THE CSIA 5 SKILLS FRAMEWORK

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Introduction

The Framework defines the interaction between the snow, the skis and the skier. We explore how the skis affect speed control, direction, and balance and how we affect them through our body's movements. The 5 Skills are a tool to simplify skiing and allow us to distill it into root components and explain the relationships between those components.

At its core are the 5 skills of Balance, Rotary, Edging, Pressure and Coordination movements; these skills are present in every turn and in all terrain. The framework is broad enough that all skiing outcomes can be described through the combination of the skills. The Skills Framework provides a way to define WHAT a skier does with their skis and HOW they must move to do it. Use the Skills Framework as a guide for assessing and developing skiers, designing tasks and lesson plans for your learners and improving your own performance and understanding of skiing. The intent of this document is to break down the sport of skiing into simple elements to provide clarity and understanding for CSIA instructors.

Frames of Reference

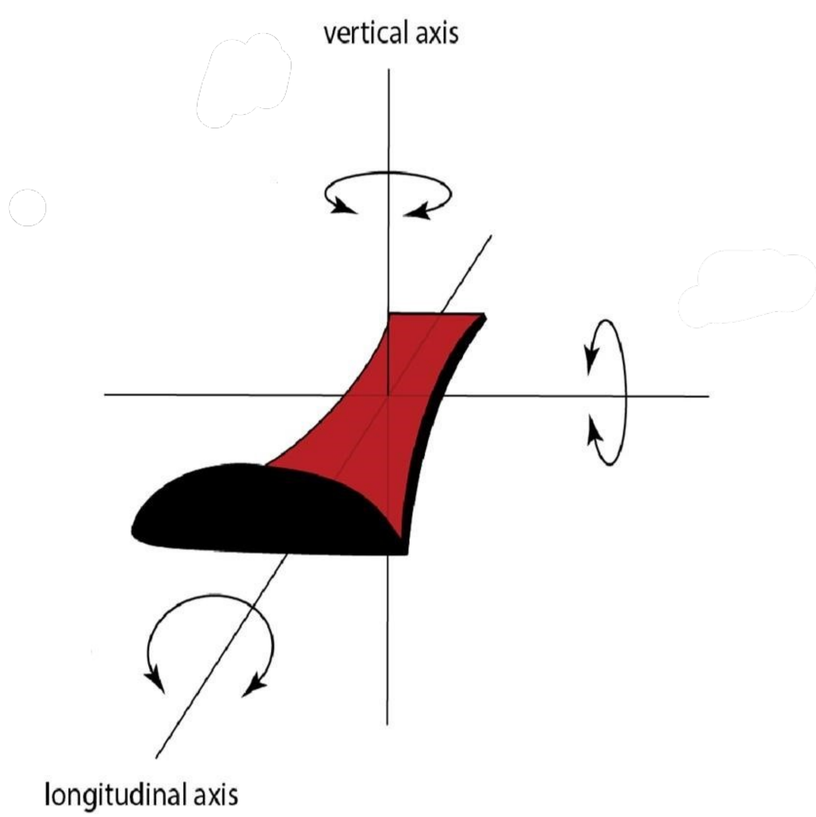
We will first explore the components of the framework and the relationships between them to better understand the Skills as a whole. The forces acting on the skier affect direction, speed, and momentum. Manipulating the interaction between our skis and the snow enables us to harness the forces created by motion. The Framework encompasses both the skis and the movements with which we can affect the skis.

The Skis

Our skis and boots are the tools we use to control the forces created by gravity and our movements. By managing the interaction between our skis and the snow, we can control our descent down the mountain. The skis provide us with the means to go where we want to go, at the speed we want to travel. Discovering how the actions of the skis on the snow determine the skiing outcome of our actions. This provides a powerful method to assess and evaluate ski technique.

Understanding how the skis work is crucial to understanding the Skills Framework and skiing as a whole. We manipulate the skis through twisting, tipping and pressure. The combination of these actions determines where the skis point and how much they grip. We define the ski's relationship with the snow along its longitudinal, lateral, and vertical axes. We influence this relationship primarily through the ski control actions of steering angle, edge angle and platform angle.

Figure 1. The Skis can be twisted to help in turning, tipped over sideways to increase the amount of edge and or tipped along the length of the ski and finally, the ski can be bent to make the turn radius tighter



The skis represent half of the cause-and-effect equation, the other half is comprised of the movements we use to control and manage the skis.

The 5 Skills – Balance, Rotary, Edging, Pressure and Coordination

The 5 skills are comprised of the 5 essential building blocks of skiing. Each of the Skills requires the action of the skis and the movements to create that action. It is important to understand the distinction and relationship between cause and effect when developing skiers. Every part of ski technique can ultimately be evaluated by how it affects the ski's interaction with the snow. In the following sections we examine each of the Skills, independently discussing the action of the skis and the movement options associated with each skill.

Blending of the Skills

The approach above provides a framework for technical understanding. In practice, we use a combination and blending of the skills in every turn. Various combinations and proportional application of the skills give us precise control over the performance outcome of our skiing.

- The desired OBJECTIVE determines the ski-to-snow interaction
- The ski-to-snow interaction determines the blending proportions of the skills
- The skill blend determines our movements

The skier should be encouraged to reflect on WHAT they want to happen, what the skis need to do to accomplish that, and how they the skier can do that.

Ski Performance

As a skier develops skills and blending competency, ski performance and overall ability will increase. Our chosen descriptors – Carved, Steered and or Skidded, define points along a spectrum of outcomes concerning the ski path and interaction with the snow. The performance spectrum covers all stages from the most skidded to no skid at all (carving – limited versatility but exhilarating). The turning action mechanism for a skidded turn is oversteering, where the ski tail slips more/faster than the tip as the ski moves forward. Novice skiers will have significant skidding in their turns; as their skills increase, the amount of skidding will diminish.

Carved: The ski tail follows the tip and leaves a definitive arc in the snow. when the snow is soft two clear lines are visible in the snow. In a purely carved turn, there should be no visible skidding.

Steered: Producing a rounder "arc" to the turn, some visible tracks are left in the snow but no defined lines.

Skidded: Defined by Z-shaped turns, with little edge grip and little control of turn shape. Typically, there will be no visible lines or tracks left on the snow.

Figure 2: Turn Types:
Skidded *Steered* *Carved*

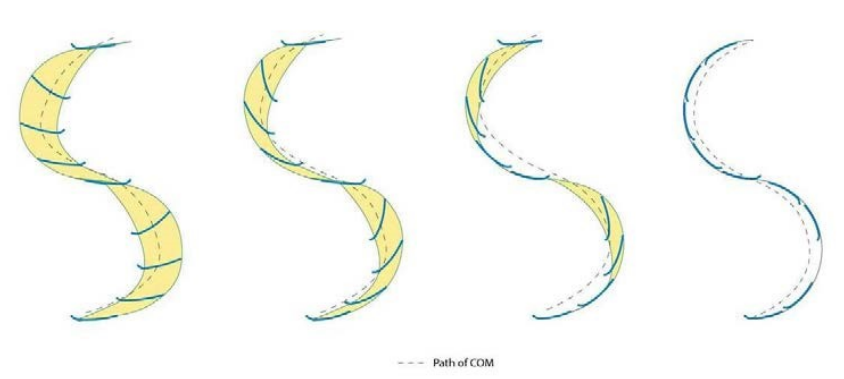


Figure 3. Turn types: carved.

Turn Type: Steered

Turn Type: Skidded

Highly skilled skiers can intentionally slip the skis to skid in one part of the turn or run, steer through another part and or carve another section. The ability to slip and reduce the ski grip within a turn provides versatility in controlling turn outcomes. Different turn sizes, shapes, speeds, and performance outcomes will require a different blend of the above turn types to achieve the desired results.

Stance and Alignment

Stance (relative balance) and alignment (relative position between body segments) determine the positioning of the body for the most efficient and effective ski control and movement actions. As referenced in many sports, an 'athletic stance' is ideal. In skiing, a stance that is too low is overly strenuous on the legs, whereas adopting a stance that is too tall is unstable and ill-suited to managing variations in terrain.

Within the Skills Framework, balance is a skill as well as an outcome of the ski-to-snow interface (the BOS). In order to direct forces through the COM we align our body and BOS.

BALANCE

Balance is the result of aligning our body and our movements. The skis are our base of support (BOS). Combining alignment and movement enables us to control the relationship between our base of support (BOS) and our center of mass (COM) and as a result our balance. The ski's relationship with the snow comprises the 'effect' and our movements are the 'cause'. These concepts are at the heart of the 5 Skills Framework. Each movement occurs within a plane, rotational plane, fore aft, lateral and vertical plane.

Figure 4. COM

Base of support (BOS)

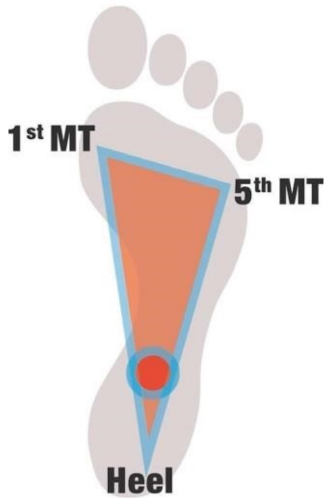
The BOS is the location of a skier's weight on the snow: the skis.

Figure 5. BOS- feet and pole

Figure 4. BOS – outside ski

Within the BOS, under each foot, is the Centre of Pressure (COP). Efficient skiing requires us to place the COP within a triangle defined by the three arches of the foot: the anterior transverse arch, the lateral longitudinal arch, and the medial longitudinal arch.

Figure 6. Foot arches triangle.



Centre of mass (COM)

The Centre of mass is a specific point in the body where we consider the mass of the skier and their equipment to be concentrated. It is generally located just below the navel but moves as we change the skier's position and body type.

Figure 7. COM location B.

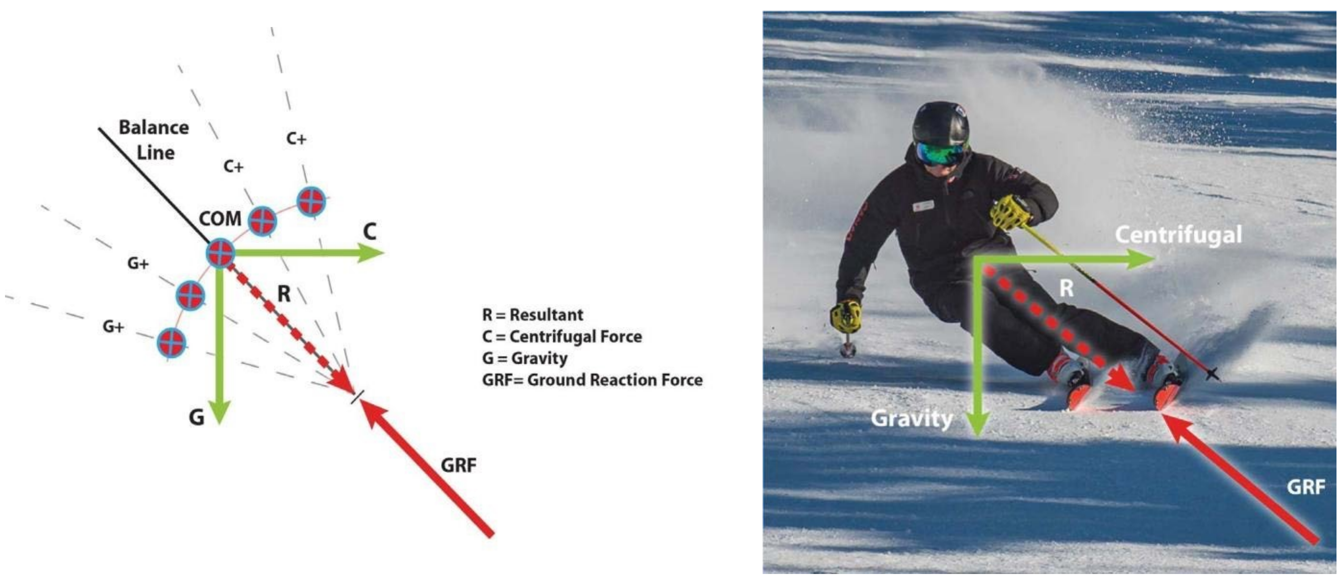
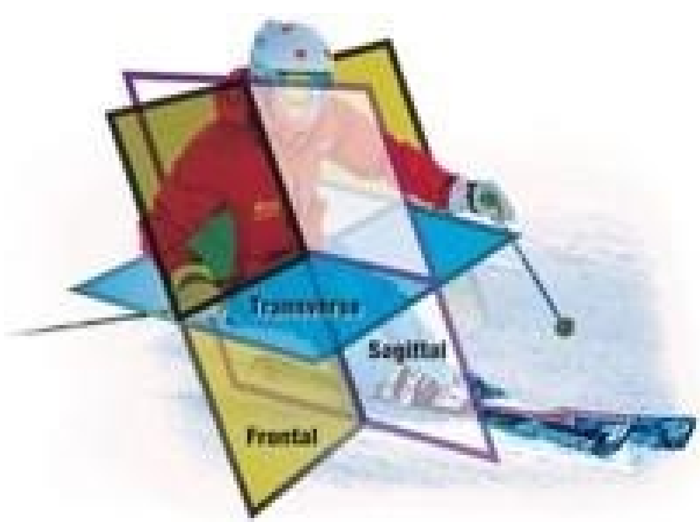


Figure 8. Optimal balance

The planes of Balance

Stance, or posture, refers to a skier's alignment of BOS and COM at any moment in time. The movements a skier uses to maintain or change a particular position can be grouped into categories: Vertical, Fore-aft, Lateral and Rotational.

Figure 9. Biomechanical descriptions of the planes for balance can be defined from a frontal, sagittal and transversal frame of reference and can be used to describe specific movements.



*V*ertical movement – Sagittal plane

Vertical movements are comprised of flexion and extension along the line of balance. These movements control snow contact and the magnitude of pressure on the base of the ski and the distance between the BOS and COM. Minimal vertical range is required in the beginner stages of skiing, but the demand increases with situational skiing and higher performance skiing. Vertical movements are seen at high speed on the lateral plane, as performance increases the skiers increase the degree of lean (i.e., inclination and angulation) as a result the vertical movements appear as side-to-side movements and result in increased deflection the skier experiences laterally.

Our stance must accommodate a range of movement in order to control the magnitude of the reaction force coming upwards from the snow. Just like the suspension of a car, we use flexion and extension movements to allow the upper body to travel smoothly down the mountain (pressure). As performance increases, so does the degree of inclination, making vertical movements necessary when the body is inclined into the hill that the skier is travelling so that vertical movements are lateral in nature.

A skier can manage the magnitude of the reaction force by bending their joints, this reduces the distance of the COM and the BOS. An athletic stance supports this vertical movement. The body does not have a specific joint to facilitate pure vertical motion. Vertical movements are achieved through coordinated flexion and extension of multiple joints, including the hip, knee, ankle and spine). Articulation of a single joint can move our COM forward or backward, the skier. Working to improve the range of movement while in ski boots is beneficial. Our bodies are accustomed to having a far greater range of ankle freedom in day-to-day life.

Figure 10. Vertical movement.

Notice that the feet and legs are retracted as the skier crests the bump. The skier then points the tips down the side of bump to maintain snow contact, and then the skier extends the legs toward the trough of the moguls.

Ski boots restrictively encapsulate the ankle and set the angle of the lower leg. This angle is critical and one that deserves attention to ensure the correct setup based on individual anatomy and equipment.

Ideally, one should be able to squat down to a tuck position (femurs to horizontal) and not fall backwards when not clicked into skis. If necessary, the forward lean of the boot can be adjusted. Finding the optimal range of movement will enable the legs to manage forces, negotiate changing terrain, and maintain snow contact.

Figure 11. Tuck Turns position.

Fore Aft movement – Sagittal plane

Fore aft movements control the balance line along the length of the skis and the pressure distribution front to back along them. As viewed from the sagittal plane, parts of the body are in front of the balance line and others are behind it. Starting from the snow up, the ankle joint sets the tone for everything else to follow. Knees will typically be in front of the balance line, hips behind, shoulders and head in front. The ankle joint can greatly control pressure distribution along the length of the ski. As it is the first joint in the kinetic chain, even a small movement of this joint can have a considerable impact on our COM position in the fore-aft plane.

As skiing is conducted on a slope, fore aft movements are utilized to maintain stability and keep the balance line perpendicular to the surface of the snow. We must anticipate the changes in the pitch of the slope as we turn upon it – the pitch becomes steeper as we turn into the fall line and less steep as we come out of it.

Figure 12. Perpendicular aspect to the slope - fore aft.

Lateral Movement – Frontal plane

Lateral movements are any side-to-side movements across the skis that control and manipulate the edge angle of the skis and our inclination, angulation, and tipping.

Viewed from the frontal plane, the ski is rarely flat on the surface of the snow; we tip the ski over on edge every time we turn. The majority of our weight balances against the inside edge of the outside ski for most applications, so the outside ski platform is between the snow turning forces and our COM.

Figure 13. Lateral plane - outside ski relationship with COM.

Rotary movements – Transverse plane

Rotary movements turn the skis and also describe the relationship between the upper and lower body segments.

From a rotational perspective, our legs lead the turning effort. We are considered successful in this regard when our hips and torso face more to the outside of the turn than our skis and legs. This separation, or independence, of the lower and upper body is referred to as counter rotation. Just the right amount of counter is dependent on individual body types; it's easy to have too much or not enough.

A sufficient amount of counter-rotation facilitates a greater range of angulation at the hip. It enables a body alignment where the upper body can bend towards the outside of the turn, giving us the range of movement to adjust our balance against the outside ski.

By creating correct posture through counter-rotation, we have the ability to move the balance line laterally towards the outside ski.

Figure 14. Counter rotation facilitates torso movement toward the outside ski.

Counter Rotation

Counter rotation refers to the upper body and lower body twisting in opposite rotational planes and is often generated by a quick and intense rotational muscular effort. The movement directs an aggressive and quick rotational force to the skis and is effective in short turns or when the skis are off the snow and offer very little resistance. Applying an outside force, such as a pole plant or dragging the inside pole, can enhance the efficacy. Counter rotation can also be effective as a recovery manoeuvre. At the core of the Skills Framework are the 5 Skills: balance, rotational, edge, pressure and coordination. These skills are present in every turn and in all terrain. A technical assessment and description can be made for any turn by evaluating the combination of these five components.

ROTARY MOVEMENTS

Separation in body segment plays an important role in allowing the skier to grip the snow with their skis, independent movements of the lower and upper body around the balance line provide this fundamental action.

Ski Actions - rotary

Rotary movements help the skier control the amount of rotation of the skis around their vertical axis, as viewed from the transverse plane. More simply, the direction the skis point.

- Pivoting refers to rotation around the vertical axis of the skis, flat to the snow surface
- Turning refers to rotation around the vertical axis of the skis with edge engagement of the snow surface
- Steering implies more active engagement of the edges

Steering angle

The ski's steering angle is the angle between the line of travel and the direction the skis point.

A sideways force (turning force) on the ski must be present in order to change direction (turn). This turning force is created by placing the skis at an angle to the direction of travel (a steering angle or angle of attack), tilted to the snow surface, while the center of mass is located inside the outside ski. The turning force presses against the ski bases, including the edges, and both slows the skis down and pushes them sideways.

Varying the steering angle alters the proportions of the slowing and turning components - the greater the steering angle, the greater the magnitude of the slowing component.

It is important to understand that the ski turns first, directed across the trajectory of our COM (direction of travel) before we actually turn.

Figure 15. Edge Angle

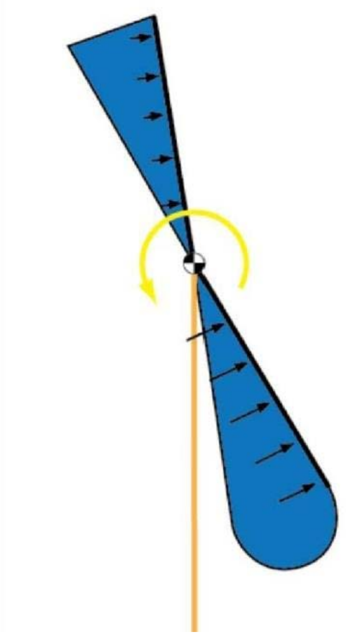
The desired turn shape, the pitch of the run and the objective have an effect on the steering angle. Typically, the shorter the turn or steeper the terrain, the greater the initial steering angle.

Note: even in a purely carved turn, a steering angle is a prerequisite and is omnipresent due to ski design properties.

There are three ways the ski can provide a steering angle:

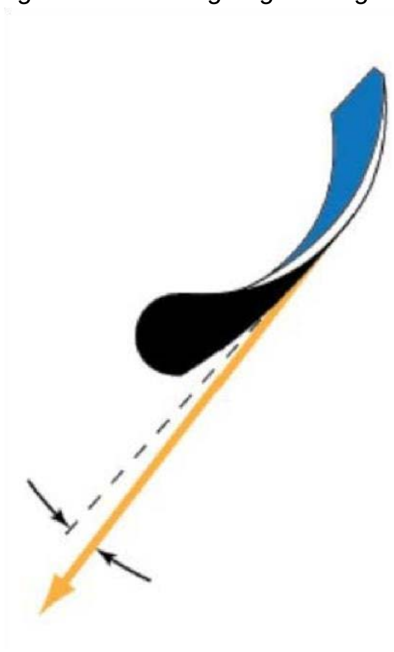
1) Rotated around its vertical axis at an angle to the direction of travel. This steering angle action is the most common, versatile, and most applicable to a rotation control discussion.

Figure 16. Steering angle - transverse plane



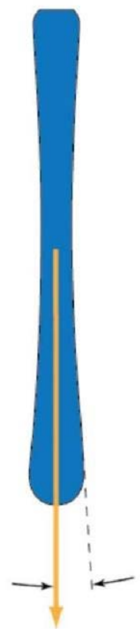
2) Flexing along its longitudinal axis to provide an angle across the direction of travel (ski bent into reverse camber).

Figure 17. Steering angle - longitudinal axis flex



3) The steering angle is provided by the sidecut geometry of the ski.

4) *Figure 18. Steering angle - sidecut induced.*



Rotary movements occur when the body or parts of the body move around an axis. The body can make a number of such movements to provide rotational input to the skis. Within a skidded turn, with the exception of external forces, these rotary actions, in combination with edging the ski, are the only way we can change direction.

Leg Rotation

Leg rotation is a turning force generated from the legs that changes the direction of the skis. Internal and external rotation of the legs from the hip socket down (femoral rotation and tibial rotation) can be further separated into upper and lower leg rotational actions. These movements are controlled by the rotator muscles of the hip and the leg adductor muscles. When the leg is extended, the rotator muscles of the hip play a larger role. As the leg is flexed, the adductor muscles become more accessible and provide greater strength in the rotational plane.

A flexed leg can twist the skis more powerfully due to the creation of a moment arm at the knee.

Figure 19. Leg rotation.

Leg and foot rotation are efficient movement patterns and have a direct influence on the ski. These movements provide the most effective control over the rotational axis of the skis in most applications, as rate and intensity can be manipulated quickly. Favourable pelvis and femur relationship/positioning enable effective hip angulation and allow the upper body to remain quiet and stable, promoting balance.

Pelvis and upper body rotation

Pelvis, spine and upper body twisting, and rotation can initiate a ski turn, but this is less efficient than turning the legs in the hip socket. The action creates a rotational response at the skis via a transmitted torsional force generated from the upper body mass. In comparison with using leg rotation to turn the skis, the movement typically decreases the skier's biomechanical strength and, over time, increases the risk of injuries. Turning the upper body is often used by inexperienced skiers as a way to force the skis to turn. However, it can be an effective situational tactic and source of rotary input in certain situations and conditions (e.g., when in the air, in deep powder, etc.).

Hip rotation also has the potential to add power to high-performance turns as a source of rotational input if mastered through body segment independence and discipline by arresting hip rotation following the apex of the turn.

Figure 20. Upper body rotation: notice the logo on the back of the skier becomes more visible.

In a more specialized application, doing a 360 (helicopter) jump also uses the principle of generating torque from an upper body input in the rotational plane.

Common problems associated with hip and body rotation:

- Balance issues due to the centre of mass disruption
- Difficulty in maintaining pressure/grip on the outside ski, particularly in the lower portion of the turn where forces are greatest
- Movement can become a habit or crutch to generate the turning force
- Often a sign that fore and aft alignment is making it difficult to steer the skis with the lower body

External force

An external force is required to both create and apply active rotational input via leg rotation. Understanding and exploiting this fact can be a great advantage, particularly in situational skiing environments where the skis are more difficult to twist like power, wind pack and slush.

Skis have self-turning characteristics, but they must first be positioned with a steering angle to gain from this design advantage. It is often necessary to enhance the amount of turning contributed by the skis alone by directing them with the legs through leg rotation. To initiate the turning of the legs and continue to turn them, an outside force is required.

In the case of leg rotation, we create a point of contact with the planet to supply a force against which to turn the legs. In skiing, it is a rotational force of the legs that turns the skis in the desired direction. This required outside force can be created in several ways, often utilized in combination.

External force options

- Inside pole contact with the snow (pole drag) - the most effective way to provide a continuous external force
- Pole plant - provides a short/quick blocking action for the upper body against which to turn the lower body
- Counter rotation (as an external force for the legs - internal to the body as a complete system)

Pole plant

The pole plant is not technically a movement around a rotational axis but should be considered a rotational control action.

A pole plant, when executed correctly, allows the skier to connect with the snow through the pole. This pressure creates torque around the balance line, which provides a turning force. Through muscular tension of the hand, wrist, arm, shoulder, and core, the skier can counter the torque created by turning the legs and blocking the upper body from continuing to turn. The pole plant also acts as a second BOS for the skier. Short turns and situational skiing, like bumps, benefit from the stability provided to the upper body by the torque generated from a well-executed pole plant.

Figure 21. Pole plant

Figure 22. Pole Plant - Torque forces

Rotational plane actions

Active rotational actions:

Robust leg actions direct the skis. This action is most apparent in short turns.

Passive rotational actions:

A stable pelvis coupled with efficient edging produces a carved turn. This action is most apparent in expert parallel turns. The femur starts the turn by rotating in the hip socket the movement continues as a result of the skis arcing under the body. The turning effort is still led by the lower body and continued as a result of the ski design.

Rotational independence (separation)

The ability of the upper and lower body to rotate independently is critical for efficient skiing. This movement is referred to as separation. The legs rotate more than the upper body, predominantly at the hip joint. Rotational independence is accessible throughout the kinetic chain. Using a countered position after the fall line in a short turn as an example, visualize the following body segments positioned around the balance line:

The legs will rotate the most, pointing in the direction of the skis. The pelvis will be less rotated than the legs, the lower spine less rotated than the pelvis, the upper spine less than the lower spine, and the neck less than the upper spine. Internal muscular tension throughout the core and pelvis strongly influences (independent) rotational efficiency. The use of a pole plant and/or dragging the inside pole creates an additional point of contact from which we can derive rotational leverage and stability, by tapping into an external force.

EDGING

Edge control is the ability to regulator the ski's lateral relationship with the snow. Command of this ability allows gripping and slipping of the ski and snow interaction. Additionally, edge control is the primary skill to invoke ski design features.

Ski actions – Edging movements

Edging or lateral ski control refers to the tipping action of the skis along their longitudinal axis, as viewed from the frontal plane (roll). The application affects the ski-to-snow angle, or edge angle, which affects how much the ski bends along its length.

Figure 23. Lateral ski control. Platform angle is also a relevant term which is discussed later in this document.

Side Slipping

Side slipping is the lateral or sideways movement of the ski across the surface of the snow. There is equal displacement of the tip and tail of the ski. Increasing the edge angle increases friction (plowing effect) and reduces sideways slipping.

Figure 24. Side slipping

Skidding

Skidding is a blend of side slipping and forward sliding of the ski. The ski tails laterally displace more/faster than the ski tip as the ski moves forward.

The sideways travel is reduced as turns become more carved, when first learning to ski with the skis in a parallel position, turns are often skidded and or z shaped.

Figure 25. Skidding

Steering

A steered turn is a less skidded turn but not yet a carved turn. The track in the snow is narrower than a skidded turn as it has more active steering actions present but wider than a carved turn, producing a rounder arc to the turn shape.

Carving

In a carved turn, there is no sideways skid to the ski path; it is very much a turn shape of ski geometry. The ski tail follows the tip and leaves a definitive arc in the snow.

Self-steering

Tipping a ski on edge invokes several design features - sidecut, longitudinal flex and complimented by a longer ski forebody than tail - that provide a self-turning function to the skis. A torque is produced that turns the ski as it moves forward.

Platform angle

The platform angle represents the direction of force the skier applies to the ski and the platform the ski cuts in the snow.

The platform angle determines whether or not a ski slips sideways as it travels forward, assuming the ski edge penetrates the snow and that the snow surface has enough integrity to hold the skier. The platform the ski's edge cuts into the snow provides the surface that supports the weight of the skier. If the ski is edged (tipped) less than the inclination of the skier, the ski will slip and when the ski is edged more or equal to the inclination of the skier, the ski will not slip.

The platform angle varies along the length of the ski. The middle of the ski provides more grip than the ski extremities, the tip and tail always flex more in torsion than the middle of the ski. All skis have torsional flex, how much flex depends on the torsional rigidity of the construction. Achieving a platform underfoot that aligns the forces does not mean that is the case at the front and the tail of the skis.

Figure 26. Platform angle

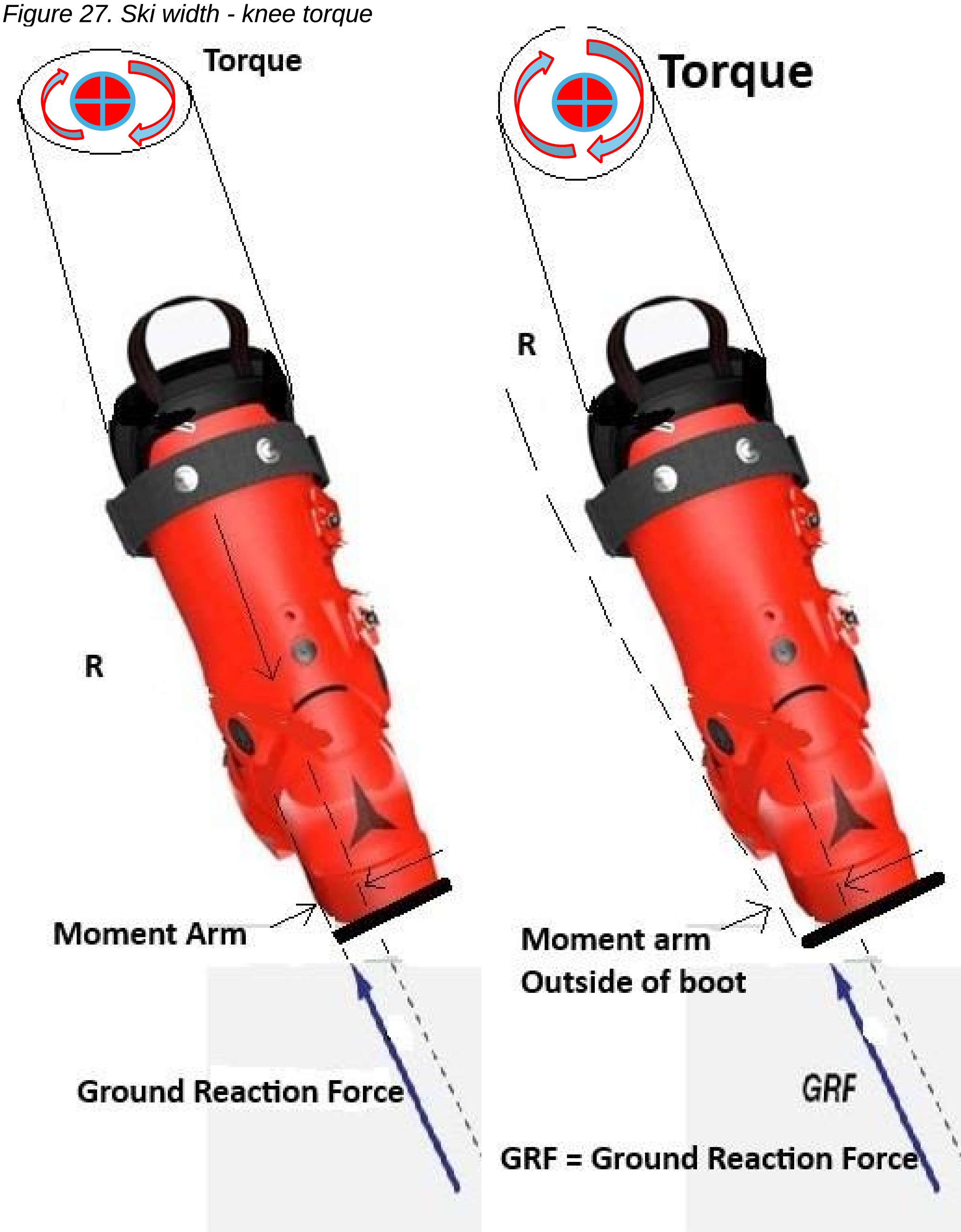
Ski width

The width of the ski waist has a direct effect on the difficulty of holding an edge. The force from the snow pushes on the inside edge of the outside ski. The wider the waist of the ski, the greater the distance from the centre of the ankle to the weight supporting platform. The greater the distance, the greater the force (torque) acting to flatten the ski (reduce edge angle).

Snowpack density greatly influences this situation. On hard snow, the ski edges cut a smaller platform and the distance from the centre of the ankle to the force from the snow is greater. In softer snow, the ski edges cut a larger platform, reducing the distance.

Skiing on hard snow with a wide ski places more force on the knee than would a narrower ski. Using wide skis on hard snow creates strain and fatigue potential on the knee joint due to the muscular effort of edging and holding an edge against the opposing torque working to flatten the ski.

Figure 27. Ski width - knee torque



Angulation provides a mechanism for some adjustment of the force from the snow, closer to the longitudinal axis of the ski. Angulation reduces the length of the moment arm, which in turn, reduces the amount of torque.

Movements - Edge control

Lateral movement occurs across the base of support - from side to side. The movement can be viewed either from the body moving laterally across the BOS or the BOS moving away/sideways from the body.

Edging is achieved by a specific movement or a combination of movements, depending on the desired objective. To turn, the COM must be inside the arc. The parts of the body moved towards the inside or outside of the arc (lateral movements across the skis) are considered edging movements. A variety of movements can provide edging input to the skis.

Ankle control/tension

Ankle control and tension directs force towards the inside or outside of the foot (pronation or supination) and changes the platform angle.

The ankle joint can manipulate edge angle the fastest, exerting a strong influence on early edging outcomes and enabling the angulation between the foot and the tibia.

Knee

An angle is created at the knee joint, as viewed from the frontal plane. The knee joint has little capacity for lateral movement; perceived knee angulation is a combination of internal leg rotation, knee flexion and ankle eversion.

There is greater apparent utilization of the knee in short turns compared to longer turns, as there is less use of the hip. Angulation of the knee is fast and reactive but weaker than hip angulation.

Hip

Creating an angle at the junction of the pelvis and hip joint - leg and upper body independence.

Accompanied by rotational independence (separation) between the legs and pelvis, a hip hinge motion allows the body to bend laterally. The upper body moves towards the outside of the turn as the hip moves further inside the turn, creating an angle at the junction of the pelvis and hip joint. The lateral tilt of the pelvis is effective but only a small amount of tilt is accessible without some counter position of the pelvis.

Figure 28. Hip angulation

Hip angulation allows the legs to tilt the skis more quickly than using the whole body to do so. The movement is strong and powerful but generates slower edging movements compared with knee and ankle angulation; it is most suited towards higher speeds where greater forces are encountered. The hip enables angulation between the legs and pelvis and is the only joint in the skiing kinetic chain that offers circumduction movement ability.

Blending edging movements

A blend of the above movements is most common when skiing.

Desired outcomes and situations dictate the combination and extent of edging inputs, with speed and radius being the main influences.

Inclination

Inclination is the degree of lean relative to the line of gravity. It also represents the balance line as viewed from the frontal plane.

The line from the BOS (supporting foot/feet) through the COM describes the angle (lateral movement) of the COM towards the inside of a turn.

Every turn has inclination, allowing the COM to balance against the turn forces.

Figure 29. Inclination with angulation.

Angulation

Angulation describes several movements which create discreet angles between the ankle, knee, hip and through the spine – lateral independence. Angulation allows a greater edge angle relative to our speed and radius than inclination alone.

Hip angulation, for example, creates an angle between the upper leg and pelvis. The lower body parts are angled towards the inside of the turn and the upper body parts angled to the outside of the turn.

Angulation is present in all well-executed turns. It allows lateral adjustments of the balance line towards the outside ski. When used in conjunction with counter (upper and lower body independence/separation), the range of movement is greater.

Figure 30. Angulation

Continuous progressive edging

In a skidded turn, the steering effort must be continued to produce a round turn.

Turning forces increase as the turn progresses due to the pull of gravity downslope. If the turning effort is not maintained, the turn shape will elongate (radius will increase). This elongated turn shape is prevalent in novice skiers, as they lack the ability to create and resist the turning forces after crossing the fall line.

In a carved turn, the COM must progressively move further inside the turn as the forces build.

The largest edge angles are created during the transition between the end of the control phase and the start of the completion phase of the turn where the forces are at their greatest.

Figure 39. Progressive edge angle

Edge release

Edge release refers to reducing edge angle of the skis in a predictable and controllable manner. The ability to dynamically adjust the edge and platform angles to intentionally slip and feather the edge is of great utility.

Edging ability involves controlling the ski grip and applying it more or less as required. Training the movements that reduce ski grip develops the versatility and adaptability needed to control many situations and turn outcomes. This aspect of edging is often overlooked. Competency is developed over time by understanding the concept and through dedicated practice. It can be advantageous at higher speeds to allow the skis to come off of the snow between turns to create a smooth link with no edge contact with the snow.

Figure 31. Edge release

Turning force

Centripetal force (a centre-seeking force) is the sideways force making us go around a turn. Whenever centripetal force is present, the COM must move inside the turn. The greater the force, the more the COM needs to move inside the turn.

Every turn has inclination due to this force. The degree of inclination depends on the magnitude of the force.

PRESSURE

Pressure is a blanket term for managing forces in skiing. There is artistry in mastering pressure movements. Exceptional skiers are described as having a unique ‘feel’ for the snow. Pressure is simply a force divided over the distributed area (P=F/A). That statement is extremely accurate when you consider skiing is controlling forces distributed over the instruments, our skis.

Forces in skiing come from two main sources:

- Actions or movements created by the skier
- Variations in terrain and snow surface/conditions

Forces at the skis

Fore aft: distribution of pressure along the length of the ski around its lateral axis (pitch).

Ski to ski: distribution of pressure from ski to ski (as viewed in the frontal plane).

Vertical: magnitude of force acting on the ski base, including the edge of the ski.

Fore-aft distribution of pressure along the ski length effects the self-steering function of the skis by manipulating torque. Moving pressure forward increases the self-steering function, whereas moving pressure rearward decreases it.

Pressure regulation movements

Fore/Aft

Fore/aft stability is constantly challenged when skiing.

Terrain features and the changing gradient of the slope require continuous fore aft adjustments between the BOS and the COM to stay in an optimal balance state.

As the skier's location in the turn changes, the gradient of the slope relative to the direction the skier is facing also continuously changes. As a turn is initiated, the incline of the slope becomes increasingly steeper through the fall line and then rapidly decreases through completion of the turn. Snow conditions (ice/powder) and terrain also have a considerable effect on the resultant force trajectory and required fore-aft pressure adjustments.

Manipulation of pressure forwards at the start of a turn has balance and turn initiation advantages. Aft pressure distribution enables more effective grip through the middle and turn completion phases.

Relationship between the BOS and COM

The pull and push of the feet moving the BOS fore-aft under the COM is typically quicker than moving the COM fore-aft. Refinement of muscular tension and foot/ankle/lower leg proprioception has a significant influence on fore-aft pressure at the expert level.

Subtle manipulation of pivot point changes fore aft along the ski can be achieved. Pressure/force distribution towards the toe or heel piece of the binding also influences ski performance characteristics.

Directing increased pressure/force towards the front of the ski enables easier turn initiation and aids in a forward, perpendicular to the slope, BOS/COM relationship. Directing such pressure/force toward the tail of the ski in the middle and turn completion phases creates grip.

Joint Movement in Isolation:

The below movements have the following effects:

- Hip Flexion - Moves COM forward
- Hip Extension - Moves COM backwards
- Knee Flexion - Moves COM backwards
- Knee Extension - Moves COM forward
- Ankle Flexion - Moves COM forward
- Ankle Extension - Moves COM backwards

Figure 32. Joint articulations

The Ankle

The ankle is deserving of special mention in the context of advanced management of pressure. Being the joint closest to the ski to snow interface and the first joint in the kinetic chain, the ankle can influence rapid pressure distribution on the ski both fore-aft and laterally.

Expert edging and pressure refinement requires mastery over the movements of this joint. Small increments of articulation at the ankle produce a significant influence on balance and ski performance.

Dorsiflexion and plantar flexion, combined with hip flexor and glute activation, facilitate expert level fore-aft pressure/ weight distribution.

Ski to Ski

As we predominantly ski on the outside ski, the transition of weight/pressure from ski to ski is required.

Reasons for skiing on the outside ski:

- We constantly fall inside during a turn in order to continue to turn. The inside leg can catch us if we fall too far, too quickly, by controlling inclination.
- The outside leg is more extended and, therefore, stronger in the vertical plane (perpendicular to the ski base).
- The outside leg is biomechanically stronger, with more effective alignment to control turn forces.
- Maximizes grip. Greater edge angle and more pressure is produced on the outside ski.

As our legs can manipulate the vertical distance between hip socket to ski independently, we have the ability to rapidly transfer weight from ski to ski through flexion/extension movements of the ankle, knee and hip joints and a small amount of pelvic tilt. This leg action independence substantially controls the path of the COM from turn to turn.

Figure 33. Clean carved turn in soft snow

Weight transfer can also be achieved through gross movements of the upper body, but these movements are considerably slower and less effective. Different combinations and timing of these faculties provide numerous techniques to obtain weight/pressure transfer between skis.

Vertical movements

Vertical movements describe the movement of the COM closer to or further away from the BOS, vertically along the balance line.

The BOS/COM relationship is controlled predominately through flexion and extension movements of the ankle, knee, and hip joints; the spine and trunk also play a role. These movements occur along the balance line, as the push from the snow (pressure) acts perpendicular to the base of the ski.

Vertical movements are continuously adjusted to regulate the pressure through the base of the ski and control ski to snow contact. Regulating pressure as terrain and turning forces change allows the COM to stay quiet and stable, providing a predictable upper body mass against which to turn the legs.

Vertical movements to moderate pressure are most apparent at the expert level. Expert situational skiing environments often demand a full range of vertical movements to successfully manage variations in terrain.

Example: Expert short turns

Rapid pressure buildup demands absorption of pressure between turns to maintain snow contact and initiate the next turn successfully and elegantly. Vertical movements (flexion) along the balance line manage the magnitude of force through the bottom of the skis to enable this performance level of skiing.

Figure 34. Absorption - short turns

Example: High impact expert bumps

By anticipating the trajectory of the snow pushing on us upon impact, we rapidly extend and place our feet between the impeding impact and our COM. Controlled, resistive flexion movements through the full range of the vertical axis arrest the large forces encountered in these situations.

Figure 35. Absorption – bumps

Unweighting reduces forces (pressure) at the ski-to-snow interface.

Unweighting

Unweighting is a term used to describe increasing and decreasing the pressure (force) between the snow and the skier. We use unweighting to manipulate and manage the magnitude of pressure acting on our skis.

We typically refer to two forms of unweighting, up-unweighting, and down-unweighting. In its simplest form, we use unweighting to reduce the amount of pressure on the skis, making it easier to direct them.

Unweighting is achieved by accelerations and decelerations between the COM and the snow.

Up-unweighting

In up-unweighting, an extension of the legs momentarily increases pressure, but at the top of the action actually reduces pressure on the skis, making them lighter. It is easier to twist the skis when there is less weight on them (reduced pressure).

The speed and duration of this movement provides options for specific tactics and objectives.

Down-unweighting

Down-unweighting is a quick flexion movement of the joints that creates an unweighting (reduction of force) on the skis at the start of the movement. The speed and specifics of this movement - actively pulling feet up or dropping COM down - provides options for specific tactics and outcomes.

The COM will still predominantly rise in a down-unweighted manoeuvre, but it will rise less than the feet, as the feet are absorbing/taking away force (pressure). An example is bump skiing: flexion movements occur during edge change, but the COM path still rises as the skier moves over the bump.

Figure 36. Coordination of movements in short turns in the bumps

COORDINATION

Moving the body segments in the correct order creates efficiency. Efficient movements help direct the COM from arc to arc with little interruption of momentum (motion). This is the flow we notice when we see a good skier, and the seamless blend of the skills can be seen with a smooth glide between turns.

Coordinated Movements refer to the skill of harmonizing movements so that the right things happen at the right time. In a sport such as skiing, where the very essence of the sport is balancing while moving over changing terrain, coordination is crucial to progressing beyond the beginner stage.

Initially, the student learns to do simple tasks like edge the skis at the right time, extend or flex at the right time, and later, do several of these actions simultaneously (coordinate the movements). In expert skiing, coordination is a magical element that makes skiing appear effortless and fluid. More experienced skiers utilize sensory input by looking ahead to anticipate terrain changes and feeling variations in snow conditions, adjusting their technique well before the fall line or terrain feature.

Figure 37. Coordination of movements in Carved Expert turns

Various combinations and proportional application of the skills give us precise control over the performance outcome of our skiing.

Timing

Timing a skier's movements is integral to achieving the desired outcomes. Timing refers to when, for how long, and how intensely a movement is applied. Forces need to be managed smoothly to create effective skiing at all stages of learning.

Key points:

- Successful timing relies on using the appropriate movement for the appropriate duration, given the desired outcome
- Starting and stopping a selected movement at the appropriate point in the turn or maneuver is also a principal element of timing
- Advanced coordination skills will make a group of complex movements appear as one single effort
- Skiers can develop coordination skills by challenging themselves with the speed and or combination and sequence of movements

The order of movements or actions in a ski turn must be properly sequenced, ensuring that each movement occurs in the correct arrangement and will contribute to the overall execution. Maintaining rhythm with a consistent pace and flow throughout the run movement will increase the skier's efficiency. The skier should try to anticipate the actions and their sequence to achieve the desired outcome. Effective integration ensures that the movement of each part is harmonized to perform the skill efficiently.

Adaptability

The ability to adjust movements in response to changing conditions or new information. Adaptability allows for flexible and responsive coordination, which is essential for dynamic ski environments. These elements collectively contribute to the effective coordination of movements in motor skills, leading to improved performance and efficiency.

Conclusion

The 5 Skills Framework stands as an important resource in the teaching and mastery of skiing. By focusing on the five essential skills—Balance, Rotary, Edging, Pressure, and Coordination—this framework provides a structured approach to understanding and improving skiing techniques across all terrains and conditions. It offers a comprehensive means to articulate what skiers do with their skis and how they must move to execute various maneuvers effectively.

Embracing the 5 Skills allows CSIA instructors to accurately assess and guide skiers, design purposeful lesson plans, and refine their own skiing proficiency. Ultimately, seeking to simplify and clarify the dynamics of skiing, equipping members with the tools needed to teach with precision and insight.

Credits

Thank you to all members who appear in these pages

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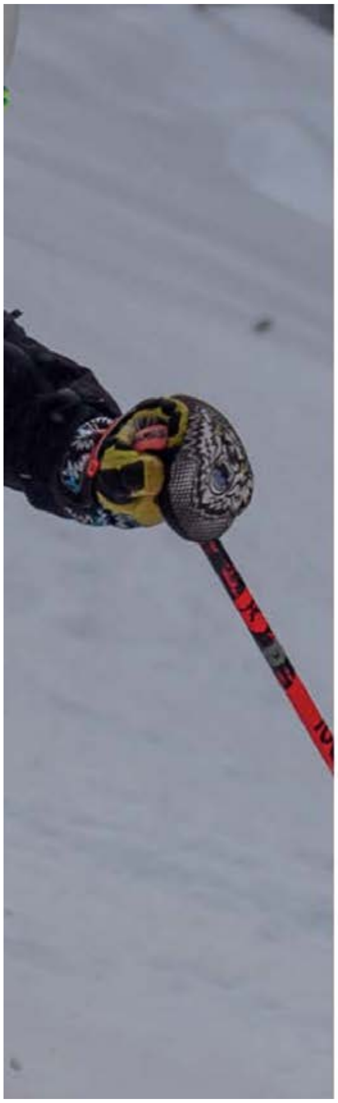

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