Innovating in Alpine Skiing

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1. Introduction: Innovating in Alpine Skiing

Federiga Bindi

Skiing is a very old mean of transportation and a relative old sport. While skis today have a different shape than the original wooden ones, and technique has changed accordingly, how much has coaching and the whole idea of being an athlete evolved?

In 2016, Kris Ochs and Dan Leever uncovered showed how the #1 factor behind ski racers' success is the support of their families. Thanks to the *DC4SKI* project we found however that that the #1 factor for athletes to quit skiing is their families' fear that it is not compatible with a successful educational career, regardless that both literature and our own empirical experience shows the contrary. Good athletes are in fact also likely to excel in school, and later in life.

Alpine competitions are governed by 100 years old regulations originally drafted by Sir Arnold Lunn in 1922. Well written, understandable, and accepted, reflected the technical capacities of the time. In the technical disciplines, slalom was the king, while GS was introduced in 1935. Two runs on two courses, inspected by ascend, fastest times averaging 5 minutes per run, measured in full seconds. Wooden skis without edges, equipped with fixed "bindings", and wooden poles, no helmets, goggles or any protective gear, baggy pants, wool sweaters, and low-cut leather boots. The course was packed by the skis, the surface was soft.

Fast forward to today, we see armoured knights, going through (breakaway) gates, on icy surface for which super sharp metal edges are needed, with state of art boots and bindings. Slopes are professionally prepared. Skiers average 50 k/h in technical races and 120 k/h in speed events. Victories and losses are measured by a thousand of second, with occasional three ways ties! Runs last around a minute and every single turn counts. One mistake and the race is finished.

In sum, a totally different world. Yet, we still go by the rules and principles set a hundred years ago. Meanwhile, socio-cultural standards changed dramatically, along with the skyrocketing costs of the sport and (luckily) increased safety precautions.

We often hear of making racing "affordable, local and fun" but in effect little ever changes. In fact, we are going towards an extremization of racing at ever younger ages.

This manual is the result of the work done under the ESKI project, with the financial support of the European Union.

For the last 3 years, clubs and federations across Europe and the US – ranging from the University of Colorado and Stratton Mountain School to the Lithuanian and Bulgarian federations to the Alpine Club of Athens - have been working under the coordination of the Alta Badia Ski Team on a project aimed at innovating in Alpine Skiing.

The project, called ESKI (*Promoting Education, Skills Development & Dual Careers in Alpine Skiing*), was financed by a European Commission ERASMUS+ Sports grant. Working with experts, we created educational and skills development opportunities for Alpine ski coaches and elaborated innovative pedagogical tools and best practices both on snow and off-snow – see for instance a here a SL progression developed by Richard Rokos.

We also brought together European mountain ski high schools with US Ski academies to compare notes and started working with European Mountain Universities to learn from NCAA to develop best practices allowing athletes to both ski and study in Europe, too.

In the following chapters, we will present a part of the results of our work with ESKI. From dissecting the fundamental techniques that form the bedrock of a skier's skill set, to understanding the nuances of race preparation and performance optimization, this book offers a holistic approach that caters to athletes of all ages and skill levels. We will explore the psychological dimensions of coaching, delving into motivation, confidence-building, and the art of fostering resilience in the face of challenges that the mountains present.

2. Alpine Skiing as a Unique Sport

Richard Rokos

Mental and physical balance in ski racing is an absolute necessity. A large number of articles and studies have been produced on the element of balance in ski racing. For a good reason. Skiing is all about balance and maintaining it.

Mental balance by the definition is “the healthy psychological state of someone with good judgment and soundness”. Mental health is “the psychological state of individual functioning at a satisfactory level of emotional and behavioral adjustment”.

Just imagine what happens if you do not have “good judgement and mental soundness” going downhill at 60 miles an hour restricted to a corridor of just a few feet wide (the ideal line), on a steep icy surface, almost naked, in freezing temperature, bad light and a blowing wind. Alpine racers must suppress many instincts on one side and employ others at the same time. Stress in some adverse conditions can actually manifest in “fight or flight” symptoms. Noticeably would be the release of adrenaline into a bloodstream. What else can keep you warm, right?

Most people will label it as crazy, but all these above conditions are there to challenge your judgement and those with the sharpest senses and most sound judgment will conquer these challenges and emerge victorious. In fact, there are very few speed sports demonstrating such a close confrontation of the body with the surrounding environment in three-dimensional motion. Motorcycle racing could be comparable however it is conducted in a far more controlled environment. Alpine Skiing is undoubtedly a sport dealing with most and hardly imaginable variables.

All of this must be supported by an individual’s physical fitness, but it is fair to say that mental strength is a necessary part of the sport. Reducing feelings like fear to a substandard level is an absolute necessity and repeating this over and over becomes routine. Only an injury can temporarily “reset the clock”. Injured skiers have to undergo physical and mental rehabilitation and getting back to the no fear zone can sometimes be a challenge.

Frustration is the most common human condition created when confronted with an unexpected outcome. Most humans feel threatened by frustration because they do not adapt well to new situations. However, in Alpine ski racing sudden shifts are the skiers’ daily routine. Cancelled or postponed races, quickly changing weather and atmospheric conditions, challenging courses, bad visibility, missed wax, wind, snow are common occurrences. Dr. Jim Taylor has written numerous excellent articles on this subject, although his works are mostly related to junior skiers.

The purpose of this chapter is to explore the phenomenon of the mental balance a one step further. What all above unique exposure will do with the individual is not as well documented, known and communicated. Thanks to my job and the fact that for 40+ years I have experienced over and over a transition of retiring (graduating) skiers from athletic to the normal life I can attest to an incredible mental quality of those individuals. This applies even to those who did not compete intercollegiate but retired from skiing in later age. There is virtually non-existent and not recorded anyone who will fail the life or the job.

Years of exposure to the above “torture” exhibits in something what could be labeled as an “extra benefit” of sport of Skiing.

If I could create a CV for ski racer it would include terms as:

Mentally balanced, Efficient, Organized, Disciplined, Calculated risk taker, Capable to adapt to any new situation without hesitance, With sharp senses and sound judgement.

Controlling the race run carries well past the finish line. You hardly see the mature racer display any excessive emotion. The finish coral is reserved to the smile and throw the fist or shrug of the shoulder and hanging down the head. Any out of proportion behavior is reserved to younger and less mature competitors.

The average age of the entry level Alpine skier would be 10 years with about 10-15 race starts per year. It will increase slightly for U 14 and increase dramatically at FIS entry level.

In peak of the career the number of starts per season would be 30 at minimum and 50+ at max. Accuracy of this number does not matter too much. What matters is the exposure to the standard race day.

Wake-up at 0600

Lift opens 0730

Training course. 0745

Inspection 0800

First run 0900

Etc. ....until 1400 - second run.

Fairly long days of all mental and physical exposure described above.

Perhaps an Ultra Triathlon makes a lot tougher but equally long daily exposure.

Add to it 80 on snow training days in the season, 20 Summer skiing days, 100 dry land trainings and you have a conservative year schedule of average FIS/collegiate skier. Ops! Forgot to mention the school:)?! Finals, unforgiving professors, tests and academic rules. Overnight study is mostly portrayed as a “nice mental diversion”. This all transpires in to 12 years of life for those taking it seriously and sometime 20 for extremists. 400 to 600 race starts, 1500 on snow training days and the countless hours of physical training. It all becomes a exposure shaping a body and soul.

There is not another sport with such a profound impact on the mental quality of the individual.

Typically an excellent students with extreme large class absence documenting that a class attendance is not a necessity to academic success. Skiers are traditionally the best students among all varsity sports. The Academic awards are handed to them on a regular base. Graduation rate is 100% because everybody understands there is the real life somewhere on the other side.

Few of those not willing to separate from skiing will end up in variety of ski industry related jobs. Ranking from general managers to coaches or ski company reps. As a coaches they will mostly go through National Team experience, landing later at the club programs as a Head Coaches or Directors.

Coincidently large number of graduates has degree in business administration and would start work in investment branch of the acclaimed companies. Some Companies are actively pursuing and preferring skiers as a new employees noticing a difference in quality of work ethics of new hires. What would set them for the life is not a accomplishments in the sport but the mental and physical skills acquired during an athletic career.

Driving the vehicles is another and exceptional strength of the skiers. Skidding and sliding on the skis somehow transpires to a rubber and wheels. Cornering an apex of the turn is a familiar geometry, speed is a friend and the point system is only opposite to the FIS list. Faster driver gets more points:). Forced to drive in the mountain and in adverse condition on the day when the schools and businesses are closed due to weather makes you outcast. In the end of it, being able to come on time to the work on the day when everybody turns in bed on the other side can be a good ground for a promotion.

Winter solstice is a heliocentric term related to the position of the sun towards earth. It becomes a factor in December training.

Being on the hill two hours before the daylight and the regular lift opening, skiing in pitch dark with greatly overrated headlight makes you feel exceptional and adds to the list of invincible. Obviously the person permitting those things must come from the same background because it defeats all and any insurance standard.

Skiing is relatively a small sport easy to follow with about 500 elite, FIS registered skiers. The ranking system allows you to compare yourself with the best in the World which in some sense develops in to an virtual relationships. Everybody know each other.

Highly exposed to International competition and Summer camps in Southern hemisphere and you have a world traveler with no boundaries and with friends in all parts of the World. Very often repeated critique of foreigners participating in US schools is not a concern for US athletes. Affinity through the sports comes way ahead of the emigration laws and ethnic differences. Those becomes actually a flavor of the sport merging everybody in the athletic melting pot. Thirty plus marriages among a Team members across the border in the same school in past 30 years is just a documentation of another side effect. Having a friends in Norway, Central Europe or Estonia is only a geographical obstacle. Travel to birthdays and anniversaries across the globe is a standard. The friendship and camaraderie has an unmatchable strength and any tragedy in the community has a heavy impact on all.

Going back to the cost of the sport. Yes!, the sport is very expensive but there is a unspoken benefit influencing profoundly the life of the individual. It is a no way to put $ amount on it but those who stay longer in the sport benefit out of it most and this is something the parents should consider before pulling a plug on financial resources. To pull someone out of this lifestyle (injury or another reason) and you have an individual desperately seeking to fill the void. Most of the time the skiers will find the way out . It is not easy to replace a such a complexity. To invest the all energy, courage, discipline, in different sport can create an instant champion.

To invest it into a society and you have a champion of life and that is a hidden benefit worth of investment.

In conclusion, Alpine skiing is not just a sport; it's a unique journey that demands exceptional mental and physical balance. The challenges faced on the slopes, from battling extreme conditions to making split-second decisions at breakneck speeds, are not for the faint of heart. Alpine racers must develop mental strength, adaptability, and resilience, traits that serve them well both on and off the mountain.

The mental fortitude required for Alpine skiing goes beyond the sport itself. Skiers learn to conquer fear, adapt to rapidly changing circumstances, and maintain composure in high-pressure situations. This mental discipline often translates into success in academics and later in professional life.

Alpine skiing is a lifestyle that shapes individuals profoundly. It fosters a close-knit global community and instills values such as discipline, determination, and adaptability. The friendships forged on the slopes are enduring, transcending geographical boundaries and cultural differences.

While Alpine skiing is undoubtedly costly, the intangible benefits it offers are immeasurable. It molds champions not only in the sport but also in the game of life. So, before considering pulling the financial plug on this unique journey, parents and individuals alike should recognize the hidden value of investing in Alpine skiing—a value that extends far beyond the realm of the sport itself.

3. Coaching 101

Richard Rokos

“Everything regarding human interaction has been invented. Coaches are just adapting to a new - wave of challenging athletes’ behavior”.

Principles of Coaching:

Athletic coaching has a rich history dating back to ancient Panhellenic games (in athletics) and armed forces history (ranks and files). Anyone—whether a parent, teacher, boss, supervisor, officer, priest, politician, or group leader—is essentially a coach. While there exist numerous definitions of the coaching profession, there is always room for more to be included.

Coaching, as a profession, has limitless boundaries defined only by law and ethics. Coaches are often seen as role models and must understand the responsibilities, commitments, and consequences associated with this perception. Maintaining a healthy, positive lifestyle, diet, and attitude is a prerequisite. To maintain credibility, coaches should refrain from bad habits and socio-political extremes.

Some individuals in the coaching business believe that separating private life from occupation is manageable and relatively easy. While it is possible, a compromised reputation can hinder effective coaching. The depth of the coach-athlete relationship, mutual trust, dependence on success, and mental recovery in case of failure all require absolute and undeniable honesty. This could be a reason behind the lack of coaches or the lack of quality coaches. Education is a quality that can be attained, and predispositions are partially mental and genetically determined. Any coach finding this aspect challenging should consider an alternative occupation as a goal.

A well-known, popular, and anecdotal definition is: "A coach pushes athletes to do what they do not want to do in order to achieve what they dream about."

Coaches exploring individuals' mental and physical limits classify the occupation under the category of controlling extremes. The coach-athlete relationship offers an infinite number of potential scenarios. The opportunity for total control and exploitation of individuals is enormous, and unfortunately, it is sometimes abused by those in control. This is why the coaching profession is exceptional in its mental aspect and sensitivity. Incompetence or lack of experience can lead to serious mental breakdowns or the athlete's withdrawal from the sport. Abuse, harassment, and blackmail are unfortunate parts of the coach-athlete relationship, so extensive that the subject requires a separate discussion.

Coaching styles and philosophies are defined by three extremes, with everything else falling somewhere in between:

Each extreme style has its pros and cons, and a different blend could be suitable for different types of personalities. These extremes can be graphically represented by an equilateral triangle, with each coaching style represented by one vertex, similar to human physical or mental somatotypes. Coaches find themselves somewhere inside this triangle, and it's up to their personality to determine which style should be dominant.

Team coaching and individual coaching display different dynamics. In team sports (games), individual identity is replaced by team goals and ambitions, which may not necessarily align with an athlete's individual goals.

Individual sports have a different dynamic, akin to a doctor-patient or teacher-student relationship.

Autocratic style (my way or the highway, like Bobby Knight): Extremely demanding with little to no room for athlete input. This can lead to quick success or disaster, including athlete injuries.

Democratic style (based on coach-athlete dialogue): A confrontation between the coach's expertise and the athlete's honest expression of feelings. The lack of coaching expertise or athlete honesty can hinder the development process.

Holistic style (embracing everything, developing the whole individual, as advocated by Skinner/Thorndike): Focuses on positive feedback.

In any case, the coach must be well aware of the athlete's background to select the right coaching strategy. The ideal coach-athlete relationship is, in fact, a rare occurrence.

Modern coaching style (based on current societal development) would predominantly lean toward a holistic approach. However, this could be influenced on a micro scale by geographical and cultural aspects. The coach-athlete relationship should be based on deep mutual trust, understanding, and respect.

Compartmentalization:

Breaking down the training process into small tasks with a separate coach for each segment of training can be beneficial, as each coach likely has expertise in their field. However, there must be one individual overseeing the process in a supervisory capacity. The danger of compartmentalization includes potential loss of athlete identity, detachment, lack of communication or excessive feedback, and oversight issues. These problems are also seen in standard coaching complexity, including overtraining or lack of daily attention. Emotional estrangement and a lack of confidentiality are other potential risks.

The complexity can have unique benefits in building athlete confidence, character, self-reliability, and responsibility, among others.

Principles of Behaviour

Communication with your athletes, motivation, and managing athlete behaviour.

The coaching process, as an interaction between coach and athletes, heavily relies on mutual behaviour. While the coach's behaviour should be standardized and well-defined, athletes' behaviour can vary greatly, ranging from introverted to extroverted tendencies with various nuances. Documented statistics indicate that 80% of young adult athletes receive mental treatment or consultation.

The most significant factors influencing athletes' behaviour include age, overall health, family background, economic situation, educational experiences, level of motor skills, and the ability to

learn new skills. The coach's goal should be to gather as much information as possible and choose an appropriate coaching strategy.

Traditionally, coaches have taken a comprehensive approach, while a modern trend involves compartmentalizing the coaching process and distributing it among various individuals ("coaches"), often resulting in a lack of understanding about the athlete's background. Similar to psychosomatic medicine, there should be a single individual who comprehensively understands all aspects. This person can then truly be called "A Coach."

The new generation of athletes comes from a broad spectrum of backgrounds. Some come from traditional families, while others come from non-traditional families. The last two years of Covid restrictions have significantly impacted the younger generation during their most sensitive developmental phase. The shift to home schooling, the influence of social “woke” movements, and the lack of social interaction have all affected adolescents' social skills. Coaches must consider all these aspects in order to tailor their coaching strategies accordingly.

The Psychosomatic Aspect of Coaching

The psychosomatic aspect of coaching delves into the intricate relationship between the mind and body in the context of sports coaching. It acknowledges that an athlete's mental state profoundly influences their physical performance. Coaches who understand this dynamic can employ various strategies to optimize their athletes' overall well-being. They work on building mental resilience, instilling self-belief, and managing stress, recognizing that these factors can significantly impact an athlete's physical capabilities. Moreover, they emphasize the importance of goal setting, visualization, and mindfulness techniques to enhance an athlete's focus and motivation. In essence, coaches who embrace the psychosomatic aspect recognize that the body and mind are interconnected, and by nurturing both, they can unlock an athlete's full potential, fostering not only better physical performance but also mental strength and emotional balance in the pursuit of excellence.

Psychosomatic Medicine

Psychosomatic medicine can be defined as a comprehensive and interdisciplinary framework for assessing the psychological factors that affect an individual's vulnerability, as well as the course and outcome of illnesses. It involves a biopsychosocial approach to patient care in clinical practice and includes specialized interventions to implement.

Current advancements in this field hold practical implications for medical research and practice. These implications particularly pertain to the role of lifestyle, the challenge of medically unexplained symptoms, the psychosocial needs associated with chronic illness, the appraisal of therapies beyond pharmaceutical reductionism, and the active role of patients in contributing to their own health. Nowadays, the field of psychosomatic medicine is more scientifically rigorous, diverse, and therapeutically relevant than ever before.

In summary, the psychosomatic aspect of coaching underscores the profound connection between an athlete's mind and body. Coaches who grasp this connection are equipped to enhance an athlete's overall well-being by nurturing mental resilience, self-belief, and stress management. They recognize that mental factors can significantly impact physical performance and employ strategies like goal setting, visualization, and mindfulness to boost an athlete's motivation and focus. This holistic approach acknowledges that the body and mind are intertwined, unlocking an athlete's full potential not only in terms of physical prowess but also in terms of mental strength and emotional balance.

Moreover, in the broader field of psychosomatic medicine, the interdisciplinary approach to understanding the impact of psychological factors on health and illness is evolving. It embraces a biopsychosocial perspective, acknowledging that patient care should consider the whole person. Today, psychosomatic medicine is more scientifically rigorous and diverse, with practical implications for medical research and practice. It addresses lifestyle factors, the challenges of medically unexplained symptoms, the psychosocial needs of individuals with chronic illnesses, and the importance of patient engagement in their own health. This evolving field holds promise for more comprehensive and effective healthcare interventions in the future.

Margin of Victory

In skiing, one second represents about 16 meters at the finish line for GS (Giant Slalom) and 8 meters in slalom. Nowadays, it is not uncommon to see a three-way tie or 10 people finishing within one second where these ten individuals possess similar abilities. Even a slight difference can have a huge impact and separate competitors. Here are some of the resources required for achieving that separation between competitors:

1. Strength - to resist extreme forces, well exceeding what most average people are capable of.

2. Agility - to accommodate extreme skeletal (joint/muscle) flexibility.

3. Balance - to maintain self-awareness in space and time.

4. Speed - to react to unpredictability.

5. Endurance - to sustain the physical demands of an average race day (6+ hours) and perform consistently over time. Required for season-long performance.

6. Mental strength and capacity - to overcome the fear of injury, ability to override self-preservation instincts, and resist extreme elements like cold, moisture, and wind.

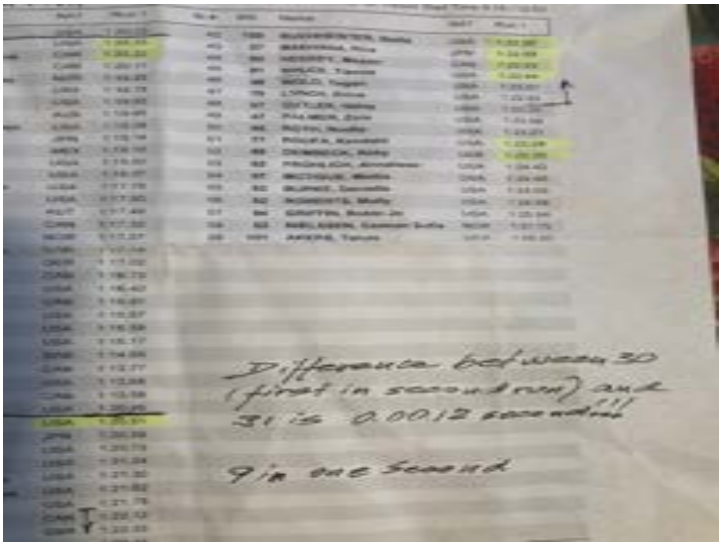
7. Technical ability - to ski the course within two feet of the ideal line.

8. Tactical ability - to time and anticipate movements according to the given course and utilize physical resources effectively.

9. Equipment and wax –These play a crucial role in performance but are mostly adjusted and adapted in preparation, most of which is done off the snow which allows better exploration of the extremes of a given task.

Analyzing these resources individually will open up potential for improvements.

Now, let's discuss a crucial aspect known as the Magic **"**Flip 30", which is an underestimated phenomenon. In the technical disciplines (Slalom and Giant Slalom) the typical separation between 30th and 31st position after the first run is only a few hundredths of a second. For instance, 0.00.12 seconds. This small fraction of a second gives the competitor in 30th position (after run 1) an undeniable advantage in the second run when the top 30 (after run 1) are **"**flipped" to run in reverse order.



The fresh course and the mental aspect of being the first on the course would transpire to a couple of seconds of benefit. The advantage gained after the first run (originally just 0.00.12 seconds) typically translates to a significant time separation in the second run, creating a solid margin (the margin of victory!).

Positive attitude/ bad conditions

Maintaining a positive attitude is essential, especially when facing challenging conditions. Alpine skiing is an outdoor sport that can be affected by negative phenomena such as temperature, wind, moisture, and visibility. These adverse conditions can negatively influence a skier's confidence, with possibly 50% of the race field showing signs of displeasure, which ultimately affects their performance. Maintaining a positive mindset can give you an edge and turn the negative attitudes of your competitors into your advantage.

General health

Additionally, general health, including blood pressure, sinuses, middle ear infections, and overall skeletal well-being, can also impact your balance. Lack or impairment of balance undermines performance. Arriving at the race with any of these conditions compromises your chances and increases the risk of injury.

When participating in individual sports, you function as a unique unit and are fully responsible for the outcomes of your actions.

On the other hand, team sports depend more on collective action. There's a concept known as "The Power of Attraction and Quantum Energy," as well as the "Home Advantage" that comes into play in team sports.

4. **Innovating Technique and Language in Alpine Skiing**

Richard Rokos

The Past:

Alpine competition has been governed by regulations drafted originally by Sir Arnold Lunn in 1922, enduring for a century. These regulations were well written, understandable, and widely accepted, reflecting the technical capabilities of that era. Among the technical disciplines, slalom held prominence, while GS was introduced in 1935. Competitors completed two runs on two courses, each inspected before ascent, with average run times in the vicinity of 5 minutes per run, measured in full seconds. Turning points were marked by respected wooden poles of varying dimensions. The equipment consisted of wooden skis lacking edges, equipped with fixed "bindings," and there were no helmets, goggles, protective gear, just baggy pants, wool sweaters, and low-cut leather boots. The course surface was packed by skis, yielding a soft standard length with a vertical drop.

The Present:

Fast forward a century, athletes, akin to armoured knights, navigate breakaway gates on extremely icy surfaces, using super sharp metal edges, state-of-the-art boots and bindings, on well-set and prepared courses. They reach speeds averaging 50 km/h in technical events and 120 km/h in speed events, measured in thousandths of a second (with occasional three-way ties!). They carve each turn with precision, completing the run in just over a minute, where the smallest mistake could eliminate a racer from competition. They follow a one foot-wide ideal line while risking a collision with each gate. They inspect the course by descending and can observe the top race competitors via smartphones or monitors at the start arena.

Meanwhile, socio-cultural standards have drastically evolved, along with the rising business costs and safety measures, which are exceedingly expensive.

A torn ACL or rotator cuff has become an accepted drawback, and injury rehabilitation is now part of the training protocol. Due to the high cost of attendance and transportation, parental involvement has become a necessity.

"Is that what Sir Arnold Lunn envisioned a century ago?"

Race days can be quite boring for those unable to complete the first run (sometimes not even getting past the second gate). For parents of these athletes, it becomes a financial ordeal. On challenging courses, a 60% DNF rate is not uncommon. With typically only two runs lasting a minute or more per day (in the best scenario) spread across five hours, it doesn't match the level of activity expected for active adolescents. While running two races a day was a revolutionary step, it places more demands on organizers than racers.

A Better Option:

The introduction of a dual format in Alpine skiing offers several advantages. Typically set on shorter courses (200-300 meters) within enclosed arenas, it's easier to observe, maintain, and administer.

Modified Version of racing formats:

Modern timing and reduced start intervals enabling up to 4 racers to start within a 1-minute span opens up the potential for as many as eight runs (4 heats over two hours), dependent on the organizer's capabilities. A surface lift servicing the arena's proximity is desirable. The "forgiveness formula" permits a racer to remain in the race despite a faulty run. Adding times (no elimination format!) with the fastest racers at the heat's end generates excitement until the very finish. This format can be easily organized at any time of day. With just one inspection and possibly one course reset (determined by the Technical Delegate), races can conclude in under 3 hours. It accommodates a large field, allowing both genders to compete on the same course. It proves to be a far more athletic format compared to the traditional one, delivering excitement for both racers and spectators.

In Conclusion:

This proposal doesn't signify a revolt against the existing system and format. Instead, it's an expansion of an existing opportunity to make racing "affordable, local, and enjoyable." Additionally, this format serves as a preparation for extending racing opportunities into adulthood (World ProTour), potentially transforming an amateur activity into a profitable occupation.

Initiation, Execution and Transition: the need for a common language

Richard Rokos

The coaching of Alpine skiers is evidently lacking a "common language." Despite the excellent educational systems in traditional Alpine countries (NOR, AUT, SUI, GER), the protocols are predominantly presented in the native language, with little consideration for the global interest in skiing. For instance, if a Canadian athlete spends their winter in Canada or the US (where the first attempt to unify the language was made by FWD and Ron Kipp recently), goes to Austria and Italy in the spring, spends the summer in Australia, and returns to Argentina for the fall, they may be exposed to five different teaching methods, each with its own language.

These various "schools" describe the same fundamental movements differently, leading to a significant amount of confusion.

ESKI aims to establish a foundation for unifying these languages. It won't be easy, given the established traditions and pride, but with the hope of understanding the problem and mutual effort, we can lay the cornerstone to achieve this goal.

To start, a verbal description of the turn and direction of movement would provide guidance for future development.

Transition: The point at which one turn finishes and the next starts. The body moves across the skis, down the hill to momentarily reach a “neutral” position. Bodyweight shifts from the downhill ski to

Initiation: The body moves from the previous "neutral" position towards the apex of the new turn with a strong forward and downhill motion.

Execution:

Each frame of the stop photos below can be attributed to a stage in a turn which can provide us with common understanding of the turn and each stage. Following the racer in the sequence of the turn the stages can be seen as Transition #1 and #2; Initiation #3; Execution #4, #5, #6.

For the start a verbal description of the turn and direction of movement would give a guidance to a future extension.

Initiation - the body movement from previous “neutral” position toward the beginning of the new turn with a strong forward and downhill motion.

Execution - the established body position through the turn to the new direction

Transition - in between the turns.

The terms are on purpose described as simple as possible to establish a mutual understanding.

Transition #1 and 2; Initiation # 3; Execution #4,5,6


COLORADO
COLORADO
COLORADO

5. Off season training

Richard Rokos

Off-season training for alpine skiing is essential for athletes looking to maintain peak performance on the slopes. During this time, skiers focus on a variety of exercises and activities to improve their strength, endurance, and overall fitness. Strength training plays a crucial role, with skiers targeting their legs, core, and upper body to enhance their stability and power. Cardiovascular conditioning is also vital, as it helps improve stamina and cardiovascular health, which is critical for enduring long days on the mountain. Additionally, flexibility and balance exercises are incorporated to enhance agility and reduce the risk of injury. Off-season training often includes activities like cycling, running, weightlifting, yoga, and plyometrics. These efforts not only keep skiers in top physical shape but also mentally prepare them for the challenges that the upcoming ski season may bring, ensuring they can carve their way down the mountain with confidence and precision.

As ESKI shows, there is no sport or activity that mimic Alpine skiing. However, people have long tried to find alternative to on snow training.

Different rolling devices have been used for Alpine supplemental and summer training for a long time. Roller skates didn't fit into the concept due to different mechanics. Experiments with roller boards in the late 70s didn't satisfy the protocol due to static and permanent foot positions.

Roller boards in the 70s

Inline skates fit the pattern of skiing the best and became a popular device for supplemental alpine training. For around four decades, similar to grass and artificial surface skiing, inline skates experienced a solid boom.

Carve, don't slide

CU skier Eric Archer approaches a gate while practicing for this weekend's Coors Light/Ski Magazine Skate to Ski Challenge. The Rollerblade race is a benefit for the CU Ski Team.

In the fall of 1991, CU hosted the first official inline slalom competition, sponsored by Coors Light and Paul Mitchell Cosmetics, televised by ESPN. We called it a World Championship and Eric Archer became “the Champion"! Unfortunately, Paul Mitchell shifted focus to snowboarding as an emerging sport, and the project was shelved.

Herman Gollner and Harald Harb, inventors in the Alpine ski world, noticed potential benefits of inline skates (originally modified from Nordic roller skis), and Herman implemented inline skates into SMS training. Meanwhile, Harald began manufacturing two-track "inlines" with bindings to fit regular ski boots in the early 1990s. His "Harb Carvers" and training course, a section of the frontage road near Dumont with embedded pipe pieces in the asphalt, offered an alternative opportunity for course setting and became as popular as the Düsseldorf indoor arena. Two-track inline skates provided an exceptional opportunity to replicate the sensation of carving on the snow, with exceptional benefits.

For over 30 years, inline skates were on and off part of training with marginal or large benefits depending on use and the spending power skiers had.

In the meantime, off-season snow training gained ground due to accessibility. Alpine training then became a year-round sport with minor interruptions (usually two weeks long) in Spring, Summer,

and Fall. This off snow training could be sandwiched between late spring camps (wherever a patch of turf was left). Summer training on Mt. Hood, in the Southern Hemispheres, or on European glaciers, and Fall training in Copper, Loveland, or areas with early snow, provides exceptional opportunities to bridge the seasons. Moreover, indoor skiing facilities worldwide became integral to junior programs, turning Alpine skiing into a year-round affair.

However, this changed the 2022 summer. Due to warmer temperatures, traditional European destinations became obsolete, and this trend might continue. The global energy situation could be another limiting factor in the future.

In the search for new training methods, we might go back to "dust off," reinvent, and improve the good, old, and existing. Bob Beattie's old principle of "make it local, inexpensive, and fun" gains new meaning in times of high inflation and energy costs.

Inline progression rocks!

The undeniable benefit of balance training means that inline skates are gaining popularity again. With no attached cost, a full-scale Alpine progression could be done on slightly sloped parking lots or driveways.

Equally as beneficial as lateral (easy to carve) training, the training of linear (fore-aft) balance is the most beneficial learning tool. A platform of a foot or less in length demands the correct positioning of the centre of mass. You're either too far forward, on your nose, or too far back. While skis offer unlimited support in the linear direction due to their length, inline skates are unforgiving. They're the best tool to develop a sense of being "above the boots"!

The outstanding benefit is adding a third dimension (rolls) to two-dimensional training (on flat surfaces), which puts heavy demands centre of mass control. An Alpine coach's command to "put pressure on the top of the turn" is crucial on rolls. The pressure, along with aggressive forward motion at the start of each turn, is crucial for safe, fast, and correct execution. Imagining a bike on a roll is a good starting point. Doing a lap without pedalling is an eye-opener.

Video

By Descriptive Geometry, each turn is a flat sinusoid (in the side projection). Placing the short platform (inline skates) on the sinusoid - whoppedoos - is a priceless experience!

Video

For beginners, the challenge is maintaining balance. However, with increased confidence, active forward movement becomes an overriding sensation. The goal is to apply enough pressure on the back side of the bowl (top of the turn) so acceleration becomes self-propelling, using it as the only source of momentum.

Apart from inline skates, all kinds of rolling devices have become popular and are good for balance training.

Video

In conclusion, Alpine ski racing is a sport where victory margins are measured in hundredths of seconds, and three-way ties aren't uncommon. Every detail counts. Balance is a major component, and training in it can make a difference. The negligible cost and instant impact is clear. Don't disregard the inexpensive and easy opportunity to polish the skill!

6. Getting Ready to Ski at Altitude

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There are two key factors to consider when getting ready to ski at altitude. They are: 1.) Staying hydrated (particularly maintaining blood volume) and 2.) Replacing muscle glycogen stores (main energy source needed for skiing). If you live 0-300m (0-1,000ft) above sea level and are skiing or training in the mountains that are typically 2000m (6,500ft) or higher your body will automatically go into an adaptive stress mode.

First, it will try and increase red blood cell concentration so oxygen delivery is not compromised. Unfortunately, our body does not just kick out more red blood cells as quickly as we need them. The body improvises by dumping some blood plasma (the watery part of blood). This is a natural dehydration process that makes the same number of red blood cells circulate a little more often, thereby having a similar effect as having more of them. The down side of this is that it makes the heart work harder. Within several days, "given adequate fluid intake", the body will start to release more red blood cells. But that only if blood volume is back to normal levels. And the only way to keep blood volume at normal levels is to stay hydrated. Drink enough to prevent yourself from feeling thirsty and so that you pee normally. A quick check is urine color and odor. It should be light yellow with no strong odor (exceptions-vitamin supplements or specific foods can alter this). Water works ok, but only in small amounts (1-3oz) at a time. We recently demonstrated in our lab in St. Cloud that drinking large quantities of water at one time results in increased urine output with only ~30% retention of fluids. Sports drinks with electrolytes appear to work better, but our work with Alpine racers in Park City suggests, a sports drink with some carbohydrate or carbohydrate-protein combination works best.

The second factor to consider when skiing at altitude is getting enough carbohydrate to your muscle. As the body senses mild decreases in oxygen at altitude, it will use more carbohydrate for energy and the body makes this switch without asking. We found with junior Alpine racers that when they consume a combination of carbohydrate and a little protein (3-5:1 ratio found in items such as Chocolate milk, some energy bars or Accel gels) racers felt better and DNF'd half as often in training as with a placebo. And these are racers used to altitude. Imagine what affect this might have on athletes not accustomed to altitude.

Here's how you start: Before you even go to altitude, you'll want to become "Euhydrated" which means normally hydrated. A few days or better yet a full week before going to altitude and on the way to altitude, carry a bottle of water and sip on it all day long. Taking in about 3-4 oz per hour is a good amount. It will allow the water you take in to be absorbed. Drinking too much too fast will just result in sending you off to the bathroom every 30 minutes. After a while, you should notice that your urine output is about the same as before, but it will often times be quite clear (that's a good thing). This should tell you that you are euhydrated.

Keep up the same fluid intake as you travel, but you might switch to carb-electrolyte or carb-protein to make sure your muscle glycogen stores are full which often takes a few days of eating well to achieve.

When you arrive at altitude, avoid drinks with caffeine and/or alcohol. These are diuretics (increase urine production) causing your blood volume to drop. Remember, your body will automatically reduce plasma volume and you don't want to reduce it even more. Within a day or two your plasma volume will return and your red blood cell count may even go up a bit.

Skiing at altitude will take more energy from carbs and therefore it is a great idea to eat something as you head back up the chair. A 60 sec. training or race run can burn anywhere from 40-100 g of carbs. Your body only has a usable store of about 200-400g total. That means you have got to replace some of the carbs you use as soon as you can. Here's where convenience foods are great. Is there anything magical about these convenience foods or gel packs… nope. The carb-protein combination is beginning to show an edge; however, just carbs are better than nothing: granola bars, trail mix, sports drinks, energy bars, (A few years ago, bananas and gummy bears were what the Sports Science Team was using for the US Ski Team), it doesn't seem to have much difference as long as you're active and you're getting some carbs to replace the ones you're using.

So, drink a little extra, try a Gel pack or some gummy bears. Find something that works for you. Then, just eat some extra carbs and in so doing, you won't compromise your experiences. The last thing you'd want to do is run out of gas before the end of the training and/or competitive week.

7. Fluid and Dietary Considerations For Alpine Ski Racers

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The Science

Alpine skiers are required to perform repeated bouts of short duration, moderate to high intensity exercise when training or competing in their sport. Their success, often times, is based on their ability to repeatedly maintain high energy outputs required of them during their training and subsequent performances. Physiological profiles have long been used to describe positive attributes for alpine racers (Bacharach & vonDuvillard, 1995); however little physical testing data demonstrate meaningful correlations to racing success (Bacharach, 2003). What this suggests is the need to better understand how hydration and diet can affect daily training as well as being at one's best on race day.

Seifert, et al. (2001, 2006a) showed that hydration status is a critical factor in maintaining muscle strength during a single day of skiing as well as two consecutive days of free skiing. Meyer et al. (2001) addressed several issues specific to alpine skiers which included concerns for adequate hydration and caloric intake. Harmon et al. (2007) showed water along with a carbohydrate-protein gel can reduce perceived efforts and training impulses of four consecutive days of alpine race training. All of this is done in the cold which adds another challenge to the body (Bader et al., 1952).

What appears consistent in anecdotal evidence from both coaches and athletes is that skiers typically experience fatigue in 3-5 days. Fatigue compensation strategies have been hypothesized to help skiers cope with the stress of multiple days of training; however, there are only a few published studies addressing metabolic requirements and muscle fatigue characteristics of alpine skiing over a period longer than one week. Determining adequate fluids and fuel to reduce physiological stress and feelings of fatigue over a 14-day period was investigated by Bacharach and Bacharach (2009, 2011). They found athletes on average needed to consume 1-1.5L of fluid and an additional 500 Calories per day for each day of training.

Energy Demands:

Due to the high energy demands required during alpine ski training, this increased energy is chiefly produced through greater activation of anaerobic pathways, most specifically glycolysis. This is beneficial in that anaerobic glycolysis can drastically increase its rate of energy production from resting values. However there are two major drawbacks to using this energy pathway: 1.) muscle glycogen is used as the primary substrate and can quickly become depleted, and 2.) additional hydrogen protons are produced as a by-product causing interference to muscle contraction. One or both of these factors can lead to a decreased power. Glycogen is stored within

the liver and muscles in limited amounts. There is about 15g/kg of muscle (~200-300g), and around 100 grams in the liver. When glycogen stores drop roughly below half of their initial content, as in repeated high intensity exercise, energy production slows.

Energy requirements

It has been well documented that ingestion of a carbohydrate (CHO) and/or carbohydrate-protein (CHO-P) supplement has an ergogenic benefit by way of sparing muscle glycogen during exercise and improving glycogen resynthesis rates following exercise (Ivy et al., 2002). Slowing the depletion of muscle glycogen that accompanies exercise becomes very important in maintaining power output and performance; however, dietary data typically show a negative calorie intake for skiers. Ad lib caloric intake without supplementing appears to be inadequate for ski training. To help alpine skiers reduce the depletion of muscle glycogen one must either maintain circulating glucose via supplementation or increase the rate of glycogen resynthesis during recovery. Consumption of a carbohydrate-protein (CHO-P) supplement during exercise and post-exercise has been shown to do both (Saunders et al., 2004). Nanna Meyer created the Athlete's Plate® to help sport dieticians and athletes themselves create more appropriate diets for their level of training. The plates were then validated by Reguant-Closa, et al. (2021) and found it quite accurate for many sports including alpine skiing.

Fluid requirements

It is also well documented that alpine skiers require fluids to maintain hydration status; albeit, few skiers actually consume adequate fluids during training (Meyer et al., 2001; Seifert et al., 2001). With dehydration, comes reduced blood volume, decreased glucose delivery to muscles and reduced buffering capacity. Seifert, et al. (2005) reported alpine skiers do not drink enough fluids while skiing and even with a mid-day break return to skiing dehydrated. Several other studies have demonstrated that skiers take in too little fluids (Seifert et al., 2001; Meyer et al., 2001; Seifert et al., 2005; Seifert et al, 2006a) and/or calories (Meyer et al., 2001; Harmon et al, 2007). Even verbal encouragement does not seem to be enough to get skiers to meet their daily needs. The combination of dehydration and inadequate CHO supplementation during ski training leads most skiers to premature fatigue. When fluids were forced with a schedule and CHO-P Gel packs were required, skiers received enough fluids and calories to match their daily energy expenditure (Bacharach & Bacharach, 2009).

Recommendations

Regarding fluids, water is the basic “go to” liquid. Drinking water throughout training (taking small sips at a time) with a target of consuming 300-500ml/hr is highly recommended. If another non-carbonated, non-caffeinated drink is preferred that allows the target volume to be achieved, then great, drink up.

The energy demands on metabolic systems favoring carbohydrate as its primary source of fuel appear to be very important for modern day alpine ski racers. It is clear that energy demands for

ski training exceed the normal calorie intake of young athletes in spite of encouragement from coaches to eat and drink. Supplementing a skier's diet with 500-600 CHO calories while race training, appears to provide enough energy to match the demand of a 3-4 hour training session. An easy to consume supplement such as an energy bar or gel that can deliver 20-60g of CHO per serving is a good option. These tend to be well tolerated and provide a convenient way to get the needed calories. There is however nothing special about supplements. They just provide convenience. A hard roll with Nutella, cheese, gummy bears or trail mix can also be consumed in similar quantities. The key is ingesting ~100g of CHO over the course of a 3-4 training session.

Additional General Recommendations:

For the athlete, carbohydrates are the most important ingredient on the menu, especially when they are training hard. When athletes don't train much or are in their off-season, they have to learn how to eat lower calorically dense foods in order not to gain weight. So the plates of the athlete look similar to a recommended plate for the inactive average American: Half of it should come from seasonal vegetables and fruit, with a handful of whole grains in their least processed form, such as whole wheat pasta, lentils, beans or whole grain bread. It also should include a good serving of lean protein, either animal- or plant-based. Fats are there for flavors and should be used in moderation. The athlete, as well as the average American, needs plenty of water and really does not benefit from sports drinks, soda, or corn-syrup sweetened juices.

1. Lay off high sugar food and drink unless you are training intensely.
2. Carbohydrates are "the" fuel for alpine skiers, but those carbs should ideally come from fruits, veggies and whole grains, NOT processed foods or foods with added sugars.
3. When you're not training hard, cut back on the carb calories. At rest, and for light activity, you don't use them.
4. Lean protein sources either animal or plant based is a must. No need for extra protein powders.
5. Having some fats in your diet is a good thing. You need them for tissue repair and normal hormonal function.
6. Post training snacks of 100-300 calories after strenuous work that can deliver about a 4:1 carb to protein ratio can help recovery. String cheese, yogurt, chocolate milk, granola mixes or some prepared sports gels can provide this in convenient packages.

8. Racing Service – Ski Tuning

Stefan Thaler

Ski tuning and binding adjustment are paramount for ski racers, exerting a direct impact on both performance and safety on the slopes. Here's why these elements are of crucial significance:

1. Performance Excellence: Ski tuning encompasses edge honing, waxing, and base refinement. These fine-tuned adjustments directly mold ski-snow interaction. Well-crafted skis yield heightened grip, stability, and agility, empowering racers to execute meticulous turns, maintain control, and attain remarkable speeds.

2. Precision Edge Management: The essence of sharp edges emerges when tackling icy or compacted snow. In ski racing, where victory pivots on fractions of seconds, optimal trajectory through turns stands pivotal. Aptly tuned skis cement superior edge control, emboldening racers to stretch their limits with assurance.

3. Velocity Amplification: Skillful waxing techniques minimize base-snow friction, propelling skis to exhilarating speeds. In the realm of competitive racing, where micro-advancements carry monumental weight, this is a defining advantage.

4. Unwavering Consistency: A racer's ally is equipment consistency. Meticulously tuned skis furnish a stable, foreseeable platform, enabling racers to seamlessly execute strategies irrespective of evolving snow conditions.

5. Adaptive Agility: Ski tuning presents the opportunity to tailor gear to the distinct demands of each race. Varied snow textures and temperatures necessitate nuanced tuning methods. Racers adept in these techniques harness adaptive prowess, optimizing performance across diverse terrains.

6. Injury Abatement: Binding adjustment secures skiers' boots while enabling controlled release during falls. Improper adjustments elevate injury risks. Accurate binding settings minimize these risks, fostering overall safety.

7. Personalized Biomechanics: Racer individuality extends to biomechanics and skiing styles. Binding adjustments accommodating these nuances amplify power transmission, control, and agility.

8. Psychological Empowerment: Confidence blossoms when equipment is finely tuned, bindings are correctly set. This boost fortifies racers mentally, allowing them to channel focus towards strategic racing and techniques, yielding heightened performance.

9. Regulatory Compliance: Ski racing adheres to specific equipment rules. Binding adjustments fall within this purview. Adherence preserves fairness and a level playing field.

10. Competitive Edge: In the realm of competitive skiing, even slight advantages wield substantial influence. Well-honed skis and accurately adjusted bindings metamorphose into the quintessential edge, propelling racers towards triumphs and podium accolades.

In essence, the tandem of ski tuning and binding adjustment fundamentally shapes a ski racer's performance, safety, and overall engagement with the slopes. Racers who prioritize these elements navigate a path to success by ensuring their equipment stands poised in precision, sculpted to match their aspirations. This commitment unfurls their potential, paving the way for accomplishments that resonate with skiing's essence.

The objective of racing service is to tune a machine-prepared ski automatically or manually for the requirements and the discipline of a ski racer.

Typically, racing skis are delivered to the athlete by the manufacturer, already machine-processed and ready to be fine-tuned and tailored to the athlete's needs. However, it's crucial for the athlete or ski technician to recognize any defects or issues in the ski's processing.

It's important for the athlete to familiarize themselves with the processing parameters and accessories used during the preparation of their skis. This is of fundamental importance in selecting the subsequent steps of processing.

Constrution of a race ski:

An alpine race ski, known as a racing ski, is meticulously crafted with specific designs and materials to maximize performance and control for competitive skiing. While construction methods may vary between manufacturers and models, here's a general overview of how an alpine race ski is typically built:

Core: The core forms the ski's central structure. High-quality race skis often utilize wood like ash or beech due to its strength and lightness. Some skis may incorporate synthetic materials such as foam or carbon to enhance specific performance attributes.

Top Sheet: Serving as an outermost layer, the top sheet acts as both a protective shield and a canvas for graphics. It's usually made from durable and lightweight materials such as plastic or composite.

Sidewalls: Sidewalls are vertical sections along the ski's edges, linking the top sheet and base. They provide crucial edge grip and transmit power for precise control during turns. Race skis commonly feature robust and responsive sidewalls.

Metal Layers: Many high-performance race skis integrate metal layers like titanal or aluminum for stability, torsional rigidity, and vibration absorption. These layers mitigate vibrations at high speeds, enhancing stability and control.

Titanal Sheets: Some racing skis strategically include titanal sheets to amplify edge grip, stability, and responsiveness. These sheets are positioned beneath the core, adding strength without excessive weight.

Carbon or Fiberglass Reinforcements: Composite materials such as carbon fiber or fiberglass may be layered within the ski to fine-tune characteristics. These reinforcements contribute extra stiffness, energy transmission, and responsiveness, optimizing overall performance.

Camber and Rocker Profiles: Camber is the upward arch when the ski is on a flat surface, while rocker is the curvature from tip to tail. Race skis often embrace a cambered profile to heighten edge grip and power transfer, particularly during aggressive turns.

Base Material: Crafted from durable and low-friction polyethylene, the ski's base features micro-grooves and pores that retain wax, optimizing glide.

Edges: High-quality steel edges run along the ski's sides. These edges are meticulously tuned to offer exceptional grip across diverse snow conditions, facilitating control during turns.

Bindings: Bindings secure the skier's boots to the skis. In race skis, bindings are typically placed slightly closer to the ski's center, enhancing agility while trading off some stability.

In essence, race skis undergo meticulous design and construction to deliver the precise performance, control, and speed that competitive skiers require. The fusion of advanced materials, strategic layering, and precise engineering culminates in a specialized tool tailored for high-speed downhill racing and assertive turns.

Basic Ski Designs

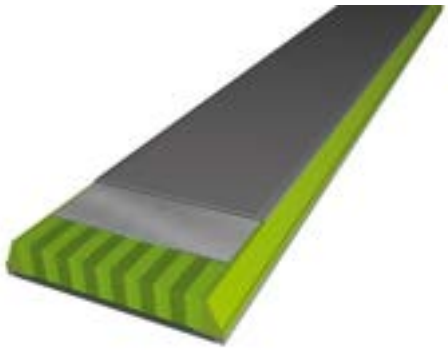
- Sandwich construction

Wood is used as the core material for this technique (beech, ash). The rebound after serious flexion is particularly good thanks to the wooden core. At the same time, it absorbs shear stress better than other core materials.

All elements of the ski (the edges, sidewalls, base,...) are placed in a mould and "baked" under pressure (up to 20t) and at a higher temperature (70 - 130° C).

The camber is set by adjusting the press and by the temperature.

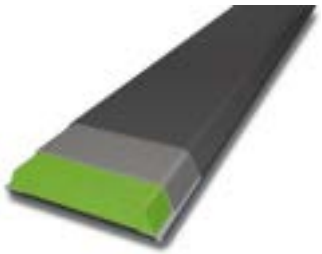
- **Flex, pretension and torsion can be precisely defined.**
- **Longer life expectancy thanks to "living" core which is resilient to fatigue**
- **Good skiing properties thanks to quick rebound**



- PU construction

PU construction involves placing the top surface belts, base and edges into a special mould. Polyurethane is injected under pressure; it expands and then hardens. It is important to fill the cavity as evenly as possible, and for the PU foam to bind with the other components. This means that substantial quality differences occur using this process.

- **Simple and fast production, and thus a cheaper price, ideal for children's and beginners' skis.**

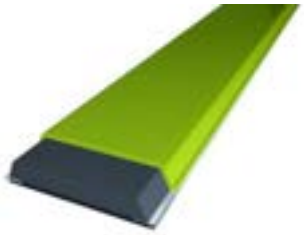


- Cap/monocoque construction

Cap/monocoque construction is the most popular tech-nique for ski making today. The side walls and top sheet are molded as a one piece "cap" used as the only load-bearing part of the skis or board. The core, either wood, foam or a combination of both along with the reinforcing layers, base and edges are inserted and bonded.

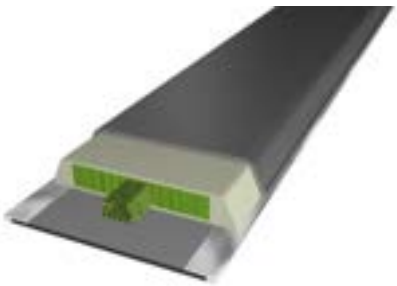
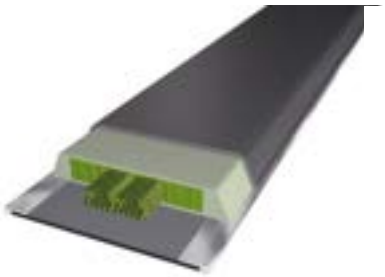
Some constructions have a self-supporting core with different wood, aluminum, or carbon laminates with the CAP serving only as a closed surface.

- **Flex, pretension and torsion can be precisely defined**
- **Long service life**
- **The cap/monocoque construction with its cap absorbs acting forces well and allows direct power transmission ton the edges**
- **Excellent skiing characteristics and rebounding abilities**
- **Simple production method (future technology)**



Hybrid types

- Various hybrid types have evolved from the basic constructions over the years.
- Hybrid types combine the product and production technology benefits of the various construction types.


- Base Types
    - Extruded Base
    - Sintered Base
    - Graphite Base
    - Application Area, Charakteristics, Processing

Base type	Extruded base	Sintered base	Graphite base
Application area	Skis and boards in the lower price class	Skis and boards in the mid- to higher price classes	Skis and boards in the higher price classes
Characteristics	The base is fairly soft and not very resilient against scratches	The base is harder and more resilient to wear and tear than an extruded base	Similar to sinter base, carbon creates the black base
Processing	Base is easy to grind	Base repair is more difficult; grinding takes more steps	Like sinter base, special graphite material available for base repairs

- Extruded Base
- Typically used for lower priced skis (cheaper to produce). This base is easy to grind and also has good wax holding abilities. The base is fairly soft and thus not very resilient against mechanical impact (scratching). The gliding properties are poorer than those of sinter

bases. The lower melting point makes this base easier to repair with legacy methods (refilling).

- **Base manufacturing**
- Polyethylene granulate is melted under heat and extruded by screw through a nozzle. The raw material is then cooled, milled, cut laterally and rolled.
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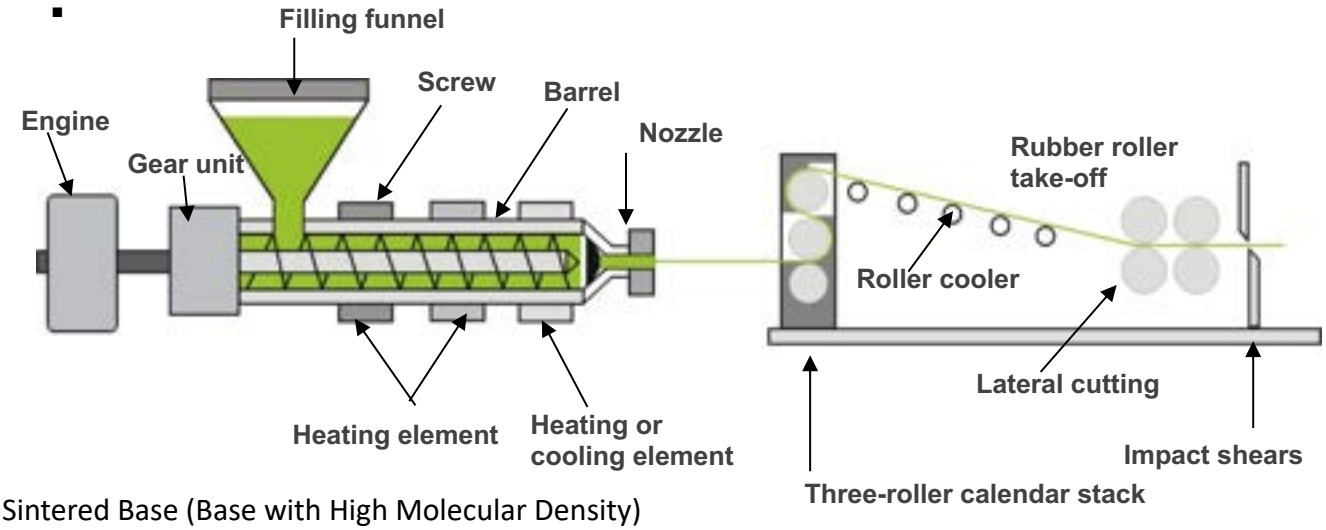
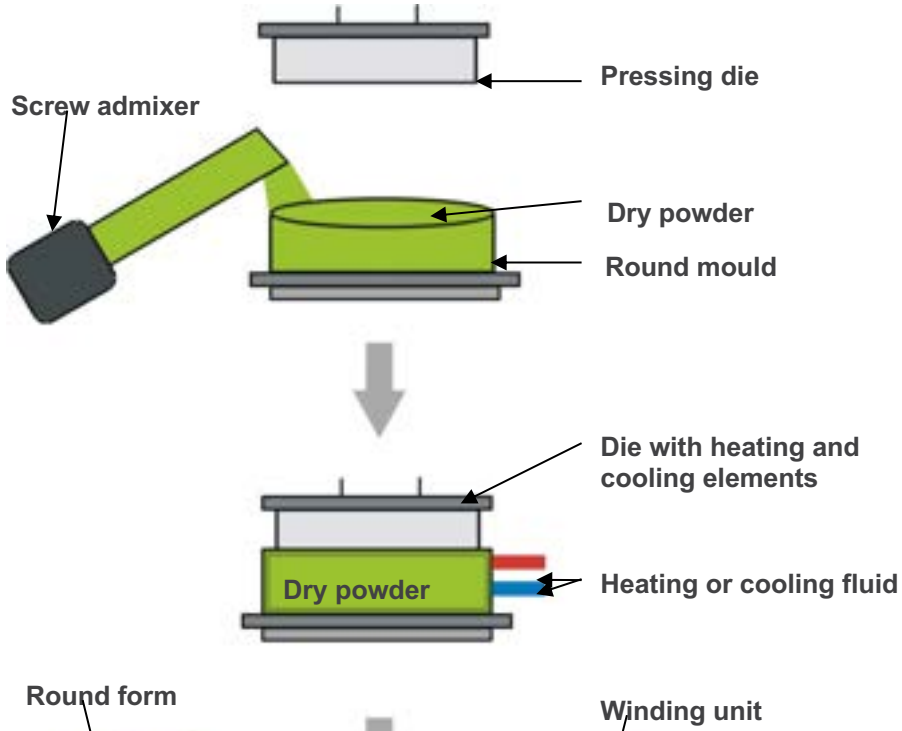


Sintered Base (Base with High Molecular Density)

This base is typically used for mid to higher priced skis. The addition of special gliding additives (nanosilicates) enhances the gliding properties of this base which is also very resilient to wear and tear. The higher molecular weight (density) means that it holds wax better than an extruded base, however, it is harder to repair.

Base manufacturing

Polyethylene powder is compressed in a mold while applying heat and high pressure (sintering) to form a round block. The base is cut from this block using a blade. Due to the more complex manufacturing process the sintered base is more expensive than an extruded base.



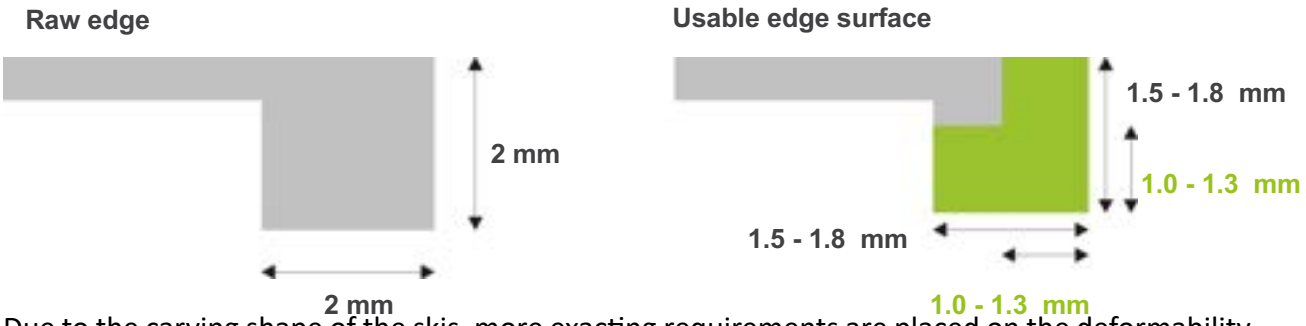
Graphite base

To improve wax holding ability and gliding properties (improved static discharge), carbon or graphite is added to the sintered base.

Larger gouges are best repaired by die cutting the damaged area and gluing in a new piece of base or metal grip. Smaller areas of damage can be repaired by p-texing.

Edge

- The raw, undressed edge has a thickness of approx. 2.0 mm
- The edge on a new ski has a thickness of 1.5 – 1.8 mm
- The usable surface is approx. 1.0 – 1.3 mm



Due to the carving shape of the skis, more exacting requirements are placed on the deformability of the edge compared with legacy skis. à Edge steel will tend to be softer today (38 – 52 HRC [Rockwell hardness]).

Edge hardness

On the one hand, steel edges need to be hard as possible, on the other hand, they need to exhibit maximum possible ductility (ductility = plastic deformability, bending ability without breaking).

However, as hardness increases, ductility drops.

In the last 5 - 10 years, steel edge hardness has been reduced in favor of ductility. Carving skis with a more pronounced waist, new ski models and a softer ski structure all mean that steel edges need to be able to deform more without breaking than previously.

This explains why steel edge hardness today is in the region of 38 to 52 HRC (compared with 46 to 54 previously).

You can roughly differentiate between:

Carving and free-ride skis	High level of ductility required	38 - 42 HRC
Standard skis	Compromise between hardness / ductility	42 - 48 HRC
Racing skis (downhill, GS)	High level of resilience to wear required	48 - 52 HRC

Manual Processing

This is a generic description of service staff methods in World Cup skiing. These steps may differ slightly depending on the brand of ski, base and finish. The starting point is a flat, structured ski.

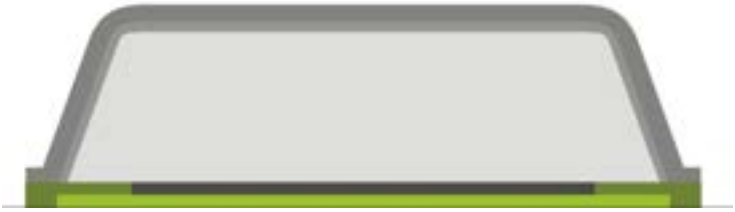
Stone Grinding

Various initial situations

Concave ski

Convex ski

Flat ski

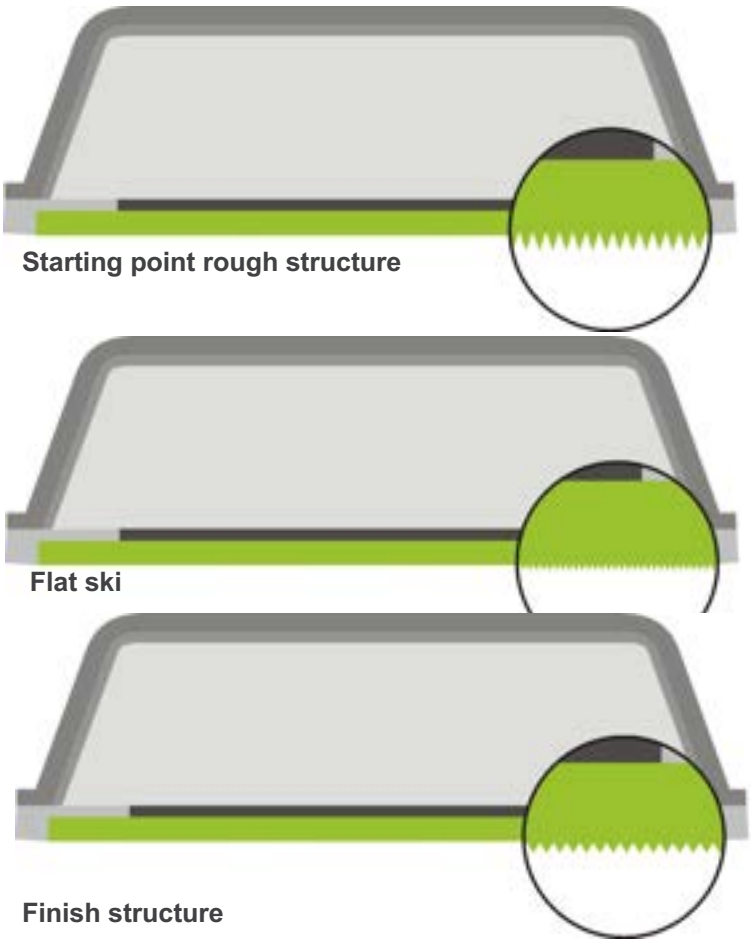


Stages in Stone Grinding

The first stage of stone grinding is to achieve a flat ski. Depending on the state of the ski, the base is ground flat in small steps (max. 3). e.g.:

- 12 mm/sec
- 9 mm/sec
- 6 mm/sec

Once the base has been ground flat, and finely structured, the required finish is applied as a single grinding step.



Stone Grinding: Base Surface and Structures

Alpine skis are also prepared using machines. First by the ski manufacturers, who today put much time and money into the process, and later by the ski workshop. Today's stone grinding machines are typically very good and modern.

For ski manufacturers stone grinding serves to visually enhance the ski while ensuring good, gliding performance. The grinding stone can be prepared before grinding to tune the base for specific snow conditions.

Knowledge of the right structures for snow conditions, and how to program the grinding machine to create the right structure, is extremely important.

The new, harder sintered bases are also more difficult to work as more friction occurs between the grinding stone and the base. Increased friction, and sometimes too high a grinding stone speed can cause the base to overheat and thus harden the edges (discoloration).

If the base is overheated during grinding, its surface is too tightly compressed and practically sealed. Excessive compression of the base impacts its natural gliding performance and reduces its ability to hold wax.

Racing skis should never be ground at too high a grinding stone speed and at too low a ski feed speed. It is a good idea to check the surface characteristics of the base on new racing skis, to correct it yourself where necessary, or to have a good ski service workshop rework the base.

Experienced ski technicians know how to deploy their machines to achieve the desired base structures.

Racing ski bases are categorized as polyethylene bases with an extremely high molecular weight. These bases offer various benefits compared to cheaper extruded bases.

These bases are known as "sintered" bases, where sintering refers to the manufacturing process. Small particles of polyethylene (powder) are compressed to form a homogeneous unit using heat and high pressure. The polyethylene wheel is then fed over a peeling blade and cut into strips for use as ski bases.

The ski bases are either transparent or black. Black bases are manufactured in the same way as transparent ones, however, soot (graphite) is added (5 - 15 %).

- Greater impact strength, more resilient against wear and tear at low temperatures, a much lower friction coefficient and far superior wax holding abilities.
- Graphite bases have superior thermal electrical conductivity. This characteristic reduces the static charge which occurs in cold and dry snow conditions. However, the coat of water which occurs at warmer temperatures is more easily interrupted.
- For this reason adding graphite is a big advantage in case of extremely cold conditions. The fact that graphite is a natural lubricant substantially reduces friction in other conditions, too. Also, the base does not pick up as much dirt.
- One critical feature of all sintered bases is the fact that they can hold a large amount of wax which enables perfect adjustment to actual snow conditions.
- Racing bases have very good gliding properties!

Disadvantages

- Racing bases are more difficult to grind and require several steps!

Wet snow: - 0° C and warmer

Coarse structures are required for wet snow conditions and for high speeds on old snow. A wet snow structure uses a coarse linear structure as the basic substrate and a finer crossed structure as the finish. The aim of this structure is to dissipate the film of water that builds up between the snow and the base as quickly as possible and to avoid a suction effect.

Moist snow: - 0° C to -15° C

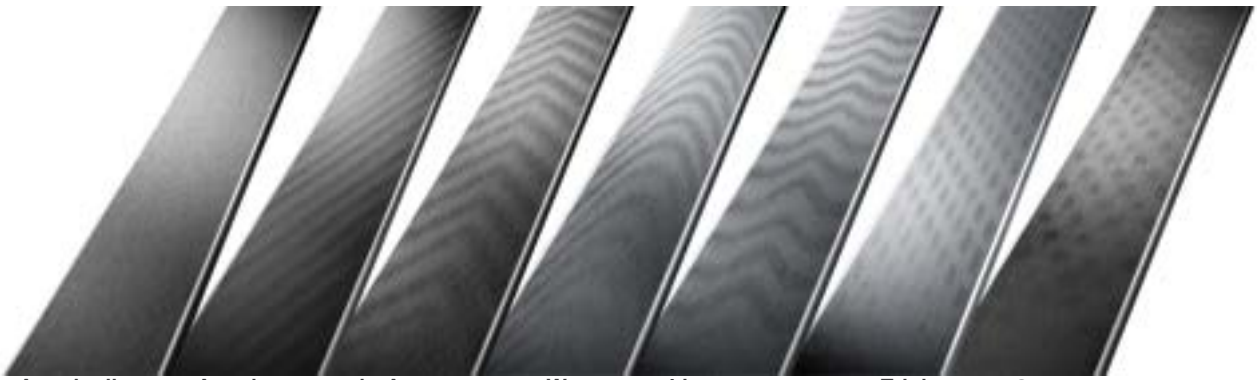
The second and most common type of snow friction can be described as moist, or a changing combination of dry and wet snow, depending on the temperature. In these conditions a medium, crossed structure with left or right displacement is required. The structure serves two purposes: first, it reduces the contact area between the snow and the base; second, it reduces the surface tension by interrupting the layer of water. These conditions are typical for artificial snow.

Dry snow: -15° C and colder

A finely crossed structure is required for cold temperatures and new snow. The purpose this structure serves with dry snow is to reduce the mechanical force of the snow surface when the base glides over it.

As these conditions do not produce a coat of water, gliding relies on breaking, splitting and moving snow crystals. This process only occurs in the top layer of the snow surface. If the structure was too rough, the snow crystals would grip too deeply into the base and cause more friction.

Finish Structures

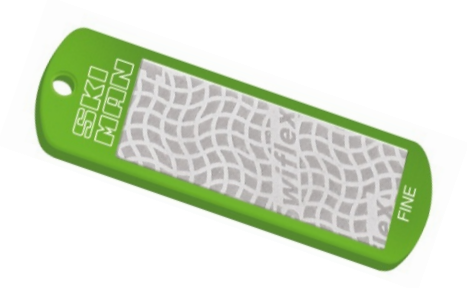


1. Check the base and edges for damage
2. Use a aluminum oxide stone to repair damage to edges (hardening due to rocks)
3. If base repair is needed, clean damaged spots in the base with wax remover
4. Repair damage to base with repair candle (black or transparent)
5. Use a body file to remove excess base material
6. Sand the damaged area lightly using dry sanding paper 180 or 220 grain
7. Dress the base with a sharp plexi-blade
8. Cut the side wall for optimal filing of the ski edge (if needed) Dressing the side walls

Dressing the side walls

9. Set the bevel on the

Grinding the side edge



10. Bevel file the base edge

11. De-tune the tip and tail, lightly de-burr the entire length of the edge

Breaking the edge

12. Dress the base with a sharp plexi-blade

13. Brush with a bronze brush

14. Hot scrape the base with a soft Hydrocarbon wax multiple times until all visible fluoros and dirt have been removed

15. Brush with a bronze brush

16. Iron on the day wax mixture and allow the ski to cool
17. Remove the wax from the edges and side walls
18. Dress the base with a sharp plexi-blade
19. Brush with a bronze brush

20. Again dress lightly with a plexi-blade

21. Brush the base with a horsehair brush from the ski tip to the tail

22. Polish the base with polycloth
23. Bind the skis together with Velcro
24. At the start, lay the skis separately on the snow
25. Free the base and edges from any ice and brush lightly from tip to tail with a horsehair brush
26. If needed, apply fluoride to the base, polish and brush using a cork and a horsehair brush for that specific fluoro only!
27. Deposit the ski in the snow until the start of the race

In the electrifying realm of competitive skiing, the relentless pursuit of flawlessness reigns supreme. As snowflakes gracefully settle and skis effortlessly traverse immaculate slopes, the imperative significance of race ski tuning emerges unequivocally. Much like a conductor fine-tunes each note of a symphony, the meticulous art of ski tuning wields the potential to harmoniously delineate triumph from defeat on the racecourse.

At its core, this art form amalgamates science and craftsmanship. Every edge meticulously honed, each base structure thoughtfully etched, and every wax layer delicately applied – these constitute strokes of brilliance that metamorphose an ordinary ski into a precision instrument. The delicate interplay of friction and glide, control and velocity, distinctly demarcates champions from contenders.

This is a ballet with the elements, an intricate choreography. A comprehension of snow conditions and temperatures, an adeptness at deciphering a racer's technique, and the prowess to draw forth the ski's full potential – these are the skills emblematic of a true tuning virtuoso. Yet, it transcends mere mechanics; it embodies a celebration of commitment and ardor. It encompasses the camaraderie shared amongst ski technicians, coaches, and athletes, all orchestrating a symphony to craft the flawless run.

As race day dawns and tension crescendos, the race ski stands as a testament to uncountable hours of ardent dedication poured into its conception. It carries the racer's aspirations and the tuner's pride. The symphony of exertion and expertise culminates in that fleeting moment when the racer hurtles down the mountain, the skis responding as an extension of their very essence.

Here's to the finesse of race ski tuning – where precision intersects with passion, and each turn becomes a masterpiece in motion. As the snow sparkles and racers carve their destinies, let us

always honor the unsung heroes behind these impeccably tuned skis, weaving aspirations into reality, one slope at a time.

9. Ski-prep for Alpine Ski Racing

Stefan Thaler

Ski boots are of utmost importance in alpine ski racing, serving as the critical link between the skier and the skis. Beyond being a mere connection point, they directly influence a skier's performance, control, and safety.

A primary reason for the significance of ski boots lies in their role as the vital connection between the skier's body and the ski. The boot's design ensures optimal power transfer, enabling precise movements and quick reactions. Well-fitted and comfortable ski boots establish a direct and efficient connection to the skis, enabling racers to transfer energy effectively and maintain stability as they navigate through gates.

The stiffness and flex of the ski boot also play a crucial role in supporting the athlete's movements. The right balance of flex allows for the necessary responsiveness, allowing racers to adapt seamlessly to varying terrains and conditions. Boots that are too soft can result in a loss of control, while overly stiff boots may hinder the skier's ability to make precise adjustments during turns.

Safety is paramount in the high-speed, high-risk world of alpine ski racing. A properly customized ski boot enhances protection for the skier's feet and ankles, reducing the risk of injuries. Advancements in boot technology, such as improved shock absorption and lateral support, further enhance the overall safety of racers on the slopes.

Customization options are another critical aspect of ski boots in alpine ski racing. Professional racers often rely on custom-made boots tailored to their specific foot structure and performance preferences. Customization ensures a precise fit, essential for optimal power transfer, reducing discomfort, and minimizing the risk of injury during intense training and competition.

Ultimately, ski boots are the foundational element in alpine ski racing. Their ability to support, control, and protect the athlete directly impacts their performance on the racecourse. As technology and design continue to evolve, it becomes increasingly evident how crucial it is to choose the right ski boot tailored to each skier's needs. In the highly competitive world of alpine ski racing, ski boots remain a vital tool that can make the decisive difference between victory and defeat.

There can be several reasons why there are many problems with ski boots:

The problems with ski boots are a combination of factors related to fit, comfort, technology, and individual preferences. Getting the right pair of ski boots may require proper research, expert advice, and trying different options to find the best fit for each skier.

- The foot has a complex structure is flexible and dynamic, yet rigid and unyielding.
- The ski boot is a hard plastic shell that does not yield to foot shapes without intervention.
- If we take closer look at over a period of a ski day with normal body load can be stated as follows

- If the foot is loaded, the bones become looser, the arch of the foot descends along the ankle , the ankle bone goes inside, the metatarsal heads descend, the forefoot will spread out and elongate, sometimes by as much as 2 full sizes.
- All of this is natural and evolved over time to allow us to walk. However, in a relatively rigid plastic ski boot shell, these movements can cause a lot of problems.
- The main problem here is that an unstable foot does not have a constant size , neither does it keep shape or volume and it is practically impossible to have this changing foot shape correspond to the actual shoe size measured.

Anathomy

A fundamental understanding of the lower extremities' anatomy and biomechanics is essential for comprehending the interaction between the foot and the ski boot while skiing. This knowledge enables us to understand the origin of certain issues and how and why they need to be addressed.

The foot is one of the most complex parts of the human skeleton, with a quarter of the body's bones residing in the feet. It comprises 26 bones and 2 sesamoid bones, along with numerous ligaments and muscles, all crucial elements for proper boot fitting.

The foot serves two distinct functions. Firstly, it acts as a shock absorber (represented by the red bones) and secondly, it can function as a rigid lever to transmit power (represented by the white bones).

It's important to remember that the foot is a mobile, dynamic unit, while the ski boot is made of a rigid plastic shell, making it challenging to harmonize with the flexible and position-changing foot and lower leg.

The lower leg consists of two separate bones:

1. Tibia: It is the strongest bone in the lower leg, connected to the femur at the knee joint at its upper end and forming the inside medial anklebone at its lower end.

2. Fibula: The smaller of the two lower leg bones, also attached to the femur at the knee joint. It forms the lateral malleolus at the lower end and interfaces with the talus bone.

THE BONES:

The foot's bone structure is divided into three main parts:

1. Rear foot (blue): Comprised of the calcaneus (heel bone) and the talus (keystone bone of the foot).

2. Midfoot (blue and red): Consists of the navicular, cuboid, and three cuneiform bones.

3. Forefoot (pink): Contains five metatarsal bones and phalanges (toe bones) connected to the metatarsals.

The bones and joints in the foot and lower leg are crucial for supporting the body's functions and controlling movement. Proper alignment and stability in these areas are essential for designing ski boots that best suit an individual's needs.

The steps to perform an efficient and precise boot-fitting

A. Measurement & Analysis of foot and lower leg
    a. There is no exact same feet with in one single athlete.
    b. The right size of a ski boot is different from the size of everyday shoes customers are using.
    c. Exact foot analysis is the first step in boot fitting and should be always done barefoot
    d. Foot size, foot type, and foot shape are critical for a successful outcome.
    e. Do not forget to ask athletes if any foot and fit problems or previous injuries have occurred or are still present.
    f. Barefoot and in a sitting position review the general shape and form of each foot. Start at the front of the foot and working your way backwards. Take a look at the foot also from the backside - both perspectives will give you much better information.

g. To get maximum information, it is important that you look at feet in both seated and standing positions.

There are different devices and methods to measure and analyze feet:

Examples from BD:

Foot analysis Scanner:

With the use of the BD scanner you also get additional information such as boot model selection and additionally footbed selection.

Foot analysis Podoscope:

When using the Podoscope you will be able to quickly get the info of what type of foot is presented by the customer. Also a dynamic analysis should be done to make the customer understand how pressure distribution of their

feet operates during skiing.

Fußanalysis Feet view / Brannock:
If you are using a Feet View you will get information about foot length, foot width, and foot type.

Brannock / Width measurement overview:

AA to A = 92 bis 95 mm

B to C = 95 bis 97 mm

D to E = 98 bis 100 mm

E to EE = 101 bis 103 mm

EE to EEE = 103 bis 106 mm

Foot volume vs. Footlength:

An additional method of measurement is the one where you remeasure with a tape measure from the base of the heel around the ankle to the opposite side of the heel base. If this measurement is greater than the foot length, this is an indication of higher volume foot and a possibly larger boot would make more sense. If this measurement is smaller than the foot length, a smaller boot size is worth considering. Example: foot length = 26.5cm, ankle perimeter = 28.5cm, consider 27.5 size. Example: foot length = 26.5cm, ankle perimeter = 24.5cm, consider 25.5 size.

ANALYSIS LOWER FOOT

The key to successful boot fitting it is to match the shape, size, and volume of the ski boot as much as possible to the customer's foot. That is why all of this information is crucial in the selection of the ski boot.

A. Footlength

You should always use the same analysis system to get a corresponding routine in the size determination. Always measure both feet standing and weighted, but also in a seated position unweighted to see how much elongation occurs. This is important to determine the required support for the arch of the foot. Always measure to the longest toe and do this for both feet Does the length of the foot changes under load? If so, this is usually an indication of pronation and should be explained to the customer. Another method and in determining the required boot size is to stand on the insole of the boot. In this method, the insole should not be greater than a maximum of 1 cm relative to the foot. Perform also the Shell sizing Test! Remove the liner from the ski boot, and have the customer enter the shell barefooted. Ask the customer to move their foot so that big toe or second toe touches the end of the boot shell gently. Have the customer

flex forward, and using a light source, visually inspect the distance from the heel to the rear ski boot shell wall. Use the following guide for fit choice. 23mm or greater = High comfort or loose fit. Heel may rise when skiing! 15mm to 23mm = Standard comfort fit. Heel should fit secure, mid and forefoot secure. 10 to 14mm = High performance fit. Heel is tight and boot will need modifications to be comfortable. 9mm or less = World Cup race fit. Boot may not be donned with liner easily. Many modifications required! For professional fitters only!

B. Footwidth

Look closely at the structure of the fore foot to see which foot width exists. Check the big toe joint and the small toe joint to see if they have a bunion or tailor's bunion in any way. If so, then this should be modified in the ski boot. Adjustments on the first and especially on the fifth metatarsal heads are among the most common modifications which you will need to perform. You will now be able to generally classify the foot in one of three main families:

• narrow width • medium widthe • wide width

Check out the general shape of the forefoot. Do the foot spread in the front foot while standing and if so, how much?

C. Foot Arch:

Inspect now the arch and determine the type of foot.

• Low arch

• Medium Arch

• High Arch

Explain to the customer the need for a customized footbed. Different arch heights need different support levels. The fine tuning of the ski boot is obtained by the thermal molding of Boot-Doc insoles .... The insoles from the product manufacturer have no support function and are comparable to a cheap carpet. Short term cushion, but no support! During skiing, there will be better power transmission, significantly longer skiing pleasure because the feet do not get as tired, less joint problems, no numb feet .... Therefore, I recommend the following BD Footbed!

D. Instep Height

Caution- the instep height can be a difficult point to solve if the wrong shape of the boot is selected. Generally, a high instep and high arch is a sign of a strong and relatively rigid foot shape. If the foot is unstable and pronates, you will find that the instep height will lower when loaded. If this type low arch foot is not positioned in the boot properly it can lead to discomfort.

E. Ankleshape

Pay close attention to both ankle bone shapes and special attention to the inside or medial side of the ankle. It is common to have to reshape the ankle area of the ski boot. Under load does the

navicular become prominent? Again, these are sure signs that you‘re dealing with an unstable foot shape. Also check the general ankle width and volume, this is an important point in choosing the right boot and is another area where modifications are often required.

F. Heelwidth

If the heel width is very narrow or very wide, it should be taken into consideration. Heel fit is an important factor because too much movement in the boot can cause problems for the comfort and as well as performance. Have a look at the rear of the heel bone for signs of inflammation or abnormal tissue growth. These deformations or bumps (bursitis) are usually caused by too much pressure in conjunction with friction and are always reinforced by strong pronation. Modification in the ski boot shell is required.

G. Achilles tendon

The Achilles tendon is usually visible in most cases, but you will have customers where the tendon will be hardly visible and seems to be rounded. Again this might have an impact on the heel hold in the boot. The padding of the inner shoe is intended to „grab“ around the Achilles tendon, but a rounded tendon makes this much more difficult. Use BD fit materials for adjustments!

H. Calf and lower leg:

Look at the volume of the calf muscles and establish where the majority of the muscle volume resides. If a large muscle is present, you may have to select the ski boot carefully and find opportunities to move the buckle or buckles receiver to ensure a that the fit is not too tight. This problem with lower calf muscles tends to be more frequent in women than compared to men. Check the lower legs of the customer in a hip width parallel ski position! Do they have O legs or X legs? If so, you should choose a boot with dual sided adjustable cuff, so you can adjust the cuff to the lower leg shape.

Stability of the foot?

Stability of the foot is influenced by two crucial biomechanical terms: pronation and supination. These concepts are often used but frequently misunderstood phases of foot motion.

PRONATION entails a flattening of the arch, with the inside ankle moving inward and downwards. This motion unlocks the foot, creating a loose structure that facilitates excellent shock absorption and improved balance. The medial column, consisting of the Metatarsals (1, 2, 3), cuneiform bones, navicular, and tibia bone, plays a dynamic role in this process.

In contrast, SUPINATION is the opposite of pronation, where the ankle tilts towards the outside of the foot, resulting in a more rigid structure. This allows for stronger and more stable foot positioning, enhancing forward propulsion. The lateral pillar, comprised of the 4th and 5th Metatarsals and the Cuboid, forms the rigid column of the foot.

Understanding and managing the balance between pronation and supination is essential for ensuring proper foot stability and effective weight distribution while skiing. By maintaining the right equilibrium, skiers can optimize their performance and reduce the risk of injuries.

Stabilization of the foot with footbeds

Footbeds are customisable aids for any sport or in everyday life. They act to stabilize, support, and provide relief for the muscle system through the additional cushioning characteristics.

- **Standard-footbed**

  Which are inserts for boots or shoes that are designed more or less as a sockliner and due to the fact that shoe manufacturers do not know which type of foot will use their footwear, no special support provided at all.

- **Trim to fit footbed**

  An 'off the shelf footbed' - some of them are designed with biomechanical principles and provide more or less support and stability. Some are equipped with different arch heights depending on the manufacturer. This footbed usually spans several sizes and needs to be trimmed or cut to fit the shoe or boot.

- **Step in / Semi Custom footbed:**

  These constructions are similar to the Trim to Fit footbed, but do also offer the potential for thermal adaptation using heat while the shape of the footbed fits the arch shape of the customer's foot.

- **Step in 3D:**

  This construction consists of a thermoform resin materials and comes in a basic anatomical shape. A partial adjustment can be completed in a short time to the foot shape of the customer. For comprehensive adjustments, Fit Pillows or vacuum stations are necessary.

- **3D / full custom**

  Made out of thermo moldable resin materials for molding with Fit Pillows or vacuum stations. An accurate image of the foot shape is the objective.

  The proper fitting of this footbed provides optimum comfort, stability, and performance for the foot. This type of footbed provides the best performance for most types of feet and provides optimized pressure distribution under the foot.

Techniques for footbed casting with 3D Vac:

A good Bootfitter should know that there are different techniques for making a cast of the foot using a vacuum type system for footbed production.

Semi – weighted, where the customer is in a seated position and weight is limited only to what the leg and foot produce.

Full weighted , where the customer is standing in a weight bearing position on the casting tray.

Both techniques have advantages and disadvantages, but should be understood based on the biomechanics of each customer.

Semi weighted

Pros:

- Foot arch is in neutral automatically by not have the added weight of the body
- Easy to put the foot in sub-talar neutral
- Provides maximum support.
- Easy for the technician to work with the customer
- Relaxing for the athlete

Cons:

- athletes with a tight windlass mechanism will find the arch shape to high
- Foot does not elongate and represent the actual foot position inside a ski boot
- Metatarsal head impressions are difficult to generate

Weighted

Pros:

- Foot is represented in a dynamic position, or actual loaded POSITION like in a ski boot
- Arch shape is generally more comfortable
- Good for feet with high windlass resistance
- Takes into account foot elongation and metatarsal head shape.

Cons:

- Difficult to generate enough arch support for pronated or loose foot types
- More difficult for the customer to balance and cooperate
- Technician needs to be more diligent and skilled to generate a good cast.

After customizing the insole to fit the foot, it is crucial to remold the heel, flatten the area from the 1st to the 5th metatarsal, cut the insole to size, and smooth the edges. The insoles must be adapted to the shape and size of the ski boot, ensuring they are stably positioned inside the shell. These manual adjustments must be precise and accurate, and tested in the boot until the perfect fit is achieved. Improperly shaped insoles can lead to foot issues, pressure points, reduced foot sensitivity, and decreased power transfer.

The importance of the use of heel cups for race footbeds:

A heel cup provides heel support and provides support and cushioning to sensitive areas of the foot. Distributes pressure more evenly, reducing shock and stress on heels during skiing.

Stable:

A heel cup increases the stability of the foot within the skiboot. It helps prevent excessive lateral movement (pronation and supination), which can lead to over-pronation or supination problems, which can lead to foot, ankle and lower extremity problems.

Align Right:

Heel support helps keep your feet in a natural position. This improves overall posture and biomechanics, reducing pain and risk of injury associated with poor foot alignment.

Suspension:

A heel cup with additional cushioning material provides shock absorption, reducing impact forces on the heel and lower leg during skiing.

Comfortable:

The presence of a well-designed heel cup increases the overall comfort of the footbed or insole. It provides a sense of security, reduces footwear slippage, and enhances the overall wearing experience.

Heel counters come in a variety of shapes, sizes and materials to suit different foot types and specific needs. Custom footbeds often feature heel cups that are molded to the shape of an individual's foot, providing customized support and comfort.

Overall, the heel cup plays an important role in the footbed design. They contribute to foot stability, proper alignment and comfort, making them valuable components in improving foot health and overall performance.

Choosing the right shell and last

It is very important to know the different size of the ski boot lasts, different shell shapes, liner fit, and custom-fit liner technique for different models in the range.
Use the time at the beginning of the season to try on different ski boot models out of the assortment in the shop. Try boots on with and without liner.

Size: Boot-size test without liner!

Remove the liner from the shell and put the customer's foot in the shell .

When the toe front slightly touches the shell, there should be at the heel 1 to 2 cm of space (in soft comfort boots with thick cushion max. 2.5 cm).

This space difference is completely sufficient for the inner boot.

Athletes: distance heel- shell max 10mm

Test with thin stockings or compression stockings. When the customer is in the boot (incl. Liner) and is in typical skiing position, they should not touch the end of the boot with their toes. As soon as they stand up (where the heel pushes forward slightly), they should easily touch the toebox.

If the customer is not touching toebox, then this an indication that the boot is too big!

Last

Every manufacturer has a different idea of foot shapes, therefore different shell shapes and last shapes, which are categorized in widths eg.

Atomic: Narrow 95-98 mm, Medium 100-101 mm, Wide 102 +

- Race Tech CI & Race Tech TI

Mondo point	Sole mm	Last mm CS & TI	Last width mm CS	Last width mm TI
22.0-22.5	266	244	90	87
23.0-23.5	274	254	92	89
24.0-24.5	284	264	94	91
25.0-25.5	294	274	96	93
26.0-26.5	304	284	98	95
27.0-27.5	314	294	100	97
28.0-28.5	324	304	102	99
29.0-29.5	334	314	104	101

The reference size for most manufacturers, is for example The Mondopoint size from 26.0 to 26.5. For each whole Mondopoint size, the width changed to 2-3 mm / this varies by manufacturer.

In racing boots (hard Flex) the liner comes with thinner padding. Adjustments of the liner (foaming of the inner boot) or deforming / milling of shell (= Boot Fitting) are necessary because the last width is very narrow and tight.

Cuff volume:

To select the right size of the cuff, it is necessary to remove the liner from the shell. The customer should get into both boots and stand in a hip width position. Now close the upper buckles lightly. Measure the distance between the leg and the boot. If the distance is less than 1 cm, the cuff pressure would probably be too high and as a result lead to numbness in the toes, leg cramps and poor heel fit.

Solution:
Select very broad opening or a much lower upper cuff. Manufacturers use one size of cuff for every two sizes of the lower shell 26.0 and 27.0.
Buckle position change!

Upper cuffs on models for women are lower than men's models, the height of the inner boot should be matched to the height of the collar.

Flex

Although manufacturers use a numerical Flex-Index, there is no certified standard.
The flex index value can be compared only within the brand ski boot models. In general, the higher the Flex-Index value, the harder the plastic used for the boot.
The flex is the resistance (stiffness) of the ski boot shaft forward.
The harder the flex (= higher Flex-number), the stiffer the ski boot, and more energy transfer.

The softer the flex (= lower Flex-number), the softer the boot, and more dampening or cushioning.

The Flex is designed to provide enough resistance to transfer control inputs (eg skitip pressure), but should not interfere the natural movement of ankles!

Since the pressure distribution is done mainly by shifting weight, the weight of the skier plays a (co-) determining role in choosing the appropriate flex.

Outside temperature while skiing affects the hardness of the shell so much that the flex can vary by 10 - 20%

If you want to change the flex of the boot, use the mechanical Flex adjustments on the boot, if provided.

Also there is the possibility of the V-section cut.

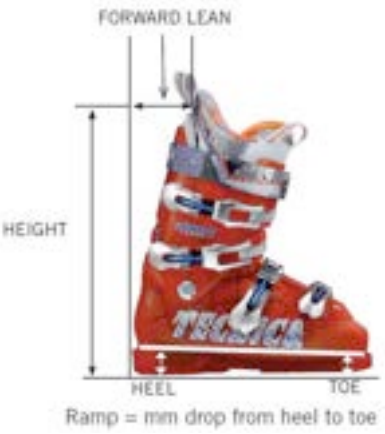
Racers need a higher flex and a close-fitting thinly padded liner that provides direct transfer abilities.

Adjustment and Alignment of the Boot

- After choosing the ski boot, various settings on the boot should be done.
- The setting of the alignment on the ski boot has to be made from the center of the hip socket through the center of the knee mass and through the first and second phalanges of the foot.
  The body position should be centered and the body weight over the middle of the foot.
- In this alignment the skier is also in the best position to keep the skis flat as possible so that edging movements or forward pressure can be easily initiated and controlled.
- Deviation of this position increases the stress on muscle groups, as additional compensatory movements of the upper body are required to provide control while turning or in variable terrain.
- If advanced skiers are carving their turns, then they need a more comprehensive alignment of hips, knees, and feet together with balance of forward and backward movements.
-

Forward Lean Adjustment

Setting the forward lean angle and also the ramp angle of the ski boot



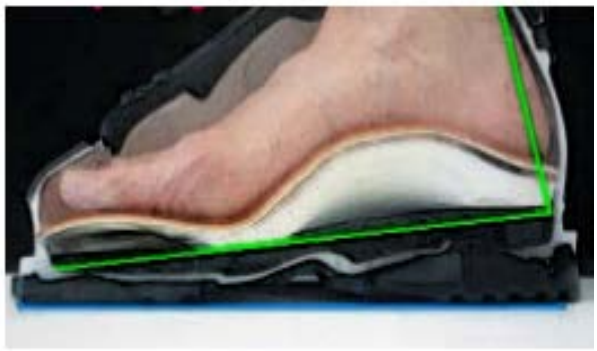
- The lean angle can be adjusted mechanically via a mechanical hinge, or also with a forward lean wedge which is mounted between the liner and shell.
- Most of the current generation of ski boots have a standard forward lean of 14 ° to 16 °. For the majority of the skiers this is sufficient but for others it may be too little or too much.
- Changes in lean angle will influence the shin pressure and also result in pressure distribution changes on the sole of the foot. Forward lean also affects upper leg strength, ankle mobility, and forward to rearward balance.

Ramp angle

Ramp angle adjustement will change the center of mass of the skier over the foot.

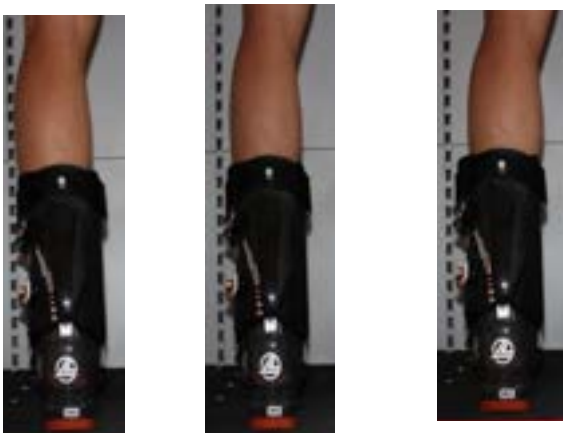
By increasing ramp angle, center of mass usually moves forward and by decreasing ramp angle, the center of mass usually move rearward.

Less ramp angle: helps reduce knee and lower back strain while also making it easier to tip and generate edge angles that compliment shape ski design



Canting:

- Canting is a common term in skiing that refers to the ability to set the ski on edge with even and consistent pressure.
- Skiers who experience difficulty in maintaining a strong edge position may have a leg angle that is either „ bowed“ outward from the hip , or „knocked“ inward from the hip.

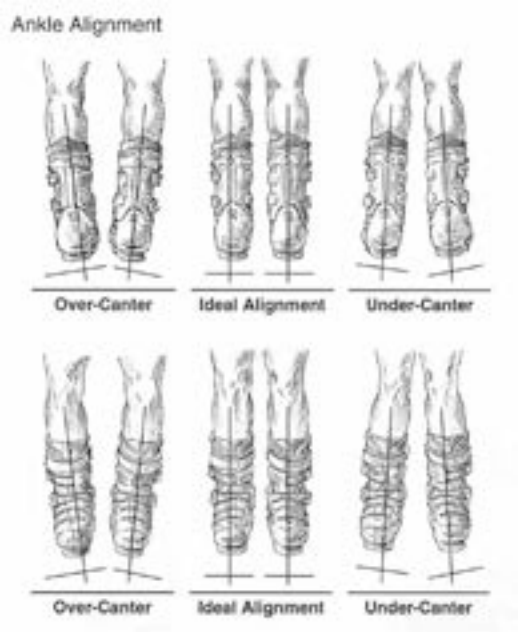


The cuff should be adapted to the shape of the leg. This type of customization allows a range from 0 to max. 2 degrees outwardly and is sufficient for the majority of skiers.

The best way to perform this setting is as follows: position the footbed in the shell, have the customer get into the shells while on the footbed and in a hip width skiers position.

The cuff should be adjusted to the shape of the lower leg with the help of the canting.

- This diagram shows an ideal alignment relative to the sole and cuff.
- The center of the knee axis goes vertically in a line so that tibia and fibula can keep constant pressure on the skis during the turning phase.
- This balanced position helps the skier in the development of skiing technique and in various difficult terrain and snow conditions.



Choose the right Innerboot

- Once you have completed the "Set up" for the shell, you can heat mold the liner. Always follow the recommendations for heating from the manufacturer.
- Remember that, if you mold a liner with heat then you create more space in that liner. If the athlete has a narrow foot, then it is not necessary to increase the volume.
- You may at any time heat up again the liner later, if there should be any small problems.
- If more space is needed at the ankle, instep, or forefoot , you should use foam pads on those zones . This will reduce the pressure after molding. Toe caps are also important for generating more room in the toe area.
- The thickness of the stockings is significant and can play a huge role in fine tuning the fit.
- Buckles should be easy to close, but with equal pressure. Closing the buckles too tight can squeeze the foot into an uncomfortable position.

Custom Liner

- EVA thermal moldable liner
- contain various amounts of thermoformable, anatomical padding that easily and quickly adapts to the form of the foot.
- These liners are padded with EVA foam type and can be heated in an oven. Once heated you should put the liner in the boot, put the boot on the customers foot and then the cooling phase begins.
- Suitable for recreational skiers, much lighter than other liners, and provides more insulation from the EVA construction and are well suited for difficult to fit feet.
- They are particularly suitable for use after injuries, in very cold weather, and are ideal for people with very large calf muscles (wrap-around models) are more effective than those with a tongue.
- Fischer Vacuum:
- Another technology to adapt ski boots comes from Fischer. On the VACUUM FIT Station adaptation can be produced in just twenty minutes.
- Fischer VACUUMFIT ski Boots consists of a shell material which is moldable at 80 degrees Celsius.
- The customer steps onto the station in the preheated shell, forward lean is chosen depending on the skiers ability, then pressurized air and with different settings of the boot / liner can be adjusted.
- **Foam Liner:**
- Is a boot liner with an empty bladder, which gets filled with PU foam to produce a very accurate and close fit around the ankle and foot.

- They are often used to maximize grip and precision for performance skiers, but also for comfort skiers where a soft foam is used.
- This Soft Foam Liner is an important aspect of comfort for ski touring as well as Ladies Boots.

Boot modification techniques

Once it is determined what the problem is and which areas need modification, the most appropriate method to solve the problem should be used. Always try to use a method which is reversible and to also respect the appearance of the boot to keep the outside design as nice as possible.

- Liner changes either by adding or removing material.
- Shell expanding by heating the shell and stretching with special tools.
- Grinding shell material to create additional space.

Inner Boot changes by adding Material.

- This is a quick and easy way to fit the foot and improve fit or remove pressure points.
- Additional Fit materials may be attached to the outside of the inner boot to add more pressure in the area in need of filling.
- This technique is usually required if too much movement of the foot is present.
- fit mats offer for changes in the forefoot, ankle, tongue, cuff and navicular, eg. a donut or C-form-fit mat can be very useful.

Add Material

Another use for fit mats is to relieve pressure points. Although this is usually only a short-term modification and a permanent solution like stretching or grinding should be considered. The spaces around the ankle and navicular, a donut or C-form-fit mat can be very useful. But also in the region of the metatarsal joints, padding on both sides can relieve the pressure points. Examples:

Pressure shin area: Fit mat tongue

Reduce Volume Cuff: Fit mat Calf

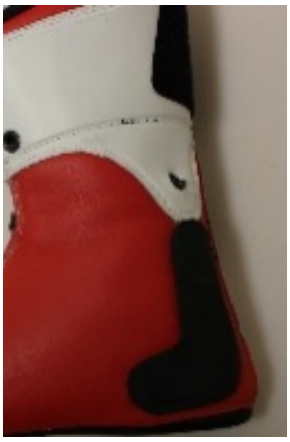
Better Heel Grip: Fit mat Heel

<u>Higher ramp angle, Heel fit, relax Achilles tendon</u>

Reduce volume inside Boot: Volume Reducer 3mm/5mm

Pressure point ankle

Pressure point or Heel fit Problem

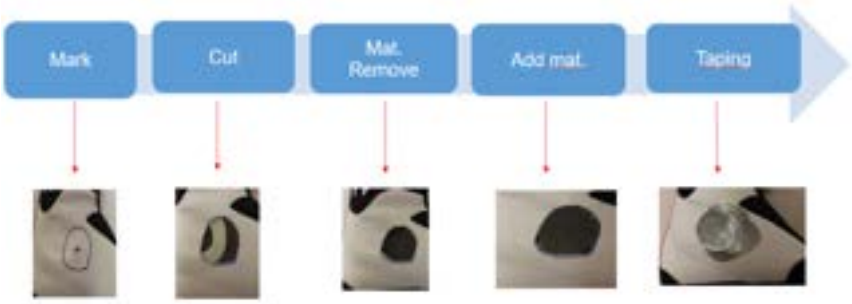


Pressure point in shin area- medial, lateral, front: gel pad

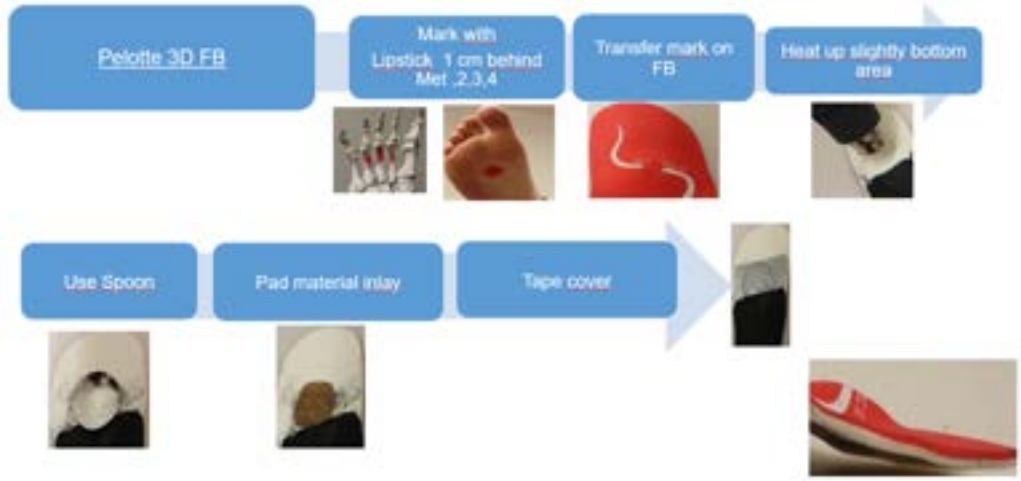
Cold Feet, Volume reducer: neoprene cover

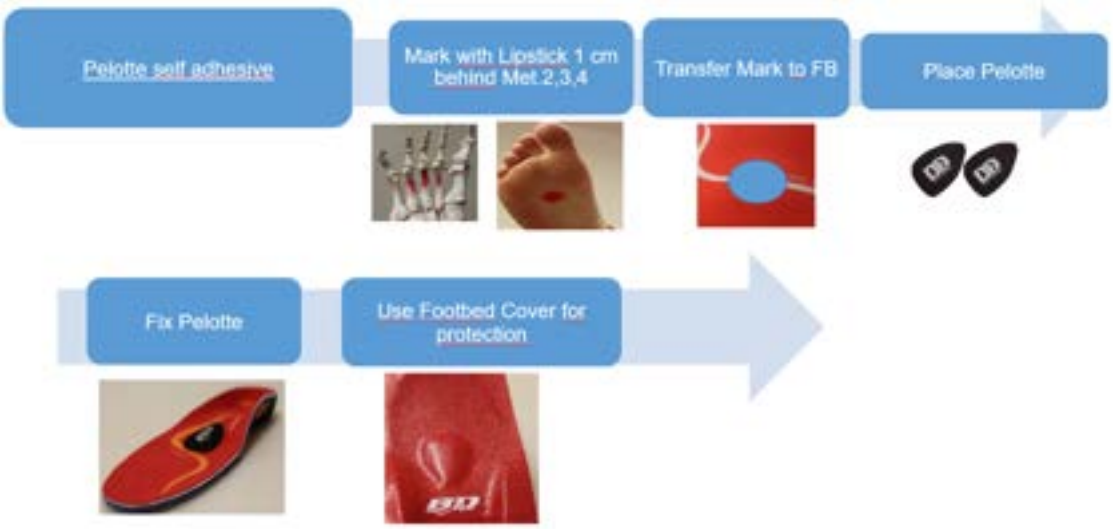
Innerboot Modification by removing Material

- Material may also be removed from the inside padding of the liner, and can be replaced with a softer, more cushioning material.
- Mark the region where modification on the liner needs to be done.
- Cut the outside of the liner with a sharp knife.
- Insert gel material or foam and tape the modified area before placing the liner back into shell.



Modification Technique Footbed example





Modification Technique Shell

If a modification made by fit mats is not enough, modifying the shell either by stretching or grinding has to be done. Both solutions are effective but must be applied for various areas of the Boot and for different problems.

Shell stretching:

Stretching the shell enables a long-lasting custom modification, which increases comfort significantly.

There are different devices to complete the stretching.

Ultracam: with different last sets.

BD Fitting Tool Set: with hydraulic spindle with different last shapes for selective processing.

Ankle Hand set:

Modification Technique Shell

Marking: The best way for marking is to use the lipstick on the foot, then install the footbed in the empty shell, have the customer enter, center the foot, and push against the shell, so the lipstick can be seen on the plastic.

- Marking: If the outside of the shell has to be marked, work with a wax pencil which does not mark the shell permanently.
- When stretching in forefoot areas, be careful because you can very easily loose height over the instep area.
- To avoid this use wedges to block and support the shell in this area.
- The most common areas into which the boot expanders are: Ankle, navicular, forefoot width, length forefoot (toe box), hallux, bunion inside and outside.

Cooling down phase:

- Once the tool has been positioned the last step is the cooling down phase.
- Air cooling is the simplest one , but also takes up the most time. To speed up the cooling process cold water, snow or cooling pads can help. If the Boot is thoroughly heated, the expansion when cooled properly will not go back.
- Should the expansion go back, either the boot shell was not heated enough, or it was not cooled sufficiently.
- By reheating or having the boot stored at too high temperature the elongation decreases.

Shell grinding:

In some cases, and especially when the plastic of the boot is rather thick , then milling is easier and more efficient than expanding.

This technique is very often used for modifications in Race Boots and also here the marking is done with lipstick.

Obviously, the milling is only recommended for high wall thickness of the shell.

The most common area to be milled:

Heel, ankle and forefoot inside-outside. The larger diameter of the milling heads (25-30mm) work well to remove material. The result is an even and smooth surface. When used with a smaller diameter, this tool also valuable for removing rivets for buckle changes.

Problem Areas / Causes / Solution

Problem	Causes	Solution
Ankle In - outside 	1.) shell	1a.) Customize foot shape
	2.) liner fit	2a.)Use BD Foam Liner
	3.) Pron. foot	3a.) BD footbed
	4.) Supi. foot	4a.) BD footbed
	5.) large ankle shape	5a.) Stretch ski boot shell in the ankle area and modify

Problem	Causes	Solution
Black Toes 	1.) boot too large	1a.) Volume reducer 1b.) Heel pad 1c.) Heel Wedge Install 1d.) consider a new ski boot
	2.) foot slipping in the shoe	2a.) Heel Wedge Install 2b.) BD footbed with grip material
	3.) toe / lack of space	3a.) Toe box expanding 3b.) Thinner Socks 3c.) Thinner insole
	5.) boot is too small	4a.) Toe box expanding 4b.) Thinner insole 4c.) Heel cup 4d.) consider new ski boots
	5.) not enough FW lean during skiing	5a.) Heel Wedge Install 5b.) Ski lesson 5c.) Ski boots with more standard Forward l.

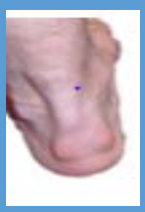
Problem	Causes	Solution
Numbness Forefoot 	1) Too large sized boots causes the skier to over buckle 2.) The overlap is too low, too high pressure in the forefoot 3.) bad heel fit causes the skier to over buckle 4.) unequal pressure points 5.) Too narrow boot	1a.) Use Volume reducer 1b.) Heel Wedge Install 1c.) use BD Footbed 2a) Grind from above. 2b.) reduce tongue volume or use BD Tongue 2c.) V-section in the overlap liner 3a.) use BD Footbed 3b.) use Heel pads 3c.) use Heel Wedge 3d.) BD Foam Liner 4a.) use BD Footbed, BD pad against pressure 5a.) Widening or Grinding

Problem	Causes	Solution
Sole Burning 	1.)Socks are too thick 2.) The inner boot is too tight 3.) The boot shell is too tight 4) Too much pressure and pressure on the forefoot	1.) BD compression socks - thin and wrinkle-free 2 a.) heat mold the Liner 3a.) Ski boot shell Expanding or Grinding 4a.) Customize BD footbed 4b) change ramp angle - lower in the heel area 4c.) Decrease / remove Tongue material 4d.) Skiing technique

Problem	Causes	Solution
Cramp / Archarea 	1.) Poor blood circulation -shell or inner boot is too tight 2.) Low arch - arch has fallen 3.) Hollow foot not supported 4.) insole too strong supported	1a.) Thinner Socks use Compression socks 1b.) Use BD Foam Liner 1c.) Cushioning material liner 1d) boot shell stretching or milling 1e.) Foot position , lower tongue , volume reduction 2a.) customize BD FB add. support with heel cups 3.) BD FB. and reduce to lower Footposition 4a.) Insole Correction

Problem	Causes	Solution
Pain in shinarea 	1.)Forward flex too stiff	1a.) add a V- cut to Lower shell
	2.)Forward Flex too soft	2a.) block Lower shell 2b.) attach Additional shell material on the cuff
	3.)Tongue too hard	3a.) BD Tongue Foam wedge / Gel Pad 3b.) BD Foam tongue 3c.) remove Material from Tongue
	4.)Tongue too soft	4a.) BD Tongue Foam Wedge / use stiffening material 4b.) BD Tongue foam
	5.) wrong shell cuff size	5.) exchange to the right size

Problem	Causes	Solution
Hallux 	More often with women	1a.) custom BD Footbed 1b.) expand ski boots in hallux area 1c.) use BD Foam liner
Tailors Bunion 	1.) tight boots cause friction	1a.) Expand or grind out ,also possibly medial side
	2.) The foot pronates too much	2a.) BD Footbed
	3.) too wide boots causes friction	3a.) BD Footbed 3b.) BD Foamliner

Problem	Causes	Solution
Hag Lund  	1.) Often Strong friction pain in the forward motion	1a.) Expand or grind this area
	2.) ski boots not modified	2a.) Boot Fitting already in Juniors age 2b.) Foamliner

Raceboot Fitting

By using technical boot tools and the necessary know-how a performance-oriented tuning of the Racing Boot is possible.

The following settings on ski boots are necessary:

- Ramp angle
- Canting of lower shell and cuff
- Flex tuning
- Lifter
- **Ramp angle**: 12mm and +/- 4 mm variable setting

More Ramp angle: (Heel higher – Toes lower) more pressure threw the heel!

for speed disciplines more suitable because at turn initiation there is a delayed reaction from the skis, increasing radius at the end of turn which results in an earlier gliding phase.

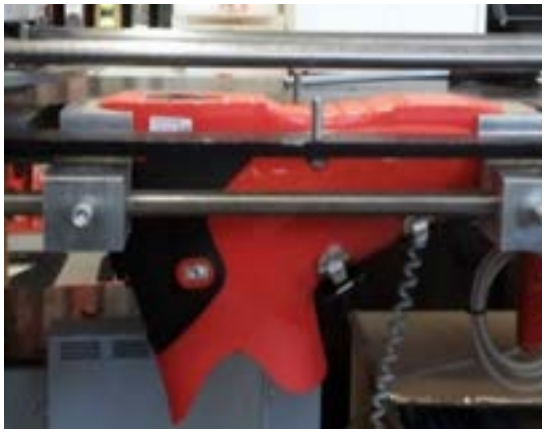
Less Ramp angle: (heel lower – toes higher) more pressure on the ball! Is a set for the technical disciplines because a faster turn initiation is generated and a tighter radius can be done. Maximum stand height: consider 43mm FIS standard.

Sole canting: is for the fine tuning of the edging angle and is made on the lower shell / sole and on cuff of the shell.

The Sole Canting:

Settings of the ski boot sole inward or outward can strongly influence the effectiveness of edging angle. These adjustments are calculated in degrees and are made on the bottom side of the Boot.

Lower shell Sole Canting: settings +/- 2 °further laterally (outward) = more aggressive, further medially (inward) = less aggressive. A thin layer is milled or planed from the lower shell sole with an adjusted angle.



Cuff: settings +/- 2 °
further lateral = more aggressive
further medial = less aggressive
Settings for speed disciplines: Example 0/0 ° 0 / 0.5 °, 0/1 °
Settings for techn. disciplines: Example 1/1 °

Lifter:

Adjustments with lifters the edging angle is increased or decreased. There are different levels of the lifter from 3-7mm depending on the discipline.
Before the lift is screwed on to the boot the lower shell has to be planed.

<u>Race - Flex:</u>

The Flex stiffness of different brands are not comparable. Flex stiffness for WC athletes are 150-180 flex depending on discipline and personal set up. The Cuff/ Flex hardness relative to Lower shell / Flex hardness can be chosen. Generally softer flex for speed and harder flex in tech. disciplines.

Junior Racing:

what should you take care within Junior Race fitting?

Shoe Size / mostly too big – well/known examples which have gone 1-2 smaller sizes MP in EC and WC after their teenage years.

Flex Boots usually too stiff

Buy the Racing Boots in the current foot size and forget the idea "should fit next year also".
Footbed fitting 3 mm lift as sole **protection** to shoe size 21.0 MP

Shell materials:

Shells are made in a thermal injection molding process and this takes about 1 minute and 30 seconds and this is injected at a temperature of 190-210 ° Celsius with TPE and TPU at 210-230 ° C into the mold. The presses have to keep a pressure of 500-650 tons to keep the molds closed.

The most commonly used materials of the ski boot industry: Polyurethane PU: consisting of 2 families PU ether and PU ester PU ether - the top material in the ski boot production.

Features: highly scratch resistant, the form keeps well and is used primarily for performance boots. It can be stretched and milled but is generally requires more heat for deformation. Good properties during milling. Is highly transparent - brilliant colors good stability Flex.

Processing temperature: 135-150 ° C.

PU ester: Top material also with properties similar to Pu ether –it is not transparent but milky. Processing temperature: 125-150 ° C.

Polyolefine/ Polyethylene PE: consisting of 2 families TPE / TPO & polyethylene / poly Seb

Features: very light, very good stability, Flex Temperature fluctuations, UV stable and cheaper to buy, less scratch resistance, difficult adjustment, rubber coated during milling and allowed no clean finish.

Processing temperature: 110-125 ° C.

Pebax: relatively light weight but still stable and firm in relation to its weight - is primarily used for ALL terrain or backcountry Boots. Difficult to deform, Abrasion resistance is good – grind poorly during milling.

Processing temperature: 95-110 ° C.

Pebax Rnew: organic-based version of Pebax, but softer and less abrasive. Better milling and shaping and potential to be used in future as a sustainable plastic.

Processing temperature: 95-110 ° C.

Grillamid:

100% polyamide nylon. Very temperature-resistant and also more rigid than Pebax. Is partially used in very high-quality ski boots due better rigidity relative to actual weight. More expensive to buy than Pebax, easier to deform and even easier to grind at lower speed by milling of shell.