Tech Manual Nordic 2012/2013

Racing-Service

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Introduction
Waxing at the World Cup level is a pretty specific science. National Teams have enjoyed enormous success with Toko, but naturally expect us to be close-lipped about it so as not to lose their advantage. This doesn't just mean regarding what brand is being used, but more importantly, what waxes they are using where and when. For this reason, we don't talk much about who is using what internationally. We can tell you though that virtually every national team uses Toko. Many national teams are involved in the development process of the waxes as they are first introduced on the World Cup level before they hit the retail shelves. If our waxes are popular among National teams and successful like they were during past seasons, we can be very confident in releasing them to the retail market.

This is Toko's last step in evaluating new products. If they are readily accepted by National team technicians and used in big events, then they get the final green light to become mass produced and be sold in the retail stores. **Toko does not have "race stock wax". The products used on the World Cup are identical to those sold in the shops, except for the occasional test product that, if really good, will hit the shops the following year. This has always been Toko's procedure.**

When Jakob Tobler founded Toko in 1916 (first as the Tobler Company which a bit later became Toko), he had no way of imagining what a rapid development lay ahead in ski sport. The tricks and secrets of waxing - together with expert knowledge - over a period of many years of research and development permitted the creation of a wide range of Toko products. For decades, the users of the Toko line could depend on the latest experiences from professional racing continuously being applied in the development of Toko products. What happens in the fringe between snow and ski today is a research subject for entire scientific institutions. The conversion of this knowledge to speed, gliding comfort, and care for ski bases is Toko's very special expertise.

Toko Innovation
Toko has quietly pioneered most of the recent wax technology breakthroughs and innovations that have occurred in recent history. Some examples of this include the following: Toko was the first to develop a hand structure tool that allows the waxer to apply an offset structure which makes skis glide faster in moist snow - **Toko Structurite**. Toko was the first company to develop and offer a fluorocarbon in block form (Streamline). This product line is carried on by the **JetStream Bloc** waxes. **Toko developed the first fluorinated glide waxes (Dibloc).** This tradition continues with **the Tribloc HF and LF** product lines. Toko is still the only company to offer a Copper Brush. The **Toko Copper Brush** is softer than any other metal brush on the market yielding fewer (or no) hairs raised as a result of brushing, but is still aggressive enough to get the job requiring a metal brush done properly. **Toko GelClean** was the first product of its kind. Other companies have since copied, but it still sets the standard. Toko was the first company to recognize that Fluorinated kick waxes were NOT the way to go in general. The **Nordic Grip** waxes have a revolutionary new canister which allows the wax to be twisted out resulting in always having the optimal amount of wax "showing" and eliminates litter from peeling back canister material. Toko was the first company to develop an iron specifically for the purpose of waxing skis. This concept has been greatly built on and the **Toko T14 Digital and T8 Wax Irons** are the newest Toko offering. The **Toko Scraper Sharpener** was the first hand tool developed to sharpen scrapers. It has since then been anatomically shaped and been made more affordable. **Toko Irox and Irox Fluoro** make skiing far more fun for the working (time challenged) skier who likes to ski on fast skis, but doesn't want to take the time to wax them before every ski. Irox Fluoro also is a great product for junior and youth program coaches who wax dozens of skis before a race. It is affordable, easy and quick to put on, and performs extremely well. This is a unique product to the industry that is bound to be copied soon as it is being very well received. **Red Creek Roto Brushes** (distributed under the Toko name) were THE Roto Brush Pioneers. Red Creek uses the best materials and tests many new possible products every season. Red Creek invented Roto Brushes and continues to set the standard. From our experience, **Toko Plexiscrapers** are made from a denser plexiglass than our competitors and hold a sharp edge for a relatively long time. The **Toko Thermo Bag** has been a widely used product on the World Cup. Toko was the first company to come out with a finished product of this kind (a portable digitally controlled hot box).

Outside of innovative products, new raw materials, and fast, durable, well performing waxes, Toko has also greatly influenced the industry with its idea of what a wax line should consist of. The Nordic Grip wax line consists of a base wax plus 3 temperature/snow specific hard waxes and a base klister and 3 temperature/snow specific klisters. **This simplicity requires not only less investment on the users end, but also allows the user to become extremely familiar with each wax and its attributes**. The glide wax line has similar strengths: the NF, LF, and HF lines consist of 3 temperature sensitive waxes and DLC Black which is an additive with many properties that will be explained later. To be a Toko waxer requires less investment and allows the waxer to be far more familiar with each product. Of course waxes can (and should) be mixed which is easily done. There are three Fluorocarbon products each available in block or powder form (JetStream Yellow, Red, and Blue). Toko HelX is available in Yellow, Red, and Blue formulations as well. Not only does a Toko waxer save money and understand the line better, but he will also be using a product that is certainly the wax of choice on the World Cup and elite North American racing scenes.

The concept of a fast ski
What makes for a fast ski? This is an age old question and there ARE answers to it. Start with the shape of the ski itself (height of the camber, stiffness of the camber in relation to the tips and tail). Ideally, a fast ski would properly share the load of the skier's weight over most of the surface area (especially not forcing the front third of the ski into the snow, but allowing it to run OVER the snow), at the same time, remaining stiff enough not to hyperextend when a skater pushes off (causing drag under foot) or retaining enough camber so when a classic skier glides, the wax pocket is not in contact with the snow. Additionally skis for wet conditions are generally stiffer and have a shorter area of contact with the snow to minimize suction. Secondly a fast ski will have a running surface that is hair free and that has a structure and base material appropriate for the snow conditions. Finally, the base has been prepared with the appropriate wax. So, outside of ski selection, the deciding factors are base material, base structure, and wax.

Base Material
This is a subject that is rarely talked about because generally people have very little choice as to what bases they have available to them. Most elite racers today use a graphite base in all conditions. The main advantage of graphite bases over transparent is that they are good electrical conductors which reduce electrostatic charging caused by friction between the running surface and the snow. This is especially advantageous in dirty snow where dirt absolutely clings to the ski base because of glide-reducing static. There are many types of graphite bases being used by ski manufacturers involving different densities and containing different ratios of materials, but the bottom line is that our options here are limited to what is being offered by the manufacturers.

Base Structure

This is a rapidly developing area of our knowledge of what makes skis fast. Stonegrinding allows us to make a precise finish that we can test, duplicate, and improve on leading to even better finishes. Generally speaking, the best course of action is to start with a fine stonegrind and then add hand structure as the conditions would dictate. This gives the skis a wider array of conditions that they would perform in. Skis that are suited for wet conditions could be stoneground with a grind that performs well in those conditions generally, but still adjustments will need to be made by hand to suit the day's conditions.

Obviously the less the moisture in the snow the shallower and finer the structure on the base needs to be and the more moisture in the snow the deeper and coarser the structure. Within this realm though, there are many options (linear, cross hatch, compound structures) that perform better or worse based on crystal size and type and whether the conditions are going to change during the event or not. When the snow is especially dirty, the structure should be kept finer, even if there is a lot of water in the snow because the structure pattern on the base will collect dirt slowing the skis down after a few kilometers.

Wax

Waxing isn't so difficult if the basic concepts are understood. When it comes to kick and glide waxing, there are two things that have to be considered: the snow characteristics (and forecast) as well as the characteristics of the waxes that are available. A person has to simply match them up.

Glide Waxes

The different racing glide wax categories include paraffins, synthetic waxes/hardeners, antistatic (black) waxes, fluorinated waxes, and fluorocarbons. Each has its special properties which offer advantages in certain conditions and disadvantages in other conditions.

Paraffins (NF) are the waxes of the good old days which resembled candle wax, except in the Blue range where they are hard and brittle. Paraffins generally are utility waxes by themselves and are good for base cleaning, saturating bases with wax, storage and travel waxing, and preserving the ski bases during training. Pure paraffins are generally slower than the other waxes in their respective category strengths.

X-Cold is a synthetic wax or hardener and is useful in two ways. X-Cold can harden the ski base making it fast in extreme cold snow and can be mixed with other waxes to make them faster in colder snow or more durable. Synthetic waxes are also useful in preventing the ski base from becoming abraded, which happens especially fast when conditions are cold and abrasive. **X-Cold is also very effective when mixed with the Tribloc waxes as it makes them more durable and makes the skis "break away" easier in dry powder snow (Rockies)** - this is a very common combination.

Tribloc LF Blue is a very hard wax. It is an **excellent base wax for X-Cold as well as an excellent final layer in very cold dry snow.**

Toko's antistatic additives have progressed from graphite to molybdenum to DLC (Diamond Like Carbon) which has similar properties to the other antistatics on the market, but seems to work better in general for ski sport. DLC is an amorphous form of Carbon. The name is not some kind of gimmick, the material is called Diamond Like Carbon. This is not a name that Toko made up, it is the name of the material that other industries use extensively. DLC has properties similar to graphite, molybdenum, or wolfram in that it is an antistatic, a shear lubricant (prevents dry friction and dirt build up), and increases durability. The biggest difference probably is the durability factor as DLC is molecularly very hard which makes it especially durable and dirt resistant. So, the idea of using DLC is nothing new, but the element DLC has proven itself to be better than the other materials currently used on the market for this purpose. **Tribloc LF Black (DLC) should be used as a base layer wax in all conditions below freezing**. Above freezing, Tribloc HF Black (DLC) is an excellent base wax (as is LF Black).

Tribloc is a natural progression from Dibloc. Dibloc came about because it was the world's first fluorinated hydrocarbon (aka LF or HF wax). This means 1/2 of the molecule was a fluorinated hydrocarbon and the other half was simply a hydrocarbon (paraffin). Hence the name Dibloc ("Di" meaning two). Tribloc molecules consist of three parts. A hydrocarbon part is sandwiched between two fluorinated hydrocarbon parts. It is still LF and HF, but it means that there is simply more part that is fluorinated. Also, getting more technical, when a LF or HF wax is ironed on the ski, the molecule orients itself. The old Dibloc molecules would stand on the ski such that the hydrocarbon end was on the ski and the fluorinated part was facing the snow. This makes it a perfect base for a pure fluorocarbon top coat (as fluorocarbons do not like hydrocarbon - like oil and water). The new Tribloc molecules do the same - they go on the ski in kind of a U shape such that the bottom of the U is the hydrocarbon part and the parts of the U that are sticking up are the fluorinated hydrocarbon parts that reach out toward the snow. Again, this makes it a perfect base for a pure fluorocarbon topcoat such as HelX or JetStream. Theoretically this yields a more potent fluorinated hydrocarbon. Practically speaking, the new waxes have tested very well and are an improvement.

The Tribloc HF waxes are optimally fluorinated for each temperature range. These are also your most commonly used racing waxes. These are paraffin based waxes with fluorine added to them (and some syntheric as well) which makes them both water and dirt repellent and an excellent base for JetStream. **It is important to note that the fluorinated wax with the most fluorine in it is NOT necessarily the fastest. The optimal amount of fluorine needed varies according to snow crystal shape and the water content of the snow**. Generally, as it gets warmer, more fluorine is needed, which is why Tribloc HF Yellow has more fluorine in it than Tribloc HF Red and HF Blue.

JetStream and HelX

JetStream and HelX both come in blue, red, and yellow formulations. A good general rule with these waxes is to use the blue JetStream or HelX when waxing with a blue glide wax. Use red with red and yellow with yellow. The waxes can also be mixed very effectively for in between conditions.

In past years, JetStream and HelX were completely different waxes using unique technologies. Now HelX is basically JetStream in liquid form. The waxes test very similarly in any condition. The basic difference is ease and speed of application and durability (see two paragraphs below).

JetStream comes in Block or Powder form. HelX is a liquid. The application method generally reflects which form of the wax that will be used. If rubbing and corking or rubbing and rotocorking, the best form to use is JetStream bloc. If ironing, it is easiest to use JetStream Powder. The quickest and easiest is to use the HelX and spray the wax on, let it dry completely (ideally in a warm room), and polish.

In terms of durability, ironing is the most durable, rotocorking the second most, spraying and polishing the third most, and rubbing and polishing/corking the least. Durability depends greatly on the conditions – how abrasive and dirty the snow is.

First the basics on Fluorocarbons: they are very hydrophobic and dirt resistant. Basically the more water and/or dirt in the snow, the better they will perform in general. Many people think that all Fluorocarbons are the same as they are pure 100% Fluorocarbon. This is not at all true. There are different size molecules which alter the waxes properties as well as different raw materials manufacturers which has an effect on the end product. They can be tailored to perform better in different conditions as well (more moisture, cold, dirt, etc). In short, Fluorocarbons are much like regular wax in that some perform better than others and in different conditions. The blue, red, and yellow JetStream products use different raw materials. They actually have different molecular weights. The containers that the three JetStreams come in (the powders only) are the same size, but there are different amounts of wax in them. JetStream comes by weight, not volume as the molecular weights are different (think a box of Grapenuts versus a box of Raisin Bran).

There are different recommended **methods for applying** JetStream: ironing and "cold" application. For ironing, apply the JetStream to the ski. Iron once very slowly (about 20 seconds tip to tail) without going back at all with the iron on at around 300F or 150C (depends on the wax). Put enough JetStream on the ski to protect the base from the bare iron. Wait for the wax to completely cool and brush out with a nylon or nylon polishing brush (fluorocarbon brush only). Then polish. Then **lightly** rub on some more JetStream and polish. This makes for a faster finish especially in new snow. If the snow is dirty, don't add that last lightly rubbed on layer.

Cold application is as follows: rub the JetStream on and cork it aggressively into the base with a Plasto Kork (synthetic). Take a dedicated horsehair or nylon polishing fluorocarbon brush and work the JetStream into the base (don't brush it OFF the ski, but into the ski base). After this is completed, polish the base. Then **lightly** rub on more JetStream and just polish it well. **One very important point about applying JetStream is that before JetStream is applied, the wax that is under it needs to be brushed out very well.** This is even more important when rubbing it on, brushing it in, and polishing it because the Horsehair or Polishing brush that is used to brush the JetStream into the base will bring up paraffin and mix it with the JetStream if the ski is not completely brushed out. This will make the JetStream less effective and will also gum up the Thermo Pad when polishing. This works very well for short races such as sprints.

The best overall application method for applying JetStream is to rotocork it. Rub a thick layer of JetStream on the ski. Orient the rotocork such that it wants to run backwards (towards you) or another way to look at it is so that it pushes the wax down the ski towards the tail. Then give it some gas, push down pretty hard, and move the rotocork such that takes about 12 seconds to travel from tip to tail. The amount of "gas" to give depends on the drill. Less powerful drills (less torque) seem to do a great job as the friction can be easily controlled by manipulating the pressure and speed at which the rotocork is moved. **The combination of the speed and the pressure (both down and forward) should have an effect of leaving an iridescent or oily-looking film on the base**. This is a sign that the job was done properly. Then brush the wax out with a polishing brush and polish with a pad.

Some people use a lot of speed and very little pressure with success. I have had success with very low speed and higher pressure. I find that I have better control and the end result is clean, fast, and durable.

Another very good method for applying JetStream is to do a "quick iron" – 300F and taking about 6 seconds tip to tail – followed by rotocorking.

Mixing the JetStreams is very effective when conditions are changing or in between.

HelX is not as durable as JetStream and thus is generally used for short races (and Alpine). There are two main methods of **applying HelX**. The first is to prepare the base by cleaning it with the yellow side of the Dual Pad, and then to spray HelX on so the **entire base is wet**. Then let dry for around 30 minutes (or overnight). This works best inside in a warm place. Then polish the base well with the white side of the Dual Pad. If dried properly, this application is as fast and as durable as any other.

The second method is quicker and **can also be done last-minute outside**. Spray the HelX so the entire base is wet. Rotocork the base until the base is shiny and polished looking (don't worry about the groove). Then brush out with a Nylon Polishing Brush, and then polish with Thermo Pad or Dual Pad. This method tests identically to the above method in speed and durability, but takes less time. Rotocorking in this method should be done with <u>very</u> little pressure.

Before applying HelX, make sure that the underlying layers of wax (HF, Black, etc) have been scraped and brushed out properly.

After waxing with HelX, the ski should be treated just like after waxing with JetStream (brush out well with Copper Brush, then wax with NF, scrape and brush out well with Copper Brush, then LF Black, then HF of the day, then HelX again.). We have done a tremendous amount of testing here and this is adequate post-HelX treatment.

Snow conditions

Extreme cold new snow (snow temp at less than 7 F) is usually very dry and abrasive. The crystals are extremely sharp. To skis, these are the most "extreme" conditions. Skiing on cold new snow could be likened to skiing on broken glass. **The only real factor slowing the skis down is the dragging of the sharp pointy crystals on the ski base. The solution is to make the base as hard as possible**. (About the only thing that slides on broken glass is glass as it is so hard the broken glass doesn't stick into it). This is where X-Cold is so valuable. Another thing to consider when waxing for a race in extreme cold new snow is what the skis were waxed with the last few times. If a warmer wax was used, then this needs to be taken into consideration as the base will be softer than if a colder wax was used. The longer the race is, the more layers of cold wax need to be applied as each layer makes the base harder and more durable. If the base didn't get enough layers then it will become abraded and break down during the race and become slow. Tribloc LF Blue followed by Tribloc LF Black (DLC) followed by Tribloc LF Blue, followed by X-Cold is an optimal combination. After waxing, the skis should be scraped well with a sharp scraper and brushed out well first with a copper brush and then with a horsehair brush to get every bit of wax off of the surface of the base as it would only drag on the sharp snow and slow the skis down. Another very good combination is the same first two layers followed by a mixture of Tribloc LF and HF Blue or Tribloc HF Blue mixed with XCold Powder 1:1. If conditions are fast, JetStream Blue will be very good even in the extreme cold.

Applying JetStream Blue with a rotocork only consistently yields a faster ski than ironing the JetStream in nontransformed cold snow. This is a key point.

When examining cold new snow conditions, an important element to consider is at what temperature the snow fell and what the moisture content of the new falling snow was. The warmer and wetter the snow fell, the more aggressive, sharper, and abrasive the snow will be. If the snow fell in below 0 F temperatures, it will be extremely dry and not sharp. **XCold Powder is really good as a final layer in this type of snow which is traditionally very slow.**

Cold old snow is different to cold new snow conditions. The crystals aren't as sharp and the moisture content is higher. A racer could probably use **Tribloc HF Blue** depending on humidity and snow temperature. The warmer and more moist it is, the more fluorine can be used. As a final layer**, JetStream Blue** is generally **faster than straight HF Blue** in these conditions.

The most common conditions seem to be either new or old untransformed snow with snow temperatures between 20 and 30 degrees F. The main consideration in these conditions as to what wax to use is how slippery the wax is on the snow. This is a strange concept, but is the main factor in these types of conditions. JetStream is excellent in this situation as are the HF Tribloc waxes which makes selection simple. The **Tribloc HF wax should be selected according to snow temperature and JetStream should be applied afterwards. Tribloc LF Black (DLC)** is an excellent underlying base wax for the Tribloc HF waxes and is generally what we use under the Tribloc wax of the day.

When the snow is somewhat cold to very cold and fast, waxing is pretty straight forward. You'll want to use **JetStream** over **the Tribloc HF** wax of the day. If the snow is slow and somewhat cold to very cold, you will need to add in **XCold** Powder. This is a special wax that does not just harden the base. It is most useful in increasing breakaway speed. The skis slide better at slower speeds with **XCold**. It can be used by itself as a top layer when it is very cold and slow, but normally it is mixed with the wax of the day- usually **HF Blue**. Drip the HF wax on the skis and then sprinkle the **XCold** on top of it. Then heat them in **together**, let cool, scrape, and brush. If the HF wax is heated in before dripping the XCold on top, the XCold doesn't seem to go into the base as well.

In new fallen wet snow to new saturated snow the big challenge is repelling water so suction doesn't slow the skis down. **Tribloc HF Yellow is the optimal wax followed by JetStream.**

In dirty snow, the primary concern is keeping the skis clean. Once skis become dirty, they will be slow in any condition, especially wet snow. In these conditions, the recommendation is to wax with LF Black (DLC) (wet dirty snow) or LF Blue (cold dirty snow) followed by HF Black (DLC) (wet dirty snow) or HF Blue (cold dirty snow) followed by the appropriate JetStream ironed in, brushed out, and polished. If a structure change is necessary (rilling or Structurite), it should be applied directly before the JetStream is put on so it stays sharp and clean.

Kick Waxes

The Nordic Grip wax line and Nordic klisters are simple yet effective. When you look at most grip wax lines, there are a few outstanding waxes that seem to dominate whereas others hardly ever get used. In short, some waxes have far broader ranges of use than others and are generally far more effective. When creating the Nordic Grip Waxes and Klisters, we tried to create the products that get used a lot and leave out the products that don't.

The concept of waxing for classic skiing is such that ideally when the skier is in the glide phase, the kick wax is barely off the snow. During the kick phase, the wax pocket should be fully depressed so snow crystals embed themselves in the kick wax allowing for kick. Accomplishing this scenario is dependent on the skis having the proper relationship in camber to the skier's weight and fitness. The skier also needs to have the necessary fitness and technique to work the camber properly.

The hard waxes and klisters can be applied according to the temperature/condition recommendations. This is straightforward business. A base wax should be corked or ironed in before applying the wax of the day. The kick wax of the day should be applied in layers. This makes the wax more durable as well as allowing the waxer to keep the finish smooth. Generally the first layers should cover the entire kick zone. The last few layers should be concentrated more in the middle (shorter).

Some techniques specific to kick waxing include layering, ironing, covering klister with hard wax, and mixing waxes. Layering a colder wax over softer wax is effective in loose snow to allow for better kick because it allows the snow crystals to penetrate the kick wax easier (for better grip) at the same time the softer kick wax isn't going to drag as the conditions are not abrasive and the softer wax is covered with a colder wax.

Sometimes the snow shears underfoot. This is when the snow breaks. The kick wax sticks to the snow, but the snow that the kick wax is sticking to breaks from the snow underneath it creating a slip. In this case, it is good to extend the length of the kick zone to minimize the chance of the snow shearing. Outside of this scenario, it is best not to lengthen the kick zone as it causes drag.

In long classic races where the temperatures are going to warm up in later parts of the race, a warmer softer wax (that ought to work late in the race) ought to be covered by a harder wax (that ought to work in the beginning of the race). During the race, the softer wax will become exposed. In such scenarios, it is important to ski carefully on the downhills so the soft wax isn't exposed to early or rubbed off completely as it will not be as durable as the hard waxes in the early colder conditions.

Generally speaking, when a skier wants good kick and fast skis throughout a whole ski session, the wax pocket should be sanded (150 grit in klister conditions and 180 grit in hard wax conditions). Then either Nordic Basewax Green or Green Klister should be ironed in and corked such that a thin smooth layer remains. After this layer cools, the appropriate wax can be added. If the waxes are added outside on-site, and it is cold out, it is important to warm the green (especially in klister conditions) enough to make it slightly tacky. This will enable the new wax to adhere to the green. Otherwise the final layer will wear off quickly and the Base Green Klister will be left by itself.

In cold conditions when using klister (Green Klister covered by Blue Klister for example), sometimes it is cold enough that the klister freezes. At this point, the wax is there, but it loses its properties – frozen klister is not at all sticky – and does not kick at all. Warm the klister up and cover it with a layer of kick wax such as Nordic GripWax Blue. This will help prevent the klister from freezing.

Klister can also be covered by hard wax effectively in conditions where there is ice covered by a little powder. Before applying the hard wax, the klister must be allowed to cool. When corking the hard wax, the cork should be kept moving in a light fashion and the klister should not be "corked". The

corking should be superficial. The most common scenario in covering klister is Blue or Red klister covered by blue or red grip wax. The klister has to completely cool first before applying the hard wax. Mixing waxes is generally a technique used with klisters. When mixing klisters, the easiest way is to make stripes of klister covering the distance from the groove in the middle of the ski to the edges on each side. Mixing can be accomplished by alternating the klisters used in the stripes. The wax should then be heated by a torch and smoothened out.

We have also found Basewax Green to be very versatile and interesting. Here are two ways to use it other than as a traditional binder (base) wax.

Nordic Basewax Green, when applied EXTREMELY thick, is incredibly versatile. (Rub on very thick, iron in, smooth and let cool, then rub on thick and cork, then rub on thick and cork. Use Klister zone for hard track skis and go short with powder skis.) This is especially effective in abrasive man-made snow or semi-transformed snow where one isn't sure whether to use kick wax or klister. We have found that in order for the Basewax Green to work very well (kick) it needs to be applied very thick. This will compromise glide, especially if not kept off the snow. **For this reason, this special wax and application is recommended for difficult waxing conditions with multiple conditions around the course. It is highly resistant to icing and kicks on almost all types of snow. Since 2002, we have used this solution to win many elite races. It can be superb in difficult conditions, especially those between klister and hard wax.**

If conditions are powder snow with transformed snow mixed in, the straight Basewax Green will probably be too draggy for racing. The solution is to sandwich layers of the Basewax Green (after putting down a base layer) with the wax of the day (probably Nordic GripWax Blue or Red). Cork between each layer and build toward the middle. The result is a fast gliding, super kicking, and extremely durable wax job. This is really effective in marathons as well. This is a very common thing to do and is highly recommended.

When selecting kick waxes, the two big determining factors are how much "kick" the wax gives as well as how "fast" the wax is. Most people forget about the glide part and focus on the kick part. This is a bad practice especially as sometimes a softer wax will be just as fast but offer better kick. On the other hand, sometimes a harder wax will be far faster and kick just as well. Of course the conditions need to be considered, especially in classic skiing as the tracks can change so fast and generally do during an event. Events with multiple loops change especially fast (usually glazing as the course gets more and more skied in which requires a softer wax than otherwise) where it usually will become more difficult to get "kick" on the later laps.

A very common mistake when kick waxing is to be "too conservative" and wax way too warm. This is not conservative really as a wax that is softer than necessary for the conditions will be scraped off the skis very quickly resulting in no "kick" at all. If <u>really</u> worried about kick, go with a **thick** layer of Base Green (as suggested above) and go for it. It will be slow, but provide superb kick.

On the elite level, just as important as which wax to use, is ski selection. An elite skier ought to have klister flex skis, hard track skis, and soft track skis. The more concerned the skier is about losing wax and the better the classic skier is, the higher the probability that the skier ought to use stiffer skis. When a skier's skis drag on the kick wax or klister, this not only slows the skis down, but is also a sign that kick wax is being lost.

When kick waxing skis for another, it is important to keep in mind first and foremost, that the skis need to work for the other person. To test the skis and to find that the skis are good, shows only that the skis are good for you. The final tester ultimately needs to be the owner of the skis. They need to be waxed according to his abilities. Needless to say, the better the classic skier is, the easier the task becomes.

Tools and Brushes

Tools, brushes, and Thermo Pads are a vital part of ski waxing. Tools such as plastic scrapers, groove scrapers, metal scrapers, and structurites must be kept clean and sharp. Scraping with a dull scraper is not only less effective but leads to a poor base finish. A sharp scraper doesn't need as much pressure put on it and will also continue to remove unwanted base hairs. Brushes remove wax from the base structure. If they are dirty the skis can pick up this dirt. Brushes also need to be designated for specific wax groups as the wax is retained by the bristles and then returned to the ski in later uses. **A serious racer should have a horsehair brush for extreme cold, two Nylon Polishing brushes (one for finishing the Red and Yellow hot waxes and another dedicated to finishing JetStream), and a copper brush (the most commonly used brush).** Brushes should be marked clearly for their purpose so no compromise is made. **Thermo Pads are used to polish JetStream (or HelX).** It is important to point out that a Horsehair brush is especially good for cold temperatures not because of the issue of static build up, but because the bristles are so fine. The Horsehair bristles are something like 1/4 as wide as a regular Nylon brush bristle, such that they go deeper into the ski. The Nylon Polishing brush also has bristles that are very fine, but are not as stiff as the horsehair brush. This makes it perfect for finishing all waxes especially JetStream. In cold temperatures, it is especially important to remove all of the wax from the surface of the ski. Because of this, it is recommended to do most of the brushing with a Copper brush followed by Horsehair. It is a good tactic to bring the Horsehair to the start and brush the skis out again as the bases will be cold and more wax will be pushed out onto the surface of the skis. You want that wax removed so it does not drag on the cold sharp snow. In wet dirty snow, it is very important that the Tribloc wax be removed completely from the surface of the ski before the JetStream is applied. This will make the JetStream more effective and keep the skis more hydrophobic and dirt resistant. The copper brush should also be used after skiing and before waxing to remove dirt and to "open" the ski base. It is true that in past years, we have done just fine without a polishing brush. However, the polishing brush is outstanding when finishing fluorinated waxes (HF/LF) and is highly recommended for finishing fluorocarbons such as JetStream.

A review of brushes:

Copper – use always before waxing to clean base and prepare it for wax. Also use Copper as the first brush used after scraping. Brush just in tip-to-tail direction. Basically, the copper brush can be used all the time after skiing and before waxing as well as the first brush that you use after scraping (obviously except for with JetStream). Follow this with a more appropriate brush depending on the wax that is being brushed out.

Nylon – an "all purpose" Nylon brush is OK but doesn't do anything really well. If a person had just one brush, it would be OK. If a person were to have three brushes though, Copper, Horsehair, and Nylon Polishing would be the three recommended brushes. The Nylon brush can be used in both directions and also "scrubbed" with.

Combi – for people who don't want to buy a Nylon <u>and</u> a Copper. This brush is purely a question of economics.

Horsehair – recommended for finishing blue waxes in cold conditions. Bristles are very fine and pretty stiff.

Nylon Polishing – can be combined as a daily training brush with the Copper (start with Copper and finish with Nylon Polishing). It is also an excellent finishing or polishing brush for all waxes. Lastly**, it is an excellent brush to finish Fluorocarbons (JetStream and HelX) with as it removes the wax, but doesn't completely take it off the surface of the base as Horsehair can do.**

The Structurite is wide enough to accommodate any racing ski on the market. It comes with a Red bit which is good for most conditions around freezing. The Yellow and Blue bits are available separately. The Blue bit is surprisingly good in colder conditions. Structure can be applied before the HF layer, before the JetStream layer or on top of everything. The earlier that it is applied the less aggressive it will be (and the less that will be left). The later it is applied in the ski preparation process, the more aggressive and stronger it will be. Generally, but not always, structure is applied after scraping the last layer of hot wax but before applying the fluorocarbon topcoat (such as JetStream). It works out great than generally speaking, when waxing with Blue, the best bit to use is the blue one. When waxing with red, then the red one and with yellow, the yellow one. This is an easy way to get fast skis.

Roto Brushes are especially advantageous when preparing many pair of skis. There are 4 different brushes to the Red Creek Nordic brush line. They are Grey Nylon 4 mm (universal brush for paraffins or fluorinated waxes), Black Nylon 10 mm (softer brush for polishing and fluorocarbons), Horsehair 6 mm (harder brush for colder waxes), and Copper 11 mm (an ideal brush for cleaning the base and opening pores before waxing). With the first three brushes rotation speed should be about 3000 rpms (high), but with the Copper, rotation speed should be kept below 800 rpms. **When brushing, weight should be kept completely off the brush (don't push down).** The shafts are hexagonal, which ensures that the brushes will never slip.

Rotocorking is a super effective way of applying JetStream. Any serious waxer who uses fluorocarbons should have a rotocork.

General

Now and then ski bases get a little slow from improper usage of fluorocarbons (without using paraffins in between) or because they haven't been waxed consistently and have become abraded or dried out. **A good way of reconditioning them is to hot wax, scrape, and copper brush them multiple times. The hot wax should alternate between a hardened wax (such as LF Blue or NF Blue) and a softer wax such as NF Yellow or LF Yellow (or best yet, Hot Box and Cleaning Wax).** This alternating between soft and hard restores the ski base. The application of the softer wax (which goes deeper and easier into the base), allows the harder wax to go deeper and easier into the base than otherwise making for a truly fast and durable wax job. This method is also recommended for new skis after 5 initial coats of soft wax. NF Red and LF Red are excellent waxes to cover the bases with if storage is necessary (over the summer for example). LF Black (DLC) can be mixed in as well. Base Prep wax is also a good storage wax.

The recommended snow temperature ranges listed on the waxes and on the waxing charts are only guidelines. Experienced waxers will also be able to read between the lines and make adjustments. For example, a common condition in the Rockies is 18% humidity with snow temperatures that are fairly warm (28 to 31 degrees F). A waxer would be tempted to go straight off the snow temperature, but since the humidity is so low, there is surely less moisture in the snow than would be normally found at those snow temperatures. A recommended adjustment would be use a wax colder than what would normally be recommended (Go with HF Blue instead of HF Red in this case). A similar adjustment would be made for windblown snow, which generally has very little moisture content. Of course a major issue often times overlooked is also how cold the snow became the night before. When it gets very cold the night and morning before an event, the snow will be especially dry until it really warms up and the wax selection should be adjusted accordingly (go with a "colder"/harder wax) unless very warm snow temperatures are anticipated.

Another mistake that is commonly made is that people scrape their skis without letting the wax cool long enough. The wax must be allowed to cool for at least 20 minutes (at room temperature) and preferably an hour. The reason for this is that it takes time for the wax to slowly cool and stay "in" the base. The most delicate part of this is the absolute surface area of the base. If this wax is still the least bit soft then the wax will not adhere (in reality it will not remain IN the absolute top layer of base) and the base will have a matte finish like it was over scraped (same effect actually). This is especially important in powder snow conditions where all mistakes or inadequacies make a bigger difference.

When waxing with extremely hard waxes (LF Blue, HF Blue, or XCold), the wax needs to be ironed evenly on the base in a consistent tip to tail motion (this is the same with all waxes). The iron also needs to be hot enough to really melt the wax. This way there will be no air between the wax and the ski after the wax cools. Then the scraper should be very sharp. When scraping, little pressure should be applied downwards (as always). The wax should NOT chip, but rather resemble fine sawdust when scraped properly. If the wax is chipping off, most likely there was air between the wax and the base because the wax wasn't heated enough.

Many people hot scrape to clean their skis. When hot scraping, most times the scraper picks up a mass of "black stuff". Most of this is actually base material. When a base is hot, it is also soft. A plexiglass scraper is much harder than this soft warm plastic base. The results ("black stuff") are predictable. Be careful when hot scraping not to put much pressure on the scraper. This is the same when scraping in general. Most times people scrape until they have scraped into the base (lines of dry Ptex can be seen behind the scraper). Keep in mind that hot scraping removes structure. Stonegrinds are expensive.

Great attention needs to be paid to forecasts and incoming weather as the real issue is picking the correct wax for the conditions during the event, not before it. **Weather prediction is often the greatest challenge as identifying an appropriate wax in any given condition is usually straight forward.** At elite competitions, wax is tested the morning of the race (at least top finish) and then all of the skis are waxed quickly at the last moment, but this is not realistic for 99% of the racing that takes place. Even then though, if the conditions are changing (getting skied in, warming, or starting to precipitate), a wax might be used that isn't testing the fastest at the moment. This is pretty common of course as conditions generally change significantly from early morning to the afternoon.

Ski maintenance is a simple concept that if not practiced can make a profound difference. **Ski ties (sleeve style are most effective) should always be used**. They don't just help keep skis together, but also protect the bases from rubbing together and scratching. Skis should be waxed before travel to protect the bases from drying out. Skis also should be storage waxed for the summer. A medium type wax such as NF or LF Red is effective as it is hard enough to last the summer, but soft enough to really go into the base. When removing dirt or old kick wax from bases, Toko Gel Clean or Toko Wax Remover should be used as these products don't dry the ski base and are easy to work with. The Copper brush is also excellent in cleaning and getting a base ready for waxing after skiing.

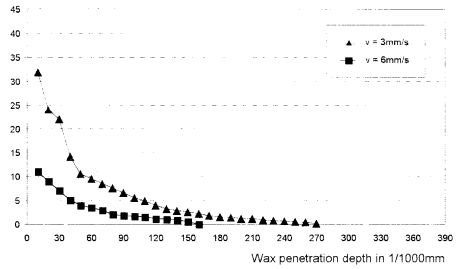
Optimally a **form bench should always be used when working the ski base** (scraping, corking, or brushing). A form bench supports the ski along the whole length such that when the base is worked, the ski is supported, and pressure can be applied evenly and confidently. Without a form bench supporting the ski, the base will have uneven pressure applied to it, mistakes will be made, and the ski base will lose its good characteristics.

Ironing

Ironing is very important as heat is dangerous to ski bases, but it is also how we apply wax. A quality iron is the first step to proper ironing. A quality iron has a thick base which allows the heat to disperse to the whole base before contacting the ski base, accurate temperature settings which allow the operator to see what temperature the iron is set at, and a good thermostat. Irons can be compared to cooking with a frying pan on a stove. If the frying pan is very thin, then the food over the heating element becomes burned while the food on the edges hardly even gets cooked. This is why a thick base is needed. If the iron has a poor thermostat, when it gets too cool, the heat gets turned up until the base gets too hot until the heat gets turned down etc. A quality thermostat is sensitive to small temperature changes and makes the proper adjustments so temperature is kept within an optimal window. A digital thermostat as found on digital irons keeps the temperature very constant. This is especially important when you consider that the iron wants to heat up between waxings when sitting on the table and cool off when it comes in contact with the ski. "Travel irons" and clothes irons are exactly what should not be used as they have all of the properties of a poor iron. Furthermore, the iron should always be kept moving in a deliberate tip to tail motion. Ideally the motion should be fluid with no stops. **A useful test to see how hot the ski base is becoming is to touch the ski base immediately after the iron has passed over it with a clean finger. If the base is too hot to keep the finger on it, then the iron is heating up the base too much.** (Either turn the temperature down or move the iron a little faster).

Diagram 1 shows two bases waxed in different ways. In the case of base 1, the hot wax device was drawn over the base at a speed of 3 mm/s, twice this speed being used for base 2 (6 mm/s). The temperature was 130 °C.

Diagram 1 wax temperature T = 130 °C



This shows clearly that the amount of wax penetrating the base is proportional to the heat treatment time. It also shows that the wax penetrates to a far deeper level.

The temperature that a ski feels is a result of the combination of the temperature that the iron is set at and the amount of time the ski is exposed to the heat. Although heat can lead to base damage, it also leads to the best wax penetration. (See diagram 1). We need to use as much heat as possible, especially when dealing with hard glide waxes on a cold race day. The more heat used (combination of iron temperature and time) the better the wax penetration. Heat is our friend so long as it doesn't damage our base.

It is also important to note that some skis seem more prone to bubbling from heat than others. This is due to a difference in base materials as well as a difference in ski construction. (Ex. a foam core and a honeycomb core will insulate the base differently). Keep this in mind when ironing and get to know your equipment.

Toko R & D – Testing

Many years, the Toko team tests hundreds of new Toko formulations of glide waxes, grip waxes, and klisters. These formulations get narrowed down to just one which gets introduced to the market when the Toko Race Service and chemists are confident that it is the optimal formulation based on the latest technology and scientific know-how.

Glide Testing Skis

Glide testing is more complicated than people think. Some would have you think that all you need to do is get a speed trap, pick a gradual hill, slide down the hill a few times, and pick the pair of skis with the fastest times. If this is what you do, there is a good chance that you will have blown it.

The slightest amount of wind, even a very light breeze makes such a test worthless. Bad (incorrect) information is worse than nothing. When there is even a slight wind, the results should be thrown out as the difference in the wind between runs makes for a bigger difference than the difference in speed between the skis.

Furthermore, speed trap testing is done in a track. The conditions in the track change rapidly as they get skied in. After a short while, the conditions in the track are different than the conditions out of the track (generally the track is glazed while outside of the track it is not). Such a test will give "results" and "information", but the information is not pertinent to what will run best out of the track. This is a big problem. People want "results" though and look past this obvious problem.

Also, it is rare that the snow conditions are consistent throughout an entire race course. Often times there are sections that have been shoveled or have had snow making. There are sections that are generally shaded and are thus colder with finer snow and other sections that receive more sun and either contain more moisture or are corned up and faster. To test in one section of a course (in the tracks and with a breeze) and to then focus on these results like they are FACT somehow is simply weak-minded and improper. The wax used will consistently be the wrong one, regardless of what the "results" say.

The ski that glides the farthest or the fastest in a test is not necessarily the fastest ski for the race. The important thing to note here is that the test has to fit what we are trying to measure. The two basic components of ski speed measurement (as relates to cross country skiers) are breakaway speed and terminal velocity. Breakaway speed is the speed at which the ski suddenly begins to feel free and accelerates. Most conditions offer a distinctive breakaway speed which is usually somewhere around the pace skiers race at. This makes the breakaway speed especially important as a small discrepancy will make a big difference over a race. **Breakaway speed can be noticed subjectively and will also show up in tests that involve speeds resembling that in a race (from as slow as climbing to as fast as on a flat).** Terminal velocity is the high end speed that the ski can reach. In courses with long fast downhills with runouts this is also worth noting, although most of the time breakaway speed should be the most important consideration. Testing on a steep downhill will give an indication of the skis highest end speed (or terminal velocity). The breakaway speed test should be done on more gradual terrain. The skiers should start from standing and after a few seconds of acceleration time should go through the timing system with the window about 4 to 5 seconds. **Average speed through the timing system should be similar to that in racing.** During speed tests, the body should always be in the same position (tuck is most consistent because of wind) and the skier should concentrate on starting the same way every time.

The best method of testing remains skiing and "going by feel" as well as timing long (20-30 seconds) sections on gradual rolling downhills out of the tracks. These long sections should include slower speeds that would reflect the speed skiing on a gradual uphill or flat. Most times such downhill sections are not available near a start, so "going by feel" should be the primary testing tool. Despite this, most companies and big teams use speed traps in tracks to test which is simply misleading.

Racers spend hundreds of hours training and thousands of dollars on equipment each year. Making skis perform better is an essential component to winning races and enjoying ski sports. Toko is the world leader in this specialty.

For demonstrations of ski preparation, go to www.TokoVideos.com

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