# SKYTECHSPORT

## SKI SIMULATOR

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# Instructor Guide

## CONTENTS

# CHAPTER 1 - OVERVIEW

## HOW TO USE THIS GUIDE

This guide is designed to provide a basis for professional skill and knowledge related to skiing and developing skiers' abilities using the SkyTechSport Ski Simulators. The manual is divided into seven chapters; the first three contain essential knowledge for all instructors. The Fourth chapter outlines the methodology and progressions used to introduce and develop the skills of alpine skiing, both on and off the simulator. Chapter 4 – Alpine Technical Progression, is based on material in the preceding three chapters, therefore the information contained will be essential for successful lessons.

Chapters five and six, Biomechanics and Physics of Skiing, provide further learning opportunities. Once familiar with the essential elements of teaching, basic alpine skiing skills and teaching progressions, the following chapters will help develop and expand base knowledge of the sport.

Chapter seven is a glossary. Understanding the language of snow-sports education is an essential part of becoming a professional instructor. There are many skiing-specific terms used in this manual. The glossary should be used when questions on terminology arise.

The information in this manual is primarily derived from three PSIA-AASI publications:

- Alpine Technical Manual
- Core Concepts Manual
- New Instructor Guide

Both of these can be purchased from PSIA-AASI and can be found at www.thesnowpros.org.
Other reference materials that may be useful include:

- Children's Instruction Manual, 2nd Editions
  - PSIA-AASI
- 2015 Teaching Handbook
  - PSIA-AASI
- Cues to Effective/Ineffective Teaching
  - PSIA-AASI
- Ultimate Skiing
  - Ron LeMaster – Human Kinetics

# PSIA-AASI – WHO WE ARE

Snowsports instructors are professional teachers and educators. To our customers, instructors are the "face" of our industry, and we should conduct ourselves as professionals and exhibit an outgoing and welcoming persona. This first impression is critical to establish trust in you, your school, and the students' confidence in your ability to meet their expectations.

## ABOUT PSIA-AASI

### VISION

Inspiring lifelong passion for skiing and snowboarding.
The **Professional Ski Instructors of America (PSIA) and American Association of Snowboard Instructors (AASI)** is a nonprofit association dedicated to promoting skiing and snowboarding through formal instruction. We develop education standards and materials that serve as the core components of instructor training.

### MISSION

We support our members, as a part of the snowsports industry, to:

- Develop personally and professionally
- Create positive learning experiences
- Have more fun

PSIA-AASI national office s are headquartered in Lakewood, Colorado and the association is represented throughout the United States by nine autonomous geographic divisions, which conduct training and examinations for a variety of snowsport disciplines.

## SKYTECHSPORT – WHO WE ARE

SkyTechSport strives to enhance opportunities to experience sensations of snow. We let people of all ages and levels experience all sensations of skiing and snowboarding indoors, providing a safe environment for learning and a universal training tool for practicing carving technique.

The company developed a unique technology of recreating real G-forces of snow sports. Ski and snowboard simulators are used by:

- national ski teams and top world's athletes in preparation for races
- snow sports amateurs who need to advance in order to fully enjoy skiing or riding
- complete beginners, who can learn the basics of the carved turn before ever stepping on the slope,
- fans of active lifestyle who want a fun and engaging workout,

Each simulator is equipped with a virtual reality system with fully customizable slopes and GPS-scanned copies of famous Olympic racetracks.

## WHO ARE OUR CUSTOMERS?

Our students are our customers and our guests. They may be adults or children, people who are fit and athletic or people who are less active. They may be from other states or countries. Regardless of who they are, as an instructor, there are three core tenants to follow:


The safety of the guest must remain the primary concern of every instructor. Safety guidelines for the simulator and all on snow activities must be followed at all times. Unless the guest feels that he or she is in a safe and secure setting, learning and fun cannot occur.

A snowsports instructor not only represents him/herself, but also the snowsport school, the area, and PSIA-AASI. Customer service is one of the most important things that we as instructors provide. In PSIA-AASI, we describe the way we interact with customers as "customer-centered."

We have expectations about the products and the services we purchase, as so do our customers. There are several things we can do as instructors to make our customers' experience enjoyable. First, take the time to learn and use your student's names. Begin by learning how to recognize equipment issues before the start of the lesson. Learn how to pace your lesson to avoid fatigue or information overload. Use timely moments to share safety considerations with your students to ensure they know you have their best interests at heart.

## KEEPING IT SAFE

As snowsports instructors, our first duty is to our student's safety. A student that feels safe and is having fun is a student who has the potential to learn. Safety awareness is important throughout a lesson. Many safety concerns are covered at the beginning of the lesson, and you should be prepared to address safety at any time.

During the first lesson, it is not unusual for a student to be, or become, very self-focused. As an instructor, identify when this is happening and help them so that this doesn't negatively affect their experience.

### SKYTECHSPORT SIMULATOR SAFETY GUIDELINES

READ THROUGH THE USER MANUAL OF THE SIMULATOR FIRST, make sure that you're familiar with the all the equipment on which you are teaching.

- Your student should see a physician for a complete physical examination before training on the ski and snowboard simulator. Overexertion or work to exhaustion on the Ski Simulator is dangerous. If the trainee feels any pain or abnormal symptoms, stop the training immediately and consult a physician.

- 7 years is the minimal age of any student. 25 kgs (55 lbs) is a minimum weight of any student, 120 kgs (265 lbs) is a maximum weight of any student.
- Non-supervised training on the simulator is not permitted, make sure to always keep your eyes on your student.
- Make sure to tell your student to always keep their skis/snowboard flat and to keep their hands on the hand rail, while you're making any change to speed, snow conditions, turning simulator on, off or switch between different slopes.
- While the simulator is on, keep your hands away from all moving parts.
- Hold the remote kill switch in your hand during training, and never train without the remote in your hand. Your thumb must always be on the kill switch button of the remote to be able to switch off the motors at any moment.

Inspect the simulator before your training session:

1. **Inspect the simulator visually**. Carefully inspect the guide rails of the carriage, check if skis / snowboard are firmly attached to the moving carriage, check if there is tension on pulley cables of the carriage.
2. **Make sure skis / snowboard move smoothly along the platform and nothing is blocking their way**.
3. **Test the optical safety system**. Start the simulator application and load infinite slope. Activate motors of the simulator by pressing the MOTORS button on the control handle (on 2015 and older simulators, activate control unit 1, see manual for more detail).
4. **Test the remote kill switch**. On infinite slope try starting the simulator and turning it off with a REMOTE SWITCH. Make sure the remote you have in your hands is from the simulator you're planning to be teaching on.
5. **Test the skis / snowboard**. On infinite slope before turning on the simulator platform angle the skis / snowboard. Look at the touch control monitor and note if edging angle indicators are showing the correct edging angle of skis/snowboard.
6. **Test the motors**. On infinite slope set the speed to 10 km/h, TURN ON the simulator platform and carefully angle the skis to about 20 degrees. Feel if the resistance is coming from skis. Once complete, turn the simulator off.

In case of technical failures contact a representative of the maintenance organization of the Manufacturer.

Basic Safety Requirements:

1. Make sure that children under the age of 14 wear a ski or bike helmet during your training session.
2. Unsupervised by adults, children under the age of 10 must not stay in the room with a working simulator. Remember: the moving carriage of the Simulator is a potential hazard!
3. Anyone observing your training session must stay at least 1 meter (3 feet) away from the platform of the Simulator.
4. Make sure there are no animals in the room with a working simulator.
5. Unauthorized persons are not allowed to stand or sit on the platform of the Simulator.
6. Do not activate the MOTORS (motors button) until your student is in the bindings. Do not step onto the platform, adjust/fasten/unfasten the bindings, or walk down from the platform when the power block is on.
7. Do not put foreign objects on the platform or into the guide rails of the Simulator.
8. Students should wear proper exercise clothing during training and avoid loose clothing.

9. When the MOTORS are on, it is strictly prohibited to touch any wires and cables of the Simulator.
10. Make sure your student increases their edging angles gradually, while achieving full control of motion during exercises. Do not rush your student to make progress.
11. Ask your student to avoid making unnecessary hits of the carriage against shock absorbers on the sides of the platform.
12. While simulator is on, keep your hands away from all moving parts, make sure there are no objects blocking the path of the carriage.
13. Keep the liquids away from the equipment.
14. The training session must be stopped immediately if:
    1. Boots are not fixed securely inside the bindings;
    2. Movement of the carriage is blocked;
    3. There are error messages on the display or signs of overheating of the motors or any other parts of the Simulator (e.g. specific smells);
    4. There are faults in the operation of electronic connections or controlling program of the Simulator.

Switching the Simulator ON.

1. Press the COMPUTER button on the simulator. Wait for the operating system to load.
2. Launch the simulator's application by clicking on the SKYTECHSPORT icon on the desktop.
3. Enter the time of the training session, log into the session.
4. Step on the simulator's platform and buckle into the bindings of the ski/snowboard imitators.
5. Press the MOTORS button on the simulator.
6. Launch a desired slope.
7. Take the simulator's remote control, press its button to TURN ON the engine.
8. The interface will display a green TURN ON button. Press this button and start edging skis gently.

CAUTION: When switching the drive, the trainee must stand on the Simulator with the bindings fastened, hold on to the handrail and keep the ski/snowboard imitators flat (i.e. not edge them). In the 'Endless slope' mode the indicators of angles under the image of a skier in the interface must **show 0 (zero) degrees and be red**.

Switching the Simulator OFF.

1. Make sure the trainee has stopped moving, put the skis/snowboard flat and is holding on to the handrail.
2. Press the button of the remote control and wait for a click indicating that the drive is off.
3. Make sure that the big red STOP button in the interface changed to grey.
4. Unbuckle the bindings of the imitator(s) and step down the platform of the simulator.
5. Go to the MAIN MENU of the application.
6. Close the application.

Turn the computer off following a standard Windows algorithm: press START in the menu, then SHUT DOWN. Wait for the computer to shut down.

# CHAPTER 2 – TEACHING & LEARNING

## HOW WE TEACH

Teaching is much more than simply explaining how to do something. The most effective, and successful teachers make a point of:

- Developing a trusting relationship
- Understanding students and how they learn
- Being an active and effective listener
- Creating a safe learning environment

The best teachers do this throughout their lessons, and PSIA-AASI provides resources that can help you and your students be more successful. The PSIA-AASI Teaching Model incorporates the core components of how to create a successful lesson. See Chapter 1 of the *Core Concepts for Snowsports Instructors* manual for more information about the Teaching Model. The Teaching Model provides a way to organize your lessons so that you learn about their students, design a teaching plan tailored to them, practice and anchor the learning, all while creating fun and memorable experiences.

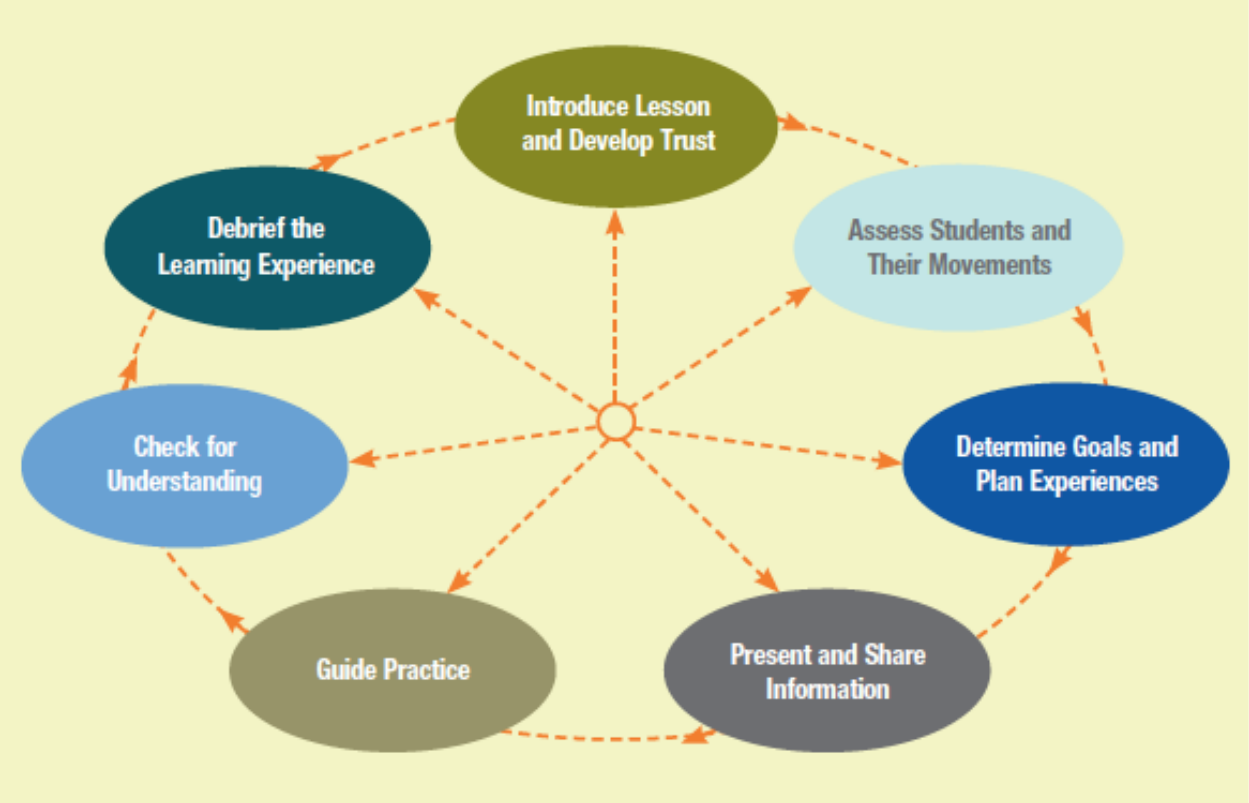
The use of a teaching model should also help to build a partnership where the instructor understands the goals of the student and then uses this information to make adjustments throughout the lesson to help the customer reach their goals. Your goal as an instructor is to create a successful learning partnership with every student. Understanding your student's makeup, or profile, allows you to adapt and adjust your instructor behavior to create an effective learning partnership.

**TABLE 1: THE TEACHING MODEL**

| Student Makeup + | Instructor Behavior (Teaching Cycle) = | Learning Partnership |
|---|---|---|
| *Discover your student's:* | *Use your skills to:* | *Create a lesson that:* |
| ■ Characteristics and background | ■ Introduce Lesson and develop trust | ■ Is creative, individualized, and student-centered |
| ■ Learning styles and preferences | ■ Assess students and their movements | ■ Is interactive, experiential, and FUN! |
| ■ Motivations, understandings, and desires | ■ Determine goals and plan experiences | ■ Contributes to the student's success |
| ■ Emotional states | ■ Present and share information | ■ Produces positive results |
| ■ Beliefs, attitudes, and values | ■ Guide practice | ■ Provides ownership of skills |
| ■ Physical conditioning and health | ■ Check for understanding | ■ Creates lasting memories |
| | ■ Debrief the learning experience | ■ Encourages future learning |
| | | ■ Culminates in guest satisfaction |

The Teaching Cycle provides a pathway to present the lesson information. The teaching cycle holds core components to successful, well managed lessons. As your experience and understanding of

teaching and learning grow, you will find yourself continually adjusting where you are in the teaching cycle so that you best meet the needs of each student at that moment.



## How We Learn

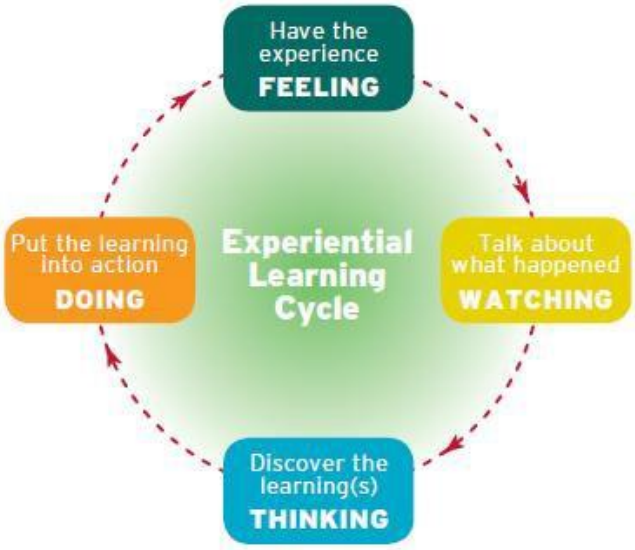
The goal of teaching is to enable learning. In snowsports instruction, students must learn to move, understand the movements they are attempting and feel comfortable and inspired to attempt them.

While every student will have a slightly different way of learning, all students will have to go through a cycle of experiences to learn the sport of skiing or riding. It is important for a good instructor to have a method for creating experiences that will be effective for a broad range of students.

Learning styles or preferences characterize the ways students collect, organize, and transform information into skills. Learning preferences can be broken down into two basic components: how we perceive and communicate information, and how we process that information. Within the ski instruction community, two schemas are used to help describe a student's learning preference:

- Visual, Auditory, Kinesthetic (VAK)
- Watcher, Feeler, Doer, Thinker – See diagram

Visual, Auditory, Kinesthetic (VAK) largely depicts the channels that an instructor uses to deliver information and a student uses to collect or perceive information. While students may have a preference to one or two of these areas, it is important to recognize that most students will need to perceive information through all three channels to effectively learn a new skill. Skiing and riding are movement sports; therefore, learning to develop a kinesthetic awareness of how the body moves to create desired performances needs to happen early in a student's development.




Much like VAK, students may be predisposed to learning in one or more different ways; for learning to be effective and lasting, most students will have to pass through a series of experiences. For more information on the learning process refer to the *Core Concepts for Snowsports Instructors* manual.

Learners of any new movement pattern, regardless of sport or outcome, move through three levels of motor skill acquisition:

- Initial: crude movements, lacking in rhythm, will more focus on sensation than quality.
- Elementary: starting to gain some control, will look at body part to connect what is happening
  with movements, will enjoy exploring if in control. Will focus on active avoidance of fixed or moving objects.
- Mature: refined, coordinated, and mechanically correct. Will be able to share equally attention to environment, other people and tasks at hand.

Understanding that each level must be passed through helps the newer instructor understand what they may be seeing in their student. Some students acquire new skills quickly and adroitly, while others may struggle and take longer. Regardless, each level has its own unique characteristics and allows the body to adapt and process new learned movement.

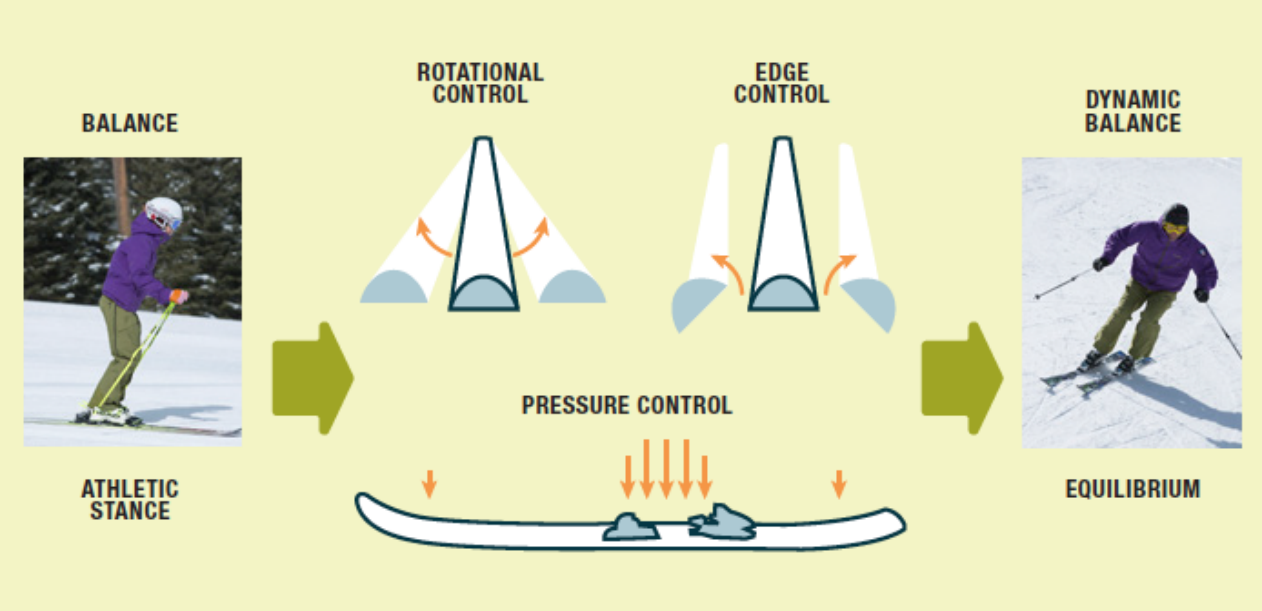
# CHAPTER 3 - SKILLS CONCEPT

## DEFINING THE SKILLS

This chapter introduces the Skills Concept and defines the skills of alpine skiing: rotational control, edge control, and pressure control. The skills are described separately to emphasize a connection between the action of the skis and the corresponding body movements for each skill. Balance is both a source and outcome of effective movement. For the purpose of this instructional manual, we will describe balance as Athletic Stance – the source of effective movements.

The Skills Concept serves as the technical model of American ski instruction. It is based on the knowledge that three skills – edge control, and pressure control, and rotational control – are integral to all turns, and they are essential for maintaining balance. These skills provide a clear framework to analyze the action of the skis on the snow and the skier's movements to accomplish these actions.

- **Edge control** refers to tipping the skis relative to the length or longitudinal axis of the skis. Skiers use this action to increase or decrease the ski-to-snow angle.
- **Pressure control** relates to managing forces acting on the skis. Skiers manage the distribution of pressure along the length of the skis, transfer pressure from one ski to the other, and adjust the overall magnitude of the forces acting on the skis.
- **Rotational control** refers to turning the skis about the vertical axis of the body. Skiers use this action to affect the direction their skis point. Though Rotational Control is critically important to the sport of alpine skiing, in the controlled environment created through use of the SkyTechSport Simulator, the skill is not thoroughly addressed. Therefore, in the section addressing use of the simulator, Rotational Control will not be discussed in depth.




In the following sections, skills are defined in terms of the movement of the body, the action of the skis that results, and how these affect balance.

## EDGE CONTROL

Edge control is the ability to tip the ski onto its edge and adjust the angle between the base of the ski and the snow. This angle has a significant impact on both speed and direction of travel. A high edge angle is when the ski is tipped more on edge, increasing the angle between the base of the ski and the snow. A low edge angle results when the ski is tipped less and is flatter on the snow. Effective edge control involves using only the amount of edge angle necessary to accurately affect the path of the ski through a turn, promoting a gliding action of the skis.

Lateral movement of the body is required to balance against the forces that act on the skis when they are tipped on edge. Inclination and angulation are terms that are commonly used to describe body movements relative to the edge control skill.

The skill of Edge Control is the principle skill that electronically activates the SkyTechSport Simulator

### INCLINATION

Inclination occurs when there is deviation from a vertical position. In skiing, inclination is the general term for any lateral movement of a skier toward the inside of a turn. Some degree of inclination is always present in order to balance against the forces in a turn. The amount a skier inclines depends on the magnitude of force, which is influenced by edge angle, turn radius, pitch of the hill, snow conditions, and speed of descent.

### ANGULATION

Angulation refers to movements that create angles between body parts. Two types of angulation are commonly used in skiing: hip angulation and knee angulation.

### KNEE ANGULATION

Knee angulation refers to the appearance of angle created at the knee joint. The knee joint has little lateral movement, especially when the leg is straight. In this respect, knee angulation is mostly a result of lateral and rotational motion of the leg combined with bending the knee joint. Knee angulation, while present in most turns, is most apparent in shorter turns where the forces are not long-lasting, or in instances when greater edge angles are required at slower speeds. As forces increase due to greater speed, hip angulation keeps the body in stronger alignment, although slight

adjustments in knee angulation can be used to fine-tune edge angle. Knee Angulation is the first edge control movement developed on the SkyTech Sport Ski Simulator.


### Hip Angulation

Hip angulation refers to the angle created at the hip joint. It allows a skier to adjust edge angle while maintaining balance toward the outside ski as forces increase in a turn. This type of angulation is most apparent through the shaping and finish phases of turns. On the Simulator, Hip Angulation will be developed as speed and intensity increases.

### Edge Control Outcomes: Action of the Skis

Skis are designed to turn while they are on edge. The edge control movements described above are critical to tip the skis. The angle of the ski on the snow (simulator) will ultimately determine how much force acts on the ski. Some turns require higher edge angles, while other turns benefit from lower angles. Just as we have terms to describe ski actions relative to the rotational component, we have terms to describe ski performance relative to the degree of edge engagement:

### Carving

**Carving** refers to the action of an edged ski traveling forward along the length of the ski with minimal to no sideways travel. A high edge angle allows the arc of the turn to be created by the bend of the ski, as the tail follows in the path cut by the tip. As the turn develops, inclination (angulation) will increase to maintain balance with forces that build, and to keep the ski carving through the snow. A carving ski leaves a very narrow track in the snow. Any minimal amount of skidding is not visible in the action of the ski, or the track left in the snow. The term "arcing" is also used to describe the action of the tail following precisely in the path cut by the tip. The action of carving, and the forces that result will be emphasized when using the simulator.

### Slipping

**Slipping** refers to the action of the skis as they travel in a direction sideways to the length of the ski. Slipping is also known as “sideslipping.” The slipping action can occur straight down the hill or in a forward or backward sideslip, slipping sideways while traveling diagonally down a hill. The edge angle adjusts the speed of descent without creating a turning force. Higher edge angles slow the descent, while lower edge angles allow speed to increase. **Slipping will not be experience on the simulator, but will be an important concept to understand when transitioning to snow.**

### Skidding

**Skidding** blends forward and sideways action of the skis. The skidding action of the skis covers a wide range of ski performances, and represents the most common interaction between the skis and snow. One end of the skidding spectrum is very similar to slipping, with sideways travel, except the skis move through some degree of an arc instead of a straight line. The other end of the spectrum is very similar to carving, with the skis moving forward along their length, and having only a slight amount of sideways travel. Edge angles for skidding cover the entire range from nearly flat to steep, depending on the skier's desired outcome and experience level. **Like slipping, Skidding will not be experience on the simulator, but will be an important concept to understand when transitioning to snow.**

### Edge Control and Balance

Any lateral movement a skier uses to increase or decrease the angle of the skis on the snow affects balance. If a skier moves too far to the inside of a turn and the corresponding edge angles are too high, the skis will tend to go straight and not continue in a curved path, and/or the skier will fall onto his or her hip. If a skier does not move far enough to the inside of a turn and the corresponding edge angles are too low, the skis won't hold their intended path; they will slip or skid sideways, and compromise balance.

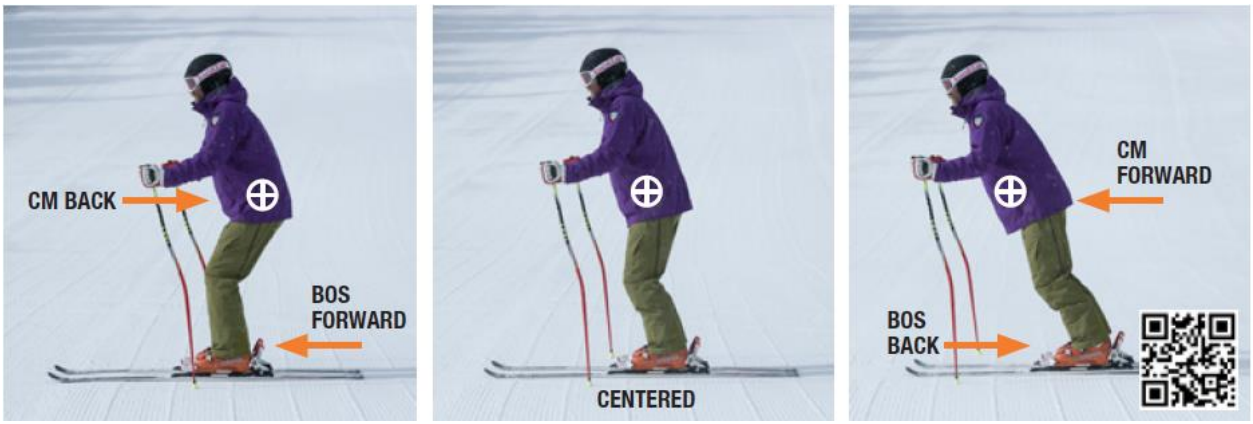
## Pressure Control

Pressure control requires movements to manipulate forces. It is those forces that affect the action of the skis on the snow. Pressure control has three distinct functions:

- control the distribution of pressure along the length of the ski
- control the distribution of pressure from ski to ski
- control the overall magnitude of pressure acting on the base and/or edge of the skis.

### Controlling Pressure along the Length of the Ski

Skiers primarily have three means of distributing pressure along the length of the ski, all of which require a forward or backward (i.e., fore or aft) adjustment between the skier's center of mass (CM) and his or her base of support (BOS). The CM is the central balance point of a person's body mass. A skier may move his or her CM forward or backward relative to the BOS. Alternately, he or she may move the BOS forward or backward underneath the CM. Both of these actions produce the same result by adjusting pressure forward or backward on the skis. A third and very effective approach combines these two actions, moving the CM and the BOS in opposite directions, allowing for a quicker adjustment in pressure along the skis.




### Moving the Center of Mass

Fore/aft movement of the CM is most effective when it originates and is controlled by flexing and extending the ankles. Flexing, or closing, the ankle joints can move the CM forward relative to the feet, moving pressure toward the tips of the skis. Extending, or opening, the ankle joints can move the CM back relative to the feet, moving pressure toward the waist or tail of the skis. As much as possible, the fore/aft movement of the CM and fore/aft adjustment of pressure should be controlled with the range of motion in the ankles first, and then complemented by movements in the rest of the body (knees, hips, and upper body).

- Flexing at the knee joint alone moves the CM backward. Extending at the knee joint moves the CM forward. This movement is much like sitting down and standing up from a chair.
- Flexing at the hip joint alone moves the CM forward. Extending at the hip joint moves the CM backward. This movement is much like bowing.

## Controlling Pressure From Ski to Ski

The ski that is farthest from the center of the turn's circle is referred to as the "outside" ski, and the ski closest to the center of the turn's circle is the "inside" ski. This "outside" and "inside" terminology also applies to the skier's legs in the turn sequence.


Turning is caused by force from the snow pushing on the skis. To maintain balance, the skier aligns the body to the outside ski. To turn and to link multiple turns, the skier actively directs pressure toward the new outside ski, while reducing pressure on the inside ski. This exchange allows the snow to push the ski in the new direction.

Because the simulator operates only from "side-to-side" with no forward movement, turning does not occur. However, it is important to recognize the inside ski and outside ski. When moving to the right, the ski on the LEFT is the OUTSIDE SKI. Conversely, when moving to the left, the RIGHT ski constitutes the OUTSIDE SKI.


This transfer of pressure (and balance) from one ski to the other is one of the most fundamental aspects of alpine skiing. To accomplish this, the skier must move the CM toward the inside of each turn and direct his or her balance toward the outside ski. Through this transition, the distribution of pressure from ski to ski may range from a complete transfer – in which 100 percent of the force is directed toward the outside ski – or a partial transfer with only slightly more pressure directed toward the outside ski.

This redistribution of pressure from ski to ski requires releasing pressure from the old outside ski and establishing pressure on the new outside ski, which can be done in in any of the following ways.

### Flexion of Outside Leg with Extension of New Outside Leg

In one approach, the old outside leg (that is, the leg that was outside at the start of the turn) relaxes or flexes (reducing pressure) at the finish of the turn as the new outside leg extends and lengthens (increasing pressure) to complete the transfer of pressure. The extension of the new outside leg helps to control the direction of movement of the CM as it actively moves the CM across the BOS.

### Extension of Both Legs

Alternatively, a skier can extend both legs through the transition from one turn to the next. The new outside leg extends at a faster rate than the old outside leg, transferring the weight to the new outside ski. In this method, the CM travels upward as the extension of the new outside leg, along with an edge change, directs the body down the hill and across the BOS. Common in medium and long turns, the weight transfer can happen gradually or quickly since the skier has control over the amount, direction, and rate of extension.


### Flexion of Both Legs

In another approach, both legs flex through the transition from one turn to the next. The old outside leg flexes at a faster rate than the new outside leg. Along with edge change, this transfers weight to the new outside ski. The rate of flexion of the old outside leg controls the rate at which transfer takes place. In this method, the CM lowers or remains level with the ground as weight is transferred and the CM and the BOS realign. This occurs in bumps and other variable terrain, and in dynamic short turns when the skier needs to release a great amount of pressure through the finish of a turn.

Each of these examples of how a skier transfers pressure from ski to ski, or shifts weight, involves similar mechanics. A slightly different intensity, rate, and/or timing of weight shift occur. Generally, a combination of these examples is used on a given run depending on tactics, conditions and/or intent.

### Controlling the Magnitude of Pressure

The most direct means of managing the overall magnitude of forces in a turn is to increase or decrease the rotation or edge angle of the skis. These actions change the relationship of the skis to the snow, increasing or decreasing resistance and resulting in a corresponding increase or decrease in pressure. Resisting or absorbing forces with extension and flexion movements of the legs and spine can also manage the forces acting on a skier. Rotational and edge control have been covered previously, and the following describes flexion and extension movements that manage the overall pressure acting on the skis and skier.

### Up Unweighting

In this movement, a quick extension of the legs produces a momentary reduction in pressure when the skier's CM slows or reaches the top of its movement. When Up unweighting is

used on the simulator, the skier will be tallest when the skis are flat.

### Down Unweighting

Here, a quick flexion of the legs produces a momentary reduction of pressure as the skier's center of mass drops. Pressure returns as the CM reaches the bottom of its movement. When down unweighting is used on the simulator, the skier will be most flexed when the skis are flat.

### Absorption

Allowing muscles to relax and give in to the forces pushing on the skis creates a momentary reduction in force. The rate of flexion occurs more slowly than with down unweighting and retraction, and for a longer duration. Absorption is used to regulate pressure over varied terrain such as round bumps or rolls.

### Pressure Control and Balance

Pressure control has a unique relationship with balance. Since the forces that bend the skis and cause them to change direction are the very same forces with which the skier must maintain equilibrium to stay in balance, the movements used to control the pressure on a ski also keep the skier in balance.

A skier makes adjustments to increase, decrease, or maintain pressure on the skis by adjusting stance to remain in balance. To create or react to pressure, the skier may adjust balance fore/aft along the length of the skis, laterally from the edge of one ski to an edge on the other ski, and/or through extension or flexion movements to increase, decrease, or resist pressure.

## Rotational Control

Rotational control highlights the ability of a skier to control the direction the skis point (toward the left, right or straight ahead).

We differentiate upper- from lower-body movements. In this context, we define the upper body as the pelvis and above, and the lower body as originating from the top of the femurs down. The hip joint defines the connection between the upper and lower body.

### Leg Rotation

Leg rotation is the primary form of rotation that we teach and is defined as movement of the lower body to affect the direction the skis point. This includes elements of rotation from the femur in the hip socket and lower-leg (below the knee) rotation.

As the body flexes, abduction (movement of the leg away from the midline of the body) and adduction (movement of the leg toward the midline of the body) have a greater effect on rotational control. The legs can provide a wide range of rotational input to the skis. This varies from a quick, explosive rotational movement, to a slow, consistent torque throughout the turn. This degree of versatility makes leg rotation the most effective source of rotation for most alpine skiing applications.

To be effective, the rotational action of the legs requires a strong ("stable" or "quiet") upper body to turn against. As a result, the direction, duration, intensity, rate, and timing of movements can be finely adjusted throughout a turn.

### Rotational Outcomes: Action of the Skis

The movements described above transmit rotational input to the skis, and the following terms define the resulting ski performance.

### Turn (Turning)

A turn (or Turning) refers to the rotational action of the skis relative to the surface of the snow. It is the result of muscular input used to change the direction the skis point. This term is also used to describe a skier's curved path of descent, or change in direction of travel.

### Steer (Steering)

Steering refers to actively directing the skis along an intended arc by turning (using muscular action) an edged ski (using the ski design). The rotational component of steering combines with forward movement of the skis and at least a minimal degree of edge angle, causing the skis to follow the curved path of a turn. Commonly referred to as guiding, these terms describe the action of the skis resulting from a blend of tipping the skis while turning the legs.

### Rotation and Balance

When rotational movements of the body are transmitted effectively to the skis, the rotation occurs about the vertical axis of the body and balance is not disturbed. It is important that the skis rotate around an axis near the center of the skis. A skier may choose a tactical application where the skis rotate about the tips or tails, however, this will compromise ski performance and balance.

Rotational balance describes the relationship of body parts as they move relative to each other. Rotating one part of the body with respect to another alters the biomechanical alignment of joints and muscles, and can greatly affect the body's ability to move efficiently and maintain balance.

## Balance

A body in balance is in a state of equilibrium. More specifically, equilibrium denotes opposing forces in a state of balance. In skiing, a person must maintain equilibrium between the forces that act on him or her (gravity and inertia) and the forces that act on the skis (centripetal and friction). This relates to the forces acting on the CM (the central balance point of body mass) and the BOS (location of weight on the snow) as discussed in *Chapter 5: Physics of Skiing*.

Skiers control the external forces that affect balance by rotating or edging the skis and resisting, increasing, or absorbing pressure. The same movements a skier creates to turn, tip, and manage pressure on the skis also affect the momentary relationship between the CM and BOS. It is these relationships that define equilibrium or balance.

As in all sports, an Athletic Stance provides a balanced foundation from which all effective movements originate.

## Athletic Stance

An athletic stance – which is virtually the same for any motor sport – is defined by the ability of the athlete to move in any direction at any time. In an athletic stance:

- The feet are approximately hip-width apart to provide a BOS
- All major joints are flexed
- Weight is distributed evenly across the entire foot
- The arms are raised slightly above the waist, with the elbows just in front of the body and the hands positioned slightly wider than the elbows
- The pelvis is neutral (with the lower back neither arched nor the tailbone tucked)
- The head is up with the vision forward

The goal of an athletic stance in skiing is to align the body to have maximum access to the three basic skills, while maintaining a balanced relationship between the CM and BOS. The basic stance for a skier includes flexion of the ankles, knees, hips, and spine. From a side view, the slant of the lower leg is parallel or nearly parallel to the slant of the upper body. The overall height of the stance is determined by boot setup, intent, and ability of the skier.

**The importance of this stance cannot be overstated**; any style or habit that negatively impacts these elements of an athletic stance will have a negative impact on the skier's ability to move effectively.

References for an athletic stance relative to the Skills Concept:

### Pressure Control Along the Length of the Ski

- The skier's posture maintains a degree of forward lean relative to speed, terrain, and snow conditions.
- The degree of ankle flex determines the lower-leg angle, which is matched by the angle of the spine.

### Pressure Control from Ski to Ski

- The skier's hips, shoulders, and hands remain relatively level (perpendicular to gravity) as the CM moves to the inside of the turn.

### Rotational Control

- An imaginary line that crosses the front of the bindings is parallel to lines drawn across the knees, front of the hips, shoulders, and hands.

## Summary

Every desired outcome can be understood and explained in terms of rotational-, edge-, and pressure control. A wide variety of outcomes are possible in modern skiing. It's "all good" in terms of what can be done on a pair of recreational, all-mountain, race, freestyle, or big-mountain skis. Yet, for each specific outcome, there is an appropriate, effective blend of skills. Good skiing, in any form, can be defined by the Skills Concept.

# CHAPTER 4 – ALPINE TECHNICAL PROGRESSION

## FUNDAMENTALS

An instructor today needs to know the common elements between a halfpipe rider, a back country hiker, a mogul enthusiast, and a World Cup racer. Those common elements are the concrete mechanics involved in our sport: the action of the skis on the snow and the corresponding body movements. Though techniques get refined and modified, the laws of physics don't change. Though motivations and aspirations evolve, the human body's biomechanics remains constant.

The Skills Concept discussed in Chapter 3 explains the actions of the skis on the snow. In this chapter, we will identify and discuss how the body moves to create those actions. The Skills Concepts can be considered the alphabet of skiing, whereas the Alpine Skiing Fundamentals used in this chapter are the words and sentences that describe how we move, and are the foundation of the SkyTechSport Ski Simulator progression.

The Alpine Skiing Fundamentals outline these common elements of great skiing. Developing these skills sets our students up for success in all aspects of skiing.

## SKIING FUNDAMENTALS

1. Control the relationship of the Center of Mass to the base of support to direct pressure along the length of the skis.
2. Control pressure from ski to ski and direct pressure toward the outside ski.
3. Control edge angles through a combination of inclination and angulation.
4. Control the skis rotation (turning, pivoting, steering) with leg rotation, separate from the upper body.
5. Regulate the magnitude of pressure created through ski/snow interaction.

The SkyTechSport Simulator primarily develops abilities in the first three fundamentals. The progression in Sections 1 and 2 below, highlights these fundamentals.

The remaining two fundamentals (repeated from above):

- Control the skis rotation (turning, pivoting, steering) with leg rotation, separate from the upper body.
- Regulate the magnitude of pressure created through ski/snow interaction

are critically important to alpine skiing and will be addressed when the skier transitions from the simulator to Snow.

## BASIC GUIDELINES FOR SIMULATOR LESSONS

- Students should wear standard athletic attire
- Take regular breaks (each session should go no longer than 10 minutes)
- Keep water nearby and offer it regularly
- Have a clean towel nearby for guest use

## Section 1: Warm-up and Introduction to the Fundamentals of Alpine Skiing

***Depending on the student's athleticism, the following introductory exercises can be done with ski boots on or off. If the progression is started with boots off, it should be repeated with boots on***

### Equipment and Mobility

Ski boots and equipment are foreign to those who have never skied. A person's first experience wearing ski boots will feel awkward, as the boots will limit the range of motion in the ankle joint. The first step with any beginner is to gain familiarity and comfort with the new gear.

After introducing the basic equipment that will be used in the lesson, insure boots fit and are buckled properly. Boots should fit snug and make contact with the entire foot and ankle.

The following exercises will aid in developing mobility and comfort in ski boots:

- Walking in ski boots to develop range of motion in the ankle joint
- Gentle ankle flexes
- Deep knee bends (squats)
- Rocking fore/aft
- Hops

### Balance and Athletic Stance

The students will learn the elements of a basic athletic stance with weight evenly distributed laterally and fore/aft on both feet.

- Shin and spine to be at similar angles
- Elbows forward of the torso
- Eyes focused ahead

### Direct Pressure from Foot to Foot

The student will learn to transfer weight side to side from one foot to the other. The following exercises will teach this fundamental movement.

- Step from one foot to the other (with minimal movement in the torso)
- Flex ankle (dorsi flexion), of the weighted foot
- Lift inside foot/knee up toward skier's torso
- Explore varying rates

### Adjust the Edge Angles of the Skis by Tipping the Legs (keep the upper body stable)

The skier will learn to control edge angles through movement of the lower body.

- Symmetrically tip boot cuffs side to side keeping the lower legs parallel.
- Use a wall or doorway to demonstrate feet, knee, hip inclination and angulation
- Emphasize that tipping movements should originate in the feet and lower legs.
- Develop muscular awareness inside the boot by highlighting the sensations the skier should be feeling in the feet and lower legs
- Explore varying rates of tipping.


### Combine the skills of Pressure and Edging

This is the final step in preparing the skier to use the simulator.

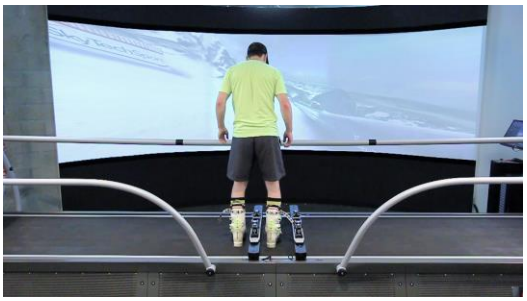
- While tipping skis from side to side, feel the "pressured" inside (arch) of the weighted foot
- Use a door frame or wall for stability, and actively move the body from side to side demonstrating edging and weight transfer.
- Explore varying rhythm and tempo.

## Section 2: Development of fundamental skills on the Simulator

Before getting onto the simulator for the first time, students will need a brief introduction to the equipment. Refer to safety guidelines in Chapter 1 for full details. All safety guidelines must be followed at all times.

### Introduction to the simulator

- Have skier hold the handrail while climbing the stairs to the simulator.
- Line up with one foot in-between the skis and one foot next to the skis.
- While holding the handrail, click in to the bindings, one foot at a time
- Using the handrail, have the skier push themselves to the end of the simulator to experience sliding across the simulator.
- Review basic skiing terminology
  - Outside and inside ski
  - Edge and edge angle
  - Turning and turn shape



### Review Athletic Stance

The simulator, particularly when off, is less stable then the floor. This will challenge the skier's ability to stand athletically. Have the student use the handrails for stability until they feel safe and comfortable balancing unassisted.

- Have skier evenly distribute weight over the entire foot
- Look for shin and spine to be at similar angles
- Elbows should be forward of the torso
- Eyes are focused ahead

### Explore and Develop Fore-Aft Movements

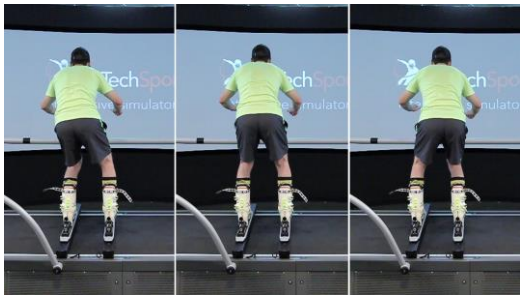
The following activities are vitally important to transition the skier from solid ground to simulator, and learn to remain in balance on the equipment while in motion.

- Ask the skier to slide skis fore and aft in opposition (scissor the feet)
- Flex and extend in all joints, raising and lowering the CoM. Explore full ROM
- Demonstrate appropriate ROM to achieve athletic stance
- With the simulator in “Power Mode”, have the skier extend leg on edge with muscular tension

### Skier to Direct Pressure from Foot-to-Foot

Learning to direct pressure from one foot to the other is a critical element in skiing. This will be a very subtle movement due the feet being fixed to the simulator.

- Insure that the pelvis and torso remain stable while pressure is shifted
- Vary the rate at which weight is transferred from foot to foot to gain comfort with the movement while on simulator



### Adjust Edge Angle Using Angulation and Inclination

Learning to tip the skis from side to side is not only an alpine skiing fundamental that allows turning to occur, but it is also the principle movement that electronically activates the simulator.

Have the skier…

- Cause the skis to travel from one end of the simulator to the other by slowly tipping the feet and lower legs to put the skis “on edge”.
- Use the support handrails for balance if needed.

Do this one direction at a time and focus on tipping the feet and lower legs independently of the upper body (coaching necessary at this step).

Link “turns” by gradually tipping from one set of edges to the other

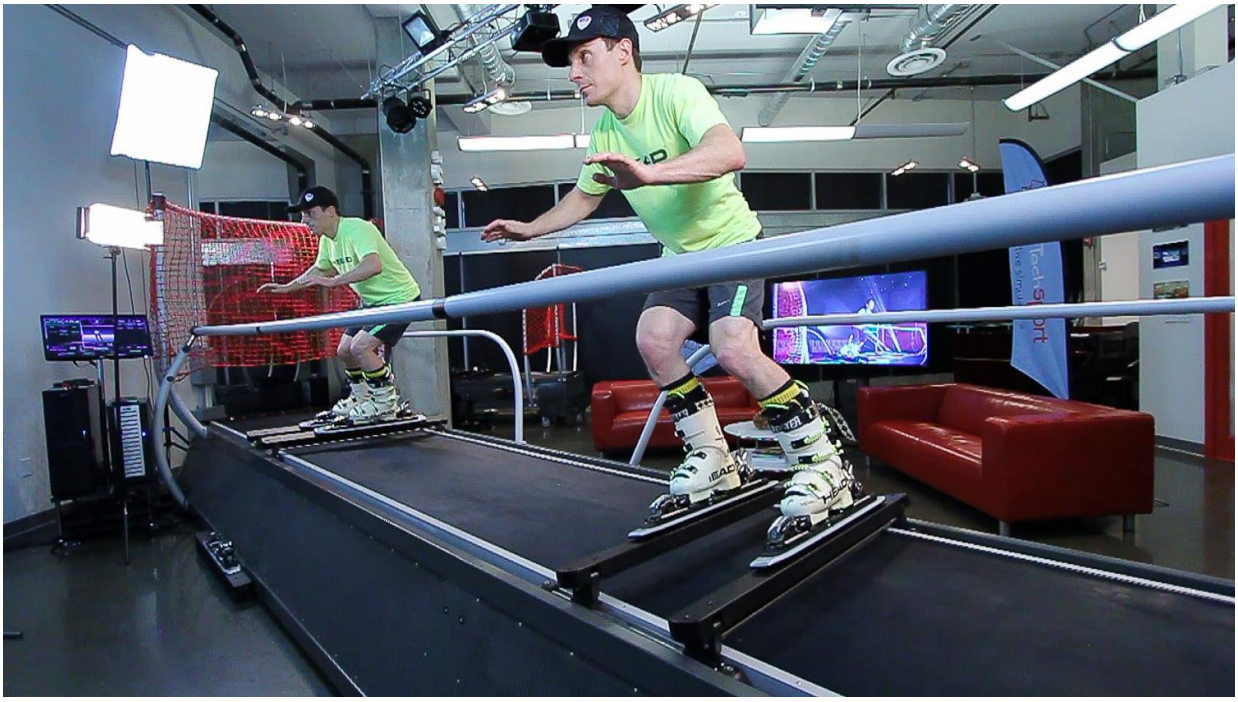
- All movements should be symmetrical from left to right side.
- Tipping movements should be slow and use the full range of the simulator.
- Highlight the natural weight shift that is created through turning.
- Perform shorter turns keeping the skier in the middle of the simulator. This requires quicker bursts of edging movements.

### Active blending of Edging Skills and Pressure Control Skills (foot-to-foot movements)

Use the following exercises to practice blending the skills to experience all of the dynamic capabilities of the SkyTechSport Simulator.

- Have skier actively shift weight to the “outside” ski while tipping the skis on edge.
- Develop the timing necessary to blend these movements at varying levels of intensity.
    - Establish balance on the new outside ski as the skis are flattened.
    - Increase pressure and stability against the outside ski as the skis are tipped to their edges.
- At this stage, the skier is developing the ability to actively extend the outside leg while flexing the inside leg (knee and hip joint primarily).

- Introduce extension of the knee and hip to move the skiers body across the skis and changes edges.
- Introduce flexion of the knee and hip to allow the skier to balance against the outside ski.
- Develop timing and fluidity.



## SECTION 3: TRANSITIONING TO SNOW

Training on the SkyTech Sports Ski Simulator sets a new skier up with familiarity with some of the Fundamentals of Alpine Skiing and will set them up for accelerated learning on their first day sliding.

### BEFORE THE SNOW

While still indoors, revisit the basic indoor activities outlined in **Section 1.**

On the simulator, the guest was introduced to the first three Alpine Fundamentals. Before proceeding to the snow, we will need to introduce the fourth Fundamental:

- Control the skis rotation (turning, pivoting, steering) with leg rotation, separate from the upper body

The ability to turn the legs is an essential skill for the student to maintain control over direction and speed while skiing. The following indoor exercises will introduce the skier to this Fundamental:

1. With hands on hips, shift weight to one foot while keeping the other foot on the ground. Isolate the movement of turning the unweighted foot in each direction. With the hands, the student should physically restrain the pelvis from twisting in conjunction with the foot.
2. With equal weight on both feet, and holding the hands on the hips, have the student twist both feet simultaneously in each direction.
3. Complete exercise number 2 above with the feet and lower legs tipped on edge. Add ankle flexion and range of motion.

## On the Snow

### Single Ski – Learning Mobility on Skis

Outcomes: Comfort moving on and applying skills while clicked into one ski.

Terrain: Level/flat snow-covered area.

Exercises:

- One-ski straight-line scootering (using poles). Repeat on each foot. Encourage balance and ankle flexion.
- With one ski: step turn in the direction of the foot without the ski. (Have the ski on the outside of the turn).
- Repeat any exercises as needed until the skier can complete while maintaining balance throughout.

### Both Skis – Learning Mobility on Skis

Outcomes: Comfort moving on and applying skills while clicked into both skis

Terrain: Level snow-covered area then gentle slope

Exercises:

- Step in a circle with both skis on. Displace the tips of the skis in the direction of the turn.
- Using ski poles, push and glide on two skis on flat terrain
- Side-stepping
- Side-slipping
- Repeat any exercises as needed to gain proficiency

### First Time Sliding

Outcomes: Balance on a sliding platform and speed control through turn shape.

Terrain: Gentle slope.

Exercises:

- Diagonal descent: pointed across and slightly down hill, have skier glide on uphill edges. Use poles to push if necessary.
- Glide or step ski tips uphill to stop.
- Glide diagonally across the hill and 1 or 2 steps uphill/displacing the ski tips up hill. Emphasize steering by turning of the legs.
- Shuffle skis while gliding across the hill – encourage skidding.
- Repeat any combinations several times in both directions. Note that turning and direction change creates a slowing to a stop.
- As the student becomes more comfortable with sliding, increase angle of descent and begin closer to fall line.

### First Turns

Outcomes: Repeated practice of gliding arcs in preparation for complete turns.

Terrain: Gentle, slightly steeper beginner slope.

Exercises:

- At a slight diagonal, begin descent with skis parallel. Tip the boots slightly uphill gliding to a stop, or take a few small steps in direction of turn.

- Introduce and use the Bull Fighter Turn (BFT) to change direction. Stress tips displacement in direction of the turn with small steps. (Avoid a wedge step.)
- Repeat several gliding arcs linked by BFT's to bottom
- Garlands in a fan progression
- Gradually start pointing more downhill

### LINKED TURNS

Outcomes: Turns are connected by edge release, steering and re-edging

Terrain: Gentle, slightly steeper beginner slope, same as above

Exercises:

Step into and through the fall line. Gradually reduce steps. Emphasize glide and skid

- Shuffle ski tips to and through the fall line.
- Tip feet downhill to release ski edge. Steer ski tips to and through the fall line. As the skis start to slide, tip feet and turn legs in the direction of the intended turn and glide to stop.
- Develop controlled skid.
- Balance equally on both feet to start, then commit to the outside ski during the maneuver.
- Discourage heavy edging and/or braking.
- Repeated practice. Multiple laps.

The end result should be a skidded arc with progressive edge increase throughout.

# SECTION 4: DEVELOPING ADVANCED TECHNIQUES.

The SkyTechSport Ski Simulator was created to replicate the physical forces encountered while skiing. For experienced skiers, this device creates an environment that can:

1. Identify deficiencies in a skier's existing movements.
2. Highlight and challenge a skier's already effective movements.
3. Develop physical strength, agility, endurance, and tactics.

## IDENTIFYING DEFICIENCIES IN A SKIER'S EXISTING MOVEMENTS

After the skier's initial exposure and use of the simulator, a trained instructor can implement a development plan for the skier. the simulator is designed to enhance the 3 fundamentals identified in section 1 of this manual. For each fundamental below, become familiar with the visual cues that identify a skill deficiency while using the simulator.

## FUNDAMENTAL #1: CONTROL THE RELATIONSHIP OF THE CENTER OF MASS TO THE BASE OF SUPPORT TO DIRECT PRESSURE ALONG THE LENGTH OF THE SKIS

Visual cues that indicate fundamental skill deficiency

- The skier lacks outside ankle dorsiflexion when the skis are edged
- The skier is unable to maintain athletic stance throughout
- Excessive fore/aft adjustment in the upper body or the need to use guardrail for balance

Use exercises from the Posture and Stance portion of the exercise section to develop the skier.

## FUNDAMENTAL #2: CONTROL THE PRESSURE FROM SKI TO SKI AND DIRECT PRESSURE TO THE OUTSIDE SKI

Visual Cues that indicate a fundamental skill deficiency.

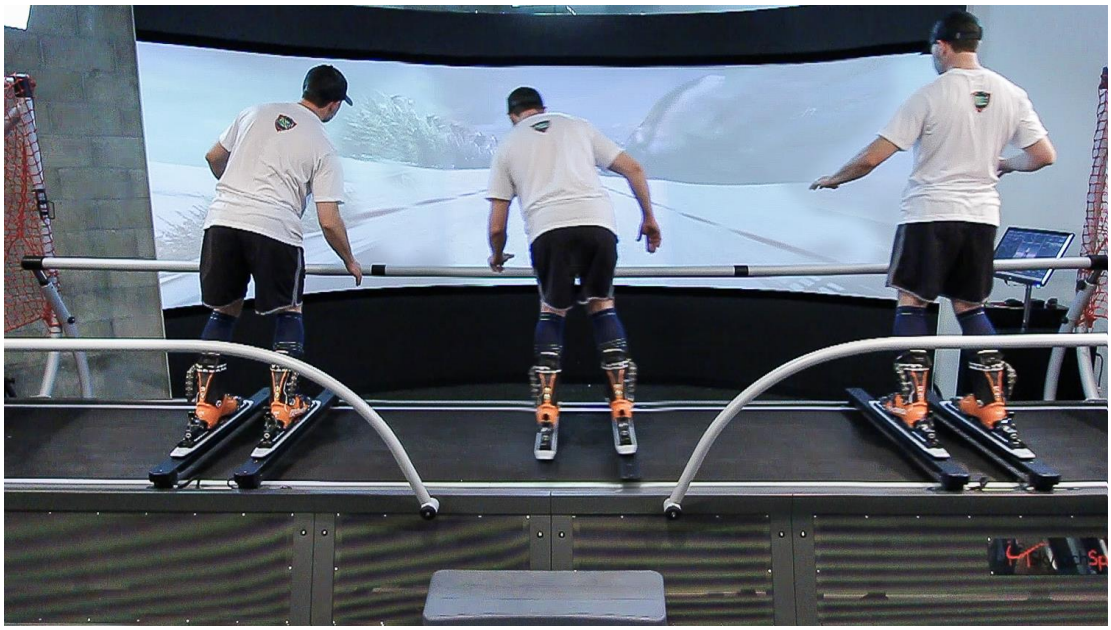
- The skier's upper body is tilted to the inside of the turn.
  - Instead, the upper body should remain level to the ground
- Spine flexes laterally to direct pressure towards the outside ski.
  - Replace this movement with angulation in the hip joint.
  - Keep the spine neutral while adjusting pressure from foot to foot
- Large vertical movements are required to adjust pressure foot to foot
  - Vertical movements should be minimal and complimentary to foot to foot pressure control movements

Uses exercises from the Blending Edging and Weight Shifting portion of the exercise section portion of the exercise section to develop the skier.

### FUNDAMENTAL #3: CONTROL EDGE ANGLES THROUGH A COMBINATION OF INCLINATION AND ANGULATION

Visual Cues that indicate a fundamental skill deficiency:

- Whole body tips from side to side instead of movements originating in the feet and legs.
- Outside ski tips more than the inside ski causing asymmetrical edge angels (A-Frame may be present).
  - The lower legs should edge simultaneously and symmetrically.
- Large vertical movements are required to flatten the skis and change edges.
  - Vertical movements should be minimal and complimentary to edging movements.



Uses exercises listed under Blending Edging and Weight Shifting, or Accuracy in Edging in the exercise section of this manual to develop the skier.

### HIGHLIGHT AND CHALLENGE A SKIER'S ALREADY EFFECTIVE MOVEMENTS

It is important to recognize an experienced skier's existing skills, as well as any new skills they are currently developing.

### EDGE CHANGE WITH EXTENSION

This involves an extension of both legs at edge change. This type of edge change releases tension on the muscles and increases the transition time of the edge change. This type of transition is often used for

long turns (using the entire length of the simulator). This type of edge change is often used at slower speed with less dynamics.

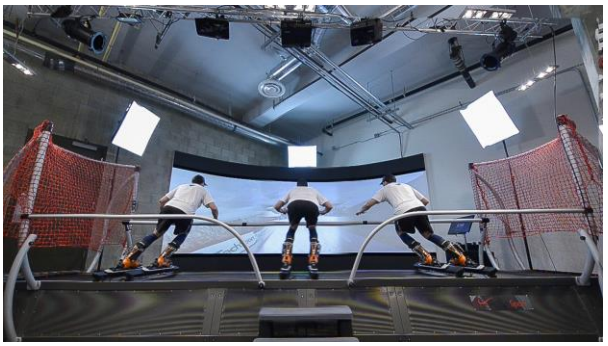
### EDGE CHANGE WITH FLEXION (ABSORPTION TURNS)

With the simulator in "Power Mode" have the skier…

- Extend legs from a flexed position while edged. This creates lateral movement of the legs and increases edge angle
- Flex legs with muscular tension at a slow rate. This will cause the skis to flatten and move back under the body.
- After practicing this several times on one side, repeat on the other side

Switch the device to "normal mode," and have the skier…

- Perform Absorption short turns
- Perform Absorption short turns, gradually increasing to Long turns that use the entire length of the simulator



### DEVELOP PHYSICAL STRENGTH, AGILITY, ENDURANCE, AND TACTICS

The simulator can be utilized as a very effective exercise tool placing physical demands on the body. Experiment with turn size and speed, changes in rhythm, increasing the length of time of each use, and exploring the assortment of terrain and snow conditions pre-loaded in the simulator's software.

Here are just a few sample progressions that can be utilized:

- Long turns - Long turns using the entire length of the simulator, gradually increasing their speed.
- Short Turns - Many short turns gradually increasing speed and intensity.
- Funnel Turns: Long – Medium – Short - Start with long turns using the entire simulator and gradually shorten the turn size until the skier is making short quick turns in the center of the simulator. This can also be done in opposite order (Short – Medium – Long)
- 5-1-5 – Start on one side of the simulator making a series of five (5) short turns, then make one (1) long turn that sends the body to the other end of the simulator and complete another series of five (5) short turns. that's one set. Complete a series of sets.

- 3-5-3 – Starting in the center of the simulator, make 3 short, quick Absorption-style turns followed by 5 Long extension turns, followed by 3 Short, quick turns. That's one set. Complete multiple sets.

Create Your own combinations of rhythm and timing to challenge the skier's fitness level.

The SkyTechSport Ski Simulator has several different modes that create challenges to develop versatility, adaptability, and accuracy.

Adjusting the snow conditions will create increased level of difficulty and develop a skier's reactive skills.

The options for snow conditions are:

- Normal
- Icy
- Heavy
- Gentle slope
- Crud
- Heavy crud
- Small bumps
- Large bumps

As students become more skilled, alter the snow conditions to create greater challenge. User exercises from the **Drills and Exercises** section to develop skiers in various snow conditions.

Racing and learning to ski different gate combinations develops skier's adaptability, versatility, and athleticism. The SkyTechSport Ski Simulator has a number of different options that should be explored when developing advanced skiers.

The following progression is a starting point for using gate training as a tactical way to develop skiers.

Developing versatility and adaptability in short turns:

- Start with a rhythmical slalom course.
- Progress to a course with a predictable rhythm change.
- Use the various competition courses to challenge students and measure their progress.

Developing versatility and adaptability in long turns:

- Start with a rhythmical giant slalom course.
- Use the various competition courses to challenge students and measure their progress.

## SECTION 5: DRILLS AND EXERCISES

We use drills to take a skier out of their normal movement pattern and allow him/her to isolate a single movement or skill for the purpose of development. See videos for full descriptions of the drills and exercises.

### POSTURE AND STANCE

- Fore/aft leaning from multiple joints
    - Explore how the ankles, knees, and hips flex and extend in order to establish balance.
- Squats and deep knee bends
    - Lower your hips downward, even with your knees and then resume athlete stance.

### ACCURACY IN EDGING

- Tipping with hands and feet symmetrically

- Hold your hands in front of your body, and while tipping your feet and lower legs from side to side, imitate that movement with your hands. This provides a visual reference and strengthens the neuro pathways between your feet and your brain.

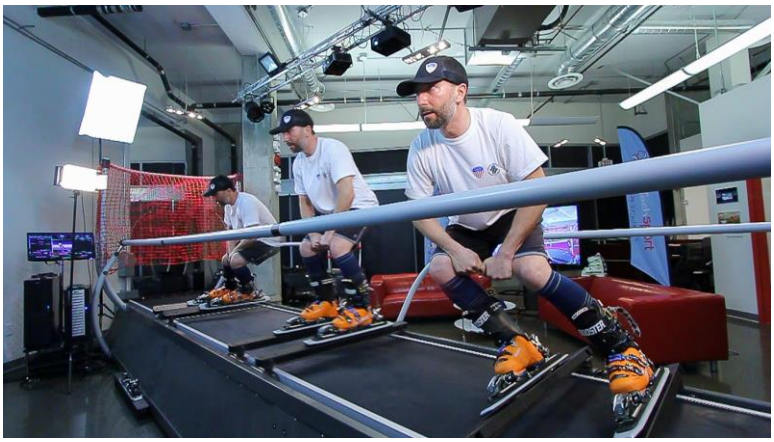
- Hands on knees
  - Hold one hand on each knee while making foot and lower leg tipping movements.
- Both hands on inside knee
  - Place both hands on the inside knee (switching with each edge change). The intent is to physically manipulate the inside knee so it moves in unison with the outside knee,

preventing the very common "A" Frame.

- Hands on inside of knees, pushing out
  - With one hand on each knee, push the knees outward. This exercise keeps the lower legs moving in symmetry for optimal body positioning.

- Hand on outside of knees, pushing in
  - Same as previous exercise.

- Double fists inside of knees
  - Ski with your two fists side by side, with your knees holding them firmly on each side.



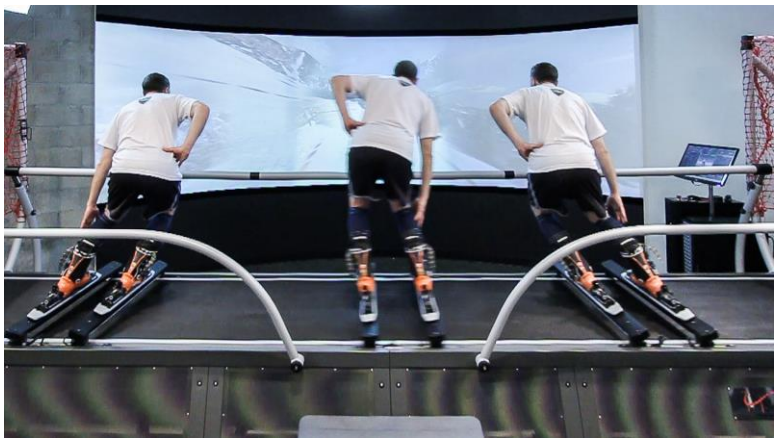
- Ski pole behind knees
    - Hold a ski pole behind your knees, grasp the pole with an overhand grip just outside your knees. With your closed fists, physically push/pull your knees to the desired edges. Repeat as your roll the edges and change direction. This drill helps to emphasize symmetry while insuring ankle flexion throughout the exercise.

### Blending Edging and Weight Shifting

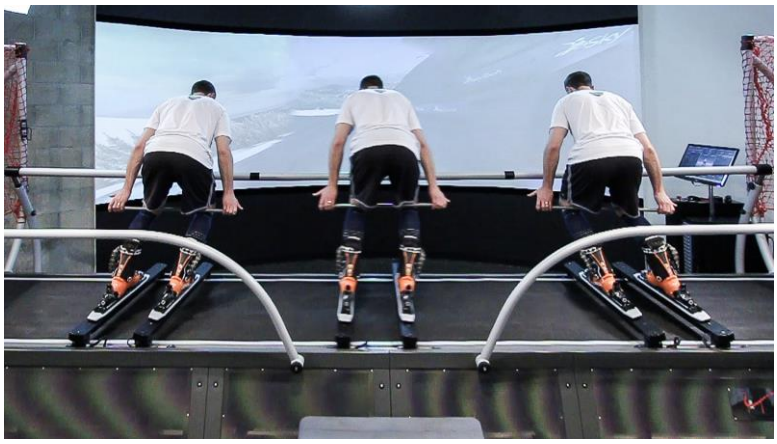
- Edge change with Extension
    - When changing edges, extend the new outside leg to move the center of mass vertically up and over the feet. This type of transition lengthens and oxygenates the muscles and recruits the skeleton for support.
- Edge change with flexion
    - When changing edges, focus on shortening the old outside (support) leg to allow the body to cross over the skis without moving vertically. This type of transition generally can happen more quickly, but it keeps the muscles in the upper legs contracted throughout.
- Heisman Drill/parallel position drill
    - Also referred to as the "Super Man" or "Tea Pot" drill, this exercise reinforces the parallel position of skeletal alignment through a turn. While holding the inside hand/arm at shoulder height, drive the insider shoulder, pectoral, hip and knee forward. In conjunction, hold the outside hand on the outside hip, keeping the upper body stable and quiet. As you transition to the new edges, be sure to change edges BEFORE you change hand position.

- Inside hand on hips, outside hand on outside knee

- Similar to the Heisman drill above, but with adjusted hand positioning. This position draws the outside half of the upper body downward, insuring the shoulders remain level as the skis are tipped on edge.



- Ski pole behind knees, pulling up on inside of knees
  - Hold a ski pole behind your knees, grasp the pole with an UNDERHAND grip outside of your knees. With your inside hand, physically pull the pole forward against the back of the knee, insuring that the inside ankle remains flexed, and the inside foot, knee, and hip move forward through the turn.



# CHAPTER 5 – BIOMECHANICS

This section covers human anatomy and biomechanics. It explores the planes of motion, and describes how bones, joints, and muscles work together to create the movements of skiing.

## INTRODUCTION

Whether throwing a baseball or skiing down a mountain, there are many ways to perform an athletic activity. A fielder can throw a ball with the palm facing upward, downward, or sideways. A pitcher can throw in a straight line, a curve, or with a purposeful drop. Understanding the forces that act on a person and how the body moves allows an athlete to determine the ideal actions for the desired outcome: a fastball, curve, or slider. The same is true for alpine skiing. Effective and efficient movement allows a skier to exert strength against external forces, produce accurate body movements, and accomplish desired ski actions.

The study of **biomechanics** considers the science of living organisms ("bio") and how they act when subjected to forces ("mechanics"). In studying biomechanics, you'll examine anatomy and the forces related to skiing in order to learn how a skier can move effectively and efficiently. Skiing competently (and teaching others to do so) begins with an understanding of how the human body works.

## PLANES OF MOTION

The **planes of motion** provide references that describe the direction of body movements. Human movements happen in three imaginary planes of motion: sagittal, frontal, and horizontal. While you might not use these terms with students, understanding them helps you better understand biomechanical movements and organize them in your mind.

## SAGITTAL PLANE

The sagittal plane divides the body into right and left halves. Fore and aft (i.e., forward and backward,) movements occur in this plane. Flexing at the ankles to move forward toward the ski tips or extending the ankles to sit back are examples of pressure-control movements in the sagittal plane.


## FRONTAL PLANE

The frontal plane divides the body into front and back halves. Lateral movements occur in this plane. Inclining to edge your skis or moving sideways to shift weight from one ski to the other are examples of edge-control movements in the frontal plane.

## HORIZONTAL PLANE

The horizontal plane divides the body into upper and lower halves. Rotational movements occur in this plane. Turning your legs against a stable upper body or rotating 360 degrees off a jump are examples of rotational-control movements in the horizontal plane.

The planes of motion provide a frame of reference when talking about skiing movements made in these planes, but the action of skiing does not exist in one plane only. Skiing movements occur in more than one plane at the same time.

## ANATOMY

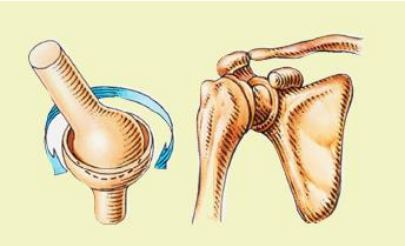
Even though two people may wear the same model of boots and skis, their skiing stance may be very different. Experience aside, anatomy plays a large role in performance. A skier's bone structure, joint movement, muscular strength, and connective tissue all effect how he or she skis.

## BONES

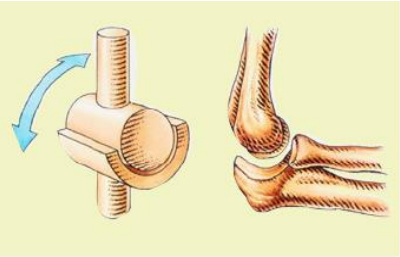
The lightweight yet strong structure of bones provide a framework for body support, protects vital organs, and offers attachment points for muscles and connective tissue. When the bones of a skier's skeleton are aligned, or "stacked," to withstand skiing forces, muscular effort is less strenuous.

## JOINTS

A joint is the juncture where two bones meet. Some joints can only move in one plane of motion, while others can move in all three. The range of motion of a joint is the distance it is capable of moving along the direction of its plane(s) of motion.



A hinge joint flexes and extends in a single plane. For example, the elbow is a hinge joint. The knee is a modified hinge joint; it also glides and permits a minimal amount of rotation.



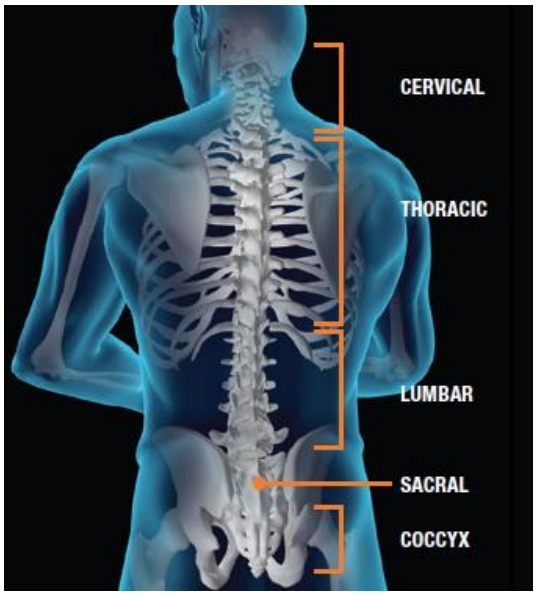
Like a joystick, a ball-and-socket joint has the ability to move in all three planes, giving it a broad range of motion. The hip is an example of ball-and-socket joints.

The joints move in specific ways within their plane(s) of motion. With flexion, the angle between two body parts decreases, as when you flex your elbow to move your right hand toward your right shoulder. In extension, the angle between two body parts increases, as when you extend your knee to straighten your leg. With joint abduction, a limb moves away from the midline of the body, as when you lift and move your leg to the side. In adduction, a limb moves toward the midline of the body, as when you bring your knees together. Rotation occurs in a joint when a part of the body turns in the horizontal plane, as when you rotate your femur in your hip socket to turn your leg inward or outward.

The key joints involved in skiing are the spine, hip, knee and ankle joints, along with two major foot joints.

## SPINE

The spine consists of many bones, called vertebrae, which are separated into four regions: cervical, thoracic, lumbar, and sacral. Movement occurs between the vertebrae except in the sacral region, where the bones of the sacrum and coccyx are fused. The range of motion between any two moveable vertebrae is very limited, yet when several of the vertebrae are involved, the spine as a unit moves significantly in all three planes of motion.



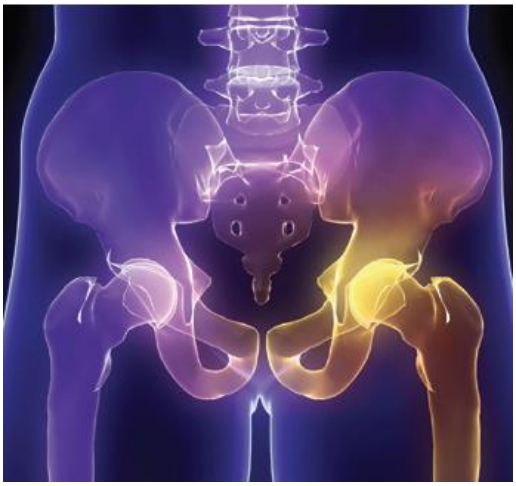

The spine can flex and extend, bending forward or backward in the sagittal plane; flex and extend laterally, bending sideways in the frontal plane; and rotate, twisting left and right in the horizontal plane. It is capable of moving along the planes of motion in any combination.

If they were merely a stack of bones, the 33 vertebrae of the spine would be as vulnerable as the tower of building

blocks in a game of Jenga. The connective tissues and muscles that attach to and surround these bones make the spine a sturdy support for the entire body. For the spine to serve, literally and figuratively, as the "backbone" of effective movements, a skier should employ the strength of the core muscles in the torso. The spine needs to remain stacked in its most biomechanically effective posture to resist strong forces.

The spine's flexibility, a great asset in many circumstances, also means there are many ways to flex or twist the spine into a weaker position. That's why a functionally strong core is critical to skiing. It is only when a skier's core muscles support the vertebrae that the core will be stable enough for the limbs to effectively move against.

### Hip Joint



The hip is a ball-and-socket joint consisting of the side (socket) of the pelvis and the head (ball) of the femur. The femur moves at the hip joint in all three planes, similar to a computer joystick. Technically, the femur rotates, abducts, adducts, and flexes and extends in the hip joint.

The hip's range of motion plays a vital role in skiing. It allows the legs to rotate and turn the skis (rotational-control skill). It allows the legs to flex and extend to manage pressure (pressure-control skill). It also allows the legs to move sideways, whether by lifting a leg outward to the side or by moving the pelvis sideways (edging skill). Rotation, abduction, and adduction of the leg at the hip, combined with knee flexion, allows the knee to "tip" sideways into a turn (rotational, pressure-control, and edging skills).

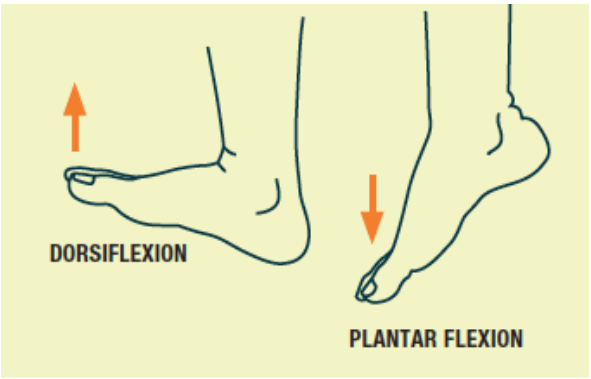
### Knee Joint

The knee is the largest joint of the body and supports nearly all of the body's weight. It connects the femur to the tibia and the patella (kneecap). The knee is a modified hinge joint that allows the leg to bend (flex), straighten (extend), and to rotate very slightly.

Although the knee is primarily a hinge joint, rotation can occur when the knee starts to flex. The amount of rotation increases as the knee flexes toward 90 degrees, with the maximum internal and external rotation at about 25 degrees. Knee flexion combines with pelvic or femoral rotation to incline the lower leg and aid in angulation.

### Ankle, Subtalar, and Midtarsal Joints

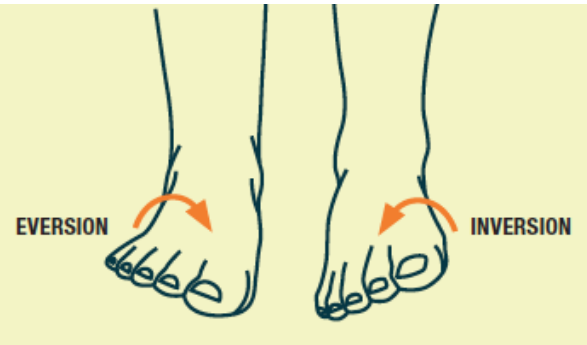
The ankle is the hinge joint connecting the tibia and fibula (lower leg) with the foot's talus bone (which sits above the calcaneus, or heel bone). Movement in the ankle joint allows the foot to dorsiflex and plantar flex.)




**Dorsiflexion** is the flexion of the foot upward, toward the shin (as when you take your foot off your car's gas pedal). **Plantar flexion** is the extension of the foot downward, away from the shin (as when you press down on the gas pedal).

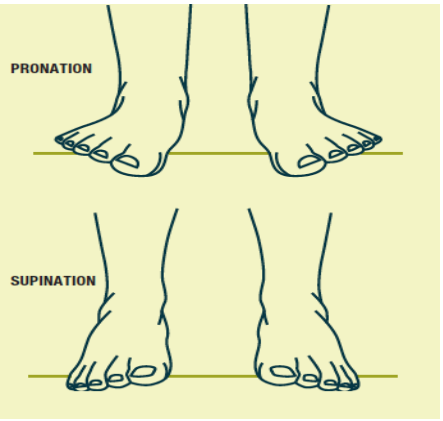
Ankle tension is important for maintaining the flexed position that allows a skier to make subtle, efficient edge and pressure adjustments. Moving the lower

leg toward the foot is a more efficient way to flex the ankle, and certainly less tiring, than pulling the foot upward toward the lower leg (although for a recovery move, this can enable a skier to quickly pull the CM forward when his or her weight is too far back).




The subtalar joint is a gliding joint below the ankle joint, between the talus and calcaneus bones. This is where side-to-side roll of the foot occurs, creating eversion and inversion. **Eversion** is the action of the foot rolling inward, as when you tip the outside ski of a turn onto its inside edge. **Inversion** is the action of the foot rolling outward, as in when you tip the inside ski of a turn onto its outside edge.

The midtarsal joint is a gliding joint crossing the foot between the talus and calcaneus, and bones of the midfoot. The midtarsal joint allows for small amounts of adduction (movement toward the midline of the body) and abduction (movement away from the midline of the body) of the foot.




Pronation and supination are terms that are commonly used in reference to the position of the foot. **Pronation** is a movement that consists of ankle dorsiflexion combined with eversion and abduction of the foot. **Supination** is a movement that consists of ankle plantar flexion combined with inversion and adduction of the foot. Both pronation and supination occur when the foot is weighted.

## MUSCLES

**Muscles** are bands of soft tissue fibers that contract and relax in order to stabilize or move joints. Working in groups, muscles regulate tension for performing complex movements. Muscles move joints through three types of tension: concentric, eccentric, and isometric.

In **concentric tension**, the muscle actively flexes and the fibers shorten (contract) to overcome opposing forces and move the joint, as when the hamstring muscles concentrically create tension to flex the knee.

In **eccentric tension**, the muscle lengthens as a result of exerting less tension or force than the outside force it is working against (such as gravity). It can act as a braking force to slow down or smooth out a movement. For example, when a mogul skier flexes the knees and hips to absorb a bump, the quadriceps and gluteal muscles eccentrically contract to slow the skier's flexion and absorb the bump in a controlled manner. As the tension on these muscles increases, the muscle fibers elongate.

Isometric means "equal measure" — so **isometric tension** does not change the muscle length. An example is the increased tension a skier feels in the quadriceps and gluteal muscles (thigh and butt) from resisting the forces acting at the apex of a carved turn. The skier increases the tension in the quadriceps and gluteal muscles to maintain extension of the outside knee and hip joint (maintaining the leg length rather than changing it).

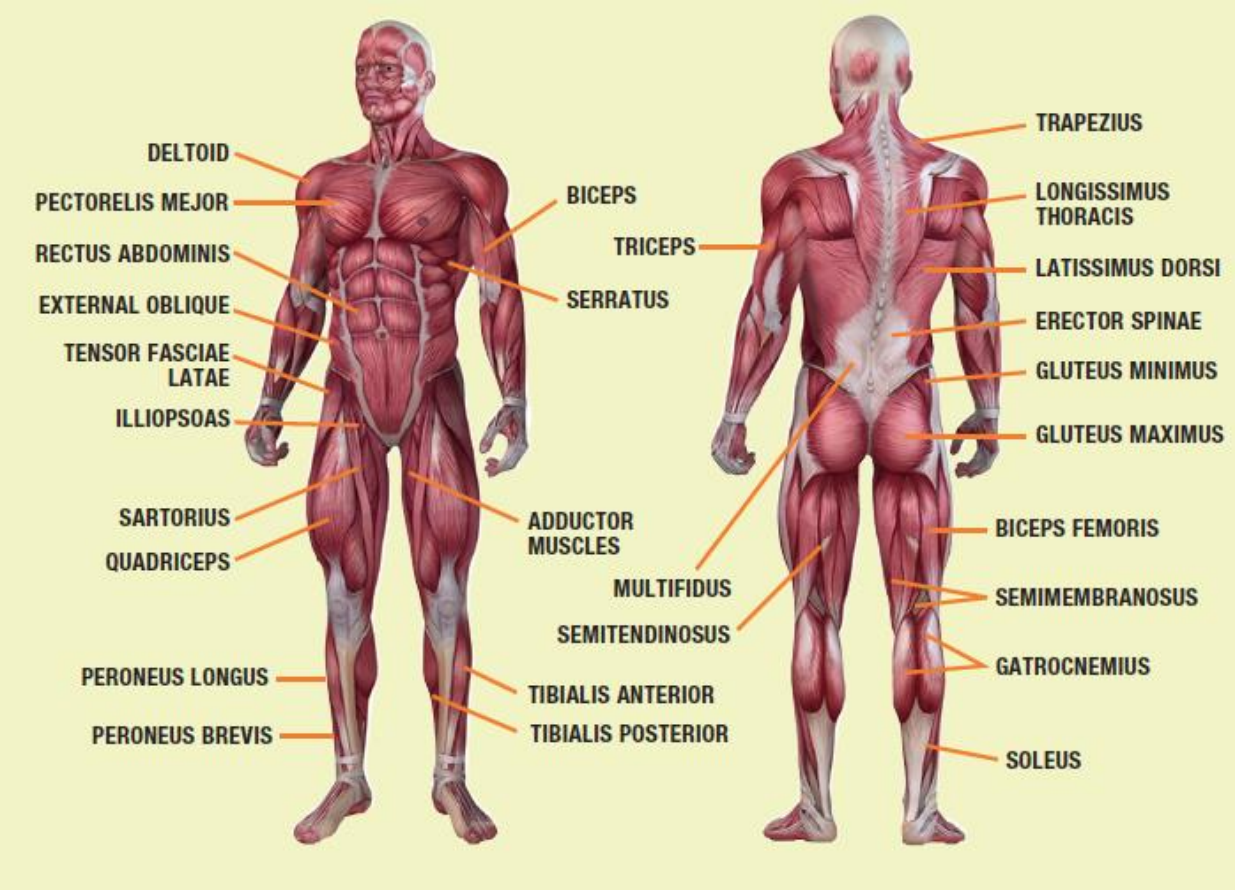
Isometric tension of the core is key for a skier to maintain a stable upper body while skiing. Increased forces due to turning or terrain variations can compromise spinal stability, so functional tension in the core serves to stabilize the spine and pelvis. To maintain this strength and stability, a skier must increase the tension by isometrically contracting core muscles.

Skiing requires a blend of all three types of tension, often simultaneously. Forces acting on a skier change constantly in both magnitude and direction. To manage and stay aligned with these changes, skiers must engage varying forms of tension and balance them with opposing muscle groups. For example, to force buildup from the snow during the shaping phase of a medium-radius turn, a skier is concentrically tensioning the lateral quadriceps while eccentrically tensioning his hamstrings.

Two processes by which muscles create tension are voluntary or reflexive. When a skier completes a turn on gentle, groomed terrain, leg flexion may be voluntary. However, when skiing the zipper line of a mogul run, the legs most often bend reflexively in an automatic response to absorb the terrain.

Any muscular tension requires a stimulus. Flexing the ankles to move forward and pressure the front of the skis requires flexion of the tibialis anterior muscle on the front of the lower leg, near the shin. This happens in response to a brain signal and electrical impulse through the nervous system that causes the muscle to contract. This signal stimulates the nerves in the muscle; a process called **innervation**. Any type of muscular tension or change in tension, whether voluntary or reflexive, requires stimulus. Competent skiers maintain a functional degree of tension to some degree at all times in order to stimulate (or innervate) the muscle groups required for management of, and reaction to, forces. This "functional tension" allows a skier to react more quickly, adapting to ever-changing speeds, terrain, and snow conditions.

In general, skiing with functional tension describes having a degree of tension in the following muscles and muscle groups used in alpine skiing.




## TORSO

In most examples of effective skiing, the legs turn and tip under a stable upper body. Torso muscles are commonly referred to as the "core" muscles. Recall that the spine, and therefore the torso, is inherently unstable. The primary purpose of the core muscles is to add stability to this structure, allowing a skier to accurately make adjustments for balance. Core muscles also create the torque required to rotate and tip the legs as needed. Primary torso muscles are:

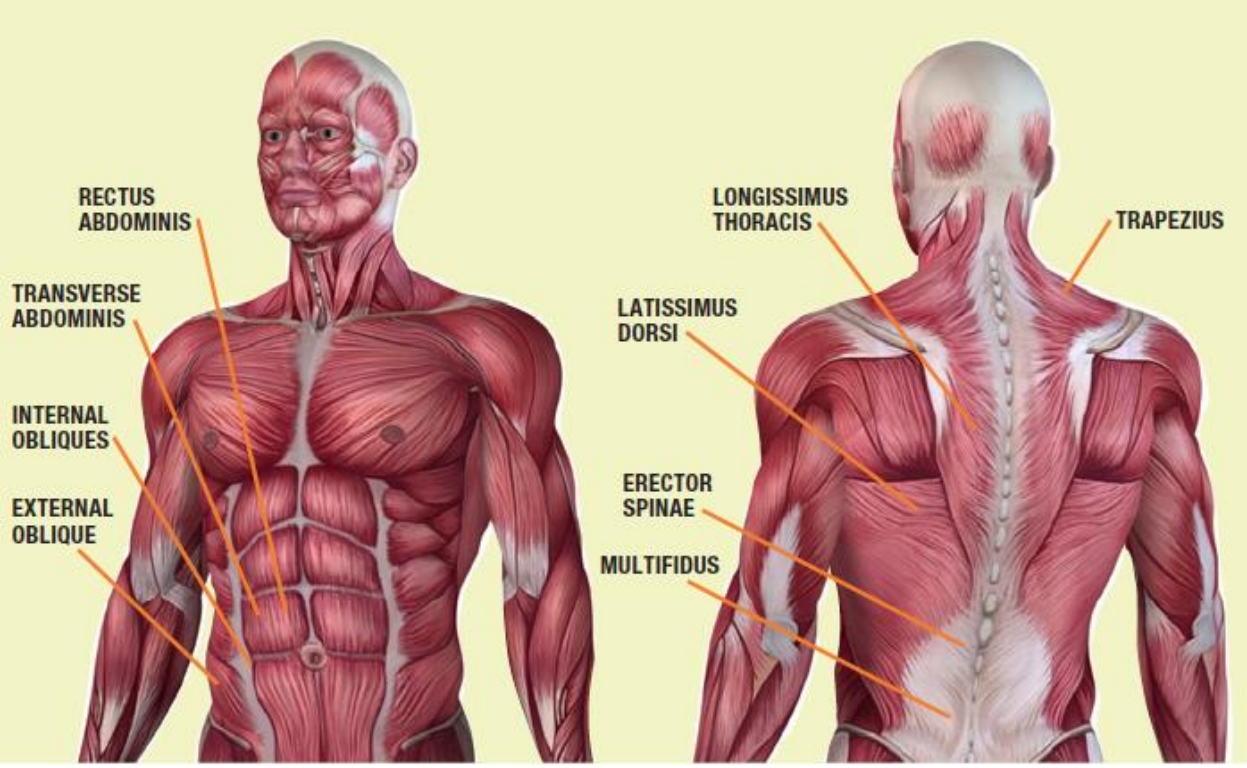
- Transverse abdominis: These are the deepest of the core muscles, essential for stabilizing the lumbar spine.

- Internal and external obliques: These muscles assist in breathing, and help stabilize and control lateral flexion of the spine (frontal plane).
- Multifidus: This muscle group is responsible for initial stabilization of the lumbar spine during physical activity. Engagement of this muscle group allows force to be directed over a larger area. In doing so, they help protect from harm the discs that cushion spinal vertebrae.
- Rectus abdominis: Often called the “six pack,” the rectus abdominis is primarily responsible for flexion of the lumbar spine.

Together, these primary muscles of the core make up “the natural belt” that stabilizes the lower back. These muscles must be engaged for a stable upper body.

The following muscles and muscle groups also constitute part of the core. They play an important role in stabilizing and controlling movements of the upper body, and therefore play an essential role in balancing movements.

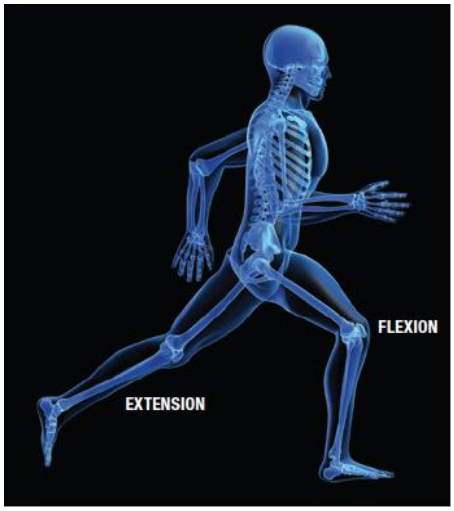
- Erector spinae: This muscle group is responsible for extending the vertebrae, or back extension.
- Latissimus dorsi: This muscle is responsible for arm extension, adduction (lateral flexion), and rotation.
- Trapezius: This muscle primarily effects movements of the arms and shoulders, but can effect movements of thoracic and cervical spine.
- Longissimus thoracis: This muscle is primarily responsible for movements of the head and extension of the thoracic vertebrae.




The pelvis is part of the upper body. The gluteus maximus, among other muscles, helps stabilize both the pelvis and upper body. Many of the muscles in the pelvic area can also be described as part of the core.

### Pelvis and Hip Joint

Muscles around the pelvis serve to control the hip joint, which moves in all directions in a complex relationship of muscular actions and range of motion. For the sake of simplicity, individual muscles are grouped into categories of movement.




### EXTENSION

These muscles play an important role in all extension movements, and in managing and resisting pressure coming from the snow. They also help control the rate of flexion.

- Gluteus maximus (butt)
- Hamstrings (back of thigh)

### FLEXION

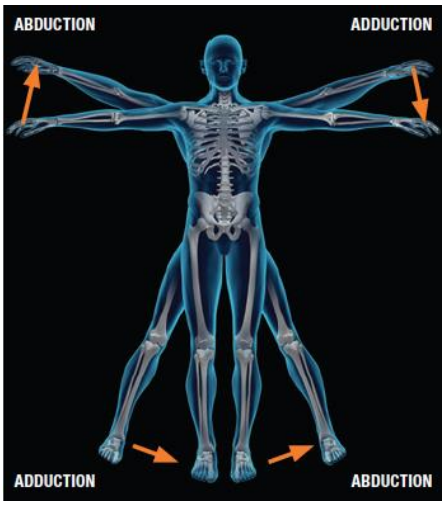
These muscles play an important role in all flexion movements, and in managing pressure. These muscles also help control the rate of extension.

- Iliopsoas (front of thigh through top of pelvis)
- Sartorius (inner thigh)
- Rectus femoris (part of the quadriceps muscle)

### ABDUCTION

These muscles aid in lateral balance, and in aligning the skeletal structure with forces acting on it. They also play an important role in rotation of the skis.

- Gluteus medius (outer/side of pelvis)
- Sartorius (inner thigh)




### ADDUCTION

The following muscles help stabilize the skis and keep the skier's CM in alignment with the inside edge of the outside ski. They also play an important role in ski rotation.

- Adductor longus (inner thigh)
- Adductor brevis (inner thigh)
- Adductor magnus (inner thigh)

### ROTATION

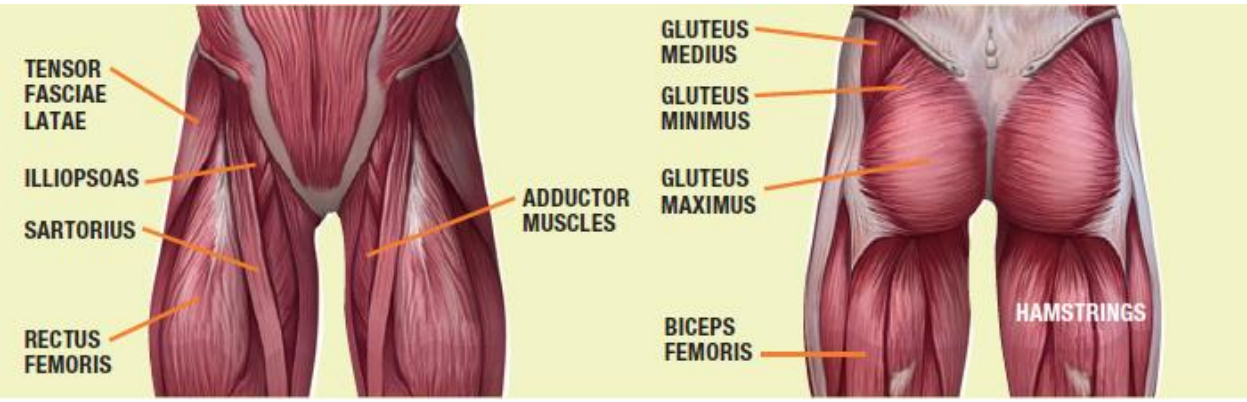
Rotation of the femur – whether internally or externally – is one of the main ways to control the direction the skis point. A number of muscles play a supportive role in femoral rotation; this list includes only the primary muscles.

Internal rotation:

- Gluteus minimus (outer/side of pelvis)
- Tensor fasciae latae (outer thigh)

External Rotation:

- Gluteus maximus (butt)
- Gluteus medius (outer/side of pelvis)
- Sartorius (inner thigh)
- Adductor brevis and magnus (inner thigh)




## Upper Leg

The primary functions of the upper leg muscles are to flex and extend at the knee. The knee is crucial to all aspects of pressure management: lateral, fore/aft movement, and the overall magnitude of skiing forces.

### Quadriceps (front of thigh)

The quadriceps femoris is a group of four large muscles located on the front of the femur. When contracted, the quadriceps muscle extends the knee. One of the quadriceps (rectus femoris) also assists in flexing the hip joint.

### Hamstring (back of thigh)

Located on the back of the femur, the hamstring consists of three muscles (semitendinosus, semimembranosus, and biceps femoris) acting together. When contracted, it flexes the knee joint. It also helps extend the hip joint.


## Lower Leg

The muscles of the lower leg control foot and ankle movements. Because the ankle is in direct contact with the ski boot, and the boot is the lever that transmits forces to the ski, ankle movements are crucial for fore/aft adjustments in skiing. Many of the following muscles in the lower leg also work to maintain standing posture and aid in knee flexion.

### Tibialis anterior (shin)

This is primarily responsible for ankle flexion or dorsiflexion, and is essential for managing fore/aft pressure control. The tibialis anterior in also involved in foot inversion.


### Gastrocnemius and Soleus (calf)

These two muscles on the back of the lower leg constitute the calf. While the gastrocnemius flexes the knee, they both plantar flex the ankle, and help maintain standing posture.

### Peroneus longus and brevis (outer side of calf/lower leg)

These two muscles create foot eversion and aid in ankle plantar flexion.

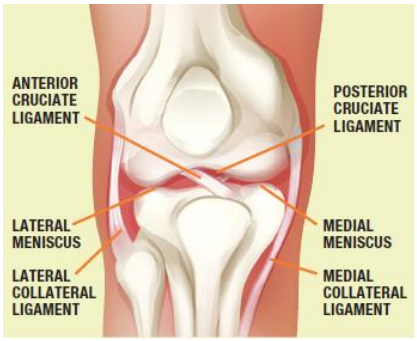
### Tibialis posterior (middle lower leg)

This is a key stabilizing muscle of the lower leg. Also aids in foot inversion and ankle plantar flexion.

## Connective Tissue

Connective tissue supports, connects, or separates different types of tissues and organs. The two kinds of connective tissue most commonly referred to in skiing are ligaments and tendons.

### Ligaments




A ligament is a band of tough, dense, fibrous tissue connecting bones to other bones. Ligaments are important components of both structural and joint stability. For example, the anterior cruciate ligament (ACL) is a large ligament connecting the back of the femur to the front of the tibia. When the hamstring muscle stretches past an effective point, the ACL is one of the primary ligaments that serves to maintain knee joint stability.

### Tendons

Tendons and ligaments are both made of collagen, but tendons connect bone to muscle, rather than bone to bone. When a muscle tenses, it applies force, pulling the tendon(s) connecting a muscle or muscle group to a bone. As force is transmitted through the tendon to the bone, a joint flexes or extends. Tendons also have elastic qualities, which help manage forces acting on the body and aid in stability.

### Summary

Skiing requires a continuous flow of movement and, unlike baseball, takes place on a variable, slippery surface. As with throwing a baseball, there are many ways to perform movements. The ability to identify key bones, joints, and muscles – and understanding how the body moves – will help you make choices conducive to effective, efficient skiing. With this knowledge, you're better armed to achieve your desired outcomes and help your students achieve theirs.

# CHAPTER 6 – PHYSICS OF SKIING

This chapter covers general physics concepts and terminology, and explains the science of skiing. It addresses the forces involved when skis interact with the snow and how to manage these forces in skiing. The SkyTechSport Sports Ski Simulator replicates many of the sensations of skiing, but does not exactly replicate the forces that create turning on snow. As an instructor, it is important to understand how the movements trained on the ski simulator will be applied on snow. A basic understanding of the physics of skiing will enhance your use of the simulator and enable you to better translate the simulated to on-snow environments.

## INTRODUCTION

Physic**s** is the study of matter, energy, motion, and force. These are the natural laws that govern every turn skiers make in every condition possible. Learning about physics concepts helps you learn about forces involved when skis interact with the snow, how skiers create or manage these forces for different turn outcomes, and how they balance forces to remain upright. A greater understanding of the basic laws of physics results in a greater understanding of ski turns.

## BASIC ELEMENTS

The basic elements of physics include several of the concepts already addressed in this manual, and those you may have learned about elsewhere. Some may be completely new to you. By grounding yourself in the fundamentals of physics, you'll better understand what skis and skiers are capable of doing.

### FORCE

A force is a push or pull that acts on a body, changing its position or speed. The forces that are most relevant to skiing are gravity, friction, and centripetal force.

### PRESSURE

Pressure is the amount of force distributed over a given area. It is expressed by the unit of force divided by the unit of area (P=F/a); where "P" is pressure, "F" is force, and "a" is area; such as in pounds per square inch. In alpine skiing, we talk about managing pressure from ski to ski, along the length of the ski, and by controlling the magnitude of pressure.

- Ski to ski: Your weight (the force of gravity) can be distributed more over two skis than one ski. The total weight (or force) remains the same, but the pressure on one ski would be greater than if it was divided between two skis.
- Along the length: If you move your weight toward your ski tips, your weight or force would remain the same, but the pressure would increase toward the front of the skis.
- Magnitude of pressure: You exert the same force (body weight) on a flat ski as on an edged ski, but the force is distributed along a smaller area when the ski is on edge. Therefore, pressure is greater along the edge of the ski than along the ski's base.

### CENTER OF MASS

A person's center of mass (CM) is the central balance point of body mass. In a straight run, a skier's CM in an athletic stance varies from person to person, but in general, it is slightly behind and below the navel.

As a skier moves, the CM moves; it is not a set point. It moves forward as the skier rocks forward to pressure the ski's front. It moves laterally as the skier tips the skis onto a steeper edge. The location is different in a tuck position than in an upright stance.

### Momentum

An object's momentum is equal to its mass multiplied by its velocity (speed). A skier's mass stays the same but as speed increases, momentum builds. A skier's rate of travel stays nearly constant while sliding down a smooth, gentle slope. As steepness increases, the skier's speed and momentum also increases.

### Newton's Laws of Motion

Newton's Laws of Motion describe the relationship between the forces acting on a body and the resulting motion. These universal laws help explain how skis interact with the snow.

- Law #1: An object remains at rest or continues to move in a straight line at a constant speed if there are no unbalanced forces acting on it. This principle is called inertia, the resistance of an object to change its state of motion or rest.
- Law #2: When the forces acting on a body are not balanced, the net force causes the body to accelerate. This is expressed as F = ma. The net force is "F," the mass of the body is "m," and the resulting acceleration of the body is "a." When "F" is a lateral (sideways) force, it causes a constant change of direction instead of a change of velocity (speed), resulting in motion along a circular path. Technically, circular motion is a form of acceleration.
- Law #3: Every force has an equal and opposite reaction force. When a skier stands on the snow, he or she pushes down by the force of gravity, and the snow pushes up with an equal force. Forces are balanced, that is, the net force is zero.

## Forces

The forces that are most relevant to skiing are gravity, friction, and centripetal force.

### Gravity

On a horizontal surface, gravity pulls the skier down upon the snow, such that he or she compresses snow beneath the skis. The gravitational force is equal to the skier's weight.

### Friction

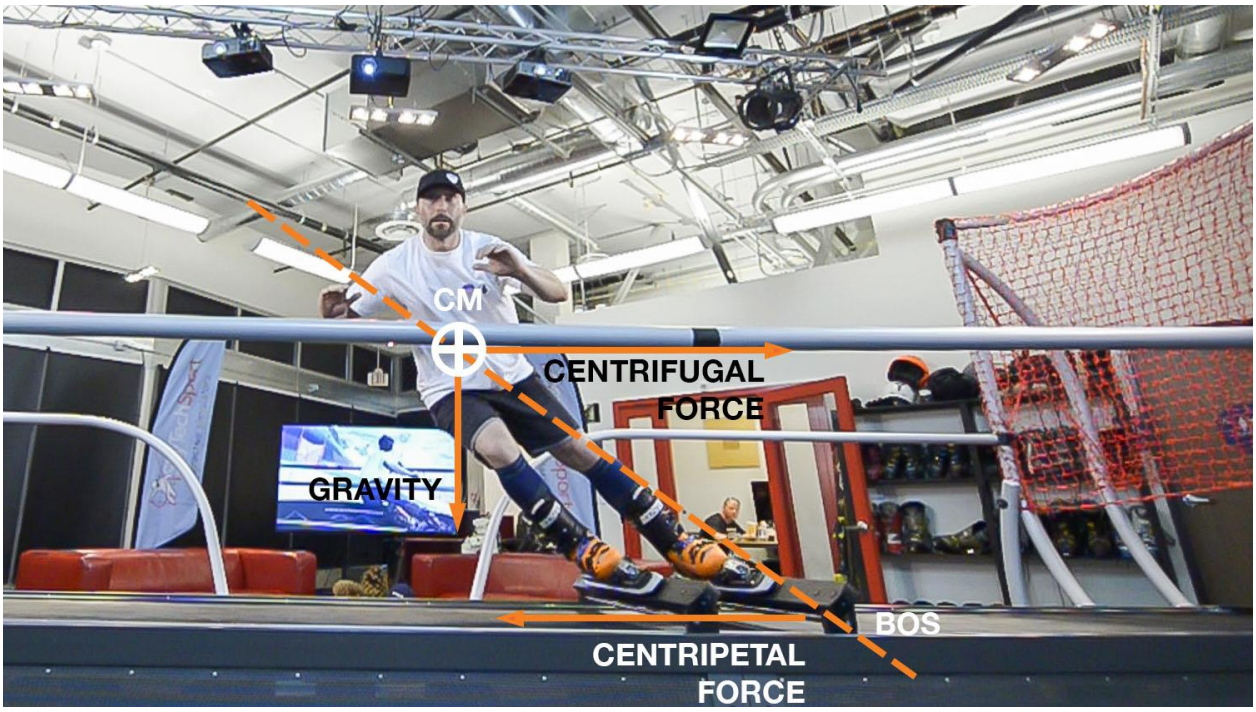
Friction is a force that opposes motion, acting in the direction opposite to forward motion. The uphill (resisting the sliding) frictional force exerted by snow upon the ski is balanced by a downhill frictional force of the ski sliding on the snow. For example, a skier standing still on flat terrain or a very gentle slope does not move because gravity and friction (the two acting forces) are in balance. A skier exiting a chairlift and accelerating down the ramp travels forward because the component of gravity pulling the skier down the ramp is stronger than the friction exerted by the snow.

Different snow conditions and temperatures create different magnitudes of friction. The degree of friction is extremely low while skiing on ice on a relatively warm day, and high while skiing on the sharp, crystalline snow of a very cold day. When skiers hit a bare surface (no snow) during a spring thaw, the degree of friction is very high, usually causing them to decelerate abruptly, and perhaps pitch forward into a fall. In scientific terms, the force of friction is equal to the perpendicular component of force on the snow multiplied by the effect of friction.

### Centripetal Force (Lateral Force)

Centripetal force in a turn is the lateral (sideways) force from snow (simulator) pushing against the edged skis. It is an inward force, toward the center of the turn and parallel to the surface of the snow. This force from the snow causes the edged skis to bend and then turn. Since the force is perpendicular to the

direction the skis travel, it does not oppose forward motion and the skier's speed does not change. In a carved turn, increasing the edge angle increases centripetal force and decreases the turn radius, resulting in a sharper turn. In a skidded turn, depending upon snow conditions, the lateral force is partly or largely a frictional force.




While turning, skiers may feel the sensation of being pulled to the outside of the turn and down the hill. This sensation is often referred to as centrifugal force, but it is actually inertia and gravity. Skiers can balance against the outside ski and stay in the arc of the turn because of the interaction of the skis in the snow due to centripetal force. This force can come from an edged ski in the snow, the base of the ski in powder, or even a terrain feature — such as when a skier turns on the wall of a halfpipe or makes a banked turn caused by a rut in a race course. The groove that is made by a ski cutting through ice creates very little platform for balance. This explains why skiing ice is so difficult.


## Further Application of Physics

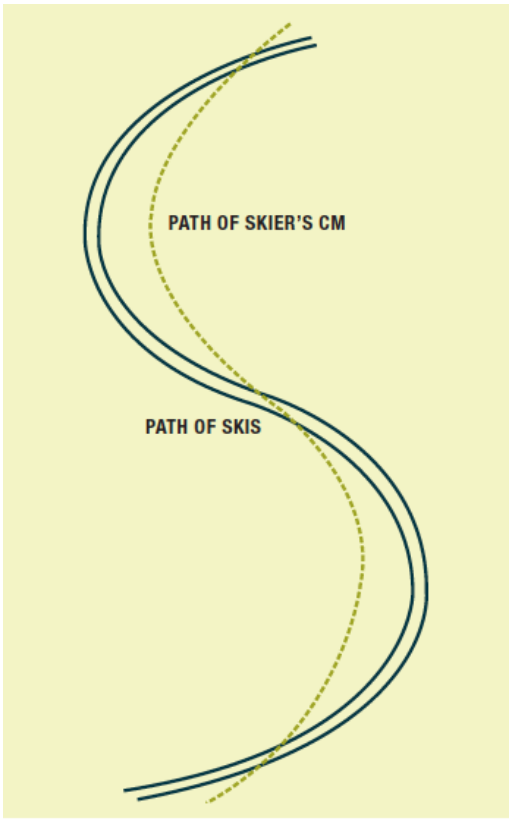
This short physics lesson has a few more elements to cover before you can explore these concepts in your own skiing and with students.

### Center of Mass Relative to Base of Support

When a skier slides downhill in a straight run, force from the snow is perpendicular to the ground and the base of the ski is parallel to the surface of the slope. The path the skier's CM travels is directly over the path of his or her base of support (BOS), which is the location of the skier's weight on the snow.

During a turn, the skier's CM will always be inside the path of the BOS (i.e., the path of the skis).

Since centripetal force acts toward the center of the turn and not straight up from the ground, the skier must move the CM laterally to the inside of the turn in order to remain in balance. In a turn, a skier balances predominately against the outside ski, with the BOS located underfoot and along the inside edge of the ski.




Lateral movement of the CM toward the center of the turn is called inclination. Since the path of the CM is always inside the path of the BOS, some inclination (most often, angulation) is present in all turns. The degree a skier must incline depends upon the magnitude of the centripetal force.

A skier cannot wait for centripetal force to build and then move toward the inside of the turn — he or she must make the first move. The action to tip the skis on edge requires moving to the inside of the curved ski path. Tipping the skis on edge is necessary for the pressure to build and skis to bend. This conscious move to the inside of the turn prepares the skier for pressure buildup, and creates alignment for balancing predominantly against the outside ski.

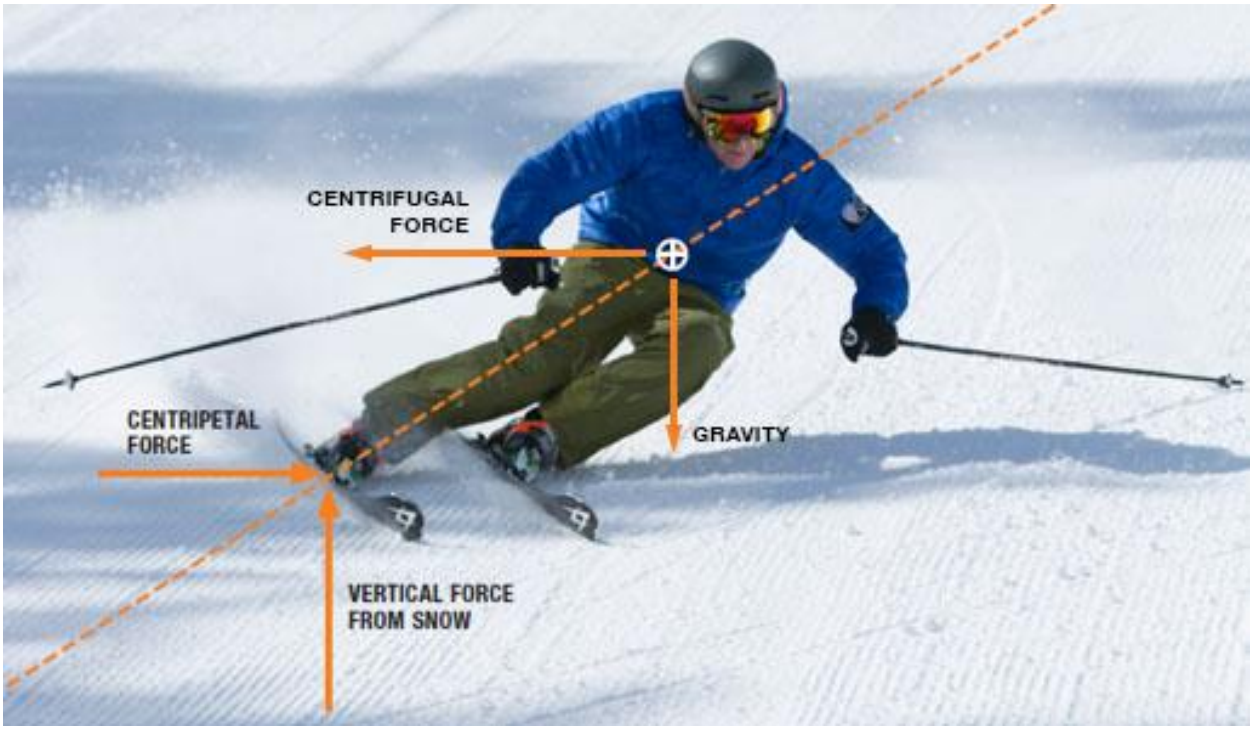
A skier's lateral movement is accompanied by forward movement, which, in combination, directs the body diagonally down the hill in medium or long turns, and relatively straight down the hill in short turns.

If a skier's diagonal movement is not perfectly timed, or if the skis don't react as predicted, adjustments are necessary: whether big, subtle, or constant. Often, a skier leans in, or moves too quickly or too far toward the inside at the start of the turn. He or she usually counteracts this by trying to redistribute weight toward the outside ski, often by increasing angulation. The adjustment helps to move the skier's CM back over the BOS (inside edge of outside ski) so forces are balanced and the skis turn along the intended path.

### Ski-to-Snow Interaction

For turning to take place, the edge of the ski must grip the snow. When the ski tips on edge, it creates a small platform for gliding. The ski must penetrate and compress the snow to create a platform, and the platform (snow) must support and push back against the ski.

In a carved turn, snow pushing back against the edged ski causes it to bend, and therefore travel in an arc through the snow. On hardpack or ice, snow reacts to the ski very quickly since it cannot compact very much. In powder and softer snow, the reaction that creates turning happens more slowly as the snow must compact to a point where it is dense enough to push back against the ski and cause it to bend.




### LINE OF ACTION

The **line of action** is the line along which a force is acting. In a turn, the line of action passes through the inside edge of the outside ski and through the CM. The force vector working along the line of action is the result of two components: centripetal (horizontal) force and the vertical force from the ground pushing up against the ski, supporting the skier's weight. Since the line of action passes through both the ski edge and the skier's CM, the angle of the line of action equals the degree of inclination the skier must experience, due to the forces acting on the skier throughout the turn.

## SUMMARY

Sliding straight down a snow-covered hill is ordinarily great fun, but the sensation of changing direction can be extraordinary. The skis' interactions with snow enables the exhilaration felt when one turn flows perfectly into the next. Understanding physics concepts can deepen your knowledge of how the skills of skiing interface to shape turns, manage speed, and keep skiers in balance over ever-changing terrain.

# CHAPTER 7 – GLOSSARY

## A

**Abdominal muscles:** The muscles between the chest and pelvis; and enclosing the stomach, intestines, liver, spleen, and pancreas.
**Abduction**: Movement of a limb away from the body's midline.
**Absorption**: Allowing the leg muscles to relax and joints to flex in response to forces applied to the skis, creating a momentary reduction in force.
**Acceleration:** The rate at which an object's velocity changes over time, including both magnitude and direction.
**Active:** Movements generated to change the ski-to-snow interaction.
**Adduction**: Movement of a limb toward the body's midline.
**Aerobic exercise:** Increased exertion under oxygenated conditions, as opposed to anaerobic (without oxygen) exercise. The intensity of aerobic exercise allows it to be performed for a sustained period of time. Examples are running, swimming, and nordic track skiing.
**Aft:** Toward the tail of the skis. Also see Fore.
**Agility:** The capability to move quickly and easily.
**Alignment:** Positioning the body so that forces derived from the interaction of the skis on the snow pass through the body's center of mass to produce the intended movement. This is optimized when the skis and boots are selected and/or modified to either complement or correct body movement to enhance strength and predictability of movement.
**Alpine skiing:** The term used to distinguish downhill skiing from its nordic counterparts. This type of skiing evolved from nordic skiing with the invention of ski lifts and fixed-heel bindings.
**American Teaching System™ (ATS):** An evolving system of student-centered methods, models, and philosophy of teaching snowsports – as collected, developed, and disseminated by PSIA-AASI.
**Anatomy:** The science of bodily structure.
**Anaerobic exercise:** Exercise in which energy is released without the use of oxygen. The body releases this type of energy via a phosphate energy-delivery system that is later replenished by oxygen. Anaerobic activities that require short bursts of energy include skiing or riding in demanding conditions such as moguls or race courses.
**Angulation**: Laterally tipping the body relative to the slope while creating angles between various body parts, primarily at the hips and knees; used to adjust platform and edge angles, and to counteract forces, especially in short-radius turns. Examples are hip angulation and knee angulation.
**Arc:** The curved path of the skis during a turn. Also the flight path off a jump, which, ideally, aligns the skis to land flat on the pitch of the landing zone.
**Athletic stance**: A body position in which the skier is in balance without excessive leaning (laterally, fore, or aft) and is aligned over the feet. Defined by the ability of the athlete to move in any direction at any time.
**Auditory learners:** Students who process information verbally and cognitively. These students enjoy descriptions and talking about their experiences.
**Axis:** A line about which something rotates; a reference line for human movement.

## B

**Balance**: A state of equilibrium that provides both a source of and an outcome for effective movement; when the center of mass is aligned through a skier's base of support with the forces generated from the snow.
**Balancing movements:** Muscular actions to maintain equilibrium, or the desired alignmentThese movements are usually divided into two categories: 1) actions that affect fore/aft balance and 2) actions that affect lateral balance.
**Ball-and-socket joint**: A joint where a ball-shaped surface of one rounded bone fits into the cuplike depression of another bone. This type of joint can move in all three planes, giving it a broad range of motion. The hip and shoulder joints are ball-and-socket joints.
**Base:** The bottom surface of skis.
**Base of support (BOS)**: The location of a skier's weight on the snow.

**Beginner/novice zone:** A component of the “skier zones” used to categorize general ability
**Bindings:** Devices that attach skis to the boots.
**Biomechanics**: The study of mechanical principles affecting movement of the living body.
**Body performance:** An element of movement analysis in which the instructor observes how a student’s body movement influences performance.
**Bones**: The lightweight-yet-strong structure that provides the frame that keeps the body supported, protects vital organs, and provides attachment points for muscles and connective tissue.
**Boot alignment:** Adjustments made to a skier’s footbed, cuff, and/or boot sole to achieve more optimum alignment.
**Boot flex:** Because ski boots are designed to transfer energy to and from the skis, they should support certain movements of the ankle and lower leg but resist others. Proper flex is determined by the skier’s weight, ability level, and typical skiing speed.
**Boot shell:** The outer casing of the boot, without the liner, which represents the overall size and shape characteristics of the boot.
**Brake:** To slow down by interrupting the flow of a turn; also the claw-like device of a ski binding that drags in the snow to stop a ski that’s been separated from the boot.
**Bumps:** See Moguls.

## C

**Cant:** A wedge-shaped item that can be placed under a boot or binding to align the boot from side to side; or to make adjustments to a boot/binding setup to align the boot from side to side.
**Canting:** The process of making lateral adjustments to skis, binding, or boots for optimal alignment and effective edging. Canting is typically an exterior addition or subtraction to the equipment.
**Carved turns:** To make turns with minimal skidding by tipping the skis on edge and allowing the shape of the device to create a turn with minimal lateral slipping or skidding. Carved turns display clean, long arcs in the snow as the entire edge of the ski passes through the same point in the snow. A skidded turn, by contrast, utilizes more muscular rotary movements to cause the ski to turn.
**Cause-and-effect relationships:** An element of movement analysis in which the instructor evaluates the cause or origin of an action and its effect or result.
**Center of mass (CM)**: The central balance point of a person’s body mass. Also known as the center of gravity.
**Centripetal force**: Occurring in a turn, centripetal force is the lateral (sideways) force from the snow that pushes against the edged skis. It is an inward force, toward the center of the turn and parallel to the surface of the snow.
**Check for understanding:** To determine whether students understand a task, exercise, or concept.
**Concentric tension**: In this type of tension, the muscle actively flexes and the fibers shorten (contract) to overcome opposing forces, and move the joint.
**Connective tissue**: Tissue, such as tendons and ligaments, that supports, connects, or separates different types of tissues and organs of the body.
**Coordination:** The harmonious functioning of muscles to execute movements.
**Corrective feedback:** External feedback an instructor delivers to suggest more efficient or effective movements for a specific outcome.
**Cuff adjustment:** A means of making a boot more closely match lower leg shape by changing the lateral alignment of the cuff.

## D

**Deceleration:** A colloquial term often used to describe slowing speed or velocity; also called de-acceleration.
**Demonstrate:** To perform a task or exercise highlighting particular movements.
**Desired outcomes:** The goals of a lesson, or task within the lesson, which are largely based upon what the student wants to achieve but can also represent an effect of a particular lesson strategy to achieve those goals.
**Direction:** An element of movement analysis in which the instructor not only observes the duration, intensity, rate, and timing of body movements but also the direction of the movement or action of the skis.

**DIRT**: Acronym for the elements of movement analysis in which the instructor observes the duration, intensity, rate, and timing of a skier's movements. These are quantifying terms that attach a value to the movements observed in a movement analysis process.
**Dorsiflexion**: Ankle flexion of the foot upward, toward the shin.
**Down unweighting**: A quick flexion of the legs that produces a momentary reduction of pressure as the skier's center of mass falls.
**Drill:** A task or exercise used to enforce a desired performance or retain knowledge; or to practice or repeat an exercise.
**Duration**: The length of time a movement occurs (which the instructor observes as a quantifiable element of movement analysis).
**Dynamic balance:** Balance in motion; see Balance.
**Dynamic turn:** A parallel turn with more carving than skidding. Energy stored in the ski during one turn is released to aid the start of the next turn. In contrast, a non-dynamic turn relies on more muscular rotary movements to cause the ski to turn.

## E

**Eccentric tension**: In this type of tension, the muscle lengthens as a result of exerting less tension or force than the outside force it is working against.
**Edge:** A metal strip inserted between the base and the core on the side of a ski; the edge can be sharpened, allowing a skier to slice through hard snow and ice.
**Edge angle:** The amount of ski tilt relative to the surface of the snow and to the hill. A ski placed flat on the snow has zero degrees of edge angle. The greater the edge angle and equipment sidecut, the shorter the turn radius.
**Edge control**: Tipping the skis relative to the length or longitudinal axis of the skis. Skiers use this skill to increase or decrease the angle of the ski to the snow.
**Edging:** One of the three basic ski skills, as defined by an early version of the Skills Concept (circa 1977). Also known as edge control.
**Edging movements:** Movements that increase or decrease edge angle. Edging movements are one of the skills of the early PSIA Skills Concept.
**Effective posture:** The body position from which a skier has the greatest amount of movement options. See Athletic Stance.
**Efficiency:** The expenditure of the minimum amount of energy required to accomplish a given task; the expenditure of the required amount of energy to get the maximum performance from the equipment; or the ratio of the input energy to the output movement or performance.
**Equilibrium**: A state of balance between opposing forces.
**Eversion**: Movement of a body part outward, away from the midline of the body, such as lateral rotation of the foot. Typically, this is associated with foot pronation. See also inversion.
**Exercises:** Situations and tasks instructors create to break down and isolate certain movements and skills for development. Exercises are often combined into a progression, or exercise line.
**Experiential learning:** Learning through experience. Instructors create situations through use of terrain or tasks for students, enabling them to learn first-hand how to apply knowledge presented during the lesson.
**Extend:** To make longer; to stretch or open, e.g., extend a joint.
**Extension**: Any movement that increases (i.e., opens) the angle (as expressed in degrees) of a joint. At times, the skier extends the knee, hip, and ankle joints simultaneously. Also see Flexion.
**Extrinsic feedback:** A reward given to a student for a good performance; undermines intrinsic motivation. Also see Intrinsic motivation.

## F

**Fall line**: An imaginary line that follows the steepest line of descent; the path along which a ball would roll if released down the slope.
**Fan progression:** An exercise line in which the skier performs a movement or skill in progressive steps, with each step being slightly more challenging that the previous one; specifically one in which the skier starts with a shallow traverse and builds to steeper arcs in the fall line.

**Feedback:** Information instructors give students about their performance; helps clarify if and/or what action is needed to achieve a desired result; or information instructors receive from students by watching and listening,
**Finish phase**: The last third of a turn, beginning shortly after the fall line and continuing until the skier achieves the desired direction change.
**Flexion**: Any movement that decreases (i.e., closes) the angle (as expressed in degrees) of a joint. Often, this entails bending the knee, hip, and ankle joints simultaneously. Also see Extension.
**Flexors:** The muscles that cause flexion at a joint.
**Footbeds**: Inserts for ski boots designed to support the foot and/or provide a neutral stance.
**Fore:** Toward the tip of the skis.
**Forward lean:** Measured in degrees, the design of a boot that establishes a certain amount of ankle dorsiflexion and limits plantar flexion; adjustable in some boots.
**Force**: A push or a pull that acts on a body and changes its position or speed; a vector quantity arising from contact or at a distance. The forces most relevant to skiing are gravity, friction, and centripetal force.
**Freestyle:** A style of skiing (or snowboarding) that encompasses jumping, butters/presses, halfpipes, rails/boxes spines, tabletops, and other natural and manmade terrain features.
**Friction**: Resistance to an object sliding across a surface. A ski sliding on ice experiences less friction than a ski sliding through wet snow.
**Frontal plane**: An anatomical plane that divides the body into front and back halves. Lateral movements occur in this plane.
**Fundamental movements:** An umbrella term for how skiers move. These movements include flexion/extension and rotation; and specific references such as inversion/eversion, supination/pronation, and adduction/abduction.

## G

**Garlands:** A series of linked “half turns,” in which the skier turns down the fall line, then turns back across the hill in the original direction of travel.
**Giant slalom:** A course set with gates a skier must pass through; the vertical distance between gates is 10 to 13 percent of the total vertical drop.
**Gliding wedge:** A means of developing early ski skills and speed control without turning, in which the skier adjusts the width and size of the wedge (e.g., from large wedge to small wedge back to large wedge) to get a feel for the slipping action of edged skis over the snow.
**Goal:** A purpose, aspiration, intent, outcome, or end to be met.
**Gravity**: A force acting perpendicular to the earth's surface; a primary motive force in snowsports.

## H

**Hinge joint**: A joint in which a convex part of one bone fits into a concave part of another, allowing motion in only one plane. Knee and finger joints are hinge joints.
**Hockey stop:** A maneuver in which the skier quickly turns the skis sideways to the direction of travel and sets the edges, causing the skis to skid rapidly to a stop.
**Hop:** To move by leaping or springing from both feet at once; or the movement thus created.
**Horizontal plane**: An anatomical plane that divides the body into upper and lower halves. Rotational movements occur along this plane.

## I

**Inclination**: Any kind of tipping of a body part relative to the slope. A skier can incline the entire body into the slope (banking) or tip different parts to a different degree (angulation). Inclination is the general term for any lateral movement of a skier toward the inside of a turn.
**Inertia**: The tendency of an object to remain in its current state of motion (or lack of motion) unless acted upon by external forces sufficient to effect a change.
**Initiation phase**: The beginning, or approximately top third of a turn.
**Innervation:** The process by which a brain signal stimulates a muscle for action.
**Inside ski: C**onsidering a turn as part of a circle, the ski that is closest to the center of the circle is the inside ski of the turn.

**Instructor Behavior**: The portion of the Teaching Model in which the instructor learns about the student and establishes an open, trusting, learning environment. Also known as the Teaching Cycle.
**Intensity**: The amount of effort or power given to a movement (which the instructor observes as a quantifiable element of movement analysis).
**Intermediate zone:** A component of the "skier zones" used to categorize general ability level. Skiers in this zone can perform consistent parallel turns on beginner and easy intermediate terrain.
**Inversion**: Movement of a body part inward, toward the midline of the body, such as medial rotation of the foot. Typically, this is associated with foot supination. Also see Eversion.
**Isometric tension**: Muscle tension with no change in the length of the muscle.
**Joints**: A point where two or more bones are joined by ligaments and move relative to each other.

## K

**Kinesiology:** The study of the principle of mechanics and anatomy in relation to human movement.
**Kinesthetic:** A term that refers to forces that act outside the body to create a sensation, such as the boot pressing upon the leg.
**Kinesthetic learners:** Students who process information through feelings and sensations (also known as proprioceptive learning).

## L

**Lateral: D**irected or proceeding toward the side, away from the midline of an object. A person who is standing and steps sideways is moving laterally.
**Learning environment:** Conditions affecting the ability to learn.
**Learning Partnership**: Part of the Teaching Model, this is the rapport an instructor forms with the student. Essential to the success of this relationship is the instructor's understanding of the student's needs and expectations and the student's willingness to actively participate in learning.
**Learning preference:** The student's preferred combination of sensing and processing information.
**Leg rotation**: Movement of the lower body to make the skis turn. This includes elements of rotation from the femur in the hip socket and lower leg (below the knee) rotation.
**Lesson plan:** A plan for executing a lesson; includes goals, objectives and activities.
**Ligament**: A band of thick, strong, fibrous tissue that connects bones and strengthens joints.

## M

**Mass:** The property of an object that causes it to have weight in a gravitational field; the amount of material that an object contains. Mass is commonly but imprecisely used as a synonym for weight.
**Mechanics**: The essential actions of the skis and basic body movements present in all skiing, regardless of terrain, snow conditions, pitch of the slope, and speed of descent.
**Medial :** Toward the median axis or center of the body.
**Median axis:** An imaginary line that bisects the body into right and left halves.
**Model:** An analogy in which concepts are related to a familiar device or system to facilitate understanding.
**Moguls:** The series of mounds (or "bumps") that naturally form on a run when skiers and snowboarders push the snow into piles as they execute short-radius turns. The steeper the slope, the bigger the bumps and deeper the troughs between bumps.
**Momentum**: Inertia in motion; defined as an object's mass multiplied by its velocity. Speeding up, slowing down, and turning are all changes in momentum. An external force must be involved to change momentum.
**Movement analysis (MA)**: The process of observing a movement and determining the relevance and effect of that movement on other movements and the action of the skis. MA helps the instructor prescribe changes for enhanced efficiency, effectiveness, and performance.
**Muscles**: Tissue composed of cells that can shorten (contract) and lengthen (relax) to stabilize or move joints.

## O

**Neutral:** Posture in which the alignment of the body is centered.
**Never-ever:** A student who has never skied before.

**Newton's Laws of Motion**: Fundamental laws of physics that describe the relationship between the forces that act on a body and the motion that results.
**Off-piste:** Terrain that is not on a prepared slope; also refers to an area outside a resort boundary.
**Outcome:** The performance capability achieved by the end of a teaching-learning segment; the actual lesson outcome may or may not be the original goal and may be different for each student.
**Outside ski:** Considering a turn as part of a circle, the ski that is farthest from the center of the circle is the outside ski of the turn.

## P

**Parallel turn:** A turn made on corresponding ski edges with simultaneous edge release and engagement. The skis remain parallel throughout the turn, as opposed to converging or diverging.
**Physics**: The study of matter, energy, motion, and force.
**Piste:** A European term for a slope that is groomed and prepared. Also see Off-piste.
**Pivot:** To rotate about an axis extending upward from the snow through the middle of the skis; or the action resulting from the application of rotational forces to the skis.
**Planes of motion**: Terms of reference that help describe the direction of body movements. The three planes of motion are sagittal, frontal, and horizontal.
**Plantar flexion**: Ankle extension of the foot downward, away from the shin.
**Posture:** The way a skier stands, which may be effective or ineffective.
**Powder:** A type of snow that is light, dry, and fluffy.
**Practice:** Repetition of movement patterns or other activities designed to develop or refine a skill. Student focus and instructor guidance and feedback are important parts of effective practice.
**Pressure**: The amount of force distributed over a given area.
**Pressure control**: The skill of managing forces acting on the skis. Skiers manage the distribution of pressure along the length of the ski(s), transfer pressure from one ski to the other, and adjust the overall magnitude of the forces acting on the skis.
**Pressure-control movements:** The movements required to manage forces acting on the skis, both along their length and from side-to-side; transferring pressure (as in ski to ski), and adjusting overall magnitude of the forces acting on skis. Movements that create, maintain, or reduce, the pressure of the skis on the snow. As one of the skills of the PSIA skills concept, pressure control is achieved through leverage, extension, flexion, and transfer of pressure from ski to ski, increasing and decreasing edge angle, muscle tension, and changing velocity, direction, turn shape, and size.
**Pressure distribution:** How and where forces are applied along the length of the skis.
**Progression:** A sequence of acts, movements, or events that increase in difficulty and are designed to meet a goal. Also see Exercise line.
**Pronation**: Movement that consists of dorsiflexion of the ankle and eversion and abduction of the foot.
**PSIA:** The acronym for the Professional Ski Instructors of America, the education association for professional ski instructors in the United States.

## R

**Railroad track turns:** Turns in which the skier slightly tips both feet to make two clean and parallel tracks in the snow.
**Range of motion:** The distance a joint can articulate along its planes of motion.
**Rate**: The speed in which a movement occurs (which the instructor observes as a quantifiable element of movement analysis).
**Reactive:** Acting in response to an event or circumstance.
**Real vs. Ideal**: A comparison of a student's performance (real) to performance that would be optimal (ideal) for the given task.
**Rebound:** The recoil of a decambered ski. When a skier bends the skis through the turn (i.e., decambering) and then releases the pressure and forces, the skis rebound and create a snappy linkage from turn to turn.
**Reinforcement:** The process of rewarding students for appropriate performance. Recognizing and praising students for reaching their achievements boosts their motivation.
**Retraction**: Pulling the legs up under the body (active retraction) or allowing the terrain to push the legs up under the body (passive retraction), which momentarily reduces pressure.

**Rotation:** Circular movement about an axis, including the movement of a limb about its axis; the spinning of skis about an axis perpendicular to their base.
**Rotational balance**: The rotational motion of a body about an axis (including the movement of the body's limbs about their axes). Slowing or stopping body rotation initiated in the direction of the intended turn results in a turning effort that is transferred to the skis. The skier commonly uses the shoulders and hips, either separately or together, to develop the turning effort.
**Rotational control**: Turning the skis about the vertical axis of the body. Skiers use this skill to affect the direction their skis point.
**Rotational movements:** Movements that increase, limit, or decrease rotation of the skis. Rotational movement is one of the skills of the PSIA Skills Concept.

## S

**Sagittal plane**: An anatomical plane that divides the body into right and left halves. Fore (forward) and aft (backward) movements occur along this plane.
**Shaping phase**: The middle third of a turn, from just before the fall line to just after the fall line.
**Sidecut:** The hourglass shape of a ski when viewed from above, typically wider at the tip and tail and narrower at the waist. This characteristic helps a ski turn when the edge is tilted and pressed into the snow.
**Sidecut radius**: If an imaginary line matching the curvature of the ski continued around to form a full circle, the radius of the circle (sidecut radius) would be the distance between the center of the circle and the side of the ski. Sidecut radius influences the ideal type of turn the ski is designed to make.
**Sideslip:** A maneuver in which the skier travels in a direction sideways to the length of the ski. The slipping action can occur straight down the hill or diagonally down the hill, forward or backward.
**Sidestep:** A movement in which the skier climbs up or down a slope by standing perpendicular to the fall line and taking small steps with each ski, keeping the skis parallel.
**Skate:** To move forward on diverging skis by alternately engaging the edges and flexing/extending the legs; often combined with poling movements.
**Skidded turn:** A turn in which the edge slips laterally; or a turn that is not carved.
**Skidding**: Movement of skis characterized by simultaneous sliding and slipping.
**Ski flex**: How a ski bends along its length to form an arc.
**Skill**: Learned movement, resulting in proficient movement that is controlled, coordinated, and efficient.
**Skills Concept**: The technical model of American ski instruction. It is based on the knowledge that three skills – rotational control, edge control, and pressure control – are integral to all turns, and essential for maintaining balance.
**Ski performance:** An element of movement analysis in which the instructor observes the action of the skis in relation to the student's desired outcomes and body movements.
**Slalom:** A course set with gates a skier must pass through. The vertical distance between gates is 7 to 9 percent of the total vertical drop.
**Sliding**: The movement of skis across the snow, in the direction of the long axis.
**Slipping**: The movement of skis across the snow, in a direction perpendicular to the long axis.
**Snow types:** Approximate classifications of snow: powder – snow that is light, dry, and fluffy; packed powder – snow that is pressed together or groomed; corn – pellet-sized snow particles that have formed through repetitive thawing, refreezing, and recrystallizing; crud – settling snow that is cut up by skiers and riders; wind-crust – snow with a wind-compacted top layer; cement – uncompacted, heavy snow with a high moisture content; ice – snow that has become very dense and hard.
**Spine:** The series of small bones, called vertebrae, along a person's dorsal side, which support much of the body's structure, is flexible to allow movement, and protects the spinal cord. Or a park feature that's generally built with a steep takeoff ramp and a groomed transition on the left, right, and back of the feature; the top of a spine is generally very narrow.
**Stance:** How a skier stands on skis. One of the basic indicators of performance at all levels of skiing, stance affects the application and blending of skills. The "stacking" of body segments is often best observed from the side.
**Steering**: Using muscular movements to turn the skis. Steering allows skiers to actively direct the path of the skis while responding to terrain and snow conditions.

**Step turn:** A turn in which the skier uses the downhill ski as a platform and steps the uphill ski into a parallel or converging position.
**Straight run:** The act of sliding in the fall line.
**Student-centered teaching:** A teaching style that addresses the student's needs, desires, expectations, preferred learning styles, and reactions to the learning process.
**Student Makeup (profile)**: Part of the Teaching Model, this term represents the "non-technical" factors each student brings to the learning environment, including personal characteristics and background, motivation, emotional states, beliefs and values, and physical health.
**Supination**: Movement that consists of plantar flexion of the ankle, and inversion and adduction of the foot.

## T

**Tactics**: The strategic choices a skier makes to achieve a goal. Decisions are based on intent, knowledge, and level of performance within the context of the skiing environment.
**Tail:** The back of a ski.
**Taper**: The amount that the tail of a ski is narrower than the tip.
**Tapered sidecut:** A progressively tighter curve as the sidecut nears the tail of a ski.
**Task:** An assigned activity that focuses on specific instructions, goals, movements. or skills.
**Teaching Cycle**: The portion of the Teaching Model in which the instructor learns about the student and establishes an open, trusting, learning environment. Also known as Instructor Behavior.
**Teaching Model**: The model of the American Teaching System that consists of Student Makeup Instructor Behavior, which together form the Learning Partnership.
**Technique**: How skiers move, or the methods skiers use to apply the mechanics of skiing. Different techniques provide movement options for how skiers affect or react to the action of the skis on the snow.
**Tendon**: Tissue that joins a muscle to the bone, upon which the muscle acts and creates movement of joints.
**Timing**: When a movement occurs (which the instructor observes as a quantifiable element of movement analysis).
**Torsion**: The amount of effort it takes to twist the ski along its length.
**Transition**: To end one turn and start a new one, or the phase of the turn in which this action takes place. Also, the curved part of a halfpipe.
**Traverse:** To move across the slope without entering the fall line.
**Turn**: A curved path of descent or change in the direction of travel. Also, the rotational action of the skis relative to the surface of the snow, as a result of muscular effort to change the direction the skis point.
**Turning:** One of the three basic ski skills, as defined by an early version of the Skills Concept (circa 1977). Now known as rotational control.
**Turn radius**:If an imaginary line matching the curvature of the ski – when it's placed on edge, weighted, and bowed into an arc – continued around to form a full circle, the turn radius would be the distance between the center of the circle and the side of the ski. Synonymous with sidecut radius, turn radius influences the ideal type of turn the ski is designed to make.
**Turn shape:** The shape skis leave in the snow during a turn. Turns might take a variety of shapes, such as C, S, J or Z.

## U

**Up unweighting**: A quick extension of the legs that produces a momentary reduction in pressure when the skier's center of mass slows or reaches the top of its movement.
**Unweight:** To reduce pressure on part or all of a ski or both skis.
**Upper-body rotation**: The movement in which the upper body turns first, followed by the legs turning in the same direction.

## V

**Velocity:** A vector measurement of motion describing the rate of change of an object's position, including both speed and direction.
**Visual learners:** Students who receive and store information best through visual input such as pictures, images, and demonstrations.

### W

**Waist**: The narrowest part of the ski, located under the foot.
**Waist width:** The width of the ski at its narrowest point underfoot, which influences edging characteristics and optimum turn radius.
**Wedge:** A position in which the skis converge so the tips are closer together than the tails and the skis are on opposing edges. Also a device used to prop up one side of a binding and tilt it under the foot.

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### SOURCES

Chapters 1 and 2: PSIA-AASI New Instructor Guide - PSIA-AASI 2012
Chapters 3, 5, 6, and 7: PSIA Alpine Technical Manual - PSIA-AASI 2014

### DIAGRAMS AND PHOTOS

Chapters 1 and 2 - PSIA-AASI New Instructor Guide, PSIA-AASI 2012
Chapter 3 - PSIA Alpine Technical Manual, PSIA-AASI 2014
Chapters 5, 6, and 7 - PSIA Alpine Technical Manual, PSIA-AASI 2014