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# Competition-Coaching Introduction Advanced (T2T)

# Step 2:

# Technique Development Theory

**Reference Material**
**for On Snow Workshop**

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## 2.1 Review of Key Biomechanical Principles

Analyzing and correcting technique requires a solid foundation in biomechanical principles. The following is a review of information covered in the L2T reference material on biomechanical principles. The topics are expanded on further in the L2C reference material.

**Skill Phases:** All skills can be broken into four main skill phases. When observing a skill in it important to understand which phase of the skill is not being preformed correctly in order to intervene with the appropriate feedback. In general, skiing skills can be broken into four phases:

- **Preliminary Movements:** These are the movements that an athlete undertakes when getting ready to perform a skill. For example raising the hands and torso up at the start of a double pole motion.

- **Force Producing Movements:** These are movements that an athlete executes to produce force for the purpose of propulsion. This is the most significant phase in the execution of a skill. E.g. The entire contact of the poles with the snow during a double pole.

- **Critical Instant**: This is the point that determines the effectiveness of a skill. Ideally, the athlete has applied the right amount of force, in the right direction and at the right time – at the critical instant! At this point an athlete cannot do anything to alter the skill's effectiveness, any changes must be made prior to this. E.g. When the poles leave the snow in double poling.

- **Follow-Through:** This refers to the body movements that occur after the critical instant. In cyclical skills the follow-through is part of the preliminary movement of the next cycle of the technique. Follow-through actions may provide useful information about the critical instant and force producing phases. E.g. The extension of arms behind the skier in double poling.

**Biomechanical Principles**

There are five biomechanical principles that are particularly relevant to the analysis of cross country ski skills. By referring to these principles you will be better able to analyze technique and make accurate observations about what changes are necessary to improve performance.

**Principle #1: Stability**

Stability refers to a state in which an object (e.g. a skier) is steady or in balance (i.e. in equilibrium). It also refers to the capacity of an object to return to equilibrium or to its original position after having been displaced.

The following bullets summarize important underlying concepts or definitions relevant to stability:

- **The centre of gravity** is the imaginary point at which the mass of the athlete or object

may be thought of as being concentrated. The lower the centre of gravity, the more stable an athlete will be.

- **The base of support** is the area bounded by the supporting limbs (in cross-country skiing, the legs). The larger the base of support, the easier it is for an athlete to be stable and the more margin for error there is in establishing and maintaining stability.

- **The line of gravity** is an imaginary line passing straight down through the centre of gravity to the ground.

- The centre of gravity must be within the base of support for the athlete to be balanced. In other words, the line of gravity must fall within the base. If an athlete's centre of gravity moves outside of the base of support, or if it deviates sufficiently to one side or other of the line of gravity, balance will be lost. However, loss of balance is not necessarily undesirable, nor does it imply that stability will be lost as well. It is often necessary and/or desirable to "lose balance" in order to initiate weight shift and create momentum. Provided that the loss of balance occurs in a controlled manner and results in a return to a balanced position at the end of a movement, stability is retained.

**Principle #2: Use All of the Joints**

The production of maximum force requires the use of all the joints that can be used. In the sport of cross-country skiing, skiers rarely, if ever, apply maximal force, but want to utilize all the appropriate joints in order to maximize technique effectiveness.

**Principle #3: Use the Joints in Order**

The production of maximum velocity requires the use of the joints in order - from largest to smallest. Leaving out one joint will reduce the force of the action.

**Principle #4: Increased Impulse Equals Increased Velocity**

An "impulse" is made up of (1) the force applied, and (2) the length of time the force is applied. The longer and more powerfully the force is applied, the more velocity increases.

- Cross-country skiers can increase the length of time that a force is applied, and therefore the impulse, by applying the force through a greater range of motion in their joints. In general, the fastest cross-country skiers have longer stride lengths (greater impulse), but similar stride rates, to less skilled skiers.

**Principle #5: Movement Usually Occurs in the Opposite Direction to the Applied Force**

This principle is related to Newton's Third Law of Motion, which states that every action has an equal and opposite reaction.

- In cross-country skiing, however, movement down a ski trail is not this simple because snow is slippery. For example, when executing classic technique it would be ideal if an athlete could push back with the foot the same as when running. Instead, because snow is slippery (even with good wax), it is necessary for the athlete to push down into the snow as well as back down the track.

***For more information on biomechanical principles please review your learning to train reference material.***

## 2.2 Teaching Technique and Skill Acquisition

Imparting new technique and skills to athletes can be a challenging proposition, and those new to coaching may find it difficult to convey concepts and skills to developing athletes. The following section will explore the underlying theories of skill acquisition and provide you with methods that will improve your ability to impart technique and skills to athletes.

### Teaching technique


*Figure 1: Imparting strategy to athletes (Photo Credit: Noemi Berube)*

During training sessions, the coach must provide guidance to athletes to ensure they learn new skills effectively. To do this the demonstration and practice of the new skill will be manipulated by the coach to best suit the individual, their skill level and the context of the practice. When teaching any new skill, coaches need to be aware that there are four key steps to properly imparting technique to athletes. These four steps are:

**Instructing:** Instructions must be given to an athlete for them to complete the task or skill. These may be written or verbal. The coach must ensure the athlete knows what is required of them.

**Demonstrating:** Coaches may provide a demonstration of the skill or may get a peer to perform it. It is key that this is a good demonstration to allow the athlete to form a model in their memory and mentally rehearse the skill to be performed.

**Applying**: After instruction and demonstration the athlete should then practice the skill to acquire a feel for the motor skills need to perform the activity.

**Confirming**: This step requires the coach to provide feedback and information to the athlete about their execution of the skill. Feedback should be positive and constructive focusing on large movement patterns first. All steps can be repeated as required.

## 2.3 Practicing Skills in Different Environments

*Figure 2: Challenging ski conditions (Photo Credit: Steffan Lloyd)*

There is a significant difference between running skiers through drills on one specific section of terrain versus having them practice tactics in sprint simulations. The stability of the environment dictates what type of skill is practiced by the skier. **Closed skills** are practiced in situation where environment and terrain are controlled and athlete response is predictable and can be planned. For example, having an athlete practice legs only striding up a hill is a closed skill. **Open skills** are performed in an environment that is variable and unpredictable during action, for example mid mass start race. Finally in a **mixed skills** situation the environment is semi-predictable, such as in an individual start race (some influence of other skiers, but general the skills are in the control of the athlete). Based off these distinct environments practice situations can be broken down into distinct types:

- **Variable Practice:** The skill is practiced in the range of situations that could be experienced. Open skills are best practiced in this way.
- **Fixed Practice**: A specific movement is practiced repeatedly, known as a drill - Closed skills are best practiced in this way.
- **Massed Practice:** A skill is practiced without a break until the skill is developed. Suitable when the skill is simple and motivation is high, and the purpose of the practice is to work on a specific skill a skill. Best with experienced athletes.
- **Distributed**: Breaks are taken while developing the skill. Suitable when the skill is new or complex, fatigue could result in injury or motivation is low.

Distributed practices are generally considered the most effective type of practice as they allow mental breaks and encourage long term learning by forcing athletes to think about the skill they are learning every time they come back to it. An excellent example of distributed practice would be to practice double pole technique for 10 to 15 minutes, then switch to balance drills for 10min, then return back to double pole for the remainder of the session. This switch in technique and focus forces the athletes to reconsider the technique pointers they were working on in the first part of the practice fostering increased retention of skills. This system also helps to keep athletes interested in practice with variety.

## 2.4 Methods of Skill instructions

The manner in which skills are taught can further be broken down to suit the individual learner style and the complexity of the skill/technique in question. The following are methods that coaches can utilize to work with unique learning demands of various athletes.

*Simple and Complex Skills:* Simple and complex are terms used to describe a skill. Simple skills are ones that an athlete finds easy to perform whereas complex skills are ones that the athlete finds more difficult. Remember, what is a simple skill to one athlete may be complex to another so as a coach you need to determine how each athlete perceives the skill.

### a) Whole Practice Method

Ideally, a skill should be taught as a whole as the athlete can appreciate the complete movement and execution of a skill. The whole method of instruction can sometimes mean the athlete having to handle complex movements e.g. the diagonal stride

### b) Part Instruction

When a skill is complex, or there is an element of danger for the athlete, it is more appropriate to breakdown the complex movement into its constituent parts. The parts can then be taught and then linked together to develop the final skill. When part instruction is used it is important that the athlete is demonstrated the whole skill so that they can appreciate the final product and understand how the set of parts will develop the skill. An example of part instruction would be practicing legs only skate skiing before attempting a one skate.

### c) Whole - Part - Whole Instruction

Initially the athlete attempts the whole skill and the coach monitors to identify those parts of the skill that the athlete is not executing correctly. Part instruction can then be used to address the limitations and then the athlete can repeat the whole skill with the coach monitoring for any further limitations.

### d) Shaping

Shaping is suitable for complex actions with simultaneous elements e.g. switching from one skate to hop skate offset and back. A possible sequence to shape the transition skill over a number of training sessions is as follows:

- Skier to one stake and transition into an offset on gradual terrain
- Set up cones and have the athlete transition into stepping over the cones in offset.
- Add in a transition out of offset, back into one skate at the end of the cones.
- Gradually adjust the speed of the skill and height of the cones to more closely resemble the race skill.

No one method is suitable to all occasions, but studies have shown that:

- simple skills (and perhaps simple is relative to each individual) benefit from the whole method
- skills of intermediate difficulty benefit from the part method
- closed skills are often taught with part instruction
- difficult skills are best dealt with by oscillating between part and whole
- multiple combined skills benefit from the use of shaping.

## 2.5 The Stages of Learning

No athlete will go from novice to expert in a single practice; it takes time for them to move progress from stage to stage to acquire new skills. Coaches should have a general understanding of how athletes improve, as this will help them understand what type of coaching method and skills should be used to effectively engage with the athlete.

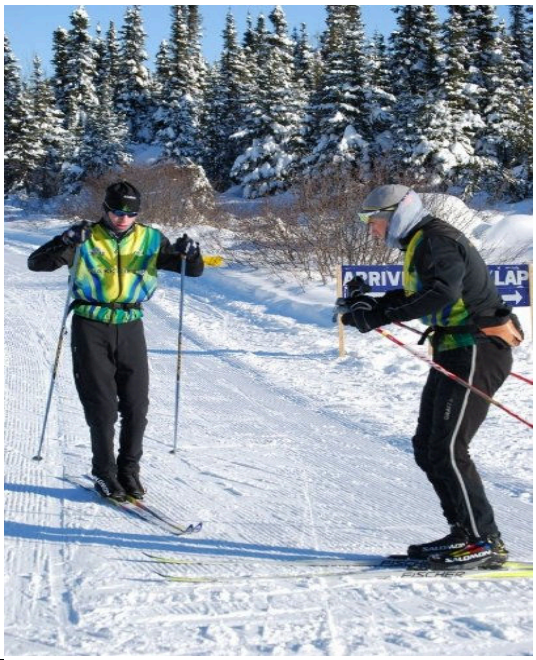

*Figure 3 Reviewing body positions (Photo Credit: Peter Lloyd)*

**a) Cognitive or Understanding Phase:** In the first stage of learning performances are inconsistent and success is not guaranteed. Performing the skill requires all of the athlete's attention and they rely on the coach for cues. This is a process of trial and error with a success rate of 2 or 3 out of 10 attempts. Correct performances must be reinforced through external feedback.

- *Coaching focus for the understanding phase:* Athletes learn the basic sport-specific skills; coaching is structured to maximize athletes' ability to learn and execute these skills.

**b) Associative or Verbal Motor Phase:** Performances are becoming more consistent as motor programmes are being formed. While the simpler parts of the skill now look fluent and are well learned, the more complex elements still require attention. The athlete is starting to get a sense of internal 'kinesthetic' feedback when they perform the skill well. They are starting to detect and correct their own errors and success rate has risen to 5-7 out of 10.

- *Coaching focus for the Verbal Motor Phase:* Athletes perform the skills regularly and can make their own adjustment repeatedly in "race-like drills" and scenarios. Coaches must create a learning environment where athletes are actively engaged and committed to the learning and practicing processes to a point where they can see a marked improvement and consistency in their performances.

**c) Autonomous or Motor Phase:** In the final stage of learning, performances have become consistent, fluid and aesthetically pleasing. The motor programmes involved are well learned and stored in the long-term memory. There is now spare attention which can be focused on opponents and tactics. To retain the new skill at this level, it must be constantly practiced to reinforce the motor programmes. Success is now 9 out of 10.

- *Coaching focus for the Motor Phase, adding race-specific drills:*

  **Pace/tempo:** As athletes master execution of the technical skills, coaches should increase the pace/tempo of the activity to simulate the race competition level.

  **Physical fatigue**: Athletes need to be trained to overcome, or at least mentally handle, the impact of fatigue on the accuracy and quality of their technical skills execution. Coaches should create practice situations that demand a high level of skills execution with the onset of fatigue as athletes need to be able to overcome and adapt their performances in the later stages of races.

  **Mental Workload:** One of the most important variables for athletes is to execute technical skills at a "race pace" while feeling the effects of fatigue. This is also true for athletes to perform under the mental pressure or workload of the contest. It is imperative for coaches to create and/or simulate controlled "race-like" scenarios in practices. Coaches should force athletes to demonstrate technical and tactical proficiency in situations with high mental demand. Note mental pressure should not involve stressing an athlete with expectations of performance. Rather coaches should challenge their mental focus by add distractions or mental tasks to perform while being physically challenged as well. For example have athletes count the total number of strides, double poles and kick double poles they complete during an interval set.

## 2.6 Tools for Analyzing Technique

*Figure 4: Fliming double pole sprints (Photo Credit: Peter Lloyd)*

Today there are many programs available for breaking down athlete technique and viewing it in slow motion, and compare athletes and add diagrams to video to show angles to athletes clearly. The following is a brief summary of products available for coaches today.

**Ubersence and Coaches Eye (apps for phones and tablets):** Using a phone or tablet to record video, these apps allow coaches to provide instant slow motion feedback. Ubersence and Coaches Eye also have drawing tools to measure or highlight form, can compare two videos side-by-side and even synchronize comparison videos for a more effective evaluation. Finally apps allow for voice-overs on videos that can be sent to the athlete later.

**Kinovea (computer program):** A more robust version of the phone and tablet apps, Kinovea can perform all of the similar skills to phone apps, but also allows for coaches measure distances and times manually or use semi-automated tracking to follow points and check live values or trajectories. It is 100% free and open source.

**Sprongo:** The youtube of video analysis, allowing for video analysis to stay online with annotation and commentary. Some costs can apply.

**Dartfish:** The largest software package available for technique analysis with functions for laboratory quality analysis and video capture. The most expensive option for biomechanics evaluation.

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