of acceleration to describe only an increase in speed. Gaining speed is but one of many forms of acceleration, which also describes a *decrease* in speed or a change in direction of motion (a turn).

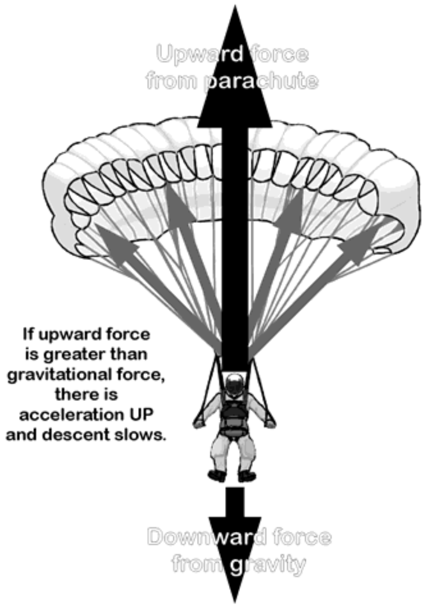
The terms that describe motion are *velocity* or *momentum* (mass times velocity). Velocity describes both the speed and the direction of movement. Thus any turn (change in direction), or increase or decrease in speed involves acceleration. In a car, the "accelerator" produces acceleration, of course, but so do the steering wheel and the brake pedal. Braking ("deceleration") is negative acceleration.

> ***In a car, the "accelerator" produces acceleration, of course, but so do the steering wheel and the brake pedal.***

A = F/m. Acceleration results whenever unbalanced forces apply to an object, according to Newton's Second Law of Motion. In other words, if the sum of all the forces acting on an object is not zero, the object will accelerate. Both force and acceleration are *vector quantities,* having both magnitude and direction. Both can be represented by an arrow whose length represents the strength of the force and amount of acceleration, and whose direction shows the direction in which the force pushes or pulls. Whatever the direction of the force, acceleration will be in the same direction. The change in motion (acceleration) is determined by the mass of the object and the strength and direction of the force (Acceleration equals Force divided by mass, or A= F/m).

In plain English, all this means that forces in the direction we're going speed us up, forces in the opposite direction slow us down, and forces in any other direction turn us—and any of these changes is defined as acceleration. The two primary skiing forces that cause acceleration (turns) are gravity and the push ("deflection") of the snow against the ski edges. Lesser forces include pole-snow interaction and wind. And friction is always a force opposing the direction of travel, tending to slow us down.

It is important to understand that you can accelerate in one direction while moving in another. When skydivers first pop open their parachutes, they continue moving down, but they accelerate up. The lines to the parachute represent the force caused by the parachute, like vectors in a diagram. That force clearly pulls UP, so the direction of the acceleration is also up, and descent of the skydiver slows.



Forces acting on a skydiver when the 'chute first deploys—quickly slowing the descent as it pulls up on the harness. Movement is still "down," but the direction of acceleration is "up."

So what? In skiing, this concept applies when we discuss *weighting* and *unweighting*. How many times have you heard skiers argue about how "up" or "down" movements affect pressure on skis? In fact, it is irrelevant which direction (up or down) you move—what matters is the direction of acceleration. "Up-unweighting" occurs when we slow down the up movement; "down-unweighting" involves speeding up a down movement. Both describe downward (toward the snow) acceleration of the center of mass, which reduces pressure on the skis regardless of the direction of movement.

Kinesthetically, this concept is obvious. We can feel it and do it, and our bodies know how it works. But if we don't understand the physics, it is all too easy to confuse and misinform as soon as we open our mouths. It may be simpler just to say "sinking reduces pressure"—or "sinking increases pressure"—but it is simply wrong! Both statements miss the true cause-effect relationships between motion, acceleration, and force.

ACL

See **Anterior Cruciate Ligament**.

Active Turns

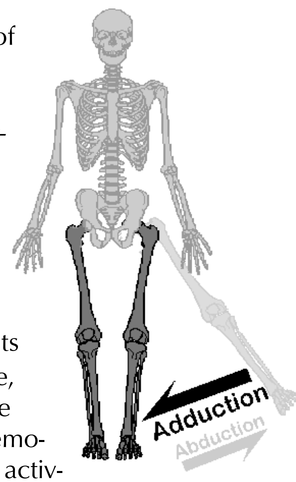
As defined by the United States Ski Coaches Association (USSCA),[6] active turns are ski turns involving any degree of muscular rotary (twisting) movements. The skier "pilots" the turn, controlling its shape with steering. By contrast, *passive turns* involve no rotary input from the skier. They result purely from the pull of gravity and the carving action of the skis—the skis bend and turn, but the skier does not steer to control the line. A freight train following a curving track makes passive turns; a driver in a car on a winding road makes active turns—he steers. Virtually all "normal" turns are active turns, although the rotary movements may be so refined and subtle as to appear non-existent.

It is a common belief, especially among racers, that active rotary movements always produce skidding. They don't! A car doesn't go into a skid every time we turn the steering wheel. Pivoting movements, or attempts to push the tails of the skis to the outside of the turn, do cause skidding. But proper steering movements aimed at guiding the ski tips *into* the turn can be as active as desired without necessarily increasing skidding.

See **Passive Turns** and **Steering**.

Adduction

Adduction means movement of limbs or body parts *together* or toward the central axis of the body, as in pulling the legs or fingers together. Muscles that cause adduction are *adductors*. The opposite of adduction is *abduction*—movement apart or away from the central axis of the body. Adducting the legs is a stronger movement than abducting them.



Affective Domain

Educational theorists classify learning into three categories—the affective, cognitive, and psychomotor domains. The affective domain concerns emotion, including the level of emotional involvement and commitment to an idea or activity. Skiers range from those with only a passing interest to those whose passion for skiing pervades their whole life. Learning objectives in the cognitive domain involve increasing the depth of understanding. In the psychomotor domain, the objective is to increase skills. And learning objectives of the affective domain involve increasing the level of commitment.

Alignment

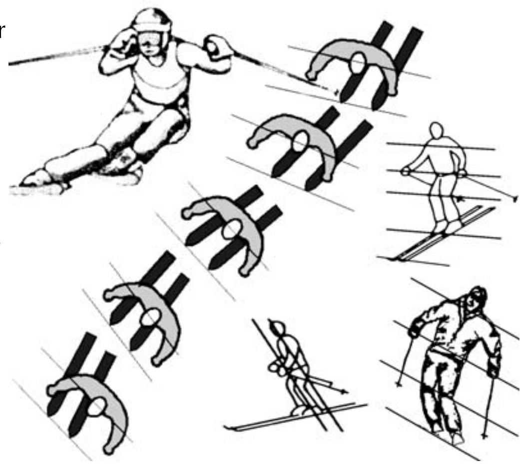
Alignment refers to the positions and movements of a skier's body parts in relation to each other. The term to refers to stance and body movements, as well as issues of boot-fitting and canting to adjust for variations in leg and foot configuration. Essential to good skiing, proper alignment enhances both performance and safety.

> ***In a right-hand turn, the right hand leads, and vice-versa!***

Because joints are restricted in the ways they can efficiently and safely move, because all movements affect balance, and because many movements affect rotary, edging, or pressure on the skis, skiers are limited in how we can move. Skiers, like most athletes, seek a natural, athletic stance. Balanced, neutral, "alert," ready for action, skeletally and muscularly efficient, and comfortable, the athletic stance is the foundation of good skiing at all levels.

But stance is a static concept in this sport of constant motion. Alignment addresses the skier's ability to maintain the functionality of the natural athletic stance while making turns and responding to the changing demands of skiing. Skiers flex and extend, angulate, turn the skis, manage pressure, and make constant balancing movements. Good skeletal alignment makes all these movements possible while allowing joints to move naturally.

Improper alignment hinders many movements. It prevents efficient rotary/steering movements, limits flexion/extension and absorption movements, and interferes with angulation and edging movements. Proper skeletal alignment allows the bones to support much of a skier's weight and to resist the forces of skiing, freeing the muscles for fine adjustments and balancing responses. Improper alignment forces a skier to resort to gross and inefficient movements and to rely on muscular strength to resist forces. Even more important, poor alignment increases the risk of injury if it results in muscles and joints moving in ways for which they are not designed.



***Parallel lines of Alignment**. Lines across any two corresponding left and right points are parallel. The inside (in turns) or uphill (in traverses) ski, foot, knee, hip, shoulder, and hand lead and rise above their outside counterparts .*

What is good alignment, then? How do we distinguish good from bad? First, look for "parallels." When a typical athlete stands in a natural, athletic stance, lines through any two corresponding left and right body parts—both knees, hands, or shoulders, for example—are parallel. Think of a soccer goalie poised to block a shot, or a football linebacker ready for action. When a skier assumes this natural stance while standing sideways on a hill, as in a traverse, these parallel relationships remain. Naturally, the uphill foot is higher on the hill than the downhill foot. The uphill knee, hip, shoulder, and hand should also rise higher than their downhill counterparts. Viewed head-on, lines through any of these parts are parallel to each other and to the angle of the hill. In addition to being higher, the uphill foot will also move naturally ahead of the downhill foot. The uphill knee, hip, shoulder, hand, and so on, will mimic the lead of the foot. Viewed from overhead, once again these lines should parallel each other.

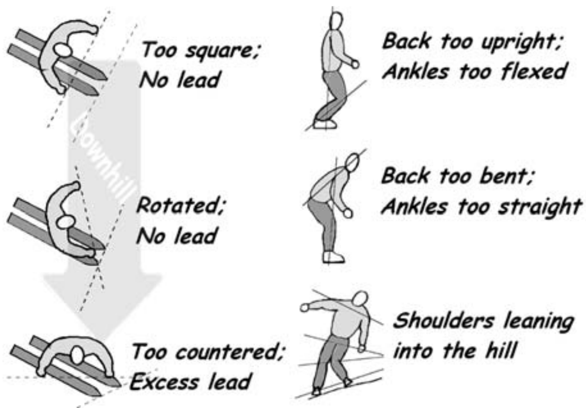
These parallel relationships define the natural, athletic stance. Normally, as the well-aligned skier turns left and right, steers the skis, flexes and extends, inclines and angulates, all these imaginary lines move but remain parallel. The ski lead changes when a new turn begins, and the lead of the whole body changes with it—the "inside half" of the body leads the "outside half" through turns. So if a skier makes a left turn with his right hand ahead of his left, he is out of alignment. The fault may result from too forward a stance, initiating the turn with upper body rotation, or perhaps from an attempt to halt a tail wash out by rotating the upper body and arms into the turn. In any event, the rotated torso brings the hips out over the skis, reducing hip angulation, requiring increased angles in the knees to keep the skis on edge. This effort places the knee in a vulnerable, biomechanically weak position, just when the stresses from the turn are greatest. Similarly, when a skier comes through a left turn with the left hand down by his knee and his right hand high in the air ("hi, Mom!"), hip and knee angles vanish and the skier struggles for edge control and balance.

Principles of Good Alignment

1. ***Lines through corresponding left and right sides of the body are parallel in both horizontal and vertical planes.***
2. ***In turns, the inside half of the body is above and ahead of the outside half.***
3. ***Proper alignment is the result of a stable, disciplined upper body and active legs.***

Good alignment is the result of a stable upper body and active legs. It is a common mistake to focus too much on the upper body, when all the action takes place below. In a right-hand turn, the right hand leads. In a left-hand turn, the left hand leads. It is not the *hands* that moved though, only the feet. Simply moving the right hand up and forward obviously does not cause a right turn. Try something with me: stand up without skis on and assume a natural athletic stance. Now, holding the upper body perfectly still, turn your feet to the right, as in a right turn. Imagine moving now in the direction your feet are pointing. Your right hand (and foot, knee, hip, and shoulder) will lead—they will get there first. Turn your feet (and only your feet) straight ahead and you will be in "neutral"—there is no lead. Now turn your feet to your left, and the lead of the whole body reverses (left half leads). But all you moved was your feet and legs. Again, good alignment results from stability of the upper body and activity of the legs. Poor alignment—left hand ahead in a right turn, for example—is usually a sign of upper body rotation, which means an active *upper* body pulling relatively passive legs and skis through the turn.

In the history of skiing, various techniques have involved alignment contrary to these principles. The Arlberg school, emphasizing *rotation* of the upper body, considered it proper for the right hand to lead through a left turn and vice-versa. The old Swiss Technique dictated extreme *counter-rotation* of the upper body and resulted in a lead of the inside half of the body, but with a much more pronounced countering than in modern skiing.



Crossed Lines of Misalignment

So how much countering is correct? How far should the inside ski, knee, hip, shoulder, hand, and so on lead their outside counterparts? The answer lies again in that natural, athletic stance. If you stand on a level floor and lift one foot up, it moves naturally ahead of the other foot. Likewise, standing sideways on a slope (try this), the upper foot will move ahead of the downhill foot a small amount and, if you relax, the rest of your body will mimic this natural lead. Your torso will face slightly downhill while your skis point across the hill. The key word is *natural*. The stance is relaxed; you feel a general lack of tension. If you twist your torso to face directly downhill (increasing the degree of countering), you feel an increase in tension—you feel twisted. You also feel tension if you square your upper body to the direction of your skis or rotate it uphill. Relaxing returns you to the original, slightly countered stance. If you square your upper body over your skis and even up the skis (no lead), you find that your hips move over your feet, eliminating all hip angulation, although you can easily create big angles in your knees (which puts your knees in a weak position). If you *exaggerate* the lead of your uphill ski and uphill half of your body, you find that your downhill knee becomes locked. Now it is impossible to use knee angulation and you've also lost your ability to steer the downhill ski, both because you have used up all the rotation available in your hip joint. Hip angles, though, are now easy from this radically countered stance.

So too much countering precludes knee angles and promotes hip angles; too little precludes hip angles but allows knee angles. Just *enough* allows both knee and hip angles and maximizes my options, while keeping me relaxed and in a biomechanically strong stance.

Another tendency of the aligned skier is that the shoulder, knee, and ball of foot line up. This characteristic may not occur with the consistency of the parallels we've discussed, but when grossly out of line, something is usually wrong. Too much ankle flexion will cause this misalignment, as will too upright a torso, or breaking forward at the waist. Boots with too much or too little forward lean, or a skier's attempt to put too much forward pressure on the boot tongues also bring a skier out of alignment. It remains a common myth that good skiing requires leaning forward, pressing on the boot tongues. The knees may drive into the turn, but very *rarely* in good skiing are the boots flexed deeply with forward leverage. As Georges Joubert stated twenty years ago, "You must constantly maintain pressure on both these zones [ball and heel]. An important point to remember: don't lean on the fronts or backs of your boots."[7] As we flex and extend, we move the knees, ankles, hips, and spine such that, combined with the dynamics of the turn, we remain "cuff neutral" in the boots with balance over the "sweet spot" of the skis.

I have devoted a lot of ink to this concept of alignment. You may suspect that I consider it of crucial significance—and you are right! Alignment is fundamental. Only when well-aligned can skiers enjoy their full range and efficiency of movement—at any level of skill. Reacting to skiing's myriad of changing forces, especially at speed, in race courses, and in the hugely variable conditions off piste, demands sound, fundamental, disciplined alignment. Practice. Develop this discipline. Look for it and nurture it in other skiers. Observe the effects of poor alignment. Note the discipline of the elite in World Cup competition who, despite their need to move their hands and arms in ways contrary to these principles as they block and cross-block gates, maintain near-perfect alignment with the rest of their bodies. Establish good alignment as the cornerstone of good technique. Some hard work and discipline here will pay huge dividends as we build our skills on this foundation. Sloppiness will degrade performance, increase chance of injuries, and inhibit learning throughout a skier's career.

Allais, Emile The great French ski racer and coach Emile Allais was an Olympic gold medalist and a pioneer of alpine skiing. Generally recognized as the originator of the *parallel turn*, Allais won the FIS slalom and downhill titles in 1937. In the United States, Allais was instrumental in the development and trail design of Telluride, Colorado.

Alpine Skiing With its roots in the Alps of Europe, alpine skiing is *downhill* skiing, as opposed to "nordic skiing," or cross-country skiing. Alpine ski equipment is optimized for performance in the descent—with stiff boots firmly anchored heel-and-toe to heavy, sharp-edged skis. Free-heeled nordic equipment sacrifices some downhill power and precision for lighter weight and natural motion on the flats and uphills.

Alpine skiing has evolved from its early days as a practical means of transportation in the snow-covered mountains. Nearly useless for going uphill and inefficient on the flats, alpine equipment requires some other means of transportation to get to the top of the mountain.

Stereotypically, alpine skiing is the sport of speed and adrenaline, precision and control, while nordic skiing is the quieter sport of solitude, granola, and aerobic fitness. These distinctions blur today, though, as heavier "nordic downhill" equipment brings the *telemark* turn to the ski slopes and "alpine touring" equipment frees the heels of alpine skiers, allowing them to climb the chairlift-less mountains of the backcountry.

Alps While probably not the actual birthplace of our sport, these are the mountains that give Alpine skiing its name and much of its history. The Alps are the youngest and highest mountain range in Europe, with France's Mont Blanc massif their highest peak at 15,781 feet. Covering an area of about 80,000 square miles, the Alps occupy parts of France, Switzerland, Austria, Germany, Italy, Liechtenstein, and Slovenia.

Alps. *The Matterhorn, Zermatt, Switzerland. Photo by Bob Barnes.*

American Ski Technique Predecessor to today's American Teaching System™, the American Ski Technique was the early PSIA skiing and teaching model. It was an outcome-based progression through ten "final forms," grounded on seven "basic principles."

The early development of modern skiing saw the evolution of various "national techniques." In Europe, each alpine nation developed its own version of ideal skiing and teaching methods, usually based on the style of a successful and popular racer. There was a Swiss Technique, an Austrian

Technique, an Italian, a French, a German Technique. Major differences between national techniques included the fundamental stance and methods of unweighting and propelling skis into a turn. Austrians and Germans, and to a lesser extent, Swiss and Italians, emphasized a countered "reverse shoulder" stance, while the French Arlberg technique involved a square stance and upper body rotation. French, Italian, and Swiss schools taught "up-unweighting" to start a turn while Austrian turns used a "down-unweighting" style. Each technique was a source of national pride, and if you took a lesson at a Swiss ski school, for example, you could be sure of an approach consistent with that of any other Swiss school.

Meanwhile in the United States, where ski areas were more geographically distant than those in the Alps, schools of ski technique exhibited little consistency, with vast regional differences. In the late 1950's, instructors from various American ski schools met in an effort to develop a consistent, unified American Technique. In the early 1960's, PSIA (Professional Ski Instructors of America) emerged, and in 1964 *SKI Magazine*'s *Annual Almanac*[8] published PSIA's official American Technique.

The American Ski Technique represented somewhat of a rebellion against the rigid and stylized European techniques. Nevertheless, it drew heavily from the Europeans—reverse shoulder from the Austrians, up-unweighting from the French and Swiss—and added a distinct American flair. The American Technique was natural and based on sound, basic mechanical principles, rather than on the style of some national hero. The basic stance was uncontrived and surprisingly contemporary. While the Austrians insisted on extreme counter-rotation and the French on exaggerated full-body rotation, PSIA encouraged a more natural stance. "The uphill shoulder is advanced by the same slight amount as the uphill ski," wrote Peter Estin in 1964.[9] "In effect the skier's entire uphill side—ski, ski boot, knee, hip, shoulder, arm, and hand—is slightly ahead (some three or four inches) of the downhill side." And, from the editors of *SKI* magazine in 1964[10]: "The American System emphasizes natural position. It insists that the skeletal structure should carry the weight of the skier. The skier should use no more of the reverse shoulder motion than is needed to make the turn. This leaves him in a rather relaxed position, ready to adjust to the terrain or snow." These ideas are just as applicable today as they were more than thirty years ago.

This "Natural Positioning" was one of "Seven Basic Principles" of the American Ski Technique. The others were "Total Motion," "Unweighting," "Axial Motion," "Edge Control," "Weight Transfer," and "Leverage." Years later the American Teaching System™ would consolidate these seven principles into the basic skill groups of Balance, Rotary, Edging, and Pressure Control that we recognize today.

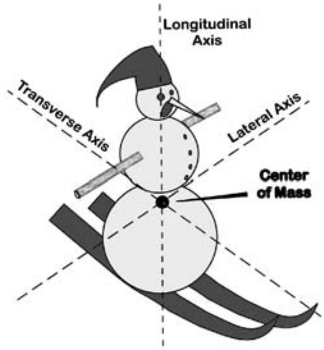
Like the current PSIA teaching model, the American Technique was outcome-based and student centered, as opposed to process-based. PSIA identified ten “Final Forms” representing a linear learning progression from beginner to expert. Ski instructors all taught these same final forms, but the methods they used to arrive at them were up to the individuals. The ten final forms were 1) Straight Running, 2) Straight Snowplow, 3) Snowplow Turn, 4) Traverse, 5) Stem Turn, 6) Sideslip, 7) Uphill Christie, 8) Stem Christie, 9) Parallel Turns, and 10) Wedeln. From these early final forms, today’s PSIA *Center Line™ Milestones* have evolved. Unlike the diverse Final Forms, the Center Line™ Milestones represent the same set of fundamental mechanics and movement patterns in linked turns at various development levels. The Milestones differ from each other only in speed, terrain, and accuracy, intensity, and refinement of movements. Final Forms were based on form and style, while Center Line™ is based on mechanics and efficient movement patterns.

The American Ski Technique represented the first uniquely American contribution to ski instruction. It allowed American skiers finally to take lessons at different resorts in different parts of the country with consistency and continuity. And, while we have come a long way since 1964, we still owe much of our current knowledge, methodology, and philosophy of skiing to those who developed the original American Ski Technique.

American Teaching System™ (American Teaching Method) ATS (or ATM) is the current official teaching method of the Professional Ski Instructors of America (PSIA). Conceived in 1972, largely through the efforts of Horst Abraham, and formally introduced to the skiing world in 1975, ATS represented a revolution in ski teaching. Based, like the American Ski Technique before it, on a simple mechanical progression, ATS introduced the **Skills Concept**. ATS emphasizes a humanistic, holistic, student-oriented approach to ski instruction. Today’s instructors don’t teach skiing to people—we teach *people* to ski! Since its inception, ATS has evolved significantly, enlarging its scope and drawing from diverse knowledge pools of biomechanics, teaching methodology, learning theory, and athletics (hence the name change from “Method” to “System”).

The American Teaching System™ comprises a skiing model (the Center Line™ Model), a teaching model, a movement analysis model, and now a Guest Service model. Continuously evolving to keep pace with changes in technique, equipment, knowledge, and the state of the ski industry, ATS endures as the teaching strategy of PSIA and has gained respect worldwide for its groundbreaking methodology and humanistic approach.

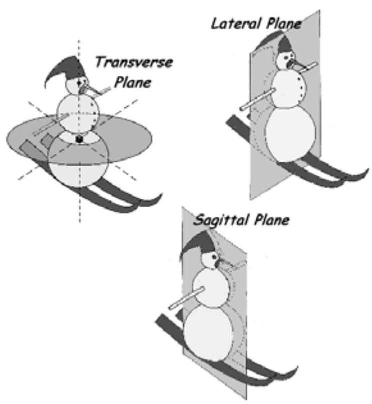
Anatomical Reference Axes These are three imaginary lines that run at right angles, passing through the center of mass, that mark the center of the body. The *longitudinal axis* passes through the center of the body from head to foot. The *lateral axis* passes from left to right. And the transverse axis passes from front to back. A body spinning through space would rotate about one, two, or all three of these axes. Any two of the reference axes defines one of the three *anatomical reference planes* described below.



Anatomical Reference Axes. *These three lines intersect at right angles at the center of mass.*

Anatomical Reference Planes

The anatomical reference axes described above define three planes that intersect at the center of mass. Each plane divides the body precisely in half. The horizontal plane, which divides the body into top and bottom halves, is known as the *transverse* plane. The vertical plane that divides the body into equal halves left and right is the *sagittal* or *anteroposterior plane*. And the vertical plane that divides the body into front and back halves is the *lateral plane*.



***Anatomical Reference Planes**. Three planes intersecting at the center of mass divide the body into upper/lower, left/right, and fore/aft halves.*

Angular Acceleration

Angular acceleration is a change in the rate of rotational motion (*angular momentum*). When I apply *torque* (twisting force) to something to turn it, as in cranking a nut with a wrench, spinning a top, or turning a ski with my leg, I cause angular acceleration.

See **Angular Motion**.

Angular Momentum

Angular momentum describes the motion of a rotating object. To say that something has angular momentum is simply to say that it is spinning. Like linear momentum, angular momentum is a function of the object's mass (technically, its "moment of inertia" about the axis of rotation) and its velocity—in this case *angular velocity*, or spin rate. Newton's First Law of Motion applies to spinning objects, implying that there can be no change in angular momentum unless some force (torque) applies.

Angular momentum is an important concept in skiing, as every turn involves rotational motion of the skis, legs, or entire body ("ski/skier system"), which we must manage with skiing skills and the tools on our feet.

See **Angular Motion**.

Angular Motion

"Angular motion" is the technical term for rotational motion, the motion of spinning, twisting, revolving objects.

Why is it called "angular" motion? (Wouldn't "circles" describe spinning better than "angles"?) The expression refers to the change of an object's angle as it revolves. It's really not an uncommon usage—we refer to such angles when we say things like "turn the wheel ninety degrees."

Angular velocity refers to the speed and direction of rotational motion, the rate of change of the angle. *Angular momentum* refers to the "quantity" of rotational motion of an object, a function of its angular velocity and the amount and distribution of its mass. *Angular acceleration* describes a change in rotational motion (a change in angular momentum), and results from *torque,* which is a force applied through a "lever arm," as in twisting a bolt with a wrench.

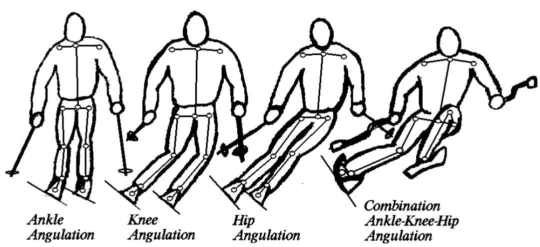
Angular Velocity

Angular velocity describes the "spin rate" of a rotating object. Like linear velocity, angular velocity will remain constant unless an external force applies to change it. The force that causes a change in angular velocity is called *torque*.

See **Angular Motion**.

Angulation

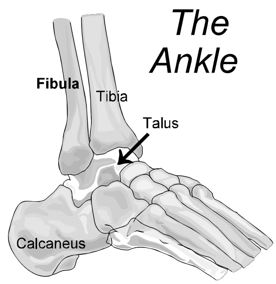
Defined by the *American Heritage Dictionary* simply as "the formation of angles,"[11] angulation in skiing implies a more or less *sideways* bending at a joint, primarily used to control edge angle. While we can angulate in almost any joint of the body, the most important joints for skiing are hips, knees, and ankles. Angulation is biomechanically complex. Knee angulation, for example, is a combination of a hing-



ing at the knee (it isn't supposed to bend sideways!) with an inward rotation at the hip.

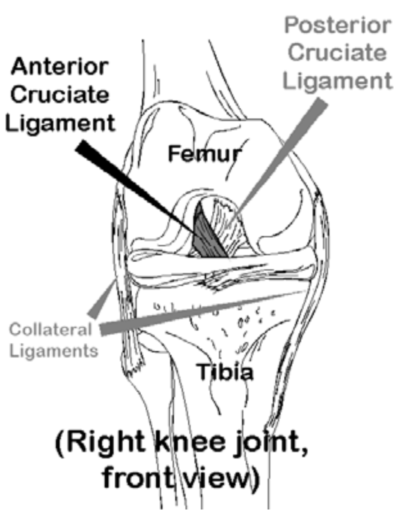
See further discussion under **Inclination**.

Ankle One of the most important joints in skiing, the ankle is a complex mechanism. The true ankle joint, which joins the two bones of the lower leg (*tibia* and *fibula*) to the *talus* bone of the foot, is a *hinge joint*, capable of flexion and extension (up/down motion of the foot) only. The rest of the movements of the ankle and foot—twisting, tipping, and side-to-side motion—occur in the complex system of bones of the foot, and in the *subtalar joint*, which joins the *talus* and the *calcaneus* (heel bone). Combined with an elaborate system of ligaments, tendons, and muscles in the lower leg, the ankle allows all the movements of *plantar flexion* and *dorsiflexion*, *pronation* and *supination*, and *internal* and *external rotation*.



While stiff ski boots restrict the motion of the ankle somewhat, ankle movements are critical to good skiing. Fine edge control movements begin in the ankles. Ankle tension is essential to make the skis hold, and relaxing the ankles is a key part of releasing the edges to begin a turn.

Anterior Cruciate Ligament Ligaments are the tough elastic tissues that attach bone to bone in joints. The anterior cruciate (ACL) is one of four ligaments of the knee, connecting the tibia (shin) to the femur (thigh), and crossing in front of the *posterior cruciate* ligament (PCL).



Unfortunately, injuries to the ACL are not uncommon in skiing. Recent research has tried to address the causes and contributing factors of ACL injuries. One factor may be what is known as the "phantom foot" phenomenon, caused by the extended tails of our skis. The human knee evolved along with a foot that does not extend behind the heel. I don't think its designer anticipated the stresses those ski tails can apply. ACL injuries often occur when that "phantom foot" bears a lot of weight. A common scenario results from attempting to recover from a backward fall, hips below knees, hands behind hips. Evidence also suggests that trying to get up from a fall while still sliding downhill contributes to many ACL injuries. The usual advice: if you're down, stay down until you come to a stop. Please don't sue me if this advice doesn't work!

Much work has yet to be done if we are to eliminate ACL injuries. Modern bindings, though they have drastically reduced lower leg injuries, don't prevent knee injuries. High, stiff boots, and ever-increasing stresses due to higher speeds and better equipment may even increase the incidence of knee injuries. Radical sidecut "carving" skis, with their ability to subject "average" skiers to far greater turning forces than their physiques or techniques may withstand, may also contribute to knee injuries. Proper alignment and technique are more important in this regard than ever. (Of course, as skiers gain more control of their lines through better turns, reduced injuries from collisions and such may more than offset the risks of knee injuries.)

Fortunately for us, medical technology and techniques of dealing with ACL injuries have improved dramatically in recent years. Many top skiers, and athletes from other sports, continue to compete even after completely severing their anterior cruciate ligaments. There is hope!

Anteroposterior Plane

See **Sagittal Plane** (synonymous). See also **Anatomical Reference Planes**.

Anticipated Position

"Anticipated position" is another name for a *counter-rotated,* or *reverse shoulder* position. When you turn your upper body in the direction of the next turn (usually downhill), you stretch the muscles which you are about to use to turn your skis. This twisted relationship between the upper and lower body is the anticipated position. A skier can create an anticipated position by turning the upper body in the direction of the upcoming turn, turning the feet in the *opposite* direction, or both. Like the baseball pitcher winding up to pitch, we rarely hold an anticipated position for long.

Upper-Lower Body Relationships

It is easy to confuse an anticipated posi tion with the *slightly countered* position of the natural stance. The difference should be clear: in an anticipated position there is muscular tension. The skier is literally twisted, not relaxed. By contrast, a *lack* of tension characterizes the natural, slightly countered stance of a traverse or turn. If I stand sideways on a slope and relax, I will be in a slightly countered position—my uphill foot will lead my downhill foot by a few inches and my uphill knee, hip, shoulder, and hand will mimic this lead (see **Alignment**). My torso will not face exactly in the direction of my skis, but slightly downhill. If I twist my torso directly down the hill, I will be anticipated. If I then relax, either my skis will turn down the hill and align with my torso, or (more likely) my body will realign over my feet, with a slight lead of the uphill shoulder, hip, knee, and foot—"slightly countered."

The opposite of the anticipated position is the *rotated* position, where the upper body is turned more up the hill or toward the center of the turn being made (as opposed to the center of the upcoming turn in anticipation). A *square* position means the upper body is facing the direction the skis point, as in a straight run.

Anticipation

Commonly "to expect or plan for," in skiing this term refers to a twisted relationship of the upper and lower body in preparation for a turn. With anticipation the upper body twists toward the upcoming turn, stretching the muscles of the torso, waist, and hips (the "stretch zone") and creating tension. The *release* of this tension, by relaxing other muscles, allows the stretched muscles to contract, creating a rotary force on the lower body, and thus on the skis. A pole plant can "block" or stabilize the upper body, making the mechanism more powerful. Even without a pole plant, though, the heavier upper body has enough inertia to provide a fairly stable mass against which the lower body can turn.

Anticipation is a windup action equivalent to drawing back a bow string or winding the prop on a rubber-band plane—letting go unleashes a powerful force. See also **Windup-Release** and compare with **Counter-Rotation**, which involves similar movements but is an entirely different mechanism for creating rotary force. Anticipation as a rotary mechanism requires a "one-two" movement (windup, then release), whereas counter-rotation involves a simultaneous movement of the upper and lower body in opposite directions. An anticipated position can result from turning the upper body toward the new turn, turning the lower body and skis *away* from the new turn, or both.

Applied Forces Also called "external forces" or "motive forces," these are the physical pushes and pulls that produce changes in motion ("acceleration"), as required by Newton's First Law ("a body at rest will remain at rest unless acted upon by an unbalanced, external motive force..."). In skiing, applied forces are what move us around the mountain, speeding us up, slowing us down, and causing turns.

Note that applied forces are necessarily *external* to the object whose motion they change. An object cannot push itself around, nor can we lift ourselves up off the ground. When we jump up, we push down on the ground with our feet. It is the pressure of the ground pushing up on our feet (the "equal and opposite reaction" of Newton's Third Law) that actually provides the applied force to make us go up. When we move part of our body, the applied force comes from *other* parts of the body. When the whole body—the "ski-skier system"—accelerates (turns or changes speed), the applied force must come from outside the system. The four main applied forces that cause turns in skiing are gravity, the push of the snow against the skis and poles, and air resistance.

For a change in motion, the external forces applying to an object must be "unbalanced." In other words, if several forces apply at once, they must not cancel each other out. When the net effect ("*resultant*") of all forces applied is zero, the forces are balanced. The effect is the same as if no force applied, and no acceleration will occur. So Newton's "unbalanced, external motive force" refers to a hypothetical force that is equivalent to the sum of all forces applying at any time.

When acting on the whole object, applied forces have the same effect as if they acted on the center of mass—they cause acceleration. When directed toward the edge or some point other than the center of mass ("through a lever arm"), applied forces generate *torque* or "rotary force," causing the object to spin or change its rate of rotation about an axis.

There is a second category of forces that are *not* applied forces. *Inertial forces,* such as centrifugal force, do not cause acceleration—they result from it. Centrifugal force is an effect that the skier feels when turning. When a skier turns, some applied force obviously pushes in the direction of the turn, while centrifugal force feels like a push in the opposite direction. Of course, from the skier's moving frame of reference, there is no acceleration (from my point of view, I am always "here" and other things move relative to my position—see **Frame of Reference**). Therefore, there is no unbalanced applied force. Centrifugal force, from the skier's frame of reference, *is* an applied force, that counteracts the other forces and keeps the skier in balance.

See also **Force**, **Inertial Force**, and **Newton's Laws of Motion**.

Aptitude Aptitude is the capability of developing an ability—a potential ability, a talent. Aptitude refers to the innate physical and mental preparedness to learn something. Traditional thinking holds that the amount people can learn is directly related to their individual aptitudes.

The teaching strategy of *direct instruction* (see) and the theory of *Mastery Learning,* which PSIA embraces in the *ATS Teaching Model*, hinge upon a modified definition of aptitude. Rather than assuming that aptitude predicts how much or how well a student can learn, mastery learning theory suggests that aptitude correlates to *how long it takes* for an individual to learn something. Under this optimistic view, with properly individualized teaching styles and pacing, most students can flourish.[12] This idea lies at the core of modern ski teaching strategy.

See **Mastery Learning**.

Arlberg High in the western Tyrol region of Austria's Alps lie the renowned ski resorts of St. Anton, St. Christoph, Lech, and Zurs. This is the Arlberg, an enormous interlocking network of lifts, trails, mountains, and villages. Many of skiing's legendary figures came from the Arlberg region, and the Arlberg-Kandahar racing tradition is one of the sport's oldest.

Arlberg Technique The Arlberg Technique was a style of skiing developed by Hannes Schneider in Austria. It formed the foundation of an entire teaching methodology (Arlberg Method) in the 1950's. Ironically, despite its place of origin and its Austrian founder, Arlberg Technique became the style associated with the French ski schools, and it was very different from the official Austrian Technique.

Arlberg technique revolved around the mechanics of *total body rotation*. "*Projection-Circulaire,*" the French called it. Arlberg technique's version of a turn begins with a big windup of the upper body *away* from the turn. The turn initiation involves throwing that upper body up and around, then forcefully pulling the skis around after it. Compared with today's techniques on modern equipment, this turn looks like a hugely exaggerated error! But I suspect that, if I were to strap eight-foot wooden planks loosely onto soft boots, I too would use exaggerated upper-body gyrations to hurl the things around. And the mechanics of rotation, while rarely so extreme, still remain valid, sometimes important, technical options.

These brief paragraphs hardly do justice to the historically important and all-encompassing Arlberg system of skiing and teaching. For a more in-depth look from those who knew it much better than I, I refer you to *The New Invitation To Skiing,* by Fred Iselin and A. C. Spectorsky, originally published in 1947.[13] Complete with "stop-action robot photography" and some great illustrations, this book was once known as the "skier's Bible." Beyond technique, "the Bible" discusses all the "current revolutionary designs in equipment [such as] double boots, safety bindings, laminated . . . skis, etc." as well as tow-riding, etiquette ("Your real skier is a gentleman or gentlewoman . . ."), fashion, and conditioning. Read it!

ATS (ATM) See **American Teaching System™ (Method)**.

ATS Teaching Model PSIA's American Teaching System™ comprises a skiing model (the *Center Line™ Model)* and a *teaching model.* Based on established principles of modern education, in particular the concept of *Mastery Learning* and *Direct Instruction* formulated in 1971 by Benjamin Bloom and John B. Carroll, the ATS Teaching Model is a simplified guide for conducting ski lessons. Here are the seven points of the ATS Teaching Model:

1. **INTRODUCING THE LEARNING SEGMENT:** Establish rapport, create a fun, open learning environment, clearly outline the agenda for the day and give the students a broad overview of the lesson (lunch times, ending locations, etc.).

2. **ASSESSING THE STUDENT:** Ask a wide range of questions for an initial verbal assessment. Ascertain the student's previous experience with skiing and other related sports. Find out about their goals and expectations, their limits, and concerns. Find out if they have a dominant learning style and what kind of learner they are in general. Watch them ski, and perform a movement analysis. Assess their skiing and see if their current ability matches their goals and expectations.

3. **DETERMINING GOALS AND PLANNING OBJECTIVES:** Set goals based on your movement analysis and the student's expectations. Compromise a goal if students' expectations are too high for their current ability. Formulate a logical progression that will address the goal. Choose appropriate terrain and conditions. Clearly state the goal to the students and briefly outline some of the steps they will experience along the way.

4. **PRESENTING AND SHARING INFORMATION:** Present the lesson targeting a variety of student learning styles (doer, feeler, watcher, thinker) and sensory preferences (VAK). Utilize appropriate teaching styles (command, task, guided discovery, problem solving, individual, reciprocal), to present the information in the most beneficial manner. Pace the information, practice, feedback and reinforcement to keep the lesson fun and the students motivated.

5. **GUIDING PRACTICE:** Set practice tasks to the level of the students. Provide specific and individual feedback. Guide initial practice and set students up for meaningful independent practice. Provide appropriate reinforcement.

6. **CHECKING FOR UNDERSTANDING:** Verify the students' learning based on their performance. Ask key questions to make sure students understand the lesson objectives.

Check for understanding often and loop back through the lesson if students have not retained the behaviors and understanding you outlined in your objectives.

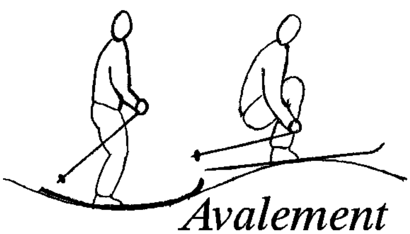
7. **SUMMARIZING THE LEARNING SEGMENT:** Review the lesson goals and objectives and communicate the degree of accomplishment to the group and individuals. Preview the next lesson and encourage further development. Establish independent practice guidelines.

These seven points are not meant to be "steps," performed one at a time and checked off. They may occur in different sequences, and several points may be addressed at once. And a lesson may loop through the points more than once. In particular, the model should not imply that "checking for understanding" should only occur *after* practice! Students must not practice errors, so checking for understanding is a continuous process, before and during practice. While experienced instructors may not always apply the Teaching Model deliberately or consciously, each of the seven points is an essential part of virtually every great lesson.

See **Mastery Learning**, **Direct Instruction**, **Practice**, and the **Basic Practice Model** for a clearer understanding of the principles underlying the ATS Teaching Model.

Avalement

In French, avalement literally means "to swallow." Georges Joubert introduced the term in skiing to describe *active* absorption of terrain (*i.e.* moguls) and pressure through muscular retraction and extension of the legs and body. Compare with **Reploiment** (passive absorption).



Axial Motion

One of the original "Seven Basic Principles" of the American Ski Technique (predecessor to the American Teaching Method), axial motion refers to rotary motion around a longitudinal body axis. Rotation, counter-rotation, and leg rotation are examples of axial motion.

Axis

An axis (plural: *axes)* is an imaginary line about which something rotates, like the axle for a wheel.

See **Anatomical Reference Axes**.

B

Balance Balance is “the action of maintaining equilibrium.”[14] Most often defined as a “stable state” in which all forces acting on an object cancel, in skiing, and most sports of motion, we must think of balance as an activity (“balancing”), rather than a state. Because the forces acting on a skier change constantly, the skier must continuously move and adjust in order to remain in balance.

Balance refers to the equilibrium between the (unbalanced) applied forces acting on the skier, causing accelerations, and the resulting inertial forces. If we consider only applied forces, ignoring the counteracting inertial forces such as centrifugal force, we cannot speak of balance in the normal sense. In this analysis, if a skier is turning, he is accelerating and thus is not in balance!

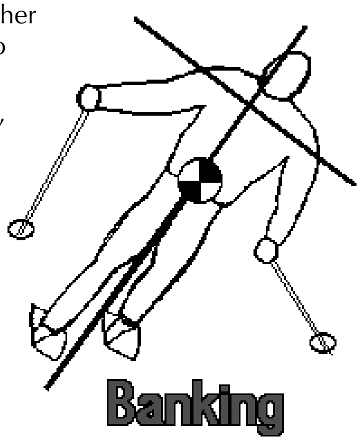
Before skiers can adjust to imbalance, they must *sense* the imbalance. Some athletes sense imbalance sooner, and can sense lesser degrees of imbalance, than others. This sensory ability is probably mostly innate. On the other hand, once we sense the imbalance, we must react to it—or we could move in advance if we could anticipate the imbalance. The precision, accuracy, and timing of these balancing movements represent skills that are primarily *learned*. Thus balancing requires both ability and skill, involves both innate and learned components.

Good balance is the foundation of skiing. In the Skills Concept of ATS, PSIA recognizes balance to be the “master” skill (or ability). Balance is the king that allows the other skills (rotary, edging, and pressure control) to work—and to support it.

See also **Static Balance**, **Dynamic Balance**, **Skills Concept**, **Equilibrium**.

Banking Banking means leaning (“inclining”) the entire body into a turn without angulation. It is a special case of *inclination*. Banking has also been called “total body angulation.”

Except at high speeds, as in a downhill race, banking does not usually produce



Banking—Inclination without Angulation sufficient edge angle to hold turns. Since banking is really a balancing move, a skier can only bank into a given turn a certain amount—no more, no less. When the skier needs more edge angle, he cannot just lean farther into the turn—he must "angulate" (bend sideways).

Banking skiers typically skid turns on harder snow. They often also lose balance and fall to the inside ski.

In spite of its limitations, banking keeps a skier in a tall and skeletally strong stance. When conditions do not demand ultimate performance, and a little skidding is acceptable, banking can be a relaxing and effective way to get down the mountain. For less athletic, elderly, or just plain tired skiers, banking allows a graceful, efficient, low-energy cruise down gentle runs.

See also **Angulation** and **Inclination**.

Basic Christie

See **Christie**, **Basic**.

Basic Practice Model

See **Practice Model, Basic**.

Bathtub

I quote from *The New Invitation To Skiing,*[15] the self-proclaimed "skiers' Bible" of the 1950's:

> *Bathtub. Often called Sitzmark (the Austrian term). It is the embarrassing hole in the snow which results from sitting down hard, usually the outcome of rücklage. Good skiers fill up bathtubs and smooth the snow before going on, out of consideration for the next man, who can have a nasty spill if his skis dip into a bathtub and plow below the surface.*

How things change!

Bias

The dictionary defines bias as "preference or inclination that inhibits impartial judgement; prejudice."[16] In skiing, a bias in our technique prevents pure *functional skiing* and inhibits our ability to adapt to the situation underfoot. There are many ways to turn skis—rotation, counter-rotation, rotary pushoff, leg steering, and so on, and many different pools of movements available for skiing. In the history of skiing, whole nations have staked their pride on one type of turn mechanics or another, proclaiming their way to be the best. A truly great skier must master all these options, but should not become stuck on any one. *Options* are good, but biases are limiting. Especially when demonstrating for students, we must strive to eliminate biases in our skiing.

See **Center Line™**.

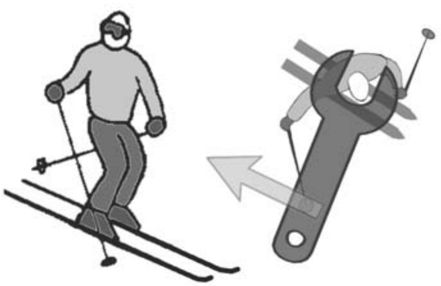
Bilateral Motion The motion of skiing that contrasts with normal walking motion, bilateral motion means that the left or right hand and foot move forward together. Walking, a "*cross-lateral*" motion, involves the left hand moving forward with the right foot, and vice-versa. This opposite movement pattern is a good example of *negative transfer*—prior learning that interferes with new learning.

Bilateral Transfer Meaning "transfer of a skill from one side of the body to the other,"[17] bilateral transfer is particularly important in skiing where we want symmetry right and left. While most of us will always have a favored side, it is useful to know that one side of the body can "teach" the other side.

Biomechanics Biomechanics is the scientific study of living bodies in motion, particularly human bodies. It combines the fields of *mechanics* (the physics of forces and objects in motion) and *anatomical function* (muscles, bones, and joints).

Black Ice Black ice is the "snow" condition of rock-hard, clear, frozen water. It is pretty rare, fortunately, although some skiers in the eastern U.S. would like you to believe it's what they ski all the time. I'm not sure if they're bragging, or complaining!

Blocking "Blocking" describes planting a pole solidly to stabilize the upper body or to produce *torque* (twisting force). A blocking pole plant often combines with *anticipation-release* to prevent the upper body from turning, thus strengthening the turning of the skis. Blocking is a powerful rotary mechanism, as torque is transmitted directly from the snow through the extended arm, literally "cranking" the skier around like a wrench.



Blocking Pole Plant

Snow pushes on pole, which transmits the force through a "lever arm," producing torque that twists the skier and skis.

Blocking is a defensive move. In most "offensive" gliding turns ("Center Line™" turns), a blocking pole plant is unnecessary—it disrupts the smooth "flow" of the center of mass. But on steeps or whenever extreme rotary or braking is needed, the blocking pole plant is very important. It is also useful sometimes in moguls to stabilize the body during jarring edgesets and imbalances and to create powerful twisting rotary forces.

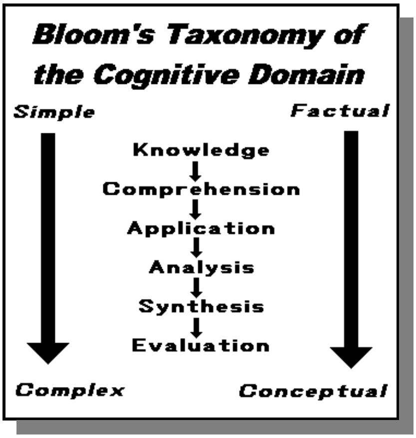
Blocking Pole Plant

See **Blocking**.

Bloom's Taxonomy of the Cognitive Domain

(**Bloom's Levels of Cognition**) In the 1940's, a group of researchers developed a system of goals and objectives for education. Their system identified three important spheres of learning—the *affective, psychomotor,* and *cognitive domains*. Within each domain, they developed a hierarchy, or progression, of learning objectives. Bloom's Taxonomy refers to the hierarchy of objectives for the cognitive domain.

The cognitive domain deals with knowledge and understanding (as opposed to the *affective* domain, which concerns emotion, and the *psychomotor* domain, which deals with acquiring physical skills). We can "know" something to different levels, from simply remembering a fact to deep understanding of its meaning, application, and usefulness.



Cognitive psychologist Benjamin Bloom and several colleagues defined six levels of cognition on a hierarchy from simple to complex. Bloom's six levels are *knowledge* (recalling information), *comprehension* (understanding and interpreting, putting information in your own words), *application* (doing it, applying the knowledge), *analysis* (breaking complex concepts into simpler components, understanding the parts that make the whole), *synthesis* (combining or recombining information to create a new idea or concept), and *evaluation* (judging against a standard, choosing wisely among options). These levels represent a progression of objectives as we acquire knowledge and understanding.

For example, if this is the first time you have heard of Bloom's Taxonomy, you could memorize the names and order of the six levels. You would then "know" Bloom's Taxonomy, but only at the shallowest level. With a little more study and thought, your understanding would deepen, until you comprehended the real meaning, and could describe the levels in your own words. With a deeper understanding yet, you might be able to apply your knowledge in, say, some ski teaching situations. And so on, through *analysis*, *synthesis* and *evaluation*. At the highest level, you would deeply understand Bloom's Taxonomy, its background and reasoning, its usefulness in teaching and in other areas of life. You would know how it fits into the overall scheme of education. You could apply it in your own teaching, and judge when and when not to use it. You could recognize at what level others understand ideas, and use this knowledge to take them to the next level. And of course, you wouldn't need to bother reading this definition!

See **Cognition**.

Booting Out

A recent addition to the skiing lexicon, "booting out" describes what happens when you tip your skis to such an extreme edge angle that your ski boot hits the snow, preventing the ski edge from gripping. It is an unnerving phenomenon when carving radical turns at speed, as the skis suddenly lose all edge grip. Extreme sidecut skis, especially those with very narrow waists, respond so well to dramatic edge angles (see **Darcside**) that they are prone to boot out.

One solution to booting out involves elevating the boot farther off the ski with binding platforms or built-in lifts on the skis (see **Lift**). Boots for extreme carving are evolving now too, with narrower shells and internal lifts.

Bottomless

"Bottomless" is soft, fresh powder snow deep enough that skis float *in* it, rather than riding on the solid surface beneath it. True bottomless powder is a rare treat in most parts of the world, at least within public resorts. Skiing it demands some technical adjustments because of the absence of a solid platform. A balanced, centered stance with weight on both skis, simultaneous movements of the skis and legs where they act as one, and enough speed to allow the skis to float are essential tactics for skiing bottomless snow (see **Powder**).

Brake

One of two primary ways to reduce speed, braking means using the ski edges as scrapers to increase the resistance of the skis on the snow. Wider wedges, hockey stops, increased skidding and edging—these are all forms of braking. The other way to slow down is to ski uphill, using grav-

Ironically, the faster you go, the less you can afford to hit the brakes!

ity as the slowing force. By carefully choosing "slow enough lines," great skiers seldom need to brake. Braking means fighting gravity, using the skis to produce *friction*. Great skiers play with gravity, and they use their skis to control *direction*.

Braking is an essential skill, of course, but it is a very bad habit. It is hard work, muscles against gravity. And, ironically, it is dangerous. The faster you go, the steeper, icier, or otherwise gnarlier the conditions, the less you can afford to hit the brakes and skid. At high speeds, experts rarely apply the brakes except in an emergency. Turning the skis sideways might work at eight mph on nice groomed terrain; at eighty on ice it could be the last thing you ever do!

Skis can work as brakes, and as tools to control line, but *not at the same time!* Indeed, the movements are incompatible. Braking is skidding, but the more skis skid, the less they hold the line (and *vice-versa)*. Unfortunately, many skiers rely almost exclusively on braking for speed control. They may think—and say—that they are *turning*, but if their real goal is to slow down, the result shows in their actions—they push their ski tails away from the direction of each turn, increasing friction, but skidding off their line. Many skiers turn not to "go that way," but just to stop going "this way." The thoughts are not the same, nor are the movements they inspire.

I suspect that few skiers have really thought about this essential distinction between turns meant to slow them down and turns meant to control direction. Braking is braking. Turning is not. Thinking of turns as a way to slow down transforms them into braking, defensive, skidding moves and is perhaps the most limiting thought in all of skiing. Skiers—at any skill level—are doomed to perpetual mediocrity as long as they think of their turns as a way to slow down and their skis as brakes. Changing this defensive way of thinking often provides just the "paradigm shift" needed to break out of the intermediate rut and into the world of expert skiing.

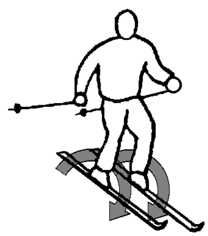
> ***Skiers are doomed to perpetual mediocrity as long as they think of their turns as a way to slow down!***

Contrast with **Turn**. See also **Good Skiing**, **Speed Control**, and **Line**.

Braking Wedge A braking wedge is a wedge in which the angle of the "V" and the edge angle of the skis are sufficient to create enough resistance to slow or stop the skier—a "wide wedge." With its defensive posture, widely spread feet and strongly edged skis, a braking wedge is not conducive to turning or athletic movement. On the other hand, while one goal for beginning skiers is to develop a *gliding wedge*, it is difficult to relax and glide without the confidence of knowing that braking and stopping is possible. Novices usually find it easiest to learn to glide first in a straight run on very gentle terrain with a good runout, then learn to brake, then learn to take the brakes off again and glide to make those first turns.

Braquage

"Braquage" is a term Georges Joubert used to identify an important *rotary mechanism*. Specifically, braquage is the simultaneous rotation of each leg independently, each using the other as a base of support or "fulcrum." [Fulcrum: "one that supplies capability for action."[18]] Braquage is the simultaneous special case of the *fulcrum mechanism*, which can be simultaneous or sequential, or one leg only. Like all fulcrum turns, braquage requires an open stance (some space between the skis) and some weight on both skis.

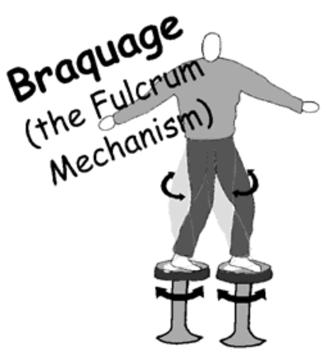


***Braquage**—Simultaneous Leg Steering*

Gross braquage movements are often the first rotary mechanisms beginners discover. It was these inelegant, harsh twisting movements that Joubert originally labeled "braquage." But the mechanism is highly versatile, and refined braquage movements are the dominant steering mechanics in most high-end gliding (*i.e.* "Center Line™") turns.

For a thorough analysis of the mechanics involved in braquage, see **Fulcrum Turn** and **Rotary Mechanisms**.

There are two important points that distinguish fulcrum turns from other rotary mechanisms. First, the fulcrum mechanism, including braquage, takes place entirely within the lower body, below the pelvis. The legs turn in the hip sockets, the lower legs twist, or the feet turn from the ankles. As the "bridge" that links the legs, the pelvis itself does not turn with braquage. The action, as well as the reaction required by Newton's Third Law of Motion, takes place in the legs, which are countered by the *earth*, not the upper body.



Note that the feet and legs turn in the hip sockets, but the pelvis and upper body do not turn.

Which explains the second point: both feet must be on the snow, and there must be some space between them. A locked (feet together) or totally one-footed stance precludes braquage as a movement option. This is one reason we actually inhibit a beginning skier's progress if we insist on a strong, active and complete weight transfer to initiate a turn. The fulcrum mechanism involves two separate pivot points, one for each leg. If you were to stand with a foot on each of two barstools and turn the stools with your legs, the turning mechanism would be simple braquage. (The explanation to the bartender would be more complex.)

Braquage is far more versatile than rotary mechanisms that involve the upper body—*rotation*, *counter-rotation*, or *blocking* with the poles. Horst Abraham writes in *ATM Teaching Concepts:*[19]

> "When executing braquage with the legs comfortably apart, the movement is strong and versatile in the sense that it can be done slowly, rapidly, intermittently, or all at once. As soon as the skier closes his stance, or stands on only one foot, the mechanics change insofar as "rotation" or "counter-rotation" of the entire body take over."

We can steer the legs strongly and quickly to pivot the skis, or gently and continuously to guide them throughout the turn. Upper body mechanisms can pivot the skis, but they cannot "steer" them. Rotation, for example, requires the skier to turn the upper body first, then start the turn by transferring the rotary momentum of the upper body to the feet. Once the skier kicks off the turn he is committed—he can no longer regulate the strength of the rotation. If the turn is "under-initiated" the skier will have difficulty completing it; if "over-initiated," the skier will need to compensate to avoid overturning or washing out at the end of the turn. Using braquage instead, the steering can be continuous. Like the driver of a car, the skier can shape the turn from start to finish.

Compare with **Vissage** or **Counter-Rotation**, which generally involve one pivot point (*i.e.* both feet on the same barstool) and the lower body working against the upper body, rather than one leg working against the other. See also **Rotary Mechanisms**.

Breakable Crust

One of skiing's most difficult conditions, breakable crust is a thin layer of hard snow, wind slab, or ice on top of softer snow. Like skiing on egg shells, sometimes the skis break through the crust, sometimes they don't. It is unpredictable, and the skis behave very differently depending on whether they break the crust or not.

A great test of balance and skill, breakable crust especially punishes skiers who rely on skidding and braking for speed control, rather than carving completed turns. Short turns or long, keep the skis going the direction they're pointed! Skidded turns or attempts to brake usually result in immediate face plants.

Simultaneous leg movements usually work better than sequential movements, as the inconsistent crust makes an unreliable platform to push off from. Stepping and stemming are poor tactics. Short, rhythmic turns with exaggerated up/down movements to free the skis from the snow during the initiation phase can work. So can very subtle movements and keeping the skis either under or on top of the crust. But once the skis break through, they can't be pivoted or moved sideways, so any imbalance usually leads to a fall. It's often best to pressure them briefly, as in slalom turns, then rebound strongly, turning the skis and making any necessary recovery moves in the air.

Breakable crust is one of those conditions I ski just to challenge myself. I wouldn't do it for fun!

Breakaway Gate

See **Rapid Gate**.

Breakthrough Experience

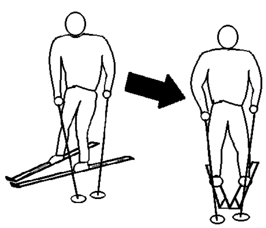
From *Inner Skiing,*[20] a breakthrough experience is one of those dreamlike moments we have all enjoyed when everything "clicks" and we ski (or perform in general) better than ever before. It is "peak performance," finding "the Zone." Breakthrough experiences happen when your mental processes enhance your physical ability—you are relaxed, focused, aware. Absent are judgmental, negative self-talk and distractions.

A breakthrough experience is not magic. We don't suddenly become more skillful—those skills and that performance were inside all along. Mental exercises that help us enter the breakthrough experience zone are important, but they cannot take the place of practice. Indeed, practice and the confidence in our skills that it breeds allows us to relax and not worry about the physical performance—which puts us in the "zone."

See also **Peak Performance** and **Zone**.

Bull-Fighter Turn

The bull-fighter turn is a technique often taught to beginners to allow them to comfortably turn and face downhill, supported by their poles to prevent sliding until they are ready. Not always necessary, the bull-fighter turn should at best be used with caution—we do not want to develop the dangerous habit of using the poles as brakes.



Bull-Fighter Turn

Bulletproof

"Bullet proof" describes well a very hard, slick, evil snow condition. Unlike "black ice," bulletproof often disguises itself as friendly snow. White and smooth, it can look like a nicely groomed slope or a field of unbroken powder. On ski runs, bulletproof often results from skiers scraping off the loose top snow down to an older, solidly frozen layer. Off-piste, it can describe an "unbreakable" crust of frozen rain or old wind-scoured ice.

Bumps

Bumps, or *moguls*, are a natural and inevitable feature of modern skiing. Skiers cause bumps, and as our sport increases in popularity bumps become more prevalent. The ultimate challenge and thrill for some, a condition to avoid at all costs for others, bumps evoke passion in most skiers. Whether you love them or despise them, though, you cannot avoid bumps forever. You must learn to ski "corrugated terrain" or forever relegate yourself to freshly groomed, artificial conditions. And even there, the time will come when you will find yourself staring down a bump field. Phil Mahre's tongue-in-cheek advice (see box) is increasingly hard to follow. I've seen green novice runs, groomed twice a day, become seas of three foot moguls by early afternoon. Real skiers, whether they prefer them or not, can ski bumps.

Student: Phil, what should I do when I'm skiing along and suddenly I find myself at the top of a great big bump field?

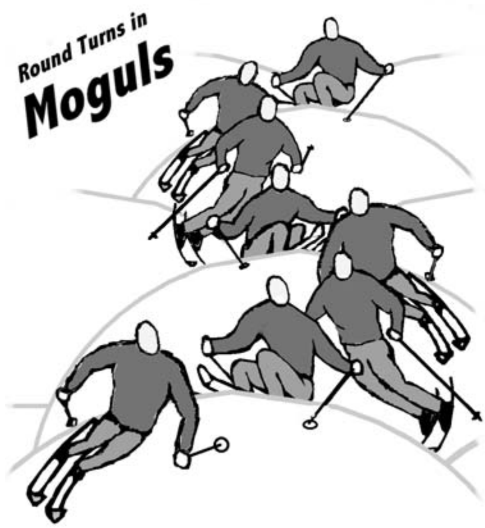
Phil Mahre: Get off it!

(Conversation at the Mahre Training Center)

Moguls have an undeserved bad reputation. To ski them, you need not be young, foolish, expert, or bullet-proof. Intermediate (but properly applied) skills, average athletic ability, and the right attitude are all it takes to learn—and enjoy—bumps.

The bad reputation of moguls is easy to explain. They appear violent and painful because most skiers ski them the hard way. It is possible in bumps, unlike most conditions, to substitute athletic ability and reflexes for technical prowess, which makes them perfect for young athletes with unsophisticated techniques. Bumps mask—even reward—poor technique. The unschooled but athletic skier who skids every turn, trips in deep snow, and cannot hold an edge on ice, finds bumps quite skiable. It's easy to pivot skis on top of a bump and skid down the steep, often icy, backside, helped by the convexity of the bump and natural "terrain unweighting." Unlike flat ice, though, the skid will stop as soon as the skis slam sideways against the next bump. Pivot—skid—WHACK, pivot—skid—WHACK, it's like hopping with both feet down a staircase. Straight down the hill, skis always beneath the center of mass, exhausting, loud, and jarring, but as reliable as it is unsophisticated, this way of skiing is well-suited to those with sixteen-year-old knees and more athletic ability than skill.

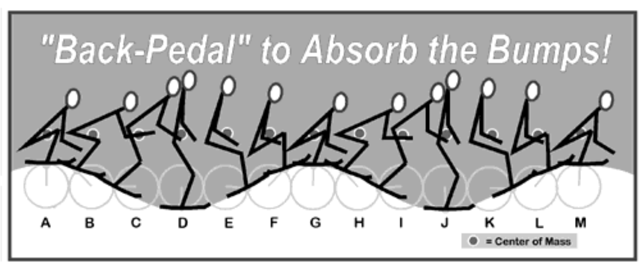
There *are* other ways to ski (most) bumps. Solid fundamentals combined with good tactics will mellow the moguls. As always, the key to efficient, smooth skiing is to control speed indirectly through choice of line, rather than directly by using the skis as brakes. Highly aggressive, the harsh skiing described above is still *defensive*. Skis move sideways. Technically excellent skiing is *offensive*, in bumps as elsewhere. Skis should glide forward, as the precision carving instruments they are designed to be.



As in all good turns, skis go the direction they're pointed, and speed control comes from skiing a "slow enough line as fast as you can"—with little skidding and braking only when necessary. The body actively folds and unfolds to keep the skis in contact with the snow.

How? Well, a little bad news—there is no magic trick. Bumps are *not* the place to learn fundamentals. If you can't make reasonable carved shortswing turns with offensive speed control, a disciplined upper body, and an accurate pole plant on groomed snow, bumps will only reinforce bad habits. Practice. Bring the tools with you, because you won't find them in the bumps. For those who are ready, here are some thoughts:

Stance and Shock Absorbers. Our stance must allow us to absorb bumps. If you tend to ski too forward, with a lot of pressure on your shins, your stiff boots will prevent your legs from folding and unfolding with the terrain. Try this: lean forward against your boot tongues. Now imagine that I grab your ski tips and suddenly yank up on them, as if they had hit a bump. Your boots will jam your shins, and



The feet move in circles beneath the body when skiing bumps—not just up and down like pistons. In this illustration, the skier's center of mass moves at a constant speed and in a straight line, while the legs and body move to maintain constant pressure on the snow. The feet move forward and up beneath the hips as the skier climbs the bump (frames D, E, F and J, K, L). The skier then pulls them back and presses them down to accelerate down the back side (A, B, C and G, H, I).

you'll fold over at the waist, because your stance is off. Now, slowly move your hips and upper body back until the shin pressure is gone. Remain in contact with the boot tongues, without pressing on them. The upper body should be quite upright. Now, to simulate absorbing a big bump, pull one knee up toward your chest. No problem! Traverse, slowly at first, across some large smooth bumps and practice this folding and unfolding of the legs, trying to keep your hips from moving up and down.

Do you still get thrown around, especially fore-and-aft? Perhaps you have an image of your feet moving up and down, like pistons or shock absorbers. But it is more complicated! When you ski up the side of a bump, your skis slow down and tip up. To stay in balance, you have to let your feet move *forward* under your hips, not just up. On the other side of the bump, your skis accelerate and tip down. If your feet are still forward, they will leave you way behind, so you must now pull them *back*. Think of your feet as moving not *up* and *down*, but *around* in circles, like pedaling a bicycle in reverse (see illustration). Add this image to the traverse exercise, feet moving in smooth circles beneath the upper body. Once you can slither across a field of bumps without getting thrown around, they will not appear so threatening. Which will help you relax. Which, of course, will help you absorb the bumps even better!

Basic Bump Technique. Now the turn. Find a run that has nice round bumps, not too steep or threatening. Stand on top of a bump, in the same low position as if you were traversing over it and absorbing it. This is where the turn starts. Look downhill and make sure your shoulders face downhill too. Plant your pole. Now, relax your ankles and "fall" off the bump, turning your ski *tips* downhill. Let them go, down into the trough, straight ahead. Extend your legs into the trough, just like the traverse exercise. Keep steering the tips smoothly until you glide up the side of another bump. Do not twist the skis so they scrape sideways! Absorb the bump, and come to a stop right on top. Nothing violent about that! You should be in the same low position as before, skis pointing the other way, body still facing downhill, ready to do it again. Practice this move, one turn at a time to a stop, over and over, forty or fifty times in a set. Then link them together, slowly at first, then adding speed. The key is that the skis should point straight downhill and glide on the backside of the bump. They should *not* skid sideways. It may be frightening at first, but it doesn't last long.

Note that the timing of flexing and extending movements in bumps is directly opposite the usual pattern on groomed snow. Typically, we start turns taller, flex through the turn, and end tall. In bumps, we start flexed on top of a bump, extend into the trough, and end flexed. It can take a lot of practice to break the mold and find the new timing.

Some very basic reflexes also fight us in bumps. The "walking reflex" *("extensor reflex")* compels us, even as infants, to extend our legs in response to pressure on the soles of the feet, and then to relax when the pressure stops. In order to retract our legs to absorb a bump, then extend down the backside, we must short-circuit this reflex. Again, lots of practice is in order. (That's good news, not bad—go skiing!)

This explanation of bump skiing cannot possibly substitute for going out and doing it with some good coaching. But I hope it will give skiers a few ideas to try, and add a little to the instructor's bag of tricks.

Here are a few final notes on basic bump technique. Simultaneous leg movements usually work better then sequential movements. If you tend to ski in a wide stance, narrowing it somewhat (don't close it) can help keep both feet on the same general area of the bump, and help the legs work together. Develop absolute discipline of the upper body and arms. Rotation, or dropping the uphill hand down or back, makes bump skiing nearly impossible. Keep your hands up where you can see them and work on a quick, accurate, precise pole plant with minimal arm movement. A real pole "plant," rather than just a swing, helps stabilize the upper body, but a lighter touch sometimes smooths out the ride. Experiment!

The Fifty Percent Rule for Skiing Bumps

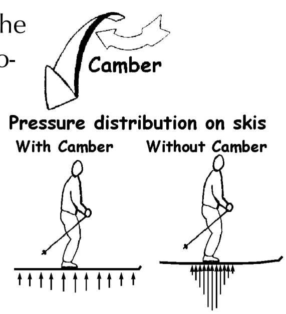
50% of skiing bumps is doing it right.
The other 50% is doing it anyway!

The Rest of the Story. Finally, despite my description of the smooth, basic turn, keep in mind that bumps demand versatility. We need sound technical habits, but we also need every trick in the book at times, including braking. No condition rewards good technique more, but remember this: fifty percent of great bump skiing is skiing them right. The other fifty percent is skiing them anyway! Be prepared to make athletic movements, out of balance, in the air, on one ski, doing whatever it takes to keep going. Fight for balance! Otherwise, ski bumps slowly, because mistakes happen in direct proportion to increased speed. Practice the bump technique above to improve the first fifty percent.

To master the "other fifty percent," always pick your stopping point before you start. Commit to skiing to that point, whether it is two bumps down or the bottom of the run, no matter what happens. Unless, of course, you fall. Falling in bumps is expected and honorable, but consider stopping short of your target without falling a disgrace! If you could stop, you could have just slowed down instead. Mistakes will happen; we can't worry about them! By continuing on, perhaps in a new line, or with a spectacular recovery move, you will gain the confidence you need to ski the bumps with speed and flair. You will free yourself to focus on tactics, rather than technique, to think about where to turn, when, what size and shape turn, what line to ski—rather than *how* to turn.

To really master bumps, use my "fifty percent rule" as a performance guideline. If more than half your turns are perfect, speed up! If most of your turns are recoveries, slow down a little. Most of all, have fun in bumps. Don't let them beat you up, but don't shy away from them either. Learning to ski bumps, even if you never learn to love them, will make you a better, more confident skier in all conditions.

C



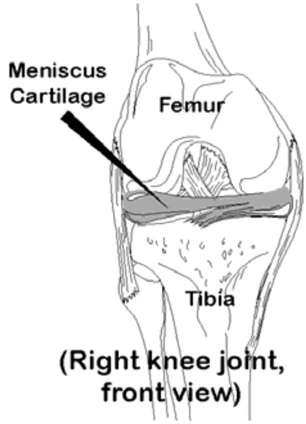
Camber Camber is the built-in curve along the base of a ski, easily seen by holding the skis base-to-base. Camber distributes pressure along the length of the ski.

Cant Cants are thin wedges used in or under boots to compensate for under- or over-edging and other leg alignment issues. Boots can also be "canted" by grinding the soles at an angle. Bow-leggedness, knock-knees, and unequal leg length are among the anatomical anomalies that cants can often correct. Today's precision equipment makes proper anatomical alignment more important than ever. Many technical difficulties are often the result of problems that an expert boot-fitter/canting specialist can solve. Good instructors can usually spot these problems as well, and can recommend a visit to a specialist.

Canting and boot-fitting is both an art and a science. For a good treatment of the subject, refer to Part 2 of *The Athletic Skier,* by Warren Witherell and David Evrard.[21]

Cartilage Cartilage is the tough, rubbery tissue that forms part of the skeleton, and gives structure to noses and ears. Smooth, elastic, and slippery, it also lines joints, covering bone surfaces where they meet, and forming cushioning pads such as the *meniscus* of the knee. Like ligaments, cartilage is relatively poorly supplied with blood vessels, so injuries tend to heal slowly if at all.

Carving Carving is turning with little lateral slippage of the skis. The carved turn is a turn made by the ski, bent into *reverse camber,* slicing a clean arc in the snow. Ski tail follows tip as the entire ski edge passes through roughly the same point.



(Right knee joint, front view)

This description may seem clear enough. But the real essence of carving defies such simplicity. If you like things simple, do not read on!

Digression—an inquiry into the essence of ***Carving:***

We usually distinguish carved turns from *skidded* turns, and there does appear to be a clear distinction. But all real turns skid to some degree, just as a car slips and perhaps squeals a little as it clings to a curve. If carving is the opposite of, or the absence of, skidding, then the pure carved turn exists only in theory. By this definition, carving represents a theoretical extreme on the spectrum of turns, with straight slipping on the opposite pole. Horst Abraham, in *ATM Teaching Concepts,*[22] calls all turns skids:

> ". . .we are making *skidding* the generic term for direction changes where the skis are in contact with the snow. If the skier skids a lot, he may come closer to 'slipping' his turns; if he skids less, he will come closer to 'carving' his turns."

Abraham is right, of course. On one level, there is no such thing as a real carved turn, with no skidding. But I can't accept this idea as a working definition of carving. Where is that clear distinction? Look on any ski hill and you will see skiers who carve, and skiers who don't. It is not an arbitrary line on a continuum, either—there are two distinct *types* of turns. Indeed, some clearly "carved" turns skid

The Turning Continuum—must all turns be in the gray area?

more than some obviously "skidded" turns. Think of a top downhill racer barely clinging to her line on an icy race course at eighty miles per hour. That ski may skip and chatter several feet sideways, yet there remains something very "carved turn-like" about her movements. Nor does the difference seem to relate entirely to skill level. Many skiers are very, very good at skidded turns! And some beginners and intermediates do the best they can at obviously carved turns.

So we still need a real definition of what makes one turn carved and another skidded, something that accounts for what we see and experience. Some say carving is a product of the amount of *rotary* force applied to twist the skis, that carving is the result of reducing rotary and focusing on pressure and edge control movements. True, tipping a modern ski on edge and riding that rail through a turn is one way to carve. And pivoting a flat ski that was sliding forward will cause it to skid sideways. Yet some carved turns involve powerful steering input. And pressuring the front of an edged ski *("forward leverage")* to tighten the turn radius causes the tail to straighten out and skid, even without any twisting. At best, this idea still only offers a scale of mostly gray area, that does not fit our observations. Once again, there is some truth here, but it still isn't quite right.

Here (I believe) is the answer! What separates carved-type turns from skidded-type turns is what I call "*positive*" *vs.* "*negative*" movements. Simply put, a positive movement is one in the direction of the intended turn. To initiate a carved turn, every movement should tend toward the new turn. The body (center of mass) moves downhill, into the turn, aided perhaps by a pole swing. The skis roll toward the new turn, flattening, then increasing their edge angle. Rotary, if any, steers the tips downhill, into the turn.

Carving is an Intent—not an Event!

Skidded turns, on the other hand, are just the opposite, as they are based on *negative movements.* Initiating a skidded turn involves pushing the ski *tails up*hill, or away from the turn. The center of mass also moves away from the turn, perhaps pushing off from a "*platform*" created by *increasing* edge angle, and aided by a blocking pole plant that prevents movement down the hill. What could be more different? To carve, I *pull* my *inside* ski *tip into* the turn. To skid, I *push* my *outside* ski *tail away from* the turn.

So that's it! Carved turns result from positive movements, skidded turns from negative movements. Black *vs.* white—this definition finally expresses that undeniable observation that there are two distinct types of turns out there. There is no hazy sliding scale here. By this definition, the amount of slippage is not important. The skill level is irrelevant. These factors may indicate how *good* a turn is, but neither defines the type of turn.

Carved turns are *offensive;* skidded turns are *defensive.* Both are useful in their place. Like so many things we do, state of mind affects movements. Carved turns are the embodiment of a skier's intent to *go* in a particular direction. Skidded turns are the result of the skier's intent to *stop going* in a particular direction. Either can be done expertly or shoddily. Carving, in short, is really an *intent,* not an *event!*

See also **Skidding** and **Turn**.

Cause and Effect

Why does that happen? What is the result of doing this? Did the egg cause the chicken? Perhaps nothing in ski teaching is more important than correctly assessing cause and effect relationships. Watching people ski, it is obvious *what* they are doing—turn type and shape, speed, skill level, basic stance and movement patterns. We can observe *when* they do things—timing and rhythm. And with a trained eye, it is usually easy to see *how* they do things—what skill blends and mechanics are involved. But *why*?

Cause and effect analysis addresses the *why* question, which we must answer for several reasons. First, if there is an error, we must identify and fix its real cause. Second, we must consider the potential consequences of everything we teach or suggest, be it a movement, a tactic, or an equipment recommendation. Finally, we must distinguish those things that we can control—body movements, equipment, terrain—from those things we cannot—the laws of physics, personal backgrounds and athletic talents of skiers, and the weather. We cannot affect effects, so we must identify and work with causes.

Cause & Effect

- "*Why* does it happen? What is its cause? What will be its consequences? What performance aspects are within our control?"

Issues:

- *Skier Profile*—Goals, desires, motivation, comfort level, age, sex, athletic background and ability, cultural background, equipment.
- *Transfer*—Positive and Negative.
- *Skills Hierarchy*—Balancing moves affect mechanics; Rotary mechanics affect stance, edging, and pressure movements, etc.
- *Turn Phases*—if something appears in one phase, did it begin in another?
- Common skier types. "Packages" of Movements—stance-based mechanics;
- Is it an error? Or is it an effective and important compensation for another error?

Does weight transfer cause turns, or do turns cause weight transfer? Why does the lead change from one ski to the other? Does sinking weight or unweight the skis? What happens if the stance is too far forward? If I teach these beginning students to turn by lifting a ski and throwing their upper bodies, it will work, and they'll love me for it—but how will it affect them in the long run? How do life-long devotions to water skiing, ice skating, or television remote-control-clicking transfer to skiing? And Why the Hell does she keep doing that, anyway? Effective instructing absolutely demands that we correctly answer such questions as these.

Understanding cause-effect relationships simplifies movement analysis. Many movements come in causally-linked packages. For example, you might observe that a skier's downhill ski tail skids out at the bottom of turns that are "fish-hook" shaped. Also that skier tends to face uphill at the end of the turn, rotate the upper body to start the turn, use a lot of knee angulation but little hip angulation, show an "a-frame" lower leg stance, and "bank" into the turn. This is a long list, but if you understand cause and effect, you will recognize that all these symptoms often occur together, and that they are related.

Related to what? This hypothetical skier probably needs a stance adjustment. He is probably too far forward on his skis, a common cause of this whole set of effects. It would do no good to try to fix any of the symptoms. Telling this skier to create more hip angles, or to face the upper body downhill at the end of the turn would only lead to frustration, because these are effects, not causes. The skier can't control them until their root cause changes. Indeed, many of these symptoms are really *not* errors—they are effective compensations for the original error. If we eliminate these compensations, this skier could be in trouble!

In the example above, the "package of movements" is based on stance. Other movement "packages" stem from skier type, especially related to attitude or state of mind. In an article in *The Professional Skier*[23] (Winter 1995), Weems Westfeldt and Squatty Schuler of Aspen identified four common skier types, each with a unique and identifiable set of characteristics. The nervous "double-edge death grip" skier, the showy, locked-stance "dig-me" type, the smooth and efficient "glider," and the sequential, rotary push-off-biased "lock-and-step" skier—it is a rare skier who does not fall into one of these categories. Once we recognize a skier's "type," many of the mechanics—and their causes—become clear.

Of course, sometimes the cause-effect relationship is not clear. Some things are both causes and effects. "Vicious cycles," positive feedback loops, chickens and eggs, the effect in all these returns to reinforce its cause. Rotating the shoulders to start a turn inevitably causes the shoulders to face uphill at the end of the turn. But facing uphill at the end of a turn requires that the shoulders rotate downhill to start the next turn, and around, and around. Fixing either could fix the other. Or perhaps there is another cause deeper down (*i.e.* the forward stance) responsible for both symptoms.

It is often easier to observe the effects than the error that underlies them. Subtle mistakes early in a turn can explode into glaring errors in a later phase. Herein lies the art—and the value—of expert ski instruction. The louder an apparent error shouts out, the more important it is to find and address its true cause. It is all too easy to try to change the defect, blinded by its obviousness. The only way to filter through the glare is to thoroughly understand the mechanics of skiing, or to ski with someone else who does. Well-meaning friends, and inexperienced, unknowledgeable instructors, frequently cause more harm than good!

We can trace the cause of many movements, good or bad, to a skier's athletic background. Experience in other sports certainly influences a skier's ability to learn skiing. "Teaching for transfer" addresses this impact of previous learning on current learning. Closely related activities can both help and harm. If skiing seems similar to something else that is familiar—water skiing, for example—the applicable movements will be easy, but it may be hard to avoid those things that are different. As similar as skiing is to ice skating, they are not the same! Ice skaters pick up the sport very quickly, but the moment they try hockey's version of "crossover" (crossing the legs to skate through a turn), they find that it doesn't cross over! Effective instructors must recognize these effects of transfer, both positive and negative.

> ***We should not teach "beginners' turns," but should introduce beginners to the basics of the turns of experts.***

Every exercise and drill we use to teach skiing involves positive-negative transfer issues. We would not use an exercise if we didn't think something good from it would transfer to skiing. But remember—every exercise also has something wrong with it—otherwise it would *be* skiing! Any exercise can backfire unless we clearly focus on its positive aspects and bear in mind its potential to cause problems. How many errors are caused by misinformation or misinterpretation?

We must anticipate the effects tomorrow of what we teach today. Teaching shortcuts that accomplish a short-term goal may please our students at the moment, but when they later find that they must "unlearn" what we taught them, that pleasure will turn to anger. Once again, to avoid this problem, even those who teach only beginners must comprehend thoroughly the fundamental mechanics of expert skiing. We should not teach "beginners' turns"—we should introduce beginners to the basics of the turns of experts.

Constant awareness of all aspects of cause and effect mark all effective ski instruction. Master instructors are sleuths who never take outward appearances for granted. They see movements as linked chains. They look for causes, understand effects, and consider the individual makeup of each student and situation, before deciding on a course of action. And they understand the effects of their own actions, attitudes, and body language. This awareness takes time and effort to acquire, but it is fundamental to the art of ski instruction.

See also **Movement Analysis** and **Stance-based Mechanics**.

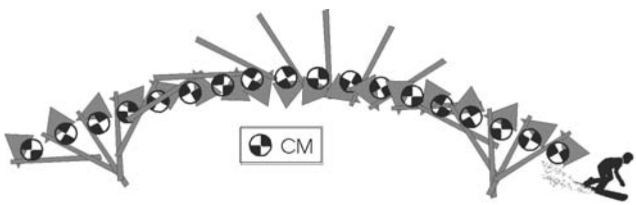
Center of Gravity (CG)

The center of gravity is the point in or near an object upon which gravity acts as though the entire object were concentrated at that point. An object spinning unimpeded through space would rotate around its center of gravity (or its center of mass, an equivalent term for practical purposes).

Center of Mass (CM)

The center of mass is the point at which all of the mass of an object acts is if it were concentrated, for purposes of mechanical analysis. There is a technical distinction between center of *mass* (CM) and center of *gravity* (CG), but for our practical purposes, the terms are interchangeable.✱

For an object flying through space, affected only by the pull of gravity, the center of mass follows a predetermined parabolic arc. Jumping skiers, for example, cannot change the trajectories of their centers of mass after leaving the ground, no matter what movements they make (except for the effects of air resistance). Forces acting on the center of mass cause an object to accelerate (change speed or direction); forces acting on any point other than the CM ("through a lever arm") create torque and affect the rotation or spinning of the object around its CM.

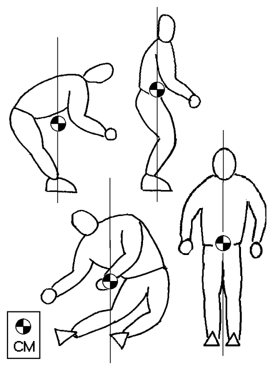


***Flight of the Tomahawk**. The tomahawk rotates about its center of mass (CM), and the CM travels in a smooth arc (technically a parabola, if we disregard air resistance). Every other point—end of the handle, for example—travels in a much more complex path. If the tomahawk were lying on a slippery ("frictionless") table, and you were to push (apply force) on its CM, it would slide in the direction of your push, without rotating. If you push "through a lever arm" on the handle, or any other point off the CM (and not directly toward the CM), it will rotate.*

Technically, we should think of a skier, with all his moving parts, not as an "object," but as a system of linked objects, each with its own center of mass. (Forget, for a moment, that ATS requires us to think of the skier as a *person!)*

When we refer to the skier's center of mass, we mean the center of mass of the entire linked ski-skier system. With our muscles, we can move the individual parts (limbs) relative to each other, but only an *external* force can alter the path of the ski-skier system's center of mass. After launching from a jump, skiers can flail their arms and legs any way they want, but they cannot change the parabolic path of their centers of mass. Like the tomahawk in the illustration, that path is pre-determined at the moment of take-off.

Within the "ski-skier system," the center of mass is mobile. It does not take up a permanent spot like an organ of the body, but moves around as we flex, extend, angulate, and move our limbs. Indeed, every movement we make moves our center of mass to some degree. The CM need not even be located within the body—where is the point around which a boomerang spins? The center of mass lowers when a skier puts on skis. And it is typically lower in women than men. Men can affect their centers of mass more with arm and upper body movements; women can move their centers of mass more with leg and hip movements.



The CM moves, relative to the body, depending on body position.

Specific measurements of the location of the center of mass in a person standing upright place it at 55% of an average woman's height or 57% of a man's.[24] Twenty pounds or so of skis, boots, and bindings lower the center of mass to roughly 45% of the skier's height. And again, any change in posture will change the location of the center of mass.

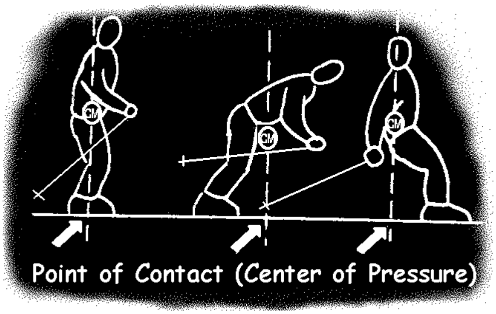
The lower its center of mass, the more stable the object. Ironically, though, balancing movements are more effective when the center of mass is higher. Balancing a ski pole on your fingertip is much easier than balancing a pencil, is it not? For this reason, it is more difficult to control balance in a low tuck than in a taller stance.

The *line of action* (see) passes through the center of mass. The angle of this line, which also passes through the "point of contact" on the snow, shows the degree the skier is *inclined* into a turn. We cannot "adjust" this line without losing balance. Therefore, when we flex and extend, angulate and incline, or move fore and aft, the center of mass may only move along the line of action—closer or farther from the feet. If we move the CM in any other direction—thus moving the line of action—balance is lost. So if we move the hips, for example, farther into the turn to create more edge angle, something (upper body and arms) must move out to compensate. This is the reason we *angulate* to adjust edge angle.

✱ For those who obsess over trivia, here is the difference between center of mass (CM) and center of gravity (CG): In a "uniform gravitational field" the two points would be identical. But gravity is not uniform—the pull of gravity (and hence "weight") decreases the farther an object moves from earth. Mass, which is a measure of the quantity of matter in an object, remains constant regardless of gravity. Since the lower half of your body is closer to the earth than the upper half, the pull of gravity is slightly stronger on your lower half. For this reason, the CG is VERY slightly below the CM. The difference, of course, is so minuscule as to be irrelevant to most everyday things—like skiing. For very large objects—the moon, for example—the center of gravity is substantially closer to the earth than the center of mass.

Center of Pressure

Synonymous with *point of contact,* the center of pressure is the "balance point," where the *line of action* intersects the snow. It is where pressure on the skis is focused fore-and-aft and laterally. While we often have a large base of support, with two long skis and poles, the center of pressure is the spot where one foot would need to be for us to balance on it. A string with a weight on it, suspended from the center of mass, would point directly at the center of pressure. When we lean forward or back to pressure different parts of the skis, we move the center of pressure. In most good turns, the center of pressure is somewhere along the inside edge of the outside ski, between the ball and heel of the foot. When both skis bear weight, the center of pressure is between them.

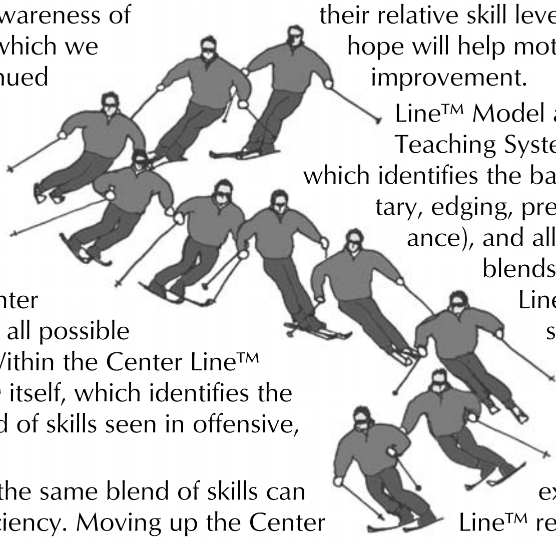


See **Point of Contact**.

Center Line™

"Center Line™" is the name of the skiing model of the American Teaching System™. It is a concept PSIA developed in the late 1980's to identify sound, accurate, technical fundamentals of good skiing at all levels from beginner through expert, to be used as a tool for movement analysis, as a framework for understanding all the movements of skiing, and as a reference point for "lateral exploration."

The Center Line™ Model serves also as a marketing tool for ski schools and PSIA. Depicting clean, elegant, beautiful skiing, the Center Line™ presents an inspiring image for the sport, a goal worth pursuing. And it encourages skiers' awareness of their relative skill level on the road to that goal, which we hope will help motivate them toward continued improvement.



The Center Line™ Model augments the American Teaching System™'s *Skills Concept,* which identifies the basic skills of skiing (rotary, edging, pressure control, and balance), and allows a variety of different blends of those skills. The Center Line™ Model encompasses all possible skill blends and biases. Within the Center Line™ Model is the Center Line™ itself, which identifies the balanced, efficient blend of skills seen in offensive, gliding, controlled turns.

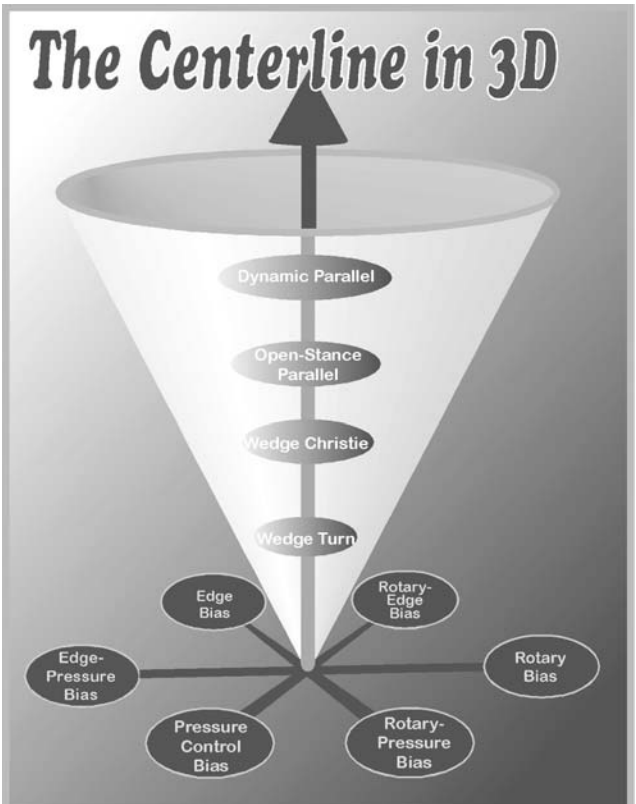
Of course, the same blend of skills can exist at any level of proficiency. Moving up the Center Line™ represents the *same* efficient turns at ever higher skill levels. The *Center Line™ Milestones* demonstrate "benchmarks" of skill level. The fundamental movement patterns and technical and tactical elements that remain constant along the Center Line™—the elements that form the essence of all the Center Line™ Milestones—are the so-called *Common Threads* of the Center Line™.

In the Center Line™ Model's original incarnation, there were six Milestones (known then as the Center Line™ Maneuvers)—wedge turn, wedge christie 1, wedge christie 2, open stance parallel, dynamic parallel, and "diverging parallel." Each milestone demonstrates the essential elements ("common threads") of the same good turns. All that really differs between lower and higher maneuvers is the speed and steepness of terrain, and the heightened intensity, timing, and accuracy of the movements required to deal with the amplified forces that result.

The Center Line™ represents LINEAR LEARNING and provides a reference for LATERAL LEARNING.

For simplicity, the six Milestones have become four. The two wedge christies are now one and diverging parallel has vanished into obscurity.

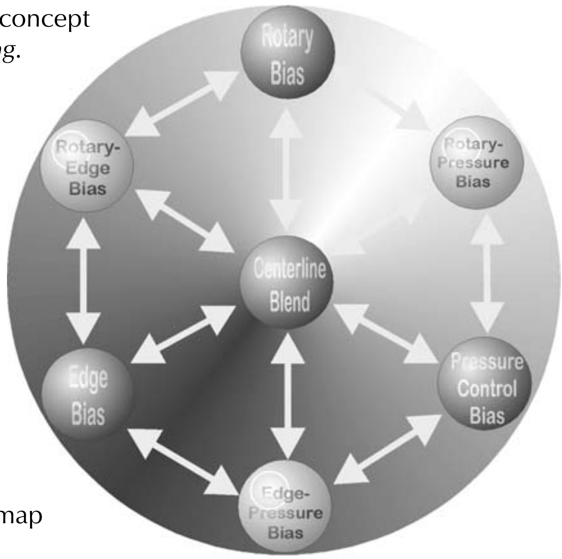
Great skiing involves mastering a vast array of technical and tactical options. Many rotary mechanisms can turn the skis. Turns come in infinite shapes and sizes, and there are countless ways to use the skis as tools. There are turning movements and braking movements, offensive and defensive movements, carves and skids, moves that conserve energy and speed, and moves that dissipate it. The Center Line™ Model does not dictate or prescribe the "correct" way to ski—it embraces them all. We do not "teach the Center Line™" or insist that students ski a certain way in all situations or conditions.



***The Center Line™ Model In Three Dimensions—The Cone of Learning**.*
In this illustration, the horizontal "base" represents the variety of skill blends and biases in skiing, with the "Center Line™ blend" in the center. The vertical axis (the Center Line™ itself) represents increased levels of skill as we move up, passing the four named "milestones" along the way. The cone represents all that we should explore and teach, both linear and lateral learning. There are, of course, more options as skills grow, as the ever-widening cone suggests.

However, the "Center Line™ Blend" of skills, as exemplified by the Milestones and the Common Threads, is not an arbitrary blend either. There are many perfectly effective ways to get down a mountain, using any skill blend in the spectrum. But there are very few good ways to make perfectly controlled, precise, efficient turns. The Center Line™ represents these "perfect turns." Everything else, valid and useful or not, is "off the Center Line™."

The need to master all these movement options inspires the concept of *linear* and *lateral learning*. Moving "up" the Center Line™ toward the next Milestone is linear learning. Exploring other skill blends and alternative movement patterns "off" the Center Line™ constitutes lateral learning. We can, of course, make "better" turns and we can make "different" turns. We must learn in both directions. The Center Line™ Model provides the road map to keep us from losing our way as we heighten our skills and explore the whole playing field.



The Center Line™ in Two Dimensions
A cross-section of the "cone of learning" in the previous illustration, this diagram shows the full spectrum of skill blends and biases, at any skill level. Arrows indicate the many possible directions for lateral learning. For skiers with a skill bias, developing the skill(s) directly opposite on the diagram will develop a more "Center Line™" blend. A "rotary biased" skier, for example, will benefit from some work on edging and pressuring skills.

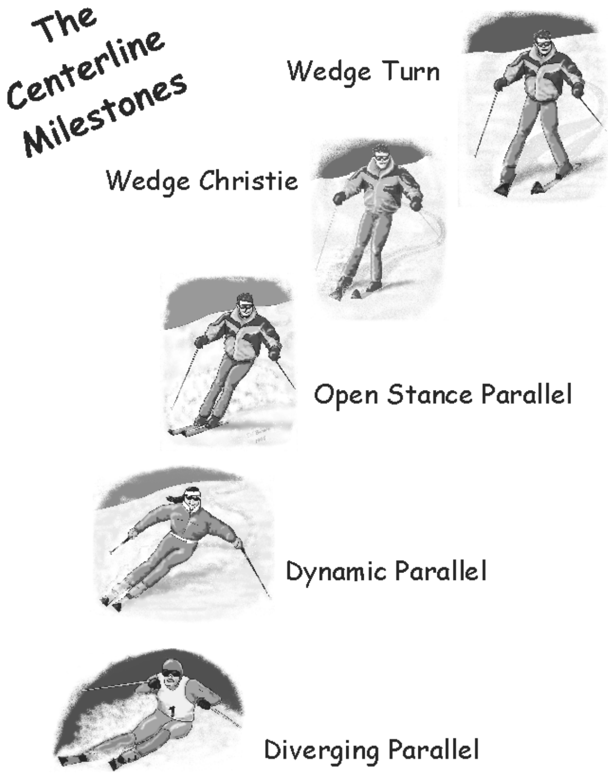
So the Center Line™ Model is an elegant and effective guide to skiing's complex assortment of movements. Without it, skiing is a jungle of miscellaneous turning mechanics, styles, turn types, and movement patterns. Is that a better turn? Or is it just a different kind of turn? Will practicing this exercise increase my skill level, or make me more versatile? The Center Line™ Model makes the answers clear.

See also **Center Line™ Milestones**, **Skills Concept**, **American Teaching System™**, **Linear** and **Lateral Learning**, and **Common Threads**.

Center Line™ Milestones (Center Line™ Standards, Center Line™ Maneuvers)

Wedge turns, wedge christies, open stance parallel, and dynamic parallel—these maneuvers are benchmarks of skill development that represent *linear learning* from beginner to expert.

The Center Line™ Skiing Model of PSIA's American Teaching System™ identifies the movement patterns, skill blends, mental aspects, and other characteristics that are the signature of good skiing. While true mastery requires developing all possible options as well *(lateral learning)*, we can identify the movements that are the essence of good turns. Making the turns of experts requires learning and practicing their fundamentals from the start. It should be an uninterrupted path from the first turns to the World Cup—no backtracking, nothing to unlearn. The Center Line™ Milestones represent benchmark levels along this road. From wedge turns to dynamic parallel turns, the same essential elements are inherent throughout. Fundamentals of stance and balance, rhythm and flow, turn shape, and application of rotary, edging, and pressure control skills begin at the basic wedge turn level. They vary only in intensity, deliberateness, accuracy, and timing as the skier evolves toward expert skiing.



The Center Line™ Milestones are technically specified, linked turns. The Milestones exemplify the Center Line™; moving from one maneuver to the next represents *linear learning*. As conditions, terrain, speeds, or desires of the skier change—as the skier explores technique and terrain options *(lateral exploration)*—skill application may deviate from the Center Line™. The skier may use skill blends more rotary dominant (twisting, skidding) or more edge/pressure dominant than the movements of the Center Line™. The Milestones thus exemplify linear learning and provide a comparison or reference for lateral learning.

None of the Center Line™ Milestones is detuned. The wedge turn is not a "beginner's turn"—it is an introduction to the fundamentals of the turns of experts, at a low speed on very easy terrain. The movements at each level are precise and accurate and appropriate in intensity to the speed, turn radius, and terrain upon which they are performed. The Wedge Turn involves only subtle flexion and extension, minimal pressure on the skis, no pole plant, and only mild angles, but the extreme movements of dynamic parallel turns would be excessive on the gentle terrain and at the modest speeds involved. Even the lowest level Center Line™ Milestones are not "easy" to perform well, as many instructors training for certification have discovered. Any one of the Milestones can reveal biases and weaknesses that plague us in our skiing. But all the Milestones represent *skiing* as opposed to posing or artificial, static "forms" and positions.

The Center Line™ Milestones therefore represent an option, a way to ski that is efficient, elegant, and appropriate in many conditions. They are terrain and speed specific, depicting how good skiers at various levels might ideally ski in very comfortable circumstances. They are good turns, but they do not represent the *only* good movements on skis. We do not *teach* the Center Line™ Milestones. We may teach with them, toward them, away from them. We may use them to define a level of skill. We may assign them as tasks to help us in movement analysis. We may practice them to develop discipline in our own skiing and to help eliminate biases. And a high level of proficiency and understanding of the mechanics is required for passing a certification exam. But it is the skills and movement patterns involved, not the milestones themselves, that we teach.

The Center Line™ Milestones evolve to keep pace with changes in technique, equipment, and understanding. Originally we recognized six Center Line™ Milestones: Wedge Turns, Wedge Christie 1, Wedge Christie 2, Open-Stance Parallel, Dynamic Parallel, and so-called "Diverging Parallel." Today we have simplified the list to four, combining the wedge christies into one, and eliminating the diverging parallel turn (a valid milestone, but one that can easily confuse). See entries for each of these in this book. Of course, four is also a somewhat arbitrary number—we could identify any number of milestones along the seamless progression from beginner to expert. For a discussion of the characteristics of the Center Line™ Milestones, see **Common Threads**, and read "The Common Threads of the Center Line" in *The Professional Skier*.[25]

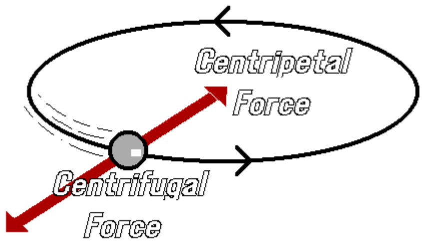
See also **Center Line™** and **Turn**.

Center Line™ Model

See **Center Line™**.

Centrifugal Force

Centrifugal ("center-fleeing") force is an *inertial* force—an effect of acceleration—as opposed to the *motive* or *applied* force that causes acceleration. It is the force a skier feels as a sideways pull toward the outside of a turn. To maintain balance, a skier must lean in (*incline*) just enough to counter centrifugal force (disregarding, for a moment, other forces against which the skier must also lean—crosswinds, gravity and such).



Centrifugal force is the *result* of acceleration (turning), not the cause. Some will argue (*ad nauseam)* that centrifugal force does not exist. They are wrong! True, it is not an applied force that causes a skier to turn, but it is real enough to hold us up as we lean against it in a turn. It is a question of the point of view, or *frame of reference*.

Movement is relative and all mechanical analysis must assume a frame of reference. When looking down at skiers from above and analyzing the forces that cause them to move around the mountain as they do, inertial forces are not involved—they are merely effects the skiers feel. From the moving reference frame of the skier, though, centrifugal force is quite real. And this is the only frame of reference that really makes sense when analyzing a skier's movements. We can feel centrifugal force, and we rely on it for balance. Centrifugal force is what we lean against in a turn. It is the force that holds us up and it is as real as the pole we may lean on to demonstrate skiing positions while standing still. I challenge doubters to lean against an imaginary force! It is what makes all the change and your cup of coffee slide sideways (from your frame of reference) off your dashboard when driving fast around a curve. (Remember, according to Newton's Second Law, if the coins move sideways, there is a force in that direction!) Name it what you like, but without the phenomenon we call centrifugal force, a turning skier could not balance. In technical terms, centrifugal force is the equilibrant or "balancing force" of centripetal force (the force that causes the turn).

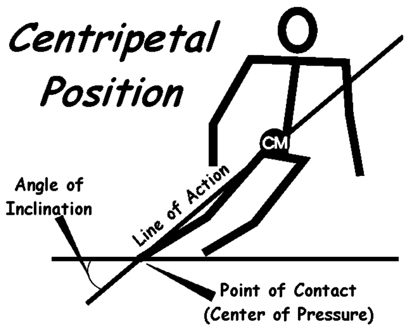
See also **Force**, **Applied Force**, **Inertial Force**, **Equilibrant**, **Centripetal Force**, and **Frame of Reference**.

Centripetal Force

Centripetal force is the force that causes turns. Meaning "center-seeking," centripetal force is directed toward the center of the curve. If I swing a ball on a string around in a circle, the pull of the string on the ball is the centripetal force. The pull *I* feel on the string is centrifugal force—it is equal to but opposite in direction of centripetal force. If the string breaks, centripetal force stops and the ball flies suddenly straight in a line tangent to the original circle (demonstrating Newton's First Law of Motion—unless acted on by an external force, a moving body will remain in constant linear motion). On skis, centripetal force comes primarily from the interaction of skis on snow—the snow literally pushes us from the side, causing a turn. A component of gravitational force also contributes to centripetal force in the first half of a turn.

Centripetal force is the generic name for *any* force that causes a turn. It is not a specific force, like gravity, friction, or air resistance. In other words, a skier is not acted upon by gravity, a push from the snow, *and* centripetal force; these other forces *are* the centripetal force that makes the skier turn.

See also **Force**, **Centrifugal Force**, and **Turning Force**.



Centripetal Position

Centripetal ("center-seeking") position is the image of *dynamic balance*. It simply refers to the *inclination* (tipping in) of a skier to balance the *centripetal force* that causes the turn. When turning, the skier's center of mass takes a shorter route than the skis, always cutting to the inside of the curve. At speed, the center of mass is well to the inside of the base of support, clearly demonstrating dynamic balance.

Cerebral Hemispheres

See **Hemispheres of the Brain**.

Champagne Powder

"Champagne" is the gourmet powder hound's ultimate delicacy. It is the deep, weightless fluff that falls only when conditions are just right. It is the two-foot snowstorm that you can blow off your windshield with a little puff. It sparkles in the sun, and flies around your face as you glide silently through it. It is . . . oh never mind.

Champagne powder is extremely dangerous, difficult to ski, and no fun at all. Everyone should stay home whenever it falls, until ski instructors and patrol have had a chance ski it to make sure it's safe . . . .

Chase, Curt

A member of the Army's skiing Tenth Mountain Division that trained in Colorado and fought in Italy in World War Two, and director of the Aspen Ski School until the early 1980's, Curt Chase is an influential pioneer of the sport in the United States. Now retired from teaching, but still skiing more days than not, he continues to inspire skiers and instructors with his enthusiasm, dedication, and expertise. Curt Chase was inducted into the Skiing Hall of Fame in 1989.

Chatter Chatter is the tooth-rattling result of ski edges rapidly grabbing and releasing during a turn, unable to hold smoothly on hard snow. Chatter results from skis that are too sharp or from over-edging—sometimes a boot fit or alignment problem. When skis are *under*-edged or too dull they will often slip and skid under the same circumstances, but rarely will they chatter.

Checking Checking is a brief braking action caused by slowing or stopping a skid with an edgeset. It often involves quickly tightening the turn radius at the end of the turn or a quick downstem, along with increased edging and pressure. Checking can create the platform and store energy for a "rebound" turn initiation. Because it blocks the smooth flow of the center of mass, checking is a defensive move and is not a movement of PSIA's *Center Line™*. Off the Center Line™, it is an essential option for advanced skiing in many situations, *i.e.* steeps, narrows, moguls.

Another form of checking, borrowed from ice hockey, can be useful in crowded lift lines, especially in Europe. Body checking, hip checking, elbowing, and tripping may provide the only means of getting through to the front of the line. This type of checking also is not characteristic of the Center Line™ and is generally not favored in the United States. However, more and more people are now using it to negotiate crowded slopes.

Christiania Légère The "light christie" was the defining turn of the once famous and still elegant French Arlberg technique. Based on upper body rotation and up-unweighting, the christiania légère began with a "counter-motion" windup and crouch, facing the upper body uphill before the turn. The skier then kicked off the turn by unwinding the upper body and "throwing" the uphill arm up and around, lifting and hauling the skis around in the new direction.

Today's high-tech equipment—stiff boots precisely linked to exotic, high performance skis—has eliminated the need for the gross exertions of the christiania légère. Today's skis carve turns almost by themselves, requiring only refined guiding movements to shape the turns.

Christie The classic definition of "christie" (also correctly spelled "christy") is a turn on skis with some degree of skidding on corresponding edges (both right or both left edges). The "other" kind of turn is the wedge turn, skidding on opposing (both inside) edges. Since all turns involve some degree of skidding, albeit slight in today's clean carved turns, christie describes any turn except a wedge turn. Wedge christies and stem christies are turns with both a wedge phase, on opposing edges, and a christie phase on corresponding edges.

With today's clean carved turns, the word "skidding" in the definition of christie is misleading. "Christie" originated to distinguish parallel from wedge turns, not to distinguish skidded turns from carved. Carved parallel turns are christies too. Christie does not imply flat skis, and it certainly does not require pushing the tails sideways into an intentional skid (although such turns are also christies).

Why is "skidding" part of the definition of christie? (And why isn't it important?) When the term originated, skis were long, heavy, straight-edged planks, and they either went straight or they skidded sideways. Surely, no one foresaw the carved turns of today. Skidding was synonymous with "turning." There were two basic ways to make skis skid (turn)—pushing the tails out against each other in a "snowplow" or "stem," or throwing both skis sideways at the same time so they skidded on "corresponding edges." To distinguish them from wedge turns, these parallel turns were called "christies." Most early christies involved a lot of skidding indeed. Now, with today's surgically sharp carving tools, we can skid much less, but carved turns are still "christies."

Nor does "corresponding edges" imply that both skis must be weighted, or even on the snow. If that inside ski lifts from the snow in a high-speed carved turn, it is still technically a christie.

I do not know how many times I've seen instructors try to demonstrate some sort of christie and intentionally push the tails out, smearing the skis into a gross skid, and removing the mechanics far from the Center Line™. A Center Line™ wedge christie, for example, while it involves more skidding due to lesser speeds and smaller edge angles, is no more *intentionally* skidded than a dynamic parallel turn (also a christie).

The name "christie" comes from the town of "Christiania" in Norway. Now Oslo, Christiania was the site of the first international ski tournament in 1892.

See also **Basic Christie**, **Wedge Christie**, **Stem Christie**, **Step Christie**, **Spontaneous Christie**, **Wide-Track Christie**, **Comfort Christie**, **Parallel Christie**, **Reuel Christie**, and **Christiania Légère**.

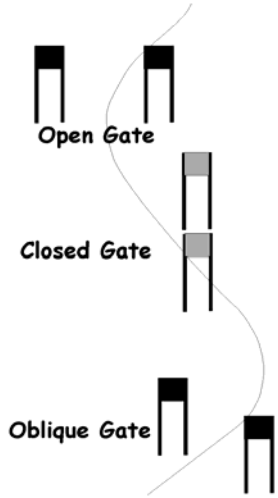
Christie, Basic 1. A turn that begins with a wedge but that involves some degree of skidding on corresponding edges later in the turn. The contemporary term is **Wedge Christie** (see).

2. First cousin of Jane, Plain.

Christie Phase The christie phase of a turn is any part of a turn in which the skis are on corresponding edges (both left or both right edges). Contrast with a "wedge phase," where the skis are on opposing edges. A parallel turn has no wedge phase; a wedge turn has no christie phase; a wedge christie, of course, has both.

Circumduction In the Jewish tradition, newborn males, uh, no wait, wrong word. Circumduction, in biomechanics, describes motion in a joint about several axes at once, with a single pivot point—the movement of the arm at the shoulder, for example, or the leg at the hip. It is a combination of several movements—flexion-extension, adduction-abduction, and internal-external rotation—and only a few joints are capable of it. The *ball-and-socket* joints of the hip and shoulder, and the *saddle* joint of the thumb are among the joints that allow this complex motion. *Hinge joints,* like the knees and elbows, allow motion primarily about only one axis.

Closed Gate A closed gate is a double-pole race gate set more-or-less vertically on the hill, as opposed to an "open" gate, where the poles are set across the hill. The third gate arrangement is the *oblique* gate, set diagonally on the hill.



Closed Loop Task Skilled athletic activity comes in two types, determined by the role of *feedback* in modifying the performance. Closed loop tasks rely on continuous feedback. In open-loop tasks, feedback is received only after the performance is completed.

Limited by reaction time, we can only modify movements based on feedback if they last longer than about a second. Therefore, giant slalom and longer turns can be closed loop tasks, each turn adjusted according to feedback during the turn—a little more edge angle here, an adjustment fore/aft, and so on. Quick slalom turns, typically lasting well under a second, are mostly open-loop tasks. They are pure motor activities, "habitual" movements made from muscle memory without adjustment once begun. We receive feedback *after* the slalom turn, and may make an adjustment to the *next* turn based on this feedback.

See also **Feedback**, **Open Loop Task**, and **Habitual** and **Perceptual Skills**.

Closed Stance

Once revered as skiing's highest form, the closed or "locked" stance, legs tightly clamped together, is a dinosaur of days past. Indeed, Georges Joubert described the closed stance as out-dated and ineffective already twenty years ago (1978)![26] "This position," he wrote, "once considered elegant—is now old fashioned." Functionally, it is as limiting as tying a rope around your ankles and knees. Most humans have two legs and modern ski technique and equipment takes advantage of both of them—and the space between.

A closed stance forces both legs to act as one. With only one pivot point, the important *fulcrum mechanism* (independent leg steering) isn't possible. To turn their skis, skiers with a closed stance must turn their legs against their upper bodies, using rotation, counter-rotation, or a blocking pole plant. A true carved turn is out of the question. With the inside ski in its way, the outside ski tip cannot turn into the turn. The only option is to push the tails out instead, for a skidded turn initiation. Just watch skiers with no daylight between their legs. Without fail, they are "tail pushers" making poorly shaped skidded turns.

Usually intentional, the result of misinformation, misunderstanding, or habit from techniques past, a closed stance can also result from a lazy inside leg. Centrifugal force pulls the inside ski out toward the outside ski. Modern skiing requires continuously pulling the inside ski away from the outside ski to prevent it from causing the same problems as the intentionally closed stance.

Experts often ski in a narrower, natural stance, but both legs remain independent, never locked. *Narrow* is not the same as *closed*! Actively steering the inside ski, the skier pulls its tip constantly into the turn, away from the outside ski tip. It comes as a shock to many skiers when they learn that those experts, whose narrow stances they so envy, actually pull their skis and legs *apart* as they turn, not together! The moment this inside leg activity ceases, the carved turn reverts to a tails-out skid.

See also **Natural Stance**, **Open Stance**, **Wide-Track**, and **Narrow Stance**; also **Fulcrum Mechanism**.

Closing (*vs.* Steering to match)

In stem christies and wedge christies, the skis transition from a converging wedge position to corresponding edges and parallel. There are two ways this can happen—skiers can pull the tails together, or they can steer the tips apart (see **Matching**). Closing is pulling the tail of the inside ski out toward the outside ski, closing the space between them. It is the move of the stem christie, a defensive "tails out" or "negative" movement.

A similar move happens in parallel turns when the inside leg is not active enough—a common error. Centrifugal force and, in the second half of the turn, gravity, pull the unweighted inside ski out toward the other ski. The skier must resist this pull with active rotary and retraction movements of the inside leg, lest the inside ski and leg interfere with the outside ski and leg. See **Closed Stance** for a discussion of the problems when skis are too close together.

See also **Matching**.

Coefficient of Drag

1. The coefficient of drag is a measure of an object's wind resistance. When a skier drops into the "egg" tuck position, the coefficient of drag decreases, allowing more speed.

2. Drag coefficient—the measure of a man's tendency to dress in women's clothing.

Cognition

Cognition refers to "knowing" and the ability to comprehend and understand and apply knowledge. Skiing involves many levels of cognition, from simple sensory perception and feedback (Visual-Auditory-Kinesthetic) to complex comprehension and reason. Judgement, choosing the most effective tactic or technical option, as well as the ability to ask "what if" (what if I hit an ice patch on that sharp curve ahead?), obviously plays an important role in performance and safety. Imagery and visualization contribute significantly to performance as well as learning.

Cognitive psychologist Benjamin Bloom (and colleagues) categorized levels of cognition according to the depth of understanding. Known as *Bloom's Taxonomy of the Cognitive Domain,* this list organizes levels of cognition on a scale building from the factual to the conceptual, from shallow knowledge (memorization) to profound understanding. The scale corresponds to the typical progression as we learn new knowledge, then gain an ever deeper understanding and ability to integrate that knowledge into our lives. (See **Bloom's Taxonomy of the Cognitive Domain**.)

Bloom's stages—*knowledge, comprehension, application, analysis, synthesis, evaluation*—represent objectives in education. In ski instruction, it is obviously not enough simply to tell students that they should "use *avalement* in bumps." If they remembered what we said, they would "know" it, but only at the most basic level. They would have a lot yet to learn. Few would even comprehend the meaning. Fewer still would be able to apply the movement at all, not to mention appropriately. The ski instructor's job involves helping students to acquire these more profound levels of cognition.

See also **Piaget, Jean**, whose studies of cognitive development and the growth of thought in children have great application in ski teaching.

Cognitive Domain

The cognitive domain is the realm of education concerned with developing knowledge and understanding—intellectual learning. Since the 1940's, educational theory has focused on three distinct "domains" of learning objectives. The *affective* domain concerns emotional objectives, while motor skills and the mental aspects of physical performance are the focus of the *psychomotor* domain.

Learning objectives of the cognitive domain involve not only learning more "stuff," but also developing higher *levels* of cognition, expanding the depth of understanding (see **Cognition** and **Bloom's Taxonomy of the Cognitive Domain**).

Cognitive Restructuring

Cognitive restructuring is a method for contending with the distracting and often destructive effects of negative self-talk. It is a way to develop more "positive thinking" and to deal with doubt.

The United States Ski Coaches Association (USSCA) describes four steps in the technique of cognitive restructuring:[27]

1. Identify harmful statements that you are saying to yourself.
2. Change the statements to more realistic and positive ones.
3. Practice each positive statement.
4. Evaluate and assess whether more positive statements than negative statements are being said.

Perhaps the most important point on this list is the first. Most of us are unaware of the extent of our damaging self-talk. It is not always obvious. Seemingly reasonable and objective thoughts, such as "I rotate in my left turns," are often better reworded in the past tense: "I have rotated . . .," or "I noticed that I rotated in my left turns on that run." These revised statements leave open the possibility that I may *not* rotate on *this* run! "I never have a good run on *Devil's Crotch.*" "I always fall when I hit a patch of ice." "I ski well on groomed, but I can't ski deep powder." Thoughts like these become self-fulfilling prophesies. Not one of them is true! They may be accurate observations about your skiing *in the past.* What has happened in the past may or may not happen again, but we certainly gain nothing by predicting failure. Recognize these types of limiting thoughts. They may stem from reality, but reword them to leave room for a breakthrough.

Colorado Skier Safety Act of 1979 By legislative decree in Colorado, skiers and other users of the slopes have distinct legal responsibilities, similar to drivers on the highway. This law effectively limits the liability of ski resorts in the event of user negligence. The Colorado Skier Safety Act of 1979 begins with a warning :

> **WARNING:** Under Colorado Law, a skier assumes the risk of any injury to person or property resulting from any of the inherent dangers and risks of skiing and may not recover from any ski area operator for any injury resulting from any of the inherent dangers and risks of skiing, including: changing weather conditions; existing and changing snow conditions; bare spots; rocks; stumps; trees; collisions with natural objects, man-made objects or other skiers; variations in terrain; and the failure of skiers to ski within their own abilities.

The Skier Safety Act decrees that

1. Each skier is responsible for knowing and skiing within the limits of his ability.
2. No skier involved in a collision with another skier in which an injury results shall leave the vicinity of the collision before giving his name and address to the ski patrol.
3. No skier shall use the ski slopes, trails, or lifts while his ability is impaired by alcohol or drugs.
4. Any person who violates any of these provisions is guilty of a Class 2 petty offense and upon conviction shall be punished by a fine of up to $300.00.

This law continues to be amended, to include snowboarders and other users of the “ski” slopes, and to address the changing legal climate. Other states have adopted similar legislation.

Comfort Christie Coined by Professor Franz Hoppichler of Austria’s renowned *Bündesportheim*, this term describes tuned down but still modern, advanced turns that could be made by older or less physically fit skiers. They are sort of “GS-Lite” turns—requiring all the skill but half the energy. World Cup champions might free-ski this way when they are tired, skiing excellent, efficient turns that are less athletically demanding than their normal high-energy race forms. Technically, the turns would involve a tall, comfortable stance and clean, non-rushed turn initiation as in any good turn, but less angulation and pressuring through the turn, allowing a little controlled skidding. Because of the gentle skidding and relaxed edging, the turn would generate less force than higher performance racing carves. The skier would maintain a taller stance and "banking" would predominate as the main edging move, taking advantage of skeletal strength.

Such turns are more than adequate for control and enjoyment at moderate speeds on groomed, uncrowded terrain. On the other hand, comfort christies might not provide the degree of control necessary for safety at higher speeds or on steeper or more crowded runs.

The late Professor Hoppichler criticized the ski instruction industry for demanding energetic racer-type skiing and thus turning away many potential students who lack the desire or physical ability to imitate the world's best. "We must have many christies in our pockets,"[28] he insisted, so that we will have something to offer the many types of people who might want to take lessons.

Comfort Zone The comfort zone is that state of mind in which a skier is relaxed and comfortable, and where optimal learning and peak performance occur. It is an individual thing—we all have a comfort zone, but one person's comfort zone may be another's sheer terror!

Many factors affect the comfort zone, including steepness, snow conditions, speed, width of trail, crowds, and the general attitude and mental makeup of the individual. Obviously the comfort zone enlarges as we gain experience and skill. But we must recognize when we approach its boundaries—its effects on performance and learning are profound.

To learn or practice a new skill, advanced skiers can always back off on speed, terrain, or conditions to find their comfort zones. Perhaps the biggest difficulty for beginners is that there *is* no comfort zone. If there is a slope, or if they are moving at all, many beginners are "out of the zone." Beginners afraid they can't stop will care little about the nuances of a good turn!

Because skiing in the comfort zone lacks the thrill and challenge of skiing "on the edge," many aggressive skiers spend little time in it. Unfortunately, these skiers usually practice only defensive movement patterns. Until they learn to enjoy spending some quality time on comfortable terrain, they are unlikely ever to experience expert skiing.

On the other hand, the reverse is also true. If we don't push the envelope occasionally, terminal intermediacy is all we can hope for. A good blend of focused practice well within the comfort zone, combined with occasional excursions on and over "the edge," will reward skiers with a disciplined but versatile technique, and bring out their athletic best. Explore new terrain, new conditions, new speeds. The mountain will teach you!

Comma Position

The comma position is the classic pose of the old Austrian technique of the 1950's. Austrians based their skiing on extreme countering and counter-rotation. "Like a comma" describes well the position of *reverse shoulder* with strong angulation predominantly in the hips.

Command Teaching Style

This term describes the most teacher-centered of the teaching styles. In command teaching style the teacher controls the entire experience through the use of specific instructions (commands). The teacher controls all variables, specifying what, where, when, and how. Feedback comes from the instructor and should be direct and immediate. Students have few, if any, options or decisions to make. The normal sequence of events is *explanation/demonstration* (by the teacher)—*execution* (by the student)—*feedback/evaluation/reinforcement* (by the teacher).

Command style is very common in teaching motor skills. This teaching style, while the simplest and least sophisticated, is useful when circumstances require precise control of the students. It is often appropriate for beginners who have minimal knowledge and are totally reliant upon the instructor for direction and feedback. At any level, command style is highly effective for teaching some simple movements or making specific changes. In the *Basic Practice Model* (see), command style is effective during the "lock-step" practice phase.

But command style teaching is limited. Because it is simple and direct, it is often overused. It is not the best way to inspire peak performance or to encourage creativity. Other styles give the students more control and choice, and often succeed with more independent, self-sufficient students. In the earlier less-humanistic days of ski instruction, command style was the predominant, if not exclusive, teaching style of many instructors. Creative instructors today mix and match teaching styles to circumstances and individuals to optimize learning.

See **Teaching Styles**.

Common Threads

In PSIA's Center Line™ Skiing Model, the "Common Threads" are the fundamental elements that are the basis of good ski turns at any level of skill—the distilled essence of great skiing. A "thread," by one definition, is "something continuous or drawn out, as a train of thought [or] a continuing element."[29] The Common Threads of skiing are these continuing elements that characterize good turns from beginner to expert. (Please note that I define "turning" quite narrowly—see **Turn**. Good skiing involves more than just good turns.)

It is central to the Center Line™ concept that important movement patterns and technical elements are essentially the same at all levels, differing only in speed and timing, refinement, accuracy, intensity, and range of motion. As we can trace the development of certain movements from a child's first steps through walking to running, we can also trace themes as skiers advance from their earliest shaky wedge turns to the solid arcs of Picabo Street and Alberto Tomba. Running is the same as walking—just faster.

> ***The Common Threads represent the distilled essence of great turns.***

There can be good and bad turns at all levels. Good wedge turns are embryonic versions of Tomba's carves, not some different type of "beginners' turns." All the same ingredients are there in wedge turns, blended in essentially the same way—they need only to grow and develop. It is these universal essences of good skiing that we call the Common Threads.

What are these essential elements? To find them, let's identify the common "signature" of all good skiing, and work backward from there. Look closely at the best, smoothest, fastest, most graceful and controlled skiers on the mountain. You will note five clear trends:

1. They are habitual turners—they almost never go straight. And their turns are deliberately shaped. Good skiing is offensive, not defensive—speed control comes from completing turns, not braking. Great skiers ski a "slow enough line" as fast as they can. All their actions are directed at controlling this line, not at controlling speed. They have brakes, but they use them only when they must. (Braking movements are not bad—they just aren't turns. They do not look or feel as good as turns, they involve more effort, and they are harder on the body. Braking is an important skill, but a bad habit.)
2. Their techniques are built on a foundation of balance in an athletic, biomechanically efficient, naturally aligned stance.
3. They ride "fast skis"—gliding, not skidding. Their skis almost always go the direction they are pointed or close to it; they rarely push them sideways or fish-tail. They glide at "terminal

velocity" on lines that reduce terminal velocity to a speed they can live with.

4. Their upper bodies are rock-stable and disciplined, while their legs are constantly active.
5. Their turns are smooth, round, and linked. Rotary, edging, and pressure control movements blend harmoniously to produce these sinuous, flowing turns.

Look again at these five points. What level skier do they describe? Experts, obviously. But every word rings equally true for beginners and intermediates, at least those fortunate enough to have learned from good instructors. At any level, good instructors strive to develop concepts and movements that will transfer directly to expert skiing. It is wrong to teach something a student will have to "unlearn" later.

From these five general points, we can now extract specific common threads of balance and stance, rotary, edging, and pressure control movements, and attitude, rhythm, and flow.

Essential elements of ***Stance*** *and* ***Balance***. Good skiing begins with a natural athletic stance that is fairly tall but flexed slightly, comfortable, and uncontrived—but "alert." This stance allows the optimal blend of skeletal and muscular efficiency. Feet and legs are spaced naturally, neither excessively wide nor forced together. Balance is on the whole foot, allowing the skier to use the whole ski; shins are "cuff-neutral," contacting but not leaning on the boot tongues. Upper body and hips are square or slightly countered to the skis, facing or anticipating the direction of travel. The upper body, arms, and poles are stable and disciplined, allowing unrestricted, active movements of the legs. Arms and poles aid balance and help direct the movements of the body. Upper and lower body share similar alignment—lines across both feet, knees, hips, shoulders, and hands tend to move always parallel to each other (see **Alignment**). With diverse physiques, individuals will show some stylistic variations, and there are some subtle but consistent differences between men and women, as well as children.

Essential elements of the ***Rotary*** *skill.* Rotary movements are the muscular actions that pivot the skis or control the direction they point. All along the Center Line™, the feet and legs steer both skis precisely throughout the turn, beneath a stable and disciplined upper body. The legs work independently, using the rotary mechanism known as "*fulcrum turning*" (better named "independent leg steering"). Harsh or extreme pivoting occurs only when a braking effect is needed (braking is not turning, and the mechanics contrast with the "common threads" in many ways.) In good turns, skis travel essentially forward, in the direction they are pointed. Rotary efforts, combined with edge and pressure control movements, are aimed at turning the ski tips *into* the turn, not pushing the tails out (which is braking). Rotary movements tend to be more active and muscular at lower levels (wedge turn, wedge christie). At higher levels (dynamic parallel), greater edging and pressure control skill, combined with larger forces in turns, allow the outside ski to bend or "decamber" into an arc which helps carve the turn. Regardless of the amount of muscular effort involved, though, the *movements* of the legs turning beneath the pelvis are essentially the same at every skill level. At all levels, active steering of the inside ski facilitates movements of the outside ski to help shape the turn.

Essential elements of the ***Edging*** *skill.* Edging movements complement rotary and pressure control movements to help the skier hold the line and shape the turn. The previous turn ends and a new turn begins as the downhill ski flattens, releasing its edge and allowing the skier to steer the ski tips downhill. The new outside ski rolls smoothly onto its inside edge (it is *not* pushed sideways to an edge), and the edge angle increases progressively through the turn, until it is released smoothly into the next turn. Edge angle, largely *determined* by movements of the center of mass (cross-over, inclination) and the angle of the slope, are *controlled* and fine-tuned through angulation in ankles, knees, and hips. At lower levels the progressive increase in edge angle occurs mostly passively, due to the changing angle of the hill relative to the skis and from a slight movement of the center of mass into the turn for balance. At higher levels, with increased speeds and steeper terrain, both of these factors intensify, and the skier also actively increases edging by creating angles in the hips, knees, and ankles. Flexion and extension movements permit the skier to create and reduce these angles.

Essential elements of the ***Pressure Control*** *skill.* Pressure on skis comes from the skier's weight and from resisting the forces of turns (the push of the snow on the skis). Pressure control movements involve regulating both the intensity and the location of pressure on the skis, and combine with rotary and edging movements to control turn shape. The skier's speed, as well as balancing, rotary, and edging movements all affect pressure. While deliberate movements of the center of mass (up/down, fore/aft, left/right) can control the location and intensity of pressure to an extent, most pressure results from the reaction force of the skis on the snow. In other words, we develop pressure not by pushing on the skis, but from the skis pushing on *us.*

On the Center Line™, accurate fore/aft movements, combined with turn dynamics, maintain balance over the whole foot. The same factors can move the contact point subtly forward or back along the ski (*"leverage"*) if required to further control the turn, but modern equipment has minimized the need for leverage in most turns.

The skier balances primarily on the outside ski, except in deep, soft conditions which demand more equal weighting. Pressure on the outside ski builds progressively and smoothly through the turn. In the transition from turn to turn the skier passes through *"neutral,"* when pressure is equal on both skis. This *weight transfer* results primarily from the dynamics of turning, combined with accurate movements of the skier's center of mass. The same phenomenon happens in a car driving an S-curve: weight moves to the outside tires in each turn, passing through neutral in the transition; driving a curvy road down a hill would intensify this effect. Like the driver of a car, the skier needs only to allow the laws of physics to apply, although movements to transfer weight become increasingly active as skill increases, resulting in an earlier and more complete commitment to the outside ski in each turn. Still, it is far more accurate to say that turns cause weight transfer, than to say that weight transfer causes turns.

Flexion (bending) movements are progressive through the middle and latter portions of most turns. Flexing allows angulation in the hips, knees, and ankles, which facilitates edging and causes pressure to develop on the outside ski as it resists the forces of the turn. Extension movements straighten these angles, reducing edge angle and releasing pressure to finish the turn and allowing a smooth transition into the next turn (by crossing over and guiding the ski tips down the hill). Like shock absorbers, flexion and extension movements also allow control of momentary changes in pressure, especially obvious in moguls. As speeds and skill level increase, forces intensify. The skier increasingly uses these forces to create pressure and bend the skis, helping to carve turns.

Essential elements of ***Attitude****,* ***Rhythm****, and* ***Flow****.* Good turns are offensive in nature, not defensive. A turn represents a "go" thought, not an attempt to slow down (good turns arise from the desire to "go that way," not to "stop going this way"). Speed control results from turn shape and completion—from direction not friction, from gliding on a slow line rather than braking on a fast line. Braking occurs whenever necessary, but only when necessary.

Good turns are rounded and linked, with a continuous, smooth flow of the center of mass from turn to turn. Movements are cyclic, progressive, rhythmic, and continuous—not "stop-and-go" or jerky. Turns are linked by flowing through a moment of *"neutral"* in the transition, analogous to the moment in an "S-turn" when a car's wheels point straight ahead. At this moment, the skier feels no centrifugal force, and there is no inclination, no lead, equal weight on both skis, and the edges release. Release of the edge of the downhill ski at turn initiation (a "moving platform") and guidance of the new inside ski enhance the smooth flow of the center of mass from turn to turn. Movements of arms and poles, analogous to arm movements in walking, running, skating, and most other sports, enhance and complement flow, timing, and rhythm. These movements, like most others, become increasingly active and refined as speeds and skills increase.

The Common Threads of the Center Line™

Stance & Balance

- natural athletic stance—relaxed and uncontrived, but "alert"
- tall, but slightly flexed—skeletally strong, but "functional tension" in muscles
- natural spacing between feet
- neutral fore/aft
- arms spread naturally; hands elbow-width or wider; elbows in front of spine
- legs continuously active beneath a stable, disciplined upper body
- upper body square to slightly countered to direction of travel
- *alignment*—inside half of body leads through turn; lines across shoulders, hips, hands, knees, and feet roughly parallel to each other and to the slope

Rotary

- *Both* skis steered through turn with feet and legs
- primary rotary mechanism is *independent leg steering* ("fulcrum mechanism"); other mechanisms may assist
- active inside leg steering facilitates movements of the outside ski and helps shape turn
- rotary movements direct ski *tips into* the turn, *vs.* pivoting or pushing tails *out*
- right ski leads when skis are steered right and vice-versa, with no lead during "neutral" moment at transition

Edging

- *release* of edge ("neutral") from previous turn marks beginning of new turn
- edge angle *increases* smoothly and progressively throughout turn
- angle *reduces* to end turn, *releases* to begin next turn
- edge angle largely *determined* by movements of CM ("inclination" and "crossover"); angle *adjusted* through angulation in ankles, knees, and hips

Pressure Control

- accurate fore/aft movements of the CM maintain pressure on the whole foot
- lateral CM movements combine with turn dynamics to put pressure predominantly on the *outside* ski
- weight transfer is smooth, flowing through "neutral" in turn transition as CM crosses over
- flexion-extension movements help regulate pressure and absorb sudden changes (as in moguls)
- pressure builds on the outside ski progressively through the turn, due to turn dynamics, then reduces as the turn ends

"Attitude," Rhythm, and Flow

- Center Line™ turns are *offensive*; intent is to control *line,* not speed (directly)
- speed control from choice of line, not use of brakes
- while not necessarily highly carved, turns are never *intentionally* skidded
- turns are smooth, rounded, and seamlessly linked; movements are cyclic and rhythmic
- CM flows smoothly from turn to turn
- arms and poles, while disciplined, help maintain and direct the flow of movement
- *neutral*—turns are linked by flowing through "neutral" in the transition (no inclination, edges release, no lead, equal weight)

These Common Threads characterize skiing in the "center" of our Center Line™ skiing model. Each Center Line™ Milestone (wedge turn, wedge christie, open stance parallel, and dynamic parallel) embodies these same themes at a different skill level, speed, and steepness of hill. But these patterns are not the only movements available to skiers. They are not even the only good movements—good skiers can blend skills many other ways. Stronger pivoting, pushing the tails out, harsher edging, movements that block the flow of the center of mass—these non-Center Line™ moves have their uses, primarily to brake and slow the skier. Braking movements are important in the right tactical situations—they're just lousy turns. Some snow conditions require slight modification to some technical elements. Deep powder, for example, necessitates a more equal weight distribution on the skis than firmer conditions. But good skiing is primarily good turning, and good turns involve these common threads at every level, from neophyte to World Cup elite.

See also **Center Line™**, **Center Line™ Milestones**.

Communication Styles

We communicate in a variety of ways, both verbally and nonverbally, and receive and process information through each of our physical senses. The topic of communication styles includes the verbal-nonverbal distinction and the concept of "VAK"—visual, auditory, and kinesthetic sensory preferences.

Verbal-Nonverbal Communication. We communicate not only with our mouths, using words, but also with our eyes, facial expressions, hands, posture, and other body language. Nonverbal communication can be conscious or subconscious. A good instructor is sensitive to as many clues and cues as possible from students regarding their wants, needs, moods, fears, and states of mind. We should also use the most effective means to communicate our thoughts and intentions to our students. And we must be aware of our own body language to avoid communicating the wrong ideas. In many ways, nonverbal communication is more important than verbal communication. With words, we convey mostly facts and sequences of events (and perhaps lies). Nonverbally, we communicate emotion, trust, concern, acceptance, approval, and disapproval, as well as whole, complex physical movement and imagery.

> ***"Don't* SAY *things. What you* ARE *stands over you the while and thunders so that I cannot hear what you say to the contrary."***
>
> ***—Ralph Waldo Emerson, Letters and Social Aims***

VAK Sensory Preferences. VAK ("Visual-Auditory-Kinesthetic") refers to the various senses through which we send and receive information, and the idea that most of us develop a preference for one over the others. Most of the information we receive about movement comes through three main channels: our eyes (Visual), our ears (Auditory) and our sense of feeling or touch (Kinesthetic). There are sensors within our bodies, especially in muscles, tendons, and joints, that tell us what positions we are in and what movements we are making—I can feel where my feet are and what they are doing; I know without looking when my knees are bent or straight. In skiing, these *proprioceptors* are critical to our ability to learn and perform. Some people prefer the expression "Visual-Auditory-Proprioceptive" (VAP) over VAK, but the inference is the same.

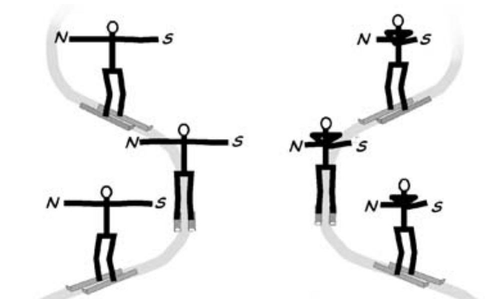
In any event, it seems that most people have a preferred mode—some of us are most attuned to what we see, some learn more from what we hear, and others are most responsive to what we feel. And often the sense we rely on to receive information is the one we prefer to communicate through when teaching. What does this mean to a ski instructor? An "auditory" ski instructor could stand and talk all day, but if the students are "visual" people they would learn little—until the instructor actually demonstrates what he's talking about. With other students, understanding may not come through talking or showing—they might need direct kinesthetic communication. Physically moving their bodies the way we want so they can feel the movement may succeed where a thousand words have failed. Kinesthetically-oriented students may also respond well to vivid descriptions of how a movement feels, or analogies and references to familiar sensations and movements.

Few of us are completely specialized, but most of us probably have a bias for one type of communication. As teachers it is invaluable to determine and communicate through our students' preferred modes. We also increase our students' chances of success by making sure that we communicate as many ways as possible. If we demonstrate as we talk, speak with vivid imagery, and describe not only what we want to *do*, but what it should *look* like, and what it should *feel* like, we cover all the bases.

We must not get too carried away with our knowledge of communication styles, though. Effective use of communication styles is important. But ultimately, *skiing is a kinesthetic experience.* As teachers we often need to communicate a thought or idea, teach students to do a specific exercise or make a particular movement, or give feedback. Masterful use of VAK principles and attention to students' individual learning styles is effective here. But once we get our point across, they must *do* it, over and over and over and over. Whether a "thinker," "watcher," "feeler," or "doer," and no matter which sensory channel they prefer, no one really learns to ski simply by thinking about it, reading about it, or watching it done. Real athletic performance and improvement demands real practice and a high level of kinesthetic/proprioceptive awareness.

See also the closely related concept of **Learning Styles**.

Compass Drill The "compass drill" is a variation on a popular theme, used to develop a stable upper body and create independence between the upper and lower body. Here's how it works: Imagine a trail that runs west. Point your left arm due south and your right arm north. Now straighten your arms and turn your torso straight ahead (downhill), as if you were the rope in a tug-of-war. Now ski, but like the needle of a compass, your arms and torso must continue to point north and south at all times, no matter which way you're going or which direction your skis point. The skis and legs should turn beneath an unmoving upper body.



Compass Drill

Crossed-Compass Drill

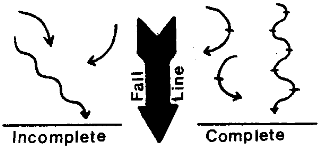
I usually prefer this exercise over the popular drill of holding the poles horizontally in front, facing downhill, or most other variations. It seems to enhance the awareness that the inside hand leads through a turn. It accentuates the countering of the upper body (it exaggerates it), whereas I tend to focus more on just "facing downhill" with some other exercises. The very wide arm stance also helps stabilize the torso, and makes any movement of the upper body more obvious.

Remember—as with any exercise, this one is not perfect. It is a great habit breaker for those who rotate, and it can help discipline the upper body and activate the legs, but it exaggerates the countering of the upper body. In real skiing, while legs do turn beneath the upper body, the upper body does *not* face straight downhill all the time. Think of a car—turn the steering wheel without moving forward. The wheels turn, while the car does not. But drive forward with those wheels turned, and now the car *does* turn. The same should happen on skis. The upper body should follow the skis, and the degree of countering should relate to the tightness of the turn (again, think of the car).

If you have mastered the compass drill, try the next level: the "*crossed* compass drill." Still on the west facing trail, now cross your arms and point your *right* arm south and your left arm north. Without the stabilizing effect of widely spread arms, it is far more difficult to avoid rotating the upper body. Practice!

Complete Turn

This is a term with two related meanings. First, a complete turn is any turn that crosses the fall line. A complete left turn, for example, begins facing the right side of the trail, turns downhill (through the fall line), and ends facing the left side of the trail.



Complete turns are turns that cross the fall line.

We also speak of "completing turns" to control speed. This means steering the skis far enough around the arc that the direction of travel naturally slows the skier, perhaps even skiing back up the hill a bit. Completed turns prevent the need to use the skis as brakes. They are the key to good skiing!

How do we know when a turn is complete? If you don't want to brake to control speed, you must ski each turn far enough around that you lose the speed gained earlier in the turn. Every time you start a new turn down the hill, you will gain speed. Therefore, the desire to gain speed is an essential pre-requisite to any good turn. (Think about that—most people think turns are supposed to slow them down!) So a turn is complete, and it's time to start a new one, the moment you want to go faster—and not a moment sooner.

Completion Phase

As defined in *ATM Teaching Concepts,*[30] the completion phase is the fourth and final phase of a turn, during which the skier must stop the turning of the skis and eliminate any rotational ("angular") momentum developed in the turn. If linking turns, the completion phase also becomes the preparation phase of the next turn. (Charles Choi of the Ski School at Keystone has a great term for this linking phase—he calls it "Finishiation.")

Completing a "Center Line™" turn is easy. Simply stop actively steering the skis while rising to reduce edge angle and pressure (and if linking turns, crossing the CM over the skis and into the new turn). For other more defensive turns, especially those involving rotation or rotary pushoff, the skier may have excess rotary momentum (angular momentum) to deal with—he is "spinning out." This skier may need to *increase* edging and tail pressure, sinking to an edgeset or brushing the downhill ski out to a downstem. This edgeset stops the turn and sets a stationary platform to prepare for the next turn.

See **Preparation Phase**, **Initiation Phase**, and **Control Phase**. Also **Rotary Momentum**, and **Over-** and **Under-Initiation**.

> ***T**rying and Relaxing are opposites, yet how often do we hear the dubious advice, "Try to relax"?*

Concentration

Concentration is the essential ability to focus on the task at hand, despite distractions. When you truly concentrate, you become so absorbed in the object of your focus that you don't realize you are concentrating. It comes without effort, without the need to say to yourself "concentrate." Often called "relaxed concentration," this state is necessary for peak performance. It is entirely different from "trying to concentrate." Indeed, usually the harder I try, the more this state of mind eludes me. It is futile to "try to relax," yet how many times have you heard (or given?) this advice? The effective instructor must learn to talk, coax, trick, push, or pull a student into the proper state of concentration.

See also **Focus**.

Conservation of Momentum, Law of

Closely related to Newton's First Law of Motion, the Law of Conservation of Momentum states that *the total momentum of a system (group) of objects will not change unless an external force is applied to the system*. If no external force applies, any change in motion of one part of the system must be countered by an opposing movement of another part. The law applies to both linear motion and rotational motion ("angular momentum").

Since a skier is actually a "system" of separately moving parts—upper and lower body, arms, legs, skis, and so on—this law applies. It is particularly applicable in understanding the rotary mechanism we call *rotation*. Rotation begins with a turning of the upper body, arms, or hips. When the skier stops this rotation, the momentum of the "system" cannot change, so it transfers to the lower body, turning the skis. Of course, the initial rotation of the upper body must have involved a force from outside the system. This force came from the snow, resisting the muscular force of the skier. A skier hurtling through space, with no contact with other objects (external forces), cannot use rotation to throw himself into a spin, no matter how he twists and turns and swings his arms around. Nor can he change the speed or direction of his motion.

The Law of Conservation of Momentum also explains the mechanism of *counter-rotation*. Muscular force alone can move a part of the "ski-skier system" relative to other parts, but it cannot change the momentum of the whole system unless it interacts with an external force. When a skier twists his or her skis one direction, with no external force involved, some other part of the "system" must turn the other direction to counter the motion. The upper body rotates opposite the feet, keeping the total momentum of the ski-skier system constant.

This law is absolute—there are no exceptions. Understanding it simplifies movement analysis by helping us sort out cause-and-effect relationships. It explains some movements as consequences of others. And knowing that any change in the skier's motion must involve some external force, complex movement analysis often reduces simply to a search for that force. What force *caused* that motion? The skier spun out of control—why? Answers to these types of questions solve most problems of movement analysis.

Contact Point

See **Point of Contact**.

Control

"Control" is a state of mind, and a basic human need. If I feel in control, I am in my "comfort zone."

Control, for a beginner, means "I can stop right here, right now." For the expert, the definition broadens to allow the controlled freefall that is expert skiing, in which the skier no longer fights to overpower and "control" gravity and the mountain, but blends with them. Expert skiers at speed can rarely stop "right here, right now." Because of this, they may have to hike a ways back up the hill to get that hat that blew off. Yet few would argue that these skiers are out of control (the Ski Patrol notwithstanding).

What, exactly, do skis control? "Control" is not specific, is it? My car has controls that make it go faster, that steer it, that turn on the headlights, or adjust the seat backs. Which control I use obviously depends on what I'm trying to control. It is the same with skis. Most people use their skis to control speed, directly scraping it away with their edges. Performance skiing, though, demands that we use the skis to control *line*, not speed (except in emergencies). This concept is perhaps the most important difference between experts (and those destined to become experts) and everyone else.

"Turns control speed"—the most limiting thought in skiing!

Why do most people think of skis (and turns) as a way to control speed? Imagine it is your first day on skis. They are slippery, awkward, frightening in a way, because you feel out of "control." Soon you learn to make a wedge. You hear those edges scrape against the snow. Finally your feet stick to the earth again, and you are able to come to a stop. You feel "control." Somewhere deep in your mind, an equation forms: "edges scraping sideways equals control." You like it, so naturally you practice and get better at "it." Soon you can make a hockey stop. "More scraping equals more control!" You can ski steeper and steeper runs. You can ski faster and faster, because you have more "control."

But control of what? As we know, the more skis (or cars) skid, the less control they have of their line. If good skiing means good turning, you now have to backtrack, because all you've really gotten good at is braking—at the *expense* of turning!

Where did you go wrong? Day one. "Scraping equals control," which evolved to "turning controls speed," is the most performance-destroying thought in all of skiing. The secret of good skiing is to remember that *gliding and controlling line equals control*. Scraping equals braking, another kind of control that we use only when we have to. Experts feel a loss of control in proportion to the amount their skis skid. Most skiers feel out of control if their skis *don't* skid ("no scraping equals no control").

This discussion may seem like a paradox. "Turns control speed," you may say, "everyone knows that." I prefer to think of it as a paradigm shift. Slow lines control speed. *Turns control line*. If we ski a slow enough line, by making good, complete turns, we never need to control speed!

As skiers, if better turns are what we want, we must banish the notion that we make them to control speed. As instructors, we must never (NEVER!) instill in our students the idea that "scraping equals control." It slows you down, sure, but braking is the coarsest form of control, and a dangerously false promise.

Control Phase The control phase is the third of the four phases of a turn as described in *ATM Teaching Concepts*.[31] It is the middle of the turn, the part when the skis point downhill and pass "through the fall line." In the control phase the skier adjusts for over- or under-initiation (too much or too little rotational momentum) and guides the skis through the desired arc. In this phase, the skier will blend all available skills of rotary, edging, and pressure control, to steer the desired line. Rotary activity generally consists of subtle steering, as opposed to violent pivoting or the more powerful rotary movements that may have been used to get the turn started. Pressure and edge angle generally both increase progressively through this phase. Ironically, it is the *completion* phase, not the control phase, that controls speed, as the skier turns back across, or even up, the hill!

In most good skiing, the control phase is the longest phase of the turn. For many skiers, though, this phase does not even exist as they rush from traverse to traverse—perhaps the most distinguishing difference between "good" skiing and all the rest.

See also **Preparation Phase**, **Initiation Phase**, **Completion Phase**, **Over-Initiation**, **Under-Initiation**, and **Rotary Momentum**.

Converging Step

A converging step is a turn initiation in which the new turning (uphill) ski is displaced (stepped) into a converging or "wedge" orientation with the old ski before weight is transferred to it. The converging step implies a move directly from the inside edge of the old turning ski to the inside edge of the new ski. This step creates a very quick direction change. Rare in free skiing, racers occasionally use a converging step in certain situations. It is useful when gates are not greatly offset. But even racers use steps, converging or otherwise, much less often today than they did a few seasons back.

Converging steps are also known as *stem-steps*, alluding to the converging skis of all stems. But this is a confusing term because, strictly and traditionally speaking, a stem and a step are mutually exclusive. Both terms imply displacing a ski, but a stem is brushed along the snow while a step is lifted off the snow. Still, converging steps are very similar to "stem christies," involving the same mechanics at different speeds and levels of skill.

See also **Inside-Inside Move**.

Coral

"Coral" is an obnoxious snow condition commonly found in late spring on cold mornings. When the sun burns hot, snow turns to slush and gets chopped up by skiers. Then a clear, cold night freezes the slush solid, preserving every little chunk, sharp edge, and rut. It is indeed the rough texture of a coral reef. It grabs your ski edges, and throws skis around mercilessly. The only reasonable tactic for skiing coral is to make sure your skis go the direction they're pointed, not sideways, as much as possible, and sometimes to keep them in the air, with quick, jabbing edgesets. Carve; don't brake! It hurts to fall in coral! As the day warms up, the coral will soften. But first thing in the morning, it is a condition to avoid, unless you really want to prove something.

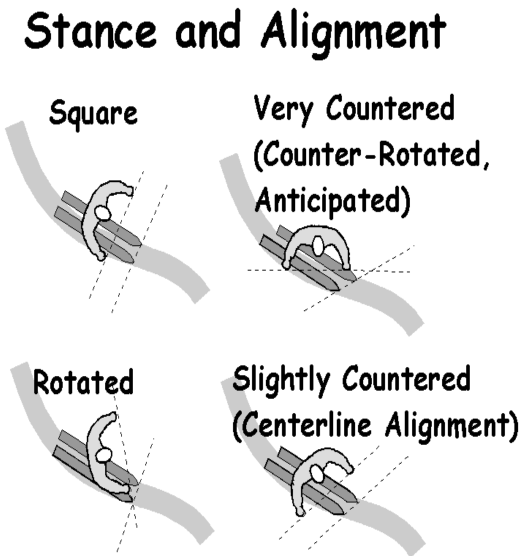
Corduroy

Another snow condition, corduroy represents the other end of the challenge spectrum from *coral*, above. Corduroy describes the small, soft, evenly spaced ridges left behind by the grooming equipment. It is the sign of freshly groomed snow. Firm but consistently grippy, with few surprises, corduroy is the most "user friendly" of all snow conditions.

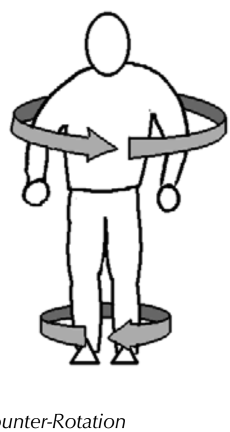
Of course, being so forgiving, groomed corduroy lets skiers get away with all manner of errors. It is a two-edged sword. The easiest of all conditions to learn on, corduroy also encourages bad habits that may not surface until a little powder falls or the skier ventures beyond the groomed. Other conditions are more "honest"—they will let you know when you aren't skiing right!

Corn Snow Corn snow is a wonderful feature of spring skiing. It is deep slush, frozen into individual kernels with the smooth texture of dried corn. It often occurs when the sun softens the rock-hard frozen "coral" (see above) after a cold night. While heavy, corn snow is easy and fun to ski. Like most conditions, it is much more fun—and less work—if the skis slice forward through it rather than plowing sideways.

Counter-Rotated Position A counter-rotated position is one in which the upper body and the lower body are twisted in opposite directions. Often the result of *counter-rotation,* do not confuse the counter-rotated *position* with this important *rotary mechanism,* which produces a twisting force (*torque)* on the skis. A counter-rotated position is a static concept. It does not produce torque, until the skier unwinds or counter-rotates the other way. It is also known as *anticipated position*.



Counter-Rotation Counter-rotation is the *rotary mechanism* in which the upper and lower body rotate in opposite directions simultaneously around roughly the same (longitudinal) axis, causing torque (rotary force) to apply briefly to the skis. The principle involved is Newton's Third Law of Motion—the law of equal and opposite reactions. If I force something (my upper body) to turn clockwise, something else (my lower body and skis) must receive an equal but opposite (counterclockwise) torque. If one were to stand on a free-spinning barstool and do



Counter-Rotation

"the Twist," he would turn the stool left and right using the principle of counter-rotation.

Counter-rotation does not require ski-snow contact, nor will a pole plant help the mechanism (as it could with *anticipation-release*). Counter-rotation takes place entirely within the ski/skier system, requiring no interaction with external forces; it can be done while sailing through the air or floating through space. Because it is entirely internal, unlike some rotary mechanisms (*rotation*, *rotary pushoff*), counter-rotation provides a fleeting twisting force to the *skis* only; it does not affect rotary momentum of the whole ski/skier system (because the opposing forces cancel). In other words, back on the barstool, once I twist and turn the stool to the left, say, then stop moving, I will not continue to spin around and around.

Counter-rotation is often the turn initiating mechanism for skiers who lean back on their ski tails. Because of the lack of rotary momentum generated, these skiers typically make Z-shaped turns linked by traverses—they turn their skis quickly, then go straight, unable to steer their skis through an arc. In contemporary high-level skiing, this mechanism is rarely the primary turn initiating move, except in emergency situations.

See also **Rotary Mechanisms**, **Vissage** (synonymous), and **Rotation**.

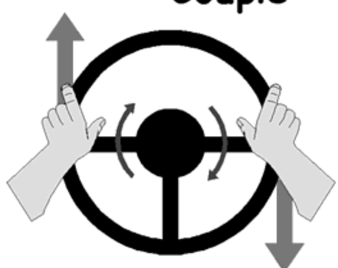
Countering To counter means "to oppose," or "to go the opposite way." Countering usually refers to the relationship of the upper and lower body, turned in opposite directions (see *counter-rotated position*). The old "reverse-shoulder" Austrian Technique of the 1950's involved extreme countering of the torso. Today's skiing usually shows countering to a more subdued degree. When traversing or turning, it is natural that the uphill or inside ski will lead the other slightly. In contemporary skiing, the rest of the body mimics this lead—the uphill knee, hip, and shoulder all lead by the same degree. Because the uphill shoulder is ahead, the upper body faces slightly downhill of the direction the skis point—it is *slightly countered* to the lower body.

Countering can produce several effects. In the slightly countered stance described above, there is no twisting tension between the upper and lower body—it is a relaxed, natural stance which promotes precise leg steering and allows the skier to create angles in knees as well as hips. In some turns, notably short, fall-line oriented turns, the upper body faces directly downhill as the lower body turns. This results in a more strongly countered, twisted relationship of the upper and lower body. There is tension in this position—the lower body is literally wound up like a spring against the upper body. The release of this tension causes a recoil effect which helps turn the skis powerfully into the next turn (see *anticipation-release*). These days it makes sense to say "countered" when referring to a natural, tension-free alignment of the upper body, and to use the expression "anticipated position" or simply "twisted" to refer to the coiled spring of the more extreme stance.

While we speak of countering between the upper and lower body, what happens in the hips and pelvis is highly significant. The pelvis can act more as part of the upper body or of the lower body, or it can play an intermediary role. Because most good skiing today involves steering of the legs and feet in and below the hip sockets, the hips tend to act as part of the stable upper body.

Too much countering of the hips, which can result from excessive leading of the inside ski, restricts the ability to use knee angulation and the ability to steer the outside ski. Both of these actions involve rotation in the hip socket; too much hip countering simply uses up the available rotation. On the other hand, hips too square over the skis cause the opposite problem—this stance makes it difficult to create hip angles. Skiers who rotate their upper bodies or remain too square tend to rely on extreme—and biomechanically weak—knee angles, because their hips stay over their skis. So efficient skiing demands that we maintain just the right amount of countering to allow maximum movement options and to keep us in a biomechanically strong stance.

Couple



Hands create equal forces in opposite directions, producing torque, to turn the wheel.

Couple Also known as a "steering couple," in mechanics a couple describes two equal and opposite forces acting on an object, but not in a straight line. Like two hands on opposite sides of a steering wheel, couples produce *torque*, turning or twisting the object.

Courage "Courage," said Mark Twain (Samuel Clemens), "is resistance to fear, mastery of fear—not absence of fear." Skiing provides the perfect opportunity to learn courage. Fear keeps us alive in this sport. Only fools lack it. But without courage, fear can also devastate performance. Courage—mastery of fear—is what allows us to play with the mountain, when we know it is more powerful than we are. Courage turns the gravity and speed that most skiers fight against into a toy great skiers play *with*.

> *"Courage is resistance to fear, mastery of fear—not absence of fear."*
> *—Mark Twain*

Courage is also necessary to learn and to continue learning, especially for adults. The hardest part about learning to ski for many adults is to allow themselves to be beginners again. Most adults have become very good at many things, and it may have been a long time since they were novices. Fear—not so much of injury or death, but of failure and embarrassment—prevents many adults from succeeding at, or even attempting, skiing. Learning takes guts!

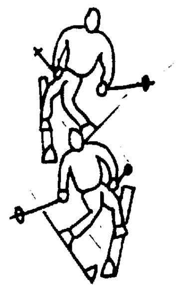
Skiing well demands courage. But facing skiing's challenges also *develops* courage. And that courage transfers to everything else we do.

See **Fear**.

Crabwalk

The crabwalk is an exercise in which the skier strongly edges first one ski then the other while in a wedge, attempting to eliminate any sideslip of the edged ski, and resulting in a "zig-zag" path. It is a great exercise for developing edging, angulation, and independent leg action, as well as creating a feel for the ski's carving effect and for independence of the upper and lower body.

As part of a progression, crabwalks are a good way to practice the edgeset, steering skills, and body positioning needed in dynamic short-swing turns. The edgeset should result from quick "down-up" movements, along with knee angulation. Make sure the skis are not pushed to an edge—there should be no skidding. After developing a rhythm, add a pole swing, then a little more speed. Finally hop from edged ski to edged ski, with no slippage. The sensations and movements are nearly identical to those of classic slalom turns.



Crabwalk

Cramponnage

Cramponnage is a historical term referring to finishing a turn with pressure on the uphill edge of the uphill (inside) ski, as a way to cut a line closer to the race gate. This movement was a mechanical predecessor to modern scissor-step and "diverging parallel" turns. Ironically the move has perhaps more validity now than ever. Today's flexible "rapid gates" allow skiers to go right through them with their bodies while only their skis pass outside the gates. Some weight on the inside ski actually allows the body to move farther inside and take an even shorter line.

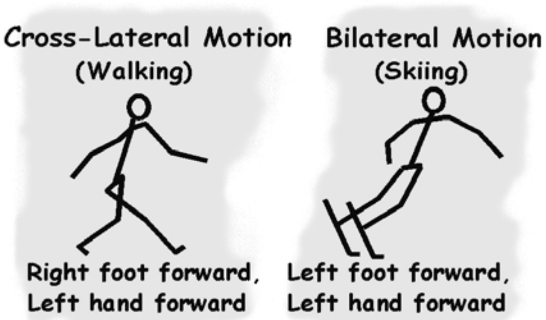
When I asked a fellow instructor what he thought this term meant, he replied "it's some crampon move thing that makes you grip better." Whatever, this Georges Joubertian term is probably one we can do without. Take two Midols and go to bed.

Cross-Blocking

"Cross-blocking" means clearing race gates out of the way with the outside arm, knocking it down in front of you. It only works with today's flexible, hinged "rapid gates."

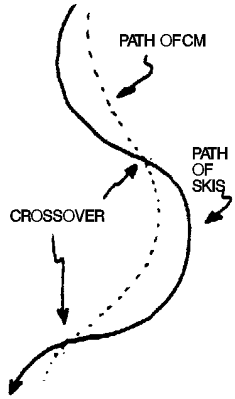
Early ski races involved trees and other immovable objects the skiers had to turn around. When bamboo poles replaced trees, skiers could go a little closer to them and clear them out of the way with their inside arms. Now, with "rapid gates," racers wearing plastic armor go right through them, cross-blocking, hitting them with their shins, getting only their skis around them. I regret this evolution, because racing has become much more artificial. Race techniques resemble less and less the techniques needed to negotiate "real" ski runs. The ski patrol, of course, frowns upon cross-blocking slower skiers, and shinning a Colorado blue spruce is generally bad tactics!

Cross-Lateral Motion Cross-lateral motion describes the common movement pattern of walking and running, in which the opposite arm swings forward with each footstep. An example of *negative transfer,* cross-lateral motion is the opposite of skiing's typical movement pattern—"bilateral motion." In skiing, if the right ski leads (in a right turn or traverse), so should the right hand and shoulder. Our tendency toward cross-lateral motion can cause problems when learning to ski, particularly upper body rotation and poor alignment.



Cross-Over (Cross-Under) Because we must lean in (*incline*) to counter the forces of a turn for balance, the center of mass moves from the inside of one turn to the inside of the next, taking a shorter line down the hill than the feet. Thus either the CM must cross over the skis or the skis must cross under the CM, or both. Every good, dynamic turn begins with a "fall" into the turn, before the skis come around and catch the skier. During the crossover, the skis and the skier (CM) move in different directions (a bad trend?). It takes faith that the skis will come back underneath the body, but a smoothly carved turn requires patience during this phase as the skier inclines into the new turn. It is in the crossover that the skier's feet move out away from the body (or the body moves inside the arc of the feet). Many skiers are reluctant to make this "falling" move to initiate a turn, but if crossover does not occur, the only option remaining is to push their feet sideways from underneath them, causing skidding.

The difference may be somewhat of an illusion, but in longer radius turns the move feels more like a cross*over*, while in shortswing, the skis cross back-and-forth *under* the body.

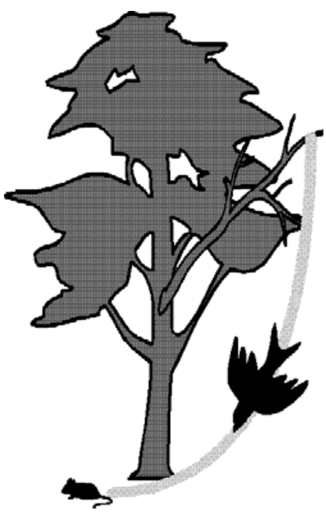


Crud Many softer snow conditions ranging from mildly challenging to truly obnoxious fall into the category of "crud." Unlike light, fresh powder snow, crud is usually heavier and inconsistent. Usually it has been skied some, tracked up and pushed into uneven piles. Often it is older, wet, windblown, or frozen and thawed, and it may have a light, breakable crust.

Skiing crud well demands a solid, strong technique. Keeping the skis going the direction they're pointed is essential (they won't go sideways)—so a technique based on skidded braking movements just won't work. If the crud is not too difficult, powerful skiers may be able to muscle skidded turns with strong upper-body rotation, but truly efficient crud skiing demands the carved turn. A slightly lower-than-normal stance adds power and stability, while increased "up-and-down" movements can help unweight the skis for easier turn initiation. Shorter radius turns are a good tactic, because the inconsistent snow makes balance difficult to maintain through longer turns. Simultaneous leg movements usually work better than sequential movements (stems and steps) because the uneven snow makes an unreliable platform to step from.

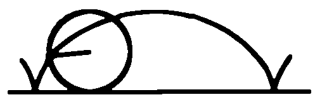
Cycloid A cycloid is the curve traced by a point on the edge of a circle as it rolls along a flat surface. When the point is farthest from the flat surface, its path approaches a straight line. As the "wheel" rolls and the point nears the surface, the curve steadily tightens.

The cycloid curve has some interesting properties. The fastest (not shortest) route from its



Cycloid—the fastest route!

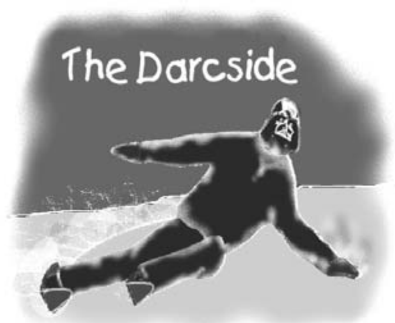
perch on a branch to its target on the ground, it is typically the path of a bird of prey swooping down to capture a meal. And the cycloid is theoretically the fastest path around a ski race gate.



The Cycloid Curve

D

Darcside Today's new "hourglass" shaped deep-sidecut skis give experts the ability to carve outrageously tight turns with extreme edge angle. The intense forces require the entire body to incline so far into the turn that skiers nearly lie on the snow. Coined "darcsides," these extreme-carved turns violate some common technical beliefs (*i.e.* "keep the shoulders level; don't bank"). Typically done without poles, on short skis with maximum sidecut and elevated bindings to prevent "*boot-out,*" darcside turns enter a new universe of skiing, somewhere between traditional skiing and snowboarding. They *are* fun. Break a few rules and come on over to the Darcside!



Playing with the Force!

Death Cookies "Death cookies" describes a snow condition consisting of loose, frozen chunks of crusty, icy snow, typically golf-ball-to-soccer-ball sized. Avalanche debris, chopped up spring frozen crud, and wet snow quick-frozen by afternoon shadows and plummeting temperatures, can all cause death cookies. The heavy chunks grab edges and throw skis around unpredictably, so good technique (skis going the direction they're pointed) is a must for surviving death cookies. The condition gets its name from what it does skiers who try to skid turns in it.

Decamber To decamber a ski is to bend it into an arc that will carve a turn. *Camber* is the built-in arch of the ski along its base, like the arch of a foot. When we tip the ski onto its edge and pressure it in the center, we press that curve into *reverse camber*, thus *decambering* the ski. Decambering a ski also stores energy in the ski, like a spring. When the pressure stops, the ski snaps back to its original shape, releasing the stored energy.

See illustration at **Reverse Camber**.

Deceleration Commonly, deceleration means "slowing down." Technically, deceleration is "negative acceleration." Accelerating (going faster), changing direction (turning), and decelerating are all technically forms of acceleration. They are the result of an external applied force, and differ only in the direction in which the force acts.

See **Acceleration**.

Defensive Skiing Defensive skiing is skiing characterized by braking movements—harsh rotary movements, abrupt edging movements, reluctance to release the edge of the downhill ski to start a new turn, poor turn shape (skidded corners as opposed to arcs) from a tendency to rush through the fall line phase of the turn, and disruptive flow of the center of mass. *Offensive* skiing describes gliding, efficient skiing without braking. Speed control comes from the skier's line and completed turns. Defensive skiing involves "speed control from friction"; offensive skiing involves "speed control from direction."

> ***Defensive skiing is speed control from FRICTION; offensive skiing is speed control from DIRECTION.***

Defensive skiing is not necessarily slow. With imprecise control of line, it can in fact be recklessly fast. It is the skiing of both the timid novice and the aggressive bump basher.

Movement patterns of defensive skiing can fall either "right" or "left" of the Center Line™. On the right ("rotary bias") side are the gross simultaneous leg twisting and pivoting movements that result in sloppy, flat-ski skids. On the left ("edge-pressure bias") are strong edging, checking, sequential leg movements, stationary platforms, hard blocking pole plants, and rotary pushoff or pronounced rebound turn initiations.

Unfortunately, the majority of skiers ski defensively, especially those who are mostly self-taught and those who spend nearly all their ski-time on slopes that challenge them. These skiers rarely feel comfortable letting their skis run. They may be able to ski any run on the mountain, but they lack the effortlessness and grace of true experts. They have become very good at putting the brakes on. Improvement demands that they learn to take the brakes off and control speed by completing their turns and choosing "slower" lines.

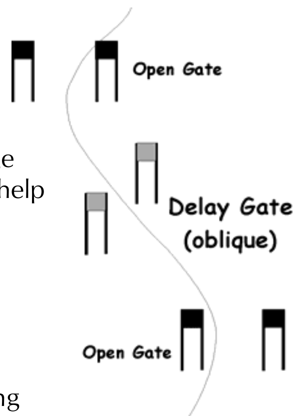
On the other hand, defensive skiing is not always bad. We all ski defensively when we encounter truly intimidating situations. Crowded areas, narrow runs, dangerous intersections, and so on may dictate that we ski defensively, as completed round turns are unsafe or impossible under these conditions.

Deflection

Deflection is any change of direction (turn) resulting from the snow's push on the skis. The term usually refers to the carving action of a decambered ski, but technically *all* completed turns require some sort of deflection or ski/snow interaction. Deflection and gravity are the two primary external forces involved when skiers change direction. Lesser forces include pole/snow interaction and wind resistance.

Delay Gate

A delay gate is an extra gate set in a race course, added to change the rhythm or avoid obstacles. It usually consists of an *oblique* (diagonal) gate set between two *open* gates. The delay gate usually does not change the racer's line substantially—it is often set only to help racers find their way between two far-apart gates.



Demo Forms

See **Final Forms**.

Demonstrating

Demonstrating—showing students how to do it—well and often is crucial to a good ski lesson. Many students learn primarily by watching and imitating and obviously need to see demonstrations. But nearly all students benefit from a good visual image.

To be effective, demonstrations must be clear, accurate, consistent, and appropriate to the terrain, conditions, and skill level of the students. Students must focus on the essential aspects of the demos—feet or knees, for example, or a particular moment in each turn. Demos are usually more effective when performed from a variety of viewer perspectives, so students can observe from in front, from behind, and from the side. Some movements are most clearly seen from particular angles. It is easy, but lazy and less effective, to demonstrate always skiing away from the class.

In my observations, few instructors pay enough attention to their demos. Most instructors could demonstrate much more frequently. Ideally, I like every third image my students see, at least, to be my demo, done as well as I can. And often demonstrations are much poorer than the instructor is capable of. This problem usually happens for the right reason, at least—instructors tend to pay a lot of attention to their students and not enough to their demos. They ski backwards. They twist their upper bodies around at the end of each turn to look back at their classes. They make only one turn, then stop and talk. Out of concern for their students, they blow their demos! When demonstrating, do *not* pay attention to your students! It is hardly selfish to make several precise turns focusing on your demonstration for the benefit of your students. Do it often!

Depth Hoar As snow ages, its particles transform from sharp, angular crystals to rounder, smoother pellets of ice. Often the cause of avalanches, depth hoar is a layer of this old, rounded, and very unstable snow buried in the snowpack.

DIN DIN is an international standard-setting organization. In skiing, DIN standards specify the dimensions of boot soles and binding design and release parameters. Before DIN, many boot/binding combinations were incompatible and setting consistent release forces from one binding to another was difficult at best. For liability reasons, many ski shops and technicians refuse to work with non-DIN equipment.

Direct Instruction Grounded in the studies of behavioral psychology, direct instruction is a teaching strategy proven highly effective for acquiring and mastering basic skills. In the family of *Mastery Learning*, direct instruction follows the established principles of practice theory, reinforcement and feedback, described in the *Basic Practice Model* (see).

In practice, direct instruction is the well-known teaching pattern of introducing a concept, testing for understanding, structured practice with feedback, and guided and independent practice with less direct feedback. It stresses the importance of identifying and clarifying goals and objectives, establishing an environment conducive to success, breaking complex tasks into achievable chunks, demonstrating clearly, and keeping the activity level high. Sound familiar? Our ATS Teaching Model draws heavily from the principles of direct instruction.

See also **Practice**, **Basic Practice Model**, and **ATS Teaching Model**. For a thorough discussion of Direct Instruction, read Chapter 18 in *Models of Teaching, Third Edition*.[32]

Discipline Good skiing requires discipline. It may appear effortless, free, and playful, but cutting a precise line at high speed through trees, race gates, moguls, or fellow skiers does not come without practice of highly specific skills and movement patterns. Physical discipline, especially of the upper body, and mental discipline and focus, combined with quality practice, provide the "edge" that allows us to ski safely at dangerous speeds, in a sport where small mistakes kill.

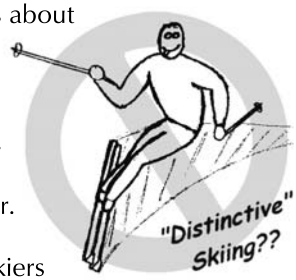
Unlike nearly everything else we do, good skiing requires an active *lower* body and a highly disciplined *upper* body. Every movement we make with the arms, head, or shoulders requires some counter-movement in the lower body to maintain equilibrium (balance). Off skis, this counter-movement rarely matters. When walking down the street, we can swing our arms, look around, point at things, reach out to shake someone's hand, or whatever, while the legs and hips move however they need to compensate. But on skis, we need precise and continuous control of the direction the skis point, the pressure on them, and their edge angle, so casual movements of the upper body must cease. On skis, the upper body balances and compensates for the deliberate movements of the lower body. If the legs have to compensate for sloppy movements of the upper body, they sacrifice control of the skis. Even innocent movements like looking uphill to see if anyone is about to run into me, looking down to see if my skis are doing what they're supposed to do, or blocking a gate with my arms, can ruin a turn.

Great skiing demands mental discipline as well as physical discipline. Skiing is full of distractions. Focus is the ability to block out distractions, worry, and fear as we concentrate on essential sensations and movements. Skiing teaches us to "center" ourselves, to find the "zone" for maximum performance. At high speeds, a loss of focus can spell disaster.

Developing this physical and mental discipline takes practice—a discipline itself! Good practice habits include intense and frequent work on skills or movements on easy terrain, as well as time spent testing those skills on difficult terrain. And effective practice, of course, demands that we practice the "right stuff." We must receive frequent, quality feedback. Accurate feedback can come from many sources—instructors or coaches, other skiers, race times, video, or self-critique—but without it bad habits inevitably creep into our skiing, and we practice mistakes.

It sounds hard. It sounds like no fun. But discipline will set you free! It does not imply frozen, stiff, or posed. With discipline, we can relax and play. It takes tremendous discipline to be loose and relaxed yet remain precise. Practice, practice, practice, develop discipline, *then* relax.

Distinctive Skiing There is good information, and there is bad! *Distinctive Skiing*[33] is a book by Mr. Bill W. West, who propounds that the only proper way to ski is with arms held high and feet and legs tightly clamped together, posing for the chairlift audience. The author appears subject to every common misunderstanding and misconception about skiing and what a ski is designed to do. He also states, with pride, that he has never taken a lesson, that most of what he knows about skiing he learned by "studying" skiers from the chairlift.



In many ways laughable, this book is nevertheless important in that it does express the attitudes and misconceptions that many skiers hold. Most skiers *do* want to be "stylish," of course. While Mr. West's concept of style and technique may make some of us gag, his ideas are not unique. Many skiers share his lack of understanding. Instructors insensitive to the desires of their students do little to promote the sport or their profession.

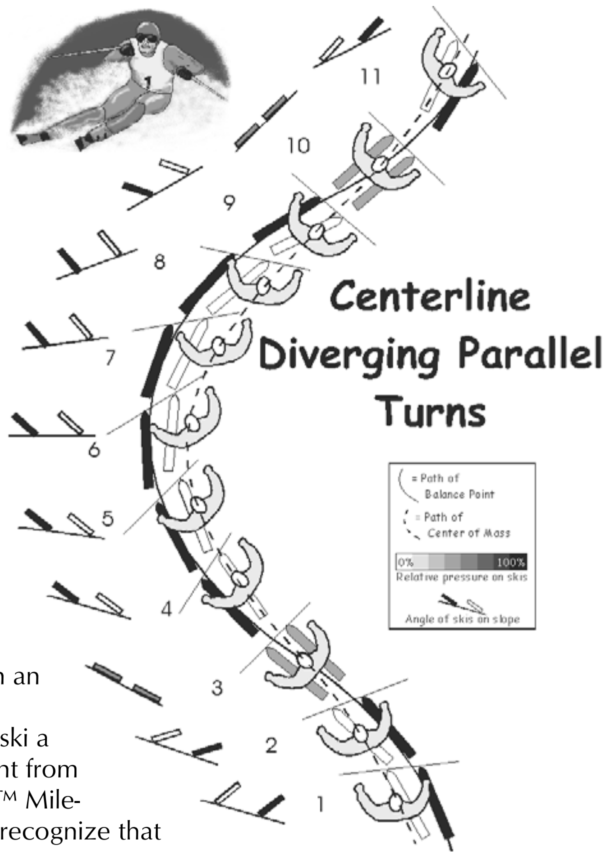
Distributed Practice Distributed practice involves intermittent, brief, focused sessions, as opposed to *massed practice* in one long, uninterrupted block. For most tasks, distributed practice is more efficient as far as amount of learning per time spent practicing.[34] Distributed practice is especially useful for reinforcing "old," already acquired skills and as a review. It may not produce the best results when introducing *new* skills or movements, where massed practice is often more effective. Even here, though, distributed practice can work well for some things. Introducing pole plants, for example, may lead to frustration if we hammer on it continuously. Touching briefly on the subject, then leaving it before frustration sets in, then returning frequently, is often the key to success.

See **Practice** and **Basic Practice Model**.

Diverging Parallel Turn The so-called "diverging parallel" turn is a high-level turn in which the inside ski diverges (tips apart) from the outside ski, due to aggressive steering of the inside leg into the turn. It was included in PSIA's original *Center Line™ Model* as the milestone representing the highest level of skill development.

Active steering of both ski tips into and through a turn is a *"common thread"* of good turns at any level. The diverging parallel turn illustrates this aggressive steering of the inside leg and ski in highly dynamic turns. We often see divergence in top racers as they aggressively pull the tips of their unweighted inside skis through the turn.

Unfortunately, this valid maneuver is often misunderstood. The diverging parallel turn is not a "scissor step" or "diverging step" turn. It is not a step turn at all. As in all turns on the Center Line™, the skier remains balanced primarily on the outside ski throughout the turn and the center of mass flows smoothly and continuously from one turn to the next. Instructors asked to demonstrate the diverging parallel turn in an exam often struggled because they tried to ski a turn somehow different from the other Center Line™ Milestones. They failed to recognize that this maneuver is simply the result of a very high level of the same skills and movement patterns seen at other levels on the Center Line™. To eliminate confusion, PSIA no longer recognizes the diverging parallel turn as an "official" Center Line™ Milestone. The *dynamic parallel* turn now represents the highest level of skill development, although we will often see the tips diverge in dynamic parallel turns. Ironically, the same instructors who seemed awkward demonstrating diverging parallel turns before now often show the diverging skis when skiing their best dynamic parallel or even open-stance parallel turns. They finally have it!

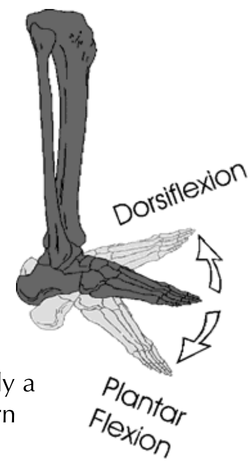


***The Diverging Parallel Turn**. Note slight divergence of skis throughout turns. Inside half of body leads throughout turn, matching lead of inside ski. Frames 3 and 10 represent "neutral," with skis flat on snow, pressure equal, and stance square (no lead). Weight transfer is 100%. As skis turn into turn, edge angle and pressure increase on outside ski.*

See also **Center Line™ Milestones** and **Common Threads**.

Diverging Step This term refers to a turn initiation involving a step to the uphill ski in a diverging (tips apart) position, similar to skating. A diverging step involves stepping usually to the uphill edge of the uphill ski (see *Inside-Outside Move*) and gliding, while the center of mass crosses over, causing the ski to roll over gradually to its inside edge for the new turn. This initiation provides a delayed start to a new turn, with extended gliding in the transition. It is useful in a race course when the gates are widely offset across the hill. The diverging step also allows the skier to gain height on the hill and recover when "off-line." On the other hand, if the move pushes the CM uphill, away from the coming turn, it is inefficient and slow (remember—the finish line is *down*hill). With skis that carve tighter arcs and courses typically less offset (less completed turns), today's racers step much less than in the past.

Dorsiflexion In biomechanics, dorsiflexion is the motion of the ankle joint when the ankle flexes, pulling the toes closer to the shin. Its opposite is *plantar flexion,* straightening out the ankle, as in pointing the toes or standing on tip-toe. When we lean forward on skis against the boot tongues, the ankle movement is dorsiflexion.



Double Stem A "stem" is a brushing out of either ski tail. A "double stem," then, is a brushing out of *both* skis simultaneously into a converging relationship, with an increase in edge angle. It is simply a braking wedge, sometimes used in preparation for turn initiations.

Do not confuse the double stem with the similar-looking but vastly different *offensive* move of Center Line™ *wedge christies.* In the wedge christie, both skis do brush to a wedge arrangement, but both are steered in the same direction (into the turn), with the uphill ski being turned more and the downhill ski's edge releasing, allowing the tip to slip downhill. In a double stem, the edge angles of both skis *increase* as the skis are pushed to a wedge. In a wedge christie, the skier gently rises during the opening of the skis to a wedge, *reducing* the edge angle to facilitate steering into the new turn. The double stem is likely to occur in skiers at the wedge christie level when the terrain is steeper or otherwise intimidating. It is a more cautious, braking and defensive move, more suited to "holding back" than to "letting go."

See **Stem**.

Downhill The fastest of the classic alpine competitive events (slalom, giant slalom, super G, and downhill), downhill racing can involve speeds well over eighty miles per hour, along with terrain jumps and dramatic turns. In a traditional downhill event, gates are set only to follow the trail and to keep speeds and trajectories within reasonably safe limits. The FIS (International Ski Federation) specifies the parameters of downhill courses, as to overall length, amount of vertical drop, and number of turns. Typical turns in downhill average 2.6 seconds apart, compared with 0.78 seconds for slalom and 1.4 seconds for giant slalom.[35]

Downstem This term describes brushing the downhill ski down into a converging (tails apart, tips together) relationship with the uphill ski. A downstem is often used with increasing edge and pressure to develop a platform, check speed, and create rebound energy for the upcoming turn. Also called an *abstem*, it was an essential move during the windup phase of the old Arlberg technique. This mechanism is still a useful option in our bag of tricks, but falls into the realm of "lateral exploration"—off the Center Line™. It is a defensive, braking movement that inhibits the smooth flow of the center of mass into the new turn.

An unintentional downstem often occurs when skiers are too far forward on their skis. Such skiers typically start their turns with rotation of the upper body, which brings their hips out over their skis, preventing hip angulation. The upper body also often over-rotates, necessitating a lot of edge angle to stop the turn. The downhill tail slips out in an abstem as these skiers attempt to use knee angulation to finish the turn and create a stationary platform to start the next turn.

See also **Abstem**.

Dynamic Dynamic describes something involving movement; the dictionary adds "characterized by or tending to produce continuous change."[36] Experts' turns tend to be "more dynamic," with higher speeds, more intense forces, greater range of movement, and increased involvement of the skis' design to help carve the turn.

Dynamic Balance The balance of good skiing, dynamic balance results from and requires movement. Riding a bicycle, like skiing, involves dynamic

The ultimate expression of dynamic balance on skis is the expert riding the "widthless" silver streak of one edge of one ski.

balance, whereas riding a tricycle involves "static" balance—the tricycle is stable even standing still. In skiing, a wide stance or wedge is more stable for beginners whose balancing skill is not yet well developed. As balance improves, the stance narrows. The ultimate expression of dynamic balance on skis is the expert riding the "widthless" silver streak of one edge of one ski.

In the static sense, advanced skiers are usually *not* balanced. In dynamic turns, skiers quite literally *fall* into each turn, trusting that their skis will come around to catch them later. It is only due to the accuracy and smoothness of the movements that we describe such skiers as balanced.

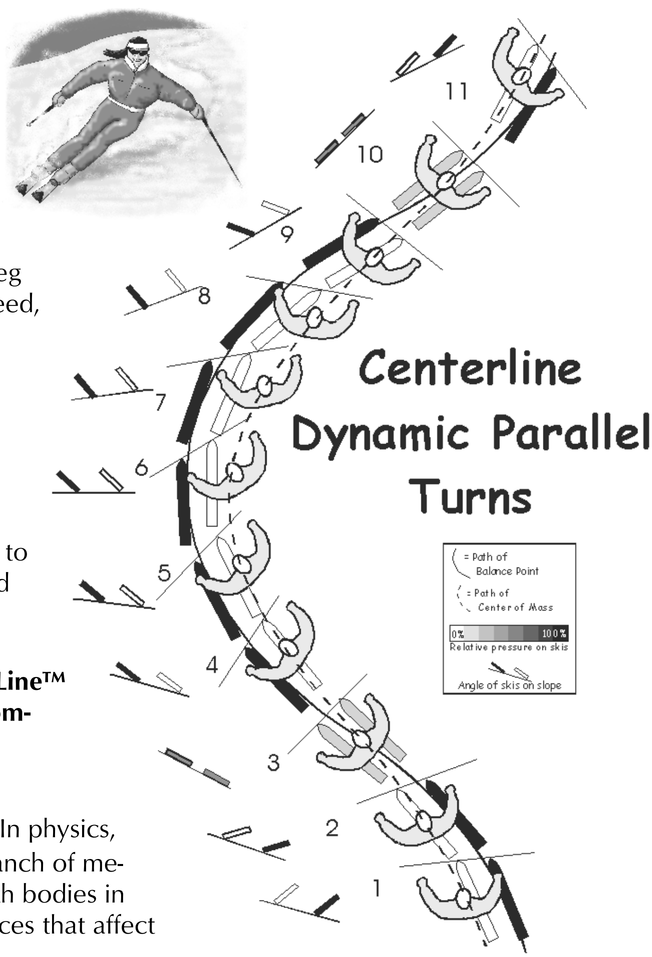
Dynamic Fall Line The dynamic fall line is the path a ball will follow down a ski slope when rolled a given direction at a given speed from a given point. This line differs from the *static* fall line, which describes straight downhill from any point. The dynamic fall line is a combination of gravity's pull and the momentum of the moving object. Its direction at any moment depends on the speed and direction of the skier as well as the direction of the (static) fall line. If I place a bowling ball on the hill, it will begin rolling straight down the fall line (static fall line). Wherever the angle of the hill changes direction, the static fall line changes (by definition). But as it gains momentum, the ball will change course only gradually and smoothly, following the dynamic fall line. The dynamic fall line is the path we follow when we relax the edges at the end of a turn and allow our skis to "seek the fall line."

It is a common but mistaken notion that the dynamic fall line is simply the path the center of mass follows as a skier skis down the mountain. It is the direction we *feel* pulled at any given moment, but not necessarily the direction we actually go. Unlike bowling balls, we skiers have the ability to control our paths. Only a completely out-of-control skier follows the dynamic fall line all the way to the end! The dynamic fall line is the direction we are pulled as we release the edges and flow into a new turn. As we use skis to alter the natural free-falling path of our centers of mass, we continuously change the dynamic fall line—it is different at every moment.

Dynamic Parallel Turn The dynamic parallel turn is an advanced turn involving a high level of skill, moderate to high speed, and a high degree of carving. The fourth *Center Line™ Milestone*, dynamic parallel represents all the *common threads* of good turns at the highest level of skill. It involves an early, deliberate weight transfer, a very active commitment of the body into the turn aided by an active pole swing, and refined steering of both skis. Pressure control skills and high edge angles play major roles in dealing with the increased forces of this high speed turn, causing the ski to bend into an arc (to "decamber") and carve the turn. Although ski design plays a significant role in creating the arc, the turn should still be controlled by active steering; it should not be "railed." Active guidance of the skis, combined with masterful control of the intensity, duration, and timing of edging and pressuring movements, determines the shape and size of the turn.

At one time, PSIA recognized another Milestone beyond dynamic parallel. The "*diverging parallel*" turn demonstrates very active inside leg steering at high speed, resulting in a slight divergence of the inside ski. In truth, any Center Line™ turn beyond the wedge turn may show some inside ski divergence due to the common thread of actively steering the inside ski.

See also **Center Line™ Milestones** and **Common Threads**.



The Dynamic Parallel Turn. Note the parallel alignment of the skis, feet, shoulders, and hands (and knees and hips, although these cannot be seen here). The center of mass takes a shorter route than the feet, crossing over the feet in frames 3 and 8. Beyond crossover, frames 3 and 8 represent "neutral," that moment when the weight is equal on both feet, the skis are flat on the snow and square to the body, and there is no lead of either ski. In all other frames, the weight is 100% on the outside ski, and the skis are on an edge angle that increases progressively through the turn, in response to the growing forces.

Dynamics

In physics, dynamics is the branch of mechanics dealing with bodies in motion and the forces that affect them. *Statics,* by contrast, deals with balanced forces and "steering couples" that cause no change in motion.

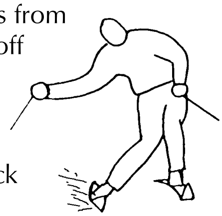
Skiing can be studied from either point of view. If we inquire into the motion down the hill, and study the forces that cause turns and speed changes on skis, we deal with *dynamics*. If we view technique from the skier's "accelerated" frame of reference, as the challenge of remaining in balance while barraged by constantly changing forces, skiing becomes a study of *statics*.

Edge Change An edge change entails moving from one edge or set of edges to the other, usually involving an *edge change movement* such as *cross-over*. Edge change is necessary when going from a right turn to a left turn and back (except in wedge turns, where the skis remain on the same inside edges from turn to turn—but even here the "dominant" edge changes from ski to ski). The edge change itself implies ski/snow contact, but the movements involved may occur on or off the snow (see **Edge Change Movements**).

The way a skier changes edges largely defines the type of turn. We can change edges with an extension of the legs, reducing knee, hip, and ankle angles as we cross over the feet into the new turn—the classic Center Line™ movement pattern. Or we can change edges through *retraction* of the legs, as the skis cross under the center of mass—especially obvious in mogul turns. In both extension and retraction initiations, the skis track undisturbed straight ahead while the skier's center of mass moves from one side to the other. Most other edge changes involve moving the skis sideways under a center of mass that moves less actively into the turn. These actions include stemming and stepping, and unweighting with a hop or push of the skis sideways, and result in more skidded turn initiations.

Edge Change Movements Edge change movements are any skier actions that produce a change in angle of the ski or skis, especially those movements that result in the ski engaging first one then the other edge, as it rolls from turn to turn. The edges need not engage with the slope to make edge change movements—skiers often change edges while in the air. The primary cause of an edge change in most turns is the cross-over and commitment of the body (center of mass) into the turn. Inclination of the body and angulation in various joints combine to control edge angle throughout the turn.

Edgeset An edgeset is a sudden engagement of the edge of a ski produced by sinking or "collapsing" and quickly pressuring and edging the ski. When well-executed, an edgeset results in a positive reaction or rebound as the ski "grabs," with minimal skidding, little grinding sound, and little snow flying. In this way, an effective edge set differs from the common "edge push" that most skiers use to scrub off speed. An edgeset is characteristic of slalom or short-swing turns, where the idea of "quick on-and-off the edges" describes the movement well.



Edgeset!

For high quality linked and flowing turns involving quick edgesets, the skier must move accurately, with precision timing. Alignment before and during the edgeset and release must approach perfection. It is all too easy for the skis to react explosively and leave the skier behind! Turns with smoother, progressive edge engagement are generally easier to manage. An edgeset often—but not always—results in a stationary platform and checking of speed, momentarily blocking the flow of the center of mass.

A good edgeset is a "relaxing" move, collapsing down onto the downhill ski. It is the gentle "down" movement we make to engage the edge of the downhill ski when sidestepping up the hill. It is similar to the quick down movement we use to pressure a spring board or trampoline, in order to generate rebound. By contrast, many skiers try to *push* on their edges for an edgeset, or twist the skis sideways. We set the edges to prevent the skis from skidding sideways—it makes no sense to push them sideways to an edgeset!

Edging Edging describes applying the edge of a ski or skis to the snow, generally to cause turning (deflection), braking, or to reduce or prevent sideslipping. To be effective, edging must involve some pressure on the skis—we can't "edge" when the ski is not in contact with the snow—although we could speak of "angulating," "tilting," "inclining," and so on. Technically, we also cannot edge our skis in deep powder, where the whole ski base—not just the edge—contacts the snow regardless of the ski's angle, although we often use the term in these conditions. It is important to understand that different factors cause an edged ski to bend when pressured on hard snow (sidecut is involved) *vs.* powder, but in either case the result is the same: the ski bends and carves the turn.

In most good linked turns, the skis roll smoothly from one set of edges, through "neutral" (flat), to the other set of edges. As the turn progresses, the edge angle increases progressively, in concert with the intensifying forces of the turn, due to three main factors. First, as the forces of the turn—centrifugal force and the component of gravity pulling out of the turn—increase, the skier inclines more and more into the turn, which tips the legs and skis. Second, the skier usually sinks and creates angles in ankles, knees, and hips to further increase edge angle. And finally, the relative angle of the slope itself changes as the skier crosses the fall line and continues through the turn. For an illustration of edging through turns, see the diagrams under any of the Center Line™ Milestones (wedge turn, wedge christie, open-stance parallel, dynamic parallel, and diverging parallel.)

See **Edging Skill**, **Inclination**, **Angulation**.

Edging Skill One of the three basic skills groups (with *rotary* and *pressure control* skills) of the American Teaching System™ (ATS), the edging skill comprises all movements and conditions that affect the angle of the skis with the slope. Good skis are sharp, precision cutting tools, and edging skill reflects the skier's ability to exploit those scalpel-like instruments. Like all skills, more edging skill does not necessarily imply more edge *angle*—but rather a more refined and sophisticated use of the edges of the skis. Perhaps a better expression would be "edge control skill."

Skillful use of edging involves both using the edges to slice and hold in turns and using them to scrape off speed when needed for braking. It also involves *reducing* the edge-grip to end a turn or *releasing* it to begin a new one.

See also **Rotary Skill**, **Pressure Control Skill**, **Skills Concept**.

Equilibrant In the study of mechanics, an equilibrant is a force that balances a system of forces to produce equilibrium or balance. If a body is not accelerating, there must either be no forces acting on it, or else all forces must cancel (add up to zero). In turns, from the skier's perspective, *centrifugal force* is the equilibrant of *centripetal force*—equal, but in the opposite direction.

While there is little need to analyze ski technique with the physicist's dry precision, it is important to remember that many changing forces act on us at once. Managing those forces in order to stay in balance is the challenge of skiing. When we lean a precise amount into each turn for balance, what we are really doing is creating the equilibrant force to counter the system of forces acting on us.

As a digression, remember also that skiing can be viewed from a variety of *frames of reference*. Only from the skier's frame of reference—that moves with him—must all the forces acting on him balance. From the skier's point of view, centrifugal force pulls *out* of the turn, and the skier leans *in* to create the equilibrant and remain in balance. From any other frame of reference, the forces acting on the skier are *not* balanced, and it is these unbalanced forces that cause turns and speed changes. From a stationary observer's viewpoint, gravity and the snow push the skier *into* the turn—and there is no force, centrifugal or otherwise, canceling these forces out.

Equilibrium Equilibrium means balance—a condition in which all forces acting on an object cancel each other out. It is important to note that in an analysis of purely applied forces (gravity, centripetal force, friction, and so on), skiers are *not* in equilibrium unless they are maintaining a constant speed in a straight line. Any turn is a form of acceleration and thus involves unbalanced forces, according to Newton's First Law of Motion. To understand balance in the turning, accelerating, and decelerating skier, we must consider the inertial forces (centrifugal force) from the moving frame of reference of the skier. If the inertial and applied forces are in equilibrium, the skier is balanced. Centrifugal force is the *equilibrant*, or balancing force, of the turning skier.

See also **Centrifugal Force**.

Etiquette Once an important topic in skiing, etiquette on the slopes seems now a lost art, as out of style as the Arlberg technique, bamboo poles, and knickers. For advice on mannerly (and womannerly) skiing, I refer you to Chapter XII of *The New Invitation To Skiing,*[37] the "skier's Bible" of the 1950's. Here are some notable excerpts:

> *Your real skier is a gentleman or gentlewoman, and the first precept of his on- or off-the-slope behavior is uniform courtesy, helpfulness, and meticulous regard for the needs and comforts of others. . . . He knows that borrowing waxes, . . . screwdriver, or whatever else may be needed on the slope can be a nuisance to his fellows. . . . You will never see him drinking to excess, . . . boasting about his prowess . . . .*
>
> *The real skier never yells "Track!" unless he has to. . . . If he falls, he immediately rises, fills in the hole he made, and gets out of the track of other skiers.*
>
> *. . . Nose thumbing at the rules of a slope or at the warning of the local Ski Patrol . . . is not a mark of independent courage, but of childish misbehavior. Attempting a slope or trail which is marked "expert" when one is*

an intermediate shows one to be foolish, not brave, and a menace to other skiers as well.

The woman skier who knows her etiquette carries her own equipment, fastens her own bindings, cleans and waxes her own skis . . . .

The real skier is a good companion on the way home . . . .

Makes you wonder about the meaning of "progress," doesn't it?

> ***"Your real skier is a gentleman or gentlewoman, and the first precept of his on- or off-the-slope behavior is uniform courtesy, helpfulness, and meticulous regard for the needs and comforts of others."***
>
> ***From The New Invitation To Skiing (1947)***

Eversion One of the two basic movements of the foot, eversion describes turning the sole of the foot outward. It combines *lateral rotation* (toeing out) with *pronation* (rotating the little-toe side of the foot upward. The opposite of eversion is *inversion* (turning the sole inward). Other foot movements combine eversion and inversion with movements of the ankle joint and other joints.

Exercise An exercise is an activity or drill designed to develop a particular skill, practice a specific movement, or to enhance physical fitness. Exercises are often parts of progressions designed to develop a more complex movement or skill by breaking it into relatively simpler chunks.

Instructors use exercises for teaching movements and skills. But we must differentiate between the exercise and the skills we are trying to improve. Mastery of the exercise is hardly the end goal; it is—in fact—only the beginning! Once we learn how to do an exercise, we must then *do* it—over and over and over. The real benefits of an exercise are not apparent until we *stop* doing it and see what has changed in our skiing. Too many instructors teach students how to do an exercise, then move on to the next thing as soon as they've "got it." With no practice, the students have learned an exercise, but they've not improved their *skiing* a bit. Practicing the exercise develops *mastery* of the skills—the real objective of a ski lesson.

Of course, it is by definition that any exercise has something wrong with it! If not, it would not be an exercise—it would be skiing. Many exercises exaggerate some movement or position, or isolate some component of skiing. Some exercises excel at *breaking* unwanted movement patterns or habits, but are too extreme, contrived, or incomplete to be themselves the desired habits. Instructors must thoroughly understand each exercise used, including pros and cons, and use them with care. We must help our students focus on the desired parts of the exercises, and make them aware of potential problems. Failure to do this can lead to real confusion ("that's not what my last instructor said . . .").

There are two types of exercises—those that develop specific technical skills, and those that involve a tactical focus meant to bring out existing skills and to improve overall performance. Skills exercises often exaggerate or isolate a particular skill or movement, and should usually take place on easy terrain or at lower speed. Performance exercises are more general, often specifying line, conditions, turn shapes or sizes, with "follow-me" and synchronized skiing, race gate drills, and so on.

Expert

An expert is someone who is highly skilled or knowledgeable in some field. In skiing, we must define an expert as someone who is good at doing the right things. Most true experts began practicing the "right things" from the beginning, and developed these fundamentals to the highest level. As instructors, we must understand the differences between great skiing and all the rest, and see to it that our students are on the road to become experts, regardless of their level. PSIA's Center Line™ Skiing Model represents an attempt to map this road, and to help identify dead-end paths that never lead to expertise.

> ***Many advanced skiers are simply very good at very bad techniques. They are not experts.***

Many advanced skiers are simply very good at doing the *wrong* things. These "pseudo-experts" may be capable of managing the most difficult runs on the mountain, but even on easy runs, they do not demonstrate the basic movements of great skiing. Their "techniques" are a clutter of errors and compensations. They do not exploit the design of their skis as precision instruments. Far from the "Center Line™," pseudo-experts work much harder than they need to, and lack the true precision (control) of experts. They are often good at *braking*, because that's what they've practiced their whole careers, but good skiing means good *turning*. True expertise involves taking off the brakes and letting the skis glide as they are designed!

See **Good Skiing** and **Common Threads**.

Extension "Extension" implies straightening or reducing the angle of one or more joints. Its opposite is *flexion*. Extension movements of the body generally end a turn by reducing *angulation* and, combined with a decrease in *inclination*, reducing the edge angle and thus the pressure on the skis.

In most turns, the extension that ends the turn begins while still balanced on the downhill ski—before the "weight transfer." In linked turns, the extension combines with an accurate move of the center of mass into the new turn (crossover) to aid in the edge release, allowing the skis to be steered smoothly into the new turn.

Rapid extension movements cause "up-unweighting," which makes it easier to displace the skis sideways to initiate a skid or braking movement. In true turns, where the skier wants to change direction as effectively and efficiently as possible, and where skidding is unwanted, unweighting is counter-productive. The extension in the transition of Center Line™ turns really amounts to a smooth return to a "neutral" stance—not a leap off the snow!

Do we extend to *end* a turn, or to *start* the next? When turns are linked the question is moot—the completion and preparation phases are one. With turns separated by a traverse, though, it becomes clear that the extension *completes* the turn. Few skiers would sink through a turn, then stay crouched down while traversing across the hill, rising only when finally initiating the next turn. By rising out of a turn I can start a new turn immediately (by crossing over and steering the skis) or I can hold a traverse as long as I want. Rising to finish a turn, if timed and directed perfectly, releases the energy stored in the body and decambered skis. The skis and the skier explode out of the turn. Too late an extension allows the skis to "die," while the energy of the previous turn vanishes. As on a diving board or trampoline, we sink to pressure the skis and store energy; when we sense that the pressure is at its maximum, we extend to release this stored energy. And timing is critical.

Generally, then, extension helps flatten the skis, release pressure, and end the turn, with two major exceptions. In deep powder we extend to push the skis down into the snow, causing pressure to *increase*. And in moguls, we extend the legs down into the troughs in order to keep the skis on, or at least near, the snow (see **Avalement**).

See also **Flexion**, **Flexion/Extension**, **Up/Down Motion**.

Extension Christie This term refers to turns in which the skier extends through the control phase, the reverse of most modern turns in which the skier progressively *sinks* to edge, pressure, and steer the skis, extending to *complete* the turn and help change edges. Rarely used on groomed runs, the extension christie is the technique of moguls and deep powder. In bumps, turns usually begin on a mogul, which compresses our legs up beneath our body. We then extend the legs down into the trough. In powder, we extend and press our skis down into the snow, creating pressure. When we relax and retract the legs, the snow pushes the skis back up and out of the snow where the next turn is easily initiated.

Ironically, the turn I've described here is often also called a *retraction turn,* because the skis flatten and change edges as the legs retract (flex) through the transition phase (after extending through the control phase). Suffice it to say that most turns involve both extension and flexion, but the timing of these movements can vary drastically, altering the mechanics of the turns.

Extensor Reflex

Sometimes called the "walking reflex," the extensor reflex is a basic, innate reaction that is usually helpful, but can cause difficulties in skiing. It causes us to extend all weight-bearing joints in response to pressure on the bottoms of the feet. Well-developed already at birth, the extensor reflex remains a strong instinct in adults. Long before they learn to walk, newborn infants will straighten their legs when we press on their feet. Certainly this instinct is useful in learning to walk, and in reacting to the stresses of jumping and landing. But it causes problems in skiing, as we must over-ride the extensor reflex to allow willful flexion-extension movements. It makes it difficult to learn to sink and create angles as pressure builds in turns. It causes us to do exactly the wrong thing in bumps, where we need to *flex* to absorb the pressure of a mogul and *extend* our legs down into the trough to keep our skis on the snow.

External Forces

"Applied forces," "motive forces," and *"external forces"* are three terms for the same thing, each describing an essential characteristic of the basic forces that push us around and cause turns and speed changes. They are distinguished from *"internal forces"* and *"inertial forces,"* neither of which can cause a body to *accelerate.* It is important to understand this difference when referring simply to "force." This is a case where being "too simple" can lead to confusion!

According to Newton's *First Law of Motion,* all direction changes require some force, and that force must come from *outside* the object to cause it to change direction. Muscular force ("internal force") alone cannot cause turns. It can push on other things, and it can move parts of the body relative to other parts, but it cannot move the center of mass! What causes the direction change when we push on something is the *external* "reaction force" as the object pushes back. If we could apply a force to ourselves, we really would be able to "pick ourselves up by the seat of our pants."

Nor do inertial forces cause acceleration (direction or speed changes). They are the *result* of acceleration—the feeling of being pulled out of a turn by *centrifugal* force, or pushed back in your seat when a car accelerates. The *external* forces in these cases push *into* the turn, or *forward* in the car—the opposite direction of the inertial forces.

So it is important to specify what type of force we're talking about. It is far more than a mere "technicality." When someone mentions a "force," he's probably referring to some external motive force, but it can be dangerous to assume. Know the difference, and beware of discussions of the mechanics of skiing with people who don't!

See also **Force**, and understand the relevance of "**frames of reference**" to describing forces as motive forces or inertial forces.

External Rotation

Also called *lateral rotation,* external rotation means turning "out," usually referring to a leg or foot. When we initiate a parallel turn, the new inside leg rotates externally, while the outside leg rotates *internally*.

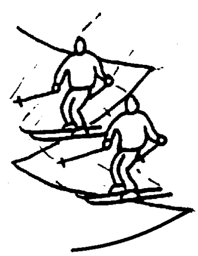
Extrinsic Motivation

Extrinsic motivation is motivation (reward) that comes from something outside the activity itself. If you teach skiing for the money, you are extrinsically motivated (and foolish!). If you teach because you enjoy it, you are *intrinsically* motivated—the reward is the activity itself. In fact, many activities and behaviors are motivated by both extrinsic and intrinsic rewards.

F

Fall Line

The fall line is an imaginary line from any point on a slope following the angle of steepest descent. In other words, it is "straight down the hill." The part of a turn during which the skier is moving or the skis are pointing straight downhill is said to be "in the fall line." We "cross the fall line" in a turn the moment the skis point straight downhill.



Falling Leaf

There are really two types of fall line. Unless otherwise indicated, "fall line" usually refers to the *static* fall line described here. The *dynamic* fall line is the path a ball would roll down a hill, which is determined by both the direction of the (static) fall line and the speed and direction the ball is moving at any point.

See also **Dynamic Fall Line**.

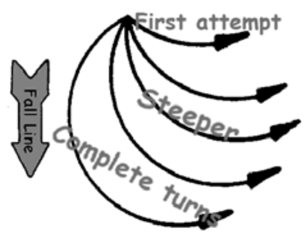
Falling Leaf

Falling leaf is an exercise in which the skier side-slips diagonally forward, then diagonally backward down the slope, primarily by adjusting the pressure forward and back on the skis. It is an excellent exercise for tuning fore/aft balance (finding the "sweet-spot") and developing sensitivity to the effects of "leverage." It also develops a refined feel for edge control and edge release.

Because of the possibility of catching a downhill edge when sideslipping, the falling leaf is best done on well-groomed, moderately steep terrain. As a fun and instructive challenge for stronger skiers, throw in some 180° spins.

Fan Progression

A fan progression is any series of exercises first performed in a shallow traverse, then progressing to steeper and steeper traverses or uphill arcs, then finally crossing the fall line in complete turns. It is a way to practice first the end of a turn (the easy part that slows us down), progressively working toward whole turns. By avoiding, at least until students are ready, pointing the skis straight down the hill, fan progressions develop confidence in a maneuver at higher and higher speeds or steeper slopes. They develop turn shape and patience through the control phase. And they can be a great way to introduce the idea of completing turns for speed control, especially for skiers who rush through turns, avoiding the fall line.



***FAN PROGRESSION*—each successive attempt begins steeper down the hill, until reaching complete turns.**

Fatigue

Physical or mental fatigue obviously decreases our ability to perform. Fatigued skiers may even regress, "forgetting" what they've learned. And fatigue can be dangerous, affecting both physical performance and judgement. We must recognize the symptoms of fatigue in ourselves and other skiers in order to avoid injuries as well as frustration. Because skiing is such an exhilarating activity and is not tremendously strenuous, skiers often do not notice that they are tired. The danger comes when an emergency arises and the reflexes suddenly aren't what they should be and the muscles just don't respond quickly and strongly. Timing is minutely off. At worst, accidents happen. At best performance decreases and learning becomes difficult.

Fear While fear can debilitate a skier, we must remember that fear also keeps us alive in this sport. Not all fears are irrational. On the other hand, learning to deal with fear and perform in spite of it is the mark of a great skier, as well as a valuable fringe-benefit of learning to ski. Instructors must recognize the signs of fear in students and develop the ability to help students overcome the negative effects of fear.

See also **Courage**.

> **"Fear of being beaten by the other racers, fear of failing, fear of falling. . . what a waste of energy! So, here's the Rx: Whenever I feel fear, I've got to scoff at it until I realize how useless it is. It's an emotion that only limited people harbor. If you're going to have an emotion about something, it should be passion. Even hate is better than fear. There's no point in being afraid. The people I know who are really afraid are just pathetic because they're stifled. It's a terrible way to live."**
>
> **—Julie Parisien of the U.S. Ski Team**

Feedback Feedback is a response to an action that affects that action or subsequent action. This cycle represents a "feedback loop," when the output of an action circles back as input. Negative feedback tends to decrease the action; positive feedback tends to increase it. The classic example of a negative feedback loop is the common thermostat. Falling temperature causes the thermostat to turn on the furnace, which causes the temperature to rise, which then shuts the furnace off, which causes the temperature to fall . . . . It would be a positive feedback loop (and a poorly designed thermostat!) if rising temperatures turned the furnace on hotter.

In skiing, feedback is any information we gather concerning our performance—sensory input (Visual-Auditory-Kinesthetic), critique from an instructor or fellow skier, video, race-course clock, and so on. Feedback is critical to regulate performance, especially when learning new skills and movements. The clearer and more immediate the feedback the better. Sensory feedback, especially kinesthetic, is particularly significant. A skier cannot rely only on an instructor or another skier to tell him how he is doing. Much of what we do on skis is the *result*, not the *cause*, of turning. As such these movements rely on feedback and awareness of the sensations and changing forces throughout the turn. Expert skiers move in a delicate dynamic balance and most of their movements represent sophisticated reactions to subtle sensory feedback.

Athletic performance involves both *"open loop"* and *"closed loop"* tasks, depending on whether continuous feedback modifies the current task as it happens (closed loop), or feedback after the task affects the next performance (open loop). Brief actions, like staccato slalom turns, are generally open loop, with no chance for the skier to modify the turn after it begins. Longer giant slalom turns are closed loop tasks—they are continuously adjusted—a little more angle when the edge slips, for example, or a subtle adjustment to turn shape.

See also **Reward**, **Reinforcement**, **Punishment**, and **Open-** and **Closed-Loop Tasks**.

Feel-Bad Turns

This is an exercise from the Mahre Training Center at Keystone, in which skiers ski on the *inside* ski, opposite the norm. This exercise exaggerates inclination into a turn and forces a committed cross-over move. It develops balance, sensitivity, versatility, awareness, and bruised hips.

Sometimes it is helpful to intentionally make an "error" in order to learn what it feels like. Only when we know the difference can we tell when it's right! And on a practical side, when that outside ski slips away from us, it's good to have practiced skiing on the inside ski!

Feel-Good/Feel-Bad Turns

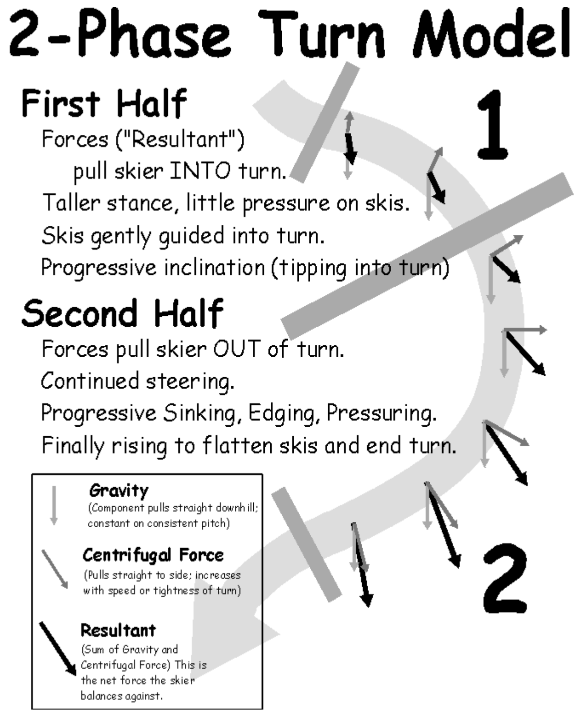
This is an exercise in which the skier skis on one ski only—either the left or the right—such that every other turn "feels good" and every *other* turn feels "bad." It develops balance and reinforces the benefits of balancing on the outside ski.

Final Forms

From bygone days of not so long ago, these are highly specified ski maneuvers in which the "form" was stressed over function and mechanics. Some final forms represented positions or parts of turns, as in a final form for the correct position in a traverse. Compare with the *Center Line™ Milestones*—complete, linked turns in which the technical, functional elements are specified, but there is room for stylistic interpretation. Each Center Line™ Milestone depicts all the fundamentals of real *skiing* at a particular level of skill development, not just parts of turns or static positions. Final forms were specific and distinct maneuvers, usually practiced to perfection before moving to the next one. In the early days of ATM and the American Ski Technique, instructors were required to perform ten Final Forms: 1) Straight Run, 2) Straight Snowplow, 3) Snowplow Turns, 4) Traverse, 5) Stem Turns, 6) Forward Sideslip, 7) Uphill Christie, 8) Stem Christie, 9) Parallel Long Turns, and 10) Short Swing. Final Forms are also known as "Demo Forms."

First Half

In a simplified analysis of skiing turns, the first half is the phase of a turn, ending roughly at the fall line, during which the force of gravity pulls a skier *into* the turn and the skier can, for the most part, just stand tall and relaxed and let things happen with a gentle guiding of the skis. It is the "light" phase, when there are few forces pulling out of the turn to resist. During the *second* half of a turn—the "pressure phase"—gravity and inertial forces combine to pull the skier *out* of the turn and the skier must work to resist these forces. The first half of a turn is characterized by a relaxed, taller stance and minimal, if any, pressure on the skis. Edge engagement is slight, although the skier will incline progressively into the turn, creating significant edge angle, to prepare to resist the centrifugal and gravitational forces that build dramatically in the second half of the turn. Rotary movements generally consist of gentle guiding and steering to augment the pull of gravity into the turn, although more powerful mechanisms (anticipation-release, counter-rotation, rotary pushoff, and others) may at times be necessary.



Two "halves" of a turn. *Gravity and centrifugal force oppose each other at the beginning of a turn (from the skier's frame of reference), so there is no force for the skier to resist. At the end of a turn, gravity and centrifugal force combine to pull the skier out of the turn. The point at which the forces begin to pull the skier out of the turn marks the division between the first and second "half" of the turn. More speed or a tighter turn create stronger centrifugal force, moving the division earlier in the turn. A steeper hill means stronger gravitational pull into the turn, moving the division later. A tight turn at high speed on a flat hill may have no "first half" at all, allowing the skier to pressure the ski and carve from the start.*

It is difficult to sustain much pressure on the skis in the "first half." Attempts to pressure and decamber a ski during this phase usually involve rapidly extending the body toward the inside of the turn, pushing on the skis. This push pressures the ski only briefly, followed immediately by a sudden *release* of pressure and loss of balance to the inside of the turn. Only in the second half of the turn, when major forces to the outside have developed, can the skier effectively sustain pressure on the ski (by resisting these forces). Patience is a virtue in the first half, as we allow the turn to unfold, the body to incline into the turn (away from the feet), and forces to develop. As we approach the second half of the turn, everything must be set up and aligned in preparation for resisting the forces.

The Mahre Training Center at Keystone uses this simplified, two-part turn analysis extensively. It is somewhat over-simplified, but for practical purposes it is highly applicable and easy to explain, feel, and understand.

Technically, the division between first and second "halves" of turns is not precisely at the fall line. With increasing speed or tightness of the turn, centrifugal force pulls the skier out of the turn more powerfully, allowing him to pressure the skis and carve sooner, especially on a gentle slope where gravity's pull into the turn is weak. Indeed, today's snowboards and radical sidecut skis can decamber and carve from the start of the turn, linking one carved arc directly to the next, at least on flatter terrain. Skiing such turns may involve no "tall" phase whatsoever, as the skier moves laterally immediately onto a new pressured, carving edge.

Nevertheless, thinking of the turn as having two distinct phases, and practicing patience to allow the forces to develop, is a good way to clean up the skidded turn that results from sinking and pressuring too soon. While equipment has evolved, the laws of physics have not changed. It is still impossible to create forces out of nothing, and pressure on skis still comes from them pushing on *us*, not from us pushing on them! We still must patiently allow forces to develop before we can use them.

See **Second Half** and discussion and illustration under **Force**.

FIS The "Federation Internationale de Ski," or International Ski Federation, is the governing body for international (World Cup) ski competition.

Flex Flex refers to a ski's stiffness or softness. In general, stiffer skis hold their edges better on hard snow but are less forgiving and more difficult to ski in softer crud and powder.

There are three types of ski flex. *Longitudinal* flex refers to the ski's ability to bend along its length. Variables include overall stiffness or softness, as well as *distribution* of flex, as in "stiff tail, soft shovel."

Torsional flex refers to the ski's resistance to *twisting*, which greatly affects an edged ski's ability to hold on hard snow and ice.

Lateral flex is the ski's resistance to bending sideways. Wider skis and snowboards tend to be more laterally stiff than narrower skis.

Today's materials and technologies allow engineers' to determine each of these three flexes independently. Not long ago, skis torsionally stiff enough to hold well on ice were so stiff lengthwise that only top athletes had the strength to bend them and carve turns. Modern skis can be torsionally stiff but still flexible along their length.

"Flex" can also refer to bending at joints—flexion. "Flex your ankles" is a commonly heard instruction.

Flexion Flexion involves bending in one or more joints, in various planes, essentially causing the skier to become "shorter." Technically, flexion is movement in a joint that causes the limbs involved to move closer. *Extension* is the reverse—the limbs move away from each other as the joint straightens.

We can bend at the ankles, knees, hips, and spine, both fore-and-aft and sideways to some extent. Typically, a skier starts a turn taller and flexes through the turn, especially in the second half, in order to control edge angle (through "angulation") and to control the pressure on the skis, before finally extending to finish the turn. Flexing helps store energy, as in sinking to bend a diving board. Extension, timed precisely, releases this stored energy—up, on a diving board, or out of the turn on skis.

Flexing also helps absorb momentary pressure changes caused by terrain (moguls, washboards, compressions, and so on). In skiing's traditional jargon, active, muscular, and deliberate absorption (I *pull* my feet up) is *avalement*; passive absorption (the bump *pushes* my feet up) is *reploiment*.

Finally, flexing (*i.e.* bending the knees) allows more powerful rotary movements. In a lower stance we can crank the skis with brute force. A taller stance is more suited to finesse and guiding.

See also **Up/Down Motion**.

Flexion/Extension Flexion/extension refers to bending and straightening in one or more joints. These movements affect pressure, edging, and terrain absorption. In order to maintain balance on skis, we flex and extend in several joints simultaneously. Bending only at the knees moves the center of mass back; bending only at the waist or ankles moves the CM forward.

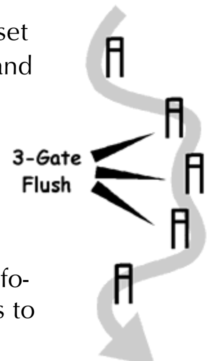
See **Up/Down Motion**, **Flexion**, **Extension**.

Flow Great skiers flow. That is not to say, of course, that they abandon their normal solid physical state, like the "changling" of *Star Trek* who spends part of his life in a bucket. A standard dictionary definition of "flow" is illuminating: "To move or run freely, in the manner characteristic of a fluid; to proceed steadily and continuously; to proceed with ease; to appear to move with a continual shifting of the component particles."[38] This definition describes the sinuous motion of great skiing very well.

Perhaps the defining characteristic of good skiing and of PSIA's Center Line™, the greatest "*common thread*," is the concept of "flow." All the movements of these maneuvers contribute to a smooth flow of the center of mass throughout the turn and from turn to turn. Braking movements such as *checking* that create a stationary platform and block this flow are not "on the Center Line™"—they are part of *lateral exploration*. Also crucial to flow is the elimination of static positions or poses in our skiing. Skiing is dynamic, forces constantly varying. We must move continuously to react to these changing forces.

Flush

A flush is a series of three or more race gates set directly down the fall line (no side-to-side offset). Flushes and *hairpins* are known as *vertical combinations.*



Focus

"Focus" refers to the ability to concentrate on the task at hand, or on a required part of the task. We can narrow our focus to concentrate on specific items or components of skiing (for example, where the pressure is focused on our foot), or we can broaden or soften the focus to encompass the total experience.

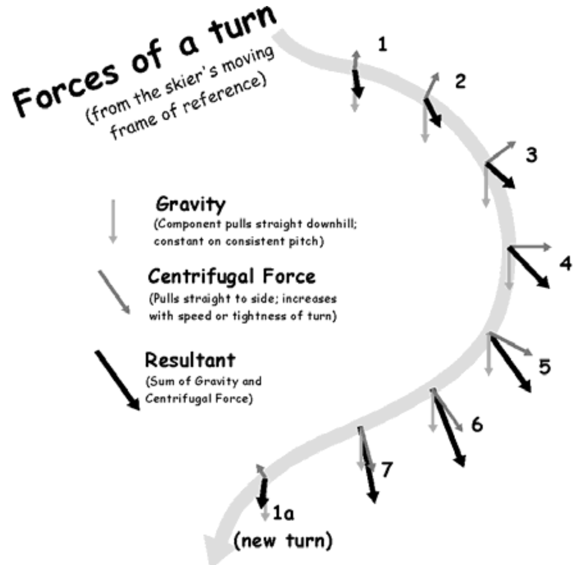
One of the key skills of skiing (and one that transfers to most other activities) is the ability to focus on the *skiing* in the face of distractions. The danger of a fall, the pressure of a race, the critical eyes of a certification examiner, even the shouts from a chairlift—all these distractions can interfere with skiing. Self-talk, self-consciousness—even the conscious effort to "try to focus"—interferes with the relaxed, focused concentration so crucial to peak performance.

See also **Concentration**.

Force The dictionary defines force as "energy that causes or alters motion."[39] A *vector quantity* (it has both direction and magnitude), force is the push or pull that changes the speed or direction of an object's motion (causes "acceleration" in the direction in which it is applied). According to Newton's third law of motion, all forces occur in opposing pairs—every force has an equal and opposite "reaction force."

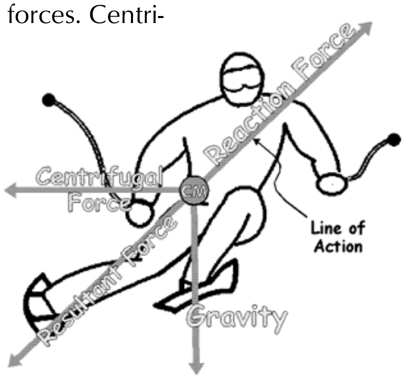
A complex system of forces acts on and within a skier throughout a turn. There are two types of forces applicable to skiing: *applied* forces, or forces that cause a turn or acceleration, and *inertial* forces, or forces that are the *result* of a turn or other acceleration.

Any analysis of forces requires a *frame of reference*. We analyze the forces of skiing in two important ways. The simplest analysis views the skier from a stationary ("inertial") frame of reference, as if looking down from above. We consider only the external applied forces acting on the center of mass, which cause turns and changes in speed. These forces include gravity, friction, centripetal force in general, muscular force, wind resistance, and forces resulting from ski/snow and pole/snow interaction. In this analysis there is no such thing as "inertial force" (centrifugal force)—these sensations are merely effects the skier feels as a result of accelerating. Inertial effects do not cause acceleration or affect the skier's path, thus they are irrelevant to this analysis. The skier is *not* in equilibrium (balance), because he is accelerating and turning. Also irrelevant are body positions and movements of various parts of the skier's body. This simple analysis is useful only to explain the path of the skier's center of mass. It does little to explain balancing movements or ski technique.



Forces change through turn. In the beginning, gravity and centrifugal force oppose each other. As the turn progresses, the two forces increasingly align. Somewhere between frames 2 and 3, the net force (resultant) changes from pulling the skier into the turn to pulling him out of turn. Where exactly this change occurs depends on speed (more CF) and steepness of the hill

In the second and more common analysis, we consider forces from the *skier's* moving ("accelerated") frame of reference. The skier reacts to forces and makes movements to balance and remain upright. Inertial forces here become real forces. Centrifugal force is the equal and opposite reaction force of centripetal force. The skier feels centrifugal force as a pull to the outside of the turn, and leans in against it to balance. The applied forces and inertial forces must always cancel to keep the skier in equilibrium (balance), regardless of turns or changes in speed. Both analyses are technically accurate, but this second view is more applicable when analyzing ski technique. The accompanying diagram illustrates the force vectors from the skier's frame of reference.



Major forces of a ski turn (from the skier's moving frame of reference). The reaction force is felt as the pressure against the ski edge. The resultant force is the combination of gravity and centrifugal force. From the stationary frame of reference of an observer, the reaction force is the push from the snow that causes the turn and centrifugal force is an irrelevant inertial effect, as the forces are not "balanced."

See also **Applied Force**, **Inertial Force**, **Torque**, **Centrifugal Force**, **Centripetal Force**, and **Reaction Force**.

Fore/Aft Balance

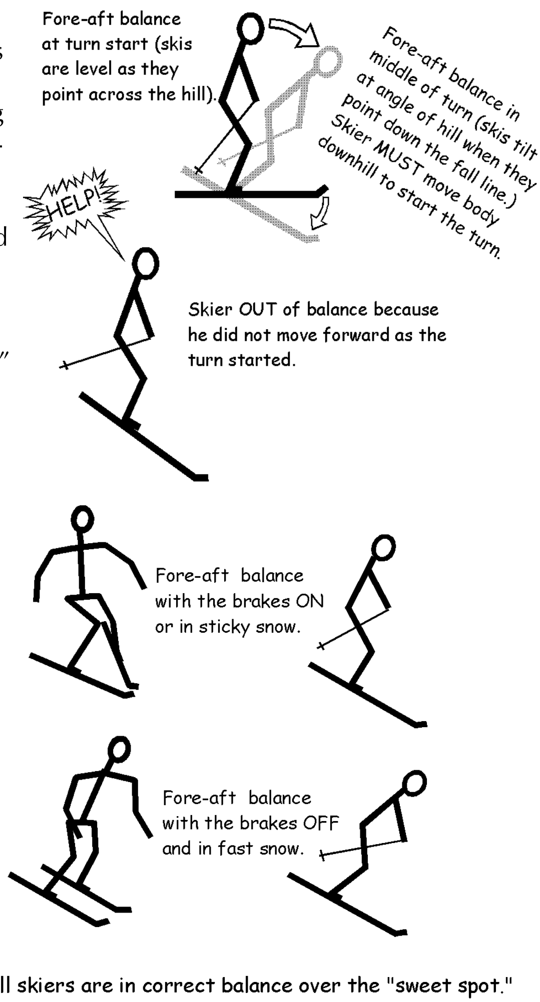
Essential for good skiing, accurate balance fore-and-aft provides muscular and skeletal efficiency, maximizes movement options, and optimizes ski performance. Perfect balance permits the skier to adjust pressure to any point along the length of the skis, although good skiing generally involves a neutral stance, biased neither forward nor back. "Balance over the whole foot, with the ability to work the entire ski" is a fundamental of good turns, a "common thread" of PSIA's Center Line™. Although myths to the contrary persist, this idea is hardly new. In the 1970's Georges Joubert advised skiers "at five miles per hour, just like the racer at sixty, try to relax and feel the two pressure zones on the front and back of your feet over the insole of your boot."[40]

Skiing shares this "whole foot" balance with most other sports of sliding or gliding—ice skating, inline skating, nordic skiing. Pressure forward on skis causes the tails to tend to wash out. Pressure on the tails makes the skis tend to run straight. Pressure in the center—the "sweet spot"—enables the whole ski edge to work in carving a turn, and allows the skier to subtly steer the ski into a tighter or longer-radius turn.

Biomechanically efficient, a centered stance allows the skeleton to support much of the skier's weight. Besides being a lot less work, this neutral stance frees the large muscle groups to make refined movements and react to the constantly changing stresses of skiing. On the other hand, even in this centered stance we must not relax *too* much because the muscles need to act and react constantly.

Maintaining balance forward and back is more complex than it might appear. It is no great feat to balance on the whole foot while standing still. But the dynamics of turning, braking, accelerating and decelerating, the constantly changing angle of the hill, and irregularities like changing snow conditions and moguls, all add to the challenge of balancing on the "sweet spot" of the skis. When skis are pointed across a hill, they are, of course, level; when pointed down the fall line they assume the angle of the hill. And with every good turn the skis accelerate as they turn downhill, then lose speed again as they turn across or even up the hill at the end of the turn. Both this change in angle and the speed change produce an effect akin to having a rug pulled out from under you.

Thus each turn re quires an active movement of the center of mass forward and



Turn dynamics affect fore/aft balance—you can't tell whether a skier is in balance just by looking at the side view.

back (relative to the feet) if the skier hopes to remain in balance. The steeper the hill and the cleaner the turn (the less skidding or braking), the more dramatic must be the movement forward to initiate a turn. Imagine trying to stand up in the back of a pickup truck without holding on to anything. As the traffic light turns green and the driver peels out, you had better lean forward or the truck's acceleration will toss you over the tailgate. And as long as the truck continues to gain speed, you must continue to lean forward. When the truck reaches a constant speed, you will stand still in a position determined by the wind resistance and whether you are going up or down a hill. Then, just before the driver hits the brakes, you have to tilt back to avoid going over the hood. And this is not to mention the lateral movements also required for balance when the truck turns. No easy task, this, yet we ask nothing less of ourselves as we struggle for balance in the never constant arena of the mountain.

Because of these dynamic factors, it is not possible to determine a skier's fore/aft balance simply by observing body position. Any position could pressure the skis either forward or back, depending on what else is happening. A skier leaning way back on his heels will nose dive forward if he hits a patch of sticky snow, or tumble backward on a slick patch of ice. A balanced stance for a skier in a strong braking wedge is much farther back than for a skier schussing. Likewise, a skier whose turns involve fishtailing and skidding *should* stand farther back than a skier carving clean arcs; advising the skidder to move more forward is bad advice until he or she takes the brakes off (think of the pickup truck!).

Snow conditions affect fore/aft balance also. Powder is "slow" and the slightly back stance of expert powder skiers is still balanced—not leaning back on the tails as the still-popular myth would have it. Even factors like type of wax and condition of ski bases affect the stance required for neutral fore/aft balance. So—instructors please take note—a skier's posture alone is *not* a reliable indicator of fore/aft balance.

There are, however, many other clues to a skier's stance because fore/aft balance affects nearly everything a skier does. Turn shape, behavior of skis on snow, and mechanics of initiating and controlling a turn, all vary according to fore/aft stance. Edged skis pressured forward tend to wash out; skis pressured on the tails "bite" and want to run straight. Skis pressured on the "sweet spot" distribute the pressure over their entire length and carve smoothly when tipped on edge.

Skiers biased forward—leaning on the tongues of their boots—typically use some form of upper body rotation to initiate their turns and finish turns twisted uphill. The tails often wash out, especially at the end of the turn, resulting in fish-hook shaped turns. And rotation of the shoulders and hips pulls the hips out over the skis, requiring the skiers to resort to strong knee angulation as they struggle for edge angle. This knee angulation often results in an "a-frame"—a tell-tale sign of skiers too far forward. Observing any of these clues in this "package" of movements and turn characteristics should suggest that the skier is too far forward, regardless of his actual posture.

A tail-biased stance also leaves a characteristic signature. Tail-weighted skis tend to run straight, so the skier usually turns by thrusting the tails sideways, using counter-rotation. Lots of snow flies and the resulting turn shape is more a corner than an arc—the classic "z-turn." The strongly countered upper body and hips prevent effective leg steering and knee angulation. Straight legs and obvious hip angles characterize these skiers.

What, then, is the mark of the balanced, centered skier? Signs include round, carved turns, with refined steering activity coming from the legs, not the upper body, precise, progressive edging movements resulting from optimal combinations of hip and knee angulation, an aligned, slightly countered upper and lower body, and smooth, gliding transitions from turn to turn. These elegant, efficient, precise—and fast—turns can only happen when the skier maintains balance consistently on the ski's sweet spot.

While perfect turns demand perfect fore/aft balance, there are times when we will intentionally apply pressure to the front or back of a ski. The term *leverage* describes regulating pressure along the skis' length to produce certain effects or help control a turn. If I *want* the tails to wash out—for braking, to adjust line and slip sideways, to quickly tighten turn radius in an emergency, or even to purposely spin around backwards—I will lever forward. To stop a tail washout, quickly check speed, or otherwise increase tail "bite," I will lever the tails of my skis. But generally, I try to keep the pressure centered throughout most turns, with shins neutral in my boot cuffs and pressure on the ball, arch, and heel all the time.

Many myths prevail concerning fore/aft balance and leverage. Some persist from techniques of the past, others arise from misconceptions and misinformation. Racers often talk of being forward, moving forward, driving the knees, and so on. And indeed, the clean, fast turns, steep terrain, and slippery skis of the best racers require big movements forward and down the hill to start turns and a near-constant struggle to keep up with skis. It is easy to be left behind. Thus the racer's mantra is often "get forward, get forward." But they really mean "stay centered." Stephan Hienszch, former U. S. Ski Team member, director of the Mahre Training Center, and head coach of the U. S. Disabled Ski Team, has said that 95% of fore/aft movements are for balance, to keep up with the skis, and only 5% are to actually move the pressure point forward or back. And the great French ski technician and author, Georges Joubert, two decades ago declared forward leverage inefficient and "old-fashioned," twenty years out-of-date even then[41]—"the modern leg action techniques of pivoting the skis with foot steering are not adaptable to a forward weighted position."

Skiers—particularly racers—often speak of moving from the ball to the arch to the heel through each turn. Not long ago skis did not carve with nearly the ease of today's skis and some extra forward leverage made it easier to initiate a turn. That forward leverage really just helped the tails wash out a little, which in turn demanded some tail leverage to stop the washout and finish the turn. Conversely, if I start the turn centered, the tails should not wash out and I should not need to jam pressure on them to finish the turn. Just staying centered, of course, demands a lot of movement forward as the skis accelerate down the hill and then back somewhat as the skis slow again at turn completion (remember the pickup truck). And because perfect balance is so difficult to achieve, even top skiers may over-compensate and move a little too far forward into a turn or fail to keep up 100% with the skis. The resulting sensation would indeed be ball-arch-heel. But I am convinced that the best, fastest turns at any level involve a centered stance throughout each turn and through the transition to the next turn. This perfection is elusive, and it is easy to find examples of turns even at the World Cup level that demonstrate ball-arch-heel pressure. Still, I believe that most often these turns represent something less than perfection. We all make mistakes!

Other myths stem from past techniques, illusions, fads, and misinformation. "Lean back in powder." "Drive the knees forward." These myths I have already discussed. "Rücklage" (backward lean), "vorlage" (forward lean), and

STANCE-BASED MECHANICS

Stance	Rotary	Edging	Pressure Control	Turn Shape	General
Forward	• Rotation/Rotary Pushoff. • Often over-initiated. • SILR or SELR • Tails OUT—skis pivot around tips. • May use blocking pole plant.	• Knee angulation; little hip angulation. • Often a downstem at completion to set a platform. • Stationary Platform.	• Tip pressure. • Often 2-footed. • Often complete weight transfer at initiation, then falls to inside. • Up-unweighting or stepped initiation. • May use brief tail pressure to end turn.	• "Fish-hook"—shape as tails wash out at end of turn (due to rotation, forward pressure, and low edge angles). • Little control phase. • May spin out completely.	• Rotated or square stance, body facing uphill at end of turn, outside hand leads through turn. • Sometimes results from intimidation.
Back	• Counter-Rotation, heel thrust. • No leg steering. • Tails OUT. • Usually SILR. • Sequential Rotary Pushoff also possible, but less common.	• Hip angulation; little knee angulation. • Skis pushed sideways to edges. • No progressive edging. • Usually stationary platform.	• Tail pressure. • Typically 2-footed. • Straight legs make terrain absorption difficult.	• "Z"-shaped. • Skis thrust sideways and pivoted quickly, then run straight. • No control or completion phase. • Incomplete turns.	• Excessively countered stance. • Straight legs. • Often aggressive—the typical "glue-footed tail-pusher."
Centered	• Leg-steering (fulcrum); all other options available. • Tips IN (or Tails Out if defensive). • SILR (SELR also possible).	• Combination knee and hip angles allow fine control. • "Gliding Platform" as edges release to initiate turn. • Angles increase progressively. • (Other options also available.)	• Pressure on whole foot; fore/aft leverage is an option. • Outside ski balance, but all options available. • Pressure builds progressively; other options available. • Flexion-extension allows pressure regulation and terrain absorption.	• Round steered/carved turns likely. • Any size and shape possible, at skier's will.	• Stance slightly countered, *aligned.* • Pole swing/touch. • "Center Line™," but all technical and tactical options are possible too.

While there are certainly exceptions, these "packages" of movements and skier types tend to accompany forward, back, or centered stances. Learn to recognize these clues and important cause and effect relationships.

"jet turns" are all ideas from skiing's past that involved sometimes extreme forms of leverage. And some of these myths refuse to die. But true skiing perfection can only arise from the enlightenment of the balanced, centered stance.

Some good exercises and drills to develop fore/aft balance include "falling leaf," "pole boxes," "leapers," "spiess hops," 360° spins on the snow, "pivot slips" in a corridor, skating and "thousand step" turns, exaggerated forward and backward lean and movements, balancing on one ski while experimenting with holding the other ski tail, then tip, then the whole ski off the snow, and moving in balance while alternating from a hard braking wedge to a parallel glide. Skiing with boots completely unbuckled creates fore/aft balance (but it can be dangerous, as it prevents the boot-binding system from functioning as it is designed). Ice-skating, inline skating, and cross-country skiing, as well as skiing on extremely short skis, requires near-perfect balance, because there is no long tip or tail and stiff boot to hold us up. For stubborn and persistent "back seat drivers," stuffing the corner of a $20 bill between shin and boot tongue, with the rest flapping in the breeze, will keep most skiers from leaning back. If not, try a $50. (Make sure it's their money!)

See also **Leverage**.

Forward Lean Forward lean refers to the angle of the shins with the skis, determined by boot design and, increasingly, binding design. More forward lean creates a stance more power-oriented than finesse-oriented. It increases the strength of some rotary movements. Some forward lean is essential to put the skier into a natural, athletic stance. For skiers with long thighs (femurs), more forward lean in the boots allows them to flex without moving their hips (and centers of mass) too far back. Women often benefit from a little more forward lean for the same reason—their centers of mass are lower toward their hips, and more forward lean allows them to keep their hips more over their feet as they flex and extend.

As a test, try standing on a hard, level floor in your ski boots. See how deeply you can flex without falling over backward. If you can't get your knees to at least ninety degrees, try a little more forward lean. Note that heel lifts and bindings that increase forward ramp angle also increase forward lean.

Frame of Reference Because all motion is relative, measuring or analyzing any movement requires a frame of reference. Things move, stand still, or accelerate only with respect to other things. When you sit still in an airplane seat, from your frame of reference you aren't moving. Even as the plane accelerates down the runway, you remain "still," although you feel a very real force pushing you back into your seat. Of course, from the frame of reference of someone standing on the ground, you are moving very fast. And that force you felt pushing *back* doesn't exist—this observer sees only the *forward* force that makes the airplane go. Two completely different realities? Perhaps. Is one more "correct" than the other? Not at all!

> ***From an inertial frame of reference, a turning (accelerating) skier is never in balance; from the skier's accelerated frame of reference, a balanced skier never turns!***

In this example, the observer's point of view is a *stationary* or *inertial* frame of reference. Of course, even this is relative—the observer is "stationary" on a planet spinning and hurtling at thousands of miles per hour through space. Your "moving" point of view is known as an *accelerated* frame of reference. From the stationary frame of reference, the observer sees the unbalanced applied forces that cause acceleration, and understands such phenomena as centrifugal force as simply "effects" of acceleration. From your frame of reference, you experience applied and inertial forces (centrifugal force) as real forces that counteract each other, keeping you in balance and in "one place." Inertia pushes you back into your seat; your seat pushes you forward. The forces cancel each other, so you stay put, obeying Newton's First Law of Motion (a body at rest remains at rest unless acted on by an unbalanced force.)

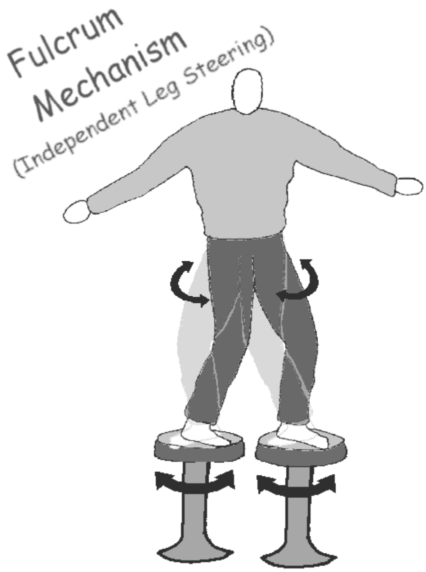
Understanding the concept of frames of reference helps us to understand inertial forces such as centrifugal force, and their roles in skiing. From an inertial frame of reference, a turning (accelerating) skier is never in balance; from the skier's accelerated frame of reference, a balanced skier never turns! Failure to consider or understand frames of reference has lead to perhaps more fruitless arguments among ski instructors than any other point. Those who argue that centrifugal force and such do not exist are thinking only from a stationary frame of reference outside the skier. That is hardly a useful point of view for understanding our movements on skis!

See **Accelerated Frame of Reference** and **Inertial Frame of Reference**.

Frost Bite A potentially serious condition for skiers, frost bite occurs when skin or other tissues freeze. It often first appears as "frost nip," pale white or waxy yellow patches on the tip of the nose, cheeks, or other exposed skin. It is very important to tell people if you see frost nip on their faces, because they cannot feel it. Caught early, it is not dangerous. Put a warm hand on the area and the color should return momentarily. Undetected, though, frost nip can become frost bite, causing significant damage to the capillaries, which then makes the person even more susceptible to future recurrences.

Frost Nip Frost nip is the early stage of **Frost Bite** (see).

Frustration While skiing can be a frustrating sport, and frustration often has a negative, self-perpetuating effect, I believe that a little frustration can be a healthy thing, and a prime motivator for learning. Because any of us has only made our best turn *once,* most of our turns don't quite measure up! We strive to repeat that "perfect" turn, but it eludes us. Knowing it's possible, though, keeps us going, growing, improving. At some point we'll be consistent at making that better turn, but long before that we'll have made an even better one. The "carrot" remains in sight, but just out of reach. So constant frustration of a sort is the mark of every good skier who continues to improve. And putting that carrot in clear view but slightly out of reach is part of the job of an instructor.



In the Fulcrum rotary mechanism, each leg rotates around a separate axis, against the resistance of the other leg. All the action takes place from the pelvis down—the upper body is not involved. Each leg rotates independently, but they can rotate simultaneously ("braquage").

Fulcrum Turn (**Fulcrum Mechanism**) Not a turn at all, "fulcrum turn" is an obscure term for an important and versatile *rotary mechanism*. Meaning simply "independent leg steering," or "foot steering," the fulcrum mechanism joins *rotation, counter-rotation, rotary pushoff, anticipation-release,* and *blocking* with a pole plant as another fundamental principle skiers can use to generate *torque* to pivot and steer skis. What distinguishes the fulcrum mechanism from the others is that it takes place entirely within the lower body, as each leg turns independently beneath the pelvis, using the other leg to support (counteract) the motion.

Often misunderstood, the fulcrum mechanism is perhaps the most essential of all the rotary mechanisms. It is the rotary principle of modern carved turns, and the key to the stable upper body and active legs of all "Center Line™" turns from wedge to dynamic parallel, as well as the mechanism of stemming and stepping movements. It is the mechanical principle of *"braquage,"* which is the special case of the fulcrum turn where both legs turn simultaneously and the skis remain parallel.

Let's look a little closer at this versatile principle that Horst Abraham described simply as "turning one foot against the other."[42] If you stand with one foot on each of two swiveling barstools (don't—you will get kicked out—trust me), and turn the stools with your legs only, you are using the fulcrum mechanism. Each stool—and each foot and leg—turns independently around its own pivot point. You can turn either one or both at the same time. You can turn them quickly or slowly, powerfully or gently. You can turn them precisely, pointing your feet any direction you choose. And the movement is entirely independent of the upper body, which can remain absolutely still, turn with the legs, or turn opposite the legs, as you wish.

Now pick one leg up off its barstool and turn the other one. It's a whole different movement, isn't it? It is no longer the fulcrum mechanism, as suddenly the upper body must come into play, countering the movement of the leg. Put both feet on one barstool, and it is the same—you again use your upper body to turn your feet. The versatility is gone. No longer can you steer the stool slowly or precisely.

So, to use the fulcrum mechanism to turn a ski, there *must* be some weight on the *other* ski and some separation between them. To turn both skis using the fulcrum mechanism, there must be some weight on each of them. Of course, if I stand on one ski and lift and turn the other, it is still the fulcrum mechanism—fulcrum is the mechanism used to guide the unweighted inside ski in high level turns. Stepping and stemming movements involve the fulcrum mechanism, as the other ski remains firmly planted on the snow to support the movement of the stemmed or stepped ski. Just remember that if we try to pivot the ski that is on the snow in a one-footed stance, we cannot use the fulcrum mechanism, and must involve the upper body.

This requirement of both skis on the snow has implications for beginning skiers. If we insist that the beginning skier lift one ski or make a strong weight transfer before turning, we eliminate the possibility of this valuable rotary mechanism, forcing the skier to use other mechanisms to turn the skis. The usual result is gross movements of the upper body and little control of turn shape. On the other hand, for more advanced skiers who rely exclusively on this mechanism, having them lift one ski can help to develop more versatility. Likewise, we can develop leg steering in skiers heavily biased toward rotary pushoff turn initiations by insisting they start turns with weight on both skis, instead of with strong weight transfers.

The origin of the term "fulcrum turn" is obscure. The movement has little to do with levers or the common "pivot point" meaning of "fulcrum." We do not turn around a fulcrum point, as some believe, as in jamming a pole into the snow and prying ourselves around it (which I call the *blocking mechanism* or *blocking pole plant)*. However, another dictionary definition of fulcrum as "one that supplies capability for action"[43] comes closer to the meaning, or at least causes less confusion in its vagueness. Each leg provides the fulcrum assistance—the "capability for action"—that allows the other to rotate.

See too **Braquage** and **Rotary Mechanisms**. Also refer to the PSIA manual *ATM Teaching Concepts (1980).*[44]

Functional Skiing

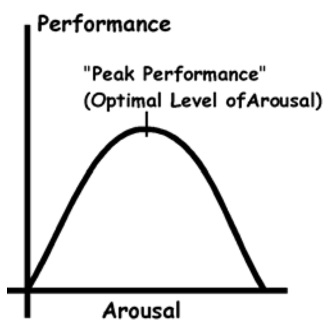
Functional skiing describes versatility and mastery of many movement options, using the best, most effective technique or tactic for any skiing situation. It is possible, especially with today's perfectly groomed slopes, to learn one type of turn only, but such one-dimensional skiers will lack the versatility to ski varied conditions. The functional skier masters many turns and in turn, masters the mountains. Functional skiing means exploring "lateral learning" as well as perfecting the "Center Line™" turn. While I maintain that, given the state of the art of equipment, the perfect turn allows little technical variation, this perfect turn is not all there is to skiing. The functional skier knows when to stop turning and hit the brakes!

Functional skiing implies versatility in blending skills and applying tactics. But despite many options, functional skiing is also free of technical biases and without extraneous movements just for the sake of "style."

See also **Situational Skiing**.

Functional Tension

Functional tension describes the level of mental and physical arousal that maximizes performance. We don't ski well so relaxed that we are nearly asleep, nor do we ski well paralyzed with fear. Somewhere between these extremes lies the optimal level of tension,



The Performance/Arousal Curve. *Performance improves with increasing arousal to the point of optimal functional tension, then begins to deteriorate. The ideal level varies with the complexity of the task—the more complicated the task, the lower the optimal level of arousal.*

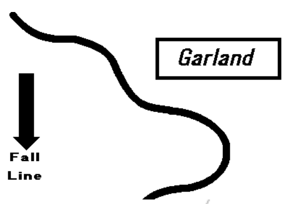
alertness and readiness for action that promotes peak performance. See the accompanying diagram, adapted from *Skiing Out Of Your Mind*.[45]

The idea of functional tension applies to muscular as well as mental tension. Too relaxed a stance (too tall, too "skeletal") interferes with muscular activity. As Georges Joubert states, too upright a stance causes "a skiing of feelings, but not of actions."[46] The proper amount of muscular tension keeps the muscles alert and ready for the quick, explosive actions of skiing.

G

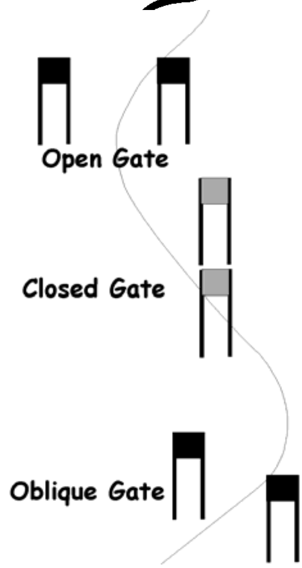
Gallwey, Tim Author of best-selling *The Inner Game of Tennis* and, with Bob Kriegel, of *Inner Skiing*, Gallwey is a renowned authority on the mental aspects of sports, developing concentration and focus, dealing with fear, and achieving peak performance.

Garland A garland is any exercise involving repeated, incomplete turns across the hill. From a traverse the skier turns downhill, but before reaching the fall line, turns back up. The tracks resemble a garland draped on the branches of a Christmas tree. Garlands enable us to practice just one phase of a turn or to practice a movement without the fear and intimidation sometimes associated with complete turns that cross the fall line.



As with any exercise involving a traverse, please beware of traffic!

Gate Gates are what racers turn around. They come in a variety of forms, and in various combinations. The simplest gates are single poles of bamboo, plastic, or plastic with a hinge at the bottom. The racer simply goes around the gate, passing left of one, right of the next, and so on.



In "amateur" racing (World Cup), gates consist of two poles or flags, which the racer must pass between. *Open gates* are set across the hill. *Closed gates* are set vertically on the hill. *Oblique gates* are set diagonally. Because the racer can pass through a gate in either direction, double-pole gates demand careful attention to tactics. Vertical combinations are a series of closed gates, as in a *hairpin,* (two closed gates) or a *flush,* (three or more).

Geländesprung German for "terrain jump," geländesprung describes springing off jumps and bumps.

Geschmozzel In the early years of ski racing, all competitors started at once in a mass start known as a "Geschmozzel start." No longer used in organized racing because of the obvious dangers, this term still well describes the chaos on a busy day at many ski resorts. A must-know word!

Giant Slalom Of the four standard alpine competitive disciplines (slalom, giant slalom, super G, and downhill), giant slalom involves the second-tightest turns. As specified by the FIS (International Ski Federation), giant slalom gates are at least ten meters apart. In timing, typical giant slalom turns (average 1.4 seconds) lie roughly half way between slalom turns (0.78 seconds) and downhill turns (2.6 seconds).[47]

Usually considered the most technical of the disciplines, giant slalom demands excellent technique and a perfect line. Great giant slalom racers carve turns with little skidding, and have a tremendous feel for tactics. In a downhill race, competitive skiers may be several yards off each others' lines, with equivalent results. In giant slalom, though, the perfect line is as important as the perfect turn, and tolerances run closer to inches than yards.

Girardelli, Marc One of the most successful and durable ski racers of all time, Marc Girardelli won forty-six World Cup Races and five overall World Cup titles (1985, 1986, 1989, 1991, and 1993). He won eleven World Championship medals, four of them gold. The only accomplishment that eluded Girardelli was Olympic gold—but he twice collected silver medals. Born in Austria in 1963, but competing since 1979 as essentially a one-man team for tiny Luxembourg, coached by his father, Girardelli won races in all four disciplines (slalom, giant slalom, super G, and downhill), finally retiring from international competition in 1997. His brilliant skiing career took its toll on his body, though, as Girardelli endured fourteen knee surgeries.

Gliding Wedge Compared to a *braking* wedge, a gliding wedge is relatively narrow and natural, with minimal edging, which allows the skis to brush smoothly over the snow. It is an offensive stance, while the braking wedge is defensive. While imparting a sense of control—the "V" only needs widening to slow the skier—the gliding wedge introduces a skier to the basic, relaxed, athletic stance and gliding sensations of good skiing. It facilitates athletic movement and balance and makes turning easy.

As important as a gliding wedge is for new skiers, without a braking wedge and the confidence that comes from knowing how to slow down, few beginners could relax and glide. Once beginners are comfortable moving in a relaxed, gliding wedge, they are ready to begin to turn. To get to this point, they usually need to learn the braking wedge, on all but the flattest terrain. Learning first turns from a defensive braking wedge is a guaranteed way to produce forever-defensive ski technique.

See also **Braking Wedge** and **Wedge**.

Glissement There is no exact English equivalent to this French word, but "gliding" comes close. We are indebted to Georges Joubert for this elegant term which refers to the techniques, attitudes, and movements that produce the fastest glide over the snow and to speed control from "direction not friction." No braking allowed! Glissement is simply good skiing.

Joubert described glissement as "the very essence, the *raison d'etre*, of the marvelous sport of skiing."[48] Glissement does not mean going fast or skiing recklessly. It implies control of speed with as little braking as possible, skiing a slow enough line as fast as you can! I can glide slowly (on a slow enough line), or I can ski fast without gliding, hacking down the mountain, skidding and braking with great effort but little control of line. "Glissement is, above all, an intention, a state of mind or a desire. 'To want to ride a fast ski' is very different from 'wanting to go fast' and even more different from the idea of 'going all out,'" declared Joubert. The aggressive racer who thrashes down the mountain, grunting and pushing, usually loses the race to the relaxed and focused skier who glides and avoids braking. The greatest racers—legends like Stenmark and the Mahre brothers, Tomba and Picabo Street,—epitomize Joubert's idea of "tranquil aggression." *Glissement* is one concept from Joubert that should forever remain in the ski instructor's vocabulary.

> "Glissement" IS GOOD SKIING!

GLM See **Graduated Length Method**.

Gluteus Maximus The "glutes" are our "butt muscles." Strong gluteus maximus muscles are important to resist the powerful forces of skiing. Often well-developed in skiers, the gluteus maximus is the part of the body primarily responsible for *"sitzmarks"* or *"bathtubs."* They are also an asset in hot tubs.

See **Lycra**.

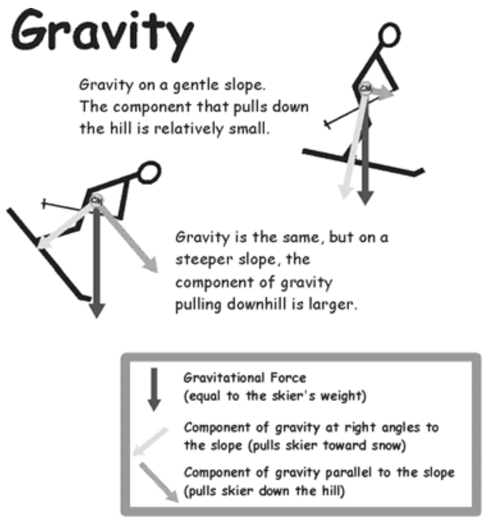
Gondola It's the "condolift," according to an anonymous five-year-old I once skied with.

Good Skiing Does good skiing defy definition? With all our options of technique, equipment, terrain, and conditions, all the various techniques of the past and present, any definition of good skiing must be somewhat subjective. Nevertheless, I think Georges Joubert's idea of "*glissement*" (see above) captures the essence of good skiing by virtually any standard, including PSIA's concept of the Center Line™. Gliding *vs*. braking, blending with *vs*. struggling against gravity, flowing smoothly, skiing the "slow line fast," offensive *vs*. defensive, carving *vs*. skidding—these ideas apply equally to the racer who wants to shave time, the recreational skier seeking grace and elegance, and the "extreme skier" in search of ultimate control down the gnarliest terrain.

Good skiing does not imply *expert* skiing. Skiers at any level can glide or brake. Beginners, of course, have no ingrained bad habits and it is part of the instructor's job to keep it that way! The Center Line™ Milestones depict good skiing with similar gliding, flowing, round turns at each level. By teaching from the very beginning skills and movement patterns that transfer to good skiing at higher levels, we avoid the need to "unteach" bad habits later.

See **Glissement**, **Line**, **Speed Control**, **Carving** and **Skidding**, and **Positive Movements**.

Graduated Length Method (GLM) The "Graduated Length Method" was a ski-teaching system introduced by Cliff Taylor in the late 1950's. GLM started students on very short skis, allowing them to develop an "instant parallel" turn without learning a wedge. The problem, as with many shortcuts, was that skiers did not learn the necessary skills to advance to expert skiing—they did not learn skills that would allow them to use the ski design and carve turns. Skiers pivoted and pushed their very short skis into braking skids—movements contrary to real ski turns. In PSIA's American Teaching System™, skiers still begin with relatively shorter skis, but we teach good skiing fundamentals from the start. With the Center Line™ concept of "common threads," skills learned at any level apply to advanced skiing, and nothing we teach should have to be "untaught" later in the student's development.



Graupel Also known as "soft hail," graupel is an unusual snow condition resembling pellets of "Styrofoam." I have also heard it described as "pretzel salt." It tends to fall heavily in brief, intense spring storms, sometimes accompanied by lightning.

Gravity Gravity, the fuel of skiing, is the phenomenon Isaac Newton first described that causes objects with any mass to attract each other. Gravity is a *force,* determined by the amount of mass of the objects and their distance apart. As a force, gravity causes *acceleration* (change of motion). On its surface, the earth's gravity is a constant force that causes objects to accelerate downward at approximately 9.8 meters per second per second (9.8 meters/sec^2).

As gravity's direction of pull is always straight down (toward earth's center), only a component of gravity's force acts to pull us down a ski slope. The rest holds us to the ground. While it is common to say that there is "more gravity" on a steeper run, it is not strictly true. Gravity is always constant, but the component of gravity that pulls down the hill is greater on steeper runs, and the component that pulls us toward the snow is less.

> ***Great skiers, and those destined to become great skiers, make friends with gravity. It is their toy.***

Great skiers, and those destined to become great skiers, make friends with gravity. It is their toy. They use skis as tools to play with gravity, turning downhill to speed up, uphill to slow down. Most skiers, it seems, think of gravity as the enemy, a force that must be overcome. And steeper slopes mean a more powerful enemy. No wonder they work so hard!

See **Newton's Law of Universal Gravitation**.

Group Teaching Style

In Group Teaching Style, the instructor forms small groups of students that work together on a task. Members of each group are assigned roles such as "Doer" and "Observer," and observation, correction, feedback, and reinforcement take place within the groups, while the teacher circulates among the groups. Differing from *reciprocal* teaching style only by using groups of more than two people, group style provides similar benefits when there is an odd number of students in the class, preventing pairing. It is a student-centered teaching style and is especially effective in developing group dynamics and developing higher levels of understanding (see **Cognition**.)

See also **Teaching Styles**.

GS

See **Giant Slalom**.

Guest Service

PSIA has recently added a "Guest Service Model" to the American Teaching System™'s Center Line™ Skiing Model and the Teaching Model. This addition is in recognition of the ski instructor's broadening role in today's ski resorts. Instructors have an opportunity not only to create better skiers, but to promote safety and to enhance the entire experience for the guests of our resorts.

Guided Discovery Teaching Style

Of the common teaching styles, guided discovery is one of the most student-centered and experience-oriented. The teacher has a goal, outcome, or answer in mind and, rather than telling the answer or demonstrating the desired movement pattern, the teacher guides the students to discover the answer on their own. This guiding may be a series of questions leading to the answer or, more likely in a ski lesson, a series of exercises and carefully chosen tasks

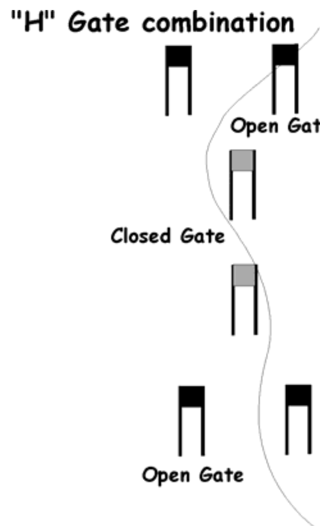
> ***Well executed, Guided Discovery can be extremely effective, engaging, fun, and confidence-inspiring for the student.***

that lead the students to discover the intended movement or sensation.

Guided discovery is especially effective when the objective is subtle and not easily demonstrated, as in leading the student to discover the "sweet spot" on the ski. Feedback is largely internal—the student must *feel* when he is doing it right, rather than having the instructor tell him. When well executed, this style can be extremely effective, engaging, fun, and confidence-inspiring for students.

Unlike *problem solving* style, in guided discovery there is only one correct "answer." The teacher waits for the answer (or the desired behavior) from the students, does not "tell" the answer, but does reinforce it when it finally arises. This style requires a thorough understanding of the topic and excellent communication skills on the part of the instructor. It must only be used when the instructor is confident he *knows* the right answer and can guide the students to its discovery. Guided discovery backfires when the students "discover" something completely different from what the instructor intends, and the effect can be confusing for the student, frustrating for the instructor.

H



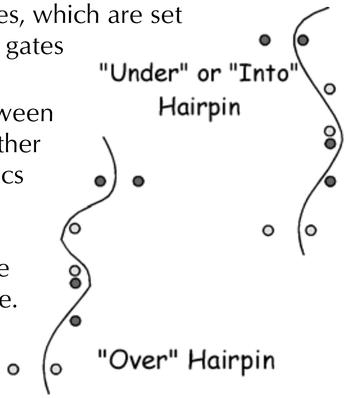
H Gate In amateur racing (World Cup), skiers must ski between a pair of gates, rather than simply passing a single gate. An H gate is a combination of gates that looks, confusingly, like the letter "**I**." It consists of an open gate (set across the hill), followed by a closed gate (set downhill), followed by an open gate, as in the illustration.

Habitual Skills These are movement patterns that are performed "automatically," the same way each time, largely as a result of "muscle memory." Signing our name, walking, engaging the clutch in a car, and chewing gum (not all at the same time) are examples of primarily habitual skills. Skiing linked turns, especially shortswing, on a consistent, groomed slope, involves mostly habitual skills. By contrast, *perceptual skills* involve adjustment or adaptation of a movement based on changing situations or conditions—running through a dry creek bed, driving someone *else's* car that we're not used to, and so on. In skiing, moguls, changing conditions, terrain transitions, and tree skiing require highly developed perceptual skills. All skiing, in truth, involves a combination of practiced, habitual skills, and at least fine-tuning or adjustment of those movements based on feedback and perception.

See also the related concepts of **Closed Loop** and **Open Loop Task**.

Hairpin

A hairpin is a gate combination used frequently in World Cup slalom races. Like a *flush,* a hairpin is a "vertical combination," meaning it consists of a series of *closed* gates, which are set vertically on the hill. A hairpin is two closed gates set in the fall line.



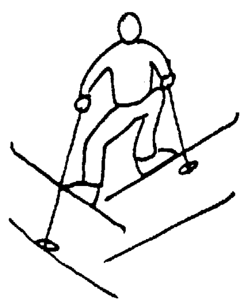
In double-pole courses, the racer skis between the two poles of each gate, and can pass either direction through a closed gate. So the tactics for skiing a hairpin depend on the gates before and after. In an *over hairpin*, the racer passes above the upper pole of the first gate of the hairpin, before skiing through the gate. In an *under* or *into hairpin*, the racer goes directly through the first gate.

Hamstrings

The hamstrings are the large muscles of the back of the thigh, opposite the *quadriceps.*

Hanger Turns

"Hanger turns" are an exercise similar to "*White Pass turns,*" in which the skier stays on the downhill ski to initiate a new turn, rather than transferring weight to the uphill ski. It often appears as an exaggerated lean of the upper body into the new turn (downhill) prior to releasing the edge of the downhill ski. Unlike the White Pass turn, in hanger turns the uphill edge of the old turning ski is not released until the new support foot is established. This movement exaggerates the "crossover" of the center of mass and is a good exercise to develop movement of the upper body into a new turn, as well as to develop balance and independent leg action.



Herringbone

Hemispheres of the Brain

The brain is physically divided into two halves, connected by a fibrous tissue called the *corpus callosum.* Evidence suggests that the two hemispheres play different roles in our consciousness. See **Left Brain** and **Right Brain**.

Herringbone

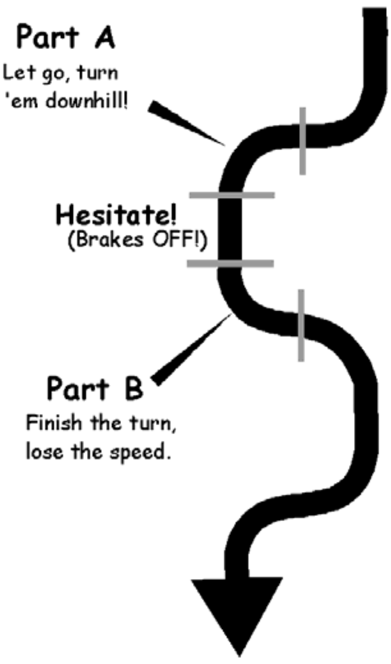
This term well describes a way of walking uphill on skis by spreading the tips apart and walking like a duck. The expression arises from the tracks left behind, which resemble the shape of the bones of a fish.

Hesitation Turns

These are turns in which the skier pauses for a moment while the skis are pointing straight downhill, letting the skis run straight down the fall line briefly before completing the turn. The resulting turn shape is not round but somewhat "squared."

As an exercise, hesitation turns develop the patience needed for a gliding, round turn shape for the skier who habitually rushes through turns to avoid gaining speed—it's the cure for the ubiquitous "Z-turn." Hesitation turns can also cultivate the feel that most turns have two distinct phases—a relaxed phase when forces pull us *into* the turn, and a "pressure"phase when we resist forces that pull us out of the turn (see **First Half** and **Second Half**). In addition, practicing these turns can develop the ability to steer the skis with the legs—it is nearly impossible to stop turning and restart smoothly using rotary pushoff, rotation, counter-rotation, or anticipation-release as the only rotary mechanism.

It should be obvious that this exercise will only work on terrain where the student feels comfortable enough to let 'em run. On the right terrain, hesitation turns are great fun as skiers develop a new sense of control—ironically, by "letting go."



Hesitation Turns

Hip Projection

Hip projection is any movement of the hips forward, "up," and/or to the side, to produce unweighting or momentum to the side, as in the "cross-over" movement into a new turn. Because the center of mass is near the hips, and the hip area represents a substantial portion of the body's weight, any movement of the hips will have a profound effect on balance. The cross-over movement into a new turn must be precise and accurate in timing, direction, and intensity to produce a clean turn and maintain balance.

Hip Rotation Hip rotation usually describes a rotary mechanism used to initiate a turn. A form of **rotation** (see), it involves first rotating the hips, then transferring their rotational momentum to the skis by slowing or stopping the hip rotation.

Hockey Slip Having little to do with hockey, this exercise is similar to *hockey stops,* except that the skis are kept relatively flat, allowing them to side-slip freely, rather than braking to a sudden stop. This is a good exercise to develop edge sensitivity, fore/aft balance ("*leverage*"), upper-body/lower-body independence, and a variety of simultaneous rotary mechanisms. The most control and precision in a hockey slide result when the pivoting comes not from the upper body (*rotation*, *counter-rotation*, or *blocking pole plant*), but from simultaneous leg steering (*braquage*—the "*fulcrum* mechanism"). When linked together, hockey slides become the exercise known as *Pivot Slip*.

Hockey Stop Like stopping on hockey skates, this movement involves rapidly pivoting the skis and digging in the edges to stop very quickly, with a spectacular spray of snow. As an exercise, hockey stops can develop gross rotary skills, upper-body/lower-body independence, stance, and rough edging skills. In high level "real skiing," this braking move is at best reserved for emergency stopping. A favorite of teenagers, especially to spray their brother, sister, or instructor with snow, we should discourage such activity because of the dangers involved should the skier lose balance and collide with his "target."

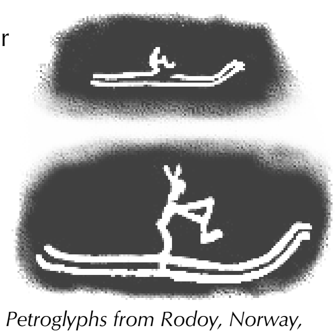
Note that the hockey stop is not a *turn*. With skis pivoted sideways and no direction change (skier skids straight to a stop), the movements are contradictory to those of turning. Unfortunately, many skiers think of the real turn as some sort of refined hockey stop. It isn't! Refining the hockey stop merely leads to better and better braking which, as I have often said, is the opposite of turning!

Holistic Holistic refers to *holism*, the doctrine that the whole is greater than the sum of its parts. Holistic teaching involves the whole person—body, mind, and spirit. A holistic approach to ski teaching recognizes that each student combines a unique attitude, personality, learning style, and motivation, along with a unique level of athletic ability, and that optimal learning can only occur when all these factors are addressed.

Holism also refers to teaching whole movements, as opposed to breaking complex movements into smaller "chunks" or positions. We learned to walk holistically. We did not first learn to stand on one foot, then on the other, then alternate between the two, then move forward as we alternated, then learn to use our hands, and so on. We did not practice the "right foot forward position," then the "left foot forward position." While it often is effective to break movements into simpler parts, the human body is pretty good at learning complex whole movements. Modern ski teaching recognizes this concept and we tend to teach far more holistically than in former days.

Although they represent a progression of skill refinement, the Center Line™ Milestones are holistic. They are all complete, linked turns and total body movements. There is nothing to add, no "next step," and no Milestone is a static position or portion of a turn. Contrast these with a progression in which we attempt to develop an advanced turn by practicing first a straight run, then a traverse, then a traverse with an uphill ski lead, then with "angulation," then with "reverse shoulder," then arcing uphill from a steeper traverse, and so on, until all the "positions" of the turn have been perfected separately. Rarely is this approach as effective as a more holistic strategy. The best instructors artfully combine holistic teaching with breaking down movements when necessary to encourage optimal learning and performance.

Hoting Ski The oldest known skis ever found, dating back to the Stone Age, have been unearthed in peat bogs of Scandinavia. 2500 years old, the Hoting ski, found in Sweden, is believed to be the oldest of them all. It is a short, wide ski, no doubt meant for transportation rather than pleasure. As ancient as the Hoting ski is, rock carvings and petroglyphs found in various regions of the arctic suggest that skiing of some sort has been around for at least 5000 years.



Petroglyphs from Rodoy, Norway, approximately 4500 years old.

Hourglass skis "Hourglass" is one of many names used to describe the new, deeper sidecut skis of today (see **Shaped Skis**). While the sidecut of these skis is much more pronounced and their hourglass figures are obvious, it is important to note that skis have for many years had narrower waists and wider tips and tails. The concept of sidecut is not new, but today's skis have much more of it than skis of just a few years ago.

Humanistic Humanistic teaching is person-oriented, as opposed to technique-oriented. It acknowledges the individual interests, desires, abilities, and goals of people. The American Teaching System™ is a humanistic approach to teaching skiing. We don't teach skiing to people. Quite the opposite—we teach *people* to ski!

Contrast with **Mechanistic**.

> ***We don't teach skiing to people—we teach* PEOPLE *to ski!***

I

Ice The definition of "ice" seems to depend on what part of the world you come from. Those who complain about ice in Colorado have never experienced real "eastern" ice (see **Black Ice**). Let's just say that "ice" refers to any hard, "loud" snow condition where the skis may have difficulty gripping.

Ice is the opposite of crud and heavy powder, where the skis simply won't go sideways. On ice, they go sideways all too easily. Ironically, the strategies for both extremes are quite similar. Neither condition forgives poor technique, but good, offensive, carved-type turns work for both. In crud, we can't make the skis skid. On ice, we can't get them to *stop* skidding. Obviously, the solution is—*don't skid!* Whether the skill level is wedge turns or World Cup, we *must not push skis sideways* on ice. Brakes don't work!

As I have often noted, though, most skiers at all levels make some sort of skidded, defensive turn, regardless of the conditions. It isn't that ice and crud are so difficult, it's that these conditions simply bring out the weakness of their techniques.

Of course, if ice makes us defensive it is difficult, even with sound fundamental habits, to make offensive gliding turns. Like hitting a patch of ice on a road when driving a car, I may suddenly wish I wasn't going so fast, but the worst thing I can do is hit the brakes. Learning not to panic is the first step for skiing—or driving—on ice.

Given strong, accurate fundamentals, ice is still challenging. Sharp edges, perhaps even filed to an acute angle, and narrower, torsionally stiff skis tend to hold best. Traditional wisdom says to get on and off the edges quickly. In this light, slalom turns with brief, staccato edgesets often work better than longer turns. Even these “harsh” edgesets, though, must be delicately and smoothly applied. Practice “soft” edgesets by simply sinking quickly toward the skis, rather than “pushing” on the skis (*never* push on the skis!). When the edges bite, they will push back like springboards, rebounding you into the next turn.

Ice demands solid foot-to-foot movements. Balance exclusively on the outside ski lets its edge dig deeper into the ice, and allows the inside ski to act as a backup, should the outside ski slip away.

Longer turns *are* possible on ice, of course—World Cup giant slalom race courses sometimes resemble tilted skating rinks. Perhaps the ultimate test, long turns on ice require strong edge angles combined with extreme edge sensitivity and the ability to fine-tune the edge angle continuously.

Watch great racers ski on ice—usually their preferred condition for racing. Legends like Ingemar Stenmark, Marc Girardelli, and Diann Roffe-Steinrotter epitomize the ability to relax and react, to be “soft” even while fiercely competing “on the edge.”

ILA

“Independent Leg Action” (see).

Inclination

1. Horst Abraham defines “inclination” as “leaning into a turn [that] allows a skier to balance/compensate/offset the effects of centrifugal force.”[49] While we can accurately use this term to describe a tipping or leaning of a specific part of the body, for example “incline the lower leg,” generally the term implies a tipping of the whole body, or more accurately, of the center of mass, into a turn. It should be clear that inclination is totally independent of *angulation*—we can incline with or without angulating and we can angulate with or without inclining. Inclining without angulating is known as “banking.”

Some sources confusingly define inclination as the opposite of angulation—angulation implying leaning part of the body into a turn, and inclination implying leaning the whole body into the turn without angulating (which I call banking). They suggest that we can choose between angulation and inclination to control edge angle. Such a definition ignores the common use of the term “inclination,” which implies nothing about how joints are bent. Inclination simply means a “lean.” I can obviously lean whether flexed or extended, angulated or not.

Suggesting that inclination and angulation are equivalent options for edge control also ignores some basic physical laws. Since inclination is a balancing move, its amount governed by the forces of the turn, it cannot be *adjusted* to control edge angle. Inclining, of course, does *affect* edge angle and may indeed be the primary cause of edging and edge change movements from turn to turn. But for a given point in a given turn, there is only one correct degree of inclination that produces balance. If I need more edge angle—or less—I must *angulate*. Some argue that we *incline* to produce edge angle, then angulate to maintain balance. I say, first of all, "who cares?" And second of all, if this is so, why do we lean into a turn when riding a bicycle, when walking, running, roller skating, standing on a bus or subway, or driving a car? To produce edge angle? No—it's to balance, of course. Inclination is clearly a balancing move. Angulation is an edge control move. The two have dissimilar purposes and cannot substitute for each another.

2. Along with sidecut, flex, and curves, you might say that "inclination" is a desirable trait in Ski Bunnies. Or you might not.

See also **Angulation** and **Banking**.

Independent Leg Action (ILA)

This term refers to moving the legs independently of each other, as in stemming and stepping movements. Sometimes called "Sequential Leg Rotation" (SELR), the subtle distinction is that ILA movements are not restricted to "1-2" actions in which one leg follows the other. ILA implies that each leg is truly autonomous. Contrast with **SLR** ("*Simultaneous Leg Rotation*"), in which the two legs act as one.

Braquage (simultaneous leg steering) involves ILA, even though the action is simultaneous, as each leg rotates independently around its own axis.

Independent Leg Steering

The most important of all *rotary mechanisms* for contemporary skiing, independent leg steering involves the legs rotating about separate axes in the hip sockets. Each leg provides the resistance against which the other turns. It is versatile, precise, powerful, continuous, and entirely independent of the upper body. It can involve either leg or both, turning sequentially or simultaneously. No other mechanism for turning the skis (*rotation, counter-rotation,* or *blocking pole plants)* provides such precision and versatility.

Although "independent leg steering" probably describes the action best, the traditional name is "**fulcrum turn**" (see), a term that causes unending confusion! It is unfortunate that such a simple and essential action is so commonly misunderstood.

See **Rotary Mechanisms** (specifically the *fulcrum mechanism)*.

Individual Teaching Style In this teaching style, the student performs a task and critiques his own performance, followed by evaluation of the critique from the instructor. The variable manipulated here is that of feedback—which comes not primarily from the instructor or someone else, but from within the student. This teaching style develops self-confidence and independence from the instructor. It cultivates kinesthetic sensitivity and self-awareness. Individual teaching is the style that teaches students to teach themselves.

Often misunderstood (it is not just a private lesson), Individual Teaching Style is an essential step in weaning the student from the teacher, enabling the student to practice and perform independently.

Inertia Inertia is "the tendency of a body to resist acceleration; the tendency of a body at rest to remain at rest or of a body in motion to stay in motion in a straight line, unless disturbed by an external force."[50] Inertia is a function of the mass—for practical purposes, the weight—of an object. When an applied force causes us to accelerate, we feel inertia as an equal force directly opposite the applied force. When an airplane takes off, the seat pushes us forward, but we feel pushed back into the seat.

Inertia is easily confused with *momentum*. An intrinsic property of an object, determined solely by its mass, inertia does not change unless the object's mass changes (it loses or gains weight). Momentum is related to motion—it is the product of an object's mass and its velocity. Momentum changes any time a force applies to alter an object's motion. And the momentum of a motionless object is zero, regardless of its mass and inertia.

See **Inertial Force**.

Inertial Force Inertial forces are the apparent forces we feel whenever we change speed or direction (whenever we accelerate), as a result of *inertia*. Whereas applied forces *cause* acceleration, inertial forces are the *result* of acceleration. Inertial force is what presses us back into our seats when an airplane accelerates down the runway for takeoff. It is the force that spills coffee and pushes all the change sideways off the dashboard when we turn a car too sharp. It is the force we lean in against when we make a turn, or back against when we put on the brakes. Inertial forces result from acceleration and must balance the applied forces for equilibrium (balance) to occur.

Because they are not applied forces, some argue that inertial forces do not exist. On the contrary—any analysis of technique must consider inertial forces and how the skier deals with them. If inertial forces did not exist, the inclining skier would fall on every turn! Mechanical analysis must involve a frame of reference. We usually analyze ski technique—and certainly experience our *own* skiing—from the moving ("accelerated") frame of reference of the skier. Our struggle to remain upright is a constant effort to balance applied and inertial forces. From this point of view, inertial forces are as real as any other force, and it makes perfect sense to refer to them as actual forces. In skiing, the primary inertial force we encounter is centrifugal force, resulting from turning. We feel centrifugal force pulling us out of a turn, at right angles to the direction we are going, and must lean in ("incline") to offset the force and stay in balance.

See also **Force**, **Applied Force**, and **Centrifugal Force**.

Inertial Frame of Reference

All motion is relative, as objects move and accelerate only in relation to other objects. To analyze the mechanics of skiing, we must first agree on a frame of reference. We must designate something as "unmoving," relative to which everything else moves or doesn't move. The inertial ("stationary") frame of reference is the viewpoint of an observer standing still (more precisely, moving with the earth). From this frame of reference, understanding skiing becomes an analysis of the movements of the skier down the slope, including the skier's velocity and accelerations, and the forces that cause these accelerations. From this inertial frame of reference, the only forces affecting the skier are gravity, interaction between skis and poles and the snow, and wind resistance. Such things as *centrifugal* force do not exist—they are merely effects of acceleration, not *motive* forces that cause acceleration. And the skier is not in "balance," because only "unbalanced" forces can cause turns or changes in speed. This inertial frame of reference defines the earth as the "unmoving" reference point, while the skier moves and accelerates relative to the earth.

The other important frame of reference in skiing is the *"accelerated"* frame of the skier. This is the actual frame of reference from which we experience life! As far as the skier is concerned, he is not really moving—no matter where you go, or how you accelerate relative to other reference points, you are still "here," from your own perspective. From this frame of reference, inertial "effects" like centrifugal force become "real" forces, pushing against us, that we must lean against for balance.

> ***Nothing is really, truly "stationary"—except in relation to something else.***

To get a little more technical, an inertial frame of reference is defined as one in which Newton's Laws of Motion apply. In other words, in an inertial frame of reference, objects always remain at rest or in constant, straight line motion, unless an external motive force applies to change that motion. If you drop a ball, it goes straight down, acted upon only by gravity. But imagine you are in a bus, going around a curve. Now you drop a ball and it goes *sideways* (from your accelerated frame of reference). Whenever the bus is speeding up, slowing down, or turning, Newton's Laws of Motion appear not to apply. If you put the ball on a tray in front of you as the bus drives straight down the road, the ball stays "still," at "rest" on the tray. Then suddenly the ball rolls off the tray, for no apparent reason, clearly violating Newton's laws! Of course you know that (from an inertial frame of reference) it was the *bus* that changed speed or hit a curve, not the ball. And the Laws of Motion held true. But from your accelerated frame of reference, the ball moved, of its own accord.

To make Newton's laws work again, we must define the force that causes the ball to move. This force is *inertial* force (centrifugal force). Inertial force does not exist from an inertial frame of reference (the ball did not accelerate relative to the earth), but it is very real from an accelerated frame. You saw the ball move, and you clearly felt the same force trying to push or pull you.

This technical digression, intriguing or not, may seem irrelevant to skiing. But it is important to understand which frame of reference we are assuming, whenever discussing motion or the forces that affect it. Two instructors describing skiing from differing frames or reference are doomed to a pointless argument, even when both are correct!

See also **Accelerated Frame of Reference** and **Frame of Reference**.

Initiation Phase

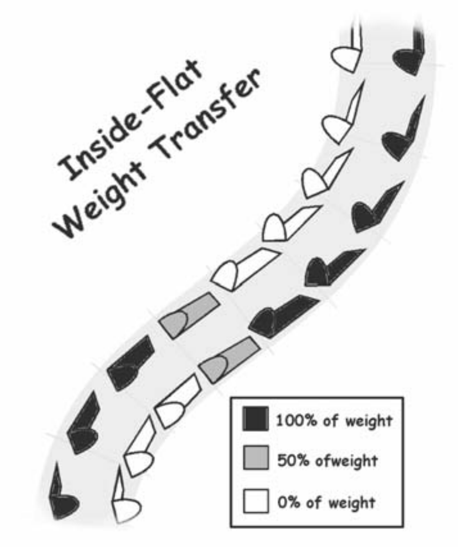
As defined in the American Teaching System™, this is the second of four phases of a turn (after "preparation"), but the one that marks the actual beginning of the turn's arc. During initiation, the skis flatten and then change edges; cross-over occurs. Although weight transfer generally occurs in this phase, there is little, if any, pressure on the skis. Rotary skills in this phase complement gravitational pull into a turn and may consist of gentle guiding or powerful "turn initiating mechanisms," depending upon the nature of the new turn and how quickly the skier wants to get it started or over with. Although many of the movements of the initiation phase began in the *preparation* phase (pole swing and crossover, for example), the actual *release* of the downhill ski and the start of the direction change marks the beginning of the initiation phase. The pole touch or pole plant, if there is one, occurs most often in the initiation phase.

See also **Preparation Phase**, **Control Phase**, **Completion Phase**, **Turn Phases**.

Inner Skiing

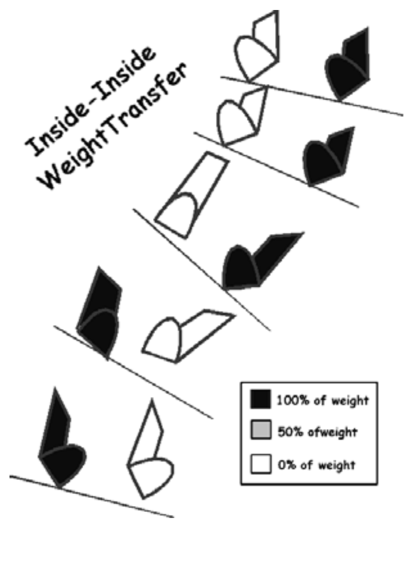
Inner Skiing is the best-selling book[51] by Tim Gallwey and Bob Kriegel dealing with the mental side of skiing and performance, including fear, self-talk, concentration and focus, and relaxation. *Inner Skiing* introduced the concept of "Self 1" and "Self 2," the sometimes antagonistic divisions of our psyche that can help or hinder performance. Sometimes maligned for its lack of hard technical advice, the book was not intended to substitute for or replace accurate understanding of ski technique. It is recommended reading for all skiers and instructors.

Inside-Flat Move



One of three basic options (see also *inside-inside* and *inside-outside* move) for initiating a turn, the inside-flat move involves a weight transfer from the inside edge of the old turning (downhill) ski to a flat new (uphill) ski, resulting in a smooth, gliding, immediate but gradual entry into the new turn. Racers may use this move in sections where the gates are moderately offset across the hill. Perhaps the most common weight transfer of advanced skiers when free-skiing, the inside-flat move describes the roll from edged skis to flat skis of Center Line™ turn initiations.

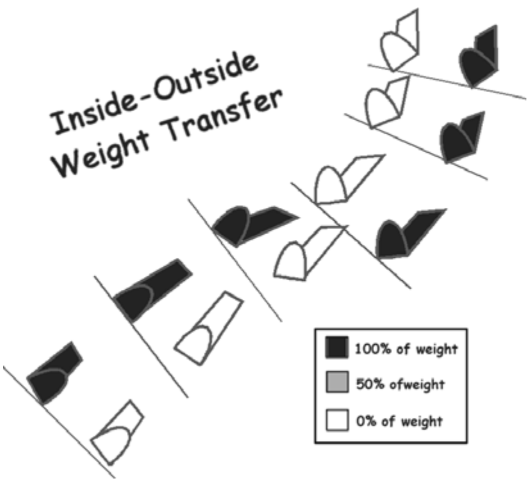
Inside-Inside Move



This turn initiation describes a deliberate weight transfer from the inside edge of the old turning (downhill) ski to the inside edge of the new (uphill) ski, resulting in a very quick entry into the new turn.

Because the new ski is on edge immediately, it must receive pressure immediately so it can bend and carve, otherwise it will not turn and the skier will fall to the inside. This need for immediate pressure implies that the move must usually occur when the new ski is near or even past the fall line, after some forces have developed to the outside of the turn (see diagram under **Force)**. Racers employ the inside-inside move especially in sections where the gates are offset only slightly from the fall line. The inside-inside move is also characteristic of slalom or shortswing turns. This move often combines with a converging step to allow the new ski to be correctly oriented to the fall line, enabling immediate pressure as soon as the ski touches down (see **Converging Step**).

Inside-Outside Move The third option for weight transfers, the inside-outside move is a deliberate move from the inside edge of the old turning (downhill) ski to the outside edge of the new (uphill) ski. The result is a delayed and gradual entry to the new turn as the skier glides on the new ski before crossing over, flattening the ski, and eventually rolling it to the inside edge. Racers may use this move when gates are far off-set across the hill, often with diverging skis (*scissor step* or *skating step*) in order to maintain speed and gain height between turns or to recover when "off line."



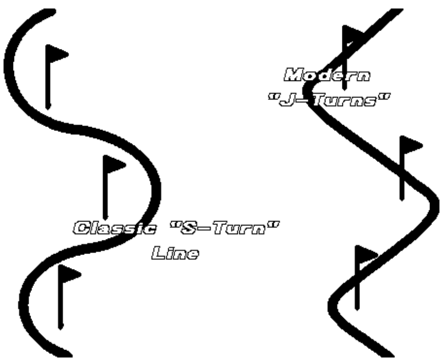
Internal Rotation Internal rotation means "turning in," usually referring to a leg or foot. When both skis turn the same direction, the outside leg rotates internally (also known as *medial rotation)* while the inside leg rotates externally *(lateral rotation)*. When making a wedge, both legs rotate internally.

Interski The "Olympics of ski instruction," Interski is an international gathering, every four years, of ski instructor "demonstration teams" representing most skiing nations, to share information and compare techniques and teaching strategies and to celebrate the sport of skiing.

Inversion Inversion is one of the two basic movements of the foot. Describing the action of turning the sole inward, it is a complex movement involving many joints in the foot and ankle. Inversion combines *medial rotation* (toeing in), and *supination* (rotating the big-toe-side of the foot upward. The opposite of inversion is *eversion*, turning the sole outward. Other foot movements involve the ankle joint or combinations of several joints.

J

J-Turn This term describes the modern slalom racing turn that has evolved with the advent of the flexible "rapid gates," along with improvements in the edge-holding capability of today's skis. Because the new gates bend and swing out of the way, modern racers can essentially go right over them with their bodies, getting only their skis to the outside of the gates. A much straighter line is possible, where the racer aims nearly straight at the gate then jams the edges for a very quick, harsh turn. The resulting turn shape is roughly "J-shaped," in contrast with the smoother round or "S-shaped" turns of classic skiing.



Jammed Thumb When we wrap our hand around a ski pole, the thumb remains exposed and very vulnerable to injury. A jammed thumb, sometimes sprained or broken, is one of skiing's most common injuries. Some pole grips and protective gloves have been designed to help minimize the risk, and some skiers choose not to wear their pole straps so they can jettison the pole in a fall.

Javelin Also called "javelin turn," this is an exercise in which the inside ski is lifted and turned to cross the front of the turning ski. Javelin turns help develop good stance and hip alignment, and improve balance and independence in the legs.

Jet Turn "Jetting" refers to directing the rebound energy released after an edgeset such that the skis and the skier "shoot" forward, exploding out of the turn. Properly executed, a jet turn is a highly refined movement in which the skier is in dynamic balance at the end of a turn. Because it may appear, especially in still photographs, that the skier is sitting back and applying strong tail pressure, many skiers have wrongly adopted a "sitting back" stance based on a misunderstanding of the dynamics of the turn. This misconception reached fad proportions in the 1970's, when ultra-high-backed boots appeared on the market to provide more rear support, along with the dubious "Jet Sticks" that attached to the rear of boots for the same purpose.

It is important to understand that, while statically the skier may be sitting back, in a dynamic sense he is in balance. The skier is not "leaning" on the backs of the boots. If executed properly, in the "next frame" the skier's hips will have caught up, crossed over, and moved into proper alignment for the pressure phase of the next turn. Jetting is a subtle, delicate, advanced movement requiring perfect timing and balance.

Joint A joint is a union of two or more bones. While some joints, such as those that join the bones of the skull, are immovable, most allow motion in one or more planes. Components of most joints include the bones involved, as well as connective ligaments, slippery cartilage, and lubricating synovial fluid produced in tissues and small sacs called *bursae.*

Freely movable joints, called "diarthroses," include most of the important joints of skiing. They come in several basic forms, allowing more or less complex motion. *Hinge joints*, such as the knees, elbows, and fingers, allow flexion (bending) and extension (straightening), although the knee allows a limited amount of rotation as well. *Pivot joints,* such as the vertebrae in the neck, allow rotation. *Gliding joints (plane joints),* such as the wrist and ankle, allow bone surfaces to slide over each other. The thumb is a *saddle joint,* which allows limited motion about several axes and gives us our opposable thumbs. The joints that allow the greatest range of motion are the ball-and-socket joints of the hip and shoulder. Ball-and-socket joints allow *flexion* and *extension*, *rotation*, *abduction* (moving limbs apart) and *adduction* (bringing them together). *Circumduction*, as in swinging the arms around in circles, is a combination of all these movements.

Many movements, especially of the hands and feet, are complex combinations of motion in several joints. To understand the movements of skiing, it is important to understand the capabilities and restrictions of the many joints involved.

Joubert, Georges A major contributor to our understanding of skiing, Georges Joubert is a French skiing technician, coach, and prolific author responsible for many of our modern concepts of ski technique, as well as many of the more obscure technical terms so popular among ski instructors. Joubert has been coach and director of the French National Alpine Team and Director of Skiing at the University of Grenoble. With at least eight books on skiing to his credit, Georges Joubert is one of the truly influential figures in the evolution of ski technique and teaching. While his most recent work, *Skiing, An Art . . . A Technique,*[52] is now twenty years old, most of its ideas are refreshingly current.

K

Kanone Here's a word for the collection. According to *The New Invitation To Skiing* (1953), a Kanone (plural *Kanonen*) is an "expert skier, usually an old-timer."[53] I guess it would take one to know one!

Kick Start A good kick start in a race involves thrusting the upper body forward and pulling with poles, then at the last possible moment, pulling the skis through the wand to start the clock. As the upper body drives downhill, the feet and ski tails kick up slightly. Properly done, a good kick start shaves mere hundredths of a second from a racer's time—but that is often all that's needed in the close world of competitive ski racing. Unfortunately, a perfect kick start takes lots of practice and perfect timing. Many racers, in their attempts to imitate a kick start, actually end up losing time more often than not.

Kick Turn Kick turns are made while standing in place, by lifting first one ski and turning it 180°, then standing on it and turning the other. They are useful for turning around while standing on the edge of a trail, or to link traverses down a steep slope. Kick turns are simple, but they can result in tangled falls until the skier masters the technique. Practice them on gentle hills before using them on the steeps.

Kinematics Kinematics is the study of motion itself without regard to the masses and forces involved. Calculating the current speed of a car that started at sixty miles per hour, then accelerated one mile per hour faster each second for a minute, for example, would be a typical kinematics problem. (The answer is— 120 miles per hour.)

Kinesiology Kinesiology is the broad study of human movement. Beyond just the biomechanics, kinesiology addresses physiological, psychological, even sociological, cultural, and aesthetic influences on human movement.

Kinesthesia Kinesthesia is the awareness of our bodies' relative positions and movements. Through sensors (*"proprioceptors")* located in muscles, tendons, and joints, we feel movement and "know" what position our body is in. Some people are more acutely tuned to the kinesthetic sense than others. Skiing, being a sport of sensation, requires a strong kinesthetic sense—we have to know what a good turn feels like.

See also **Proprioception**.

Kinetics Kinetics is the branch of mechanics that deals with the effects of energy and forces on material objects. The term commonly, but not necessarily, refers to the molecular level and the effects of temperature and pressure on the rates of chemical reactions.

KISS Principle "Keep It Simple, Stupid."

> ***"Everything should be made as simple as possible, but not simpler."***
> ***—Albert Einstein***

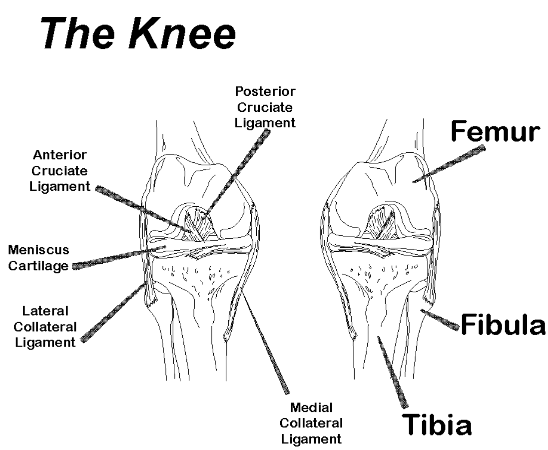
Learning to ski should be simple! Even for verbally-oriented students, there are few movements that can't be described in very few words. Many instructors seem to forget that all their hard-learned, and perhaps profound, wisdom is of little interest to their students, who only want to know what to do to get better! My advice to fellow instructors: never use a word longer than four syllables unless your student brings it up first. Especially with all the technical, specific terminology that is the subject of this book, please do not be tempted to actually use most of these words in a ski lesson!

On the other hand, this rule does not suggest that studying the details is not important for instructors. The need to keep it simple is no excuse for instructors not to know what they're talking about! Clarity follows only thorough comprehension. In skiing, as in many things, only those who deeply understand the subject, with all its details and nuances, can really present the simple essence to their students. Those who comprehend, for example, the basic principles of physics, are much less likely to confuse their students, even if they never mention "forces" or "center of mass" in their lesson. Scientists develop laws not to complicate matters, but to explain and simplify them! Nothing remains complex, once it's understood.

Albert Einstein said, "Everything should be made as simple as possible, but not simpler." Simplicity does not justify inaccuracy!

Klammer, Franz Austrian World Cup downhill racer, Franz Klammer's Gold Medal run in the 1976 Olympics will be remembered as one of skiing's greatest performances. Klammer's edge-of-disaster style inspired a new era of excitement in the downhill.

Knee Possibly the most important and most vulnerable joint of the body as far as skiing is concerned, the knee is a hinge joint that articulates the femur with the tibia and patella. It is the largest moveable joint of the body. As a hinge, the knee's motion is restricted to *flexion* and *extension*, although a small amount of *rotation* and lateral movement is also possible. Because the upper and lower leg are such long levers, it is easy to create extraordinary stresses on the knees—even more so with the long levers skiers attach to our feet (see **Phantom Foot** and **ACL**).



To minimize injuries, we should develop techniques that do not require the knees to move in ways they are not designed. Strong angles, especially to the side, put the knees in vulnerable positions. Skiers who rotate their upper bodies cannot create much angulation from their hips, so they often resort to severe knee angles for edge control. Their knees are at their most vulnerable just when the forces they must resist are at their greatest—a recipe for disaster.

Knee Angulation Since a healthy knee bends sideways to only a very slight degree, what we call "knee angulation" is a complex movement. It certainly appears in some skiers that their knees flex sideways. But knee angulation involves a normal hinge action of the knee combined with a rotation of the femur in the hip socket. Try it—lift your leg and bend the knee, then turn your thigh toward the other knee. The knee does not bend sideways.

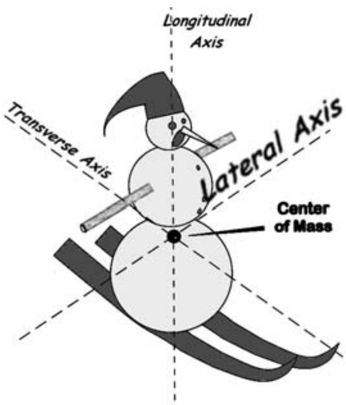
Because rotation in the hip socket is part of proper knee angulation, a well-aligned stance is essential. A stance with too much hip counter, or excessive lead of the uphill, inside ski, locks the knee and prevents knee angulation.

Kriegel, Bob With Tim Gallwey, Bob Kriegel co-authored *Inner Skiing,* arguably the best book ever written on the mental side of skiing.

L

Lateral Axis Of the three perpendicular reference axes that pass through the body's center of mass, the lateral axis is the one that passes horizontally from left to right.

See **Anatomical Reference Axes**.



Lateral Balance Lateral balance refers to balancing movements side-to-side, including balancing on one ski, movements from foot to foot, weight transfer, crossover, and stepping movements. Proper stance, a disciplined, stable upper body, and effective use of the poles greatly aid a skier's lateral balance.

Most good skiing involves balancing predominantly on the inside edge of the outside ski, all the way through each turn. To develop this skill, traverse a gentle slope (watch for traffic) while lifting the uphill ski. The goal is to leave a clean, gently curved track with the uphill edge of the downhill ski. Practice both ways. If you have trouble, check fore/aft balance (the lifted ski should be about level) and upper body alignment. Hips and upper body should be slightly countered (face downhill) and the uphill hip, shoulder, and hand should be higher than the downhill, at about the same angle as the slope.

Other exercises for improving lateral balance include traversing on the *uphill* ski, lifting the inside ski through turns, skiing on one ski only, skiing on the inside ski, skiing without poles, "thousand-steps," "leapers," "javelins," skiing blindfolded (with a trusted guide!), and many more.

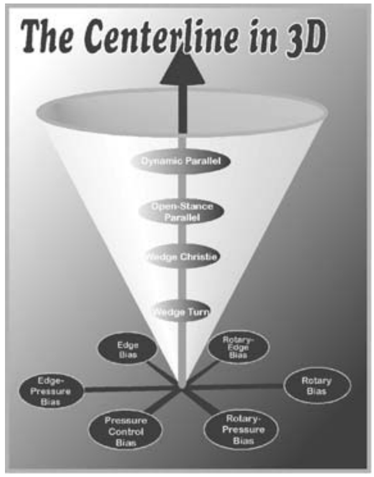
Lateral Exploration Synonymous with *"lateral learning,"* lateral exploration implies that there is no one correct way to ski. In PSIA's Center Line™ Skiing Model, lateral exploration literally means exploring the regions off, or "to the side of," the Center Line™ itself. The Center Line™ specifies certain movement patterns and a balanced blend of the basic skills (rotary, edging, and pressure control), but there are many other options and types of turns. To ski the whole mountain effectively, enjoy a range of speeds and turn types, and conquer all the conditions the alpine environment throws at us, we must master a variety of techniques and skill blends. Gliding movements, braking movements, offensive and defensive movements, simultaneous and sequential movements, edge/pressure dominant, Center Line™, and rotary dominant skill blends, all are valid and viable technical and tactical options in different situations. While perfect "Center Line™ turns" may be efficient, fast, and beautiful, skiers who restrict themselves to only one type of turn, terrain, or condition will never attain the versatility and true mastery that mark the expert.

Lateral exploration contrasts with *"linear learning,"* which implies moving "up" the Center Line™, working to improve the same set of skill blends and movements, rather than exploring new options.

See also **Lateral Learning** and **Center Line™**.

Lateral Flex Lateral flex refers to a ski's resistance to bending *sideways,* carefully controlled in the design and engineering of the ski. See **Flex**.

Lateral Learning Lateral learning is the concept of exploring technical and tactical options to develop a broader base of skills, as opposed to developing skills to a higher level (*linear* learning). Lateral learning implies "away from the Center Line™" and develops different movement patterns and skill blends. Linear learning is moving "up" the Center Line™, raising the skill level of the "same" movements and skill blends. For example, we could choose to develop a student at the wedge christie level into a "parallel" skier (linear learning, moving toward the next Center Line™ Milestone), or we could choose to explore a variety of terrain, speeds, or conditions with wedge christies, or to play with different options for making wedge christies—different turn initiating mechanisms, use of edges, different shape and radius turns, pole use, and so on. The second lesson plan would result in lateral learning. We can envision lateral and linear learning graphically, as in the accompanying diagram.



The complete skier explores both up the Center Line™ ("linear learning"), and throughout the cone of movement options ("lateral learning").

Recognizing the concept of lateral learning helps us meet the needs and goals of our students. We help develop more versatile skiers. We are better able to teach them what they want, as well as what they need. Different movement options enable the skier to experience a variety of terrain and conditions. Given modern snowmaking and grooming, we can teach most people to make a parallel turn in just a few days (linear learning only), but it is all too easy to develop one-dimensional skiers with little versatility—skiers who are out of their element when they encounter anything the groomers have not freshly buffed. By planning our lessons to encourage both lateral and linear learning, we develop well-rounded, complete skiers.

See also **Center Line™** and **Lateral Exploration**.

Lateral Plane

Of the three perpendicular reference planes that bisect the body, the lateral plane divides the body into equal halves fore-and-aft. It is defined by the *longitudinal* and *lateral* axes, which pass at right angles through the center of mass.

See **Anatomical Reference Planes** and **Anatomical Reference Axes**.

Lateral Collateral Ligament

One of the knee's four major ligaments, the lateral collateral ligament (LCL) forms the outside "side" of the knee.

See diagram at **Knee**.

Lateral Rotation

See **External Rotation**, and contrast with **Medial (Internal) Rotation**.

Lateral Step

Literally a step to the side, a lateral step involves picking up a ski and moving it sideways before putting it back down and transferring weight to it. Also known as a parallel step, it is usually a step from the downhill ski at the end of a turn to the displaced uphill ski in order to gain height on the hill, adjust line, or to recover balance. Although it is an advanced way to initiate turns, beginners use the same movement as they sidestep up a hill. Once very common in racing, steps in general occur less often today. Because they tend to interrupt the smooth flow of the center of mass down the hill (toward the finish line), steps can actually slow a racer. For the free-skier also, stepping movements have their limitations. In powder, crud, or moguls, simultaneous, turn initiations are usually a better tactic. When combined with a twist of the body, a lateral step can generate rotary momentum through the mechanism of *rotary pushoff*.

See also **Converging**, **Diverging**, and **Parallel Step**.

Law of Conservation of Momentum

See **Conservation of Momentum, Law of**.

Law of Gravity

See **Newton's Law of Universal Gravitation**.

Lawrence, Andrea Mead

One of the all-time great American ski racers, Andrea Mead Lawrence was the gold medal champion in both slalom and giant slalom in the 1952 Olympics in Oslo, Norway. So dominant in the slalom, she was able to overcome a first run fall with a two-second margin of victory in the second run.

Laws of Motion

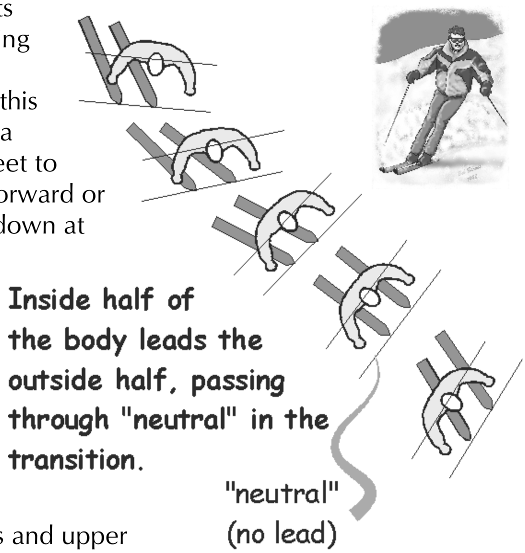
See **Newton's Laws of Motion**.

LCL

See **Lateral Collateral Ligament**.

Lead “Lead” is the tendency of the uphill ski in a traverse or the inside ski in a turn to move ahead of the other ski. Although not long ago ski lessons would spend repetitious hours perfecting the “traverse position” with a precise amount of lead, it is really a very natural phenomenon. If you stand on any flat surface and lift one foot, it tends to move in front of the other. In a traverse, the uphill foot is, of course, higher than the downhill foot. It would be most unnatural to lead with the downhill foot in a traverse. And as I incline into a turn, the inside leg is bent and shorter than the outside leg, so it likewise wants to move ahead of the outside leg.

Lead, and a change of lead from turn to turn, also results from the independent steering of the legs characteristic of modern skiing. To visualize this concept, imagine sitting on a chairlift and pivoting both feet to the left. Don’t move them forward or back—just turn them. Look down at your feet and notice that the left foot now leads the right. As you slowly turn your feet to the right, the lead changes, after passing through a neutral point when your skis point straight ahead. The result of active legs working beneath stable hips and upper body, this smooth change of lead, flowing through neutral, is obvious when you watch top skiers today. It does not happen in skiers who generate the turn with their upper bodies, through rotation of the shoulders, arms, or hips.



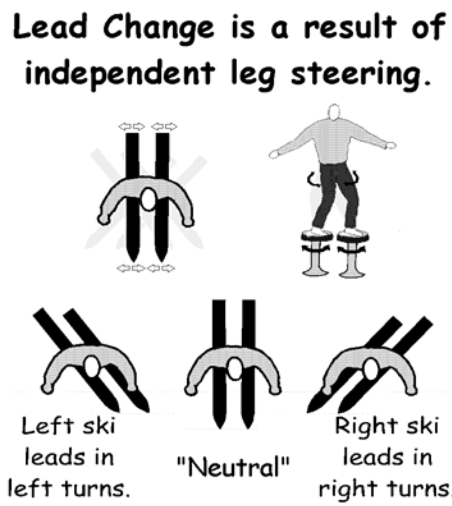
In contemporary skiing, the rest of the body usually mimics the lead of the feet (see **Alignment**). In other words, the inside ski, foot, knee, hip, shoulder, and hand should all align above and ahead of their outside counterparts, by about the same degree. This also is a natural tendency. It too is the result of steering the skis with the legs as opposed to throwing the whole body around into a turn.

So what is the optimum amount of lead? Again, the key word is “natural.” When steering the skis with the legs, the amount of lead will be proportional to the width of the skier’s stance—skiers with wider stances will have more lead than those with narrower stances. (See the accompanying illustration—following page—of the skier standing on barstools. Clearly, the farther apart the stools, the more one foot will be ahead of the other when both are turned.)

Too much lead causes excessive countering in the hips, which limits mobility and makes effective knee angulation biomechanically impossible. And because it uses up the rotation available in the hip socket, too much lead prevents effective steering of the outside ski through a turn. On the other hand, *no* lead, or not enough, usually means the hips have rotated, which moves them out over the skis and prevents effective hip angulation.

Lead change is the natural *result* of proper turning mechanics. It is a sign of good technique. But it is not the *cause* of a turn. Turning the skis with the legs causes a lead change; pushing one foot ahead of the other (or pulling one back) is not the same. Some skiers and instructors today dwell on the concept of "foot shuffle," but they often miss the point. To think that changing lead is an important thing to do to produce a good turn is to confuse the cause with the effect.

Lead Change The lead of the inside ski and inside half of the body obviously changes from one turn to the next. In most turns, this change of lead is the natural result of the steering of the feet with the legs, independently. If you sit on a chairlift with your feet hanging freely below you, and you turn both feet first to the right, then to the left, you will notice a clear lead change. Some in the skiing world have recently focused on the lead change itself, suggesting some sort of "foot shuffle" as part of initiating a turn. This focus is misplaced. It often results in an overly countered stance, with too much lead, which causes the problems with angulation and steering discussed above under **Lead**.



Leapers Leapers are turns initiated with a leap off the snow. Edge change takes place in the air, so the skier takes off from one set of edges and lands on the other. The skis should continue to point the direction they're moving throughout the take-off and landing (they should not pivot in the air and land sideways). This exercise is excellent for developing an accurate flow of the center of mass from turn to turn with good extension, as well as increasing flexibility and extending the range of motion, improving balance, and learning accurate rotary movements at turn initiation. Fun and instructive variations include mid-air weight transfers (leaping from one ski to the other), leaping from one or the other ski or from both, leaping from bumps, and leaping from skidding skis *vs.* from stationary platforms.

Learning

The dictionary defines learning as "the acquiring of knowledge or skill."[54] As ski instructors, our job is less to "teach" than to facilitate learning. Unfortunately, some students do not realize that learning is *their* responsibility—we can only help, but they must do the learning. Learning to ski is an active, participatory process—we cannot "be taught." Sometimes our highest priority is not to teach students to ski, but to help them learn how to *learn*.

See **Learning Styles**.

Learning to ski is an active process—no one can "be taught."

Learning Styles

Learning theorists identify four basic ways people learn: through *Concrete Experience* ("The Doer"), *Active Experimentation* ("The Feeler"), *Abstract Conceptualization* ("The Thinker"), and *Reflective Observation* ("The Watcher"). (See *Skiing Right*[55] for a discussion of these styles, and a test to determine your own preference.) They suggest that most people favor one or more of these categories, and that if we can determine the preferred "modes" of our students, we can modify our teaching styles and methods to their benefit. We can explain to the "thinker," demonstrate to the "watcher," experiment with the "feeler," and ski 'till we drop with the "doer."

While this concept is obviously valid, don't most of us learn different things differently? We may prefer one mode when studying physics and quite another when learning to ski. In tests (see *Skiing Right*, page 86) designed to identify individuals' preferred learning styles by asking questions about how they learn, it is remarkable how closely the results of strong skiers match—nearly all seem to favor Concrete Experience ("Doer") and Active Experimentation ("Feeler"). But ask those same people to take the same test, considering instead how they might learn something like physics. Their results usually change. A "thinker" may like to ask a lot of questions and may want to know all the technical details about skiing, but any experienced instructor knows that until this student shuts up, stops thinking, and just skis, he will not improve and often gets frustrated and regresses.

We simply cannot learn to ski just by thinking about and understanding what is supposed to happen. We *must* ski—we must experience the sensations. Thus, sometimes getting students to learn means not catering to their preferred learning styles, but teaching them how to learn, making them understand that they must adopt a more effective and appropriate learning style if they really want to learn to turn.

Think of a ski lesson as involving two distinct types or phases of learning. The instructor may want a student to practice a particular exercise to improve a certain skill. The student must first learn to do the exercise—the first type of learning. *Then* the student must actually *do* the exercise—over and over and over— to develop the skill and become a better skier. Appealing to the student's individual learning style will help teach the exercise. But for the exercise to actually develop skiing skills, all students must become Doers. Only then does real ski learning begin. Learning the exercise is only the beginning of learning—not the end!

> ***"For a man to attain to an eminent degree in learning costs him time, watching, hunger, nakedness, dizziness in the head, weakness in the stomach, and other inconveniences."***
>
> *—Miguel de Cervantes (Don Quixote)*

Left Brain The brain is physically divided into two separate but connected hemispheres. Evidence suggests that the two halves have different roles in thought, performance, and learning. The left hemisphere of the brain appears primarily responsible (in most people) for verbal, rational, numerical, and analytical activity. The right hemisphere is the artistic, holistic, intuitive brain. It is responsible for coordinating physical movement, perceiving spatial relationships, and other activities essential to skiing. Rational, logical, linear, mathematical, the left brain sometimes interferes with such activities as art, music, dancing, and sports like skiing. Too much emphasis on left brain activity causes the dreaded "paralysis through analysis."

Leg Steering (Also known as "*independent leg steering*" and the "*fulcrum mechanism*.") Just like it sounds, leg steering simply means pointing your skis the way you want them to point, using your legs. Fundamental to modern ski technique, leg steering is the rotary mechanism that allows us to shape turns precisely and continuously, while allowing the skis to carve as much as possible and allowing the skier to maintain a well-aligned athletic stance.

Unlike rotation and counter-rotation, leg steering is independent of the upper body. Each leg turns separately, primarily in the hip socket, using the other leg to provide the resistance or "counter-force." Either leg can turn, or they can both turn together.

Leg steering is the simplest, most direct way of controlling the direction the skis point. It can be very powerful, completely passive, or anything in between. As a skier skis through a modern turn, the legs and feet rotate relative to the pelvis and upper body. It matters not whether the skier muscularly forces the skis to turn, or whether the skier just stands on them and allows the sidecut to turn the skis—the movement is the same.

Leg steering is a descriptive term for the rotary mechanism traditionally known as *fulcrum turning* or *braquage*. Because these obscure terms are easy to misunderstand, I much prefer the simple term "leg steering" or "independent leg steering."

See a thorough discussion of leg steering and other mechanisms under **Rotary Mechanisms**.

Levels of Cognition

See **Cognition** and **Bloom's Taxonomy**.

Leverage

Part of the skill group of *pressure control,* leverage involves controlling where the skis are pressured along their length. Skis perform differently when pressured forward, aft, or center. Pressure the front of the ski and it tends to become unstable. The tip bites in and the tail wants to wash out. Pressure the tails and the skis tend to run straight. Somewhere in between is the "sweet spot," where modern skis usually perform their best and carve the cleanest turns. It is important not only to find this sweet spot but also to explore the effects of pressuring different parts of the ski—to learn to tighten the turn radius by pressuring forward, to stop a tail washout with a little tail pressure, and to subtly regulate pressure on the ski for maximum performance.

Leverage does not imply leaning back or leaning forward necessarily—I can pressure the tail of my ski by pushing my foot forward, or just by pushing down with my heel, as well as by leaning back. In addition, if the skis accelerate (as in a sudden steeper drop, or the start of a turn), pressure will build on the tails if I don't move forward—like having a rug pulled out from under me. If the skis suddenly slow down (as in the end of a turn, or crossing a "sticky" spot on the snow), pressure will move forward, even with no change of body position. Likewise, forward and back movements of the body may not necessarily change pressure distribution on the skis, due to the dynamics of the turns and accelerations of the skis. The skier must develop a fine sense of balance fore and aft, moving forward into a turn to stay balanced on the skis as they accelerate down the fall line. If—and only if—the skier is balanced, subtle leverage becomes possible as a tool to help control the turn.

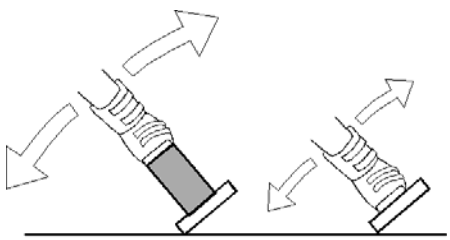
In the history of skiing, various forms of leverage have moved in and out of style. "Vorlage" (forward lean), "rücklage" (backward lean), and everything in between, has at some time constituted the vogue of popular technique. Modern skiing emphasizes balance on the *whole* foot, focusing pressure on the "pressure center" of the ski—the sweet spot. Maintaining balance on the whole foot throughout the turn and from turn to turn demands extremely accurate movements of the center of mass. Today's great skiers usually apply leverage only subtly, using active steering and edge angle adjustments instead to control turn shape. World Cup racers display an astonishing ability to control the pressure within millimeters, even as the skis jam on edge, rocket out of turns, and negotiate rapid terrain changes.

See also **Fore/Aft Balance**.

Lift

Lifts are, of course, the contraptions that get us to the top of the mountain without our having to hike there. In the Arlberg Technique days, "lift" also referred to an unweighting move to help get the skis skidding sideways into a turn.

And now we add a third definition. A recent phenomenon, lift refers to raising the boot higher on the ski, through the use of platforms and plates on or beneath the binding. Lift accomplishes two things. It provides increased edge-holding power, making the ski act more like an ice skate. And it allows the skier to tip the ski onto more extreme edge angles without the boot hitting the snow and causing "boot out." Boot manufacturers are also experimenting with adding lift inside the boots, like elevator shoes.



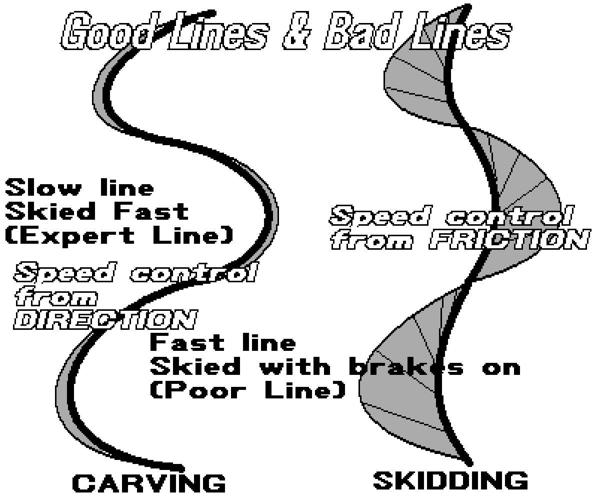
"Lifts" increase edging power, but decrease edging quickness.

To visualize why the ski holds better with lift, imagine a ski a foot wide, with the binding mounted in the center, as usual. Imagine the effort required to tip this plank up on its edge. Now imagine a three-foot-tall platform on top of the plank, with the bindings mounted on top of the platform. Like standing on top of a bench, it would be far easier now to tip the tall ski. The lever arm between your leg and the edge of the ski is extended, so you have much more power to tip the ski.

But nothing comes for free. Like using a longer wrench, you gain power, but lose quickness. Your leg must move farther to tip the ski the same amount. Rapid edge changes become more difficult. And without lift, all you need to do is relax your ankle and the ski will flatten somewhat, releasing the turn. With significant lift, it is sometimes more difficult to let go of a turn, especially when out of balance. Also, more edge power can produce tighter turns, heightened g-forces, and increased chance of injury. On racing circuits, the FIS now limits the amount of lift racers are allowed to use.

Ligament

Ligaments are the tough, elastic tissues that connect bones to bones in joints.



Line

Line refers to the skier's path down the hill, through the moguls, or through the gates of a race course. Choice of line is one of the most important tactical decisions a skier can make. There are fast lines and slow lines. "Good" skiing generally involves skiing a "slow line fast," allowing the skis to glide, as opposed to skiing a fast line slowly, skidding around with the brakes on. Expert skiers adjust their line to slow down; most skiers just apply the brakes.

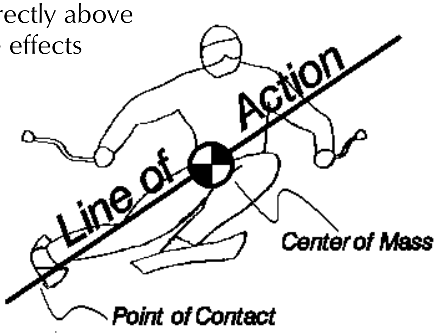
> ***Good skiing means skiing a "SLOW LINE FAST"; poor skiing is skiing the "FAST LINE SLOW."***

Line of Action

The line of action is an imaginary line passing through the balanced skier's center of mass and the "point of contact" (usually passing through the edge of the "sweet spot" of the outside ski). It is the angle of our push on the snow through our ski edges, and it is the line along which the *reaction force* of the snow pushing on the ski edges acts.

The angle of this line reflects the degree of inclination into a turn as well as the movements of the CM to maintain balance during speed changes. A plumb line suspended from the center of mass would indicate the line of action, and if it passed through the "sweet spot" the skier would be in balance. The line of action will be vertical only when the skier is not accelerating (turning, slowing down, or speeding up). Otherwise the CM must deviate from directly above the point of contact to counter the effects of acceleration.

In order for the skier to remain in balance, all flexion and extension and angulation movements must occur in such a way that the CM moves along the line of action. Otherwise the point of contact will change and the skier will be out of balance. If the point of contact moves outside the "*polygon of sustentation*" (see), the skier is falling!



Linear Learning

Linear learning means moving to a higher skill level, "up the Center Line™," as opposed to *lateral learning*. Linear learning is doing the same thing better; lateral learning involves doing something fundamentally different. Great skiing requires learning in both directions—learning and becoming expert at many different movement patterns and skill blends.

With today's great equipment and perfectly groomed terrain, most students can advance quickly through the "Center Line™ progression" (wedge turn, wedge christie, open stance parallel, dynamic parallel). But these turns all, by definition, involve the same fundamental mechanics. These students progress, certainly, but this purely linear learning yields one-dimensional skiing. To become complete skiers, they need to explore the rest of the playing field, experiment with alternative skill blends, speeds, conditions, and terrain (lateral learning).

See also **Lateral Learning** and **Center Line™**.

Lock-Step Practice

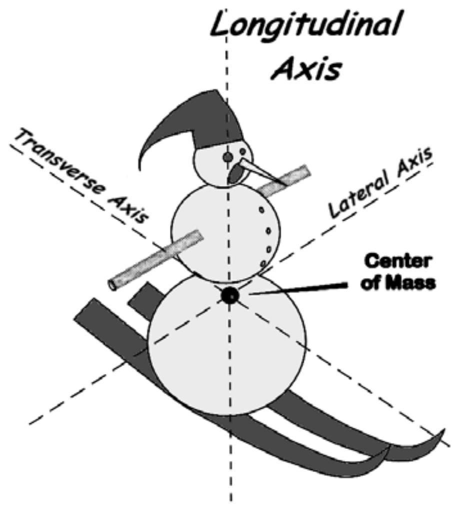
Also known as "structured practice," lock-step practice is the first stage of effective practice, during which the teacher gives constant feedback and direction to ensure that the movement or concept is done correctly. Once the student can perform the task with sufficient accuracy, practice can become increasingly independent. In the first stages of learning, the student is highly vulnerable to learning and practicing mistakes. Lock-step practice is an important step to get students on the right track.

See **Practice** and **Basic Practice Model**.

Locked Stance

A "locked" or "closed" stance is one in which the skier clamps his or her legs tightly together so they act as one. Long ago considered stylish, the locked stance virtually eliminates a skier's ability to carve clean turns and exploit the design of modern ski equipment. It ignores the natural advantages of having evolved into bipedal (two-legged) creatures.

See **Closed Stance**.



Longitudinal Axis

The longitudinal axis refers to the long axis of an object—head-to-toe on the body, the center of the length of a ski, hip-to-foot on the leg, and so on.

See **Anatomical Reference Axes**.

Lycra

Also known as "Spandex," Lycra is a truly momentous advance in ski attire technology from DuPont, bringing new meaning to such terms as "waist," "sidecut," "curve," "flex," and "smooth bottoms," and vastly improving the overall skiing experience. Unlike other ski wear, Lycra is most functional when worn by someone else. Should not be worn by everyone.

Lycra should not be worn by everyone.

M

Mahre, Phil and Steve

Twin brothers Steve and Phil Mahre, born May 10, 1957, are two of the most successful ski racers America has ever produced. Steve won numerous World Cup races and took World Championship gold. Phil was the overall World Cup champion for three consecutive years, 1981-83. In their final year of amateur competition, in the

1984 Olympic slalom in Sarajevo, Yugoslavia, Phil and Steve combined to claim both the gold and the silver medals, respectively.

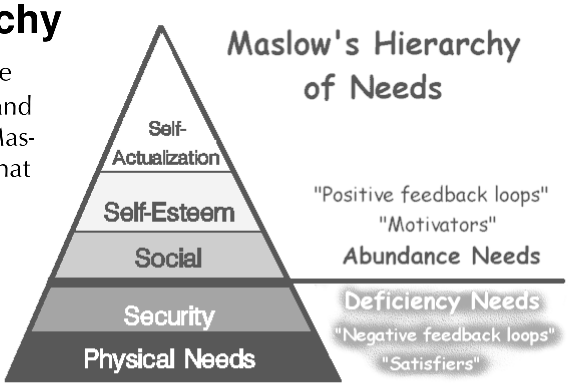
After retiring from World Cup competition, the Mahre brothers founded the Mahre Training Center at Keystone, Colorado, to share their passion for and knowledge of skiing with the recreational skiing public.

Mahre Training Center The Mahre Training Center is a multiple day skiing camp that takes place in Keystone, Colorado, based on training techniques and concepts Steve and Phil Mahre used in their quests for World Cup, World Championship, and Olympic success. The Mahre Training Center's simple approach emphasizes balance fore-and-aft, weight transfer from foot to foot, and "up/down motion" as the three fundamentals of skiing. While the terminology and emphasis may differ somewhat from that of PSIA, the basic goal of clean, functional skiing is shared by both the MTC and PSIA.

The Mahre Training Center employs specific exercises and progressions, tailored to students at different levels, along with gate drills, exploration of the mountain, video, and indoor sessions, in the pursuit of sound basic skiing skills. Guided discovery, exploration of the range of movements and options, and a focus on kinesthetic awareness help develop versatile, balanced foundations for skiing.

Mashed Potatoes "Mashed potatoes" describes perfectly the consistency of a certain heavy, wet, sticky snow condition. Usually the result of a heavy but warm, humid snowfall, mashed potatoes are typical after late spring storms. Especially common in the coastal mountains of northern California, mashed potatoes are also known as "Sierra Cement."

Maslow's Hierarchy of Needs From the study of human behavior and educational psychology, Maslow's Hierarchy suggests that some human needs are of greater importance than others and must be satisfied before "higher" needs become priorities. The needs for food, shelter, warmth, acceptance, love, sur-



vival, safety, self-esteem, and so on, are much higher in priority for most people than the need to learn to ski. By making sure that the more basic needs are met, we create an environment that encourages success.

Abraham Maslow (1908-1970) was a prominent American psychologist recognized for advances in humanistic psychology and for his studies of human motivation, "self-actualization," and "peak experiences." Maslow's theories play a major role in modern American ski instruction. Maslow would have categorized learning to ski as a "growth" or "abundance" need. Once the basic "deficiency needs" (survival, safety, belonging, and self-esteem) are met, Maslow postulated, there is an unbounded human drive for intellectual achievement, aesthetic appreciation, and "self-actualization"—to "be all you can be." Only then does learning such things as skiing become important.

Deficiency needs operate with *negative feedback*—once we have enough the need is satisfied and eliminated. Growth needs, like skiing improvement, create *positive feedback*—getting some stimulates a desire for more and more, as long as lower level needs remain satisfied.

See also **Motivation**.

Mass

Mass refers to the quantity of matter of an object. It is proportional to an object's *weight*, and we often think of the two terms as equivalent. But mass is unrelated to gravity, so an object has the same mass when "weightless" in outer space as it does on earth. Mass is responsible for *inertia*, which is an object's resistance to changes in motion (acceleration). More massive objects require proportionally greater forces to undergo the same acceleration.

Massed Practice

Massed practice refers to extended practice sessions in large doses with little or no break. Contrast with **Distributed Practice**, which describes breaking up the practice into several briefer segments. Generally, massed practice is less efficient as far as learning per time spent practicing, although many new skills require a good initial dose of massed practice. Introducing new movements or skills requires sufficient initial practice that the student gains some consistency and proficiency and gets a feel for the movement. It is a common mistake to press on to a new topic or another step in a progression once a student has performed a move only once or twice.

On the other hand, when we see the same student days, weeks, or years later, a massed practice session on the same movement would be less effective than a few intermittent, brief distributed practice sessions to refresh and reinforce the movement pattern.

See **Practice**, **Distributed Practice**, and **Simpson's Psychomotor Objectives**.

Mastery

Mastery, as defined in the *Mastery Learning Model* of direct instruction (see below), is the level of learning at which students can practice accurately and independently. Mastery of one or more specific objectives should be the goal of all ski lessons, so the instructor can be confident that students will not practice mistakes, and that real learning will continue after the lesson.

Mastery Learning

Defined by Benjamin Bloom and John B. Carroll in 1971, and based on extensive research by Bloom, Carroll, and others, Mastery Learning is a teaching strategy based on the concept of *Direct Instruction*[56] (see). Mastery Learning has proven particularly effective at developing psychomotor skills, and PSIA has embraced many of the concepts of Mastery Learning in developing the *ATS Teaching Model*.

The premise of Mastery Learning is that, given sufficient time and effective instruction, most students can achieve *mastery* of a subject. Mastery is defined as the ability to practice a newly learned concept independently of the teacher's feedback, with a high degree of accuracy and consistency. At the core of Mastery Learning is a unique definition of *"aptitude"* as the amount of time required for an individual to learn something. Thus Mastery Learning requires flexibility to allow for the different learning speeds of individual students. In addition, the model requires breaking an educational topic into "chunks"—clearly defined, relevant objectives that students can master in an allotted time. In a lesson, the instructor clearly communicates these objectives with the students. The teacher is responsible for clear presentation and demonstration of the information, checking for understanding, and for providing feedback and practice time until the students achieve mastery.

Following established principles of *practice theory* (see **Basic Practice Model**), the instructor shapes behavior through three levels of practice. The first step, "lock-step practice," involves constant, close feedback to ensure that the students learn the correct skills and do not make mistakes. "Semi-independent practice" follows, during which the students practice more on their own as the instructor continues to give feedback, but less continuously and intensely. When students are consistently correct (85-90% accuracy), they are ready for "independent practice"—"homework" on their own without the watchful eye of the instructor. They have attained mastery. The next feedback they receive from the teacher will be in a review at the next lesson!

See also **ATS Teaching Model**, **Direct Instruction**, **Practice**, and **Basic Practice Model**.

Mastery Teaching Model

Now known, in modified form, as the *ATS Teaching Model*, PSIA's Mastery Teaching Model was an early adaptation of the principles of *Mastery Learning* (see above) for ski teaching. In 1989, Steve Still of the Vail Ski School formulated the Mastery Teaching Model as follows:

The Mastery Teaching Model

1. **Introducing the lesson**—The instructor is able to
   - establish rapport between self and students, and between students and students.
   - create an open, friendly, and supportive lesson environment.
   - describe the product that the student has purchased.
2. **Determining goals**—The instructor is able to
   - assess each student's level of skiing ability.
   - ascertain and guide the student's expectations for the lesson.
   - assess source and level of student motivation.
   - set appropriate goals based upon the student's ability and expectations.
   - state goals to the group and to individuals.
3. **Planning the lesson objectives/activities**—The instructor is able to
   - select appropriate terrain and snow conditions.
   - generate a logical progression relevant to group and individual goals.
   - break lesson content into short meaningful chunks that can be mastered.
   - determine the pacing of information, practicing and skiing.
   - utilize the concept of lateral learning to determine objectives/activities.
4. **Presenting information (telling how and why)**—The instructor is able to
   - present information in a clear and concise manner.
   - make the material meaningful by providing the student with a rationale for the activities.
   - recognize student learning styles and utilize the appropriate teaching styles.
5. **Demonstrating**—The instructor is able to
   - demonstrate the "Center Line™ Model" and "Ski School Levels."
   - demonstrate from a variety of viewer perspectives (front, back, side) that give the student a clear, meaningful picture.
   - demonstrate technique/mechanics appropriate for the snow conditions and skill level of the students.
   - focus the student's attention on the appropriate portion of the demonstration.
   - demonstrate the appropriate mix of skills (pressure, edging, turning, and balance) for the selected task.
   - effectively use role model tapes to create a clear image of achievement (e.g. Sybervision, etc.)
6. **Practicing**—The instructor is able to
   - set a practice task at an appropriate level of difficulty.
   - design short practice periods so that students can focus with intent to learn.
   - provide specific and immediate feedback to students.
   - understand and apply principles of reinforcement.
   - guide initial practice and set students up for proper independent practice.
   - utilize massed practice for new learning and distributed practice for old learning.
7. **Checking for understanding**—The instructor is able to
   - verify student understanding based on physical behavior consistent with lesson objectives.
   - verify student understanding based on verbal responses consistent with lesson objectives.
   - utilize a variety of question asking techniques.
8. **Summarizing the lesson**—The instructor is able to
   - review the lesson objectives and communicate the degree of accomplishment to group and individuals.
   - preview the next learning steps and encourage further development.
   - establish independent practice guidelines for each student.

In addition to steps 1-8, the Mastery Ski Teacher utilizes the following educational concepts to enhance learning:

A. **Teaching for Transfer**—The instructor is able to
   - understand the concept of transfer in learning.
   - draw on the student's previous learning to facilitate present learning (positive transfer).
   - recognize when previous learning hinders present learning (negative transfer).
   - teach in the present to optimize positive transfer for future learning.

B. **Extending Thinking, Learning, and Performance**—The instructor is able to
   - utilize Bloom's six levels of cognition to help students think creatively, solve problems, and make satisfying and productive decisions with their skiing.
   - utilize appropriate elements of contemporary sport psychology to help students develop mental skills and strategies.
   - model consistent behaviors, attitudes and values resulting in a more powerful teaching and learning experience.
   - utilize Maslow's Hierarchy of Needs in the teaching process.

These eight points do not represent a linear "checklist" of steps that must take place one at a time. Instead, they describe essential elements that contribute to successful lessons. If we want to best help students—if we want them to succeed and come back for more—we must learn to consciously or unconsciously apply all the elements of the Mastery Teaching

Model in every lesson. We may cycle through some of the points several times and return to previous points. We may combine several points at once or address a point continuously and indirectly throughout the lesson. But if we skip a part, we must use good judgement regarding the needs, goals, and desires of the individual students (it would be justifiable to skip "demonstrating" for a blind student, for example).

Since 1989, PSIA has simplified this model to the seven points described under *ATS Teaching Model.*

See also **Practice**, **Basic Practice Model**, **American Teaching System™**, and **ATS Teaching Model**.

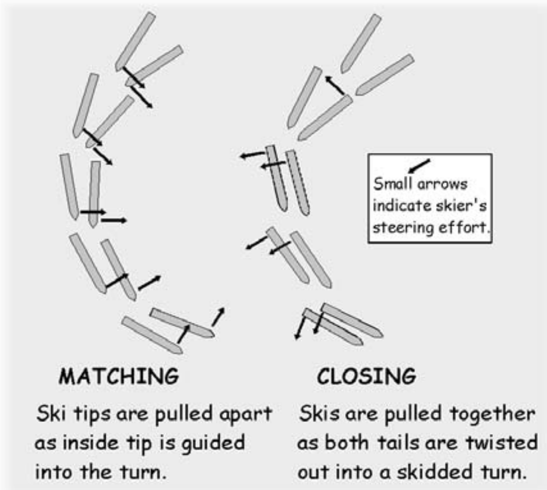
Matching

Matching means moving the skis from a wedge to (roughly) parallel at some point in a turn. For novice skiers, matching marks an exciting milestone—it is their escape from the wedge and their first taste of the "parallel" turn. Matching defines the Center Line™ Wedge Christie milestone, a turn that begins with a wedge and finishes parallel. Matching can occur in any part of a turn. It marks the end of the "wedge phase" and the beginning of the "christie phase" of a wedge christie.

Although the movement seems simple, appearances often deceive. Correct matching presents an apparent paradox as, ironically, one of the best ways to ensure that the skis never match is to try to pull them together. Watching instructors glide effortlessly through wedge christie demonstrations, it certainly seems that they must be pulling the tails of their skis together, that the back of the inside ski moves out toward the outside ski. But when the aspiring parallel turner tries to imitate the move, often the uphill (inside) just gets stuck. The harder the skier tries to pull them together, the stucker the skis seem to get. The turn stops as the inside ski rails out on its inside edge, and the skier feels only a painful twisting in the knee. Why does this happen?

Recall that a feature of all good turns, a *common thread* (see) of PSIA's Center Line™, is what I call "positive movements"—the tips of the skis steer *into* the turn, like the front wheels of a car. To turn right, nothing should move left. Pulling the inside tail toward the outside ski is a *negative* movement, a movement away from the turn useful for braking, but devastating to good turns. It causes skidding, slowing but not effectively *turning* the skier (or car—it skids into the ditch!). This move is the error of the struggling matcher. That smooth instructor focuses not on pulling the tails together, but on steering the ski tips—both of them—*into* the turn. Matching is merely a side effect!

If you have a hard time visualizing this concept, try this: Hold two pencils with their tips together in a "V." Clearly, you can make the pencils parallel either by pulling the eraser ends together or by moving the sharp points apart. The tips-apart move is what should happen in matching. Of course, the skis do not get noticeably farther apart, because as the inside ski gets pulled away, the other ski follows it through the turn, as shown in the illustration. Try imitating a right turn with the pencils. From the wedge, move the tip of the right pencil to the right (don't move the other end). At the same time, let the left pencil follow the right one, as if the tips were tied together with string. They are parallel now, aren't they? And no part of either pencil ever moved to the left, did it? You never pulled the pencils together. That's matching! Most skiers are surprised to learn that their elegantly narrow-stanced instructors are actually pulling their skis *apart* as they actively steer their inside skis through the turn.

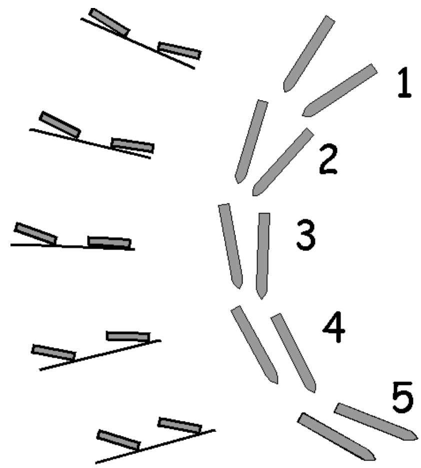


The real catalyst of matching—and the proper target of the learner's efforts—is the flattening and edge change of the inside ski. In a wedge, skis ride on opposing edges—both inside edges. Only after the inside ski releases its grip on the snow can the skier steer it to a match. Once skis match, they ride on *corresponding edges*—both right or both left edges. Again, the harder you try to pull skis together from a wedge, the more stuck they become, because pulling the legs together rolls the knees toward each other, tipping the skis farther onto their inside edges. Frustration and bad habits will ensue unless the focus moves from the wedge angle to the edge angle.

The truth is, for skiers lucky enough to have developed proper mechanics in their wedge turns, matching is not a new movement at all. It is simply the result of refinement of the skills of the wedge turn. It often happens spontaneously as a novice skier gains comfort on slightly steeper terrain or at slightly higher speeds. A good, aligned stance, balance predominantly over the outside ski, a gentle gliding wedge, and active steering of the legs into the turn beneath a stable upper body, are all the skills needed to create matching. With increased speed the hips naturally move toward the inside of the turn for balance, helping to flatten the inside ski. Steeper terrain also helps to release the edge of the inside ski in the second half of a turn, as the slope angle matches the edge angle, resulting in a ski that is flat on the snow (see diagram). If everything is right, it is difficult *not* to match as speeds increase.

As skiers progress in skill and speed, matching naturally occurs earlier and earlier in the turn. The original conception of the Center Line™ Model defined two wedge christies, distinguished primarily by where the matching occurred. In wedge christie 1, matching begins at or after the fall line in the turn (in other words, the second half of the turn). In the more advanced wedge christie 2, it occurs before the fall line. PSIA later dropped the distinction, calling them all wedge christies, but recognizing that the maneuver represents a range of skill levels.

Contrast matching with *closing,* which implies pulling or stepping the skis together. Involving most of the errors discussed above, closing the skis is a distinctly different maneuver. Closing skis when demonstrating a wedge christie is a mistake that has caused many a certification candidate to fail the exam. Understand the difference!



Hill angle affects edge angle. *The ski edge angle changes due to edging movements of the skier, as well as the changing relative angle of the slope through the turn. When the inside ski becomes flat (frame 3), matching begins.*

MCL See **Medial Collateral Ligament**.

Mechanics Mechanics is the branch of physics that deals with forces and energy and their interactions with physical bodies. Two branches of mechanics are *statics,* which deal with balanced forces and systems with no changes in momentum, and *dynamics,* which involves unbalanced forces, accelerations, turns, and changes in momentum. Related fields include *kinetics, biomechanics, kinematics,* and *kinesiology*.

Mechanism As it applies to skiing, "mechanism" denotes "the fundamental physical . . . processes involved in or responsible for an action . . . ."[57] Thus, *rotary mechanisms* are the underlying physics of the skill group we call *rotary*—they are the principles involved in twisting and pivoting skis and generating *torque.* Other mechanisms explain edging and pressuring concepts on skis.

Mechanistic This adjective describes something or someone concerned with how things work or what physically happens—technique-oriented. Compare with *humanistic* (person-oriented). The American Teaching System™ (ATS) is a humanistic approach to teaching skiing. We strive to satisfy the goals and needs of our students. Older teaching methods tended to be more mechanistic; they were form- and technique-oriented, often at the expense of ignoring the needs, abilities, and individuality of students, as in "You must learn to ski exactly like this, whether you like it or not" (preferably spoken with a gruff European accent).

ATS has taken great strides away from the mechanistic approach, so much so that by the mid 1980's, some accused PSIA of ignoring technique altogether. The perception was that PSIA believed "any turn is a good turn as long as you enjoy it." This attitude caused a lack of clarity in our teaching. A valid answer to this criticism, the Center Line™ Model now allows us to explore the spectrum of movement options while it identifies mechanics that are accurate and efficient for a given situation. We can develop options and versatility while still distinguishing good from bad technique—an ideal blend of the mechanistic and humanistic approaches.

Medial Collateral Ligament One of four major ligaments that support the knee, the medial collateral ligament (MCL) attaches the femur and the tibia on the inside "side" of the joint.

See diagram at **Knee**.

Medial Rotation Meaning "turning inward," and synonymous with *internal rotation,* medial rotation describes the "toe-in" twisting of the legs in a wedge, and the "tips-into-the-turn" steering of the outside ski in parallel turns (the inside leg of a parallel turn rotates *laterally*).

See **Internal Rotation**, and contrast with **Lateral (External) Rotation**.

Method A method is a systematic manner of accomplishing something. Contrast with *technique*—a specific way of performing a task. We employ a teaching *method* to teach ski *technique*.

Model A model, like PSIA's ATS Teaching Model and Center Line™ Skiing Model, is a representation or pattern, a simplified "picture" that highlights the main ideas of a system or process. Models serve as guides to aid in understanding, visualizing, and applying a concept.

Moguls 1. People who couldn't get up. 2. Hay bales with snow on top. 3. Anyone who can afford to stay slopeside at a modern ski resort. 4. None of the above.

Although I skied once with a child who really believed the answer was number 1, and I've encountered more than a few adults who believe number 2, moguls are a natural phenomenon of modern skiing. Like washboard bumps and potholes on a road, moguls result from traffic. One skier makes a turn, throwing a little snow. The next skier bumps into the snow pile and makes it a little higher, over and over. Often called just "bumps," these innocent little piles of snow evoke strong passions. Some skiers ski little else while others avoid moguls like a disease.

Like them or not, moguls are a fact of life at modern public ski areas. No one can claim true expertise without the ability to negotiate a field of moguls. And they are misunderstood. Moguls are not the enemy; often they make a run easier to ski. They do demand a certain level of skill, the right attitude, and a few specialized movements. But, contrary to common perception, they do not require a high level of athleticism or sixteen-year-old legs. Good technical fundamentals coupled with good tactics will tame the moguls.

See **Bumps** for a discussion of skiing moguls.

Moments of Brilliance Learning on skis comes in the form of "Moments of Brilliance." Consistency comes only after thousands of repetitions of those moments. Moments of brilliance come when we least expect them, usually when we aren't trying hard, when we relax and have fun. We should look for these moments of brilliance and encourage their appearance, rather than focusing on mistakes and trying to eliminate them. It is said that many mistakes are self-correcting, provided we ignore them. Moments of brilliance and mistakes go hand-in-hand. Rarely can we increase one without the other. Trying to avoid mistakes is a surefire way to avoid improvement as well!

> ***Learning on skis often takes the form of "Moments of Brilliance."***

See also **Peak Experiences** and the **Zone**.

Momentum Momentum is the "quantity of motion" of an object. It is the product of an object's mass and its velocity (Momentum = Mass X Velocity). So any change in mass, speed, or direction constitutes a change in momentum. According to Newton's First Law of Motion, momentum cannot change unless an external force is involved. The common word for momentum change is *acceleration*. We know from experience that light but fast moving things can have as much momentum as heavier, slower things.

The mass (weight, loosely) of a skier doesn't change much during most ski runs, of course. But each turn and every change in speed represents a change in momentum. Analysis of skiing is really analysis of momentum and changes in momentum and the forces that cause these accelerations.

"Managing momentum: That is what skiing is all about . . . ." These are the first words of the introduction to Ron LeMaster's excellent book, *Skiing—The Nuts and Bolts*.[58] Everything we do with our ski edges and our rotary and pressure control skills directly or indirectly affects momentum. Skiing is much easier to understand when armed with a basic knowledge of momentum and mechanics.

Monoski A contagious disease to which skiers in France appear particularly vulnerable? Not really, but close! A monoski is a wide ski with two sets of bindings set side-by-side, into which both feet are clamped. It is popular with skiers who believe that skiing with the feet locked together is the ultimate "style." The wide board is an effective tool in deep snow, where its extra flotation and the impossibility of crossing tips may give it an advantage over conventional skis.

But in most conditions, the monoski handicaps the skier by limiting biomechanical options. The legs obviously cannot move independently, which eliminates all stepping, skating, or walking-type movements. Most importantly, the single pivot point of a monoski precludes the independent leg steering *("fulcrum mechanism")* that is the essence of modern skiing. To apply torque to pivot or steer, the monoskier must use his hips or upper body, while the two-footed skier can steer each ski independently with his legs. Also, on a monoski, because the skier is always on the outside edge of the inside foot in turns (opposite "normal" skiing), the crossover move is exaggerated, edge changes are slow, and there is no "backup" should the ski slip out from under the skier.

Motivation Motivation is what incites and guides behavior. Why do we ski? Why do we teach skiing or take ski lessons? The best instructors understand the individual motivations of their students, and use this knowledge to teach better lessons. There are, of course, many reasons to take ski lessons. Technical improvement is only one possibility. A student may hope to look better, feel better, or conquer new terrain. But he or she may just want company, or to meet that lycra-clad bombshell or foreign ski god in the class. Praise, social acceptance, safety, self-improvement, curiosity, perhaps even money could motivate someone to take a ski lesson. Both the instructor and the student benefit by understanding the true motivation for the lesson.

Motivation falls into two categories. *Intrinsic motivation* comes from the behavior itself. Most of us ski and learn because we *like* skiing and learning—they are their own reward. *Extrinsic motivation* comes from something else—the promise or hope of some other reward or the avoidance of something unpleasant. Racers may train because they love it. But they may also train because better times will bring them riches, power, fame, or popularity, or because their coach threatened to kick them off the team if they don't. Or it could be some of each.

The science of human motivation is a vast subject. Educational psychologists have developed many theories of motivation, based on *behavioral, cognitive,* and *humanistic* approaches.[59] Behavioral approaches stress physiological needs (food, water, air, shelter, sex) as motivators. Cognitive approaches stress our ability to think and reason and understand. The humanistic approach, which combines aspects of both, is the approach of PSIA's Teaching Model.

Developed in the 1940's, largely through the research of Abraham Maslow, the humanistic model of motivation emphasizes a need for personal growth and "self-actualization" as prime human motivators. But it also recognizes that other needs are important as well, including physiological needs, security, social acceptance, self-esteem, and aesthetics. *"Maslow's Hierarchy"* (see) categorizes these needs on a spectrum from most essential—basic survival needs—to self-actualization—the complete realization of personal potential. Learning to ski for its own intrinsic value falls high on the hierarchy toward the self-actualization end, and it only becomes a prime motivator when all the levels below it are satisfied. To really succeed in ski improvement, according to Maslow, a student must not be distracted by hunger, thirst, pain, fear, cold, embarrassment, money, or lust.

See also **Maslow's Hierarchy of Needs**.

Motive Forces

Literally "forces that move things," motive forces are the pushes and pulls that cause objects to accelerate (change direction or speed). Synonymous with *external* or *applied* forces, motive forces must originate from outside the object or system of objects they affect. In other words, muscular force (internal) cannot cause a skier to accelerate—it is the reaction force of whatever we push on pushing us *back* that provides the motive force.

See **Applied Forces**.

Movement Analysis

No two skiers ski alike. Skiers come in many shapes and sizes and their movements are expressions of a myriad of intents, talents, motivations, habits, abilities, information and mis-information. An essential skill for instructors, movement analysis is the process of identifying the unique way each student skis as part of developing a lesson plan tailored to the individual. Successful movement analysis combines a well-trained eye with a thorough understanding of ski technique. Some master instructors may rely on intuition, experience, and their all-seeing eyes. But developing this expert's eye requires conscious effort and a systematic approach to movement analysis.

A good system will identify the individual *skier profile,* include a thorough *technical description* of the skier's movements, identify *cause and effect* relationships, *prescribe specific changes* to improve the skier's ability, and develop a basic *lesson plan* to help produce the desired outcomes. Like private investigators, we need to find out *who, what, where, when, how,* and *why.*

Skier Profile (Who?):

Who is this skier? What is his specific motivation, comfort level, athletic ability and condition? What are her desires, goals, and intentions? What other sports does the skier participate in that could help (positive transfer) or hinder (negative transfer) learning to ski? Is the skier in a defensive or an offensive state of mind? What is his energy level? In which level of *Maslow's Hierarchy of Motivation* is the skier operating? Is the equipment appropriate and reasonably tuned and fitted? Is there a need for boot alignment or canting? What type of equipment is it—conventional or some type of "shaped" ski? What learning style best describes the skier (Doer, Feeler, Thinker, or Watcher), and what is the skier's sensory preference (Visual, Auditory, Kinesthetic)? Finding the answers to theses questions enables us to much better understand how and why skiers ski the way they do, and to develop a truly effective lesson for each student.

Technical Description (What, How, When, Where?):

An instructor must identify the unique movement patterns and technical elements of each student's skiing, as well as the skier's skill level. Giving the student a specific task—focus, exercise, speed, turn size and shape—makes the process easier because we at least know then what the skier *intends* to do. Observing from various angles—front, back, and side—reveals more than just watching from behind or glancing over your shoulder. We should be able to describe thoroughly and objectively how the skier skis: what type of turn the skier makes, what movements and mechanical principles occur, as well as the timing and duration, intensity and speed, and accuracy and consistency of those movements. We should examine the skier's use of basic skills, based on a "skills hierarchy"—balance and stance first, then rotary movements, edging movements, and pressure control movements (it makes little sense to worry about subtle edging movements, for example, if the skier is out of balance or has a poor concept of steering the skis). What skills are lacking or weak? How are the skills blended? Does the skier have a skills (rotary or edge/pressure) bias?

I like to analyze skiing movements in relation to *turn phases.* What happens in one part of a turn often dictates what happens later, or sheds light on what happened before. This understanding is essential for determining cause and effect relationships. In the *preparation phase*, evaluate the skier's stance and balance. Does the skier establish a "stationary platform" (edge set to push off from) or "moving platform" (edge release to allow steering of the skis down the hill into the new turn)?

During turn *initiation*, evaluate again the skier's stance, balance, and alignment. How does stance affect the other skill movements (rotary, edging, pressuring)? What rotary mechanisms does the skier employ? Is the turn initiated with the upper body or the feet? Does the skier use *positive* movements (offensive movements in the direction of the turn, as in releasing the edge, moving the body downhill, and steering the ski tips downhill) or *negative* movements (movements away from the new turn, more defensive, as in a step uphill, edgeset and pushoff, blocking pole plant, and turning of the ski tails up the hill), or a combination? (Negative movements often indicate more of an intent to brake or slow down; positive movements indicate a true desire to go in the new direction and are essential for good turns). How is the edge change accomplished (body crossing over skis, or skis placed or pushed to the side)? How is the weight transfer accomplished (active, passive, progressive, sudden)?

In the *control phase* (*is* there a control phase?), what effects can we see of over- or under-initiation and of the skier's stance and balance? Is edging progressive and effective? What movements does the skier use to control edging (inclination, banking, angulation—what joints)? How and where are the skis pressured? What movements does the skier use to maintain and control pressure? Is the pressure control effective and appropriate?

Finally, in the *completion phase*, what has become of the skier's stance, balance, and alignment? What factors are the result of previous movements? How does the skier stop the turn—braking, stemming, blocking pole plant to eliminate excess rotation (over-initiation)? Or is the skier able to simply flow into the new turn without needing to deal with under- or over-initiation. What movements help release the edge—stepping, unweighting, or smooth extension and crossover? How does the skier deal with pressure? Is pressure released by relaxing the edge angle and flowing into the new turn or by decreasing steering and letting the turn straighten? Is there checking and rebound or a smooth extension and release of energy into the next turn? As an overall impression, does the speed control come from completing the turn—that is, from the direction the skis are going at the end of the turn, or from braking and the intentional creating of resistance through skidding throughout the turn? In other words, is the skier *defensive*, turning to slow down, or *offensive*, turning to control direction?

Cause/Effect Analysis (Why?):

Following, or along with, describing the movements, we must identify cause-and-effect relationships. What effects do the skier's movements have on the skis, and what, if anything, might *cause* the skier to make particular movements (Equipment? Physique? Fear? Fatigue? State of mind? Desires and intentions? Misinformation or lack of information? Compensation for another movement or imbalance?). Many movements we recognize as errors are the inevitable consequences of an error that occurred previously in the turn, that may have gone unnoticed. It is essential that we recognize and correct the actual error, and not simply mask the symptom.

Many of the mechanics of a turn relate to a skier's *stance*. A skier's basic stance, especially as he enters a turn, can produce a whole package of identifiable effects. Most "back-seat" skiers, for example, tend to use counter-rotation to thrust their heels to the side, followed by distinct hip angulation to control edging. Turn shape is characteristically "Z-shaped" and not completed, with severe skidding at initiation.

A too-forward stance, on the other hand, may result in turns initiated with upper body rotation, followed by an inability to get the skis out away from the body, edging primarily from the knees, an "abstem" to help develop a platform and deal with over-steered skis, and tail washout. Turns are typically fishhook-shaped as the tails skid out at the bottom. If the shoulders initiate the turn by rotating and moving into the turn, the hips will move out and the classic uphill lean of the upper body will almost inevitably occur at the end of the turn. For success, this error at turn completion must be corrected where it begins—in the initiation. Excessive (and dangerous) knee angulation at the end of the turn can result from being too square or rotated over the skis, which can result from initiating the turn with upper body, which can result from ineffective leg steering, which can result from lots of things—stance problems, lack of understanding, poor instruction, equipment problems, prosthetic legs, or otherwise. Only by recognizing such cause/effect relationships can we pinpoint the actual areas that need focus and create real improvement.

Prescription for Change

All right—we know everything there is to know about this skier and how he or she skis. And we've put two and two together to understand *why* things happen as they do, what causes what. Now we must decide what exactly needs to change. What skills need improvement (stance/balance, rotary, edging, or pressure control)? Do we need to change a fundamental movement (is the skier doing something wrong)? Or should we simply build

Movement Analysis Guide

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1. **Student Profile**—*Who is it?*
   - Goals, desires, motivation (Maslow) & comfort level
   - Age, sex, fitness, athleticism, disability
   - Prior learning, Transfer (other sports, positive & negative), Learning Preferences
   - Equipment—appropriate, fit, tuned, adjusted?
2. **Observation & Description**—objective and complete
   - *What happens?*
     - Ability level, turn type, shape, size, speed; overall picture—anything stand out?
     - Speed control from "direction" (completed turns) or from "friction" (braking)?
     - Rhythm & flow; upper body discipline, pole & arm use.
     - Stance & Alignment—Natural & athletic, or contrived? Square/countered/rotated? Parallel lines across feet, knees, hips, shoulders, hands? Lead change? Tall/short? Angles?
     - Balance—fore/aft & lateral (note turn dynamics, leverage, movements—not just position)
     - Turn linkage/transition; edge-change movements
       - "Tips in" or "Tails out"? Positive (into turn) or negative (away from it) movements?
       - "Stationary platform" (downhill ski holds, stem, step, up-unweighting, rotation, rotary pushoff; center of mass moves away from new turn) or "moving platform" (downhill ski edge releases, CM moves across skis, tips turn into turn)
       - Neutral phase (skis flat, no lead, equally weighted) in transition?
   - *When does it happen?*
     - Preparation, Initiation, Control, Completion; ("Finishiation"—Linkage)
     - Turn shape—rounded or sharp; where does most skidding occur? (Must learn why!)
   - *How does it happen?* Movements—type, timing, duration, intensity
     - Rotary Movements
       - Upper body (rotation, counter-rotation, rotary pushoff, blocking pole plant) or leg steering (fulcrum, braquage); combination?
       - Simultaneous or Sequential? Both legs active?
       - Timing, duration, intensity—sudden or continuous guiding
     - Edging movements
       - Timing, progressive or sudden, intensity (enough, not enough)
       - Inclination/Angulation/Banking; Ankles, knees, hips, whole body
     - Pressure Control
       - Foot-to-foot movements
       - Progressive, sudden, or static; hotspots?
       - Flexion-extension movements—appropriateness, timing, intensity, duration
       - Unweighting?
       - Fore/aft "leverage" control
3. **Cause & Effect Analysis** (*Why does it happen?*) "This happens because . . ."
   - If something stands out—good or bad—what is the cause of it? What are its effects?
   - Profile—does skier even *want* to turn, or just to control speed? Negative transfer?
   - Is it an error, or a proper compensation for some other error?
   - If a problem happens in one phase of a turn, did it begin in another?
   - Skills hierarchy (example: rotary mechanics affect alignment, edging, and pressure movements)
   - Stance-based mechanics; "packages of movements" and common skier types
   - Physical, mental, tactical, and equipment considerations
4. **Prioritize and Prescribe** specific changes/goals/outcomes
   - Which specific skill(s) or movement patterns need targeting? Why?
   - Linear/Lateral learning; technique or tactics
   - Build on solid foundation, or eliminate a bad habit?
5. **Lesson Plan**—student-focused & outcome-based
   - Activities/drills/focuses/tasks/images/progressions targeted toward the priority/prescription
   - Teaching Model—decisions
     - Student-focused—profile, goals, desires, motivations, comfort level, learning styles
     - Terrain/condition/speed choices; tactical choices
     - Teaching and Communication styles
     - Demonstrations, pacing, practice time, feedback

This guide highlights many of the important parts of movement analysis. For experienced instructors, good movement analysis becomes automatic, as their "eye" misses little. Using this guide can help less experienced instructors develop the eyes and skills of the masters.

on and improve what the skier is already doing. Should we broaden the skills base by exploring different terrain, conditions, speeds, and movement options (lateral learning)? Or should we try to move toward the next milestone on the Center Line™ (linear learning)? Of all the things we could work on, what is the single highest priority that will make the most meaningful and desired improvement in the time we have together? If we've done the first three steps well (profile, description, cause and effect analysis), this part should be easy. But it is a common mistake for instructors to teach the same generic lesson to all students at a given level, regardless of their individual needs, talents, and desires. It is important to communicate the desired changes and outcomes with students. Our goals must align. Instructors and students must form what PSIA refers to as a "learning partnership."

Lesson Plan

We know *what* we want to change. Now we need a plan for *how* to make the changes. We need to select terrain, choose teaching styles, determine pacing and practice formats, and plan exercises, focuses, or progressions that specifically target the desired changes. The instructor picks and chooses from his "bag of tricks" to develop a lesson that is concise, logical, attainable, fun, and focused on the specific desired outcomes.

This lesson is what students pay ski instructors for. Without the underlying movement analysis though, a lesson is a "shot in the dark," based on assumptions and generalities about skiers. Such generic lessons, however well-taught, almost always fail. They are boring and leave students feeling that the instructor did not care for them as individuals and did not address their particular needs and desires. Of course the converse is also true. Brilliant, insightful movement analysis alone may help the students understand their individual needs, but without a good lesson plan they may not learn how to make the changes they want.

So a lot goes into successful movement analysis and lesson planning. It is a skill that takes time and effort to develop. Again, most experienced instructors do it all unconsciously and with seemingly little effort. But that effortlessness masks years of experience and skill development. For newer instructors, I recommend lots of practice. Do *"two-minute-movement-analysis"* on lift rides: pick a skier and describe his or her movements thoroughly in two minutes. Then pull out a "cheat sheet" like the *Movement Analysis Guide* above and see if you've addressed all the questions I've asked here. If you've missed anything, can you answer it now, without looking at the skier again? Or do you need another look? Pick another skier and do it again. Do the same thing with video-taped skiers, then ask more experienced instructors to check your analysis. It won't take long before you are consistently thorough and accurate.

See also **Alignment**, **Fore/Aft Balance**, **Rotary Mechanisms**, and **Mastery Teaching Model**. And for an excellent discussion of movement analysis, read Scott Mathers' "Training Your Eyes" in *The Professional Skier*.[60]

Moving Platform A "moving platform" involves initiating a turn by releasing the edge of the downhill ski and guiding the ski tips into the new turn. It is the smooth, efficient, gliding turn linkage of Center Line™ turns. The classic techniques of earlier days usually involved a *stationary platform*, as most turns began with a pushoff or rebound from the downhill ski, in which the edge was set rather than released, and the tails of the skis were turned *away* from the new turn. While still a valid technique for some situations and intents, particularly defensive, braking moves, the stationary platform has yielded in high performance skiing to the faster, smoother, and more efficient moving platform.

See also **Platform**.

Muscle Memory Muscle memory refers to the ability of our bodies to repeat movement patterns more or less automatically after sufficient practice. Muscle memory is primarily responsible for *habitual skills* and *open-loop tasks*.

Muscle memory is also responsible for the phenomenon of *transfer*. Muscle memory of movements similar to skiing (ice skating, for example) causes positive transfer and helps us ski. Negative transfer occurs when muscle memory of contradictory movements (like the "cross-lateral" motion of our limbs when we walk) interferes with skiing.

As skiers succeed at new movements and experience new sensations, we must remember that they have only begun to *learn*. They are still many repetitions away from developing new habits. It will take a great deal of practice to hammer the movements fully into their muscle memory.

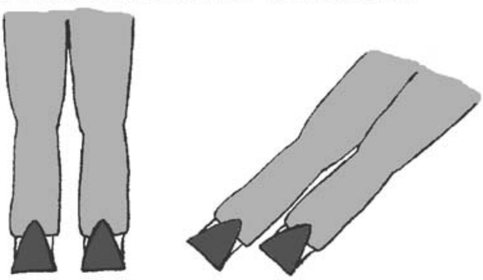
See also **Simpson's Psychomotor Objectives**.

N

Narrow Stance Expert skiers usually ski with an elegant, narrow stance. This stance is the envy of beginners and intermediates, but it is deceptive. The pursuit of the narrow stance has probably caused more problems for skiers than any other technical error.

The true expert's stance is natural, legs never forced together. Beginners usually adopt a wide stance for stability. As balance and confidence improve, the stance naturally narrows until the distance between the legs is similar to the stance when walking. This width varies with individual physical differences—narrower for some, wider for others. Even so, there is an illusion that makes the stance appear narrower than it actually is. If you look at me standing straight up in front of you, my feet will be six to eight inches apart, and you will clearly see space between my legs. But you won't often see me like that—and if you do, you'll probably be jumping for cover to get out of my way! Normally, you'll see me turning. If I incline deeply into a turn while my feet stay the same distance apart, my legs will appear much closer together (see illustration).

Open Stance appears narrower when skier is inclined into a turn. Both stances are the same width.



Once a skier's balance allows him to commit all his (or her) weight to the outside ski, stance width becomes irrelevant as far as balance is concerned. But too narrow a stance interferes with edging of the outside ski, and prohibits the skier from using the legs independently and from using the leg-steering rotary mechanism known as "fulcrum turning."

The (surprising?) truth is that today's experts continuously pull their skis apart! The forces of the turn combine to pull the inside ski toward the outside ski. If the skier did not pull the inside ski away, it would slide sideways into the other ski. And the inside ski is in the way of the outside ski tip as it turns into the turn. So the skier must actively steer the inside ski away from the outside ski. In many advanced skiers, you can clearly see this inside ski activity as the ski tips diverge throughout the turn. As the outside ski keeps "chasing" the inside ski, the distance between them usually remains fairly narrow. But the best advice remains—if you want the expert's narrow stance, *never pull your skis together!*

National Technique Watch a World Cup race today, and you will note a striking similarity in the techniques of the racers. Regardless of nationality, they all tend to ski with the same fundamental, natural, efficient movements. Such was not always the case. In skiing's earlier days, before say, 1960, racers demonstrated a variety of techniques, with often vast fundamental and stylistic differences. Forward lean, backward lean, counter-rotation, rotation, up-unweighting, down-unweighting—all these movements have won races, making heroes of the racers using them. Those heroes spawned imitation in their homelands. Their techniques became sources of national pride, and their countries' ski schools taught their techniques exclusively. Thus arose the classic National Techniques of the great skiing nations.

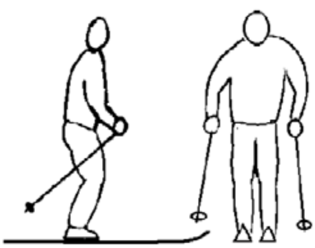
The techniques of Austria and France demonstrated the extremes of the range of possible movements. Austrians espoused counter-rotation, with down-unweighting and an extreme reverse-shoulder (countered) position. The French Arlberg technique's "projection-circulaire" involved powerful upper body rotation with up-unweighting. Germany's technique was similar to the Austrians. Italy and Switzerland used a lateral heel thrust, similar to, but with much less counter-rotation than, the Austrians and Germans, and with France's up-unweighting.

From these classic European techniques arose, in the early 1960's, the new American Technique. Americans stressed "naturalness," and probably resembled most the Italians and Swiss with up-unweighting and gentle heel-thrust. Unlike France's exaggerated rotation or the Austrians' extreme counter, American Technique emphasized a slightly countered stance with the uphill ski, knee, hip, shoulder, and hand all advanced a similar slight amount.

This natural American stance has stood time's test, as it is the near-universal stance of today's great skiers. Understanding of the biomechanics of skiing has improved, along with tremendous advances in the technology of skis and boots. While there were many effective ways to throw long, heavy skis sideways into skidded turns, today's precision carving instruments demand efficient, precise movements, leaving little room for stylistic variation. Ski instructors of the world's skiing nations may use different teaching methods, and may emphasize slightly different aspects of skiing, but the techniques they recognize as good skiing are very similar. No longer can you identify skiers' nationalities by simply watching them ski.

For a good, illustrated comparison of the classic national techniques, read *Skiing The American Way* (1964), by Peter Estin.[61]

Natural Stance As the name implies, this is an uncontrived, comfortable, functional, athletic stance. Everyone will have a somewhat different natural stance, based on physical differences. A natural stance is neither wide-track nor closed. Synonyms include "open stance," "functional stance," and "neutral stance." The natural stance is the foundation of contemporary skiing. It is similar to the basic stance of other sports



Natural Stance

involving quick, reflexive movement in any direction—the tennis player ready to receive serve, for example, or the soccer goalie poised for action. Balanced, joints slightly flexed, hands comfortably spread and in front, muscles alert with "functional tension," the natural stance is ready for action.

In a traverse across a slope, the natural stance involves a slight lead of the uphill ski and the uphill side of the body. The uphill foot moves ahead naturally, as it does when you stand on a floor and lift one foot. The rest of the body, if relaxed, will mimic this lead of the uphill foot—the knee, hip, shoulder, arm, and hand will all line up higher than and ahead of their downhill counterparts. Highest performance, biomechanical efficiency, and safety rely on this naturally aligned stance.

See **Alignment** for a more thorough discussion.

Negative Feedback

Negative feedback occurs when the result or output of a process or system tends to decrease the process that produced the result. The simple thermostat presents a classic example of negative feedback. The temperature drops, turning on the furnace, which raises the temperature, which then shuts off the furnace, which causes the temperature to drop. Some basic human needs likewise involve negative feedback—hunger, for example. You get hungry, you eat enough, and you aren't hungry any more. Many errors in skiing involve negative feedback, and are thus self-correcting. You make a mistake, you fall, you learn. As they say in Switzerland, "The mountain will teach you."

> ***"If it doesn't feel strange, you didn't change!"***
>
> ***—Phil Mahre***

The opposite of negative feedback is *positive feedback*. Positive feedback tends to stimulate the behavior that causes it. For most people, learning and improvement create positive feedback—getting some makes you want more and more.

Negative feedback is helpful if we want to eliminate unwanted movements. Unfortunately, any change, including improvement, is unfamiliar and often uncomfortable or even frightening. Thus even improvement can cause negative feedback. As the great Phil Mahre says, "if it doesn't feel strange, you didn't change!" It is important to recognize this phenomenon, and not allow it to prevent us from learning new things. Part of the role of an instructor is to add plenty of other positive feedback in these situations, to counteract the discomfort until the new sensations feel "right."

Negative Movements I call any movement in the direction *opposite* the intended direction of a turn a *"negative movement."* Negative movements characterize a defensive, skidded style of skiing, which describes the majority of skiers who use their skis more as brakes, to control speed, than as turning tools. While they are essential skills, negative movements destroy good turns!

As a defensive turn, the classic *stem christie* illustrates these negative movements well. The skier sets the downhill edge, preventing movement down the hill into the new turn. From this "platform," the skier pushes the center of mass *uphill,* and twists the *tails* of the skis toward the *outside* of the new turn and into a skid. A *blocking* pole plant further prevents movement down the hill and helps push everything away from the turn.

"*Positive movements*" (movements into the turn) are the movements of offensive, "Center Line™" turns. If the skier wants to turn right, nothing should move left. But if the skier really doesn't want to turn right, and is concerned more with checking speed, negative movements tend to take over. There is nothing wrong with negative movements per se. They are not intrinsically "bad skiing." But they *are* bad turns, if a turn is defined as the intent to control line, *versus* to skid off the road.

See also **Positive Movements**.

Negative Practice Negative practice means deliberately performing an error in order to overcome it. Sometimes "right" isn't obvious until we know what "wrong" feels like. Negative practice can be effective when the person practicing the error repeats to himself that it is incorrect or focuses on the undesirable consequences and sensations ("negative feedback") of the mistake. While we hate to knowingly do something wrong, negative practice accompanied by some sort of punishment or "negative reward" can be an effective, if little used, way to eliminate bad habits.

Negative Reinforcement By definition in behavioral psychology, all reinforcement (positive or negative) *increases* the probability of a behavior. Negative reinforcement is any painful or unpleasant stimulus the *removal* of which tends to reinforce the desired behavior. It is easy to confuse negative reinforcement with *punishment,* which *decreases* the likelihood of a behavior when it is *given*.

When a child is allowed to come out of the corner when he or she behaves well, negative reinforcement is at work. When the same child is sent to the corner as punishment for something, it may help prevent him from doing the same thing again, but it does not necessarily produce a particular desired behavior. Punishment, or "negative reward," is not a reinforcer in that it *decreases* the probability of an *un*desired behavior or response. This concept is the difference between negative reinforcement and punishment. Both may be useful, but while the child being punished knows he did something wrong, the punishment does not help create any particular *good* behavior to replace the bad. When a specific correct behavior allows the child out of the corner, that behavior is reinforced.

Sure, you could argue that *not* doing one thing is very similar to *doing* another thing. And that there is not much difference between improving things by adding something good or removing something bad (it's good either way, right?). So perhaps all these terms are really just psychological babble that describe a single, simple, intuitive concept. Perhaps psychologists aren't so different from ski instructors after all?

Keep it simple. Reinforce good behavior. Correct errors. Be careful not to encourage and reinforce bad habits by just trying to be "nice."

Negative Reward

Negative reward, psychologist-speak for *"punishment," decreases* the probability of a behavior when it is given. Technically, negative reward should not be confused with "negative reinforcement" which *increases* the probability of a behavior when it is *removed* (see **Negative Reinforcement**, above).

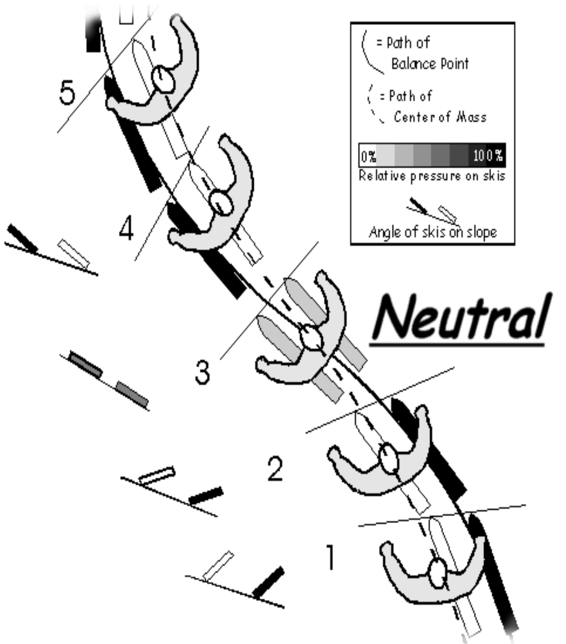
Negative reward or punishment can be effective in helping to eliminate or prevent bad habits, but it has drawbacks. Effects tend to be temporary, and it can produce unwanted emotional side effects. Also, unlike reinforcement (positive or negative), punishment does not strengthen any specific desired behavior. Negative reward is limited in its usefulness, and should be used with care.

Negative Transfer

Negative transfer occurs when previous knowledge, learning, habits, or muscle memory interferes with new learning. When we walk, for example, the left hand swings forward when the right foot moves forward (cross-lateral motion). This habit can interfere with proper skiing in which the right hand should mimic the lead of the right foot in a traverse or turn.

A more frustrating example of negative transfer occurs when an instructor teaches something "wrong" at one level that will need to be untaught by another instructor on another day. The Center Line™ Model identifies the fundamental movements and mechanics that transfer throughout skiing from beginner to expert, helping instructors avoid this mistake. With understanding, we can introduce beginners to the essential movements and concepts of the turns of experts, putting them on the continuous road to excellence.

Neutral Central to modern skiing, "neutral" refers to a moment in the transition from one turn to the next. Weight transfers from ski to ski as we turn right and left. We also move forward and back to maintain balance. The lead of the inside ski and inside half of the body changes from turn to turn—left leads in a left turn, right leads in a right turn. And edges change from left to right and back again. Neutral is the moment in between, when the stance is square (no lead), the skis are flat, and the weight is equal. It is a moment of no real duration, during which the skier is in a relaxed, neutral position. In linked turns, we don't stop in neutral—we flow through it. As a car races through a slalom course, similar things happen—weight shifts and front wheels turn left and right. The moment the wheels are straight ahead and the weight is equal from side to side, the car is in "neutral."



*This skier linking dynamic parallel turns is in **neutral** in frame 3. The weight is equal, the skis are flat, and there is no lead, as weight transfers from old outside to new outside ski, and the skis transition from left edges to right edges, and from steered left to steered right.*

There are actually three separate "neutrals" on skis. "Rotary neutral" occurs when the skis are steered neither left nor right, and the stance is square, with no lead. "Edge neutral" is, in parallel turns, the moment both skis are flat on the snow. In wedge turns and wedge christies, it is the moment the edges release, with both skis gently and equally on their inside edges. "Pressure neutral" is the moment weight is equal on both skis and centered fore-and-aft. For smoothly linked "Center Line™" turns, these three neutrals must occur at the same moment.

Only when we allow the body to pass through neutral will turns flow smoothly from one to the next. Turns should both begin and end in neutral. If they only begin in neutral but end somewhere else, turns are not linked—the skier has to do something after the turn ends to get back into neutral. Indeed, fighting to arrive in neutral at the end of the turn is the key to the linked, smoothly flowing, parallel turns of experts. If you end a turn in neutral, you don't have to do *anything* to start the next one!

Neutral Stance The neutral stance is a comfortable, centered, balanced, athletic stance that maximizes movement options and makes efficient use of "skeletal strength" as opposed to relying on muscular strength. The neutral stance involves weight on the whole foot, as opposed to forward on the toes or back on the heels. In a neutral stance, the skier's lower leg is "cuff neutral"—leaning neither on the tongue nor the back of the boot. Synonyms include **natural stance** and **open stance**. Of course, with all the movement involved in skiing, skiers are rarely in this static "position," but it describes the stance of a gentle straight run. And in good skiing, even when turns involve extreme angulation and inclination, most turns are linked by passing through a moment of "neutral" (see **Neutral** above).

"New-Old/Old-New" Rule "Perform new tasks only on familiar terrain, and familiar tasks when exploring new terrain."

We must create an environment for success in our lessons. When skiing challenging or unfamiliar terrain or conditions, it is very difficult to concentrate on a new movement or technique. The "new-old/old-new" rule merely states that when introducing new skills, we should seek comfortable, familiar, "old" terrain; when on new, challenging terrain, we should just ski it and not attempt to learn or teach a new technique. In difficult moguls, for example, we need to focus on where to turn, when to turn, what line to ski—we don't have time to think about *how* to turn.

In relation to the Center Line™ Model, to promote *linear learning,* we should seek easy, "old" terrain. On unfamiliar or challenging terrain or conditions, we should teach, or at least allow, old movements and variations on these movements *(lateral learning).* With wedge christie-level students on challengingly steep terrain, for example, I might encourage a more defensive, braking wedge christie, rather than trying to teach parallel turns.

This rule addresses the common mistake of inexperienced instructors who work hard to develop the skills students need to get off the "bunny slope" and onto the real mountain. But rather than allowing enthusiastic fledgling students to enjoy the new experience, get some mileage, and just ski and have fun, they immediately try to introduce new technical concepts, overwhelming and frustrating them.

Newton, Sir Isaac Born in England in 1643 (1642 by the calendar then in use), Sir Isaac Newton was one of history's most influential scientists. As a student and later professor at the University of Cambridge's

Trinity College, Newton developed advances in mathematics and physics that laid the foundation for much of scientific progress to this day. In mathematics, Newton (simultaneously but independently of Gottfried Leibniz) developed the branch known as *calculus*. Newton was also responsible for advances in the field of optics, including the discovery that "white" sunlight is composed of the spectrum of colors that separate in a prism.

But Newton is most famous (at least among skiers) for the Law of Universal Gravitation and his three Laws of Motion, that form the basis for the branch of physics known as *dynamics*. Though he often shunned publication, publicity, and the inevitable criticism, his *Philosophiae Naturalis Principia Mathematica*, published in 1687, remains one of the most significant scientific works of all time. In the *"Principia,"* Newton laid out the only rules by which all skiers must live. "Gravity," it is often said, "is not just a good idea. It's the Law!" Newton's three simple Laws of Motion explain the principles of forces and acceleration, momentum, and inertia. Once grasped, these laws profoundly simplify the understanding of skiing's vast array of movements.

Sir Isaac Newton died in 1727. Although he endured some controversy and some debate over his discoveries, and although subsequent discoveries by Albert Einstein and others suggest that Newton's Laws are not quite universal as speeds approach that of light, Newton's legacy of genius endures. In our sport of motion, Newton's Laws rule!

See **Newton's Laws of Motion** and **Newton's Law of Universal Gravitation**.

Newton's Law of Universal Gravitation

The unbreakable "Law of Gravity," as Sir Isaac Newton first expressed it, states that "every body (every object) in the universe attracts every other body with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them."

With this statement, Newton described the force that holds planets in orbit, pulls apples from their trees, and of course, provides the "toy" that skiers play with, the very essence of our sport.

Newton's Laws of Motion

Sir Isaac Newton's three Laws of Motion form the foundation of *dynamics,* the branch of physics that studies objects as they interact with forces. Since skiing is a sport of motion, Newton's Laws are the very laws that govern it! It is good to know the law!

Newton's First Law of Motion

Also known as the "law of inertia," the First Law states that an object at rest will remain at rest, and an object in motion will remain in constant, unchanging motion in a straight line, unless acted upon by an unbalanced, external "motive force."

In other words, any time something changes speed or direction (changes *velocity)*, there must be a force—a push or pull—coming from outside the object. No force is required to *keep* something moving. Once in motion, an object will continue moving forever in the same direction and at the same speed, unless another force slows it down, speeds it up, or makes it turn. Furthermore, "external motive forces" are the *only* things that can change an object's motion. Indeed, Newton's First Law is really the definition of "force." Force is the "agent," whatever it may be, that causes acceleration (change in motion).

What is meant by "unbalanced" force? There are usually several forces acting on an object at once. An external motive force will *always* make an object accelerate—no exceptions—unless another force or other forces counteract it. To describe a force, we must describe both its size (strength) and its direction, easily illustrated by an arrow or "*vector*." If two equally strong forces act in opposite directions, they are "balanced forces" and produce no acceleration. If one is stronger than the other, they are "unbalanced" and, if they are the only two forces acting, they will cause acceleration. Unbalanced force means that the sum ("resultant") of all external forces acting on an object is not zero, so acceleration occurs. The idea that force, velocity, and acceleration involve both quantity and direction brings us to the Second Law of Motion.

Newton's Second Law of Motion

The second law states that the change in an object's motion (acceleration) caused by a motive force will be proportional to the size of the force and in the same direction as the force. Mathematically, the second law forms the equation

Force equals Mass times Acceleration ($F = ma$).

To understand the Second Law, we must have a way to quantify an object's motion. The word that expresses "quantity of motion" is "*momentum*." Momentum is a function of an object's *mass* and it's *velocity*. Velocity, again, describes both an object's speed and the direction it is moving. Acceleration is defined as any change in momentum (not only an increase in speed, as it is commonly used). So a force acting in the direction an object is moving will speed it up. A force in the opposite direction will slow it down. And a force in any other direction will cause it to move in a different direction (to turn). The *amount* of change in motion depends on the size of the object (mass) and the size of the force.

The Second Law should be intuitive. Most people know that a heavier car (more mass) needs a bigger engine (more force), or that a bigger engine in a smaller car will make it accelerate faster. Small football players know that if you go fast enough, you can cause as big an impact (have as much momentum) as bigger but slower football players. And everyone knows that if you're going one way and something pushes you from the side, you end up going another way, and how much you change direction depends on how hard you get pushed.

What may not be so obvious is where those forces actually come from. When we walk, run, or ski and make a turn, the only force we're usually aware of is the muscular effort in our legs as we push against the ground. But when I turn left, I push with my legs to the right. And that force comes from within my body. Newton's second law requires that some *external* force must push me *left* if I'm to turn left. Where is that force? On to the Third Law of Motion, which explains how that force comes from the ground—from the earth itself.

Newton's Third Law of Motion.

Also known as the *"Law of Equal and Opposite Reactions,"* Newton's Third Law states that every action has an equal and opposite reaction. In other words, whenever one object exerts a force on another, the second object will always exert an equal force in the opposite direction, known as a *reaction force,* on the first.

When I push down on the snow with my skis, the snow pushes up equally hard on me. When I push against the ground to the right, the ground pushes me to the left. Muscular force alone, being an *internal* force, can never cause my body to accelerate (turn or change speed). Acceleration happens only when I push against something else, which causes a reaction force in the opposite direction. According to the Second Law, that object that I push against also accelerates in the direction I push it. When I jump up, I push on the earth. It pushes back, throwing me in the air. But I push it down, so it must move down as well. The earth has so much mass, of course, that the amount of movement my little push creates is imperceptible. But it does move. It accelerates according to the formula stated above: $a = F/m$, where "F" (force) is a few measly pounds (or "newtons," in the metric system) while "m" (mass) is zillions of tons, so "a" (acceleration) is virtually zero.

All three of Newton's Laws of Motion require that we think of an object's mass as concentrated in one point, or that we think of objects as "particles" with no dimension. All forces that change the object's motion are assumed to act on that point. For real objects, that point is the *center of mass.*

To apply the Laws of Motion to the real world, we need to understand another type of motion in addition to simple *linear motion*—we must understand *rotational ("angular") motion.* And we must think of complex objects with moving parts (like skiers) as "systems" of individual objects, each with its own center of mass, linked together.

Rotational Motion and Newton's Laws

When the line of a force does not pass through the center of mass, as when you push on the edge of something, the force creates *torque,* causing the object to rotate or change its rate of rotation. Newton's laws accommodate this rotational motion *(angular* motion), as well as linear motion. *Angular momentum* describes the quantity of spinning motion, determined by the object's mass, its rate of spin, and the distribution of its mass. (A wide, flat flywheel has more angular momentum than an equally heavy round ball spinning at the same revolutions per minute.) The First Law, then, states that a spinning object will continue to spin at a constant rate forever, unless acted upon by an external, motive force directed toward a point other than it's center of mass ("through a lever arm"). The Second Law addresses the proportional relationship between the strength and direction of the force (torque) and the *angular acceleration* of the object. And the Third Law again requires that there be an equal and opposite counter-reaction whenever there is angular acceleration.

The "Ski-Skier System" and the ***Law of Conservation of Momentum***

As noted, a skier, with arms, legs, skis, and all its other moving parts, is both a single object, with a single center of mass, and a connected collection of objects, each with its own center of mass. The whole ski-skier system follows Newton's laws when forces act on its center of mass. And each moving part can obviously move and accelerate relative to the other parts as well. Parts can apply forces to other parts, and counter-forces and changes in their relative motion result.

To change the motion of the whole ski-skier system, forces must act on its center of mass. When external forces apply elsewhere, they create torque which affects the rotational motion of the whole system.

When one part applies a force to another—as when muscles move arms or legs—those parts move relative to each other, *but the momentum of the whole system does not change* unless a force applies from outside the system. The First Law of Motion, as it applies to a system of objects, becomes the *Law of Conservation of Momentum.* It states that the total momentum of the system will remain constant unless acted upon by an external motive force, regardless of the individual changes of motion of parts of the system. So, if a skier were hurtling through outer space with no external forces acting on him, he would go at constant speed in a straight line. He could swing his arms and legs, and twist his body any way he wanted, but his center of mass would still travel in a straight line. If he was spinning, he would spin forever about his center of mass. All those muscular forces would move limbs relative to each other, but each movement would have an equal counter-movement within the system, canceling its effect on the skier as a whole. Momentum (motion) of the ski-skier system would not change.

The Law of Conservation of Momentum applies to both linear and rotational motion. Here is where its application comes "back to earth" for skiers. When a skier's muscles (internal force) twist one part of the body, say the shoulders, a counter force (torque) must apply to another part, turning the skis the opposite direction. This equal and opposite reaction is the principle of the rotary mechanism we call "*counter-rotation*." If an external force (again torque) causes one part of the body to rotate, the whole ski-skier system now has "angular momentum." If the skier's muscles stop the one part, that momentum must transfer to another part. This transfer of angular momentum is the principle of the rotary mechanism called "*rotation*" (or "stopped rotation"). The Law of Conservation of Momentum also explains why a wider arm stance is more stable than a narrower one. Figure skaters spin fast with arms tight to the body. When they extend their arms, they do not change the amount of rotational motion (angular momentum), but they distribute their mass farther from the spinning axis (think of the flywheel). For the momentum to remain the same, the rate of spin must decrease.

All skiing moves become clearer when we understand Newton's Laws as they apply to the "ski-skier system." As we move one part of the body to edge, steer, or pressure the skis, some other part *must* move in the opposite direction to counter the motion and keep us in balance. Likewise, if the upper body is undisciplined, the legs have no "choice" but to counter its sloppiness, seriously interfering with their ability to precisely control the skis. And when we realize that the forces that cause turns must come not from our muscles, but from outside the ski-skier system, we develop a new relationship with the mountain and with our skis. Skis become precision tools to harness those forces, not just objects to push around.

Summary

Must all skiers understand Newton's Laws? No, but for instructors it is futile to try to understand skiing without understanding the unbreakable Laws of Motion that govern it. Anyone who doesn't comprehend Newton's Laws of Motion, at least intuitively, doesn't really understand skiing. Movement analysis, error correction, cause and effect analysis, are all easier when based on a comprehension of Newton's Laws. We practically owe our sport to Sir Isaac Newton and his explanations of gravity and the interaction of forces and bodies. With the earliest known skis dating back over 4,000 years, I wonder if Sir Isaac might have actually reaped the benefits of his genius on the slopes of the Alps. Let's make some turns for him!

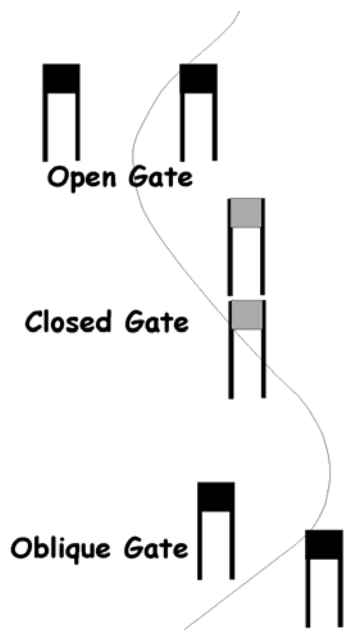
See also **Force**, **Velocity**, **Acceleration**, **Inertial Force, Momentum**, **Center of Mass**, and **Rotary Mechanisms**.

Nordic Skiing Nordic skiing, which originated as "cross-country" skiing or "ski-touring," is really best distinguished from *alpine skiing* by the equipment. Specifically, nordic equipment involves "free-heel" boots, boots attached to the ski only at the toe. Traditionally much lighter weight and less confining, nordic equipment is far better for traversing on the flats, while it gives up alpine equipment's precise control on steep descents. The classic turn for descending on nordic equipment is the *telemark turn,* although good nordic skiers can make parallel turns as well. Today, when some nordic equipment specialized for downhill skiing is as heavy as alpine gear, and with "alpine touring" equipment enabling alpine boot heels to lift off the ski, the distinctions between the two have become a bit blurred.

Traditional nordic competitive events include cross-country races of varying length, as well as ski jumping for distance and style.

Normal Besides the "normal" definition, which may not apply to skiers or ski instructors, in the study of vectors and forces, "normal" means "perpendicular to." A normal force acts at right angles to another force. I am not making this up.

O



Oblique Gate An oblique gate is a double-pole race gate set diagonally on the hill. Alternatives include *closed gate* (set vertically on the hill) and *open gate* (set across the hill).

Off-Piste See **Piste**.

Offensive Skiing Good skiing is offensive, not defensive. It is characterized by gliding skis and a smooth, continuous flow of the center of mass from turn to turn, with speed control resulting from turn completion and turn shape, as opposed to braking (speed control from "direction, not friction"). Offensive skiing is not necessarily fast skiing, and it certainly need not be reckless. As I have often stated, good (offensive) skiing is skiing a slow line fast; defensive skiing is skiing a fast line slow (incomplete turns with much skidding). Offensive skiers think of turns as a way to control direction; defensive skiers think of turns as a way to control speed.

Open Gate An open gate is a double-pole race gate set horizontally on the hill. Alternatives include the *closed gate*, set vertically, and the *oblique gate,* set diagonally.

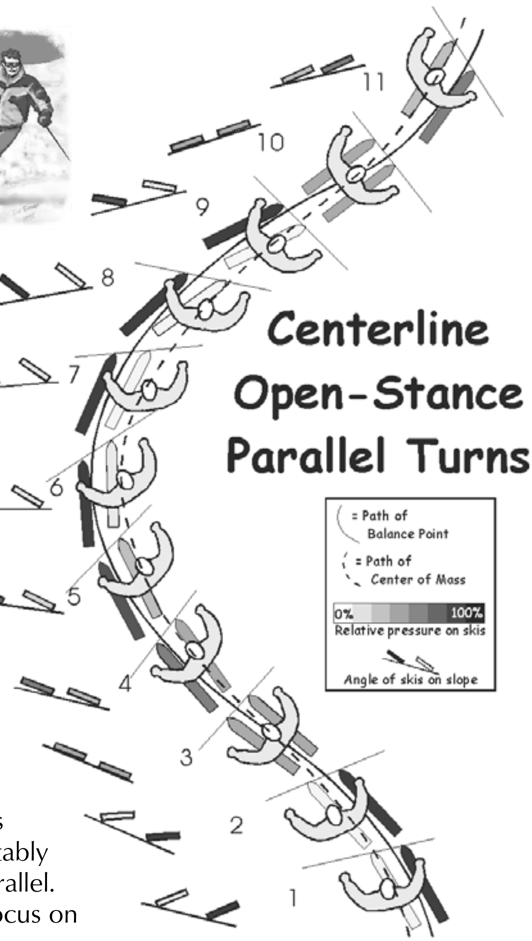
Open Parallel Turn See **Open-Stance Parallel Turn**.

Open Stance Open stance, as in "open-stance parallel turn," refers to an athletic stance with the legs comfortably and naturally apart. The open stance is not necessarily a *wide* stance, although it often implies a somewhat wider stance than that of the expert. The stance typical of intermediate skiers, the open stance is natural, but the skier may not balance entirely on one foot. Both skis may bear some weight, and the skis provide a broad, stable base of support. Most importantly, the open stance allows powerful leg steering (the *fulcrum mechanism*), independent leg action, and quick weight transfer and edging movements. As the skier's skills develop, the stance may narrow somewhat, but it should never become a closed or locked stance.

Open-Stance Parallel Turn Sometimes called simply *"Open Parallel Turn,"* this Center Line™ Milestone represents turns at the basic intermediate level of parallel skiing. In the Center Line™ Model of skill development, Open-Stance Parallel comes after Wedge Christie and before Dynamic Parallel. Like all Center Line™ Milestones, this turn embodies all the characteristics ("common threads") of the Center Line™ at a particular level of skill development. Stable, disciplined upper body, active legs, basic aligned, athletic stance, progressive edging and pressuring movements, balance on the outside ski with a smooth transfer from turn to turn, linked round turns, skis gliding the direction they're pointed (more or less), speed control not from braking but from completing turns, no intentional, forced skidding, offensive "positive" movements, and a smile, all these are in evidence here as anywhere along the Center Line™.

Open Stance Parallel differs from Wedge Christie in that both skis release and turn equally down the hill at turn initiation, staying parallel throughout the turn. A little more speed, a more active and accurate crossover move, and a disciplined pole swing all contribute to this simultaneous edge release.

The turn differs from Dynamic Parallel mostly as a matter of degree. Gentler edge angles and less steepness, perhaps an incomplete weight transfer, and slower speeds, generate less force to bend the outside ski, meaning the skis skid more than in Dynamic Parallel. Because the skis decamber and carve less, rotary movements may be more muscular than in Dynamic Parallel.



Open-Stance Parallel Turn. *All Center Line™ "Common Threads" apply to this basic parallel turn milestone. The stance is natural, not necessarily wide, and the legs work independently. Linked turns begin and end in "neutral"(frames 3 and 10), with square stance (no lead), equal pressure on both skis, and skis flat on the snow. From neutral, tips are steered with the legs into the turn, causing a lead of the inside ski, knee, hip, and shoulder; edge angle and pressure on the outside ski both increase progressively (frames 4-8). As turn nears completion, the CM begins to crossover, reducing edge angle and pressure (frame 9), finally ending again in "neutral."*

But Open Stance Parallel is *not* an intentionally skidded turn. The intent, as in all turns along the Center Line™, is to hold a line and follow an arc with as little skidding as possible. Because the skis are flatter and rotary is more active, the skis will inevitably carve less than in Dynamic Parallel. But rotary efforts should still focus on turning the ski tips into the turn, with no intentional pushing out of the tails. And these rotary impulses should come from the legs (see **Fulcrum Mechanism** and **Braquage**), not from the upper body.

Open stance does not imply *wide* stance (see **Open Stance**, above). A natural separation between the skis is all that is required. This separation creates the two independent pivot points required to steer the skis using the fulcrum mechanism. Balance shifts naturally and smoothly from outside ski to outside ski as turns are linked, but the inside ski remains in contact with the snow. The moment the ski loses contact with the snow, it is no longer available to provide the "fulcrum assistance" to allow leg steering, or to aid in balance.

See also **Center Line™** and **Common Threads**.

Options

Choices—options are different ways of doing something or accomplishing a goal. While typically in any given situation, one technical application will be the most effective or efficient (witness the striking similarities between top world cup racers rounding the same gate), it is having options that bestows versatility and allows us to ski "toute neige, toute terrain." How we stand on the skis, how we initiate the turn, simultaneous *vs.* sequential movements, stationary *vs.* moving platforms, braking *vs.* gliding—all these are choices available to the versatile skier. Often as skiers, we develop an unconscious preference for some movement options over others. This bias prevents us from performing most effectively in some situations. Options are essential to good skiing; biases are limiting.

> ***OPTIONS are essential; BIASES are limiting.***

The Center Line™ Model represents one option, one particular blend of skills and movements. There are other ways to get down a hill. But are there other ways to make the "perfect" turn? I think not. Center Line™ depicts the movements of the purest, cleanest, and most precisely controlled turns at any level. Any other options may be equally valid and valuable in the skier's tool box, but we should not think of them as good *turns*—good braking, perhaps, or expertly letting the skis take us for a ride on a railed-out carve—but inferior turns as far as controlling line.

> ***There are lots of good ways to get down a mountain on skis, but very few ways to make the perfect turn.***

Outcome-Oriented Teaching

PSIA's humanistic approach to teaching is "outcome-oriented," as opposed to "progression-oriented." This means that lessons focus on mastery of clearly-defined objectives or "outcomes," rather than on a pre-determined routine of exercises and steps.

Based on principles of *"mastery learning,"* the ATS Teaching Model stresses the importance of the "learning partnership," in which students and instructor agree on certain concrete objectives that they will work together to accomplish during the lesson. These desired outcomes are based on the students' individual personal goals and desires, ability levels, aptitudes, and motivations, shaped by the instructor's guidance and suggestions. For success, the objectives of a lesson must be clearly defined, relevant to students' long-term goals, and achievable in the allotted time. The "outcomes" have been achieved when students have "mastered" the material—that is, they can practice the new movements or ideas consistently, independent of the instructor's constant feedback.

Many students take lessons with vague or unrealistic goals in mind. They want to "learn" bumps, for example, with visions of flying down the mogul fields like Olympic champion Jonny Moseley—but they've never ventured off the groomed green runs yet. "Bump mastery" would not be a valid aim for this lesson—it is neither concrete (how do they know when they've accomplished it?), nor realistic. The instructor's first job will be to help the students set clear, fun objectives for the lesson, relevant both to the students' dreams and to reality. No lesson can fail when its outcome is mastery of something concrete that students *know* is a real step toward their ultimate goals. They will come back!

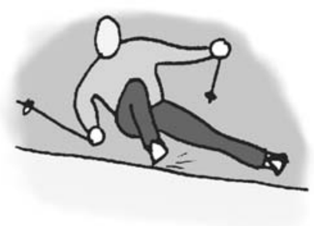
"Older" teaching methods relied on strict, linear progressions of exercises and steps, done in specified order, without regard to individual talents and goals. This mechanistic, technique-oriented approach was common to many old European schools, with their rigid "national techniques." PSIA's humanistic American Teaching Method revolutionized ski teaching in the 1960's with its outcome-oriented approach.

See also **ATS Teaching Model** and **Mastery Learning**.

Outriggers

1. In "adaptive skiing," outriggers are very short skis mounted to arm braces, used by amputees and other handicapped skiers.

2. Outriggers are also an early freestyle trick involving turning on the inside ski while deeply flexed and extending the other leg and ski far to the outside.



Outrigger turn

Over-Initiation

Over-initiation refers to a turn initiation where too much rotational motion *(angular momentum* or "spin") is imparted to the skier/ski system. When skiers throw themselves a little too hard into a turn with upper body rotation or rotary pushoff, they have over-initiated, and must deal with the consequences. It cannot happen when a skier simply steers the legs with a stable, aligned upper body (Center Line™ mechanics), but it is quite common among skiers who use rotation-type mechanics to initiate turns. Nor can a counter-rotation turn initiation cause over-initiation.

Over-initiation can lead to the tails washing out or an inability to control or stop the turn when desired. It must be corrected in the control and completion phases of the turn. Options for correcting over-initiation include increasing edging or pressure, levering (increasing pressure on) the tail of the ski, a downstem, or transferring the excess rotary momentum to the upper body, allowing the upper body to rotate instead of the skis.

ATM Teaching Concepts[62] states that we can also reduce rotary momentum by "ceasing to actively pivot the skis," by "reducing the edging of the skis," or by "reducing or eliminating the decambering of the skis." In truth, "ceasing to actively pivot the skis" involves only *internal* forces and cannot reduce rotational momentum of the whole skier/ski system. Nor can reducing edging—we need interaction with the snow *(increased* edging, as in an abstem) or some other external force. Reducing the decambering of the skis (like reducing edging) will prevent them from continuing to carve the turn, but this action also cannot reduce existing rotary momentum. Unfortunately the newer *ATS* manual sustains this misunderstanding.[63] On the other hand, in turns where over-initiation and excess rotation is *not* a problem, any of these movements can indeed end the turn. They are all common moves in the completion phase of Center Line™ turns.

See also **Under-Initiation**.

P

Panel Gate A panel gate is a race gate consisting of a rectangular flag suspended from two poles. Giant slalom, super-G, and downhill races typically use panel gates. Slalom races, on the other hand, usually use single poles. In "amateur" racing (Olympic and World Cup), two single poles or two panel gates form each actual gate, through which the skier must ski.

Parabolic A parabola is the mathematically-defined curve that describes the arc of a ball in free flight. In skiing, "parabolic" refers to skis with sidecuts of this shape. Originated by the Elan ski company, which uses parabola-shaped sidecuts on many of its skis, including those without radically deep sidecuts, the term is now commonly misused as a generic name for any deeply sidecut "shaped" ski, whether parabolic or not.

Parallel "Side-by-each." Technically, parallel lines must be exactly the same distance apart at every point, but other dictionary definitions are perhaps more applicable to skiing: "Having the same tendency or direction;"[64] "Similar or corresponding."[65]

Biomechanically, it is difficult if not impossible to keep the skis exactly parallel and to change edges exactly simultaneously. When steering both skis in parallel turns, one leg rotates out (*external rotation*) and the other rotates in (*internal rotation*). The muscles that cause internal rotation are stronger than those that cause external rotation, so balancing these moves takes practice. Similar "imbalance" affects our ability to angulate with our knees and control edge angle on the inside and outside skis.

Thus we must define parallel turns as turns initiated with the skis roughly parallel, and with a more-or-less simultaneous edge change, as opposed to with a wedge or a "1-2" action. The parallel turn has long been and will probably continue to be the ultimate goal in the minds of many skiers. It is ironic that with modern equipment and teaching methods, we can teach most skiers to make decent "parallel turns" within a few days, while the best skiers in the world use "parallel" as just one of many options. We handicap ourselves severely if we do not allow other options.

Parallel Christie A parallel christie is any turn in which the skis remain more-or-less parallel from initiation through completion, with skidding to some extent on corresponding edges—a generic "parallel turn." (As noted under **Christie**, remember that all turns involve some skidding. To say that a parallel christie involves "skidding on corresponding edges" should not imply that the turn necessarily involves a *lot* of skidding. It could also be a carved turn with almost no skidding at all. Personally, I'd like to lose the "skidding" part of the definition, but I include it here because it is the traditional definition of "christie.")

Parallel Step Used to adjust line, gain height on the hill, or recover balance, a parallel step is a lateral step to a (roughly) parallel ski. Options include "*inside-inside*," "*inside-flat*," and "*inside-outside*" moves (see), depending on which edge of the stepped ski first engages the snow. Because a big lateral step usually pushes the center of mass uphill, away from the direction of the upcoming turn, it can be inefficient and slow. But the parallel step is often necessary, especially as a recovery move. Through the 1980's, most race turns involved some sort of a step to compensate for skis that did not turn as tightly as the skis of today. With modern tight-carving skis, stepping has all but vanished in skiing as a habit. It is still an important skill and option.

Passive Turns Race coaches use the term "passive turn" to refer to turns produced with no muscular rotary input from the skier—turns initiated entirely by gravity and the curved sidecut of the skis, and completed entirely by the carving action of the decambered ski. (See *U.S. Ski Team Training Manual.*[66]) Contrast with *active turns*, in which the skier uses muscular force to some extent to steer the skis through the turn. In PSIA terms, passive turns are turns that involve only pressuring and edging efforts, with no rotary input.

Rarely will the skis take the desired path without some active steering. As Georges Joubert states, "This type of skiing isn't dangerous on smooth, wide slopes, and can even be very relaxing, however on more difficult [terrain] or in racing courses, you would need more control. . . . The skier must learn to control the path of the skis very precisely. Thus you must learn to play with the [carving] effect produced by your skis to increase as well as decrease it."[67]

Passive turns are analogous to a railroad train following a curvy track. The train turns, of course, but it has no control over its path.

Patience Turns Usually used as an exercise, these are turns entirely initiated by *gravity*—no rotary is involved. Patience Turns are "*passive turns*" (see above), at least through the initiation phase. From a previous turn or traverse, the skier merely rises to flatten the skis and release the edges and patiently waits while the skis gradually "seek the fall line." This exercise requires a wide, uncrowded slope and a confident skier unafraid to let the skis run. It is a good way to introduce a skier to advanced skiing, carving, and steering or guiding instead of forcing or throwing the skis sideways into a turn. It can be a lot of fun for skiers used to braking and unaccustomed to the sensations of gliding, offensive turns.

PCL See **Posterior Cruciate Ligament**.

Peak Performance Also called "peak experience," this is the best we are capable of, given current skill level. Peak performance occurs when there is a perfect harmonious blending of mind/body/spirit, the proper level of arousal ("*functional tension*"), "relaxed concentration," and absence of performance-impeding mental games (doubts, negative self-talk, "paralysis through analysis," and such). Abraham Maslow, the behavioral psychologist noted for his studies of human motivation, suggested that peak performance occurs only when we operate at the highest level on his hierarchy of motivation. Fear, hunger, cold, insecurity—any of the "lower needs"—interfere with peak performance (see **Maslow's Hierarchy**).

Two factors affect how well we ski: our physical ability and skill level, and the extent to which we enhance or interfere with this ability with our mental processes. We cannot ski *better* than we can ski (but we can improve!). Unfortunately, most of us rarely allow ourselves to ski as *well* as we can. Peak performance is a wonderful thing, but it can be elusive!

Perceptual Skills

Perceptual skills refer to the ability to vary and adjust movements and tactics according to sensory feedback, as opposed to *habitual skills,* performed the same way every time from muscle memory. If all ski turns were identical in size, shape, speed, terrain, and conditions, we would need no perceptual skills. We could ski by rote, automatically, relying only on muscle memory. But snow skiing isn't like that. No two turns will ever be the same on snow. Water skiing may require less perceptual skill—water is always water after all, always level, always the same consistency. Skiing consistent short turns on a groomed trail involves mostly habitual skills; skiing moguls, following another skier's track, or skiing a race course with rhythm and terrain changes, highlight perceptual skills.

The term refers not only to the adjustments we make based on our perception. It also pertains to the skill itself with which we perceive the situation—the accuracy with which we can pick a line in moguls, the sensitivity to subtle differences in speed, snow texture, edge grip, and so on.

See also **Closed Loop** and **Open Loop Tasks**.

Perfect Practice

The old saying, "practice makes perfect," is incomplete. Only *perfect* practice makes perfect. *Practice makes permanence*. We will, without question, get better at whatever we practice. Therefore it is essential that we practice good, technically correct skiing movements, lest we simply get good at bad skiing.

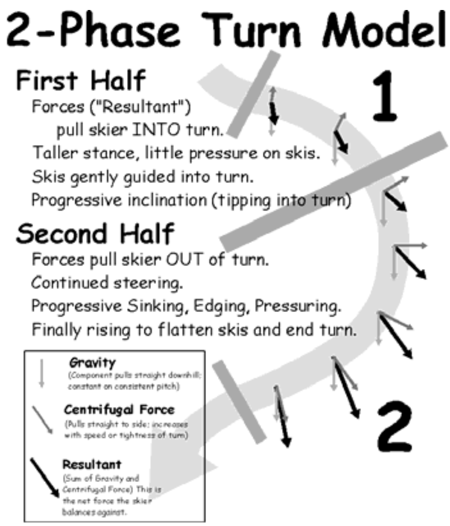
Phantom Foot

Often cited as a contributing factor in many injuries to the anterior cruciate ligament of the knee, the "phantom foot" refers to the tail of the ski. Because humans evolved with feet that do not extend behind the heel, the knee joint is not really "designed" to withstand the stresses that the extended lever of the ski tail can produce.

See **Anterior Cruciate Ligament**.

Phases of Turns Through skiing's history, various models of skiing have divided turns into two or more sections or "phases." The Mahre Training Center at Keystone divides turns in half, based on the idea that at the beginning of the turn, gravity pulls the skier *into* the turn, but at some point, gravity and centrifugal force combine to pull the skier *out*. (See **First Half** and **Second Half**.)

PSIA's American Teaching System™ recognizes four turn phases—"preparation," "initiation," "control," and "completion." Each phase involves distinct technical components and tactical elements.



Mahre Training Center's two-phased turn model. Division between first and second "halves" varies with speed, turn radius, and steepness of hill.

Preparation includes all the movements made to prepare for the upcoming turn, including beginning the pole swing, decreasing the edge angle, and perhaps *anticipation* or *rotation* of the upper body toward the new turn.

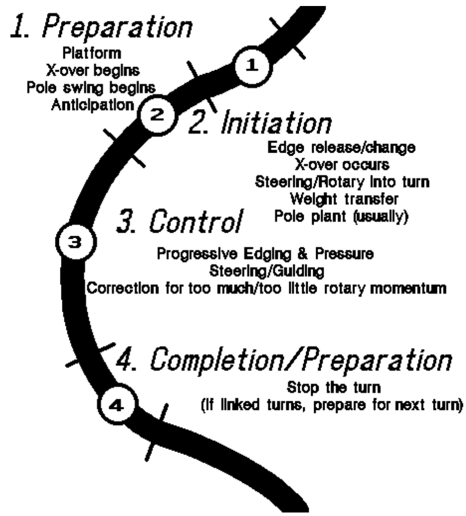
Initiation marks the actual beginning of the new turn, which happens the moment the edge of the downhill ski releases and the skis begin to turn in the new arc. Pole plant, cross-over, and weight transfer typically occur in the initiation phase, as do classic turn-initiating rotary mechanisms. These can include, optionally, steering the legs in the new direction ("fulcrum mechanism"), releasing the stretched muscles of the torso and legs ("anticipation-release"), stopping the rotation of the upper body or hips ("rotation" or "rotary pushoff"), counter-rotating the upper and lower body, and/or a blocking pole plant (see **Rotary Mechanisms**).

The *Control Phase* is the "belly" of the turn, during which the skier guides the skis down the hill, through the fall line, toward the finish of the turn. Gravity and centrifugal force increasingly pull the skier out of the turn, and resisting these forces with increasing edge angle and pressure control movements (flexion-extension) are the skier's primary job in the control phase.

The *Completion Phase* is the end of the turn. Here the skier must stop the turn, which may simply mean ceasing to resist the forces by reducing edge angle and stopping the active steering of the legs (a modern "Center Line™"

turn). Or it could involve compensating for either under- or over-initiating the turn if the turn was initiated with rotation, counter-rotation, or a blocking pole plant. (See **Under-** and **Over-Initiation**). If turns are linked, the preparation and completion phase merge to what we might call the *"transition"* phase.

While this four-phased turn model is still applicable in many ways, I think it is time to revisit it. When turns always involved throwing, twisting, or thrusting the skis sideways into a skid, then stopping that skid to end the turn, there were clearly four, distinct phases. But today's carved, steered turn blurs the distinction. When we steer a car around a curve, there are really not four "phases" of the turn—we just steer the wheel until the curve ends, then straighten it out or steer it the other way into a new curve. Carved ski turns are the same—the motion is continuous and seamless. Skis steer to the right in a right turn, on their right edges, with weight on the left ski, from beginning to end, then switch for a left turn. There is a moment of *"neutral"* (see) at the transition. If we begin and end each turn in neutral, there is no need for "preparatory" movements or "completion" movements. The division from "initiation" to "control phase" to "completion" is arbitrary in modern carved turns, and the "completion-preparation" phase can best be described as "transition" or, in the words of Keystone's Charles Choi, *"finishiation."*



Four-Phased Turn Model*—is it still applicable to modern carved turns? (See text)*

Piaget, Jean Influential, if somewhat controversial, Swiss psychologist Jean Piaget (1896-1980) devoted most of his career to the study of children's thinking and the growth of intelligence and logical ability. He believed that mental capabilities govern our perception of reality, and that a child's perception of (not just *knowledge* of) the world is therefore very different from an adult's. While much of Piaget's work applies more to how school teachers and parents can best encourage cognitive development—not really a ski instructor's job—his ideas are helpful as well to anyone who deals with children. Knowing more about how children think and perceive, we can better understand how and why they act as they do. And we gain insight that enables us to plan and conduct more effective and fun lessons for people of any age.

Piaget believed that abstract reason, hypothetical thinking, logic, and the ability to conceive and manipulate symbols are adult capabilities that develop through childhood and adolescence. His research suggested that infants are born with none of these abilities, and that adult thinking arises in a fairly predictable sequence as new capabilities add to old.

According to Piaget, it is the constant search to make sense of our world that stimulates the growth of thought. From birth, we organize our experience and knowledge into categories ("schemes"). These categories can be simple ("a ski") or complex ("skiing"). New, unfamiliar experiences tend to throw us off a little and make us uncomfortable ("dis-equilibrated"). When we encounter something new, we must ease the anxiety to return to equilibrium, either by ignoring the new experience ("it didn't happen"), by adjusting the experience to fit our current thinking ("it's weird-looking, but it's still a 'ski'"), or by adapting our thinking to accommodate the new experience—modifying the category ("skis have changed") or adding new categories ("it's a 'snowboard'"). Most new experiences result in a combination of the second two options (the first option—ignoring the facts—isn't usually a healthy way to remain in touch with reality!). It is this process of organizing and adapting that develops increasingly complex reasoning ability.

According to Piaget, all children do not develop at the same rate, but the *order* of acquiring new cognitive abilities is consistent. Originally a biologist, Piaget believed that both genetic (inborn) and environmental (experience and learning) factors influence this development. He identified four main stages of growth, and identified the rough "average" ages for each.

Sensorimotor stage (infancy—birth to roughly 2 years of age)

At birth, all reality consists of current experience. If we see, hear, feel, taste, or smell something, it exists—if we don't, it doesn't. By about seven months, "permanency" develops and infants can understand that objects may still exist even when they move temporarily out of sight. Infants experience objects, time, and space on a strictly concrete, non-abstract level.

Pre-operational thinking (2 to 7 years)

In this stage, simple categories ("schemes") begin to develop as toddlers search to understand their world. Pre-operational children begin to represent objects with "symbols" and language starts to develop. Thinking is inflexible—they may learn how to do some things, but they cannot mentally "reverse" the operations. They may not comprehend "conservation of matter," the principle that quantity or number of things doesn't change just because the shape or arrangement changes. The pre-operational mind is "egocentric." This does not mean "selfish," necessarily, but means that pre-operational children tend to believe that everyone's experience is the same as theirs, that everyone sees, believes, and knows exactly what they do.

Concrete operations (7 to 11 years)

"Operations" are mental activities, the ability to visualize actions without actually performing them. At this stage, thought processes become increasingly flexible, but still not abstract. These children begin to recognize simple logic. They can conceive of the concept of "conservation"—they understand that when you pour liquid from a tall, narrow glass into a short, wide glass, the quantity does not change, even though it may appear to be less. And their thinking becomes "reversible"—they could visualize pouring the liquid back into the tall glass, and the level returning to the original height. At this stage, children begin to "classify" things and experiences—to arrange them in order based on some quality—and to recognize hierarchies of classes. They may become fascinated, for example, with extended addresses (street-city-state-country-continent-planet-solar system-universe).[68] And concrete operational children begin to understand that everyone does *not* necessarily share their experience and point of view—their thinking becomes non-egocentric.

Formal operations (11 years to adult)

Finally, adult thought capability emerges, with complex reason, abstract thinking, and the ability to think hypothetically. The age of adult formal operations varies widely, and some people never fully reach it.

While some controversy surrounds Piaget's methods and his four defined stages, most psychologists agree that these processes do develop from infancy to adulthood. Piaget's ideas give us insight into children's behavior and suggest some practical guidelines for teaching children of varying ages. Especially for younger children (pre-operational), it is important to keep instructions brief and simple, to use concrete visual aids (demonstrate!), and to use familiar examples and ideas. Most important, children need lots of "hands-on experience"—lots and lots of "doing." And with older children and adults, it is important to remember that increased cognitive ability does not take the place of simpler abilities—it merely adds to them. So methods that work for young children remain important for adults. Adults may demand reasons and justifications, explanations, and rationales, but these cannot take the place of concrete experience.

See also **Cognition** and **Bloom's Taxonomy of the Cognitive Domain**.

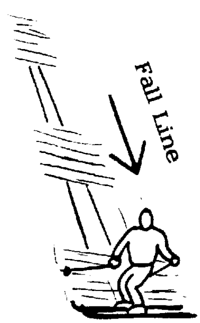
Piloting

"Piloting," as Georges Joubert used the term, refers to the sum of all the steering movements and rotary, edging, and pressuring skills we employ to control the line and shape of the turn. While edged and pressured skis will decamber and carve turns on their own (see **Passive Turns**), they will not often want to go exactly where *I* want them to go. An analogy would be a car that had a "right/left" switch instead of a steering wheel—it would turn, but I wouldn't want to drive it in traffic! Joubert states that "piloting your skis consists of very fine pivoting or counter-pivoting efforts much like the fine adjustments you make with the steering wheel of your car while driving on icy roads."[69] And piloting "corresponds to the very fine adjustments that a pilot exerts on the stick of his airplane or that a race car driver exerts on his steering wheel during controlled skids. . . ."[70] It is usually a subtle movement, not an attempt to overpower, twist, or push the skis into a skid.

PSIA emphasizes the concept of piloting, as we refer to actively steering both feet throughout the turn. While we want to get the skis to do what they can—to decamber and carve—we don't usually want to "rail" them on locked edges where we cannot control the arc.

Piste In skiing, "piste" refers to the ski trail, particularly a groomed run. "Off-piste" describes the rest of the mountain world—ungroomed, crud, moguls, powder, and the terrain beyond the boundaries and unaccessible by chairlifts. Skiing off-piste demands a high level of skill and a versatile technique. While the manicured runs of today's ski areas certainly have their appeal, in my opinion, the true beauty, adventure, and spirit of skiing are found off-piste. The farther we venture from the controlled, patrolled safety of groomed runs, of course, the more we must accept increased risks of injury, avalanche, and difficult evacuation. No one should venture off-piste, especially beyond the boundaries of a ski area, without the education and experience to minimize the dangers, and the expertise and equipment to deal with problems.

Pivot Slip Pivot slips are an exercise involving linked "**Hockey Slips**" (see). The goal is to sideslip straight down the hill, then pivot the skis 90° and slide straight downhill, then pivot them 90° more into another sideslip the other way. In a perfect pivot slip, the skier moves directly down the fall line, remaining in a narrow corridor. This exercise develops edging skills, fore/aft balance, upper body stability, and leg steering skills. It is a good test of a skier's ability to begin a turn by simply releasing the



Pivot Slip

edges and turning the feet in the new direction. It is also a good warmup drill for the tight turns of mogul skiing.

With many ways to "cheat," good pivot slips are not as easy as they look. The skis should pivot simultaneously, using independent leg steering ("braquage"). Many skiers try to twist the skis using the upper body, or using a sequential "one-two" rotary pushoff from one leg to the other. No edgeset, pole plant, or unweighting is needed.

Some people call the exercise I describe here simply "linked hockey slides." They use "pivot slip" to describe a similar exercise in which the skis pivot 180° from sideslip to sideslip, without a straight run down the fall line in between.

To improve your pivot slips, focus on developing very active feet and legs beneath a stable, disciplined, relaxed upper body. The pelvis should behave as part of the upper body, turning only slightly as legs rotate in the hip sockets. A wide arm stance can help stabilize the upper body. Fairly wide separation between the feet promotes leg steering (see *braquage*). Lower your stance slightly, look downhill, and turn your legs. No vertical motion (unweighting) is necessary. Begin each pivot with the *tip* of the *inside* ski—turn the right tip right to start the right pivot. There may be a slight divergence ("V") between your skis. Beware of one-two stemming movements that begin by pushing the tail of the outside ski out. If a wedge appears, however momentary, you are using the wrong mechanism. To help you stay in a corridor, have a partner straight-run ahead of you while you try to keep your feet on his or her tracks during the pivot slip. The *falling leaf* exercise will further develop your ability to sideslip within a corridor.

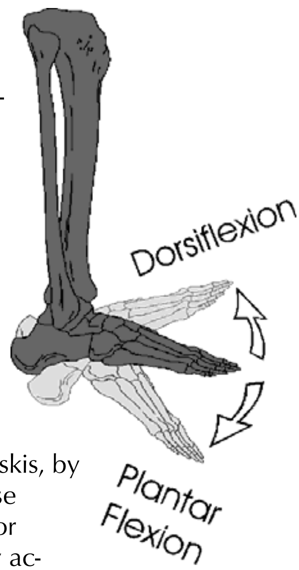
See also **Hockey Slip**, **Woozels**, **Braquage**, and **Falling Leaf**.

Pivoting

Pivoting means twisting or rotating about an axis. It is a fundamental movement in skiing. Many parts of the body can pivot around a variety of points. The upper and lower halves of the body can pivot around a central axis. The lower body can pivot as a unit around one axis, as when turning a barstool with the feet. Or the legs can pivot independently of each other, as when standing on two barstools and turning them both. And the entire body can pivot around one point, as in a helicopter jump. Pivoting can involve powerful rotary mechanisms to redirect the skis at turn initiation, or subtle guiding movements that pilot the skis through clean, carved turns.

Like jerky movements of a car's steering wheel, harsh, powerful pivoting movements have no place in good turns. In good turns, the skis go forward, in the direction in which they're pointed. Harsh pivoting causes the skis to skid, and is effective only if the skis need to act as brakes.

See also **Rotary Mechanisms**.



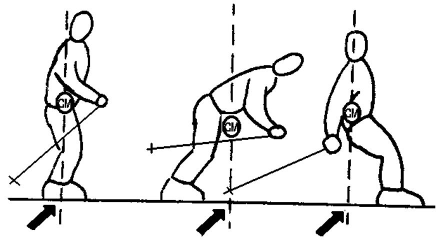
Plantar Flexion In biomechanics, plantar flexion is the motion of extending (ironically) the ankle, moving the toes away from the shin. Its opposite is *dorsiflexion,* meaning flexing the ankle, pulling the toes toward the shin. When we lean back against the boot cuff, we plantar flex the ankle.

Platform "Platform" refers to how the skier uses the skis as a base from which to move into a turn. There are two types of platforms—the *stationary* (braking) platform and the *moving* (gliding) platform. The classic stationary platform results from a slowing or stopping of lateral movement (skidding) of the skis, by setting the edge(s), which provides a stable base from which the skier can rebound, stem, step, or push off into a new turn. A pole plant generally accompanies the edgeset. As this "checking" movement momentarily blocks the flow of the center of mass, stationary platforms are not a feature or "common thread" of the Center Line™. In the Center Line™ Model, stationary platforms identify movements "left" of the Center Line™ (the "edge-pressure" side of *lateral exploration).*

Center Line™ turns involve a moving or gliding platform. The skier rises (extends) and allows the center of mass to flow smoothly across the skis and into the new turn. In contrast to the stationary platform's edgeset, a gliding platform entails a *release* of the edge of the old turning ski, allowing the skier to guide both skis into the turn with the legs. A pole swing, beginning in the preparation phase, enhances and directs the smooth flow of the body into the turn. The pole plant, usually just a gentle touch, occurs later, generally in the initiation phase.

Identifying the type of platform the skier uses to prepare for the turn should be of primary concern when analyzing a skier's movements. If there are two types of skiers out there, this concept more than any other may be what sets them apart.

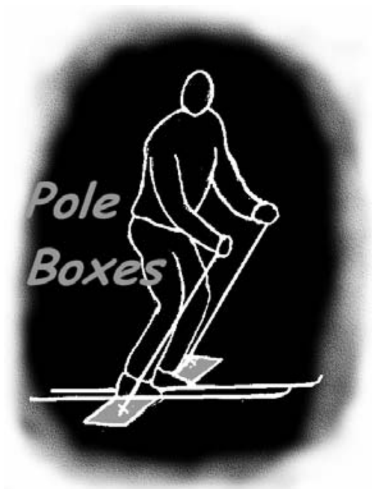
Point of Contact (Center of Pressure) A potentially confusing term, the "point of contact" is the spot upon which the pressure is focused on a ski or within the base of support. While the entire ski or both skis may be in contact with the snow, the point of contact refers only to the single point over which the skier balances. Statically, when I lean forward, the point of contact moves toward the tips of the skis; when I am in a neutral, balanced stance, the point of contact is the "sweet spot" of the ski. The point of contact moves from ski to ski in most turns. When both skis bear weight, the point of contact lies somewhere between them. Dynamically, the effects of acceleration and deceleration influence the point of contact (see **Leverage**). We can summarize good, balanced skiing as the accurate management of the point of contact throughout the turn and from turn to turn.



Point of Contact (Center of Pressure)

Pole Boxes

One of my favorite exercises for developing upper body discipline and a good, aligned stance, "pole boxes" involves skiing while keeping the pole tips in imaginary boxes attached to the sides of the boots. Begin by standing still and planting both poles comfortably off to the sides, directly in line with the centers of the boots. Relax, and let the pole grips tilt forward as the hands find their natural position somewhere in front and to the sides. Now ski a series of turns, keeping both poles scratching the snow precisely in their "boxes." Do not let either pole come off the snow, or forward or back of its box.



For most people, this exercise will demand close attention, because it is likely to change some fundamental movements and positions. Try using a partner to keep an eye on your poles. It may not feel right at first, but keep practicing until it feels natural. If you tend to rotate your arms or upper body, or bank into the turn, this exercise will prevent you from making these errors—but it will feel strange! Keep at it. (Remember, as Phil Mahre once said, "if it doesn't feel strange, you didn't change!")

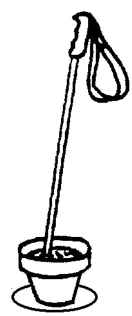
With the poles in the boxes, the hands and upper body will mimic the lead and lead change of the skis, as they should. With both poles on the snow, the shoulders are more likely to remain properly tilted "parallel" to the hill, instead of banking into the turn. I recommend pushing down and forward on the poles while skiing, scratching the snow firmly with the tips. This scratching adds auditory (you can hear it) and kinesthetic (you can feel it) feedback to the exercise. It also produces a little tension in the upper body, helping it to become disciplined and stable.

Practice the pole box frequently. It's a good exercise for cat tracks, warm-up runs, and whenever things aren't feeling "right." Pole boxes will make you perfect! Unlike most exercises, this one exaggerates nothing, other than being a little stiff, so you need not worry about over-practicing it or developing any bad habits from it. The positions and movements it produces are precise and technically accurate.

Pole Drag While it may sound lazy and inelegant, dragging one or both poles on the snow can aid balance by putting the upper body in contact with the snow (see **Pole Boxes**, above). Virtually all expert skiers drag their poles purposefully at times, yet many skiers assume it must be somehow "wrong." Bill W. West describes pole dragging as the "venereal disease of skiing" in *Distinctive Skiing*[71] (a book all instructors should read to learn the extent of the misinformation and misconceptions many skiers share).

Pole Plant The pole plant can range from a firmly engaged stab of the snow for balance recovery or blocking, to a light touch of the snow that enhances timing, rhythm, and "flow." A pole plant helps position and direct the movement of the upper body, and contributes to both physical and mental commitment to the turn.

The timing and character of the pole plant varies from turn to turn, depending in particular on the type of *platform* the skier uses to prepare for the turn. With a stationary platform (edge/pressure bias—"left of Center Line™"), a fairly solid pole plant generally coincides with or immediately follows the edge set, preceding the turn initiation. With a moving platform ("on the Center Line™"), the pole swing begins in the preparation phase, helping direct the movement of the center of mass into the new turn. A light pole touch marks the weight transfer and commitment to the outside ski in the initiation phase or even later. Skiers with a rotary bias ("right of Center Line™") generally have no functional pole use, as they twist their skis left and right.



Pole Plant

In any case, the pole plant occupies only a minute moment in a turn and represents only a tiny portion of overall pole use. The pole plant is usually just the period at the end of the sentence—the pole *swing* is the sentence. A pole plant without a pole swing only amounts to a hole in the snow! (There is even a song about this—"It don't mean a thing if it ain't got that swing. . .") It is unfortunate that so many skiers seem obsessed with the plant itself—where, when, how far to the side?—meanwhile virtually ignoring the poles throughout the rest of the turn. As Phil and Steve Mahre often say, "If poles were half as important as most people think they are, we'd call the sport *poling*."

See **Pole Use**, **Pole Drag**, **Pole Swing**, and **Pole Touch**.

Pole Swing

Pole swing describes the pendulum-like motion of the ski poles that provides tempo and rhythm to turns. A well-timed and directed pole swing helps draw the body into the upcoming turn. An improper (*i.e.* too early) pole swing or plant can actually block the smooth flow of the body from turn to turn. Expert skiers may swing their poles without a pole plant in many turns, again demonstrating that the pole plant is but a small part of pole use.

A pole plant without a pole swing only amounts to a hole in the snow!

In general, the pole swing should be smooth and fluid, but disciplined. Most of the movement should come from the wrists, with very little from the elbows and even less from the shoulders. The pole swing should not interfere with the good alignment of the upper body. It is a common error to reach too far forward with the downhill hand and drop the uphill hand down and/or back, pulling the torso grossly out of position.

Pole swing is analogous to the movements of our arms in many activities. When running we swing the arms smoothly and deliberately forward; jumping on a diving board we swing the arms up; diving off a diving board we swing the arms again forward. In all these activities the movement of the arms helps direct and lead the movement of the rest of the body and the center of mass. In skiing, the pole swing does the same: it helps lead the body into the new turn, directing the crossover movement.

See **Pole Plant**.

Pole Touch

A pole touch is just a light, gentle, tap of the pole to the snow—a "kiss" as opposed to a heavy stab. For most turns, especially those involving a *moving platform* (*i.e.* Center Line™ Maneuvers), a pole touch better contributes to the flow of the turn than a pole plant.

Pole Use

We use the poles for many things, including pushing on the flats, getting up from a fall, and as "sensors" (they put our upper body in contact with the snow, assisting balance and giving us valuable information about our degree of inclination, slope angle, and snow texture). Poles help as balancing aids and recovery aids, stabilizers to *block* the upper body, timing devices, rhythm enhancers (pole swing), and when necessary, liftline tactical weapons.

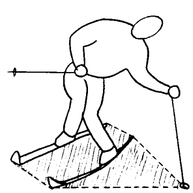
Overall, we must look at the poles as extensions of the arms and understand pole movements in the larger context of arm movements. Pole use is versatile, changing from turn to turn and varying with the situation. We must consider all these uses and not dwell on developing the robotic, useless pole plant that we see in so many skiers. The poles are only there to help us; there are as many "right ways" as there are turn types (although there are certainly plenty of wrong ways too).

As instructors, when should we introduce the various uses of poles? My rule is to introduce poles only when they will actually help the student. We cannot enhance rhythm when there is none to start with. And blocking the upper body is irrelevant when there is no independence of the upper and lower body. On the other hand, beginners are certainly ready to use the poles for balance when putting on skis, flatland propulsion, and perhaps for getting up off the snow. *"Pole boxes"* (see) is a fantastic exercise for skiers of virtually any level to develop upper body discipline and alignment. When turns become dynamic enough that a pole swing/plant could help, I usually introduce them briefly and intermittently at first, so as not to add frustration. If the poles interfere, it certainly makes sense to stop bothering with them for a while. Moguls are difficult to ski without a pole plant (although for experts, skiing bumps without poles can be a great exercise). For skiers who want to learn to ski bumps, a little review of precise, rhythmic, and disciplined pole use is often a good warmup. I have actually had some success introducing a pole plant in easy moguls, using the bumps themselves as targets for the poles.

Most important, we must recognize the dangers our poles present to ourselves and to others on the slope, especially for beginners who instinctively hold them up in front of their faces, pointing forward, presumably to protect themselves. This potentially lethal habit must be curtailed as soon as it arises. It is good advice for beginners never to allow the sharp points to come forward of the boots.

Polygon of Sustentation

These excess syllables refer to the skier's base of support, defined as the area between the skis when both are on the snow, or ex-



Polygon of Sustentation

tended farther if the pole is planted. Beginners typically spread their skis wide apart to enlarge the polygon of sustentation. As balance improves with skill, the stance usually narrows and the polygon of sustentation shrinks.

Olle Larsson and James Major introduced this obscure term in 1979 in their classic book, *World Cup Ski Technique*.[72] My compliments to the first PSIA examiner who resists the temptation to ask for a definition of this archaic term in a certification exam!

Positive Movements I describe any movement in the intended direction of a turn as a *positive movement*. Positive movements define high-performance, offensive "Center Line™" turns. For example, at a turn initiation, the center of mass crosses over the skis, moving downhill (into the new turn). At the same time, the skier steers the ski tips down the hill, also into the new turn. Both of these movements are positive movements.

Contrast with *negative movements,* which are movements *away from* the intended turn, and which characterize defensive, braking intents such as the *stem christie*.

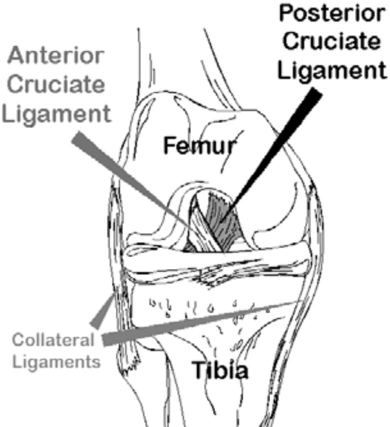
For great turns, all movements should be positive movements. To turn right, in other words, nothing should move left intentionally. Great *skiing* involves mastery of both types of movements, but great *turns* have no place for negative movements.

See **Negative Movements**, **Good Skiing**, **Turn**, and **Common Threads**.

Positive Reinforcement In behavioral psychology, "reinforcement" refers to anything that tends to increase the likelihood of a behavior. *Positive* reinforcement is any pleasurable, rewarding, or otherwise satisfying stimulus that reinforces a particular behavior when *added*. No surprises there—we all know that rewards encourage us to do things. *Negative* reinforcement is an unpleasant stimulus that reinforces a behavior when it is *removed* from the environment. Negative reinforcement is not the same as *punishment*, which is an unpleasant consequence that tends to *reduce* the likelihood of a behavior when *given*.

In teaching skiing, reinforcing the students' successes is an essential part of the job. Behavioral theory suggests that if a behavior goes unreinforced, it will diminish in frequency until it is eventually "extinct." We can create positive reinforcement either directly, by praising the correct movements, or indirectly by helping students see/feel/know for themselves when they've got it right. We use negative reinforcement less frequently, but when a student comes to us complaining of constant pain in the thighs, and we adjust the stance such that the pain goes away, negative reinforcement is at work.

Posterior Cruciate Ligament One of the knee's four major ligaments, the posterior cruciate ligament (PCL) crosses behind the *anterior cruciate* ligament (ACL) in the center of the knee, attaching the femur and the tibia.



(Right knee joint, front view)

Powder "Powder" is freshly fallen, light snow. While there is a mystique about powder, the playground of experts, it really is one of the easiest conditions to ski—provided you ski it right! Skis don't go sideways easily in powder, so anyone whose technique is based on skidded turns (most people, I'm afraid) does tend to struggle in it.

To ski powder, first and foremost remember that skis must go straight ahead, so they can slice through it instead of plowing. This means smooth carved turns. If the powder is not too deep, skis still ride on the solid surface below, and not much changes technically from skiing groomed snow—a good rhythm and perhaps a little extra "up/down" motion is all it takes. Powder is "slow," so turns will not need to be as complete as usual—ski a straighter, faster line. The balanced fore/aft position will be a little farther back than on "faster" conditions, simply because the skis do not run as well in powder (see **Fore/Aft Balance**). There is a myth that we must "lean back" in powder, but skiing on the tails of the skis is brutal on the thighs, and entirely unnecessary. So balance on the center of the skis, on the outside ski, as usual, in shallow powder.

Once powder becomes "bottomless," though, skis float *in* it rather than *on* it. Weight will need to be more equal on both skis, and very centered fore/aft. But rather than focusing on equal weight, I suggest merely keeping the stance narrower and the feet at the same *level* in the snow—the weight will take care of itself. If you tend to ski tall, lower your stance somewhat to "tighten" it, helping with fore/aft balance and strengthening steering ability. Exaggerated up/down motion will help unweight the skis, making it easier to turn them. Remember, though, that the more they slice straight ahead, the less you need to twist them, so unweighting is not as important. For those who skid turns, the only way to ski powder is to leap nearly out of the snow, turn the skis while they're free of the resistance, and land back in the snow.

Flexion/extension timing in deep powder is opposite that of groomed snow skiing, similar to skiing moguls. You must extend your legs down into the snow for pressure in the control and completion phase, then relax and let the snow push them back up underneath you to cross-over and initiate the next turn.

Finally, shorter turns with rhythm are usually a better tactic than longer "GS" turns in powder. Like a diving board or trampoline, powder has its own rhythm, and it works best to join it, rather than fight it! The biggest challenge for many skiers is simply to get used to the unusual sensations of powder. We don't feel pressure on the sides of our feet, no matter how much edge angle we use. And the equal weighting and sensation of floating are wonderful, once they become familiar. But at first, many skiers naturally stiffen up against the unknown sensations—the worst thing to do in powder. Remember—falling in it is like jumping on a feather bed, so let the skis run!

Practice

"Practice makes perfect." So they say, but after years of practice, my signature has not improved a bit. Most skiers on the mountain ski the same way, day after day, year after year. If anything, they succeed only in perfecting and ingraining their bad habits. All we can really say is that "practice makes *permanence*." Only "perfect practice" makes perfect. Truly effective practice is the essence of motor skill mastery. What is perfect practice?

> ***Practice makes PERMANENCE; only PERFECT practice makes PERFECT!***

A great deal of research in the fields of education and psychology has generated some important principles of practice and inspired a *basic practice model*. PSIA's Teaching Model is founded on this basic practice model.

Several assumptions underlie these basic principles. First, the goal of practice is *mastery* of a certain skill—developing the ability to perform that skill or movement pattern accurately, consistently, and independently of a teacher's constant feedback. Second, we will improve at whatever we practice, so it is absolutely essential that we practice the right stuff, and avoid practicing errors. Third, forgetting begins the moment practice stops, so practice is a long-term, continuous process. Finally, our attention spans are limited, so the timing and duration of practice sessions can greatly influence their effectiveness. From these assumptions arise six principles and three "levels of practice."[73]

The first principle is known as *shaping.* Shaping involves three *levels of practice,* based on decreasing amounts of teacher assistance and increasing student independence. *Lock-step* or *structured* practice is the first level. When first introduced to a completely new movement or concept, we are most prone to make and learn mistakes. Lock-step practice allows a teacher to prevent errors at this vulnerable stage. The teacher monitors performance very closely, corrects errors immediately, and reinforces success.

The next level is *semi-independent* or *guided* practice. Students practice on their own while the instructor observes, providing corrective feedback and reinforcement on a slightly more relaxed basis.

Finally, in the *independent practice* phase, students practice on their own, without the instructor monitoring. In school, we called this homework. The goal of a ski lesson should be to prepare students for effective independent practice of a specific skill, movement, or idea after the lesson. Independent practice is the *mastery* level. A lesson is ineffective if students still make, and therefore practice, regular mistakes. This essential part of practice *begins* when we've got it right. It does not end there!

Six Principles of Effective Practice

1. *Shaping.*—Levels of Practice
   a) Structured Practice (Lockstep)
   b) Guided Practice (Semi-independent)
   c) Independent Practice
2. *Accuracy.* Ensure 85-90% accuracy before moving to the next level.
3. *Monitor Performance* and provide corrective feedback and reinforcement.
4. *Short, intense practice sessions* work better than long, drawn out sessions.
5. *Distribute practice* over several sessions.
6. Provide an *optimal amount of time between sessions*—closely spaced at first, more time at higher practice levels.

How do we know when to advance to the next level of practice? The second practice principle establishes the minimum *level of accuracy* at 85 to 90 percent. Again, we must not practice errors. Only when performing consistently at one level of practice should we move to the next level, where reinforcement and corrective feedback will happen less regularly and with more delay.

The third practice principle deals with *monitoring* performance and giving feedback and reinforcement. Feedback is most effective when it is immediate, continuous, and specific.[74] This is especially important in the first (lockstep) phase of practice. In addition to preventing misunderstanding and learning of errors, immediate feedback can reduce "performance anxiety." Students don't have to worry about whether they're doing it right, because the teacher is going to tell them. As we advance toward mastery, feedback from an instructor can become less frequent. During guided practice (second level), one effective method for feedback is known as "praise, prompt, and leave."[75] The instructor circulates among the students, for each student very briefly reinforcing correct performance (praise), correcting at most one error (prompt), then moving on. In the independent practice phase—usually after the lesson—there is no monitoring or immediate feedback from the instructor. Any reinforcement will occur later, perhaps in the next lesson, to ensure continued high performance.

The fourth practice principle addresses the optimal *length of practice sessions*. While the effects of practice are cumulative—more is better—our ability to focus is limited. We learn the most at the beginning of a practice session. Therefore many short, intense practice periods usually work better than a few long, drawn out sessions. Age, mood, motivation, weather, and other factors certainly influence the ideal length of time for practicing something. From my experience, twenty to fifty ski turns or movement repetitions in a set, uninterrupted unless corrective feedback is needed, seems about right. That is actually a lot of turns. Too many ski instructors let students practice for only a turn or two, then move on to the next step. On the other hand, it is difficult to concentrate with intensity for two hundred turns at a time.

The fifth principle, *distributed practice,* extends the idea that many brief but intense practice sessions work better than fewer, longer sessions. Take a break, then go back and do another set of twenty to fifty focused repetitions. Research suggests that we forget as much as 80% of new information within a day without practice and reinforcement.[76] Mastery of complex movements may come only after several guided practice sets, over several days, weeks, or years.

Finally, the sixth principle of practice concerns the *amount of time between* practice sessions. Generally, sessions should be much closer together at the initial level. We can spread them out over hours and days as we advance through the guided practice level to mastery and independent practice.

I suspect that these principles are intuitive and obvious for most experienced instructors. As ski instructors, we have many opportunities to gauge our effectiveness. We quickly learn the dangers of being misunderstood, of allowing our students to learn and practice errors, of moving on too quickly to the next step before mastery of its prerequisite. We learn to recognize when students are accurate and consistent enough at something to be ready to practice it on their own, or move on to new ground. And we learn not to create boredom or burnout by dwelling too long on one topic. We become sensitive to the amount and type of feedback students need. We learn to create environments where students can succeed, where they have a good chance of performing correctly, especially at the critical early stages of new learning.

As skiers, we should develop good practice habits. No one, at any level, continues to improve without quality practice, feedback, and reinforcement.

We should seek advice, whether from instructors, qualified friends, video, or other coaches, to make sure that we are practicing the right stuff, and not simply getting better at compensating for errors. Ninety-nine percent of skiers, in my opinion, simply practice mistakes. They blindly assume that mastery of skiing just means skiing a lot, that mileage alone is the key to improvement. If these skiers yearn for true expertise, they must make sure they practice what those experts are practicing. Instead, most practice only gross, defensive, errors, and that is exactly what they get good at.

Most skiers think about what they're doing only when they feel challenged. But great skiers work hardest on the easiest runs. It is said, "to ski the hard runs easy, you must ski the easy runs hard." Watch World Cup racers ski along a cat track, and you will almost always see them focusing on something, doing some little drill or exercise to improve some aspect of their skiing. How do you know when it's time for a lesson or some other outside help? When you're skiing down a novice run or a cat track, if you don't feel challenged, if you don't know what you could do better there, if you don't have an exercise to practice, you are past due.

To make a day of skiing an effective learning experience, as well as a fun time, break up the day. At the mastery level, when not actively trying to learn a new skill, try my "*20:60:20 rule*." Spend some time, but not too much, skiing terrain that truly challenges you, where you are likely to make mistakes. You don't want to practice these mistakes much, but we all need this challenge, this test. Don't be foolish here—choose terrain where your survival is likely. And don't worry about making mistakes, but do notice them. Or have someone else point them out. These are the areas of technique you have not mastered, where you need some focused, guided practice.

To ski the hard runs easy, you must ski the easy runs hard.

So give at least equal time, ideally right after the challenging terrain, to working hard on very easy terrain. Most steep terrain involves some flat stuff anyway, so you need not go out of your way. Focus. Practice only correct movements, especially where you recognize mistakes from skiing the challenging terrain. You can also use time spent with slower, less advanced skiers, to work hard on your own skiing. Spend the other sixty percent or so of your time skiing terrain that is an enjoyable challenge, where you can expect to perform at the 85 to 90 percent accuracy level needed for effective practice. By mixing up these levels of challenge, and seeking effective feedback, your day should never be boring, and you effectively apply the six practice principles. *This* is Perfect Practice! Your skiing will improve.

See **Basic Practice Model**, **Distributed Practice**, and **Massed Practice**. Also **Reinforcement**, **Feedback**, and **Simpson's Psychomotor Objectives**. Related concepts include **Visualization** and **Mental Rehearsal**, **Bloom's Taxonomy**, **Mastery Learning**, and PSIA's **ATS Teaching Model**.

Practice Model, Basic

The *Basic Practice Model*[77] is a guideline for effectively applying the six principles of practice outlined above (see **Practice**). Grounded in the research of education theory and behavioral psychology, the Basic Practice Model forms the foundation for a successful ski lesson. It consists of five distinct phases.

> **Basic Practice Model**
>
> **Phase 1—Orientation**
> Assessment of technique and student profile.
> Review of previous learning.
> Objectives and outcomes established.
> Instructor describes content and framework.
>
> **Phase 2—Presentation**
> Demonstration
> Visual-Auditory-Kinesthetic
> Check for understanding (*before* practice)
>
> **Phase 3—Structured Practice** (after clear understanding of Presentation)
> "Lockstep practice" with continuous, immediate feedback and reinforcement.
>
> **Phase 4—Guided Practice** (after 85-90% accuracy in Phase 3)
> Semi-independent practice, while instructor monitors for correct performance, provides corrective feedback and reinforcement.
> "Praise, prompt, and leave."
>
> **Phase 5—Independent Practice** (after 85-90% accuracy in Phase 4)
> "Homework"
> Subsequent review with corrective feedback and reinforcement.
> Several sessions over time.

Phase one is *orientation.* It involves an outline or overview of what is to come. Analysis of the technical and athletic ability, previous experience and knowledge, and motivations and goals of the students must take place during this phase. Instructor and students must communicate to set specific objectives, based on the students' overall goals and desires. The instructor guides this process, ensuring that objectives are reasonable, appropriate, and specific. The instructor must consider the desires of students, which may be unreasonable, vague, only long-term, or even contradictory ("I want to learn to ski with my feet locked together like an expert"), and devise an appropriate goal for the lesson, one that can be mastered to the "independent practice" phase in the allotted time. Students must understand the relevancy of this outcome to their overall goals. Finally the instructor communicates the framework for the lesson, the roles and responsibilities of the teacher and students. In this phase, students must buy in to the process they are about to participate in, and it should become clear that they and the instructor are on the same team, partners dedicated to the success of the students.

Phase two is the *presentation phase*. Here the instructor presents the new information in a way that the students clearly understand. Clear communication, appropriate teaching styles, demonstrations, verbal, auditory, and kinesthetic cues, and checking for understanding are all important in this phase. Because mistakes at the early practice stages are costly, we must ensure clear understanding of the task *before* practicing.

Phase three is the *structured practice phase ("lock step practice").* Here the students perform the new movements, exercises, or ideas while the instructor monitors very closely. The instructor immediately corrects any errors and continuously reinforces correct performance.

When students can perform the task with 85 to 90 percent accuracy with the continuous feedback of the instructor, they are ready for *guided practice,* phase four of the model. Also called *semi-independent practice,* guided practice allows the students to practice on their own while the instructor observes. Less continuous and less immediate, feedback may occur only after a longer practice set. Or the instructor may circulate and offer each student very brief individual input, often in the form of "praise, prompt, leave." While feedback is not continuous, students still must not practice errors, so corrective feedback is essential.

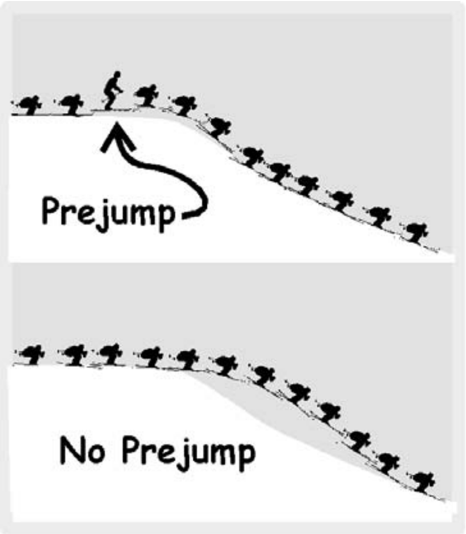
Finally, once the instructor is satisfied that the students can perform at 85 to 90 percent accuracy with minimal guidance, phase five begins. *Independent practice* involves students practicing on their own, without the instructor monitoring. Feedback and reinforcement are still necessary here, but they come largely from the students themselves, based on their own understanding and kinesthetic awareness. It will also come later, in the form of review in the next lesson.

So the general goal of any lesson must be to prepare the students for successful independent practice by the end of the lesson. Clearly, this means the outcome for a week-long lesson can be far more ambitious than that for a two-hour lesson. Instructors who give too much information, or who rush the process, succeed only in confusing their students and setting them up to practice mistakes.

These five phases may recur throughout a lesson, as mastery of small steps occurs and students move on to new ground. Like the ATS Teaching Model that is based on it, the Basic Practice Model represents more a cyclical approach than a linear, step-by-step process.

Prejump

To minimize the amount of "air time" they get over jumps and rolls, downhill racers use a prejump. The prejump is a small leap made shortly before flying off a jump or fall-away. If it's timed just right, when they reach the edge of the jump, they are already moving down, so they land much sooner than had they not prejumped.



Preparation Phase

Preparation is the "setup" for a turn, according to the four-phase model described in *ATM Teaching Concepts*[78] (see **Phases of Turns**). Depending on the mechanics of the turn itself, various things may happen during the preparation phase. Essentially, the preparation phase includes all the movements that occur prior to edge release, which marks the beginning of the *initiation phase*. As we link turns together, preparatory movements occur at the end of the previous turn. *Completion phase* and preparation phase thus become inseparably linked, combining seamlessly into what we might call a "transition phase."

Anticipation occurs during preparation, to varying degrees. Anticipation involves any *windup* movements that pre-stretch muscles, allowing them to contract more powerfully. This may involve the upper body actively turning downhill in the new direction, or the lower body and legs winding up beneath a stable upper body as the previous turn ends. A classic *preturn* also winds the lower body up under the upper body. Even in a modern turn, initiated with only gentle rotary input at most, the aligned, slightly countered position of a traverse or turn completion creates some muscle stretching. Whatever tension occurs, the release of this tension produces torque that begins the initiation phase of the turn.

Turns initiated with *rotation* will also begin in the preparation phase. Rotation is a two-part movement. First the upper body, arms, or hips begin the new turn. The skis begin the turn when the upper body *stops* rotating and the rotary momentum transfers to lower body and legs. Here, the upper body movements occur in the preparation phase. The blocking of those movements, and the turning of the lower body, mark the initiation.

Several other events that occur in the initiation phase also begin in the preparation phase. Crossover of the center of mass, edge release, and pole plant are three such movements, all related. During preparation, the center of mass begins its movement across the skis. Strong edge angles from the previous turn begin to soften. And a pole swing aids and adds direction to these movements.

The *platform* occurs in the preparation phase. A platform is the strongly edged, holding downhill ski from a traverse or previous turn. The skier either uses this platform to stem, step, hop, rebound, or otherwise push off from (*stationary platform*), or simply releases it to allow the ski tips to turn in the new direction (*moving platform*).

Finally, the preparation phase may involve a brief braking or check of speed, prior to the dive downhill of the next turn. Typically a preturn or downstem, this quick edgeset and windup of the body can create anticipation, a stationary platform, and the "pop" of the classic rebound turn.

So every variation of turning or braking movements has unique requirements in the preparation phase. On the other hand, the modern, gliding, carved turn, especially when linked, involves few preparatory movements. These turns involve continuous, seamless steering of the legs. Just as we usually don't make preparatory movements in a car prior to reaching a curve (other than perhaps to slow down), these linked turns begin simply by letting go of the old turn and steering the ski tips in the new direction. Indeed, the whole idea of turn phases blurs when applied to modern carved turns. It is far more applicable to the classic, "ballistic" notions of turning, with preturns, windups, and powerful initiating rotary movements.

See also **Initiation Phase**, **Control Phase**, **Completion Phase**, and **Platform**.

Pressure Control

Pressure control comprises the spectrum of skills and movements that regulate *how much* pressure is on the skis, and *where* the pressure is distributed (one ski or both, tip, tail, or "sweet spot"). Pressure control encompasses weight transfer (side-to-side movements), "leverage" (fore/aft movements), and "weighting" and "unweighting" (affected by flexion/extension movements as well as by terrain, turn shape, speed, edging, and ski design). In short, pressure is affected and controlled by fore/aft, left/right, and up/down movements, as well as by rotary and edging movements, terrain, and the dynamics of the turn.

Pressure Control Skill

With Rotary Skill and Edging Skill, Pressure Control completes the "big three" skill groups of the American Teaching System™'s **Skills Concept** (see). Like most skills, more skill does not imply necessarily more pressure, but rather a more sophisticated management of pressure, release of pressure, and distribution of pressure.

In truth, we could distill all ski technique to a management of pressure. What we experience as "pressure" is the force on the skis that causes turns and braking, so controlling pressure is the ultimate aim of all skiing movements, including rotary and edging moves. Skis are tools designed to manipulate pressure. Skiing *is* pressure control!

See also **Rotary Skill**, **Edging Skill**, and **Skills Concept**.

Pressuring

"Pressuring" a ski usually means applying enough pressure to it to cause it to bend ("decamber") and carve a turn. Usually we pressure the ski with a "down" movement (sinking), similar to the movement we would make to pressure and bend a diving board. This involves more than transferring weight to or just standing on the ski—it involves generating and resisting forces. When I think of pressuring a ski, I think of edging and inclining to resist the gravitational and centrifugal pulls of a turn. I can apply little pressure to my ski until there are forces to resist—I must wait until I sense that I am being pulled out of the turn, then increasingly sink, edge, and allow pressure to develop increasingly throughout the rest of the turn, as these forces develop. (See diagram under **Force**.)

Pressure on a ski comes not from me pushing on it, but from it pushing against me.

Nor can I "pressure" a flat, unedged ski except momentarily (by pushing on it). Flat skis cannot resist forces—they just slide sideways. On the other hand, I can briefly increase pressure on a ski by rapidly extending, or by dropping and "hitting bottom" (technically, by accelerating my center of mass "up"—see **Up/Down Motion**), as well as by hitting a bump or compression in the slope, but these mechanisms are necessarily brief and are generally followed by an "unweighted" phase.

Real pressure on a ski, in other words, comes not from me pushing on *it*, but from it pushing against *me*.

Preturn

A preturn is a quick turn uphill just prior to initiating a turn downhill. It can also be simply a quick tightening of the radius at the end of a turn in preparation for the next turn. Preturns provide a quick checking or braking effect, wind-up the lower body to an anticipated (twisted) relationship with the upper body, and create a stationary platform from which the skier can rebound, stem, or step into the new turn.

The preturn with edgeset and rebound is an important tool in our technical "bag of tricks," part of every versatile skier's repertoire. In the Center Line™ Model, it falls in the realm of "lateral exploration," as an alternative for some tactical situations. But it is not a common thread of Center Line™ turns because it blocks the free flowing movement of the center of mass into the new turn, and it involves an edge*set* ("stationary platform") rather than a release. Preturns, edgesets, and stationary platforms represent the edge/pressure skill bias "left" of the Center Line™.

Problem Solving Teaching Style Problem solving is a process-centered and student-oriented (as opposed to teacher-oriented) teaching style in which the teacher presents the students with a challenge which may have several solutions. Far from the teacher telling the answer, as in *command* teaching style, in problem solving style the teacher may not even know the answer. There may indeed not *be* an answer—or there may be many!

An example of problem solving teaching style would be the question, "How can we minimize skidding on ice?" The group could explore the options, and any of several answers could arise: "slow down," "make shorter turns with quick, staccato edge sets," "turn where the snow is soft and go straight on the ice," "turn on bumps," "sharpen your edges," "don't hit the brakes," and so on are all acceptable answers, as is "call it a day and go inside for a hot-buttered-rum." It is important to understand that any answer that solves the problem is acceptable. The instructor must be prepared for the unexpected and creative solutions.

Problem solving style puts the focus on the students and encourages exploration, experimentation, versatility, independence, self-confidence, and creativity. Problem Solving is not usually the best approach for introducing new information or learning basic skills, but it can help develop higher "levels of cognition" (see **Bloom's Taxonomy**) and can bring out knowledge that is already there. The style is especially good for encouraging *lateral learning* (lateral exploration), which by definition implies that there are several options that accomplish a goal.

The difference between problem solving style and *guided discovery* style is that in the latter there is only *one* correct answer or outcome, and the instructor must guide the discussion or exploration such that the students arrive at this specific solution.

See **Teaching Styles**.

Professional Ski Instructors of America (PSIA) Founded in 1961, PSIA is the professional and educational association of American ski instructors. While its mission statement stresses professional development and promotion as well as educational development, the organization has been far more successful at the latter. Through technical vision, the excellent American Teaching System™ (ATS), the Center Line™ Model, and innovative humanistic teaching approaches, PSIA has brought world-wide respect to American ski instruction. On the other hand, ski instruction remains one of the most poorly paid high-skill professions on the planet, despite any efforts PSIA has made to improve the situation.

PSIA establishes education programs and certification standards for its nearly 30,000 members through nine regional divisions. The national office of PSIA is located at 133 South Van Gordon Street, Suite 101, Lakewood, Colorado 80228.

See also **National Techniques**, **American Teaching System™**, and **Center Line™**.

Progression A progression is "a system by which a learner is lead through sequential tasks which act as building blocks for each other in an attempt to achieve a goal."[79] Learning something new is usually easier when it builds on something known. The key to any progression is that the steps must be small enough that the skier can master them in a reasonable amount of time, and that each step must build logically upon the last, toward the ultimate goal of a more complex movement.

Projection Circulaire This term describes the old French National Technique of the 1950's. Based on strong rotation of the upper body, projection circulaire involved first a windup of the upper body, followed by a great "roundhouse" thrust of the outside arm and shoulder "up and around" in the direction of the turn, combined with up-unweighting. This move was directly opposite the Austrian technique, which involved down-unweighting and counter-rotation.

Pronation The opposite of *supination,* pronation is a movement of the foot such that the bottom of the sole rotates out (the big-toe side rotates down). Hands can also pronate. When you hold your hands palms up in front of you, then rotate the thumbs toward each other and the palms down, you are pronating your hands.

Proprioception Proprioception is kinesthetic awareness. It involves the awareness of movement and the orientation in space of the body and its various parts, through internal sensors called *proprioceptors*.

See **Visual-Auditory-Kinesthetic** (V-A-K).

Proprioceptor Proprioceptors are internal sensory receptors that detect position and motion of the body, joints, and limbs. Located primarily in joints, muscles, tendons, and the inner ear, proprioceptors are responsible for our kinesthetic awareness of what our bodies are doing.

PSIA See **Professional Ski Instructors of America**.

Psychomotor Domain Educational theorists classify learning into three categories—the *affective*, *cognitive*, and *psychomotor* domains. The psychomotor domain involves physical learning—developing motor skills—including the mental and sensory aspects of athletic performance. See **Simpson's Psychomotor Objectives**.

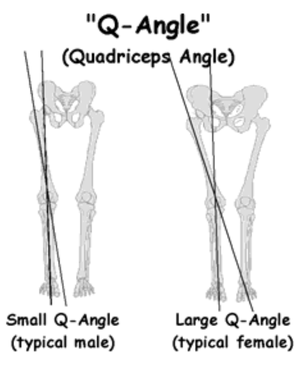
The affective domain concerns emotion, and its objectives include increasing the level of commitment and emotional involvement in an activity or area of study. Learning objectives in the cognitive domain involve increasing the depth of understanding.

See also **Cognitive Domain** and **Affective Domain**.

Punishment Synonymous with **Negative Reward** (see), punishment is an unpleasant consequence that tends to decrease the likelihood of an unwanted behavior. It can be useful in this respect, but it can also produce unwanted emotional consequences, and its effects tend to be temporary. While punishment can help shape behavior, it is not technically a form of *reinforcement*. Reinforcers are consequences that tend to make an action or a behavior *more* likely, while punishment diminishes a behavior.

See **Reinforcement**.

Q



Q-Angle Q-angle ("quadriceps angle") refers to the angle of the femur (thigh) at the knee joint. More specifically, it is the angle between the direction of pull of the quadriceps muscle (thigh muscle) and the direction of the patellar tendon, which attaches the quadriceps to the tibia (shin).

The smaller the q-angle, the more in line is the pull of the quadriceps with the movement of the knee. Large q-angles can cause problems for skiers, ranging from a tendency to be knock-kneed, with difficulty edging and releasing edges simultaneously, to knee injuries stemming from the non-in-line pull of the quadriceps.

Women tend to have larger q-angles than men, due to their wider hips. Normal q-angles for men are typically 14° plus-or-minus 3°; for women typical q-angles are 17° plus-or-minus 3°.

Quadriceps The quadriceps is the large muscle of the thigh. Actually a group of four muscles, the "quads" are the main muscle group that extends (straightens) the leg at the knee. The quadriceps attaches to the tibia via the patellar tendon, which passes over the patella (knee cap). The muscle that opposes the quadriceps to flex the leg is the *hamstring*, the large muscle group in back of the thigh.

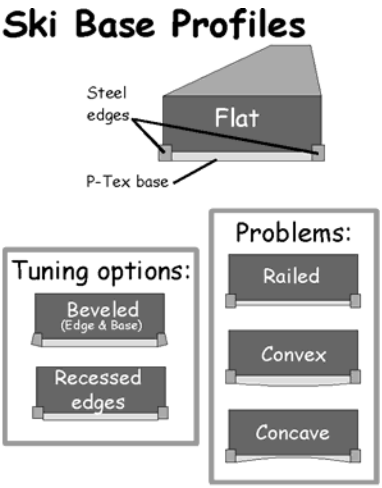
Quadriceps Angle See **Q-Angle**.

Quersprung Another colorful word from skiing's past, quersprüng refers to a ninety degree hop turn to a complete stop.

R

Radius The radius of a circle is the distance from the center to the edge (half the diameter). Since good ski turns are more-or-less round, they describe parts of circles of various sizes (radii). We speak casually of "short-radius," "medium-radius," and "long-radius" turns, but the distinctions are fuzzy and subjective. I suggest that the difference is more one of timing than of actual size. Short-radius turns involve quick, slalom-like rhythm. Smoother and more drawn out, medium radius turns describe the rhythm of giant slalom. Long-radius turns, while smooth, lack a sense of rhythm, more like a downhill race. On the other hand, a beginner's wedge turns usually describe very small arcs, but at the low speeds involved they have a medium- or long-radius timing.

Railed A ski is "railed" if the steel edges protrude beyond the plastic base. Extremely difficult to ski on, a railed ski is in bad need of a tune. Properly tuned skis are flat or slightly beveled on the edges. Some skiers even *recess* their edges below the level of the plastic base.



Railed Out A "railed out" carve is a turn made purely by tipping a ski to a high edge angle and letting the ski ride its edge wherever it takes it. While the sidecut and carving ability of most skis will cause them to turn, the skier has no control over the path in a railed out turn.

Ramp Angle Ramp angle refers to the forward tilt of the footbed of a ski boot on the ski. Higher ramp angles elevate the heel of the foot, which allows deeper flexing without the hips moving as far back. Because women typically have a lower center of mass and carry more of their weight in their hips and less in their arms than men, higher ramp angles can be especially helpful for women.

Ramp angle can be adjusted inside the boot, with heel lifts, or externally by adding spacers under the heel of the binding. Different bindings produce different ramp angles, and some new skis designed for women have built-in heel platforms to increase ramp angle.

Rapid Gate Rapid gates are flexible plastic poles with spring-loaded hinges at their bases. For many years, skiers raced around bamboo slalom, giant slalom, and downhill race gates. Bamboo was hard and relatively stiff, so racers had to get most of their bodies around them, clearing them away with their arms. Aggressive racers could shred a bamboo slalom course to splinters, requiring frequent replacement of the poles during racing and training.

Rapid gates, in wide use since the 1980's, have changed the face of ski racing. Planted more firmly in the snow, and hinging out of the way when hit, rapid gates allow racers to take straighter lines, skiing only their feet around the pole while their bodies drive straight over it. To protect themselves, racers often wear plastic armor—shin guards, helmets with face protectors, hand and arm guards.

With rapid gates, slalom racing in particular has become increasingly specialized and distant from free skiing technique. In the "real" world of free skiing, it is bad form to "shin" a tree or "cross-block" a fellow skier!

Rebound According to the dictionary, "rebound" means "to spring or bounce back after hitting or colliding with something."[80] A basketball bouncing off the court demonstrates rebound. An acrobat springing off a trampoline experiences it. In skiing, rebound refers to storing the energy of a turn by compressing the body like a spring and loading (decambering) the ski(s), then using this stored energy to spring into the next turn. Rebound usually involves a *preturn* or *downstem* to create a *platform* (edgeset), slow the skier, and store the energy. The skier must direct this rebound energy accurately, to avoid being thrown out of balance and to flow smoothly into the next turn.

Efficient, modern turns usually involve very little rebound. Instead of setting an edge, loading up, and springing back, the skier simply lets go of the edge at the end of a turn and releases the energy in the direction of the new turn. Pronounced rebound is a defensive move, although it can also be fun in a pogo-stick sort of way.

Recessed Edges Recessed edges are ski edges filed down slightly lower than the plastic "P-Tex" base (a few hundredths of an inch). Similar to *beveling* the base edges, recessing the edges allows skis to glide on the faster plastic base when flat, and allows a smooth release of the edge in the transition between turns. Unlike beveling, recessing edges still provides a sharp, 90° or less, edge when tipped up.

Because it requires careful, skillful hand work, recessing edges is difficult and/or expensive. For all but the most demanding racers, beveling the edges slightly provides most of the benefits of recessed edges.

See also **Tuning**.

Reciprocal Teaching Style Reciprocal teaching style is a student-centered teaching approach in which students are paired with each other and assigned a task. Performance of the task, observation, feedback, and reinforcement takes place between the two students, while the instructor circulates among the pairs.

Reciprocal is an effective teaching style to encourage student involvement, interest, and self-confidence. It is especially useful where constant, immediate feedback on a certain move is important but the instructor can't watch every student closely. Reciprocal style assumes a certain amount of knowledge on the part of the students, especially the "observer" of the pair. Even so, the observed movement should usually be clearly defined and specific—yes or no, black or white, you're doing it, or you aren't. Otherwise, reciprocal style may develop into a "blind leading the blind" scenario, with the students receiving no or inaccurate feedback.

See **Teaching Styles**.

Reinforcement In behavioral psychology, reinforcement refers to any consequence that increases the frequency of a particular behavior or response. *Positive reinforcement* encourages the behavior when it is received, as when a dog performs tricks to receive treats. *Negative reinforcement* increases the likelihood of the behavior when it is *removed*, as when a dog learns that doing a trick will stop an unpleasant sound or mild electric shock. While similar, *punishment* is *not* negative reinforcement—punishment *decreases* the likelihood of a particular behavior when it is *given*.

Without some sort of feedback and reinforcement, practice is meaningless. Behavioral theory holds that with no reinforcement, any behavior will diminish in frequency until it is eventually extinguished. Reinforcers can be *social*—praise or a smile, *material*—treats, money, prizes, or *activity based*—take a break, a free run, or a soak in the hot tub after a good performance. Or the behavior itself can be a reinforcer—good turns feel good!

Reinforcement can come from any of the senses—a new move can feel good, the skier can see himself on video and "look good," and an instructor can reinforce behaviors in many ways, both verbally and non-verbally. A skier may learn to stand taller when he senses how the pain in his thighs stops (negative reinforcement) or how many more members of the opposite sex he or she attracts by not looking like an ape (positive reinforcement). Other *levels of cognition* beyond simple sensory feedback may be involved—just knowing that a movement is "correct" may provide the necessary reinforcement for some individuals. Faster race course time, successfully negotiating an intimidating run, or the sensual feel of a better turn—all these reinforce a new skill or movement. With no reinforcement, though, no learning (no lasting change of behavior) occurs.

See also **Feedback**, **Motivation**, and **Reinforcement Schedules**.

Reinforcement Schedules As noted above, for learning to occur, new behavior must be reinforced. Reinforcement, to be most effective, should be consistent, immediate, and frequent. But it need not occur *every* time a behavior happens.

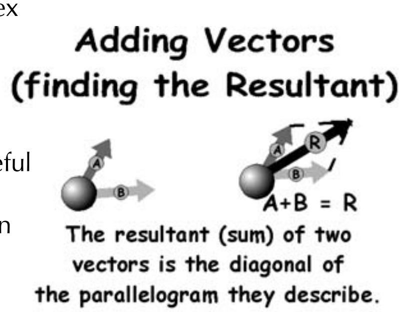
Continuous reinforcement means the reinforcer is delivered each time the behavior happens, as when a dog gets a treat every time he obeys a command. Continuous reinforcement can be the quickest way to introduce a new behavior, important in the early stages of learning.

Intermittent reinforcement is given frequently, but not every time the behavior happens. In a controlled environment, intermittent reinforcement can occur on a *fixed schedule* (every fourth time, for example), or on a randomly *variable schedule*. Most natural reinforcers occur intermittently and randomly. Intermittent reinforcement is less effective at developing a new behavior, but can make a learned behavior more long-lasting, less prone to forgetting. Variable-ratio intermittent reinforcement, where the reinforcer happens frequently but irregularly, produces the most durable response. Again, imagine dogs learning tricks. If given a treat each time they do it right, most dogs will learn quickly. But that learning will fade as quickly once we stop giving the regular reward. Praise and occasional treats, given irregularly, produce the best trained dog.

Reploiment

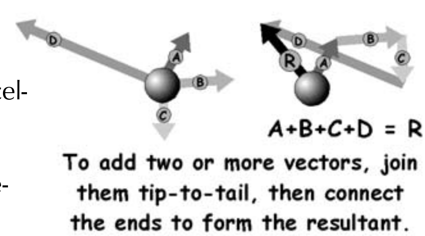
Reploiment describes *passive* terrain absorption, as opposed to *avalement*, or active, muscular absorption. In reploiment, bumps push up on the skier's legs, which flex like springs. In avalement, the skier *pulls* the legs up actively (retraction), then *pushes* them back down on the other side of the bump (extension). Reploiment is useful in smaller bumps, washboards, and such, while avalement is necessary in large to huge moguls.

See also **Avalement**.



Resultant

A resultant is the sum of two or more *vector quantities*. Force, velocity, and acceleration are vector quantities—they involve both magnitude (amount) and direction, which we can represent with arrows (vectors). When several forces act on a body at once—which is usually the case when



If these vectors represent forces acting on the ball, the Resultant (R) is the force that has the same as effect as the others combined.

skiing—it is the resultant of all those forces that determines the change in motion. All the real forces combine to have the same effect as the imaginary "resultant force."

It is easy to visualize the resultant when using vectors to represent forces. The length of the arrow represents the strength of the force, and the direction of the arrow illustrates the direction of the push or pull. Add two forces by drawing a parallelogram using the vectors as two sides. The diagonal of the parallelogram represents the resultant force. Or we can arrange two or more vectors "tip-to-tail," drawing the resultant vector from the tail of the first to the tip of the last (see illustration).

If the resultant of all forces acting on a body is zero, according to Newton's First Law of Motion (see), the body is in *equilibrium* and no change in motion (acceleration) will occur (the acceleration vector is also zero). If the resultant is *not* zero, there is an "unbalanced motive force," and Newton's Second Law specifies that the body will accelerate in the same direction as, and in an amount proportional to the length of, the resultant force vector.

Retraction To retract is to "pull back or in." On skis, retraction usually refers to pulling the legs and feet up under the body. It is an active, muscular movement, especially obvious when absorbing large moguls (see **Avalement**).

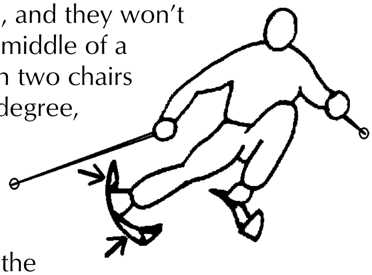
Retraction Turn The turns for big moguls and deep powder, retraction turns reverse the "normal" timing of flexion and extension. While typical ski turns begin from a tall stance, legs extended to help flatten the skis and release the edges, retraction turns begin from a low, flexed stance. The legs extend away from the body in the control phase of the turn, where normally the skier would sink. To complete a turn and change edges into the next turn, rather than extending the legs, a retraction turn involves staying low, allowing the feet to move beneath and across the path of the center of mass. The retraction phase may require an active "pulling in" of the legs, or it may simply involve relaxing the resistance against the forces at the end of the turn. In a series of retraction turns, the skier's body does not appear to move up and down, but the legs extend to the side in each turn, then shorten during the transition.

Reuel Christie Pronounced "Royal Christie," the Reuel Christie is an early freestyle move involving turning on the inside ski while lifting the outside ski up high and behind.

Reverse Camber When a ski is pressured and bent into an arc opposite that of its built-in *camber*, the ski is said to be in reverse camber. Reverse camber is what allows a ski to carve a turn, as the ski follows the shape of its own arc through the snow.

It is important to understand what causes a ski to bend into reverse camber and the relationship between reverse camber and sidecut. In soft snow—powder or crud—sidecut has no effect on reverse camber. Any ski that is soft enough will bend into reverse camber simply because the skier pushes down in the middle of the ski while the snow pushes up on the entire ski base. Thus skis specialized for powder are usually soft and wide, and may have little sidecut.

Take that same pair of straight-sided soft powder skis onto a smooth hard slope, though, and they won't bend. Think about it. Stand in the middle of a straight board suspended between two chairs and the board will bend to some degree, depending on how stiff it is. This is how skis behave in powder. Now put that board on a hard floor and stand on it. It doesn't bend. Tip it on edge and push on the middle of it, and it still doesn't bend. But—imagine a board sawn to an hourglass shape, wider in the ends and narrow in the middle, like a ski with sidecut. Tip this board up on edge and note that only the ends touch the floor. Push on the middle to cause the whole edge to contact the floor, and the board will bend. How much it bends depends on how deep the sidecut is, and how steep the edge angle is—not on how hard you push (as long as you push hard enough to bring the edge to the floor). So sidecut and reverse camber are intimately related when skiing on hard snow.



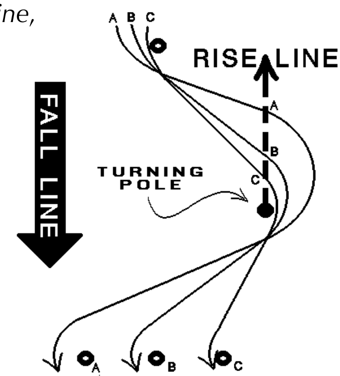
Reverse Camber

The new super-sidecut skis carve so well not because of the deep sidecuts directly, but because of the ease and extent to which they bend into reverse camber. Many people assume incorrectly that the curved edge of the flat ski somehow carves a turn, and that the shape of the sidecut is the same as the shape of the turn it will carve. I hope you can see that it is not quite as simple as that. Soft skis with extreme sidecuts will bend into reverse camber more deeply than straighter skis for any given degree of edge angle. And even gentle edge angles can create sufficient reverse camber to carve a reasonable turn. But be clear: it is the reversed arc of the ski that carves a turn, not the sidecut itself. And in deep snow, it is the relative softness and greater width and flotation of these skis that makes them excel at bending into reverse camber—sidecut has nothing to do with carving turns in powder.

Reverse Shoulder This term describes a historical skiing "position" and technique characterized by extreme countering of the upper body. Representative of the old Austrian technique, the reverse shoulder position was made famous by the great Stein Eriksen.

Right Brain The human brain is physically divided laterally down the middle into two hemispheres. Evidence suggests that, while there is some crossover and variation, the two hemispheres tend to play different roles in our thought processes and consciousness. In most people, the brain's right hemisphere seems to be responsible more for non-rational functions, such as spacial relations, rhythm, artistic and musical ability, creativity, and such, along with learning coordinated and complex physical movements like skiing. The left hemisphere, by contrast, appears to be the rational, mathematical, logical, unemotional half.

Rise Line The opposite of *fall line*, the rise line is an imaginary line running straight uphill from any point. The term usually refers to a line directly uphill from the turning pole of a race gate. In racing tactics, the rise line represents the point at which the racer should begin to turn—as the ski tips cross the rise line, the racer begins to commit his body into the new turn, releasing the edge. The more complete the upcoming turn (the more offset the next gate), the higher on the rise line the skier should initiate the turn. If the turn is started in the wrong place, it will not be as clean.



The Rise Line. *All turns begin somewhere on the rise line. Where on the rise line depends on how complete the turn needs to be.*

While understanding the rise line is especially important to racers needing extremely precise lines through courses, free skiers must also develop some feel for the rise line to add precision and control to their skiing. Every point we want to turn around, every skier and tree we hope to avoid, has it's own rise line.

Rotary

A possible solution to the problem of traffic control at ski areas; combined with traffic lights, speed limit signs, a nervous breakdown lane or two, and ski patrollers armed with deadly weapons and tear gas, just think how many skiers could be safely accommodated on the slopes! (Not to be confused with **Rotary Skill**.)

Rotary Force

Properly called "*torque*," a rotary force is a force applied through a "lever arm" as opposed to directly to the center of mass. "Twisting" forces, rotary forces cause objects to rotate about an axis, or to change their rates of rotation. We use them to muscularly turn skis. They are not the forces that cause turns. Torques (rotary forces) are the subject of the *rotary skill,* only one of the three basic skills (with edging and pressure control) involved in turns.

Rotary forces cause twisting and spinning. Turning forces cause direction changes.

To understand the forces of skiing, it is essential to differentiate between twisting rotary forces that act through a lever arm and twist things, and *turning* forces that act on the center of mass and cause a direction change (turn). We may employ rotary forces to change the direction of our skis, but it is the interaction of those turned skis with the snow that causes the turn.

Confusingly, rotary forces, like all forces, apply in a straight line, only to a lever arm (as in a wrench), or to the edge of an object (as in a glancing blow to a billiard ball which sends it spinning with "English"). Pure twisting forces that cause rotational (angular) acceleration, but not linear acceleration, occur in equal but opposite pairs called *"couples."* An example of a couple is two hands on opposite sides of a steering wheel, one pushing up, the other pulling down.

See **Torque**, **Rotary Mechanisms**, **Pivoting**, and **Steering**.

Rotary Mechanisms

Rotary mechanisms are the mechanical principles of the *rotary skill*—the physics behind pivoting the skis and controlling rotational motion. They are the ways of producing *torque* ("twisting force"). Historically called "turn initiating mechanisms" because most pivoting used to occur at the beginning of the turn to get the skis moving sideways, in modern skiing the rotary skill can apply throughout or at any part of a turn.

Rotary mechanisms are not, as some instructors mistakenly call them, "*turning forces."* Turning forces cause turns. As PSIA's own *Skills Concept* insists, turns involve *edging* and *pressure,* as well as *rotary*. Rotary mechanisms refer to the rotary skill alone. Indeed, rotary mechanisms are not forces at all. They are simply the movements and fundamental principles we use to generate the forces that twist or pivot our skis.

Few areas of ski technique inspire as much debate, confusion, and certification exam stress as rotary mechanisms. Rotation, counter-rotation, heel thrust, stemming, stepping, fulcrum turns, braquage, vissage, anticipation-release, axial motion, leg steering, rotary pushoff, projection-circulaire, ballistic rotation, simultaneous and sequential leg rotation, deflection, blocking pole plant, full body rotation, hip rotation, shoulder rotation, ... Is it really so complicated to turn our skis? Of course not!

A close look reduces all that jargon to five simple, distinct types of rotary mechanisms. Each involving different underlying principles of physics, these mechanisms are *rotation, counter-rotation, blocking pole plant, independent leg steering,* and *deflection.* Other mechanisms are sub-categories or special cases of these five, synonyms, or supplementary strengthening mechanisms. These five mechanisms look different, feel different, and have different uses as they produce different effects on the ski and the "ski-skier system."

To explore these five mechanisms that pivot the skis, let's imagine a familiar scenario—standing on a barstool that pivots (we've all done this, right?). How can we turn the stool?

#1—**Counter-Rotation**. We can simply do "The Twist." Twisting the upper body one way makes the feet and the barstool pivot the other way, according to Newton's Third Law of Motion (for every action there is an equal and opposite reaction). The upper and lower body move at the same time (in opposite directions), and stop moving at the same time.

#2—**Rotation**. Or we could first get our upper body rotating around, then "yank" the stool in the same direction by *stopping* the upper body's rotation. The Law of Conservation of Momentum states that the total motion of a system of objects must remain constant unless acted on by an external force. So once one part of the body is moving (rotating), if we stop it, that motion must transfer to another part. Also known as "stopped rotation," rotation always involves a "one-two" movement pattern (unlike counter-rotation).

#3—**Blocking Pole Plant**. We could, of course, turn the stool by pushing on something with our hands. We could use a ski pole to push against the bar, for example. Whenever a skier reaches out and plants the pole solidly at any angle other than perpendicular to the slope, it applies some torque to twist the skis. The mechanism is similar to twisting a nut or bolt with a wrench. The extended arm is the wrench ("lever arm") and the skier is the nut (no news there!).

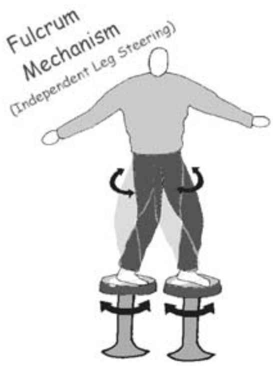
Blocking Pole Plant

Snow pushes on pole, which transmits the force through a "lever arm," producing torque that twists the skier and skis.

These three simple mechanisms are the only ways I can turn that barstool! Of course, there are a few variations on the themes. For *rotation*, I can rotate my whole upper body, my shoulders, either or both arms, my head, or my hips, but the mechanism for all these is the same. Something turns first, then the momentum transfers to the barstool. Significantly, each of these three mechanisms involves the upper body in some way, and each turns both feet (and the stool) as one. The next mechanism is very different.

#4—**Independent Leg Steering** (the **"Fulcrum Mechanism"**). Pick one foot up off the barstool and put it on the adjacent barstool. Standing now on two stools, turn the first one with your foot. Turn the second with your other foot. Note that the upper body plays no part in this movement, as each leg rotates independently in the hip socket and the lower legs and feet twist somewhat below the knees. The legs rotate beneath the pelvis, which does not move because it is supported by the other leg. Pick one foot up and turn the other stool—note that now the upper body must move again. Put the foot back down and try turning both feet at the same time, *without moving the pelvis*.

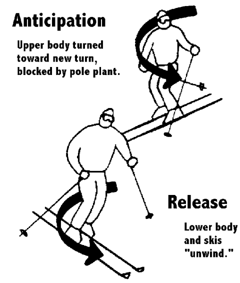
This rotary mechanism of turning the legs independently beneath the upper body is the essence of modern ski turns! Far more versatile than the first three mechanisms, the fulcrum mechanism allows gentle, continuous guiding or sudden explosive twisting. It is what allows us to steer and precisely shape our turns from start to finish. Feel it and understand it well. Note that it requires *two pivot points,* one for each leg, and to turn one leg, there must be some weight on the other. To turn both legs with the fulcrum mechanism, there must be some weight on each, and there must be some space between them.



2 separate pivot points; legs rotate in hip sockets; the upper body and the pelvis do not move.

#5—**Deflection**. Whenever we muscularly pivot or steer our skis, we use one or more of the four basic rotary mechanisms above. When something *else* pushes on the skis and turns them, it is known as *deflection.* Deflection normally describes the turning effects of the snow on the skis, as when carving a turn, or when catching the tip of a ski on a chunk of ice. Note that deflection can be a *turning force,* as well as a rotary mechanism—carving changes the direction the skier goes, as well as the direction the skis point.

So there are four basic rotary mechanisms the skier can use to turn the skis, plus deflection. What about all those other terms and expressions? Most describe special cases, sub-categories, or related concepts. Let's look briefly at a few of them.



Anticipation-Release. Also known as "windup-recoil," anticipation-release describes pre-stretching muscles to increase their strength or range of motion. It can enhance any of the basic four muscular rotary mechanisms. The classic anticipation-release turn involves twisting the upper body in the direction of the new turn prior to initiation, creating a "stretch zone" in the abdomen, like winding a spring. When this "spring" unwinds, it turns the skis. But this movement is not a unique rotary mechanism. If the unwinding occurs immediately after the windup, it throws the skis into the turn using the *rotation* mechanism. Otherwise, the unwinding of the upper and lower body involves *counter-rotation*, unless the skier stabilizes the upper body with a *blocking pole plant*. The stretch zone can be in the torso, in the hip sockets, or any combination, depending on which mechanism and which movements occur. Anticipation-release can also strengthen the *independent leg steering* (fulcrum) mechanism, in which case the stretched muscles are those that rotate the legs in the hip sockets.

Rotary Pushoff. Rotary pushoff involves an extension (pushoff) from one or both skis, during which the skier creates rotational motion with the *rotation* mechanism. Think about the rotation mechanism again. The upper body (or part of it) turns first, then the momentum transfers to the lower body. But to get the upper body turning in the first place, there must be some resistance or something to turn it against. The barstool had to be "sticky" because if it turned completely freely, the feet would turn the opposite direction (the *counter-rotation* principle). Or perhaps you could put a foot on the bar to push on when you turn your upper body. This push from the bar would be a rotary pushoff. A rotary pushoff on skis is simply rotation, using a *"stationary platform"* to push off from when beginning the rotation. This platform involves setting the edge or edges so the skis don't move while rotating the upper body. It can involve a sequential leg movement, when one ski turns followed by the other, or a simultaneous movement of both skis. In any case, the rotary mechanism involved is rotation.

Hip rotation, shoulder rotation, arm rotation, etc. These terms too all refer to the *rotation* mechanism, simply describing which part of the upper body first turns to generate the rotational motion. Interestingly, sometimes even the lower body can create this rotary momentum. In a quick "one-two" stem or step turn with rotary pushoff, it is often the blocking (stopping) of the movement of the first ski that throws the skier into the turn. The upper body may not be involved, but the mechanism that got the skier turning is still the "conservation of momentum" of *rotation*. The mechanism that got the *first* ski moving is independent leg steering (see *stemming and stepping*, below).

Braquage. Merely a special case of the *fulcrum* mechanism, braquage describes turning both skis at once in the same direction beneath the pelvis, using *independent leg steering* (not rotation, counter-rotation, or a blocking pole plant). While braquage can be highly refined, it is best illustrated by the wide-stanced novice who twists both equally weighted and nearly flat skis in inelegant parallel skids.

Stemming and Stepping. When we stand on one foot and turn the other, the rotary mechanism is *independent leg steering* ("fulcrum"). Several things can happen with that stemmed/stepped ski. If simply put on edge and pressured, it will carve a turn due to *deflection*. If the stem or step is vigorous and throws the skier immediately into a skidded turn, some *rotation* is involved. The key is whether or not the skier generates rotational momentum ("spin") during the stem/step movement, either by rotating the upper body or simply with the movement of the leg and ski, then transfers that momentum to the other ski. If so, *rotation* plays a role.

Heel Thrust. Quickly pushing the ski tails sideways involves a countering and twisting movement of the upper body. Hence the classic "lateral heel thrust" involves the mechanism of *counter-rotation*.

Summary. So there are five distinct ways to turn skis. In real skiing, several rotary mechanisms often combine. Most of these mechanisms involve the upper body and are limited to the pivoting of both skis, throwing them or pushing them into skidded, defensive (braking) turns. Only the "fulcrum mechanism" (independent leg steering) allows the active legs and stable, disciplined upper body so critical to the modern carved, steered turn. Great skiing requires mastering all of these mechanisms, any of which might be the right tactical choice at any moment.

And great instructing, which requires an understanding of great skiing, demands that we comprehend these principles that turn our skis. They are based on, and distinguished by, some of the most fundamental of all laws—the laws of physics and Newton's laws of motion.

In skiing's past, various attempts to simplify "turn initiating movements" for clarity have served mainly to confuse. Early American Teaching System™ manuals[81] divided rotary mechanisms into three questionable categories:

1. *The "Rotation Principle," including whole body rotation and leg rotation (braquage or fulcrum turning).*
2. *The "Counter-Rotation Principle," including counter-rotation and anticipation-release.*
3. *The "Rotary Pushoff Principle," including stemming movements, stepping movements, and pushoffs from both skis.*

These "categories" really make little sense. Upper body rotation and braquage, for example, involve unrelated mechanical principles, as do counter-rotation and anticipation-release. Stemming and stepping movements may or may not involve rotary pushoff, which is itself a form of rotation. If we must categorize them, it might make more sense to divide rotary mechanisms into those that *produce rotational* (angular) *momentum* in the ski-skier system (rotation, rotary pushoff, anticipation-release with pole plant), and those that do not (counter-rotation, braquage, anticipation-release without pole plant). Or we could group them according to those that involve the upper body (rotation, counter-rotation, blocking pole plant), and those that involve only the lower body (stepping and stemming when only the legs are involved, and fulcrum turning/braquage).

In any case, it should be clear that the rotary mechanisms involved have a great impact on the character of a turn and influence the interplay of the other skills and movements throughout the turn.

See also **Rotary Skill**, **Steering**, **Pivoting**. Also, see individual entries for each rotary mechanism. Contrast with **Turning Forces**.

Rotary Momentum

Properly "*angular momentum*," rotary momentum refers to the "quantity" of rotational motion (spin). It is a function of an object's spin rate, weight (mass), and distribution of mass. A flywheel, with its mass concentrated toward its edges, has more angular momentum than an equally heavy solid ball spinning the same rate (revolutions per minute). According to Newton's First Law of Motion, an object's angular momentum will not change unless an external force ("torque") acts on it. A top spins when we spin it, and gradually slows down due to the forces of friction and air resistance.

In skiing, we use various *rotary mechanisms* to control angular momentum. While we rarely want to throw ourselves into a spin, most turns require that we deal with angular momentum, and twisting the skis or the torso always affects the angular momentum of whatever is twisted, as well as the entire "ski-skier system." Some rotary mechanisms influence the rotary momentum of the ski-skier system, while others do not. When an external force (torque) is involved, the momentum of the ski-skier system is affected. Rotation and rotary pushoffs, by pushing against the snow, cause rotary momentum in the ski-skier system—they literally throw us into a spin. When only internal muscular force is involved, the whole system is not affected. Counter-rotation simply turns the skis one way and the upper body the other. Equal but in opposite directions, the angular momentums of the upper and lower body cancel each other. The whole ski-skier system remains unaffected. The rotary momentum imparted by anticipation-release depends upon whether or not the upper body was blocked by a pole plant in the snow (an external force).

In other words, for rotary momentum to be generated in the entire ski-skier system, there must be interaction with something (a force) outside the system—generally the snow. While this point sounds minor, we must understand it to truly understand what goes on in a turn—especially in reference to the concepts of "*under-initiation*" (too little rotary momentum) and "*over-initiation*" (too much) and how the skier can deal with these.

See **Torque**, **Rotary Mechanisms**, and **Under-** and **Over-Initiation**.

Rotary Pushoff

Rotary pushoff is a classic **rotary mechanism** (see) in which a push from the snow, as the skier extends from one or both skis and rotates the upper body, imparts rotary momentum to the ski-skier system to begin a turn. In the family of *rotation*, it typically goes like this: The skier stands solidly on the edged downhill ski ("creates a platform"), then simultaneously pushes off (extends) from that ski to the other and twists the upper body (or some part of it). This move literally throws the skier into a gentle spin, which helps start the turn. Too much "spin," known as *over-initiating,* may cause the skis to wash out or make it difficult to stop the turn. Too little "spin" may lead to not turning far enough. An essential move in the complete skier's repertoire, rotary pushoff should not form the basis of all turns. Unfortunately, for many skiers of all levels on the hill today, it is their only option.

Rotary pushoff leads to a basically skidded turn as it pushes the tails sideways. It is an instinctive turning mechanism for most reasonably athletic beginners, as they try to hurl themselves into a new direction. But if they are not steered toward alternatives, the move will quickly become a bad habit that will forever block the road to carving turns. Certainly, many advanced skiers develop rotary pushoff to a subtle, refined, and nearly imperceptible level. But any turn based on rotary pushoff is still a fundamentally skidded turn.

Another drawback to rotary pushoff is that the entire turn is predetermined before it starts. Like firing an arrow from a bow, once you pull back the string and let go, you have little control over the rest. Just how hard to "hurl" yourself for any given turn is always a judgement call. In deep, heavy snow, a rotary pushoff turn requires exaggerated movement. The same move on an icy slope may send the skier into a flat spin with dire consequences. Indeed, every rotary pushoff turn will be under- or over-initiated to some degree, requiring the skier to compensate somehow.

While the typical rotary pushoff turn described above involves a pronounced weight transfer, the pushoff can also occur from both skis. A stem, step, or strong weight transfer at turn initiation is often a clue that the skier is using rotary pushoff. But beware—absence of these moves does not mean there was no rotary pushoff. Furthermore, not all stems, steps, or weight transfers involve rotary pushoff. Only if some part of the body rotates to generate *angular momentum* (spin) during the extension is it a true rotary pushoff.

What are the alternatives to initiating turns with rotary pushoff? See **Rotary Mechanisms** for a thorough discussion of the options. The most important alternative for modern turns is simply steering the skis with the legs beneath a stable upper body, the way the skis of a snowmobile turn beneath the sled itself. Known as the *fulcrum mechanism*, or simply "leg steering," this versatile move can be powerful and quick, or smooth and drawn out. It can turn the ski tips *into* the turn, fundamental for carving, or twist the tails out for skidding or braking. Most unlike rotary pushoff, it can guide the skis throughout the turn, allowing the skier to control precisely the shape of the turn the way a driver steers a car. Leg steering is the foundational rotary move of contemporary expert skiing.

Ironically, it is the timid or less athletic beginner who is more likely to discover leg steering from the start. Firmly planted on both skis, these skiers often twist their legs forcefully, albeit grossly, to change direction. It is the athletic, aggressive type who is more likely to make the explosive rotary pushoff move with the upper body and transfer weight from one ski to the other. Without guidance, these skiers may never develop the movements of expert skiers.

Rotary Skill

"Rotary" refers to the ATS skill group comprising movements that twist, steer, or pivot the skis and/or that affect rotational (angular) motion in the ski-skier system. Rotary skills include all the movements available to create *torque*. With edging skills, pressure control skills, and *balance,* rotary skills complete the American Teaching System™'s (ATS) *Skills Concept,* a model which encompasses all the movements of skiing.

As with the other skills, more rotary skill does not imply more or stronger rotary movements. While beginners often use gross, powerful rotary movements to turn their skis, advanced skiers usually refine the rotary skill into subtle guiding movements which complement refined edging and pressuring skills to exploit the designed carving action of skis.

See **Rotary Mechanisms**, **Pivoting**, and **Steering**; also **Edging Skill**, **Pressure Control Skill**, **Skills Concept**, **Angular Momentum**, and **Torque**.

Rotation

Rotation is a *rotary mechanism* (a way of twisting the skis or generating torque) that involves transferring *angular momentum* ("spin") from one part of the body to the skis. Rotation actually describes a family of related movements, including shoulder rotation, hip rotation, arm rotation, and rotary pushoff, all based on the Law of Conservation of Momentum. In all of these, the skier applies torque to the skis (twists them) by first rotating some part of the upper body, then slowing or stopping that upper body movement, transferring its momentum to the skis. In its simplest and grossest form, rotation involves throwing the shoulders, arms, and torso forcefully around, then suddenly "jerking" the feet and skis immediately afterward, in the same direction. In its most dramatic form, rotation is the principle involved in throwing a "helicopter" from a jump.

The defining move of the classic *Arlberg Technique*, rotation remains a powerful but limited way to initiate turns. As with *rotary pushoff* (a form of rotation combined with a weight transfer or up-unweighting from a platform), rotation hurls the skier into a predetermined immediate future. The skier generates a certain amount of angular momentum *prior* to the turn, then makes do with that amount, like-it-or-not. Throwing the shoulders too powerfully into the turn results in *over-initiation,* which in the worst case causes the skier to spin out of control. This drawback is especially apparent in moguls or whenever the skier tries to make quick, short turns. By contrast, too weak an upper body movement (*under-initiation)* may result in the rotated turn dying before the direction change is complete. While he could wind up and do it again to complete a turn, a skier cannot use rotation to steer the skis continuously or precisely throughout a turn.

Rotation can never initiate a pure carved turn. Because it always twists the ski tails out, away from the turn, rotation causes skidding, however subtle. Habitual rotators may refine the movement until it is almost imperceptible and causes only a minute amount of skidding. But to learn to carve a clean turn, these skiers must learn some entirely new options. (Specifically, they must learn to steer with their legs, not their upper bodies—see *fulcrum mechanism*.)

As a final drawback, rotation inevitably leads to a misaligned and vulnerable stance on skis. The basic athletic stance (see **Stance** and **Alignment**) that allows the body to move efficiently and resist the tremendous forces of a high speed turn is "slightly countered." This means the inside ski, knee, hip, shoulder, and arm all lead their outside counterparts through a turn. A skier who initiates a turn with rotation ends up twisted into the hill, typically with the outside hand and shoulder, and often hip, ahead of the inside. This position restricts the skier's ability to angulate with the hips. The skier is left either with insufficient edge angle or struggling to edge with extreme angles in the knee—a dangerous, weak move for this vulnerable joint.

Let's get technical. Rotation is a two-part movement. First, the upper body, hips, or whatever must start turning. To create this change in motion (*angular acceleration)*, some external force must apply (Newton's First Law). This force comes from the snow, upon which one or both skis are anchored by friction or edge engagement. So the skier turns the shoulders, let's say, against the resistance of the snow. Now the ski-skier system has angular momentum—it is "spinning." But all this momentum is in the upper body—the skis have yet to turn. In the second part of the movement, the skier slows or stops the rotation of the upper body, using the muscles of the torso and hips. That momentum must go somewhere, so it transfers into the lower body, causing the skis to turn. Of course, the force must be powerful enough to overcome the resistance of the skis on the snow. For this reason, some form of *unweighting* typically accompanies rotation, in order to reduce the friction.

Rotation differs from *anticipation-release* in that the two parts of rotation must occur with no break between them. Anticipation-release typically involves turning the torso in the new direction, thus stretching and strengthening the muscles that will at some point turn the skis. The skier can hold this "anticipated position" indefinitely, releasing it only when it is time to start the new turn. The two mechanisms blend when the anticipating skier twists and stops the upper body with enough "oomph" to kick off the new turn through rotation.

Rotation differs from "*counter-rotation*" in that counter-rotation is a *simultaneous* twisting of the upper and lower body in *opposite* directions. Counter-rotation's underlying principle is Newton's *Third* Law of Motion—that every action has an equal and opposite reaction. Counter-rotation does *not* generate angular momentum in the ski-skier system, as the two actions cancel each other out.

Rotation differs from "*leg steering*," or the so-called *"fulcrum mechanism,"* in that leg steering involves only the lower body. Specifically, the fulcrum mechanism involves steering each leg against the resistance of the other leg, which is anchored by the resistance of the snow. Rotation, like counter-rotation, anticipation-release, and blocking with a pole plant, involves the upper and lower bodies somehow working against each other.

Rotational Momentum

See **Angular Momentum**.

Rotational Motion

See **Angular Motion**.

Ruade

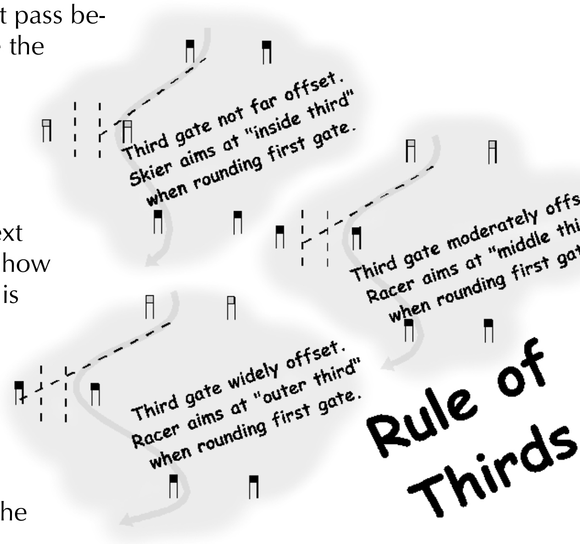
Meaning "horse kick," this historical term refers to turns made by diving forward and retracting the legs, causing the tails to kick up and around.

Rücklage

Another historical term, rücklage refers to backward lean and pressure on the tail of the ski. Its opposite is "vorlage" (forward lean).

Rule of Thirds

The "rule of thirds" helps racers determine the optimal line through the course by determining how complete to make each turn. In a double-pole slalom or giant slalom course, where each gate consists of two separate gates which the skier must pass between, racers divide the gate into imaginary thirds. Looking two gates ahead, the racer aims at the inside, middle, or outer third of the next gate, depending on how offset the third gate is (see diagram). Regardless of the direction, the next turn begins when the ski tips cross the *rise line* above the turning pole of the next gate.



See also **Rise Line**.

S

Safety

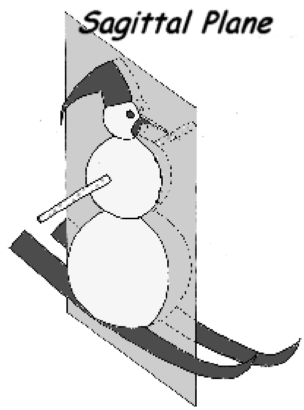
As instructors, safety must be foremost in our minds, both for ourselves and for our students. It's no fun and no one learns anything laid up in a hospital bed or worse, tied up in a courtroom. Because skiing entails risk, and trying new moves or terrain usually increases this risk, it is often difficult to determine what constitutes "acceptable risk." Many of the most effective exercises and drills are difficult and increase the chance of falling. How do we decide which of these exercises are acceptable? A tough decision! In addition to applying common

> ***We must not only teach safely, we must*** **TEACH SAFETY!**

sense and good judgement, we must become familiar with the policies, procedures, and restrictions of our individual ski areas and of the accepted standards of the profession as a whole.

For the continued well-being of our students, as well as everyone else on the slopes (including us), we must include safety itself as a lesson topic. It is not enough for everyone merely to survive the lesson. We must not only teach safely, we must *teach safety!*

On the other hand, while the age-old maxim for ski lessons is "Safety—Fun—Learning," in that order, I think we can go too far. I think of these three things as interdependent and blended, like the three skills of the Skills Concept. All three must combine for a great lesson. If any one element is missing, the lesson is a failure.



Sagittal Plane Of the three perpendicular reference planes that bisect the body, the sagittal plane divides the body into equal left and right halves. Also known as the *anteroposterior plane*, it is defined by the *transverse* and *longitudinal* axes, which pass at right angles through the center of mass.

See **Anatomical Reference Planes** and **Anatomical Reference Axes**.

Schneider, Hannes Born Johannes Schneider in 1890, high in the Austrian Alps' fabled Arlberg region, Hannes Schneider became a legend as a founding father of modern ski instruction. A ski guide in St. Anton by age sixteen, Schneider developed his techniques and teaching methods by instructing military troops during World War I. He opened his own ski school after the war, teaching group lessons with a well-developed and consistent technical progression. Schneider's technique, based on the *stem christie* and upper body *rotation*, became known as the *Arlberg Technique*.

In Austria, in addition to his ski school, Schneider also wrote about skiing and created and starred in several ski films. He became well-known in skiing circles world-wide. In 1928, with Arnold Lunn, Hannes Schneider founded the Arlberg-Kandahar alpine ski competition, one of the sport's earliest and still one of its premier World Cup events.

With World War II, Hannes Schneider left Austria for the United States, a political refugee from the Nazi party. He moved to New Hampshire, where he opened the Hannes Schneider Ski School at Mt. Cranmore.

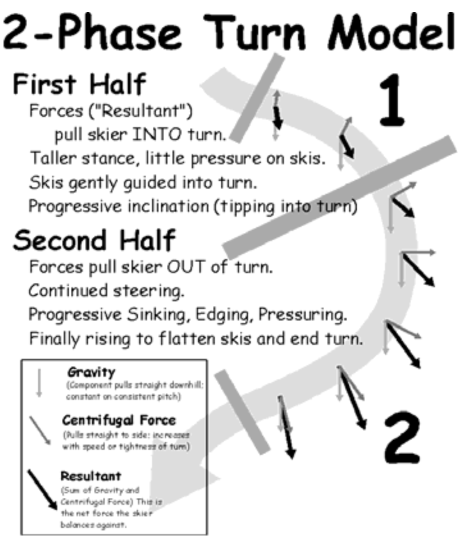
In later years, Schneider's Arlberg technique found competition from other ideas, notably Emile Allais's *parallel turns* and the *counter-rotation*-based techniques of other ski schools. From these varied and sometimes conflicting ideas evolved the modern ski techniques of today.

Hannes Schneider died in 1955, one of the true pioneers of alpine skiing and instruction.

Schuss Like it sounds, schussing means pointing 'em downhill and letting 'em run. Learning to let go and glide, to play with gravity rather than fighting it—this is one of the first crucial steps in becoming a good skier. Even at the earliest stages, skiers can learn to schuss. The very first straight run should ideally take place on a very gentle hill with a long, flat run-out where the skier can experience the seductive joy of gliding and not feel the constant need to brake. Too many skiers spend too much time on terrain where the need to brake and hold back prevents them from ever learning to let the skis run. They get good at fighting gravity and controlling speed, but never become expert skiers.

Schwingen Literally "swinging," *Schwingen* is the name of the official Austrian ski school technique.

Scissor Step Synonymous with *diverging step* and *skating step*, the scissor step is primarily a racing move used to gain height on the hill when off-line. It is helpful whenever we want to delay the start of a new turn, or tighten the radius of a turn at its completion. In free skiing, it is similarly effective whenever we need to bring a turn farther around and up the hill, or to complete a turn when off-balance to the inside.



Second Half In a simplified two-part model of a turn, such as that favored at the Mahre Training Center of Keystone, the second "half" is the phase of a turn in which gravity and centrifugal force combine to pull the skier progressively harder out of the turn. The skier must increasingly sink and add edge angle to resist these dramatically increasing forces. In other words, the second half is the part of the turn where the ski bends strongly into reverse camber and carves due to pressure from resisting the forces that want to pull the skier out of the turn. Technically, the division is not really in the middle of the turn. It varies according to the dynamics of each turn. In the illustration, the division between the first and second "half" occurs the moment the black "resultant" arrow points outside the arc.

As equipment and techniques evolve, and speeds increase, it is becoming possible to begin the pressure/carve phase earlier and earlier in the turn. Expert carving snowboarders, and now expert skiers on deeply sidecut skis or at very high speeds on conventional skis, can carve from "arc to arc," with no patient, light, steering phase ("first half") at all. Still, many skiers would benefit from being more patient, waiting until the natural forces build up before stomping down on the edge and trying to carve.

Self 1/Self 2 Tim Gallwey and Bob Kriegel (co-authors of *Inner Skiing*) used these expressions to designate two distinct parts of our consciousness. Self 1 is the part responsible for intellectual activity, rational thinking, technical analysis, "self talk," and so on. The source of fears, doubts, "paralysis through analysis," embarrassment, and judgement, Self 1 is often the biggest obstacle to performance and learning.

Self 2, on the other hand, is that part of our mental makeup responsible for physical performance and learning. Non-judgmental, holistic, rhythmic, and largely subconscious or unconscious, Self 2 is the "self" we must bring to the front and learn to trust for optimal learning and performance.

SELR See "**Sequential Leg Rotation**."

Sensory Preferences See **V-A-K**.

Sequential Leg Rotation (SELR) This term refers to turning first one leg (and ski) then the other in a one-two action, each leg using the other as the support against which it moves. SELR moves can involve only the lower body, as in stemming, stepping, and fulcrum turns. These movements differ from anticipation-release, rotation, counter-rotation, and so on, that involve both upper and lower body and usually cause *simultaneous leg rotation* (SILR). There are exceptions: *braquage* is a simultaneous move involving only the lower body. *Rotary pushoff* from one ski to the other is a sequential move involving the whole body.

SELR movements belong to the broader realm of **Independent Leg Action** (ILA).

Shaped Skis At one time all skis were straight-sided narrow slats. Today skis come in just about any shape *but* narrow and straight-sided. Short, wide powder skis, moderate-to-extremely deep-sidecut "hourglass"-shaped skis, and radically narrow-waisted skis fill the dealers' racks. The past few years have seen a revolution in ski design, and manufacturers continue to experiment with different shapes. To distinguish these modern skis from conventional "straight" skis, the term "shaped skis" has come into favor. I think there are much better names, but this one seems to be the one that has stuck.

The real issue is—what else has changed? Do the new skis change the rules, requiring a whole new technique? And do we need to teach differently? Some will say "yes," that in particular the classic skill of "steering" is now obsolete because the skis carve turns "all by themselves" when put on edge.

I say "no!" The new skis definitely respond differently to edging and pressuring inputs, but it is more a matter of degree than a real change. They may require less muscular effort to steer through a turn, like a car with power steering, but the movements are the same. And the precise control of turn shape still requires subtle steering movements. We still steer cars with power steering—it's just easier! If we don't learn to steer them, these skis will take us for a curvy ride, but who is in control?

With their much deeper sidecuts, these skis are optimized for a typical recreational skier's turn size and shape—unlike race skis that are meant for usually much longer turns. They are, as Jerry Berg of the Aspen Ski School says, "street legal giant slalom skis." They allow recreational free skiers finally to make the same efficient movements and feel many of the same sensations as racers at two to three times the speed.

Certainly the laws of physics have not changed. The tools we use to play with gravity may be much improved, but the goals are the same. Those who skied "properly" on conventional skis need only to adapt the timing and intensity of their movements to find a new level of control on super-sidecut skis. The boundaries of possibility have moved out a bit, allowing experts to carve radical, nearly gravity-defying turns even at lower speeds.

Most skiers, as I have often noted, use a defensive, skidding technique, regardless of their ability level. For these skiers, some technical changes are indeed in order if they want to ski the new (or old) skis properly. But super sidecut skis reward good technique so much that "stuck-in-a-rut" intermediate skiers may finally discover the carved turn with their help and with some good instruction.

Teaching on the new skis likewise should change very little—assuming, of course, that the instructor taught correctly in the first place. The same basic skills apply, even though timing may change a little and the blend of rotary, edging, and pressure control may shift slightly in some turns. I have always thought that skiers should develop the skills needed to ski on two-by-fours, and that better equipment just makes it easier, more controlled, and more fun. Just because these skis will turn by themselves when locked on edge does not mean we should not learn to steer them, pivot them, and throw on the brakes when needed! With these highly responsive skis, some exercises work better than before. Even first-timers on the flats can feel their skis carve arcs when they tip them on edge and slide forward. Beginning skiers usually learn the patience needed for good turns more easily, because the skis inspire confidence—they *feel* like they want to turn. The fundamentals of good offensive turns—the Center Line™ Common Threads—are the same as always, but they are easier to grasp and apply on super sidecut skis.

Shaped skis have been around for a few seasons now, and most skiers have finally accepted them. Still, there are many myths surrounding super-sidecut skis, most based on conjecture or complete misunderstanding. Yes, they carve great turns on groomed snow, if the skier knows how. They can also skid, brake, and handle bumps, powder, crud, and ice as well as any other ski of similar quality and performance. While a few skiers still insist that shaped skis are a passing fad, I am certain that they are here to stay. They aren't really new—they just represent a sudden leap in what has been a steady evolution for many years. Soon "shaped skis" will be just "skis" and their straighter-sided ancestors will hang on museum walls.

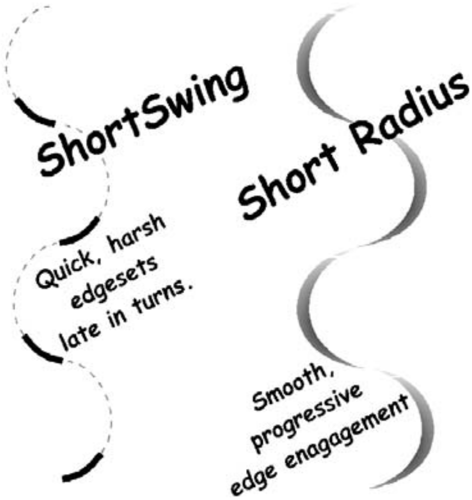
See **Darcside**. Also see **Sidecut**, **Common Threads**, and **Good Skiing**.

Shaping Shaping is a behavior-modification (teaching) method in which the teacher reinforces "successive approximations"—behaviors that more and more closely approach the "ideal" or ultimate goal. Shaping requires that the teacher break the goal into smaller, achievable steps. The concept of shaping is important during practice sessions of ski lessons. Students require more feedback at the earliest stages of learning a new movement or idea, but as they become more accurate and consistent, the teacher can reduce the amount of feedback progressively (see **Practice**).

Shinning Shinning means carving a line so close to a race gate that you hit it with your shins. Until the modern *rapid gate,* racers skied around bamboo poles that were too stout for shinning.

Short Radius Short radius turns are relatively small and quick but rounded turns. I differentiate short radius from *short swing* turns by the rounder, more steered, carved turn shape of short radius turns ("radius" implies "arc"). In short radius turns, the edge of the outside ski engages earlier, nearer the fall line, and carves more of the turn than in short swing.

How short is short? Probably every skier has a different idea of where to draw the lines between short-radius, medium-radius, and long-radius turns. To me, the distinction is more one of timing and rhythm than of actual turn size. The very slow-speed wedge turns of beginners barely resemble the staccato turns of a slalom racer, but in fact the actual radius is often similar. It is that quick, crisp rhythm of the slalom racer's turns, regardless of speed and turn size, that defines short radius turns.



Short Swing

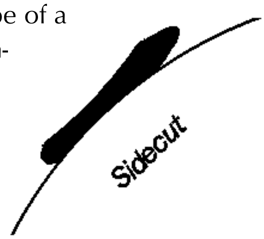
Short swing is linked, short, quick turns involving brief, harsh edgesets late in the turn, as opposed to a more gradual build-up of pressure and guiding of the skis. Short swing appears almost as a hop from foot to foot. The outside ski is not pressured until it is turned nearly to the direction it will face at the end of the turn, usually well after the fall line.

This is the classic slalom turn, often described as "quick on-and-off the edges." In a sense, short-swing turns are neither carved nor skidded—the ski does not slice through the arc of the turn, but neither should it skid once the edge is finally engaged. Short swing is an effective tactic for icy slopes, where the sharp stabs of the ski edges hold better than smooth, prolonged attempts to carve. They are also an effective tactic in breakable crust or other extremely difficult, heavy, and inconsistent conditions, as most of the turn occurs in the air between edge sets.

True short-swing turns are highly athletic. Dealing accurately with the powerful rebound of a real slalom ski in these turns is beyond the capabilities of all but very good skiers.

Sidecut

Sidecut refers to the "hourglass" shape of a ski—wider at the ends, narrower at the waist—that enables an edged and pressured ski to bend ("decamber") and carve a turn.



Current trends in skis are toward ever deeper sidecuts. Following the lead of carving snowboards with their radically curved edges, alpine skis of today resemble very little the narrow, relatively straight-sided slats of the sport's earlier days. From beginners to the highest levels of World Cup competition, manufacturers and skiers are realizing the benefits of these super-sidecut carving machines. Of course, it is the ski's tendency to bend into **reverse camber** (see) that allows it to carve, not the sidecut directly. But all else being equal, a ski with a deeper sidecut will bend into a tighter arc than a straighter ski for the same degree of edge angle. This phenomenon allows skiers with only moderate edging and pressuring skills to experience real carved turns. And it allows experts who already know how to carve to rip outrageously tight arcs with little or no skidding.

See **Shaped Skis**.

Sideslip To sideslip is to relax edging and allow the skis to slip sideways down the slope. Sideslip is a good exercise to promote skidding, edging skill and sensitivity, and the skill of *leverage* (controlling fore/aft balance). It is also a useful emergency technique for descending uncomfortably steep sections. However, because it tends to plow the loose snow off a steep slope, skiers who do this often must be prepared to endure some scornful looks from other users of the slope.

Sidestepping Sidestepping on skis simply means walking sideways, usually to climb a hill, using the ski edges to grip.

As it involves most of skiing's fundamental concepts, sidestepping is arguably the most important activity a beginner should master. Active feet and legs working beneath a stable, disciplined upper body, tipping the feet on edge, precise and constant awareness and control of the direction the feet point ("*steering*"), balance on the downhill foot, alignment of the upper body (shoulders tipped parallel to the slope), and awareness of the fall line—all these fundamentals are basic to skiing, essential for sidestepping, and often completely new and counter-intuitive for non-skiers.

Many ski instructors underestimate the importance of teaching correct sidestepping to beginners. As students almost universally struggle with it, their instructors often rush through this early phase, hurrying to get their fledgling skiers to a lift. But the same errors that cause frustration when sidestepping—leaning and twisting the upper body uphill, combined with little awareness of what the feet are doing—will return, magnified, to haunt the student's turns on the hill. Sidestepping up the bunny slope is *not* a "necessary evil," but a golden opportunity to circumvent many of skiing's most common mistakes.

My advice to instructors: take the time to *teach* the technique of the sidestep. See that students master its movements. Fascinate them with the unique concepts and sensations of sidestepping, *before* venturing to a lift or attempting to teach turns. Point out the relevant features—the tilt of the shoulders and its effects on edging, the sensation of edged skis, the need for constant awareness and deliberate control of the direction the skis point, the balance primarily on the downhill ski, and the importance of not rotating the upper body up the hill. Allow them to play and experiment. Sidestepping is easy, given a few pointers, and mastering it does wonders for students' skiing skills, as well as their confidence and their pleasure at succeeding at something new and important. No one wants to spend all day sidestepping up a hill, but the longer you can keep students enthralled with the activity, the easier it will be for them—and you—later on!

Sierra Cement

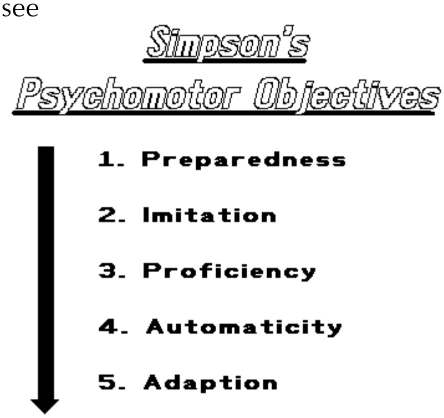
"Sierra cement" is a heavy, deep, and wet snow condition named after California's Sierra mountains, where moist Pacific storms make it a common occurrence. See **Mashed Potatoes**.

SILR

"**Simultaneous Leg Rotation**" (see).

Simpson's Psychomotor Objectives

Each of the three "educational domains"—*cognitive*, *affective*, and *psychomotor*—involves certain learning objectives. Just as the objectives of the cognitive domain (see **Bloom's Taxonomy**) describe an increasing depth of knowledge, the objectives of the psychomotor domain represent increasingly skillful and complex physical ability. In 1966, J. S. Simpson[82] classified the objectives of learning in the psychomotor domain in a progression from *preparedness* (physical and mental readiness to learn the movement or skill), to *imitation* (the movement has been made or imitated—the ability has been discovered) to *proficiency* (the movement can be made accurately and consistently), to *automaticity* (the movement can be made by rote—without conscious thought, from muscle memory—the movement has become a "habitual skill"), to *adaption* (the movement can be modified to fit the situation—"perceptual skills").



Most athletes and instructors are familiar with his sequence. It is relevant and helpful in planning lessons, designing practice sessions, evaluating progress, determining proper terrain, and so on.

Simultaneous Leg Rotation (SILR) This term refers to turning both legs and skis at the same time, as opposed to *"sequential leg rotation"* (SELR) in which one ski moves first, followed by the other, each acting as the support from which the other moves. The primary SILR rotary mechanisms include *rotation, counter-rotation, blocking pole plant, braquage,* and *rotary pushoff* from both skis. With the exception of braquage, all these mechanisms involve both the upper and the lower body, and benefit from unweighting the skis.

Modern ski technique has become more and more simultaneous. Classic racing, which relied almost exclusively on a variety of step turns (sequential), contrasts sharply with today's World Cup aces who use far more simultaneous movements. Note, though, that today's racers still have the *skills* to step when needed, but modern equipment and course demands make simultaneous movements usually more efficient.

Tactically, simultaneous leg movements tend to work better than sequential movements in soft, deep snow conditions. Because sequential movements rely on using one foot as the "platform" to stand on when moving the other, they are only as reliable as that platform. In uneven conditions—especially heavy, steep snow, wind slab, and breakable crust—that platform is not trustworthy! When skiing off-piste in steep bowls, crud, powder, and "changeable" snow, focus on simultaneous leg movements.

Because instructors now usually group sequential leg rotation under the wing of "independent leg rotation" ("ILR"), the abbreviation for simultaneous leg rotation is sometimes simply "SLR."

Situational Skiing Situational skiing implies intentionally modifying or adapting technique and using tactical options to best suit the varied terrain, conditions, speeds, and moods of skiing. There is no one correct technique or perfect turn for all skiers in all situations. The best skiers stray far from the Center Line™ at times as they explore the possibilities for getting down the mountain with finesse and style. PSIA's concept of *lateral learning* addresses the importance of not being stuck in one particular movement pattern. Remember—the best skiers focus not on technique or specific movements as "correct," but on fundamental *skills* and their infinite applications and blends.

Sitzmark Also known as a *"bathtub"* (see), a sitzmark is the hole left in the snow after you fall. In skiing's halcyon days, before grooming machines brought harder snow and crowds of neophytes to the slopes, it was considered proper etiquette to always stop and fill in your sitzmarks.

Skeletal Strength When I am in a tall "neutral stance" my body is balanced, my muscles are relaxed, and I am supported primarily by "skeletal strength." Bones stack on top of bones and I need little muscular involvement to remain upright. If I lean back or crouch down, muscles in my legs, abdomen, torso, and neck must tighten to keep me from falling—I am no longer relying on skeletal strength.

A good skiing stance takes advantage of skeletal strength. It is fairly tall and balanced. On the other hand, *too* tall and relaxed a stance leaves the muscles slow to react, preventing truly athletic movement. The perfect stance on skis involves an optimal blend of skeletal and muscular strength—efficient, yet alert and ready for action.

See **Stance** and **Tall Stance**.

Ski Board A recent development in the increasing variety of toys available for sliding in the snow, ski boards resemble two tiny snowboards, one on each foot. Usually "ridden" without poles, they are popular in snowboard terrain parks and as an alternative to skis or snowboards that shares many qualities with both. They can be a great training device for skiers to learn good leg steering skills and to quiet the upper body.

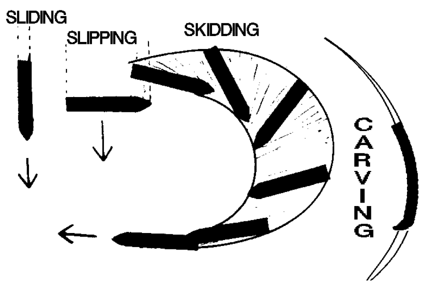
Ski Bunny *Alpinus Lapinus curvaceous*—Popular game creatures (popular if game!) unique to ski country, ski bunnies are only occasionally spotted on the slopes. Capable of surviving solely on raw, green currency, the species is generally most active at night. Highly vulnerable to predators, especially in spring when they begin to shed their heavy winter coats, *L. curvaceous* is not yet on the endangered species list, perhaps due to high reproductive success. Ski bunnies are seldom dangerous, but they are unpredictable in captivity and often resist attempts at domestication.

See also **Lycra**, **Inclination**, and **Spontaneous Christie**.

Skibonics I suggest this word as a name for the seemingly foreign language some over-zealous instructors use in their lessons. Like many specialized fields, skiing has developed its own unique lingo, much of which is the subject of this book. Nevertheless, I implore my fellow ski instructors to please *not* use most of these obscure words when teaching!

Skidding By its basic definition, skidding simply means skis are slipping sideways as they slide forward, usually through a turn. Commonly meant as a contrast to *carving,* skidding causes a loss of precise line control, but an increase in resistance or braking.

The real meaning of skidding, though, goes much deeper. Why do skis skid? Is skidding bad? Are all turns skidded? Ask these questions to a room full of ski instructors, then stand back. You will discover that you've touched off a deep-rooted, passionate debate of philosophical proportions.



Yes, technically all turns involve some skidding. Just as cars, even on dry pavement, slip sideways a little, and squeal at higher speeds, skis always skid at least slightly in a turn. The "pure carved" turn exists only in theory. Some turns involve a huge amount of skidding; others very little. So skidding really represents a continuum, the spectrum of real turns between pure sideways skidding (slipping—no turn at all) to pure carving.

Yet is there not an obvious distinction between *skidded turns* and *carved turns,* despite the truth that all turns really skid and the pure carve exists only in the equations of theorists? Watch skiers on the hill. Clearly there are two types of turns happening. What is the difference? Is there a point on the continuum where skidding becomes carving? Does a skidded turn become a carved turn simply through more practice and better equipment? Is it a question simply of skill level? The answer is "no"—there are two fundamentally different types of turns. What we call skidded and carved turns involve two distinct types of movements, and both have a place in the expert's repertoire. The real difference arises more from a skier's *intent* than from some measure of how much the skis slip sideways. Indeed, "carved-type" turns can involve a lot of skidding, and some "skidded-type" turns actually skid very little.

There are two reasons skis will skid too much in turns. The first is equipment, condition, or ability-based. Skis skid when, for whatever reason, they simply can't grip with their edges well enough to withstand the sideways forces of a turn. Edges too dull, skis too short or too soft, or torsionally soft skis that twist off edge at the ends just don't hold as well as sharper, higher performance skis. Soft, loose snow that breaks away in a turn, or glazed ice where even razor-sharp skis can't hold well cause slippage and skidding. Higher speeds increase the sideways forces in turns. All else being equal, higher speed turns involve more skidding. And technical skill level obviously affects a skier's ability to control skidding. Not enough edge angle, fore/aft imbalance, or unrefined rotary skills all increase skidding. All these factors are good reasons for skis to skid more than the skier might want. The cure is better equipment or conditions, quality lessons, and practice.

The other reason skis skid is a "bad" reason. It is *not* curable by better equipment or more practice alone. Indeed, more practice may make it worse! Most skiers skid too much not because they aren't "good" enough, but because they have learned to be good at the wrong thing. Most skiers, at all ability levels, make turns by pushing the tails of the skis *away* from the direction they want to turn. They literally push their skis into a skid. If their skis were sharp enough, these skiers couldn't turn at all. They twist their skis into a skid, then hope to control that skid through the rest of the turn. On perfect groomed snow, at moderate or low speeds, this is no problem. But on ice, they can't control the skid once it starts. And in the other extreme—heavy, deep snow, or crud—they *can't* push their skis sideways to start the turn. "My skis get stuck when I ski crud" is a common complaint. But if skiers really carved turns, they would *want* their skis to be "stuck." "Stuck" is the same thing as "not skidding," isn't it? But skidding is the very foundation of their turns. Without skidding, they can't turn. I won't mince words here: these are bad turns, resulting from bad technique. And this technique has nothing to do with ability level. And whether you're good at it or just starting out at it, it is still bad technique!

The cure for this problem is to *stop* practicing it! It involves re-thinking the turn itself. Or better, for those fortunate beginners who haven't yet developed the bad habit, the solution is to learn correctly from the start. Pushing the tails out to start a turn is what I call a *negative movement*—a movement in the direction opposite the way you want to go. Think about cars. They, too, skid more or less, depending on road conditions, tire and mechanical condition, and speed. But as drivers, we rarely *try* to make the car skid. Sure, it can be fun to spin out and "do donuts" in a snowy parking lot, but we don't usually drive this way on the road. It is not the way to make a "good turn." Engineers long ago put the turning wheels in front, so when cars turn, the front wheels pull them into the turn while the rear wheels follow. If you've ever driven a fork lift, you know how odd it feels to turn left by moving the back of the vehicle to the right. Skis can turn either way, but the carved turn is the result of turning "tips in," rather than "tails out." How well the skier does this, and how successful the result, depends on skill level, equipment, and conditions. But even beginners can make carved-type turns instead of skidded-type turns, if they focus on this offensive "tips-in" concept and learn not to initiate turns by pushing the tails out. We must learn to blend refined edging and pressure skills with rotary skills to allow the skis to bend and carve.

Is skidding bad, then? Well, no! But it is a bad *turn*. Intentional skidding is a *braking* move, not a turning move. Even the dictionary equates skidding with braking: Webster defines skidding as "to apply a brake to . . . slow or halt by a skid."[83] Most of us learn it because we feel defensive on skis at first. The first instinct of most beginners is to eliminate that slippery, no-traction feeling of skis. They just want to stop. So it is only natural that braking movements are the first that most people learn. They feel "control." Then, naturally, they want *more* control, so they keep practicing. And they get better and better at braking. Those braking movements do cause some change in direction, so they start to call them "turns." Besides, it looks like everyone else is doing it, so they continue to imitate and improve. Eventually they may become expert brakers, able to brake down even steep "black" terrain. But their entire technique is based on this defensive, braking movement, and all their turns are skidded.

Unfortunately, few skiers benefit from good instruction that introduces them to turning, carving movements from the beginning. Braking, skidding movements are, of course, essential. But as in a car, they are hardly the only skill we need if we really want control. If more skiers realized that their turns are really only glorified braking movements, they would start to ski with more control and efficiency. They would be safer, as they could control their lines with a precision they hadn't imagined possible. They could ski more conditions, including that ice, where their forced skids were uncontrollable, and that crud, because "stuck" skis are not a problem for carved turns. They would intentionally skid only where skidding is appropriate—when they want to hit the brakes. And even braking wouldn't happen very often, as they learned that, with good, gliding, carved turns, they are able to ski back uphill, stopping and controlling speed without braking.

As it is, we have a world full of "skidders," slipping and sliding all over the mountains with far less control than they realize—until they run into someone or something. Perhaps another dictionary definition is more to the point. The *American Heritage Dictionary* defines skidding as "on a downward path to ruin, failure, or depravity."[84]

See also **Carving**, **Turning**, **Braking**, **Good Skiing**.

Skier's Responsibility Code

See **Your Responsibility Code**. The Skier's Responsibility Code was a brief list of common sense "rules of the road" designed to help increase safety on crowded ski slopes. In recent years, as skiers share the slopes with snowboards, snowshoes, ski boards, and other toys, the name has changed to "Your Responsibility Code" to reflect this diversity.

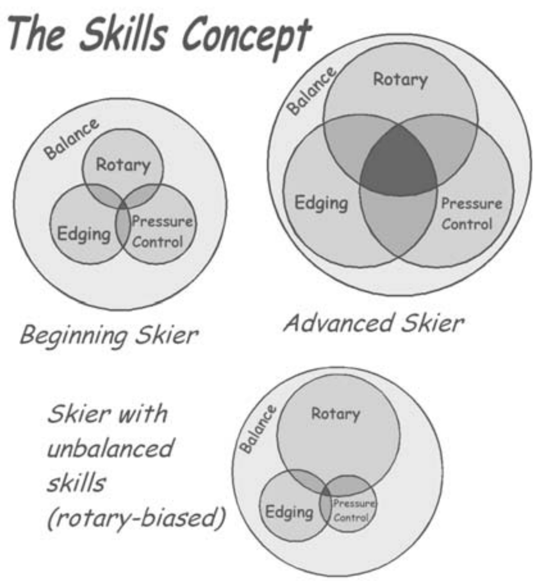
Skills According to the dictionary, skills are "[capabilities] acquired or developed through experience."[85] The key word here is "acquired." Skills are learned, and generally specific in their purpose. Contrast with *abilities*, which may have both a learned and an innate component, and are generally less specific to a particular activity, sport, or purpose. We speak, for example, of "athletic ability," but of a "skilled skier." Great skiers are usually people with high natural athletic ability who developed the specific skills of skiing through experience and effective practice.

Ski instructors commonly categorize the myriad skills of skiing into the three broad families of *rotary* skills, *edging* skills, and *pressure control* skills. We also recognize *balance* as a fundamental skill, that involves a large component of innate *ability* (see **Skills Concept**).

See also **Ability**, and the individual skills of **Rotary**, **Edging**, and **Pressure Control**.

We teach not TURNS—but the SKILLS that allow turns!

Skills Concept The American Teaching System™ (ATS) groups all skiing movements into basic, interrelated skills groups. The fundamental skills are *rotary, edging,* and *pressure control*, along with the "master skill" of *balance* (which we can also call an *ability* because of its innate components). These skills groups are simple, encompass all possible skiing movements, and are easy to observe and feel. Rather than concentrating on the myriad of specific movements and skiing maneuvers, along with each variation and adaptation, ATS seeks to identify which basic skills need development for individual students, and to focus on these skills.



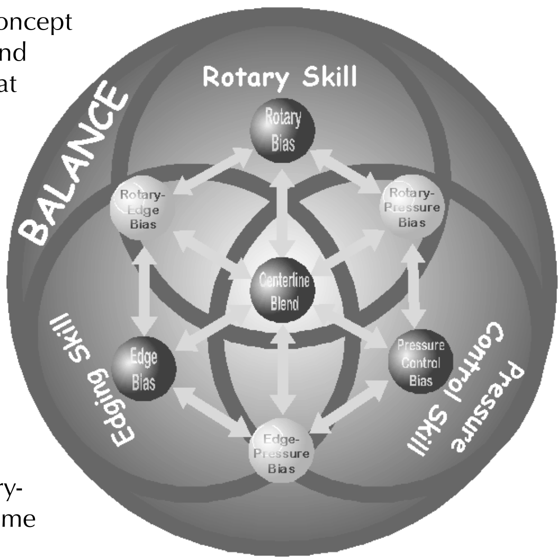
The essence of the Skills Concept is that we do not teach specific *turns* (*i.e.* wedge christie) or movement patterns (*i.e.* 100%

weight transfer). We teach instead the *skills* that allow those movements, and that allow variations when appropriate.

We can analyze any skiing movement according to the skills involved and how each skill applies. While we can focus on one skill to an extent, the basic skills actually overlap and blend. Most movements involve several skills, and turns involve them all. It is virtually impossible to practice only one skill at a time, although some exercises are good at developing specific skills.

The Skills Concept is thus a holistic approach to skiing. ATS depicts the Skills Concept with a circle diagram, as shown, representing the individual skills, surrounded by balance, growing and blending together to varying degrees depending on the development of the skier.

In concert with the Center Line™ Skiing Model, the Skills Concept helps instructors understand skiing and plan lessons that develop versatile, accurate skiers. The Center Line™ Model, with its "milestones," represents a particular, evenly balanced blend of the Skills Concept's basic skills, as a skier develops from beginner to expert. But the Skills Concept encompasses different skill blends as well. More rotary-dominant moves for extreme steeps and tight turns, edge-pressure dominant blends for longer gliding carved turns, and everything in between—the Skills Concept encompasses every possible skill blend and bias, while the Center Line™ Model provides a structure to sort these movements into *linear* and *lateral* learning. Together, the Skills Concept and the Center Line™ Model provide an exceptional tool for movement analysis and lesson planning.



The Skills Concept and the Center Line™ Model—*together they form a great tool for understanding skiing.*

See also **Center Line™ Model**, **Linear** and **Lateral Learning**, and the individual skills of **Balance**, **Rotary**, **Edging**, and **Pressure Control**.

Slalom Norwegian for "sloping track," *slalom* has come to describe the ski racing discipline involving the tightest, shortest-radius turns. While typical *downhill* race gates are two-to-three seconds apart, and *giant slalom* gates average about a second-and-a-half, slalom turns average one second or less apart.[86]

Such quick turns set slalom apart from other disciplines in two important ways. First, any movement lasting less than about a second is known as an *open-loop task.* That is, it happens too quickly for a skier to make adjustments based on feedback during the turn. Feedback comes only *after* the turn, and the skier may make adjustments to the *next* turn—or the next. Good slalom turns require a great deal of practice to make the movements habitual and consistent. When free skiing, slalom turns usually involve a metronome-like rhythm. The skier commits to this rhythm, making sure that each turn is completed in the allotted time. By contrast, longer giant slalom-type turns *(closed loop tasks)* depend on feedback and a skier can make adjustments during the turn. The skier may commit to the turn shape and completion, regardless of the amount of time it takes. (See **Open-** and **Closed-Loop Tasks**.)

The other major distinction of slalom turns involves equipment and technique. Obviously, the ski itself doesn't know that the skier wants to make a tighter turn. Slalom turns are usually tighter than the natural sidecut-determined turning radius of the ski. More edge angle and pressure can make any ski carve a tighter arc, but slalom turns usually involve more active rotary movements than longer turns. The classic slalom turn involves active pivoting of un-pressured skis until they are turned to nearly the direction of the completed turn, then a very quick, "harsh" edgeset and release. The edgeset/release creates powerful rebound, during which the skier redirects the skis for the next turn, and must move the center of mass accurately to remain in balance. "Float-sting-float-sting . . ."—this is the rhythm of the slalom turn. Point 'em, set the edge, and get off it! These athletic movements require agility and consistent accuracy. A quick, precise pole swing helps maintain the rhythm and direct the movements.

Ironically, because classic slalom turns are less "carved" than longer turns, slalom skis tend to have straighter sidecuts than giant slalom skis. Slalom skis are optimized for the quick "on-off" edgeset. Straighter edges grip immediately when pressured—they don't need to bend into an arc first—and release just as quickly.

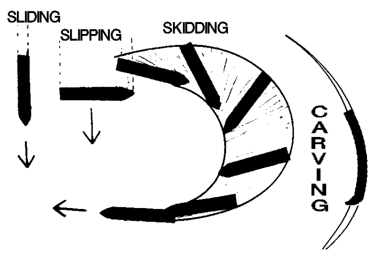
Real slalom turns are perhaps the ultimate test of skiing skills and athletic agility. Most skiers resort to twisting, braking "windshield wiper" skids, or else simply make quick, incomplete longer-radius turns. Like any good turn, a slalom turn should be an attempt to change direction—not just slow down. Speed control should come from the direction the skis go at the turn's end, not from the braking effect of increased skidding. There should be little skidding during the edgeset and the skis must be turned far enough *prior* to the edgeset to complete the turn. A common mistake is to *push* the skis, "tails out," into a skid, or to pressure the skis much too early, before the direction change is complete, again requiring the skier to push the skis into a skidded completion.

Of course, any ski will carve some sort of an arc during the brief edgeset. The deeper the sidecut, the more the ski will carve, so modern radical sidecut skis allow softer, smoother edgesets to accomplish the same turn shape as full-race slalom skis. Practicing the extreme late, harsh edgeset-rebound slalom turn, along with pure-carved longer turns, creates the skills needed to ski the entire spectrum of options in between!

See also **Shortswing**.

Sliding

Sliding refers to the ski moving across the snow in the direction of its longitudinal axis, in other words, straight forward (usually), or straight backwards. Contrast with *slipping* (sideways movement). I *slide* forward but I *slip* sideways. *Skidding* is a combination of slipping sideways while sliding forward.



See also **Slipping** and **Skidding**.

Slipping

Slipping implies a ski moving across the snow in a direction perpendicular to its longitudinal axis, in other words, sideways. Combined with sliding forward, slipping results in *skidding*.

See also **Sliding**, **Side-Slip**, and **Skidding**.

SLR

"**Simultaneous Leg Rotation**" (see).

Snowboard

A snowboard is a large, wide plank with a flat base on the bottom and a flathead on top. When inverted, it makes an attention-grabbing sculpture or a decent ski-tuning bench . . . .

All right—as snowboarding evolves and matures, I am forced to admit that my simple definition may not be entirely fair. I do not wish to further inflame any rift that has developed between snowboarders and skiers. Snowboards introduced the snow-sliding world to radical sidecuts and were the first tools to allow arc-to-arc linked, pure-carved turns. Modern carving boards can rip arcs that skiers can only envy, even on our new "super sidecut" skis, and freestyle snowboarders have developed a whole new arena of tricks and moves. The FIS recognizes snowboards with a World Cup racing circuit of their own, and snowboarding is now an Olympic event. And I'll even admit that I, myself, have tried snowboarding and found that it is, at least a little, fun.

There was a time when snowboards were the exclusive realm of the radical fringe. The equipment was new, not highly evolved, and riders, often young and rebellious and traveling in packs, presented an image of snowboarders as reckless, rude, and out-of-control. These things have changed, but still there is often animosity between skiers and snowboarders. Unfortunately, while snowboarders are not idiots, there are still a few idiots who are snowboarders. Undoubtedly the minority, these few continue to give the sport an undeservedly bad name. And those idiots who are skiers share the blame by fanning the flames.

Snowplow "Snowplow" is another word for **wedge** (see). The word "snowplow" harkens to the earliest days of alpine skiing, as the name of the beginner's tips-together-tails-apart wedge position. While today the position is as valid as ever, the word "snowplow" conjures perhaps the wrong image. A wedge need not be a braking move, pushing snow with edged skis to slow down. It can as well be a gliding, flatter-ski stance from which first turns develop. If that image of digging in and pushing snow is what comes to mind when hearing "snowplow," it could interfere with learning a gliding wedge. For this reason, instructors today tend to favor the less graphic—some might say less picturesque—term "wedge."

Speed Control Controlling speed is obviously an essential part of sliding down a mountain on slippery planks. A skier can control speed either of two ways—by putting on the brakes (*friction*), or by changing *direction* so he is no longer moving downhill. Savvy skiers tend to use the latter—speed control comes from completing the turn—skiing a "slow line"—and braking occurs only in emergencies. Speed control does not imply "going slow"—it merely means that once the skier is up to speed he or she can maintain that speed consistently from turn to turn, even as the terrain changes from flat to steep to flat.

Indeed, ironically, it is the constant attempt to control speed directly that handicaps many skiers and prevents them from reaching their potential as true experts. There is a reason experts make it look so easy and effortless: they rarely control speed! Braking is a lot of work. It's never easy, cannot be refined, and experts don't do it unless they absolutely have to. Good skiing, as I have often said, is "skiing a slow enough line as fast as you can (when you can)." Experts control their *line* precisely and deliberately, completing turns as necessary so they avoid the need to control speed (brake). For an expert, even stopping usually means skiing as fast as possible—up a hill and gliding to a stop. In short, experts think of turns primarily as techniques to control line. Most skiers think of them as a way to control speed. The difference is much more than simple semantics, as a skier's whole technique is founded on this basic paradigm.

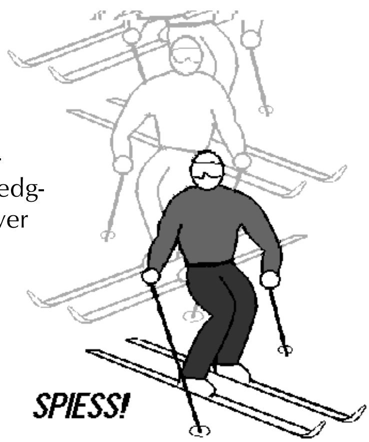
See also **Braking**, **Skidding**, **Line**, **Turning**, and **Good Skiing**.

Speed Events

In ski racing, the "speed events" are Downhill (DH) and Super G (SG), while Giant Slalom and Slalom are known as the "technical events."

Spiess

Meaning "skewer" in German, and also known as "hop turns," spiess is a highly athletic exercise in which the skier leaps and pivots the skis, landing on locked edges, then leaps and pivots again, with minimal forward movement. Spiess is a tremendous exercise for athletic students to develop a good neutral stance, simultaneous leg movements, pole plant timing, edging skill, vertical motion, upper body/lower body independence, active steering, and short turns.



For good spiess turns, make sure that the hop comes from the legs, not from the arms. A crisp, forward-angled pole plant helps stabilize the upper body, aids timing, and provides some rotary force (torque). Leap and turn the skis beneath the upper body with the legs—do not try to throw the upper body around before leaping (*rotation*). The rotary mechanism here should be a combination of *counter-rotation* and a *blocking pole plant*.

Spontaneous Christie

A *christie* is a ski turn made on "corresponding edges"—both left or both right edges, in contrast to a wedge turn, which involves both inside edges. When novice skiers begin to match their skis—bring them to corresponding edges and perhaps parallel—from a wedge turn, *unintentionally*, the result is a "spontaneous" christie. Mechanically, a spontaneous christie is a "wedge christie" or "basic christie."

By definition, we cannot "teach" a spontaneous christie, but we can encourage one by creating the right environment. To facilitate a spontaneous christie we can add a little more speed and/or ski a slightly steeper slope, using a narrow, gliding wedge. A relaxed, neutral stance is a must. With quality mileage in comfortable terrain, most beginners will discover the spontaneous christie with little technical direction.

(You didn't really refer here from **Ski Bunny**, did you?)

Stance

Stance refers to the basic posture of the skier, including the alignment of all the various parts of the body in relation to each other and in relation to the slope and the balance point ("*point of contact*") on the skis. Contemporary skiing begins with a neutral, natural, athletic stance, balanced over the whole foot, maximizing movement options and optimizing both skeletal and muscular strength. I refer to this stance as "home base"—it is not a position or pose that we force ourselves into, but a neutral "base" or "center" from which we may move, but to which we return. The basic stance, of course, changes as we move through turns, but for good skiing, certain fundamental aspects remain—see **Alignment**.

Also see **Lead**, and **Closed**, **Open**, **Wide-Track**, **Natural**, **Neutral**, **Tall**, and **Locked Stance**.

Stance-Based Mechanics

We can trace many skiing movements and skier "types" to a skier's basic stance. Skiers who are forward on their skis, for example, tend to use some form of *rotation* to begin their turns, which produces several effects. Because they twist their upper bodies into the turn, their hips move out over their skis, precluding hip angulation and decreasing edge angle. Turns have a "fish-hook shape," washing out at the completion phase. To stop the washout and create a new *platform* for the next turn, skiers often increase knee angulation, which results in an *"a-frame"* and often a downstem *(abstem)* at the end of the turn. Noting any of these symptoms in a skier should suggest to the instructor that the skier's stance is too far forward.

Skiers too far back on their tails have a completely different look. They tend to *counter-rotate,* thrusting their tails to the side to start each turn. Because of the countered stance, they lose the ability to create knee angles, but often use pronounced hip angulation. Turns are typically "Z" shaped.

Only when balanced on the centers of the feet (the "sweet spot") can skiers steer effectively with their legs (the *fulcrum* mechanism). Leg steering results in a "slightly countered" stance—neither rotated nor excessively countered—which allows both hip and knee angles, as required. Turn shape, typically round, can be whatever the skier chooses to steer.

Recognizing these "packages of movements" is a huge help when doing movement analysis. It is impossible to determine a skier's fore/aft balance simply by looking at his body position. Too many variables affect where the pressure focuses on the skis. But understanding that the movements described above all tend to result from the skier's stance provides the needed information.

To demonstrate that these movements are indeed *caused* by a skier's stance, go out and make several series of turns, first leaning way forward, then back, then centered. Note the mechanics and turn shapes that you use as a result of changing your stance. Try to use *other* mechanics, rotation when leaning back, for example. While it may be possible, it is very awkward and unnatural.

See chart of stance-based mechanics under **Fore/Aft Balance**.

STAR Test

"Standard Rating Test." PSIA introduced the STAR Test as a way for recreational skiers to grade themselves and rate their achievement as "bronze," "silver," or "gold" level. Designed primarily as a marketing device for ski lessons, as well as a way for skiers to more accurately describe their skill levels, the STAR Test has never become particularly popular and is offered at few ski schools.

Update fall '98: I think the STAR Test is now officially dead and forgotten.

Star Turn

A good exercise for beginners to familiarize themselves with their long skis and to get used to turning their feet, the star turn involves simply stepping around in circles while standing in one place on the flats. The tracks it makes in the snow resemble a star.

Static

The opposite of *dynamic,* static means "still" or "posed." Because the forces of skiing change constantly, the skier must move continuously to counter and maintain balance, control edge and pressure, and guide the turn. Skiing is a sport of motion, and static poses have no place in it.

Watching skiers on the hill, it may strike you that many of them are, indeed, "static." Perhaps they are imitating the positions they see in still photographs in magazines. Perhaps they are rigid with fear, or never learned to explore the range of motion available to them. But the only way we can communicate with our skis is through movement. Great skiers move so fluidly and continuously that it is not always obvious how *much* they move. Static poses hinder good skiing just as they would most other sports.

Good exercises to help eliminate static skiing include "thousand steps," "leapers," "uphill christies," and skating.

Static Balance

Unlike *dynamic balance,* static balance does not require movement. It is the balance exhibited on a tricycle, or a statue with a broad, heavy base, or a skier with a wide stance and both feet firmly planted on the snow. Most skiers begin with a wider stance to facilitate static balance. As skills and speeds increase, balance becomes more and more dynamic, similar to the progression from tricycle to training wheels to a real bicycle.

Static Exercise When we simulate a skiing movement while standing in place, it is known as a "static exercise." For example, having skiers repeatedly tip their "inside" ski of an imaginary wedge turn from the inside edge to flat, then steering it parallel to the other ski, is a static exercise that could help skiers learn to match their skis, the first step from wedge to parallel. Once they have the move down, they can try to apply it to real turns while actually skiing. Some static exercises require a partner or some other prop to simulate the forces of real turns, as when two skiers play "tug-of-war" with a pair of poles to learn to edge and tip into a turn.

Statics Statics is the branch of physics dealing with balanced forces that do not cause objects to accelerate. From a skier's *accelerated frame of reference,* ski technique falls into the realm of statics, because the skier must constantly balance the forces acting on him in order to remain in balance.

Stationary Platform The stationary platform is the classic edgeset preturn or downstem from which step or rebound turns begin. It contrasts with the so-called "moving platform," which involves *releasing* the edges and guiding the skis into the new turn. When skiers speak simply of a "platform," it is usually the stationary platform to which they refer.

See **Platform**.

Steadman, Dr. Richard Now of the Steadman-Hawkins Sports Medicine Clinic in Vail, Colorado, Dr. Steadman pioneered many of the breakthrough procedures used to repair and rehabilitate injured knees. Many great skiers and other top athletes from around the world owe their continued success to Dr. Steadman and his research.

Steering Brace yourself—*steering* is one of those hot-button issues sure to cause heated disagreement among ski instructors. What is it? What isn't it? Should you or shouldn't you? Do we steer when carving turns? There are almost as many definitions of steering as there are certified instructors. Here's mine:

Steering is using muscles to control the direction the skis are pointing. No more. No less. It is a good thing, integral to nearly all skiing moves. The only time I don't steer my skis is when I'm riding a chairlift. (I do steer them on surface lifts, to keep them in the tracks.) If you like the direction your skis are pointing, steering means keeping them pointing that way. If you don't like the direction they're going, you'd be a fool not to turn them because you think it's bad technique!

Steering is to skiing much the same as it is to driving a car. It is an active process. You steer a car almost continuously, throughout turns as well as on the straightaway. Sometimes you throw the wheel quickly, in an emergency or very sharp turn, but usually you just guide it very gently, or hold it still. You use that steering wheel so that you are in control of the direction the wheels are turned. Even when they point the way you want—as in that straightaway—you still usually hold the wheel and steer. The moment you let go of the wheel, you cease to steer. The car may even continue to go the direction you want, but you are no longer in control of it, because you aren't steering.

STEERING is using muscles to control the direction the skis point. No more. No less.

And so it is on skis. Steering is an essential part of good skiing. It is how we shape our turns with precision, whether skidded or carved, braking or gliding. It is what allows us to "own" our line, to determine it, rather than letting the skis take us for a ride. The more closely the skis tend to follow the path I want, as in carved turns, the less muscularly and forcefully I need to steer them.

But those who argue that steering is bad, that it is counter to carving turns, miss the point. Perhaps they equate "active steering" with gross pivoting or braking movements which indeed prevent good carved turns. But steering a car doesn't imply only harsh movements of the wheel, does it? Why should it for skiing? Of course, there are also those who insist that steering involves only gradual movements. Again, we usually steer a car smoothly, but not always.

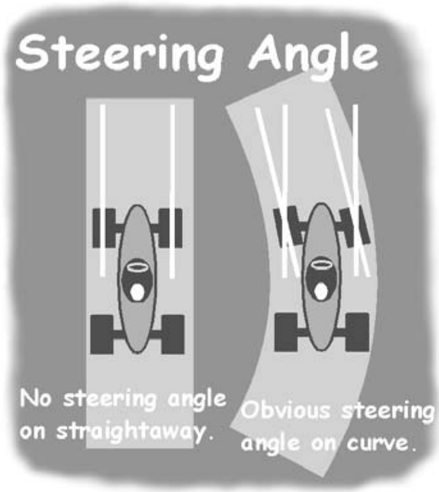
Some would say that steering is controlling the direction of *travel,* not just the direction the skis point. While the two may be related, they are not the same. In a car, again, the steering wheel really only controls the direction of the wheels. It is the interaction of those steered wheels with the road—the grip of the tires—combined with the forward movement of the car, that determines the direction of travel. Likewise in skiing, steering the skis combines with edging and pressure control and some force (gravity) to control the direction of travel. Steering is the rotary skill. Turning (controlling the direction of travel) blends rotary, edging, and pressure control.

Low speed, low-level turns (wedge and wedge christie), especially on "conventional" skis with little sidecut, require quite active, muscular steering movements. As skills grow and speeds and forces increase, the natural carving ability of skis plays a larger role in turns, and the need for powerful muscular twisting of the skis decreases. But expert skiers still rarely let go of the wheel!

See also **Rotary Mechanisms**, **Piloting**, **Pivoting**, and **Active Turns**.

Steering Angle

To cause a turn, the snow must exert pressure through the feet and legs in a direction other than that in which the skier is going. Technically then, at least part of the ski must be turned at some angle to the direction of travel in a turn. This angle, which can be very slight in carved turns, is the *steering angle*. Cars going around curves also exhibit steering angle as the front wheels obviously turn at an angle from straight ahead.



Two things can create steering angle on skis. The skier can muscularly twist the skis, using one or a combination of *rotary mechanisms*. Or the ski can literally turn itself, as it does when it arcs into the *reverse camber* of a carved turn. In a carve, the tip of the ski pulls the center of the ski constantly into the turn, creating the steering angle under foot.

Steilhang

A steilhang is a very steep, narrow, and straight section of a ski run. Perhaps the most famous example is the notorious steilhang of Austria's Hahnenkamm downhill course in Kitzbuhel.

Stem

From the German *stemmen* ("to push against"), a stem involves brushing one ski or the other out into a converging (wedge) relationship while the other ski continues to track—like a "half-wedge." Stems can check speed, develop a "*platform*" for a step, rebound, or rotary pushoff turn initiation, or create a rotary impulse or *steering angle* (see above) for turning. Stems can be either "*upstems*" (uphill ski) or "*downstems*" (downhill ski). A "*double stem*" involves both skis brushing out and is the same as a wedge.

Classic stemming involves different mechanics than modern "Center Line™" turns. Center Line™ mechanics involve a release of the edge of the old turning ski and a guiding of both skis into the new turn, rather than having one ski track while the other is steered, usually to an increasing edge angle.

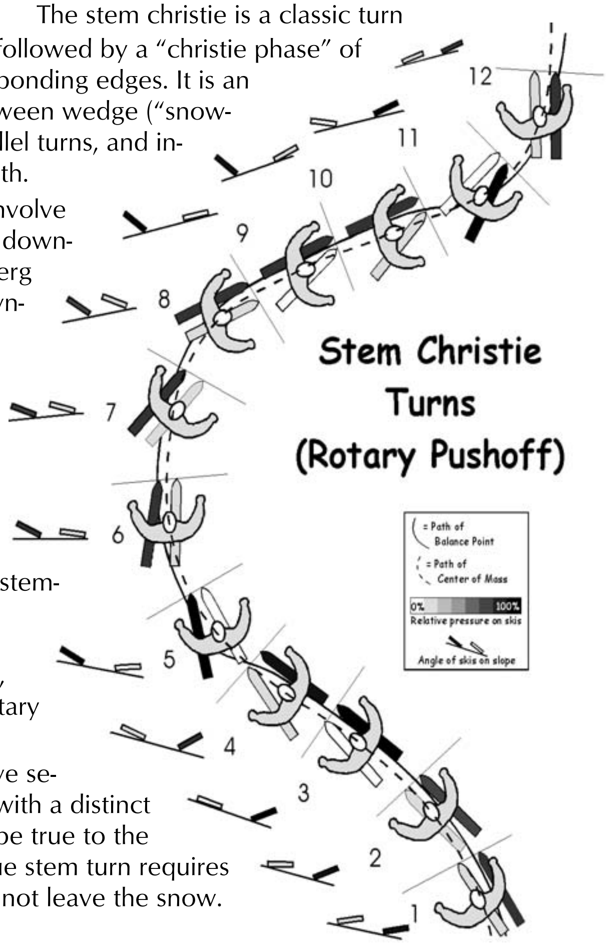
Technically, a stem differs from a *converging step* in that stemming means brushing the ski along the snow, while stepping means lifting and displacing a ski. Mechanically, though, there is no substantial difference.

Stem Christie

The stem christie is a classic turn initiated with a stem, followed by a "christie phase" of parallel skis on corresponding edges. It is an intermediate turn between wedge ("snowplow") turns and parallel turns, and involves elements of both.

Stem christies can involve either an upstem or a downstem. The classic Arlberg technique used a downstem to an edgeset to create a platform from which the skier pushed off into the new turn. In an upstem stem christie the edged downhill ski holds and tracks during the stemming of the uphill ski. Weight is then transferred to the uphill ski, often with a strong rotary pushoff.

Stem christies involve sequential leg rotation, with a distinct "one-two" action. To be true to the classic definition, a true stem turn requires that the stemming ski not leave the snow. It should be brushed out, rather than lifted. If a ski is lifted off the snow, techni-



There are many variations of the stem christie. This illustration shows the classic "upstem" christie kicked off with upper body rotation as the skier pushes off from the platform of the edged downhill ski ("rotary pushoff"). Note the negative "tails out" movements of the skis and the interrupted flow of the CM.

cally it is a step turn. The difference is one of form, however, not function, and only a true purist should care about this triviality.

The stem christie, while outwardly similar, is in many ways the opposite of the Center Line™ *wedge christie*. In the wedge christie, the skis are steered into a wedge as the legs extend and the center of mass moves downhill toward the new turn. In a stem christie initiation, the center of mass moves *up*hill, away from the new turn at initiation. This *crossover* move of the wedge christie allows the downhill ski to release its edge, rather than tracking, and the ski tips turn downhill. In the stem christie, the downhill ski holds its edge and the tails push uphill, out of the turn. On intimidating terrain, or whenever the skier is in "defensive mode," the wedge christie may become a stem christie as the skier is reluctant to release the edge of the downhill ski until the uphill ski is well into the new turn.

Simply put, the stem christie involves primarily *negative* movements—movements toward the outside of the turn, while *positive* (into the turn) movements define wedge christies (and all Center Line™-type turns). Negative moves include the "tails-out" move of the skis and the uphill push of the center of mass with the weight transfer. Even the matching (closing) move, as the inside ski tail is pulled parallel to the outside ski, is a negative move.

So the stem christie is a defensive turn. It is a good way to change direction when you really *don't* want to "go that way"—to turn down a steep hill when you don't want to gain speed, for example.

See **Wedge Christie** and **Negative Movements**.

Stem-Step

A **Converging Step** (see).

Stenmark, Ingemar

Arguably the greatest slalom and giant slalom racer of all time, Ingemar Stenmark of Sweden won a record eighty-six World Cup races during his career, from 1974 through 1989. Competing against such formidable opponents as Phil and Steve Mahre of the United States, Stenmark won gold medals in both slalom and giant slalom in the 1980 Olympics, and was the overall World Cup champion in 1976, 1977, and 1978.

Step

A step is a deliberate movement from the downhill ski to the uphill ski, involving lifting and displacing the new outside ski, usually in the initiation of a turn. As first one ski moves, then the other, steps demonstrate *sequential leg movements*. The new outside ski may be placed back on the snow in a parallel, converging, or diverging relationship with the old ski, and flat, or on the inside or outside edge. Steps can adjust line, recover balance, complement rotary mechanisms ("rotary pushoff"), and affect how quickly the skier enters the new turn. A simple weight transfer with no displacing or re-orienting of the new ski does not constitute a step.

There was a time when step turns were synonymous with racing turns, but times have changed. Many stepping movements interrupt the smooth flow of the center of mass from turn to turn—they cause the CM to move uphill first, then back down into the turn. Thus today we rarely see classic step turns even in the highest levels of racing. Most stepping movements in racing today occur to recover when "off line."

See also **Converging**, **Diverging**, and **Parallel Steps**.

Step Christie

A step christie is a christie (turn made on corresponding edges) initiated with a step. The step can be converging, diverging, or parallel.

Stretch Zone

When the body twists, as in "*anticipation*," many muscle groups and joints are involved throughout the torso, abdomen, and hips. This twisted area is the "stretch zone."

A stretch zone occurs in most rotary movements. The location of the stretch zone varies with the rotary mechanism. In rotation and counter-rotation, where the skis and legs turn as a unit against the upper body, the pelvis behaves more as part of the lower body and the stretch zone centers in the abdomen. In leg steering (fulcrum mechanism), where the legs rotate in the hip sockets, the pelvis behaves as part of the upper body and the stretch zone is in the hips and legs.

As modern high-performance turns rely on this leg steering mechanism, the hips should usually align somewhat countered to the skis, along with the rest of the upper body. In movement analysis, noting where the stretch zone occurs can shed light on the mechanics of the entire turn.

Stretching

Stretching is a part of warming up that helps prepare the muscles, tendons, and joints for strenuous activity. We perform better and are certainly safer and less likely to injure muscles, tendons, and ligaments if we allow time for stretching. It is important to warm the muscles up with some vigorous activity (running in place, "thousand steps," and such) prior to stretching. Stretching should then be done slowly, smoothly, and comfortably, as opposed to jerking or forcing the muscles.

Super G

Introduced amidst controversy in the 1980's, the super G ("super giant slalom") race combines elements of giant slalom and downhill. Its speeds and turns are midway between the two classic events. Over the years, super G has proven an exciting and entertaining test of technical skills, gliding ability, tactics, and guts.

Super Giant Slalom

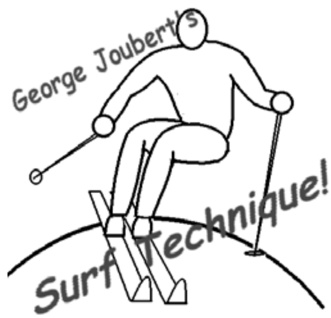
See **Super G**.

Supination

The opposite of **pronation**, supination means turning the soles of the feet inward, rotating the little-toe edge of the foot down. Supinating the hands means turning them palms up, rotating the thumbs to the outside. Some people's feet naturally supinate, putting more pressure on the outsides of the soles. More common are pronators, who tend to walk more on the insides of their feet. Either motion can cause problems in ski boots if not corrected with a good footbed and boot alignment.

Surf Technique

Descriptive of an important skiing movement described by the great Georges Joubert, this term itself is little known, and perhaps better applied to activities taking place in lower lying coastal regions where the ice and snow assume their liquid states and Lycra comes in smaller pieces.

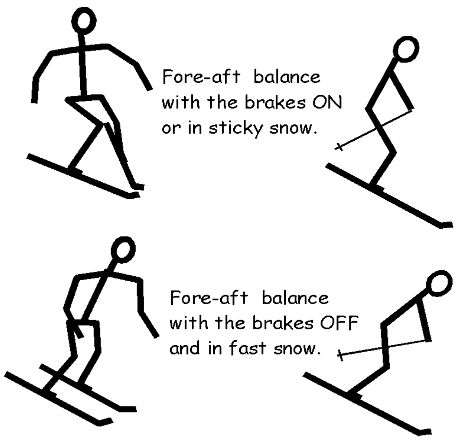


Not, of course, that Joubert's Surf Technique does not involve valid, useful movements—it does. In its simplest form, surf technique is simply a "lateral displacement of the knees to keep the skis flat on the snow."[87] Sort of a "reverse knee angulation," surf technique allows the skier to prevent over-edging and to steer the skis. It is useful when deeply flexed, which otherwise often results in severe knee angulation and edge angle. Surf technique allows us, for example, to glide and steer even while absorbing a mogul or when retracting legs to initiate a turn in deep powder.

Sweet Spot

The "sweet spot" is that point on the ski and inside our boot over which we strive to balance for optimal ski performance and athletic stance. The actual location of the sweet spot may vary somewhat, depending on equipment, individual physical makeup, and turn type. Generally, the spot is in the area from just behind the arch to the ball of the foot. The spot just back of the center of the arch, directly under the bottom of the weight-bearing tibia (shin bone) provides several biomechanical advantages. It promotes good balance and allows us to utilize "skeletal strength" to advantage and to work the entire ski. It also allows the ski to pivot around the long axis of the leg.

Note that balance over the sweet spot is a *sensation*, not a *position*. In order to stay on the sweet spot, we must constantly adjust our stance and move our center of mass as the skis speed up, slow down, and turn (see illustration). While generally we ski best if we can stay balanced over the sweet spot, subtle, purposeful pressuring forward or back of the spot (*"leverage"*) can help control the arc of a turn, increase edge bite, or facilitate certain maneuvers. Like riding a unicycle, the Center Line™ Milestones require an extremely accurate relationship between the center of mass and the sweet spot.



All skiers are in correct balance over the "sweet spot."

And that's all Sweet Spot means. Get your mind out of the gutter!

Synchronized Skiing

Synchronized skiing involves two or more skiers skiing precisely "in sync" with each other or in carefully choreographed patterns. It is skiing's version of synchronized swimming, without the need to hold your breath for so long. Synchronized skiing can be great to watch—like looking at a skier through a prism that creates multiple images, or watching the Blue Angels dance wing-to-wing through the sky.


In Sync!

It is also a great exercise to improve timing and develop certain movements. Students often experience breakthroughs when following an instructor or each other in sync. Synchronizing behind a student can help the instructor feel and understand the student's movements. Synchronized skiing develops *perceptual skills* and hones the ability to change rhythm and adapt timing according to external cues. It is a good warm-up for moguls where the mountain mandates its own rhythm.

T

Tactics Tactics are options deliberately chosen to improve chances for success. On skis, *technique* relates to how to turn; *tactics* refers to where to turn and what kind of turn to make. Line choices, turn-type and turn-shape choices, skill blend choices (more or less rotary, braking or turning movements, simultaneous or sequential movements, and so on), as well as equipment choices, all fall into the realm of tactics.

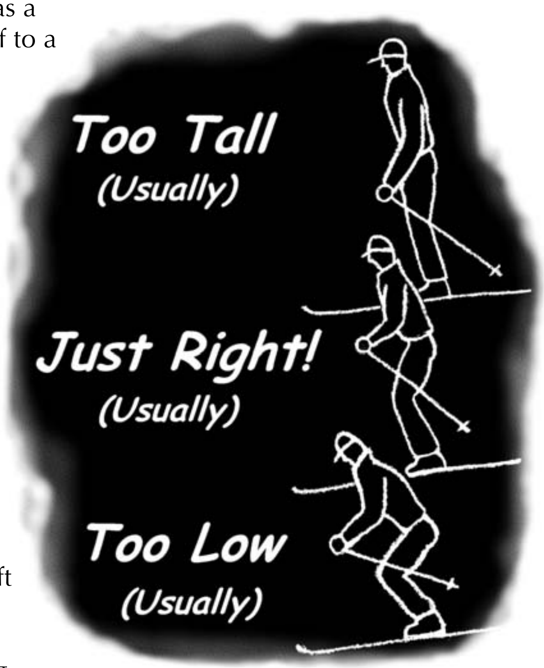
Choosing tactics involves conscious judgement—a very high *level of cognition*. Good tactics can be as important as a well-developed technique. Racing tactics focus mostly on line—exactly where to start each turn, and how complete it should be. On ice or steeps, some types of turns work better than others—the tactically wise skier may chose to ski a little slower and make quick, short-swing turns as opposed to long, round giant slalom-type turns. Tactics for deep snow include simultaneous leg movements, smooth rhythmic turns, and a straighter line that carries some speed. Especially in difficult terrain and conditions, well chosen tactics often bring success where higher skill level but poor tactics fails.

Of course, all this presupposes that the skier *has* options. One-dimensional skiers, practiced in only one type, shape, or size of turn, usually enjoy only the groomed runs. They may look good when in their comfort zone, but they fall apart whenever the terrain or conditions throw them a curve. Versatility and intelligent tactics are hallmarks of great all-mountain skiers.

Tall Stance The ideal skiing stance is neutral, athletic, and "fairly tall." Instructors place a lot of emphasis these days on this tall stance. A tall stance allows the skier to exploit skeletal strength, whereas a more crouched stance requires a lot of muscular effort just to maintain. The tall stance is natural and comfortable and allows great sensitivity. Because taller is easier and more comfortable, it makes sense to ski tall unless there is a good reason not to. So good skiers flex and angulate when needed, but usually return to this efficient tall stance when they can.

But—*too* tall a stance interferes with high-performance skiing, as Georges Joubert pointed out in 1978's *Skiing, An Art—A Technique*:

> "[Too tall] is a very economical and very relaxed way of skiing. At low speed and on intermediate slopes with good snow it is not a serious problem. In fact, it even has a certain virtue, lending itself to a very sliding type of skiing which utilizes fully the directional effects of the skis. In short, it's a skiing of feelings, but not of actions. It is here where the weakness of the upright position lies: *it does not promote muscular action*."[88]

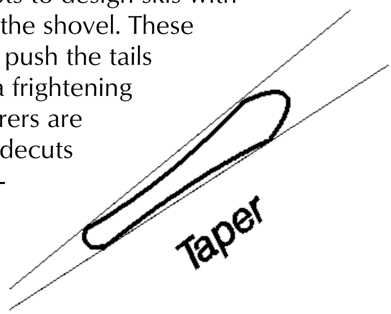


Joubert points out three problems with a stance that is too tall. First, the muscles become too relaxed and lethargic. Second, it prevents rapid fore/aft balance adjustments. And third, flexing slightly greatly strengthens steering/pivoting movements.

Thus, while modern ski instruction rightly emphasizes a tall stance for its efficiency and sensitivity, we must not lose perspective and stand too tall. And remember that in many situations (extreme steeps and heavy powder and crud, for example), a somewhat lower, "tighter" stance greatly enhances our ability to power through and fight for balance.

Taper Taper refers to the difference between a ski's width at its tip and tail. Most skis are wider in front than they are in back. Taper makes skis skid more easily, so skis for beginners often have pronounced taper. On the other hand, less taper produces skis that hold better, so higher performance skis, intended for racers and others who *carve* turns, tend to have less taper.

I know of a couple experimental attempts to design skis with no taper, or even wider in the tail than in the shovel. These skis carve like scalpels, but it is so hard to push the tails into a skid for braking that they can give a frightening ride. Most recently, several ski manufacturers are once again building skis with very deep sidecuts and no taper (equal width tip and tail), designed for "extreme carving."



Task Teaching Style

Task style is a teaching strategy similar to *command style*, but less teacher-centered, more student-focused. In task teaching style, students are given a task and allowed to practice it on their own, at their own speed, and in their own chosen location. The instructor watches and gives corrective feedback and reinforcement where needed, but the feedback may not be as direct, immediate, or consistent as in command teaching style. The teacher may establish boundaries and guidelines, but as much as possible the students are given freedom to choose and be creative.

See **Teaching Styles**.

Taylor, Cliff

Responsible for developing the Graduated Length Method (GLM) or "instant parallel" teaching method in the late 1950's, Cliff Taylor was a pioneer in ski instruction in the United States. While GLM, in its original form, has gone the way of leather boots and hickory bases, the current American Teaching System™ still shows signs of Taylor's influence. Today we focus on function and fundamental skiing skills, but we still usually introduce beginners to the sport on shorter, easily manageable skis.

Teaching Model

A teaching model is a plan, a guideline that helps teachers impart knowledge or skill and maximizes students' power to learn.

See **ATS Teaching Model**.

Teaching Styles

Teaching styles are different strategies a teacher can use to interact with students, present information, and provide feedback and reinforcement. Commonly recog-

TEACHING STYLES

Command Style
Task Style
Guided Discovery
Problem Solving
Individual Style
Reciprocal Style
Group Style

nized teaching styles include **Command**, **Task**, **Guided Discovery**, **Problem Solving**, **Individual**, **Reciprocal**, and **Group Teaching Styles** (see individual entries). The variables involved include teacher or student focus, amount of "freedom" and creativity allowed the student, type and source of feedback and reinforcement (whether it comes from the teacher, from within the student, or from another student), and how much prior information and knowledge is required of the student and the instructor.

Different styles involve different *levels of cognition*—an important factor in developing versatile, self-sufficient, "real" skiers. Creative use of teaching styles can make a lesson fun and successful, but we must use these styles purposefully—to best promote learning—rather than haphazardly or just "because I haven't used that one for a while." Some teaching styles are better suited to some students than others. And some teaching styles are far more effective for teaching certain things. Effective instructors choose teaching styles deliberately, with as much care and reason as when selecting terrain and conditions.

As teachers, our job is to provide for students what they can least provide for themselves. Sometimes that means knowledge and information; other times it means encouragement, support, coaching, confidence, or inspiration. Some teaching styles help us introduce new knowledge; others excel at drawing out knowledge or performance that is already there. We can use teaching styles effectively only if we determine what it is that the students most need.

Technique A technique is a specific way of performing a task or applying skills. Often, as in skiing, there are many techniques that can accomplish similar results. Contrast with *method*, which implies a systematic approach to achieving a goal. We refer to *ski technique* but a *teaching method*. We use teaching methods to develop ski technique.

Contrast technique also with *tactics*. Tactics are the conscious choices we make, including which technical options to use.

Cutting-edge ski technique evolves constantly, based on advances in understanding and equipment, as well as the styles and capabilities of top skiers and the ideas of creative technicians, instructors, and coaches. It is hard to say whether new technology drives technical evolution, or whether new techniques drive technology. It is probably more of a leap-frog effect, a cycle where manufacturers design new equipment to exploit the latest techniques, then athletes take the capabilities of the new technology to higher levels and new directions, which again inspires engineers to further the technology.

In any case, at least at the highest levels of competition today, technique tends to be universal rather than regional, functional rather than style-based.

Gone are the days when hugely varying "national techniques" reflected the individual styles of the stars of the day.

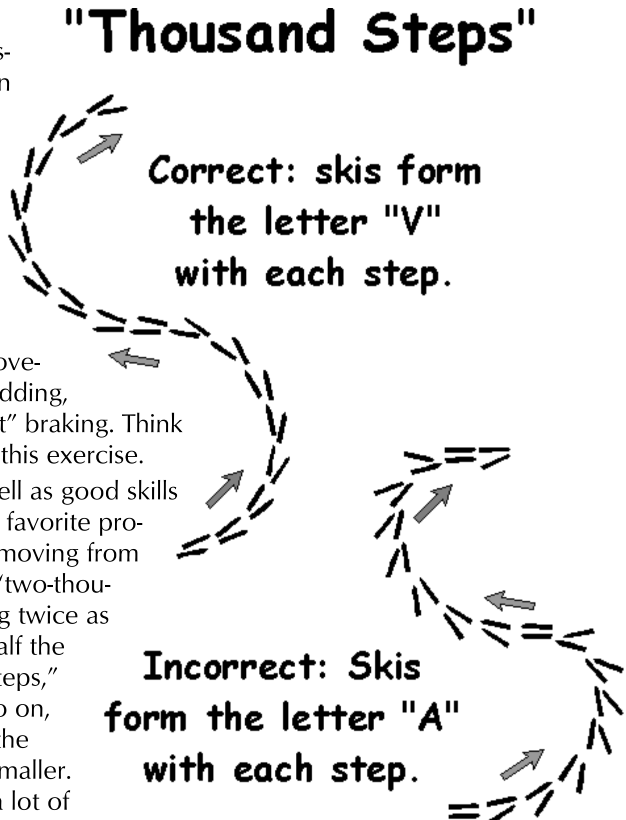
Telemark Named after the Telemark region of Norway, where Sondre Norheim developed the *telemark turn*, this term refers to a stance in which the *outside* ski of a turn leads the inside ski, opposite the normal stance on alpine skis. While this stance is biomechanically difficult and generally inefficient and unnecessary with stiff boots firmly anchored to alpine skis, it is a common and useful stance on "freeheel" nordic equipment, where it provides stability fore-and-aft. The move first became popular as a stable stance for landing from a ski jump. In recent years, the telemark turn has gained new popularity as skiers on nordic (free heel) gear have brought it from the backcountry to the groomed, lift-served slopes.

The Telemark Position

Tendon Tendons are the tough, fibrous cords that attach muscle to bone. Of similar material, tendons are often confused with *ligaments,* which attach bone to bone in joints, and *cartilage,* which forms the slippery surfaces of bone ends in joints.

Thousand Steps A drill in which the skier steps from ski to ski continuously throughout the turn, "thousand steps" is a tremendous and versatile exercise, developing many skills and movements. Thousand steps develops balance, stance, mobility, edging skill, independent leg action, round turn shape, accurate movement of the center of mass (including "crossover"), and use of arms for balance and flow, in addition to being a great warm-up exercise. Requiring continuous, dynamic activity, it can be the cure for the "static" skier.

Note that there are two ways to step around a turn. You can lift the inside ski, turn the tip away from the outside ski (creating a "V" with the skis), then step to it and bring the outside ski parallel. Or you can stand on the inside ski and turn the tail of the outside ski out, forming an "A" as you look down at the skis (like a wedge) with each step. Big deal, you say? This distinction reflects what is perhaps the most fundamentally important element of modern ski technique. The movements involved in the diverging step ("V") are those of the carved turn—"tips in," offensive, gliding, positive, "go movements." Note other movements as well, especially the center of mass and arms. Everything moves constantly into and through the turn, then across the skis and into the next turn. And note especially that transition phase between turns—is there ever an "A"? Many skiers will discover a weak link in their ability here, as they do not commit their body into the new turn enough to allow that first step to be a "V." The converging step ("A") is the movement pattern of skidding, defensive, "tails out" braking. Think "thousand V's" for this exercise.



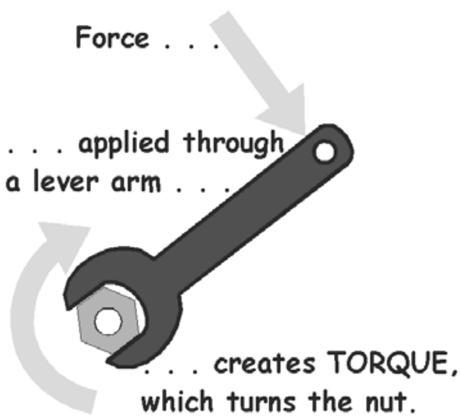
Illuminating as well as good skills training, one of my favorite progressions involves moving from thousand steps to "two-thousand steps," making twice as many steps each half the size. Then "4000 steps," then "8000" and so on, each time making the steps quicker but smaller. Note that there is a lot of activity throughout all these turns. There is certainly no less activity in "2000 steps" than in "1000 steps." And nothing really changes as we go from 1000 to 2000 to 4000, to . . . .

So how about "infinite steps"? See if you can make that logical leap to "infinite step" turns—no steps at all, really, but using the same aggressive "V-not-A" activity all the way through the smooth, round turn. As the steps get smaller and quicker, the tracks get smoother and, like a movie made of many individual still photos, the "step" turns become fluid, normal turns. The weight remains on the outside ski, while you continuously pull the inside tip into the turn. The center of mass and upper body drive through the turn, then lead the movement downhill into the next turn. There is never a moment of inactivity, even though to the casual observer it may appear that you are standing still, just going for a ride. You have in effect come full circle, from "non-stepped" turns to "infinite step" turns—which are what those stepless turns should have been in the first place! But the difference between these active, dynamic turns and the static "park-and-ride" turns of many skiers, is dramatic and fundamental. We could accurately define good turns as "infinite steps"!

This progression clearly illustrates what we mean when we speak of "active steering," "inside leg activity," "continuous activity," "driving throughout the turn," and so on. I hope it makes sense, but I really hope you will go out and try it. You have to *feel* what I'm talking about, and practice it until it is the fundamental movement pattern of every turn you make. Don't get me wrong—it is not a braking movement, so it isn't the only movement pattern to master, but it is the defining essence of the modern carved turn.

Tomba, Alberto The great and charismatic Alberto Tomba of Italy dominated slalom and giant slalom through the 1990's, succeeding Ingemar Stenmark as the king of ski racing. To date, he is the only alpine skier ever to successfully defend an Olympic gold medal, winning the giant slalom in both 1988 and 1992. He retired from active World Cup racing prior to the 1998-99 season. Tomba's flamboyant style, and smooth, powerful technique assure the multiple Olympic, World, and World Cup champion a place in history among skiing's all-time greats.

Torque "Twisting force," torque is force applied through a "lever arm," causing a change in the rate (acceleration) of spinning or rotating about an axis. In skiing, torque is what we use to turn and steer skis. Torque is the concern of the *rotary* skill group and *rotary mechanisms* are the principles available to us to develop or control torque. Complex, changing systems of torques and other forces act constantly on us as we make turns down a ski slope.



What does it mean to apply force "through a lever arm"? Think of it as pushing or pulling on the edge of something, instead of the middle. If you push straight on the center of a nut, it doesn't turn. If you apply the same push to the end of a wrench handle, it turns the nut. The wrench handle is the lever arm. The amount of torque is the product of the strength of the force and the length of the lever arm—a longer wrench allows more torque.

See also **Rotary Force** and **Rotary Mechanisms**.

Torsional Flex Torsional flex, or torsional rigidity, refers to a ski's resistance to twisting along its length. Torsionally stiffer skis hold their edges better, while torsionally softer skis tend to twist off their edges at the tip and tail and skid more easily. Higher performance skis are usually much stiffer torsionally than more forgiving skis designed for beginners or intermediates.

See **Flex**.

Total Body Angulation Synonymous with *banking* (inclination without angulation), this poorly chosen and seldom heard term refers to the angle between the skier's body and the slope, unlike the more common use of "angulation" to describe angles in various joints.

Tournant Georges Joubert proposed using this term to describe various defensive movement patterns that can be effective in very difficult conditions and situations, but that really don't deserve to be called "turns." Including wide up-stem christies and step turns, and hop turns, tournants allow the skier to link traverses with very sharp turns. "I don't dare use the word turn, which implies a degree of sliding down the slope, to describe this brutal and inelegant change of direction,"[89] wrote Joubert. Whereas turning implies an offensive state of mind and gliding skis, "tournants" are coarse and unrefined—but effective!

Track! "Track!" is the traditional shout of warning from an overtaking skier to the skier ahead. Variations include "on your right (or left)," and "track right (or left)." Like golf's "Fore!" these all mean "look out, I've screwed up!"

Unfortunately, many skiers today use these warnings to mean "get out of my way" These menaces just don't get it! While some people consider it polite, yelling "track" is obnoxious and unsafe. It gives the skier who yells it no "rights." What is the skier ahead supposed to do? Stop turning? Attempt to get out of the way? What if the skier ahead is deaf, dyslexic, or doesn't speak English? If that skier you've warned with an "on your left" turns left, and you hit him, it is your fault, pure and simple.

Yelling "Track!" has been considered bad etiquette since skiing's early days. I quote from 1958's *The New Invitation To Skiing:*[90]

> "The real skier never yells 'Track!' unless he has to. He uses his brakes instead of his horn. . . . The skier who thinks 'Track!' is an imperative directive for everyone else on the slope to keep out of his way may soon be officially banned from the slopes . . . ."

So "track!" should be reserved for those times when we are truly, *and accidentally*, out of control (and those times should be rare!). When I hear people yell "track," I assume they are out of control. I do not turn left or right until I can see what they're doing. Responsible skiers choose their speed and line such that they can miss the skiers ahead no matter what they do, even if they stop suddenly or turn without warning. There is never a need to "warn" people that you're coming—unless you've made a big mistake and really gotten yourself out of control. Furthermore, any time a skier runs into another skier ahead of him, he *was* out of control, as evidenced by the collision.

Tram Trams are huge cable cars, some of which can carry one hundred or more people at a time. While there are only a handful of trams in the United States, they are very common in the European Alps.

Transfer "Transfer," as it applies to education, is the concept that previous learning affects current learning. Prior learning can either help or hinder new learning.

Positive transfer occurs when something previously learned makes it easier to learn something new. Accomplished hockey skaters, for example, often find learning to ski very easy because of the many similarities between the sports.

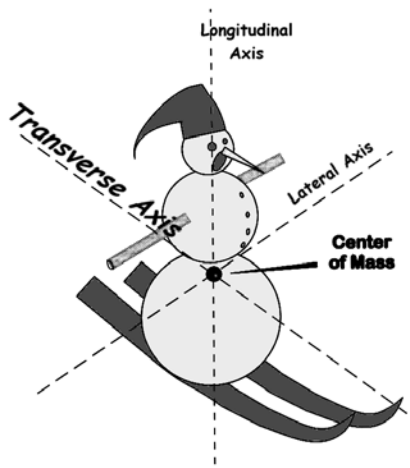
Negative transfer occurs when prior learning hinders new learning. It usually happens when there are some similarities between the old and new activity, but some important differences as well. While water skiing shares much with snow skiing, water skiers often have a hard time adopting the more forward stance of the snow skier, and angulating with the hips rather than banking the whole body.

When learning transfers from one side of the body to the other, it is called *bilateral transfer*. Learning to do something with one hand that you have mastered with the other should be easier than if you had not learned it yet, for example.

Instructors should take advantage of any previous transferable learning—other sports or activities—their students bring to the experience. And understanding those experiences that could hinder performance and learning helps us adjust for negative transfer.

Transfer, negative or positive, can come from other sports or activities, as in the examples above. Or it can come from previous learning in the same sport. Skiers taught incorrectly may have a hard time changing their movement patterns when they finally "see the light." Bad habits can be stubborn! For this reason, it is so important that instructors recognize the concept of "teaching for transfer." PSIA developed the Center Line™ Model largely to address this issue. With it, we recognize certain fundamental characteristics (the "*common threads*") of good skiing at the highest levels that we can identify at all levels. Instructors who understand the concept are much better able to avoid teaching things that will need to be "untaught" later.

With a little creativity, we can use positive transfer in less obvious ways. New skiing students with little athletic background may seem like unlikely candidates for positive transfer. Indeed, such students are often very uncomfortable in the slippery and tilted new world of alpine skiing. But these students might benefit by starting out on nordic equipment before moving to alpine gear. How does transfer apply here? Little transfers from their everyday lives to alpine skiing, because the two are so dissimilar. But softer, lighter, free-heeled nordic gear feels more like natural walking and running movements, so there is positive transfer from everyday experience. At the same time, these students learn new skills, movements, and sensations that will transfer from nordic to alpine gear when they are ready. By introducing an intermediate step, positive transfer takes place where it could not otherwise.

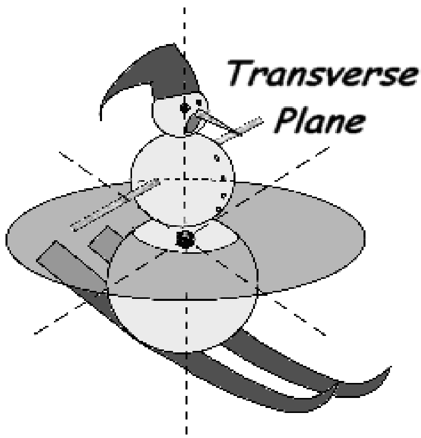


Transverse Axis Of the three perpendicular reference axes that pass through the body's center of mass, the transverse axis is the one that passes horizontally from front to back.

See **Anatomical Reference Axes**.

Transverse Plane Of the three perpendicular reference planes that bisect the body, the transverse plane divides the body into equal upper and lower halves. It is defined by the *transverse* and *lateral* axes, which pass at right angles through the center of mass.

See **Anatomical Reference Planes** and **Anatomical Reference Axes**.



Traverse To traverse means to go across something. In skiing, a traverse is a straight path diagonally or horizontally across the slope. Traverse can also be a verb—to traverse is to ski a traverse. We may traverse across a wide run until we see the line we like down the hill, for example.

Skiers often traverse across hills that intimidate them. On truly threatening slopes, linked traverses may well be the sane way down. But generally, turns flow much more efficiently and smoothly when connected without traverses. Most good skiers link turns seamlessly, directly from one arc to the next. Or they at least *try* to link them. Unwanted traverses between turns can indicate such technical deficiencies as imbalance fore-and-aft, misalignment of the upper and lower body, and improper timing. Equipment issues can also be to blame—boot fit and alignment can interfere with edge control and prevent smoothly releasing the edge of the downhill ski into the new turn.

We can learn some important things from the traverse. See **Traverse Position**, below.

Traverse Position Years ago, instructors had to practice the "*traverse position*" and ski it perfectly for certification exams. While most instructors today are correctly leery of teaching "positions," traversing can be a good way to practice alignment, fore/aft and lateral balance, and edge control. The correct body position for a traverse is the same as the slightly countered, naturally aligned stance of a good turn. In a traverse, the uphill ski, knee, hip, shoulder, and arm should be above and ahead of their downhill counterparts (see **Alignment**). A well-balanced skier should be able to traverse on one ski and leave a clean, smooth track.

Try

Try not to. . . !

"Try softer." "Trying" is associated with general muscular tension, holding the breath, and some degree of "doubt." In the immortal words of "Yoda" of Star Wars fame, "Try not. *Do*, or do not. There is no Try." It is almost always bad advice to ask our students to "try to do" something; it is especially bad, indeed contradictory, to insist they "try to relax." My motto is "Don't ever try to do it right!" Trying to do it right almost guarantees that I won't. Remember—no amount of trying will make you more skillful. Relax. Do it. Then do it again, and again, and again . . . . Skills will come.

Never* TRY *to do it right!

Tuck

The tuck is the aerodynamic "egg" position of downhill racers. While tucking does decrease air resistance for maximum speed, it is not a particularly efficient athletic stance. For this reason, racers rise out of the tuck for all but the straights and easiest turns, and whenever they need to move athletically, as when absorbing bumps.

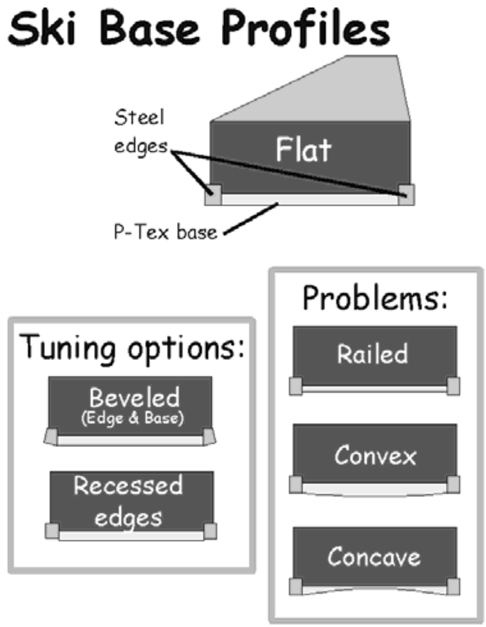
Tuning

Skis, like most high-performance tools, need tuning if they are to function at their best. Poorly tuned skis can be unskiable, especially if their bases are concave or "railed," but even well-tuned skis need frequent attention to keep their performance at its peak.

Ski tuning is a science and an art, as evidenced by the fanatical attention given to racers' skis. Few skiers will really feel the benefit of hand-structured bases, recessed edges, or $100-an-ounce high-tech fluorinated ski wax, but a good basic tune can make all the difference in their skiing and enjoyment.

At a minimum, skis should be checked to see that the bases are not convex, concave, or "railed," and stone ground or flat-filed as necessary. Gouges in the plastic should be filled and smoothed, edges sharpened and stoned smooth, and bases should be waxed. Most skis benefit from a slight bevel on the base edges—one to three degrees allows the skis to roll smoothly from edge to edge. A small side-edge bevel helps the skis to grip better on hard snow and ice. Hot waxing fills the pores in the plastic base for protection as well as better glide.

After this initial tune, it is a simple matter to maintain the tune. Liquid and paste waxes today apply in seconds, and are nearly as effective as ironed-in hot wax. A small diamond-stone carried in a pocket quickly removes burrs and keeps the edges sharp and smooth.



Turn A turn is a *change in the direction* the skier is going. Turns are how we control our direction, or line, on the hill. Contrast "turning" with "pivoting" and "spinning." We cannot call it a turn if the skis simply pivot to a new direction and skid sideways, without affecting the skier's direction of movement, as in a hockey stop. Do not confuse turning with *braking,* as many people do. Braking and turning, while in many ways similar, come from opposite intents. Turning is *offensive*, the intent to *go* a new direction, while braking is *defensive*, the intent to stop going the current direction. The natural movement patterns that stem from these intents are direct opposites!

> ***A turn is a way to control direction, not speed. NEVER think of a turn as a way to slow down!***

Because a turn is a form of *acceleration* (change in direction or speed), external forces must apply—a basic law of physics (see *Newton's Laws of Motion)*. Internal (muscular) rotary forces, no matter how powerful, can turn the skis, but they cannot alone cause a turn. It is the interaction of the turned skis with the snow *("deflection")* that causes the skier to change direction. The other major turning force for skiers is gravity, which pulls the skier downhill. Minor turning forces include wind and the reaction force of the snow pushing on the poles when we plant them.

Most people would probably agree that "turning" is what skiing is all about. But what many skiers call "turns" are really braking movements that only coincidentally alter their courses somewhat.

When you really get down to it, most skiers don't even *want* to turn most of the time. Just ask them—"why do you turn?" Nine out of ten (are you one?) will say "to slow down," or something to that effect. And it shows. They push the tails of their skis right to turn left *("negative movements")*. This move causes their skis to skid and slow down. It does not make them go left except as a side effect when their edges finally grab again and begin to turn them. Such "turns" are more an attempt to "stop going this way" than an attempt to "go that way." We don't turn a car to slow down, do we? We turn to control *direction!*

There are many effective ways to get down a mountain, but very few ways to make a good turn!

Good turns result from an attempt to control *line*, not speed. As in a car, if you want to hold a line precisely, you do *not* want to skid sideways. Good turns, whether at the wedge turn level or the World Cup level, are always an attempt to follow whatever arc-shaped line you choose. Such turns are the result of guiding the tips *into* the turn *("positive movements")*, not pushing the tails out. Again like a car, good turns are carved with precise, continuous steering.

Good turns are fast. That is to say, they do not intentionally increase the friction or braking effect of the skis. The best turn is the fastest way to follow a particular path—just ask a racer. Of course, that path can go any direction, including back up the hill. So good turns allow us to ski "slow lines" if we choose. But good turns are never braking moves. If skiing is turning, and turns are how we control line, then good skiing is "skiing a slow enough line as fast as we can." (See **Good Skiing**.)

As most recreational skiers demonstrate, good turns are not the only way to descend a mountain. Most skiers ski a "fast line" with the brakes on all the way. There is nothing technically wrong, of course, with braking, as long as that is what the skier intends to do. Just don't call braking *turning!* While all turns increase friction somewhat, and most braking movements change our direction somewhat, the movement patterns are distinct, indeed contradictory. The ATS Skills Concept and Center Line™ Model recognize the infinite possible blends of skills that produce the spectrum of options from pure "hockey stop" braking to pure railed-out carving (see **Lateral Learning**.). All these movements have their uses. But only the balanced blend represented by the Center Line™ itself demonstrates true optimal turns. Only "on the Center Line™" can the skier truly claim to "own" his line, to direct his path with precision.

There are many effective ways to get down a ski slope, but very few ways to make a good turn!

See also **Braking**, **Steering**, **Line**, and **Good Skiing**. Of course, virtually every other entry in this book also relates somehow to *turns*.

Turn Initiating Mechanisms

This somewhat obsolete term refers to the various ways we may twist or pivot our skis to start a turn. Technically, turn initiating mechanisms are the mechanical principles *("rotary mechanisms")* used to turn the skis and/or impart angular momentum to the skier/ski system (throw the skier into a controlled "spin"). They include *rotation*, *counter-rotation*, *leg steering ("fulcrum")*, and *blocking* or pushing with the poles, along with several variations on these themes. See **Rotary Mechanisms** for a discussion of each of these principles.

While we use rotary mechanisms throughout most turns to precisely guide and direct the skis, it is at the initiation phase that they are often most powerful and most obvious. This was especially true in the past, when starting turns usually required powerful movements to redirect long, heavy skis. Today the rotary input is usually much more subtle and continuous (see **Steering**). To call these rotary mechanisms only turn *initiating* mechanisms is to overlook a large part of their importance in a modern turn.

Turn Phases

See **Phases of Turns**.

Turning Forces

Turning forces are, of course, the forces that push or pull us into and through a turn. They are the applied (external) forces, acting at an angle to the direction of travel, that cause a change in that direction.

> ***The real turning forces in skiing are <u>Gravity</u> and <u>Snow</u>!***

Turning forces are not "*rotary mechanisms*," as the term is often regrettably misused. Rotary mechanisms do *not* cause turns by themselves. They are the movements and principles we use to twist and pivot skis (*i.e. rotation, counter-rotation, leg steering,* and *blocking pole plants)*. Only in combination with edging and pressure can rotary mechanisms produce turning forces. In short, turning forces affect *linear motion*—they change the path of an object in motion. Rotary mechanisms affect *angular motion*—they change an object's angle, by twisting it, or causing it to spin.

Turning forces determine the skier's path on the hill. We can think of them as applying directly to the skier's center of mass. Rotary mechanisms, on the other hand, produce *torque*—twisting force—by acting through a *lever arm*.

On skis, the main turning forces are *gravity* and *deflection* (ski-snow interaction), with lesser turning forces from pole-snow interaction and wind resistance.

See **Centripetal Force** and compare with **Rotary Mechanisms**.

U

Under-Initiation This term generally applies to turns initiated with some form of upper body *rotation*, including *rotary pushoff.* In these turns, the skier throws the upper body around to literally hurl himself into a new direction. Under-initiation means the skier did not make the move forcefully enough to turn him as far as he wanted (technically—did not generate sufficient angular momentum). The turn then dies out without enough direction change. An obvious example of under-initiation is a helicopter jump that doesn't come all the way around (ouch!). Turns initiated with *counter-rotation* can also be under-initiated. The skier throws the skis in the new direction while twisting the upper body the other way. Once this quick movement ends, the skis are turned as far as they're going to turn, so they run straight, leaving the tell-tale zig-zag track.

Under-initiation is the opposite of *over-initiation*, in which the skier throws himself *too* hard into the turn. These are the skiers who spin out and end up sliding backwards down the hill.

In either under- or over-initiation, the skier must correct for the error in the control and completion phases of the turn. For under-initiated turns, the skier has several options to complete the turn, none of them great. He could wind up and throw the upper body again to generate more "spin" (angular momentum), lever forward to cause the tips to dig in and pull the skis into the turn, or counter-rotate to turn the skis a little farther. Any of these options forces the skis again into a skid. He could also steer the skis with his legs, or tip the skis onto a higher edge angle to increase their carving effect—but if he knew how to do these things, he probably wouldn't have started the turn with rotation in the first place!

Note that good steered, carved turns do not rely on the angular momentum generated at initiation to carry them through the turn, so under- or over-initiation is never an issue. Like the driver of a car, the skier just keeps steering and the skis keep carving, until the turn is over. Imagine how hard it would be to control a car if the wheels didn't steer. The driver would have to somehow throw the car into a skid with his body, and hope he threw it just hard enough to get all the way around the bend. Because the car is so heavy, most turns would likely be under-initiated, and the car would go off the outside of the curve. Fortunately, neither cars nor skis need to be operated this way.

See also **Steering**, **Carving**, and **Rotary Mechanisms**.

United States Ski Coaches Association

Based in Park City, Utah, the USSCA is the educating and accrediting organization of American ski race coaches.

Unweighting

Unweighting refers to momentarily lightening or reducing pressure on the skis, usually to aid turn initiation. A classic example was the old "down-*HUP*-and-around" turn, where the skier leaped up and threw the tails around. There are several ways skiers can unweight, determined by the movements or mechanisms involved, including *up-unweighting* (down-*up*-down), *down-unweighting* (up-*down*-up), *terrain unweighting* (involving bumps and fall-aways to lighten the skis) and *rebound unweighting* (in which the rebound or "springboard effect" from an edgeset, downstem, preturn, or "checking" lightens the skis).

In discussing "up" and "down" unweighting, it is important to recognize that it is not the direction of the *movement* of the center of mass that unweights the skis, but the direction of the *acceleration* of the center of mass. (See *Up/Down Motion* below.) Negative acceleration ("acceleration down") of the CM causes unweighting, as in a sudden "dropping" or a slowing or stopping of an "up" movement. If you stand on a scale in a fast elevator and press "down," your weight will first decrease as the elevator starts down, then increase as the elevator slows at the bottom of the descent. If you then press "up," you will feel first heavier as the elevator gains speed, then lighter as it slows its ascent. Clearly, either direction can produce "unweighting."

Also remember that unweighting is not required for all turns. Indeed, as I define turning (the opposite of braking), unweighting is an error! All unweighting accomplishes is to release the skis' grip, making it easier to move the skis sideways. Unweighted skis cannot cause direction changes (turns)! Thus unweighting really only helps in braking, skidding movements. In true carved turns, as in driving a car, we don't *want* skidding, so unweighting is undesirable. If a car becomes airborne over a big frost-heave at the beginning of a curve, it cannot turn until it gets some pressure on the tires again. And so it is on skis. Do not confuse unweighting with the natural "light" feeling that comes as we release the edges and pressure at the end of one turn and roll and steer the tips into the new turn.

See also **Up/Down Motion**, **Weighting**, **Pressuring**, and **Turn**.

Up/Down Motion Why do we move up and down (flex and extend), and what effect does this motion have in our skiing? This is a complicated subject, often the center of hot debate among instructors. Several points are noteworthy:

1. "Up" and "Down" are only semi-descriptive, as the inclining of a skier and the dynamics of a turn often make the movements diagonal, or make it appear that the feet are moving closer and farther from a stable upper body. "Flexion" and "extension" are more accurate terms.

2. Up and down movements affect weighting and unweighting. However, weighting and unweighting have nothing (I repeat, *nothing*) to do with which direction (up or down) the skier is moving. It is the direction of the *acceleration* of the center of mass that affects weighting and unweighting, *not* the direction of movement. The direction of acceleration is completely independent of the direction of motion. It is the "slowing down of the up movement" or the "speeding up of the down movement" that causes unweighting, and vice-versa. We can move "up" while accelerating "down" (in other words, slow the up movement). It is senseless to debate whether sinking causes weighting or whether it causes unweighting—it could do either. And furthermore,

3. Who cares? These up and down movements referred to above cause only momentary changes in the pressure on the ski—they are important in smoothing out bumps, unweighting to initiate a skid, and generally controlling the momentary changes in pressure throughout a turn. The most important reason we "sink" in a turn is to allow angulation and to edge our skis, and to facilitate stronger steering. It is impossible to strongly edge a ski without sinking, unless we are going so fast around a turn that inclination (leaning into the turn) alone causes sufficient edge angle. It is to edge our skis and resist the forces, especially of the latter part of a turn, that we "sink." During this sinking phase, pressure builds strongly on the outside ski. The sensation is that sinking causes pressure, but you could as easily say that pressure causes, and requires, sinking. Conversely, we "rise" to release the edge of the turning ski, thus releasing the pressure and stopping the turn. There is always someone who will say, with a "knowing" smirk, "but sinking *reduces* pressure. . . ." Alas.

4. So, in summary, "up/down motion" affects pressure and edging of the skis. It can increase or decrease pressure briefly, as in "unweighting." And it allows us to absorb uneven terrain. But in general, we *sink* as we angulate to increase edge angle and grip, which helps *pressure* the ski; we *rise* to release the edge and *release pressure*.

See also **Unweighting**.

Uphill Christie An uphill christie is a single "J"-shaped turn, completed as far as possible back up the hill to a stop. It is a good exercise to develop gliding, offensive-type turns. Because it ends in a stop, it is also a good way to analyze many body movements and positions. If movements are correct, the legs will turn beneath the pelvis, with the upper body remaining "slightly countered" to the skis all the way through the turn. If the outside hand ends up ahead of the inside hand, it is a sure sign that the skier rotated the upper body. Studying the tracks of the uphill christie can reveal whether the skier pushed the tails out to initiate the turn (bad) or guided the tips into the turn (good).

Because it reveals so much about a skier's technical foundation, the uphill christie is often a task on instructor certification exams.

Upstem "Upstem" means brushing the uphill ski up into a converging (wedge) relationship prior to turn initiation. When weight transfers to this ski and the edge engages, the new turn is initiated by ski/snow interaction ("deflection") from the stemmed ski. If the movement is dynamic enough, and especially if the upper body and/or hips turn as the ski is stemmed, it can create rotary momentum in the ski/skier system ("rotary pushoff"), throwing the skier into a skidded turn.

USSCA See **United States Ski Coaches Association**.

V

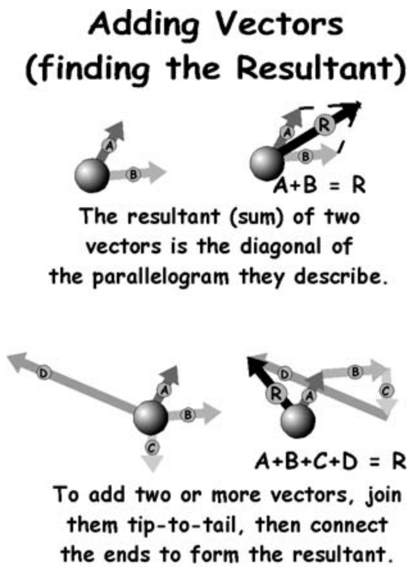
V-A-K (V-A-P) *"Visual-Auditory-Kinesthetic" (or "Visual-Auditory-Proprioceptive").* These terms represent the three primary senses through which we gather information (we see it, hear it, or feel it). Most people tend to favor one or the other mode, and it can be easier to communicate with them if we identify that preference. Conversely, many of us tend to communicate mostly through our own preferred style. As teachers, it is helpful to identify the sensory preferences of our students, or at least to appeal to a variety of senses to make sure we get a point across. We can demonstrate while we talk. We can use language that evokes sensation ("it feels like . . ."), or even physically move people into positions or through movements so they can feel them.

V-A-P and V-A-K are the same thing. "Proprioceptors" are the internal sensors in our bodies that sense motion and position, and are responsible for the "kinesthetic" sense.

See **Communication Styles**.

Vector

A vector is a way to represent quantities that have both magnitude (amount) and direction, such as forces, velocity, and acceleration. On paper, a vector is a simple arrow whose length represents the size or strength of the force or other quantity, and whose direction represents the direction of the force. Whenever instructors draw arrows on the snow to describe something, they are drawing vectors.



Vectors are mathematical quantities. They can be added and subtracted and used in equations. The sum of two or more vectors is called the *resultant*. To add two or more vectors graphically, put them tip-to-tail, in any order, then draw another vector between the tail of the first and the tip of the last (see illustration). That new vector represents the resultant, the force, for example, that has the same effect as the other forces combined.

The resultant of two vectors of equal size but opposite direction is zero—they cancel each other out. When the sum of all force vectors acting on an object is zero, that object is in *equilibrium,* and it will behave as if no force acted on it at all (it will not change speed or direction).

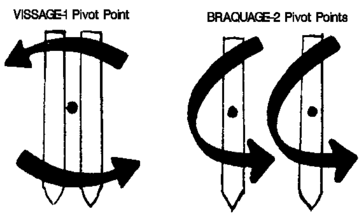
Velocity

Velocity is the property of an object that describes its speed and the direction it is going. Because it involves both magnitude ("how fast") and direction, velocity is a *vector quantity*. Velocity is not the same as *speed*, which is unrelated to direction. When you drive a car around a curve at a steady 50 m.p.h., your velocity changes, but your speed does not. Any change in velocity, whether an increase or decrease in speed or a change in direction, is technically *acceleration*. By Newton's First Law of Motion, there can be no change in velocity unless some external force acts.

Vertical Combination In ski racing, vertical combinations are sequences of *closed gates* (double-pole gates set vertically) set directly in the fall line. Vertical combinations include *flushes* (three or four gates set in the fall line) and *hairpins* (two vertical gates).

Vertical Motion See **Up/Down Motion**.

Vissage "Vissage" is Georges Joubert's word for *counter-rotation*. In vissage the upper and lower body pivot simultaneously against each other in opposite directions around the longitudinal body axis. Joubert used the expression to contrast with *braquage,* a very different movement. In braquage the legs pivot separately, each leg providing the resistance for the other to turn against, rather than the upper body turning against the lower.



The pivot axis in vissage, at least in a narrow stance, is generally the vertical body axis, with the stretch zone occurring largely in the abdomen. Technically, if done in a wide stance, vissage will create two pivot points in the lower body—one for each leg—similar in appearance to *braquage*. The essential difference is, again, that in vissage, both legs work against the upper body, while in braquage they work against each other. Vissage can occur with both skis, one ski, or neither ski on the snow, again unlike braquage.

For a thorough discussion of both vissage and braquage, refer to the person who coined the terms for skiing—Georges Joubert, in *Skiing, An Art . . . A Technique*.[91]

Visual-Auditory-Kinesthetic Also "*Visual-Auditory-Proprioceptive*." See **V-A-K**.

Visualization Visualization is mental rehearsal. It means imagining a movement, trying to develop a clear mental picture. An important tool in learning, mental imagery and mental practice can be as beneficial as actually being on snow. Visualization is a skill that we can develop. Not only can the best athletes envision a clear mental picture of an activity, but they can augment the picture with sounds and kinesthetic imagery—they can clearly imagine the experience of "being there" and "feel" themselves skiing a slalom course, floating through powder, ripping up a mogul field. In the martial arts it is said that if I cannot clearly imagine myself making a particular movement, then I am not ready—I have not practiced it enough and my body does not know the movement. We should recognize the learning potential of visualization and use it where appropriate with our students and for ourselves. Video and ski movies can be useful tools in learning to visualize skiing (provided their visual images depict good skiing!).

Vorlage This German term, from another era of skiing, refers to forward lean and forward pressure on the ski. The opposite of *rücklage* (leaning back), *vorlage* comes from the days of *national techniques*, when the different alpine skiing nations fiercely promoted their individual versions of how to make skis turn.

W

Waist The waist is the narrowest part of a ski (or ski bunny), generally somewhere near the middle.

Walking Reflex See **Extensor Reflex**.

Warm-up The warm-up is the important, if often overlooked, time to prepare the body and the mind for skiing or any strenuous activity. A good warm up should get the heart rate up, warm the muscles and increase their flow of blood and oxygen, stretch and loosen the muscles, ligaments, and tendons, as well as put the skier in a proper state of mind for performance. Not only will we ski more safely after a warm-up, but we will also ski better.

Wedeln Wedeln (or Wedel) means short, quick turns, generally involving a very narrow, often locked stance, with strong rotary movements and lots of skidding. Once thought of as the ultimate expression of skiing skill, today the classic wedeln is rarely seen in high level skiing, being supplanted by more modern "short swing," which better exploits the designed capabilities of modern ski equipment.

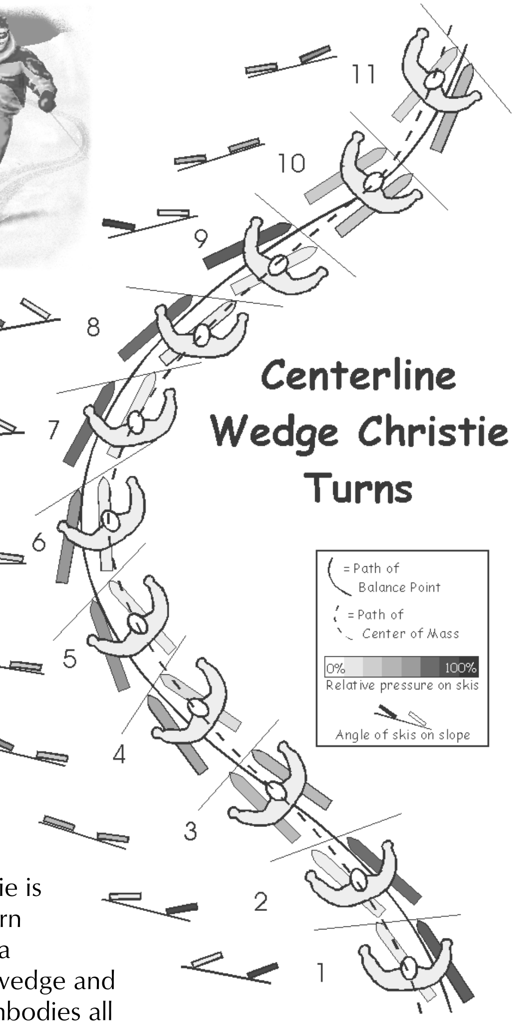
Wedge

The wedge is a skiing stance in which the skis converge—tips closer, tails farther apart. It is a stable, athletic stance which allows many movement options. For beginners the wedge provides a means for speed control as well as the basis for first turns, but for skiers of all levels the wedge remains an important option for versatile skiing. While the word "snowplow" is interchangeable, "wedge" provides a better visual image—we want to brush over the snow, not "plow" it with strongly edged skis.

See **Braking Wedge** and **Gliding Wedge**.

Wedge Christie

Representing the second "milestone" of PSIA's Center Line™ Model, the wedge christie is the step between the *wedge* turn and the *open parallel* turn. It is a gliding turn that begins with a wedge and ends parallel, and of course, embodies all the "common threads" of Center Line™ mechanics.



***The Wedge Christie**. Turn begins with a gliding wedge and ends with skis parallel, matching when the inside ski flattens and releases its inside edge (frames 5-7). Note typical, slightly countered, Center Line™ alignment—inside foot, hip, hand, and shoulder leading. Rotary movements turn both ski tips into turn (downhill) at initiation, but wedge occurs because downhill ski's edge is not completely released (frames 3 and 4). No "tails out" movement occurs at any point, including matching. Turn begins and ends in "neutral," with skis gently on their inside edges, weight equal, and no lead (frames 3 and 10).*

Outwardly similar to the classic *stem christie*, the wedge christie is in fact quite distinct. Unlike the stem christie, the initiation of a wedge christie involves flattening the downhill ski as the center of mass and ski tips move downhill into the new turn. Lower speeds and less-developed skills and balance prevent the skier from completely releasing the downhill ski and turning both skis parallel from the start. But the "wedge phase" is definitely not a braking phase. Both skis turn downhill into the turn. Continued steering brings the skis parallel once the inside ski flattens then rolls to its outside edge, and weight moves predominantly to the outside ski. This *matching* can occur earlier in the turn, as speed and balance increase, bringing the skier's hips toward the inside of the turn, which helps flatten that inside ski.

With the introduction of the Center Line™ Model, PSIA described two wedge christie turns, called Wedge Christie 1 and Wedge Christie 2. These turns represented two separate milestones. Wedge christie 1 was the entry-level wedge christie, with matching in the second half of the turn. Wedge christie 2 represented the next level, with matching before the fall line and a pole swing/plant that accompanied the center of mass moving into a new turn. The distinction between wedge christies 1 and 2 didn't last long, though. Today we identify only the wedge christie, although we recognize that different speeds and levels of skills will vary the timing and mechanics as always. In demonstrating at the wedge christie level, it is important that speed, conditions, and tactics dictate the timing and mechanics, lest they appear forced or inappropriate.

As with all Center Line™ Milestones, the wedge christie is not a goal in itself. It merely represents a stage of skier development with the same balanced skill blend as the rest of the Milestones. We do not necessarily teach the wedge christie, or any particular turn—we teach *skills*. At that level, matching may be the concrete objective, and we may focus on better stance, steering, weight transfer, or edging skills to that end. The result may be a wedge christie-like turn, if the students are on comfortable terrain, or it might resemble more the defensive stem christie on challenging terrain.

If both edges release and both skis turn *into* the turn, then why is there a wedge phase in wedge christies? There are two reasons. First, with their lower speeds, novice skiers do not incline significantly into turns. This, combined with their typically wider stance, makes it unlikely that the downhill ski will completely flatten on the snow at turn initiation. So if the skier steers both skis down the hill, the not-quite-released downhill ski resists turning more than the uphill ski. Also, the muscle groups that *externally rotate* the downhill leg are weaker than those that *internally rotate* the uphill leg. It takes practice to steer both skis equally in the same direction, even when they both provide equal resistance. As skills, balance, and speeds increase, the wedge phase naturally disappears, bringing the skier to the next Center Line™ Milestone—the *open parallel turn*.

See also **Center Line™ Milestones** and **Common Threads**.

Wedge Christie 1 *(Obsolete)* Originally the second milestone of Center Line™ development, Wedge Christie 1 involves all the common threads of stance, balance, skill blending, and flow, at a speed slightly higher and on slightly steeper terrain than the wedge turn. The slightly greater forces, requiring a compensating movement of the hips inside, combined with the steeper hill, help release the inside edge of the inside ski after the fall line, allowing the ski to be steered to a match. The turn is still primarily steered, the weight transfer largely "passive," resulting from the dynamics of the turn and a good stance, as opposed to a strong, active weight shift.

Today we no longer differentiate specifically between wedge christie 1 and 2. In today's Center Line™ Model, we might call the wedge christie 1 an "entry level" wedge christie.

Wedge Christie 2 *(Obsolete)* The third milestone in the original Center Line™ concept, Wedge Christie 2 represents the movements of the Wedge Christie 1 at a higher rate of speed, steeper terrain, and with slightly more range and sophistication of movement. A narrower wedge, higher speed, and more active weight transfer help allow an earlier matching before the fall line. What began in the Wedge Turn as a slight rising and gentle movement of the center of mass toward the new turn is now becoming a full-fledged "crossover." The increasingly dynamic movements of the body are facilitated by a pole swing, beginning in the preparation phase, and a pole touch marking the commitment to the outside ski and the beginning of matching. With enough speed and forces generated, ski design and the interplay of pressure and edges begin to play a greater role in determining turn shape, along with steering.

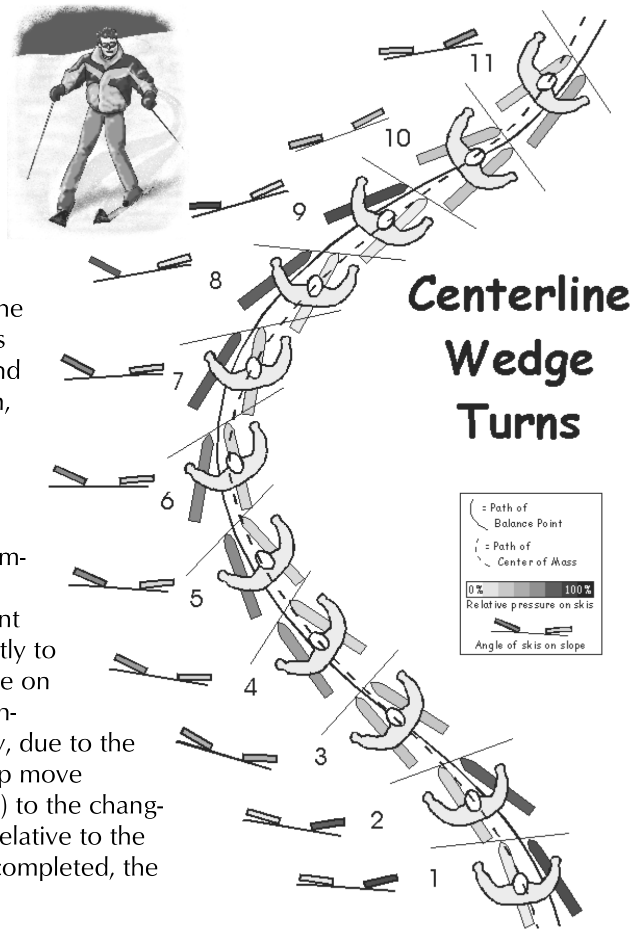
Again, today's version of the Center Line™ Model no longer includes two distinct versions of the Wedge Christie. Nonetheless, skiers at the verge of the "parallel breakthrough" will usually exhibit many of the characteristics of the Wedge Christie 2. It is the "exit level" wedge christie.

Wedge-Hops 1. Ingredient used in low grade beer, the type drunk by unemployed ski instructors between seasons.

2. Wedge hops—the exercise: An aerobically brutal drill involving hopping from the inside edge of one ski to the inside edge of the other while in a converging (wedge) configuration; an excellent exercise to develop short swing, edgesets, independent leg action, pole action, timing, and indigestion.

Wedge Turn The first milestone of Center Line™ development, a Center Line™ Wedge Turn involves all the "*common threads*" that will transfer to learning on up through expert skiing. Not in any way some sort of "beginner's turns," good wedge turns are simply entry level expert turns!

Wedge turns generally take place on gentle terrain at low speed. From a fairly tall, natural stance and a gliding wedge, the skier guides both skis down the hill into the turn, using the legs ("braquage"). As the turn develops, and as a *result* of the turn, balance moves toward the outside ski, and pressure develops progressively on the outside ski, accompanied by a subtle flexing and movement of the hips very slightly to the inside. Edge angle on the outside ski also increases progressively, due to the gentle flexion and hip move ment and (especially) to the changing angle of the hill relative to the skier. As the turn is completed, the skier gently rises toward the new turn, helping release the outside ski edge, and allowing both skis to again steer down the hill.



Wedge Turn. *Gentle gliding wedge allows precise steering of both ski tips into and through turn. Balance predominantly on the outside ski, resulting from turning forces. Body is slightly countered to skis throughout turn, except in the transition ("neutral"—frames 3 and 10).*

Because the forces involved are gentle, movements of the body are subtle and the turn is predominantly steered, as opposed to carved by a decambered ski. But the turn is still not a *skidded*-type turn, as the skier should not push the tails out, but rather turns both tips *into* the turn throughout.

Like all good Center Line™ turns, the wedge turn should be an attempt to glide while following a particular path on the snow—*NOT* an attempt to brake or slow down. It is not an intentionally skidded turn, although gentle edge angles and unsophisticated edging skills usually result in some slippage (skidding).

Variations of the wedge turn ("lateral exploration") may involve stronger, braking edge use (a wider wedge) and sequential rotary pushoff movements ("left of Center Line™"—pressure/edge dominant). These tendencies are likely to appear when the skier is defensive from steep terrain or other uncomfortable circumstances. As we explore the "right" (rotary dominant) side of the Center Line™, we are likely to see stronger pivoting of the legs, more equal weighting throughout the turn, and perhaps spontaneous matching and skidding. Incomplete turns and poor speed control from ineffective edging make these movements unsuited to steeper terrain.

While exploring both sides of the Center Line™ can develop versatile, complete skiers, we must take care to put students at this level on the correct track for future development. Biases and bad habits created at this vulnerable stage prove very troublesome and they can be difficult to remove later.

See also **Center Line™ Milestones** and **Common Threads**.

Weight Transfer

A weight transfer is simply a change of the support foot from one ski to the other. While a weight transfer happens in almost all turns, its role in skiing is widely misunderstood. Many talented skiers, especially those who learned naturally as children, will tell you that a weight transfer is the only move they consciously make. "Just stand on one ski, then stand on the other," they say. "Never mind all that about steering and hip angulation and movement of the center of mass. Like walking." Well, if walking were only that simple . . . .

Why and how do we transfer weight? And why is it important? *Is* it important? It is true that racers and other experts ski almost entirely on one ski at a time, transferring weight to the other ski in the next turn. And there are definite technical and biomechanical advantages to balancing on the outside ski in a turn. But the movements and their roles are deceptive. Do expert skiers really *step* from ski to ski to make weight transfers, like many proclaim? If so, is that really all they do? Not usually. And no.

First, note that it is very difficult to ski on the inside ski, for several reasons. Think of a car speeding down a winding road. There is an obvious weight transfer there, as the car leans toward the outside of the curves. But clearly the driver does nothing intentionally to *cause* the weight transfer, other than simply steer around the curves. There is no mechanism engineered into the car to make it lean—often quite the opposite. All the forces of a good turn want to push the weight of a car—or a skier—to the outside. We would have to fight against these forces to remain evenly weighted. Furthermore, in the second half of a ski turn, gravity pulls the skier down toward the downhill (outside) ski. So again, weight transfer is a natural result of turning, difficult to avoid.

And that's a good thing, because the outside ski has several advantages. The outside knee is in a much better position, biomechanically, to angulate and to withstand the forces of a turn. Furthermore, the *internal rotation* required to turn the outside ski into a turn is stronger than the *external rotation* needed to turn the inside ski into the turn. Balancing on the outside ski doesn't require as much of an inward lean as balancing on the inside ski. And balancing on the outside ski leaves the inside ski as a backup, should the outside ski lose its grip and slip, or should the skier lean too far into the turn.

So, weight transfer is a natural result of turning. But is it a *cause* of turning? And should an active weight transfer be a high priority of ski technique? Pressuring an edged ski properly causes it to bend into *reverse camber*, which allows it to carve a turn. Those experts who make 100% weight transfers from turn to turn use this carving effect well. But the movement is much more complex than it may seem. And the effect relies as well on the speed, balance, and rotary and edging skills, which must also be well-developed. Let's look more closely at the expert's weight transfer and the possible pitfalls for those who try to imitate it.

A World Cup racer finishes a turn, balanced entirely on the uphill edge of the downhill (outside) ski. As she prepares for the next turn, her body moves across her skis, decreasing the edge angle, then rolling the skis onto the new set of edges. She also steers the tips downhill at the same time. This movement happens smoothly but quickly. By the time she is committed into the new turn, she has transferred her weight entirely to the new outside ski.

But wait! She moved from her downhill ski to her uphill ski as her body moved from the uphill side of her skis to the downhill side. Clearly the weight transfer was not a result of any move she made, but of the forces of the turn, *in spite* of her movements. It is the accuracy of her movements and her exquisite balance and timing that allows the weight transfer to take place—not an active movement toward the new ski.

Now an intermediate skier, inspired by the racer, tries to do the same thing. She steps from the downhill ski to the uphill ski to start a new turn. But it doesn't look the same. This movement involved stepping *up*hill, not crossing over into the turn. She has stepped to a flat ski, which does not bend and carve. And that ski is directly under her body, so like the bicycle that cannot turn until it leans, she is not in position to turn at all. So she twists and pushes that flat uphill ski tail uphill and out. Now she's in a turning stance, but she had to force her skis into a skid to get there. Soon that skidding ski slips away and she falls back to the inside ski. The weight transfer here was not appropriate to the speed and accuracy of this skier's movement. Not only did it fail to cause a turn, it actually prevented a good turn and lead to a series of compensating moves.

How should the intermediate skier have done it? Balanced solidly on the downhill ski before the turn, she should have imitated the racer's move downhill, not her weight transfer. The weight would have stayed a little longer on the downhill ski, as the skis flattened and she began to turn the tips downhill. But soon the forces of the new turn would take over, pulling her weight cleanly to the outside ski, now tipped well to its inside edge. That ski would carve the turn, continuing to add pressure to the ski to the end, when the process would repeat itself. A perfect turn! A complete weight transfer, as a *result,* not a cause. Like so many things in life, the route to the goal is not always obvious!

At the core of good skiing is that smooth flowing movement of the center of mass across the skis, combined with accurate steering of the tips into the new turn, never pushing the tails out. An early and complete weight transfer is essential, but it is much more a passive movement resulting from the turn than a trigger that makes it happen.

Why is this point so universally misunderstood? There are several reasons. Good skiers who really carve turns are rare, so the image most of us see is usually the skidder, even at the highest levels. And good skiers' movements are so smooth and continuous that it is hard to see what they do—except it is usually obvious that there is no weight on that inside ski. They may even lift the ski off the snow and appear to step from ski to ski. And the most obvious sensation of turning is usually pressure on the outside ski and the weight transfer. Again like a car, the steering movements are often imperceptible, but the sensation of being pulled to the outside is very obvious. So if you ask great skiers, especially those who learned naturally as children, what they feel they do to turn, the answer is very likely to be "transfer weight." They aren't lying, either. Like walking, the obvious movement is from foot to foot. But like walking, the movement of the center of mass ahead of the feet, the subtle steering that must happen to get around curves, and the rest of the complex set of activities involved, happen unconsciously.

The same movements of good skiing at lower levels result in a more gradual and often less complete weight transfer. Beginning wedge turners on the "right track" will steer their tips into the turn. They will feel the pull to the outside. But with the wider stance and low speeds involved, they may never get beyond a 60:40 weight distribution. And that's fine! It will evolve to perfection with speed and practice. If someone tries to teach them to make a big active weight transfer, they may never again ski as well as they did in those first few turns. Their improvement will mostly consist of better compensation for the early mistake, and their turns will at best become increasingly effective braking movements.

On the other hand, because the weight transfer is so much a part of good skiing, exercises that develop balance on one ski are very important. As an *exercise,* deliberate steps and complete weight transfers can quickly improve the one-footed balance that is so critical to high performance turns.

Do not confuse weight transfer with *pressure*. It is even possible to transfer weight with no pressure on either ski. A weight transfer is a change of support foot. When we run, this transfer takes place in mid-air, as it does in the skier doing abrupt short swing turns where the rebound launches him into the air between each turn. His movements are such that when he contacts the snow again, he will be solidly balanced on the new outside ski. In smoother carved turns, the weight transfer happens during the light, *un*pressured phase of the turn. Pressure increases on the ski and bends it as a result of the skier resisting the building forces of the turn and gravity. Simply standing on a ski does not constitute *pressuring* it in the way that makes it decamber and carve. The weight transfer usually takes place very early in a turn. Pressure may not build significantly until much later in the turn.

Also, don't confuse weight transfer with *stepping*. Obviously, stepping requires a weight transfer, but steps also involve a movement of the stepping ski. Lateral stepping is a sideways displacement of the ski. Converging and diverging steps involve turning the ski as it is stepped. There are often good reasons to step a ski, but a simple weight transfer does not require a step or even a lifting of either ski.

Weighting

See **Pressuring** and **Unweighting**. To weight a ski is to stand on it, but note that when we speak of "pressuring" a ski we mean more than just standing on it—we imply resisting the inertial and applied forces (gravity) pulling to the outside of a turn as well. Body weight alone is not sufficient to decamber a ski and cause it to carve most turns. Thus "weighting" and "pressuring" are not synonyms.

See also **Weight Transfer**.

White Pass Turns

Named after the ski area in Washington state where World Cup and Olympic champions Phil and Steve Mahre grew up, these are turns initiated on the inside ski, with a very late, deliberate weight transfer well into the control phase. Because the turn is initiated on the downhill ski, the skier appears to fall dramatically into the turn. White Pass Turns are effective in specific racing situations, especially steep giant slalom sections set "in the fall line" (gates not greatly offset).

The Mahres insist that the White Pass Turn is mostly a construction of the media. They did not practice it intentionally. It is a great example of elite athletes instinctively "breaking the rules" effectively in specific situations. No one is more adamant about the importance of an early and complete weight transfer than Phil and Steve Mahre. But in training, they practice skills, not rote movements. At their skiing camp, Keystone's *Mahre Training Center*, the Mahres lead skiers through such exercises as traversing while lifting first the uphill ski then the downhill ski. They have students ski turns on the outside ski only, but they also have them ski on the inside ski only. Or on the right ski only for turns both ways. All these exercises develop balance and skill, which skiers can then apply effectively in any ski situation. Skiers develop the versatility to ski anything, and to break the rules when needed.

Wide-Track "Wide track" describes the open stance, commonly seen in lower level skiers, that provides a broad base of support for balance and strengthens the mechanism of "fulcrum turning" or "braquage" (leg steering). While improving balance skills and more sophisticated movements allows advanced skiers to adopt a natural, narrower stance, we must not forget the usefulness of this wider option in some situations, *i.e.* ice. Wide-track is not the sign of a beginner—it is the sign of common sense when nothing else works!

Wind Chill Factor Because wind makes any air temperature feel colder, the actual air temperature tells only part of the story of how cold it really is. The wind chill factor gives a more realistic description of the temperature. A windy day with an actual temperature of 20° F, for example, could have a wind chill factor of 10° below zero. This means that, with the wind, the effect will be the same on your exposed skin as a windless day at 10° below zero. Dress warm!

Wind Slab Wind slab forms when wind breaks up the surface crystals of a snow field, creating a denser, firmer surface or crust. Depending on how thick and how solid it is, wind slab can be a very challenging form of "breakable crust" to ski. Thick chunks of wind slab, cut into large "bricks" with saws, form the ideal building material for igloos.

Windup-Release Like pulling back then releasing a bow string, windup-release is a two-part movement in which the first part stretches muscles, preparing them for a powerful recoil action. Most commonly seen in skiing as "anticipation-release," like the wind-up of a baseball pitcher, the mechanism is highly potent.

Muscles contract most powerfully when first stretched to roughly 120% of their resting length.[92] In a neutral stance, most muscle groups are relaxed, so a windup creates the tension that allows those muscles to work most efficiently.

See **Anticipation-Release**.

Windshield Wiper Turns Not really true turns (direction changes), "windshield wipers" result from pivoting the skis or pushing them left and right, with poor turn shape at best, gross skidding, and minimal use of the ski's ability to carve. Usually the result of an intent to slow down or control speed, not direction, windshield wiper turns are often the skiing style of athletic skiers with poor understanding of what skis are designed to do.

Georges Joubert used this expression to describe turns with extreme tail weighting and thus a pivot point well back behind the skier's foot.

Witherell, Warren Author of *How The Racers Ski,*[93] a work dedicated to the carved turn, Warren Witherell has been influential in developing the concept and application of carving.

The first turns on skis were surely pivoted skids (the "pre-camber-ian" era). As technology and technique evolved through time, skis and skiers developed the ability to carve turns. Witherell represented the extreme view that the ideal (fastest) turn was purely carved, with no steering (the "passive turn"). Since *How the Racers Ski* was published in 1972, the pendulum has swung back toward a more moderate view that recognizes the superior gliding speed of flat *vs.* edged skis and the importance of actively guiding the skis for precise control of the turn shape.

Twenty years after *How The Racers Ski,* Witherell co-authored another influential book. *The Athletic Skier,*[94] in addition to further expounding on the carved turn, also delves deeply into issues of stance and alignment, particularly the role of equipment and the importance of proper boot adjustment.

Woozels "Woozels" are an exercise consisting of slipping downhill on very flat skis while pivoting them left and right with the legs. They are effective at developing edging skills and the edge release needed for good turns, as well as for developing independent leg steering (the "*fulcrum*" mechanism).

X

X Some children's instructors use the alphabet and numbers in their teaching. If a wedge is an "A," and parallel is the number "11," then "X" is a letter to avoid!

X-Games The "X" ostensibly stands for "(e)xtreme" in this recent made-for-television competition that involves several "adrenaline" sports including skiing, snowboarding, sky diving, and many others. With poorly defined standards and emphasis on thrills rather than skills, perhaps a better name would be the "G (goofy)-Games." Of course, someone else may have a different opinion.

Perhaps with time, these events will mature to a level where top competitors will be tempted to compete.

X-Over See **Cross-Over**.

Y

Yard Sale This colorful term describes the result of a particularly spectacular fall—and I'm not referring to the colors of a New England autumn. In a true yard sale, both skis, poles, and usually an assortment of hats, goggles, gloves, glove liners, trail maps, loose change and other pocket contents, and finally the skier, are strewn randomly all over the hill.

You're young—you can have more. This is the wrong response to an irate mother whose child has turned up missing from ski school.[95]

Your Responsibility Code Found on everything from lift tickets and trail maps to bathroom walls and napkins at today's American ski resorts, "Your Responsibility Code" clearly lays out some of the legal and common sense "rules of the road" by which all users of the slopes are bound. While it changes to keep up with the times, here is a current version:

Your Responsibility Code

Skiing can be enjoyed in many ways. At ski areas you might see people using alpine, snowboard, telemark, cross country, or other specialized equipment such as that used by the disabled. Regardless of how you decide to enjoy the slopes, always show courtesy to others and be aware that there are elements of risk in skiing that common sense and personal awareness can help reduce. Observe the code listed below and share with other skiers the responsibility for a great skiing experience.

1. Always stay in control, and be able to stop or avoid other people or objects.

2. People ahead of you have the right of way. It is your responsibility to avoid them.

3. You must not stop where you obstruct a trail or are not visible from above.

4. Whenever starting down hill or merging into a trail, look up hill and yield to others.

5. Always use devices that help prevent runaway equipment.

6. Observe posted signs and warnings. Keep off closed trails and out of closed areas.

7. Prior to using any lift, you must have the knowledge and ability to load, ride, and unload safely.

Know the code. It's your responsibility.

Z

Z-Turns Z-turns are those ugly things so commonly seen in misguided intermediate skiers, in which gross rotary efforts predominate and edging and pressuring skills are unsophisticated. These skiers typically push their skis from side to side, making "corners" instead of "arcs." There is no control phase.

While Z-turns are often the product of misguided intent, they can also arise from the mechanics of a stance that is too far back on the heels, forcing the skier to turn with counter-rotation. Counter-rotation allows the skier to push the heels out, but does not provide a way to steer the skis continuously through the arc. Counter-rotation does not generate *angular momentum* ("spin"), so once the skis are pushed to the side, the turn stops and, when the skis stop skidding, the skier goes straight in a traverse. As stance improves and skills and tactics become refined, the skis will be steered or guided throughout the arc of the turn, complementing the natural ability of the ski to carve, and producing a rounder, "S-shaped" track.

Ideally, students will learn these guiding movements and produce rounder turns from the start, with good instruction. Steering and round turn shape are common threads shared by all the Center Line™ Milestones from wedge turns through dynamic parallel turns and beyond.

Zipper Line

In moguls, the "zipper line" is a regular, quick zig-zag straight down the fall line. This aggressive, athletic line requires very regular, consistent moguls. It is the line of mogul competitions, but, as many expert skiers demonstrate, it is hardly the only way to ski moguls.

See **Bumps**.

Zone

To be "in the zone" is to find that elusive, dreamlike state of mind where peak performance happens without effort and the mind is free of the distractions of excess analysis and self-talk. Recent research points to an inverse relationship between athletic performance and conscious brain activity.[96] In other words, the more we think, the worse we perform. In the most proficient athletic performances, the reasoning centers of the brain show decreased activity, but the sensory processing centers become very active. So, when in the "Zone," skilled movements take place unconsciously, while the brain focuses on feedback and perception.

To enter this "Zone" consistently requires practice of the skills and movements, and the confidence to allow the body to perform without conscious interference. But as most skiers who have at least "visited" the Zone will attest, it is worth practicing!

"Of making many books there is no end; and much study is a weariness of the flesh."

—Ecclesiastes 12:12

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"The difference between the right word and almost the right word is the difference between lightning and the lightning bug."

— Mark Twain

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