E-LEARNING ACADEMY

Understanding The Figure Skating Blade Course

PSA Membership Package Course 3: ELBlade

This course and exam are for your use only.

By signing on to take the exam, you certify that you are the person signing on, and personally completing this exam. False statements made by anyone taking this exam may result in disciplinary action, up to and including, expulsion from the PSA both for the person taking the exam and the person listed as the taker of the exam.

Successful completion of this exam is worth 1 PSA credit

Course Description

Understanding The Figure Skating Blade Course is designed to assist coaches with their understanding of the unique performance features of various blades and their functional features. After completing this course, coaches will be familiar with blade terminology and its relationship to performance. The course comprehensively describes the various components that define each blade model that help coaches understand why a particular design is right for a particular skater. Essential Figure Skating Blade Knowledge will give coaches insight to consider the requirements of the skaters, the parts of the blade, material, performance features when making blade decisions.

Course Outline

Part 1: Introduction

Each individual skater has a unique skating style and as such, require different things from their blades. Various blade styles are available for different disciplines as skaters are required to do entirely different technical maneuvers – compare the differences between ice dance and synchro, for example. With many blades on the market, it can be difficult to decide which one to choose or recommend.

There are several important features that are significant in deciding on profile, brand, or style. The features listed and explained below can be found in many variations. Understanding how each feature affects skaters can help coaches make informed recommendations to their students, based on several criteria.

Coaches will commonly select equipment for their students based on their own experiences as a skater, and they tend to not want to stray from what they know. By that rational, it would make sense to give a rotary phone to your kids because you grew up with a rotary phone. In recommending a particular skate to their student or colleague, do coaches really consider why? Do most coaches truly understand the performance features of the blades that are now available in the marketplace?

There has been tremendous progress and innovation by skate manufacturers in recent years. Whether an athlete or a coach, it is important to educate yourself on these advancements, so as to ensure you're making the most informed decisions possible. As a coach, your understanding of the sport, coupled with an understanding of the figure skate blade, will put you in a position to help your skater make sound equipment choices as they strive to maximize their potential. Leading figure skate manufacturers provide detailed product information on their websites, and make it easy for consumers to match, for example, the proper blade to a particular skill level.

Terms and Anatomy of a Figure Skate Blade

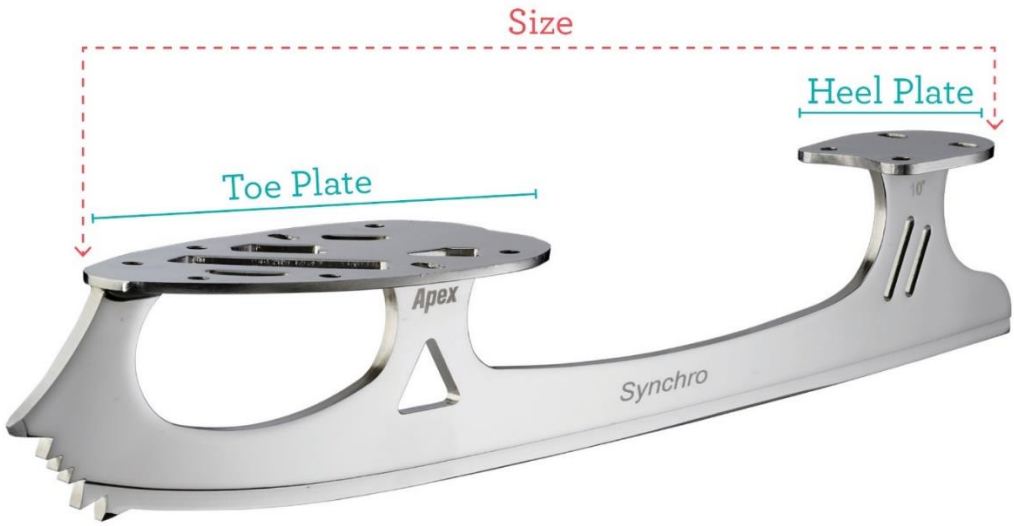
Rake, Picks, or Teeth
The Swedish revolutionized ice skates by adding saw-tooth picks to the front of the blades in the 1870s, and American Jackson Haines was credited as the first to wear them.

Drag Pick, Anchor Pick, Master Pick, or Drop Pick
The lowest single pick on the rake and furthest from the foot, this pick initiates vertical height from horizontal velocity in edge jumps and provides a pivot point on toe-jumps.

King or Primary Pick
The top pick of the rake, closest to the foot, and generally the largest pick. No function of jumping, primarily it is used securing back pivots in singles and pairs.

Non-Skateable Zone (NSZ)
Skate technician, Sidney Broadbent, popularized the term and defines its location as the space between the drag pick and where the sharpening begins. The NSZ can vary depending on blade model, and it can range between 1/2" to 1 ½". Contrary to its name, the NSZ does engage with the ice in many critical moments - during jumps and turns, for example. Trained skate sharpeners will maintain this area, along with the rocker profile.

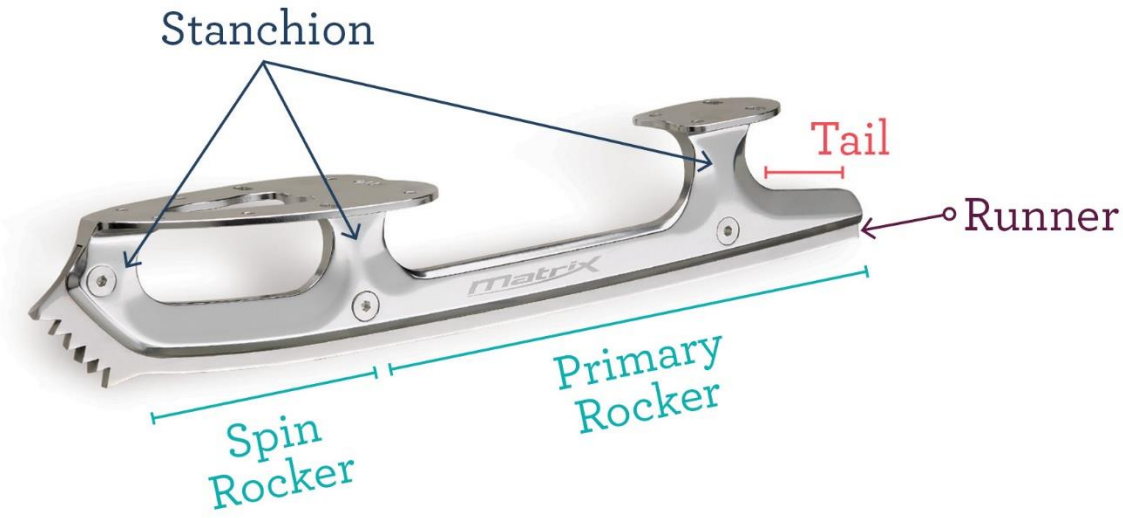
NOTE: There have been efforts to standardize figure skate terminology. Industry icon, Sidney Broadbent, received a United States Olympic Committee grant to study blade frictions. He wrote a technical manual called "Skateology" and manufactures skate sharpeners.



Toe Plate
The plate attached to the boot, directly under the ball of the skater's foot.

Heel Plate
The plate attached to the boot, directly under the skater's heel. NOTE: Jackson Haines, in 1865, developed the two-plate figure blade by forging separate toe and heel plates to one all metal runners. The plates were attached directly to Haines' boots, which added stability and allowed him to perform more athletic leaps and jumps.

Size or Size Range
The length of a blade is measured from the front of the toe plate to the back of the heel plate. Measuring blade size was introduced to help establish the proper blade length for a given boot's sole. Blades are almost always 1/8"-1/2" shorter in length than a boot's sole.



Stanchion (Often called height measurement)
The supports along the blade and for toe and heel plates. Stanchions provide distance between the boot and the ice to allow a skater to lean.

Tail
The part of the blade that extends beyond the heel stanchion away from the picks.

Runner
The bottom portion of the blade that rests on the ice surface.

Primary rocker or Rocker Radius
The primary radius of the blade from the ball of the foot to the heel. It's standard to measure this rocker in feet, most commonly 7', 8'.

Spin Rocker
Sometimes referred to as "the sweet spot" for spinning, others refer to it as "the bulge." The spin rocker is the portion of the blade's runner from the end of the NSZ to the ball of the foot, ending usually under the middle stanchion.

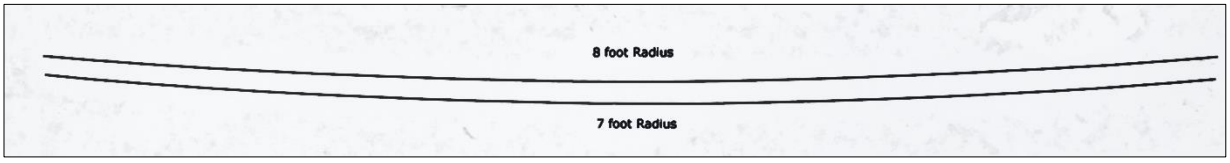
Part 2: Major Blade Elements In-Depth

Primary or Rocker Radius

The longest part of the blade (about 2/3rd of the total runner) which contacts the ice from under the ball of the foot to the heel. Most manufacturers produce blades with rockers specified in one of two common radius curves: 7 feet or 8 feet. In theory, the larger the radius, the flatter the blade contacting the ice and the greater the stability. It is also theorized that with the larger radius there is greater displacement of weight along the runner. This means less penetration into the ice - creating drag or friction - resulting in a faster blade. Conversely, a smaller radius would allow for increased maneuverability, but with reduced flow.

In reality, the difference between the two common rocker curves is possibly undetectable by most skaters. However, if a primary radius is smaller than the height of a skater's center of gravity it becomes almost impossible to balance and as the radius approaches or becomes flat the skater experiences an unacceptable lack of maneuverability. In practical terms a primary rocker radius in the range of approximately 5 – 12 feet will most likely be suitable for the vast majority of skaters and almost all manufactures aim to be in the middle of that range.

Image Courtesy of John Harmata



What is of utmost importance is the ability of the manufacturer to produce accurate and consistent blades that do not have large deviations in the rocker such as flat spots or negative rockers along the blade length.

Spin Rocker or "Sweet Spot"

The curvature in the Spin Rocker is usually measured in inches of radius. Looking at a blade, you can visually see the deeper curve as compared to the back 2/3rd of the blade where the rocker is measured in feet. The combination of curve size(s) in the spin rocker area can influence how the blade reacts and feels to the skater, particularly on jumps and spins. When jumping on a blade with a large radius in the 'sweet spot', a blade will engage the toe pick faster. For spinning, the smaller the radius in the spin rocker the more balance may be required to maintain center. Some blade's profiles may have a combination of different radii in the spin rocker while others may have just one defined radius. While the characteristics of the spin rocker play an important role in how the blade 'feels' initially, skaters generally adapt to rocker profiles after some time.

Additional Notes:

- Skaters and Coaches often only replace their blades after prolonged use. While every good skate sharpener tries to maintain the original blade profile. Sharpening inherently whittles down a blade over time. So, patience is important when going from any "old" blade to any new blade, even if it's the same blade profile.
- Furthermore, not only the area of the spin rocker, but the entire blade is affected by excessive or poor sharpening.

**NSZ – Non Skateable Zone

According to engineer Sid Broadbent, just prior to the bottom pick is a section of the blade he termed the "non-skateable zone" (NSZ).

PSA coach and skate technician Stewart Sturgeon notes, "While it is true that [off-the-ice] a blade resting on a hard-flat surface, with the drag pick touching, there is a section of blade that does not contact the surface.

However, in practical reality, the ice is not an impenetrable hard flat surface. While skating backwards as our drag pick drags, it penetrates the ice and the entire front section of the blade – up to and including the drag pick — is in contact with the ice. It is very much a skateable zone and is "in-play" and a factor in many critical moments during the execution of skating elements. "

Maintaining this 'Non-Skateable Zone' geometry throughout the lifetime of the blade as you sharpen is just as important as maintaining the rest of the original profile of the blade. While having a hollow grind or sharp edges in this section is not super important, the profile of the entire blade needs to be maintained as much as possible during the blade's useful life."

Toe Rakes or Toe Picks

So much of Modern skating is owed to the humble points at the front of the blade. There are several types of picks. The **straight cut** and **cross-cut** are the most common. Both the straight and cross-cut are available in multiple patterns and rake sizes, as well as variable relative angles to the ice.

Straight Cut

Allows skaters to dig into the ice and create grip while allowing both rotation and lift. Generally, it is less expensive for blade manufacturers to produce straight cut because it takes fewer production steps. The linear front edges will grip the ice, but the simple geometry of the pattern allows torque to pivot the skater. Even at the elite level many skaters prefer straight cut toe picks for their forgiving nature in generating rotation

Cross Cut

This pattern's key feature is the hold it offers skaters into the top layers of ice. Notable to the touch the rakes are pointed peaks alternating from each side. The cross-cut pick was first patented in 1937 by William Blochinger, a partner of the St. Paul, Minnesota Company Olympiad Skate. Quoted to be "supporting the skater without unnecessarily digging into the ice," as well as "self-cleaning", allowing the skate to initiate rotation quicker."

Stanchion Height

The height of the blade is measured from the ice to the sole of the boot. This often-overlooked feature can extremely influence performance. The height of the stanchion determines how much body lean you can achieve before the outer sole of the boot touches the ice. The lower the stanchion, the lower the center of gravity which promotes better balance but less body lean. Riedell's Eclipse Crescent, a beginner free skate blade, has a low stanchion height. The Wilson Gold Seal has the highest stanchion height allowing advanced skaters to achieve deeper edges without the boot touching the ice.

Radius of Hollow

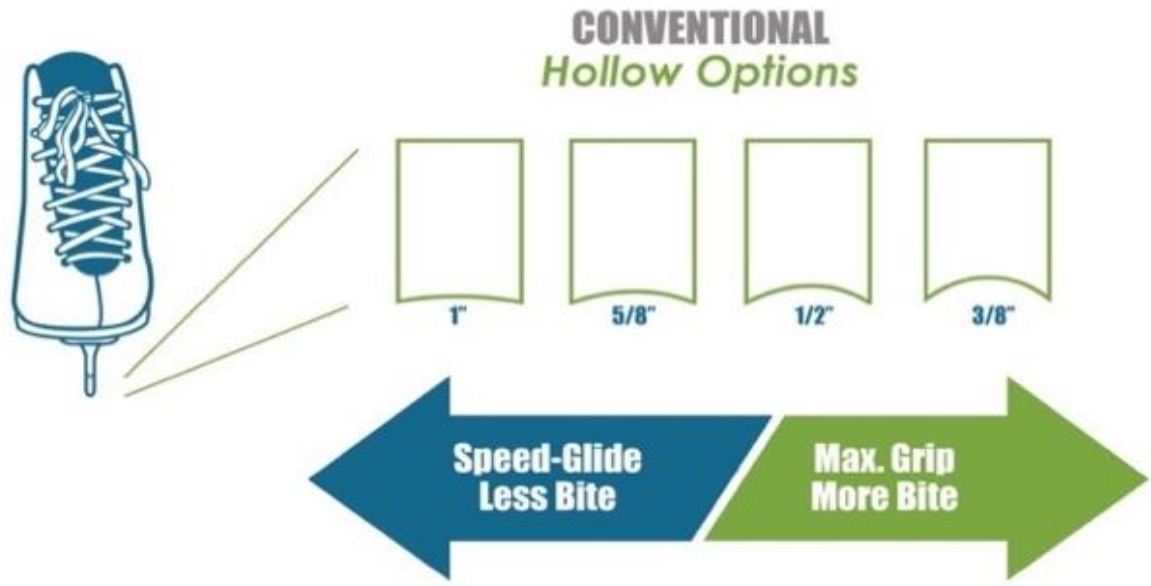
When a blade is sharpened, the area between the two edges is ground out with a circular rotating grinding stone that creates the "hollow." In the skating world, this is known as the radius of hollow (RoH) (not to be confused with the "rocker radius" discussed earlier). The RoH is typically in the range of 3/8" – 1".

The hollow was introduced in 1770 as a "fluted skate". Fluted is an architectural term that refers to a shallow groove running vertically along a surface. Today, the RoH is also referred to as a groove, a hollow grind, or a ground radius. Almost all manufacturers market their blades with the RoH listed. Realistically, this feature is irrelevant and should not be a determining factor in which model to purchase. Most manufacturers produce their skates with a "factory sharpening" included in the finished product; however, the factory grind is often not of the quality needed for most skaters. Most blades should be sharpened by a qualified skate technician before being used the first time.

Choosing a Radius of Hollow (RoH)

Each individual radius of hollow will create “bite”, which is the depth a blade will penetrate the ice, affecting control and glide. The deeper the penetration, the tighter the control and more friction; shallower penetration creates less drag, better flow, and speed, but less grip. The optimum bite for each skater, according to Sid Broadbent, varies by skating style, weight, ice hardness, and most importantly, personal preference.

A



deeper hollow will make the skater feel that the blade is in control. Most coaches prefer the Radius of Hollow from 7/16" to 5/8". One of the greatest drawbacks of any hollow less than 5/8” is that it is very difficult to make any sort of skid stop until the hollow has been blunted.

Atmospheric conditions and ice hardness will also influence the best RoH for a skater. Most hockey players prefer “hard hockey ice”, an ice temperature of 17 to 23 degrees. An ice temperature of 25 to 26 degrees is preferred by most figure skaters. High humidity during the summer months in some regions will soften the top layers of the ice, requiring a flatter grind.

During the colder months, the ice will be consistently harder. Coaches should consider that a slightly smaller radius may be required on colder/harder ice. While developing skaters need not change their radius of hollow throughout the year, elite skaters should take this into consideration.

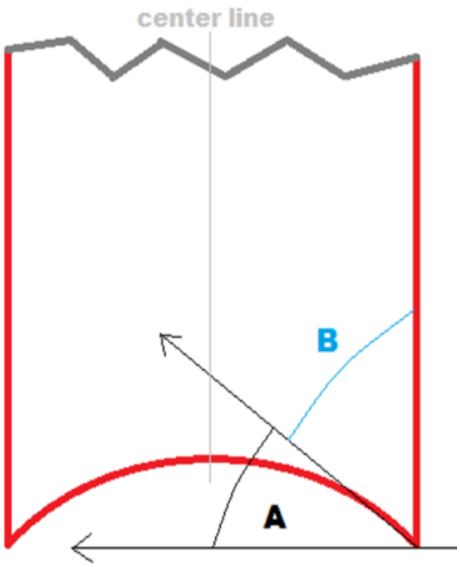
Part 3: Edge Geometry

Edge Geometry

One of the fundamental differences between blade types is their edge bite geometry. Best shown by cross section, the angle at the edge of different blades contributes to the significant differences in the 'feel' of different blades.

A skater needs to feel secure when gliding, especially at high speed or in tight turns. They must also have control to initiate lateral sliding or skidding movements with their skates. It is essential that skaters can control both the gliding AND sliding aspects of movement over the ice. There needs to be a happy medium whereby the skater can control slide, but also feel secure when gliding on a running edge.

Bite Angle



The term 'bite angle' is also a term popularized by Sid Broadbent and has been defined as the angle formed at the blade edge, tangential to the RoH. In the diagram this angle is identified as '**A**'. The complimentary angle identified as angle '**B**' is very significant too and will affect the degree of bite a skater experience for any given RoH.

In the case of a truly parallel sided blade runner with perfectly level edges, the combined angle 'A' + 'B' = 900. If the sides of the blade runner are not parallel, like many modern blades, then angle 'B' becomes smaller or more acute, the amount of grip will increase and as the angle 'B' becomes larger or more obtuse, the amount of grip will decrease.

Equal RoH will give different bite angles depending on the distance between the edges—blade thickness. Freestyle and general purpose blades average about 0.14" – 0.155" thickness between the two edges. Traditionally, dance blades have come thinner in the range of 0.10"- 0.14".

Different Blade Types

Thinking of "bite angle," consider the different blade types and cross-sectional geometry.

Parallel

The most common blade is the parallel blade. Easiest to manufacture because it has the same width from toe to heel and sides are parallel to each other. Some lightweight blades have chassis's of alternate materials like aluminum or carbon composite which hold a runner with a parallel runner. In these modern designs the blade runner will sometimes be stainless steel instead of carbon steel.

Taper (sometimes referred to as "Dovetailed")

Blade is mostly parallel, with machined with defined angled edges of several degrees along bottom length of runner. This increases bite angle and allows for greater lean control and tighter turns due to more perpendicular interaction of blade when skated at a lean. The parallel sides allow sharpeners to assess the edge more easily to be level. Like above, some lightweight blades with chassis's of alternate materials like aluminum or carbon composite hold a runners with tapered edges.

Side-Hone

These blades have sides with a concave design which causes them to be thicker at the stanchions and the edge while thinner in between. They are easily recognizable because they cause reflections to be inverted. Side-honed blades increases bite compared to parallel blades. This feature is only seen in carbon steel blades.

Slimline

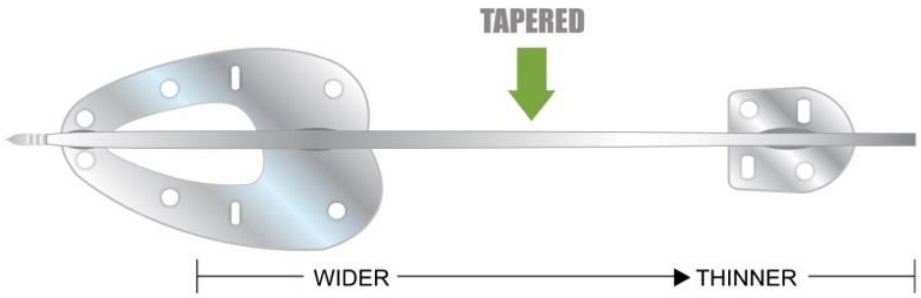
Slimline blades have a thinner blade for quicker changes from edge to edge. Simply, it takes less body lean to change edges. The wider the edge, the greater the lean is needed to change edges. That being said, the thinner blade would have difficulty keeping a straight-edge profile if subject to the impact of jumping. Slimline is generally considered a dance or synchro style blade.

Horizontal Geometry

Horizontal geometry can also attribute to bite angle.

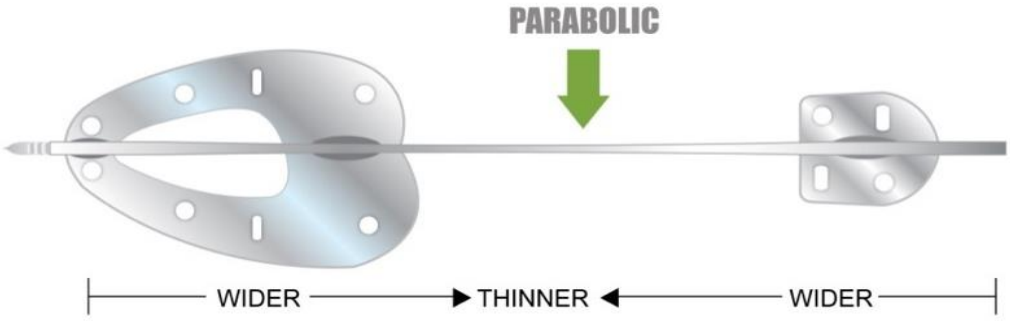
Tapered Side-Hone

Wider at the front of the blade and is thinned consistently down the length of the blade to the tail. Tapered blades are often side hollow-ground too. This feature reduces blade weight and friction along the ice.



Parabolic

The middle section of parabolic blades is thinner, while both ends are wider. The parabolic shape contacts more of the ice displacing weight along the blade giving less penetration. This feature does remove some weight and is only found on carbon steel blades.



Edge Relief

Edge relief often referred to as chrome relief is a common process used on conventional carbon steel blades. The blades are coated by electroplating nickel and chrome over the bare carbon steel. Without this protective coating, the blades would tarnish and rust.

Material

While many skate blades are made of carbon steel; most elite manufacturers have included other materials such as aircraft-grade aluminum, carbon composites, stainless steel, and titanium alloys.

Carbon Steel	Steel alloy in which carbon is added to "pure" steel. Carbon steel is generally inexpensive in comparison to stainless steel or titanium
Nickel/ Chrome	Often used for plating blades and is considered corrosion-resistant
Aircraft Aluminum Alloys	An excellent blade material due to its high strength-to-weight ratio. Aluminum is also one-third more elastic than steel alloys, making aluminum blades feel "softer"
Carbon-fiber Composite	Derived from two or more basic materials with significantly different physical properties joined to produce a composite material with very good rigidity and strength. Like aluminum it reduces the weight while keeping a high strength to weight ratio. The newest carbon-fiber on the market in 2022 features a Nano charged matrix formula. This formula is extremely light and is more rigid than other composite blades on the market.
Stainless Steel	Derives its properties from the adding of the element chromium. Due to chromium, stainless steel forms a passive layer of protection against rust and staining in wet environments. The higher grades of stainless steel have higher concentrations of chromium. Popular grades of steel used in blade manufacturing: • Stainless Steel grade 420 is a Cutlery Grade martensitic chromium alloy and often used in high end blades. • Stainless Steel grade 440C is a high carbon martensitic steel. It has high strength, moderate corrosion resistance, and good hardness and wear resistance. Grade 440C is capable of attaining, after heat treatment, the highest strength, hardness, and wear resistance of all the stainless alloys. • Japanese AUS8 Stainless Steel made of high carbon, vanadium, and molybdenum, and is also used for knives, scissors, medical equipment, and food machines. Makes excellent blade runners.
Titanium	Used in steel as an alloying element and is corrosion resistant. Titanium has a high tensile strength-to-density ratio and is extremely resistant to metal fatigue and cracking. A titanium blade can be as much as 40% lighter than a conventional carbon steel blade. Titanium's properties can also be used in plating to lengthen edge life

Ultimately, there are many combinations of features that can be recommended to your students. But there are few reasons to put a developmental skater in a blade designed for elite skaters, when many lower and mid-priced blades provide adequate performance for the average skater at each level.

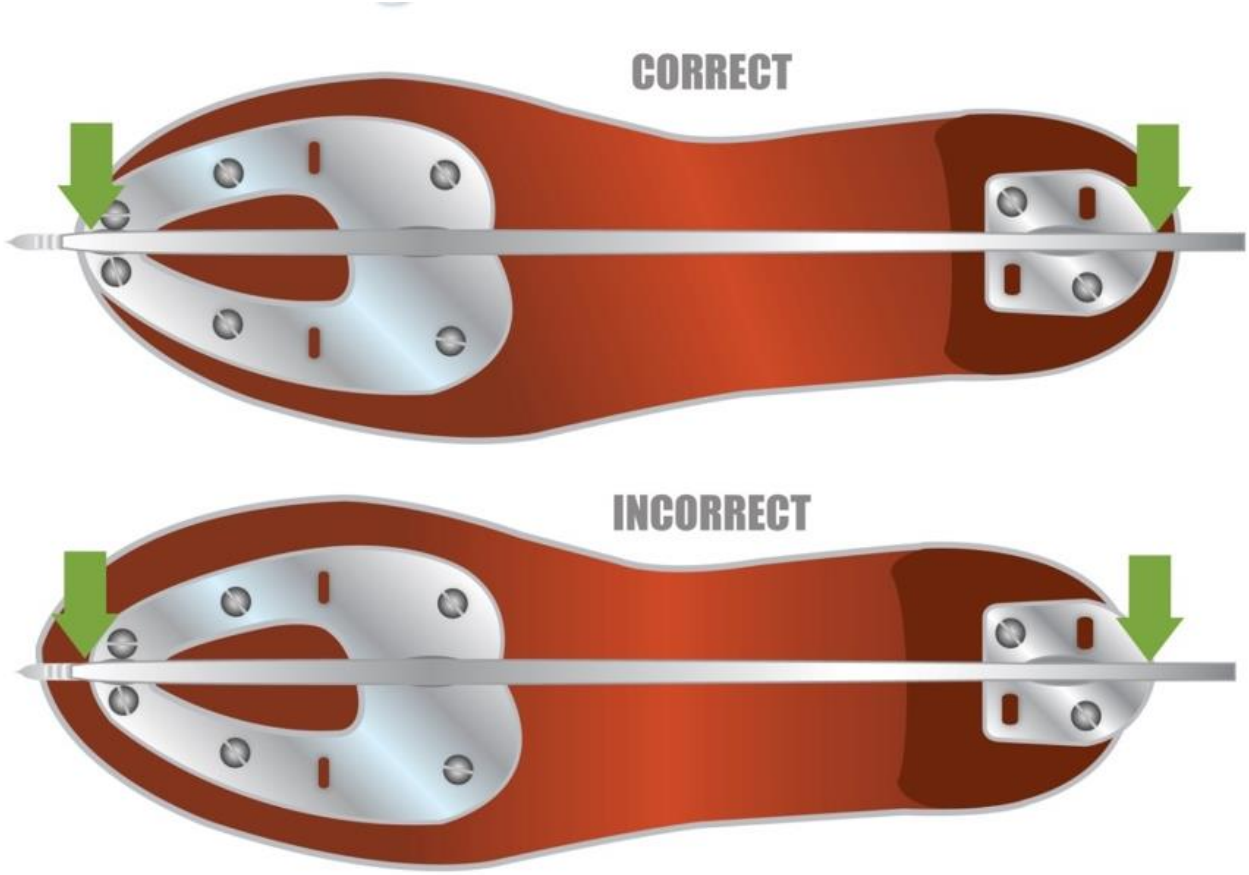
Part 4: Blade Maintenance

Steps for Blade Maintenance

1. Blades to be dried carefully after each use.
2. Guards worn on the blades at all times when skates are off the ice to protect blades from nicks or damaging effect of salt, sand, and other corrosives
3. Guards should be removed when storing blades to prevent water damage
4. Cloth soakers can be used when transporting to protect your blades from nicking.
    - Soakers aim to wick away condensation and inhibit rust.
    - If you are storing extended time, apply lubricant to blade's hollow.
5. Periodically, monthly is sufficient, check the tightness of the screws securing the blade to the sole of the boot and gently tighten any loose screws.
    - According to Fred Martin of Fred's Skate Sharpening, loose screws can often feel like dull blades.
6. Blades should generally be sharpened after every 20 to 25 hours on the ice, which for most skaters translates to sharpening every 4-6 weeks. The variance depends on frequency of skating and how advanced the skater.
    - Most skaters can feel if the edges are damaged (nicks) or do not feel secure anymore. If skaters wait too long between sharpening's, they may experience an adjustment period which can disrupt training for a day or two.
    - Ideally, if the skater times the sharpening's well, he should feel little or no difference after a sharpening.
7. Freshly sharpened blades will have a consistently satin sheen. With more skating, the blade bottom near the edge will begin to appear "cloudy" with a flat sheen.

Part 5: Mounting Blades

Although blade sizes are consistent, boots can vary in their outer sole length. Once a boot has been chosen, measure its length from the tip of the sole to the heel. The best blade fit happens when they rest the exact length or one-quarter inch less (not more than) than sole. The blade itself is measured from the back of the heel plate to the front of the toe plate. Blades come in sizes of 1/4 inch increments and with the length stamped on the toe plate. If a one-quarter inch difference is not possible, err on the long side for the blade, but do not let the heel plate extend beyond the heel of the boot.



After you've found the right blades, ask an experienced skate technician to mount them to the boots. Be aware of the following to ensure that the blades are mounted correctly:

- Prior to mounting - If wearing a skate with a leather sole, the skate should be sealed with either snow seal, varnish, or a marine grade finish
- The center of the sole and the center of the heel of the boot must be in exact alignment. Otherwise, stress is placed on the blade during mounting and the blade becomes bent or twisted.

- Holes should be pre-driven, using a drill slightly smaller than the screw size. Some technicians will seal the screw hole with silicone caulking before driving the screw into place to reduce the chance of moisture degrading the sole.
- The front of the blade should be mounted first to eliminate the possibility of a whipped or twisted blade
- The front of the long axis of the blade should be between the big and second toe. See Figure below.
- The rear stanchion should be at the center or slightly to the inside of the heel

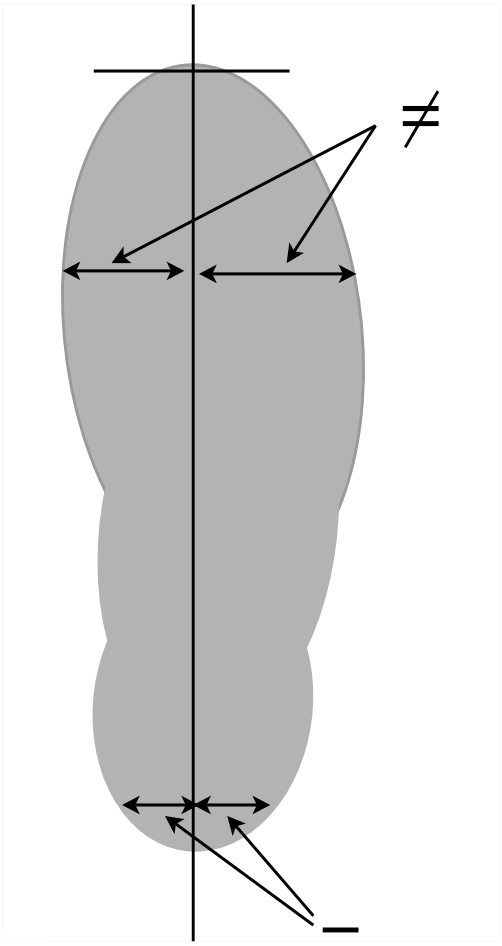
Pan-headed screws should be used in the slotted holes and tapered screws used in the recessed holes. Some skate technicians will mount the skate using 4 – 5 screws in the front and 3 in the heel. This provides options to the technician if the blade needs to be move at a later time.

Phillips Screw

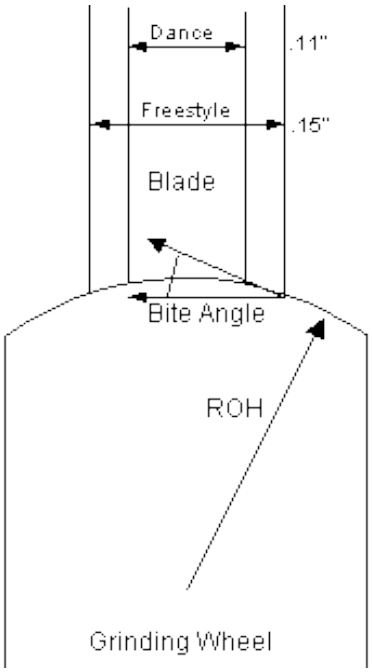
with "Tapered" head

Phillips Screw

with "Pan" head



Part 5: Blade Sharpening



Know your sharpener, a good sharpener will be knowledgeable about manufacturers and their products. Sharpening a blade mostly consists of restoring the existing hollow and removing as little of the blade as possible. Large nicks do not have to be completely removed.

As soon as your skater is comfortable with a certain degree of hollow, ask your sharpener what the radius of the hollow is and mark it on the inside of the boot. It is extremely important that the hollow required be maintained. The difference of 1/8" in the hollow of a blade sharpened to 5/8" radius would amount to 20%, a considerable difference.

For a new blade, do not assume that the hollow put in at the factory necessarily suits your requirements or that the edges are parallel or level. All new blades should be sharpened before use; preferably before they are mounted.

- A good sharpener should do the following:
- Sharpen the blade without altering the profile of the blade or the rocker radius
- Keep the edges of the blade level
- Not interfere with the toe rakes unless instructed to do so.
    - A qualified sharpener who specializes in figure skates will know when and how to adjust the toe rakes to assist in preserving the rocker profile.
- Not overheat the blade while sharpening
- Produce a reasonably smooth finish to the blade's hollow
- Be able to put a specific hollow into the blade or maintain the current one
- Advise the customer without dictating
- Have a good knowledge of the customer's branch of the sport (figure, hockey, speed)

To repeat, one highly important piece of advice to all coaches and skaters: <u>learn and remember your specific depth of hollow.</u>

Part 6: Lifespan of the Blade

The lifespan of a blade is dependent on several factors, with the quality and number of sharpening's being the most significant. As noted earlier, a good sharpener will sharpen the blade without altering the profile of the blade. Too much pressure on the blade while passing over the stone can overheat the blade, weakening the steel. Too much pressure will also remove more steel than is required, decreasing the life, and flattening the rocker.

There are four other measurable and ultimately performance changes that occur as material is removed. Many of these changes are obvious:

1. Stanchions height decreases
2. The shape and size of the drag pick changes, and the geometric relationship of all the other picks relative to the runner changes.
3. Depending on the Blade type Side-honed, or dove tail the bite angle will change.
4. Depending on the blade material, hardness changes.

Poor maintenance can also shorten the useful life of a blade. Guards stored on a wet blade will create pockets of rust that will eat into the steel, creating microscopic holes in the blade. Fully removing these rust marks can require a lot of the blade to be removed, further altering the rocker profile of the blade.

Part 7: Conclusion

There are many decisions to be made when recommending a blade for a student. Most manufacturers market each individual model specifically to a skill set to match the US Figure Skating or ISI program levels which gives the coach a starting point. In addition, this course has given you the knowledge to make an educated decision that will ultimately provide the best performance set-up for your clients.

References

http://en.wikibooks.org/wiki/Recreational_Ice_Figure_Skating/Equipment/Blades

Apparatus for tempering the weld between a tool joint connector and a drill pipe tube US 4181845 A

http://www.google.com/patents/US4181845

Fred's Skate Sharpening, Fred Martin http://fredsskatesharpening.com/qa_blades.html

Reliance Foundry, Est. 1925

http://www.reliance-foundry.com/blog/carbon-steel-versus-stainless-steel

The Ogilvie-Gutzman Blade Gauges & Basic Principles of Sharpening, Published by Ogilvie-Gutzman Gauges

Ironton, Minnesota, Copyright 1986 by Robert S. Ogilvie

Jackson Ultima http://jacksonultima.com

John Wilson Blades http://worldsbestblades.com/products

Edea Skates http://ice.edeaskates.com/en/

Mitchell & King (MK) http://www.mkblades.com/

Skate Geometry, Sid Broadbent, 2004

Skate Blade and Art of Manufacturing Same, US Patent No. 524,129, T.W. Bryant Date: Aug 7, 1894

Skate, US Patent No. 2,096,781, William Blochinger Date: Oct 26, 1937

Lateral Toe Pick for Ice Skating Blade, US Patent No. 6,234,532 B1, Peter Kollen Date: May 22, 2001

Ice Skating Blade Runner Holder and Blade Runner and Method of Manufacture, US Patent No. 7,380,801 B2, Robert K. Rudolph Date: Jun 3, 2008

Suggested Reading and Resources

Skateology™, Sid Broadbent

Optimizing Skate Performance (From an Engineers Viewpoint, Sid Broadbent