US FIGURE SKATING | PSA | CER

CONTINUING EDUCATION REQUIREMENTS

Course Title:

THE PRINCIPLES OF SPINNING IN FIGURE SKATING

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CER Topic Area:
RULES OF SPORT
CER Course Number:
ROS 203

This course is presented by the
PROFESSIONAL SKATERS ASSOCIATION

COURSE INTRODUCTION

Notice: By signing on to take the course/exam, you certify that you are the person signing on and personally completing this course/exam. False statements made by anyone taking this course/exam may result in disciplinary action, up to and including, expulsion from the PSA both for the person taking the course/exam and the person listed as the taker of the course/exam. Successful completion of this course/exam is worth 1 credit towards the U.S. Figure Skating Continuing Education Requirement (CERs).

COURSE OBJECTIVE

Principles of Spinning will address the preparation, entrance edge, inception of the spin, spin position and exit. It will discuss the fundamental knowledge outlining proper technique for all aspects of the following basic forward spins: two-foot spin, one-foot spin, sit spin and camel spin.

At the completion of the course, participants will be able to:

- Understand the basic principles and physics of spinning
- Establish the proper set-up to create and maintain a center to prevent traveling
- Effectively train and reinforce proper basic forward spin techniques with students

COURSE OUTLINE

Part 1: General Introduction
Part 2: Basic Physics of Spinning
Part 3: The Four or Five Parts of a Spin
Part 4: Basic Spin Positions
Part 5: Conclusion
Part 6: Glossary

PART 1: General Introduction

Spins are rotations of the body around a central axis while standing on a blade. Some spins include a jump at the beginning of the spin, and these are called "flying spins. A well-balanced freestyle program includes jumps, spins, step sequences, and connecting moves. While spins historically did not receive credit similar to jumps, under the International Judging System (IJS), the importance of spins has increased, as well as the variety of spins being performed. This course will discuss the following basic spins: two-foot spin, one-foot spin, sit spin and camel spin. These are the spins on which all other spins are based. More advanced spins include

Generally speaking, sit spins and camel spins occur on the front part of the blade, just behind the toe pick. Some spins occur even farther forward on the blade, with the very bottom toe pick also tracing on the ice. A one foot-spin is an example of this. The difference between the weight distribution over the blade is slight.

While spin techniques are often the basis of jumps, the two are very opposite in their execution. A good jump should explode into the air and progress from one spot to another, covering a good section of ice from the take-off through the landing. The goal of a good spin is to not "travel" across the ice, but instead to rotate in one spot. The key to a "centered" spin is found in the "hook" of the spin. Ideally, spins should be fast and controlled, and centered, and in an aesthetically pleasing position. All three aspects occurring simultaneously is ideal; however a skater may only achieve one or two characteristics at a time. Continually challenge the skater to be able to perform all three qualities.

The final GOE of a performed spin is based on the combination of both positive and negative aspects. The final GOE of an element is calculated considering first the positive aspects of the element that result in a starting GOE for the evaluation. Following that, a judge reduces the GOE according to the guidelines of possible errors, and the result is the final GOE of the element. To establish the starting GOE Judges must take into consideration the bullets for each element. General recommendations are as follows:

- FOR + 1: 1 bullet
- FOR + 2: 2 bullets
- FOR + 3: 3 bullets
- FOR + 4: 4 bullets
- FOR + 5: 5 or more bullets
- FOR + 4 and +5 THE FIRST THREE bullets highlighted in bold must be present.

POSITIVE ASPECTS OF GOE'S: SPIN ELEMENTS	
1	**Good speed and/ or acceleration during spin**
2	**Good controlled, clear position(s) including height and air/ landing position in flying spin**
3	**Effortless throughout**
4	Maintaining a centered spin
5	Creativity and originality
6	Element matches the music

REDUCTIONS FOR ERRORS: SPIN ELEMENTS			
Fall	**-5**	Poor/awkward, unaesthetic position(s)	**-1 to -3**
Touch down with free foot or hand(s)	**-1 to -3**	Slow or reduction of speed	**-1 to -3**
Poor fly (flying spin/entry)	**-1 to -3**	Change of foot poorly done (including curve of entry/exit except when changing direction)	**-1 to -3**
Incorrect take-off or landing in a flying spin	**-1 to -2**	Less than required revolutions	**-1 to -3**
Traveling	**-1 to -3**	Unbalanced number of revolutions in change foot spin	**-1**

PART 2: Basic Physics of Spinning

Most figure skating professionals are not educated physicists, but coaches still a basic understanding of some of the principles of physics. Whether or not a coach actually uses the technical terms when working with skaters, it is important to know what makes a spin rotate.

Angular Momentum

When a skater in a spin draws his or her arms and leg inward from an extended position toward the skater's torso, the spin velocity increases, or speeds up. This occurs because the distance between the axis of rotation (the skater's body over the spinning foot) and some of the skater's surface area (extended arms and leg) is reduced when the arms and leg are pulled inward. This is known as conserving **"angular momentum"** and causes rotational velocity to increase, thus resulting in a really fast spin when arms and leg are pulled in tightly.

Centripetal Force and Centrifugal Force

There are two forces at work in creating a spin: centripetal force and centrifugal force.

- **Centripetal force** is the force that causes a body to move in circular motion. It is created when appendages or limbs are drawn toward a center point. This occurs when a spinning skater pulls his or her arms and leg toward their center mass. It is always pointed towards the center. It provides an acceleration towards the center which is centripetal acceleration.
- **Centrifugal force** is the opposite. Centrifugal force is the force that makes something flee from center. It always tries to push a body away from the center or circular motion. It is always pointed away from center. It's the strong resistance that attempts to push the arms and leg away from the center point of the body.

It is the harnessing and balancing of these two forces that will result in a successful spin. Ballet dancers use the technique of "spotting" when turning. Figure skaters, however, do not. The key to not getting dizzy is in proper body alignment and gradually building up to faster spins. Skaters must keep their head and back straight in order to keep the eyes horizontal, thereby reducing the off-balance messages sent to the brain. As the brain becomes accustomed to the spinning sensation, and the centering of the spin improves, and the feelings of dizziness will diminish.

Beginning skaters should not attempt to spin at a high rate of speed until the basic upright spin can be controlled. Controlling spins is the result of a variety of skills. Some key skills include core strength and stability, balance, strength, power, and flexibility.

Core strength and stability comes from the abdominal and back muscles. In all aspects of skating, the skater needs a strong core for stability. With spins, this core strength is a major component in the controlling of the spin's rotational speed. As spins increase in difficulty, more core strength is required.
The arms and legs of a skater follow a curved path as they spin on the ice. The muscles of the body apply the inward force to hold the arms and legs in position. If a skater's muscles are not strong enough, the arms and legs will move away from the body just as the ball flies away from your hand if you release the string. As a skater's angular velocity increases, they must produce more centripetal force with the muscles to keep their arms and legs in position during the spin

Key Facts About Centripetal Force in Spinning

- The faster the skater spins, the more force is needed, all else being equal
- The farther the limbs are from the body, the more force is needed
- As a skater pulls into a tight position, more centripetal force occurs when the limbs are closer to their center of mass.
- An object with more mass requires more force to create the same acceleration.
- A skater with more mass in the arms will need more centripetal force to hold the arms in towards the body, all else being equal.

Balance is important because so much of skating occurs on one foot. With the exception of the two foot spin, all spins are executed on one foot. The skater's balance will improve through increased strength and as the brain grows accustomed to the spinning sensation. The balance receptors in the feet and lower extremities will also become more accustomed to the spinning sensation over time.

Muscle strength creates power and without this power, spins will be slow in speed and short in duration. Again, increased muscle strength is required as spins increase in difficulty. Flexibility allows for a greater range of motion, necessary for the execution of the sit and camel spins. With sit spins, flexibility aids in achieving the desired lower sit spin position with an extended free leg. Where camel spins are concerned, flexibility helps in the extension of the skating leg and the free leg, which is, ideally, above hip level.

Moment of Inertia

A skater's moment of inertia depends on their mass and their body position relative to their axis of rotation and it is extremely important for spins.

MOMENT OF INERTIA
Inertia is defined as the resistance of an object to changing its state of motion. Inertia is a measure of how hard it is to accelerate an object.
An object's inertia for *linear motion* is its *mass*. ● The larger the mass, the more the inertia and so the harder it is to linearly accelerate that object. Example: When you push a light object, it is easier to get it moving than when you push a heavier object.
An object's inertia for *angular motion* is its *moment of inertia*. ● The larger the moment of inertia, the harder it is to angularly accelerate. Example: When you push an object to start it spinning, the smaller the object's moment of inertia the easier it will spin.
The moment of inertia of an object depends on the object's mass and how that mass is distributed, or positioned, about the axis of rotation. ● The larger the mass, the larger the moment of inertia. ● The farther the mass is from the axis of rotation, the larger the moment of inertia. ● The measure of how far the mass is distributed about the axis is called the radius of gyration.

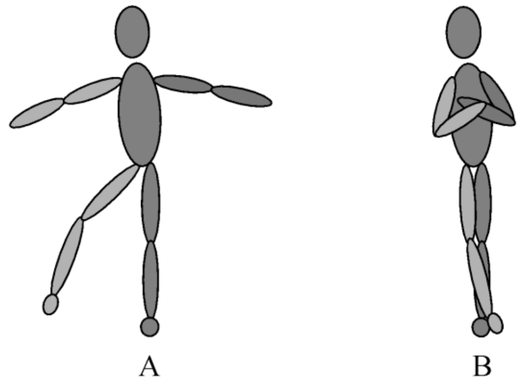
Specifically, the moment of inertia depends on mass and a quantity called ***radius of gyration***. Radius of gyration is a term that represents how far a skater's mass is distributed, or spread, about the axis of rotation. A skater's mass is made up of all the segments of their body: arms, legs, trunk, head, hands, and feet. Therefore, as a skater changes body position, the positions of body segments change relative to the axis of rotation.

When a skater's body segments are positioned far from the axis of rotation, the skater's mass is distributed farther from the axis (Figure 2). This creates a larger radius of gyration and a larger moment of inertia. When the skater's body segments are closer to the axis of rotation, that mass is clustered near the axis (Figure 3b). This is a smaller radius of gyration and a smaller moment of inertia.

Additionally, two skaters who are the same size in terms of height, width, leg length, etc. but have different masses, will have different moments of inertia even when they are in exactly the same position.

In the ISU judging system, skaters are rewarded for increasing speed within a basic position of a spin. If the skater is in a tight body position as they enter the spin, they cannot decrease their moment of inertia. She will already be at or near her top speed. This limits her ability to increase angular velocity during the spin and is disadvantageous.

Figure 2a and 2b.

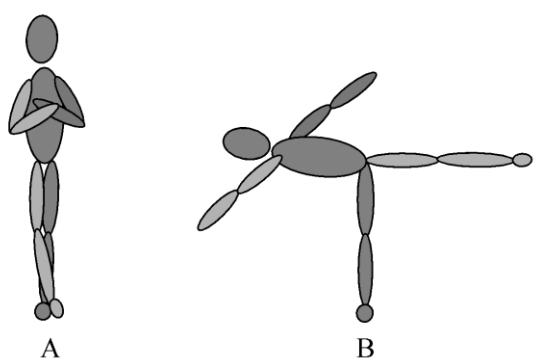


In A, the segments are held away from the body, so body mass is distributed farther away from the axis. In B, body segments are near the r body and mass is distributed closer to the axis of rotation. The skater decreases the moment of inertia by decreasing the radius of gyration.

Example: A skater in an upright spin has a small moment of inertia versus a camel spin with a large moment of inertia (Figure 3).

- In the camel spin, the head, shoulders, arms, and chest are far in front of the axis of rotation. The knee, leg, and foot are far behind the axis. The mass is distributed away from the axis of rotation increasing the moment of inertia.
- In the upright spin, the arms and legs are closer to her body and the trunk is in line with the axis of rotation. The mass is close to the axis of rotation and the moment of inertia is small.

Figure 3.



An upright spin (A) has a small moment of inertia as compared to a camel spin (B).

Example: Sally and Jenny are the exact same size in terms of inches but have a difference in body mass. They both spin in a camel position with their head, arms, chest, leg, and foot exactly the same distance from the axis of rotation (Figure 5). Their mass is equally distributed about the axis of rotation. Since Sally is heavier, she has a larger moment of inertia. Her resistance to angular motion is larger than Jenny's even though they are in the same body position. *A larger moment of inertia provides more resistance to angular motion, making it hard to spin fast and have a high angular velocity.*

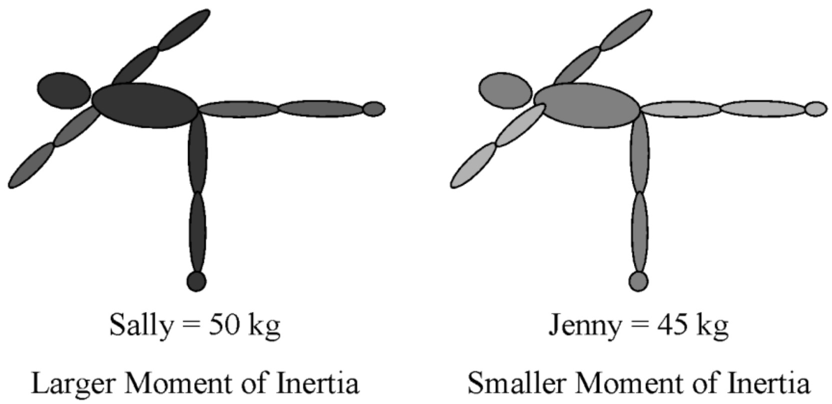


Figure 4.

Sally and Jenny are in the exact same position and have the same radius of gyration. Sally has 5 kg more mass than Jenny, so her moment of inertia is bigger.

The torque creates an ***impulse*** that gives the skater angular momentum. Impulse is the product of force and time. An angular impulse is created when a torque is applied over a period of time. It gives an object angular momentum.

Example:

- A skater can create more angular momentum by increasing the torque or the time of force application.
- Torque can be increased with a larger and/or longer push and by creating better leverage during the push.
- The amount of angular momentum created entering a spin determines the angular velocity the skater will be able to obtain and is therefore critically important.

Torque

Torque is the ability of a force to cause rotation about an axis. Sometimes torque is described as how hard something is rotated.

Torque is created when a force is applied off center. The amount of torque depends on the magnitude of the force and the length of the lever arm. The lever arm is the perpendicular distance from the force to the axis of rotation. A large force produces a larger torque. A force applied farther from the axis creates more torque because it has a larger lever arm.

A simple example is removing lug nuts on a tire. It is easier to loosen the lug nuts on a tire if you push on the far end of the wrench because you have more leverage; your lever arm is bigger. If you have a short lug nut wrench or push on the wrench close to the lug nut, it is hard to generate torque and loosen the nut. You have poor leverage because you are using a small lever arm.

Angular Velocity (The speed of the spin)

Remember that a skater's angular momentum is a product of their moment of inertia and angular velocity.

- When a skater pushes off the ice as they enter a spin, the resulting angular velocity depends on the moment of inertia and angular momentum.
- If the moment of inertia is large? the angular velocity will be small. If the moment of inertia is smaller the angular velocity will be bigger, given that the angular momentum is the same.

This is a key concept of spinning and rotating in skating. It is worth going through the concepts one at time to see how they are related:

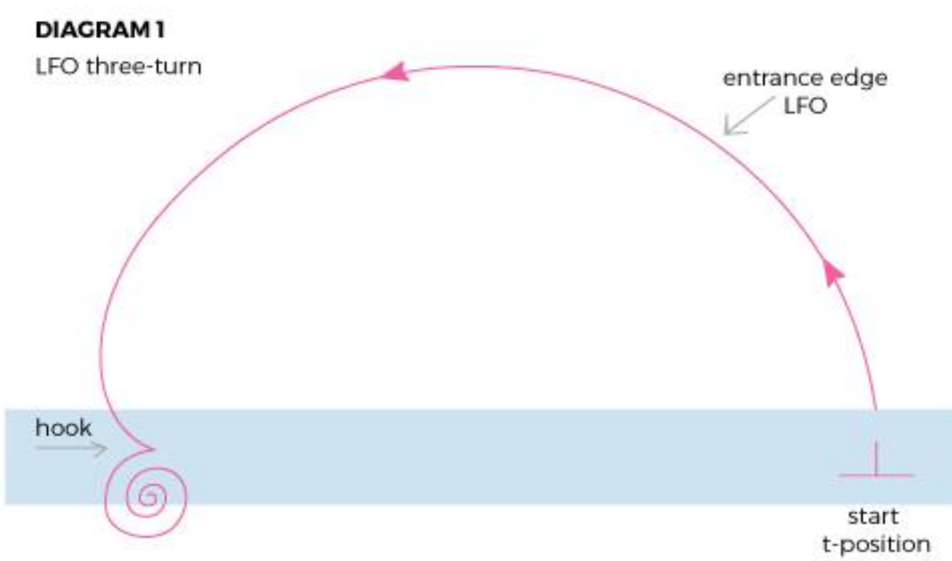
1) An off-center push against the ice creates torque.
2) The magnitude of the torque depends on the push (force), and the location and direction of push (lever arm).
3) Torque applied over a period of time creates angular impulse.
4) The angular impulse creates angular motion; the skater gains angular momentum.
5) The skater's angular velocity depends on the angular momentum and moment of inertia.
6) For any given angular momentum, the smaller the moment of inertia the faster the angular velocity.

PART 3: The Four or Five Parts of a Spin

Some coaches refer to four parts of a spin and others refer to five parts of a spin. The concept is still the same for the actually spin itself, and both are considered correct. The steps remain the same for any spin.

1. **Presentation edge** - The presentation edge is usually the sustained back inside edge of a backward crossover. A skater who spins counterclockwise might be on a held right back inside (RBI) edge following a right back crossover. An inside three-turn is also a popular precursor to a spin. A skater who spins counterclockwise would be on a held right back outside (RBO) edge following a right forward inside (RFI) three-turn. Due to deep knee bend of this presentation edge, the radius of the curve the skater is on will decrease.

2. **Push onto the spinning foot/Entrance edge** - Keeping a well-bent knee, the skater will push onto the other foot on a deep outside edge. The entrance edge needs to be strong for the spin to have power. For a skater spinning counterclockwise, that edge will be a left forward outside (LFO) edge. It is imperative that the skater steps into the circle formed by the curve of the edge created by the presentation edge.



Hook - This occurs when the deep forward outside edge catches the blade's bottom toe pick and results in a three-turn, or a "hook." For a skater spinning counterclockwise, it is a left forward outside three-turn (LFO3) and the knee stays bent through the first revolution on the left back inside (LBI) edge, after which the knee will straighten up. How much it straightens depends on what spin is being performed.

The hook is where the center is created and contributes to the force that makes the skater spin. It is important to maintain the body weight over the skating side, possibly even leaning into the circle created by the entry edge. The free leg should be extended and held strongly behind the skater until the hook.

3. **Centering** - A good spin must be centered, which means that the body is aligned and balanced over the skating blade and the spin rotates over one spot. In a spin, forward momentum must be changed into rotational force. This happens when the entry edge, due to a deep knee bend and a deep outside edge, forces the diameter of the curve to diminish as it approaches the three-turn, or hook.

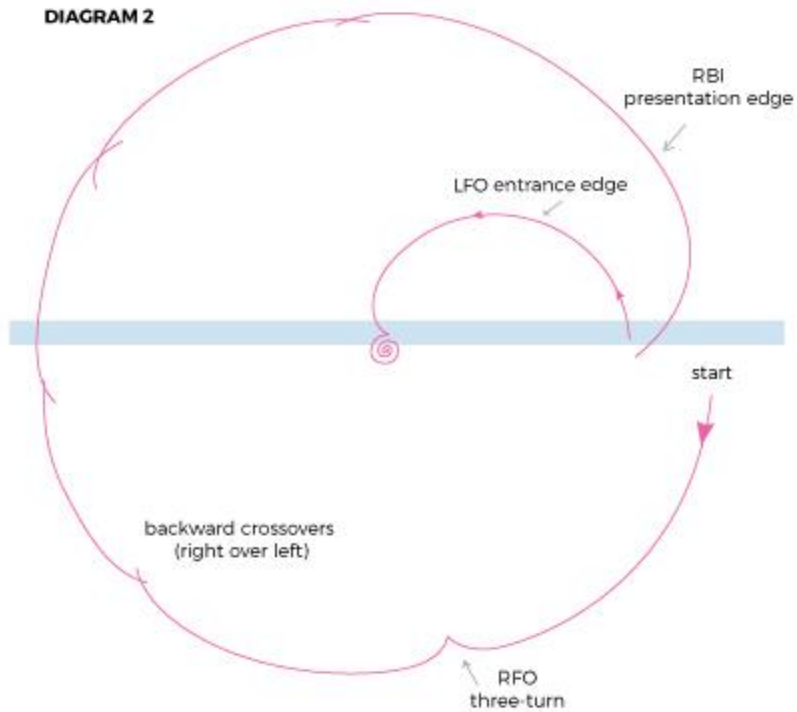
4. **Spin** - There are a variety of spin positions, but the tracings on the ice of the spin itself, no matter the position, will ideally be small, concentric circles placed beside the hook, which can lead to a fast, controlled spin. A traveling spin leaves a print that looks like a line of small loops spread out away from the hook. A traveling spin gets downgraded and usually suffers from a lack of control.

   Two common errors are usually to blame for a traveling spin. The first is a shallow entry edge that does not diminish in diameter. This likely has to do with insufficient knee bend or improper body alignment or balance over the entry edge. Second, if the free leg does not stay checked behind the skater and instead swings around, it forces the hook to happen prematurely before the diameter of the circle has diminished sufficiently.

   In addition to a controlled, centered spin, a spin should maintain and even increase speed, or velocity. The closer a skater's appendages are to his or her torso will result in a more streamlined physique, thereby increasing the opportunity to increase speed. Due to this, a spin where the arms and the legs are in tight (such as a scratch spin) is more likely to be much faster than one where the arms and leg are extended (such as a camel spin).

   Following the hook of the spin, the skater gets into the spin position. At this point, the balance over the skating foot must be maintained to maintain speed.

This is where core body and strength become particularly important, when needing to harness the pushing out of the centrifugal force to increase a spin's speed. If balance is not maintained and there is any rocking back and forth over the skating foot, the speed begins to decrease, and the spin will likely begin to travel.



There are a required number of rotations for spins in testing or competition. Deductions will be made if the required revolutions are not completed. Balance, speed, core body and strength - all of these things allow for the five parts of the spin to be completed successfully.

5. **Exit** - Most of the time a spin exits in the same position as a jump - on a back outside edge but it is the choice of the skater to add more difficult exits for features. For a skater spinning counterclockwise, the exit will be on a right backward outside (RBO) edge. Ideally, the free leg should be extended to the back, with the skating knee bent, the head up, the arms are outstretched, and the body held upright displaying good posture.

PART 4: Basic Spin Positions

Maintaining Balance in Spins

To have a centered spin with the skater in a balanced position over the blade the spin must be entered with pure angular motion. **In other words, if the skater is off-balance even slightly, the spin will travel across the ice.** The push must create a torque that creates angular momentum about the axis of rotation. The skater does not want to have ***linear momentum*** from the push, which will cause the spin to travel. The edge into the spin is important. The skater must maintain pressure on the skating knee so that the edge has a firm grip on the ice.

The skater also must maintain a balanced position, so must keep the COM ***(Center of Mass)*** over the BOS (***Base of Support*)**. The base of support (BOS) is the part of the blade in contact with the ice during the spin. It is the skater's point of rotation. If the COM shifts out of line with the BOS as the skater spins, the line of gravity will no longer be over the BOS. Gravity will create a torque about the axis of rotation, which will in addition cause the spin to travel.

BALANCE
To hold a static (stationary) balanced position, the COM must be over the base of support (BOS). The BOS is the area created on the ground between the points of contact. In skating, the BOS is the part of the blade that is touching the ice. Since this is very small, the skater must be able to control body position precisely to keep COM above the blade. While standing still, if her COM goes to one side of the BOS, the skater will fall towards that side. If COM moves towards the front or the back of the blade, the skater will start to fall forward or backward, respectively.

Basic Spin Positions

- Upright
- Sit
- Camel

Upright Spins

Upright spins are performed with the body weight of the skater balanced over the skating foot (or feet).

> **Two-foot spin** - The most basic of spins, the two-foot spin is the first spin a skater learns and is the basis for all of the other upright spins. Two-foot spins are often initially taught from a forward pivot position with the arms out to the side, slightly in front of the body. For a skater spinning counterclockwise, the left knee would bend with the right foot going out to the side in a forward inside push. The right foot is drawn in toward the left foot with both feet slightly pigeon-toed and the weight evenly distributed over both feet. The back is straight, and the head is up. The arms are then pulled inward. The left foot is making back inside circles, the right foot is making forward inside circles.
>
> **One-foot spin (Beginning)** - The transition from the two-foot spin to the one-foot spin often follows the same learning path. Once the two-foot spin is being performed well, the skater, still beginning from the two-foot forward pivot position, will bring the feet together (like the two-foot spin) and then lift the free foot to the skating boot, sliding it up the skating leg until the free foot is touching the skating knee. The back is straight, the head is up, and the arms are pulled in.

There are two techniques usually used regarding the position of the arms on the entrance edge going into a spin. The first, for a skater spinning counterclockwise, is to have the left arm strongly in front of the body with the right arm checked behind the body in a counter-rotated position. The left arm stays over the print of the entrance edge until the hook occurs and then the arm moves into its position for the spin. This method has the advantage of being able to generate momentum as the arms move into position; however, if the arms are allowed to swing across the body, the spin likely will travel due to a loss of balance.

The second method involves rotating the arms prior to stepping into the entrance edge of the spin while still on the backward presentation edge. For a skater spinning counterclockwise, the right arm is in front of the body over the print and the left arm is checked strongly behind so that, on the entrance edge, the shoulders are already rotated. This method has the advantage of more easily maintaining balance as the as the shoulders are already aligned over the hips allowing a secure center, but it is not as easy to generate momentum at the point of the hook.

Coaching Tip: To progress from the one-foot spin from a T-position on a line to using a back crossover to back inside edge, begin once again on the line with the feet in a T-position. With the right foot forward (for a counter-clockwise spin), the skater executes a RFO three-turn. The RFO three-turn is followed by a right over left back crossover. Once the skater reaches the line, the skater steps into the spin.

One-foot spin (Advanced) - Coaches generally utilize two methods to begin teaching the one-foot spin from a one-foot outside edge. The first is from a T-position on one of the hockey lines. From here, a skater spinning counterclockwise would push from their right foot onto the left forward outside (LFO) edge, curving back toward the hockey line and getting the feel of the entrance edge. The second is going directly to teaching the presentation edge from a BX and stepping onto the entrance edge.

Coaching Tip: To progress from the one-foot spin from a T-position on a line to using a back crossover to back inside edge, begin once again on the line with the feet in a T-position. With the right foot forward (for a counter-clockwise spin), the skater executes a right forward outside (RFO) three-turn. The RFO three-turn is followed by a right over left back crossover. Once the skater reaches the line, the skater steps into the spin.

At this point, with either technique, the emphasis on the entrance edge should be on knee bend and the body leaning into the circle, with the skater balancing over the skating foot so they can begin to feel the diminishing diameter of the entrance edge into the hook. The free leg should be held strongly behind the skater for the entirety of the entrance edge.

The coach's preference as to arm position would need to be initiated at this point. As with the beginning one-foot spin, the free ankle should be knee-high on the skating leg. The back is straight, and the head is up. On the exit of the spin, the skater brings the free foot down, which then becomes the skating foot, and pushes out with the foot that he or she had been skating on.

For a skater spinning counterclockwise, the right skate would be placed on the ice close to the left skate and the skater will perform a LBI push, bringing the left leg behind into the right backward outside (RBO) exit position discussed in the previous section.

Sit Spins

Sit spins are the second category of spins. These spins resemble the shoot-the-duck position in freestyle. Muscular strength is important in this spin in order to maintain the sit position, as well as to be able to get back up. Flexibility also plays a role so the free leg can be extended in an aesthetically pleasing position. Often coaches will work with their skaters on the wall doing stationary shoot-the-duck positions or squat positions in order for the skater to get the feeling of the bend at the hip joint, creating the proper angle, and their knee and ankle bending so their laces are putting pressure into their shin.

> **Forward sit spin** - The spin initiates from the presentation edge (usually a back crossover) and then pushes inside the circle onto the entrance edge. For a skater spinning counterclockwise, this will be on a LFO edge, with the skater's body weight over the left hip and the left knee bent. As the circle of the entrance edge diminishes in diameter due to increased knee and ankle bend, it will trigger the hook. At this point, after the hook, the right leg swings around from the back to the front and the left skating knee bends completely into the sit position. The right leg is extended in front, parallel to the ice and turned out. The arms/hands come together, reaching out toward the free foot. The back is straight but is angled forward in a diagonal line. For the exit, the skater rises on the skating leg, briefly bringing the free skate into the one-foot position described above and then pushing out into the backward outside exit position.

Camel Spin

Camel spins make up the third category of spins and resemble a spinning spiral position. Muscle strength is also very important with this spin to be able to hold and control the spiral position, keeping the leg up and behind, while dealing with the forces of spinning. Flexibility also comes into play to achieve the desired height of the free leg. Oftentimes coaches will also work on this position on the wall of the ice rink.

One method is to practice bending and straightening the skating leg, while maintaining the height and control of the free leg, mimicking the bend and rise of the entrance edge and the hook. Coaches may also use moving forward and backward spirals in a straight line as a training technique so the skater can feel their body weight on the proper part of the blade for the spin.

The spin initiates from the entrance edge and then pushes inside the circle onto the presentation edge. For a skater doing a forward camel spinning counterclockwise, this will be on a LFO edge, with the skater's body weight over the left hip and the left knee bent, free leg close to the ice. As the circle of the entrance edge diminishes in diameter due to increased knee and ankle bend, it will trigger the hook. Following the first revolution, the skating knee begins to straighten and, keeping the shoulders level and the arms extended and the chin up, the upper body leans forward and the free leg lifts into a spiral position. The free leg should be at least hip level. For the exit, the skater stands upright, briefly bringing the free skate into the one-foot position described above and then pushing out into the backward outside exit position.

PART 5: Conclusion

Under the IJS system, spins have gained increased importance and credibility in a skater's program and the variety of spins available for skaters to learn and perform has increased greatly.

While different coaches may employ slightly different techniques, for instance the left arm or right arm in front on the entrance edge, the process into and out of a spin is the same for spins across the board. Establishing and maintaining consistency with what the body does on the presentation edge, the push onto the entrance edge, the hook, the spin itself, and the exit will be the fastest path to correct muscle memory. It is imperative that a skater stays patient and stays down in the knee, learning not to rush the hook of a spin, so they can establish and maintain the all-important center. Coaches need to choose one methodology as adhere to eliminate confusion for the skater.

Coaches need to be aware of the proper basic positions to be maintained in each spin and make sure their skaters have the ability to get into those positions and hold them. Proper off-ice training can be extremely beneficial when it comes to the core strength and stability, balance, muscle strength and power, and flexibility discussed in Section II.

In conclusion, nothing is more important in figure skating than a solid foundation in the basics. Every new variation comes from one of the basic spins and skaters should not be taught more advanced spins until their basic spins are controlled and consistent. As a coach, encourage your skater to be able to perform fast, controlled, aesthetically pleasing solid basic spins before learning the more challenging positions.

PART 5: Glossary

Air resistance	Force resisting the movement of an object through the air.
Angular Acceleration	Rate of change of angular velocity. A measure of how fast and in what direction an object's angular velocity is changing.
Angular Impulse	The product of average torque and time. Angular impulse equals the change in angular momentum of an object.
Angular Momentum	The quantity of angular motion of an object. It is the product of an object's moment of inertia and angular velocity.
Angular Motion	Motion that occurs about an axis of rotation with points on the rotating object tracing circular paths.
Angular Position	The orientation of an object measured in the plane of motion.
Angular Speed	A measure of how fast an object is rotating.
Angular Velocity	Rate of change of angular position. How fast an object is spinning and the direction of the spin.
Anterior Posterior Axis	Axis of rotation of the body that runs front to back and passes through the center of mass.
Base of Support	Area between points of contact with ground over which an object is balanced.
Center of Mass	Location of an object about which all the mass is evenly distributed. The balance point of an object.
Centripetal Force	Inward force on an object that keeps the object moving on a curved path.
Force	A push or pull on an object. Force causes acceleration.
Friction	A force that resists the sliding of one object across the other.
Frontal plane	Plane of motion that splits the body from front to back. Motions in the frontal plane take place about the anterior posterior axis.
Gravity	The force that attracts objects to the center of the earth.
Impulse	The product of average force and time. Impulse is equal to the change in momentum of an object in a collision.
Inertia	An object's resistance to linear motion. An object's inertia is its mass.
Linear Momentum	Product of mass and velocity. It quantifies linear motion and represents mass in motion.
Linear Velocity	The speed and direction of linear motion of an object. Linear motion is motion along a straight or curved line when the orientation of the object does not change.
Longitudinal Axis	Axis of rotation of the body that runs from head to toe and passes through the center of mass.

Medial Lateral Axis	Axis of rotation of the body that runs from left to right and passes through the center of mass.
Moment of Inertia	An object's resistance to angular motion about an axis of rotation.
Momentum	The product of mass and velocity. It quantifies mass and motion.
Product	Product is used in math to denote when quantities are multiplied. For instance, area is a product of length and width. *Radius of Gyration* A measure of the distribution of mass of an object about an axis of rotation.
Radius	Used to measure the distance from the center to any point on a circle.
Sagittal Plane	Plane of motion that splits the body from left to right. Motions in the sagittal plane take place about the medial lateral axis.
Scalar	Scalar is the term used for a quantity that only refers to *magnitude*.
Tangent	A line that is perpendicular to the radius and intersects the circle at only one point.
Tangential Velocity	Linear velocity of a point moving along a curved path that is directed tangent to the path of motion of the object.
Transverse Plane	Plane of motion that splits the body from top to bottom. Motions in the transverse plane take place about the longitudinal axis.
Vector	Vector is a term meaning a quantity that has both magnitude and direction.

"The Complete Book of Figure Skating" by Carole Shulman

"The Physics of Everyday Stuff "- Figure Skating Spins" by Sam Hokin