The Science and Technology of HOCKEY

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The Science and Technology of Sports

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CHAPTER ONE

The Biomechanics of Skating

One of the talents tested at the NHL All-Star Skills Competition is speed skating—a competition to see which player is the fastest skater in the league. In 2019 the winner of the speed skating competition was Connor McDavid of the Edmonton Oilers. He skated a complete lap around the rink, which is a distance of 570 feet (174 m), in a mere 13.378 seconds.

Although McDavid's accomplishment was certainly admirable—in fact, he won the speed skating competition in 2017 and 2018 as well—much of the attention during the 2019 contest focused on the player who finished seventh. Kendall Coyne Schofield, a member of the US Olympic women's ice hockey team, was invited by NHL officials to compete in the speed skating competition at the last minute after Colorado Avalanche forward Nathan MacKinnon withdrew because of an injury. Schofield, the first woman to compete against men in an NHL skills event, posted a time of 14.346 seconds—or slightly more than a single second slower than McDavid's time. "I knew it was going to be a big moment," Schofield said after the event. "But just to see the outpouring of support afterwards. . . . It will change the way people perceive the game of hockey, and specifically women's hockey."[3] Added Auston Matthews of the Toronto Maple Leafs, "She was flying. Everybody was taking notice (during warmups) because she just looks fast. She did really well."[4]

Perhaps the person most shocked by Schofield's accomplishment was Arizona Coyotes star Clayton Keller, who was selected in the first round of the 2016 NHL draft thanks largely to a scouting report that touted his "elite speed." Keller finished eighth in the competition, posting a time of 14.526 seconds—good enough to finish one place behind Schofield. After trailing Schofield in the speed skating competition, Keller said, "She beat me, so she's doing something right."[5]

Why She Skates So Fast

Certainly, to be selected for an Olympic hockey team, Schofield has to possess an outstanding set of skills and keep herself in top physical condition, which helps explain why she skates so fast. But her physique and the way she skates has a lot to do with her ability to generate speed. For starters, she stands a mere 5 feet 2 inches (about 1.5 m) tall—much shorter than the average NHL player, who typically stands about 6 feet 1 inch tall (about 1.8 m) or more. As such, the strides she takes as she skates are shorter than the strides taken by taller players.

These shorter strides work to Schofield's advantage, helping her generate speed. To see why shorter strides helped Schofield beat Keller, one needs to look at this equation: stride length x stride rate = speed. In other words, a player's speed has a lot to do with the length of the stride multiplied by the number of strides he or she takes.

When Schofield needs to generate speed, she pumps her legs hard and fast. It is much easier to generate speed by taking shorter strides because those strides take less time to execute. Therefore, although Schofield takes shorter strides on the ice, she has an advantage over a taller player. For the record, Schofield is 8 inches (about 20 cm) shorter than Keller; therefore, Keller's stride is longer and, as the results of the 2019 All-Star Skills Competition illustrate, it took him longer to cover the same distance with longer strides. Of course, the ultimate difference between the times posted by Schofield and Keller was a mere 0.18 of

Kendall Coyne Schofield, a member of the US Olympic women's ice hockey team, took seventh place in the 2019 NHL All-Star speed competition, establishing her as one of the fastest skaters in the sport of hockey.

a second. Nevertheless, if both players were racing for a loose puck, Schofield would be expected to arrive at the target first. Andy Blaylock, a hockey coach from St. Louis Park, Minnesota (and the holder of a mathematics degree from the University of Minnesota), explains:

> If you see a skater accelerate from a medium speed up to a high speed, what happens to their stride rate in order to create that acceleration? It almost always increases. When we need to accelerate, we increase our stride rate. . . . Top-end skaters have a slightly shorter stride length than the skaters just slower than them, but they had a greater stride rate.

The Zamboni and the Mpemba Effect

Fans who attend hockey games invariably see a large machine driven onto the ice between periods. The machine sweeps across the ice, riding over the slushy layer created during the prior period of play. When the machine finishes its chore, it leaves behind a smooth, shiny, hard surface of fast ice.

The machine is known as the Zamboni, named after its inventor, Frank Zamboni. In 1939 Zamboni's family built a skating rink near Los Angeles. Soon, the family realized the warm California weather created a layer of slush on the surface. Zamboni responded by inventing a machine that shaves off the slushy layer, storing the loose ice in a tank atop the machine. In 1949 he perfected the machine, calling it the Model A Zamboni Ice Resurfacer.

The machine does more than just shave the ice. While traveling across the ice, the Zamboni sprays a small amount of water heated to 140°F to 145°F (60°C to 63°C) on the surface, which instantly freezes, providing the skaters with a smooth, hard surface. Although it may seem as though the hot water would initially melt the cold ice below, that is not true. Under the so-called Mpemba effect (discovered in 1963 by Tanzanian high school student Erasto Mpemba), hot water actually freezes faster than cold water. A main reason for the Mpemba effect is that heat escapes more quickly when hot water is exposed to ice, essentially speeding up the cooling effect on the water.

They were executing more stride thrusts in any given amount of time, and this led to greater overall forward horizontal force produced on average over time. You do that and you will be faster.[6]

The Art and Science of Stopping

The science known as sports biomechanics studies the body and how it reacts under the stress of athletic competition. Therefore, by studying the motions of skaters like McDavid and Schofield—particularly the rate at which they

force
Strength or energy caused by a physical action

pump their legs and the length of their strides—biomechanics experts drew the conclusion that shorter strides generate more speed than longer strides. In fact, so much speed is generated that women are capable of competing alongside men when it comes to skating at high speeds.

But there is more to skating in the competition of a hockey game than moving quickly across the ice. Perhaps a puck squirts loose. There is a scramble on the ice as opposing players dash for the puck. The first player to reach the puck stops suddenly, controls the puck in his or her stick, pivots, and sets off toward the opposing goal. It means a player not only needs to be a fast skater but must also possess the skills to stop instantly and change direction.

perpendicular
A position created by a right angle; when a skater turns his or her skates perpendicular, they form a right angle relative to the rest of the skater's body

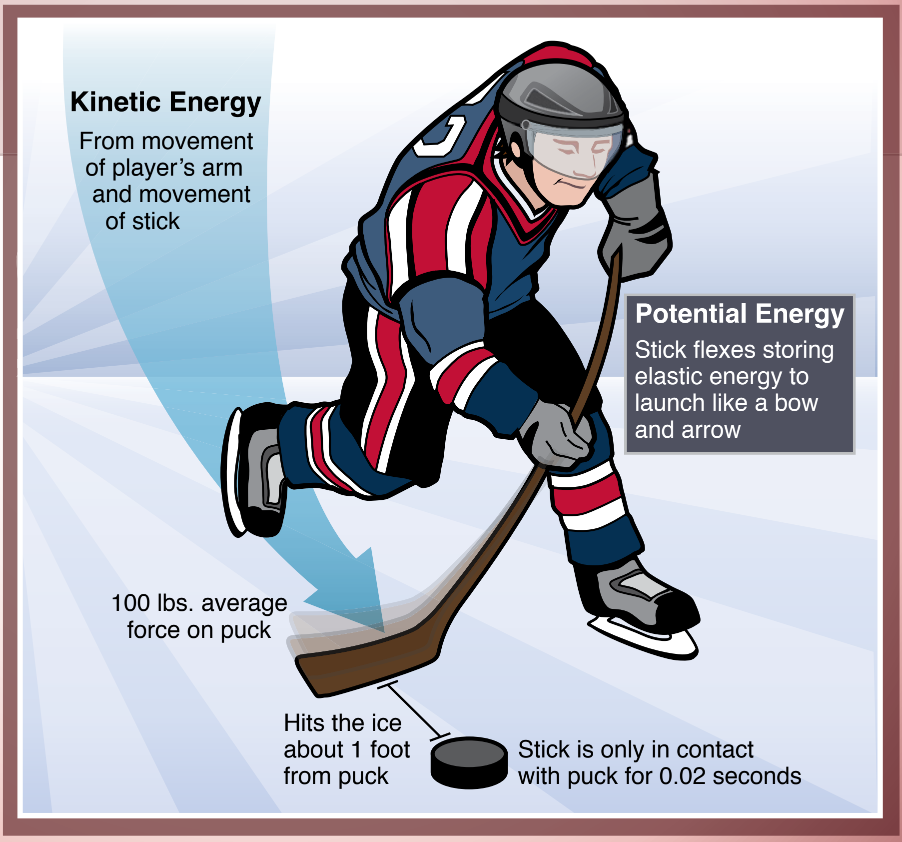
Coaches teach young players to stop their forward motion on the ice by slightly lifting their trailing leg, causing them to lean back slightly. As they start to lean back, they rotate their hips and shoulders, which causes them to turn their front leg to an angle of 90 degrees. Now, they dig into the ice with their trailing foot, also turned perpendicular to their direction, while still leaning back. With both blades angled perpendicular to the direction in which he or she is moving, the player will slow down and stop—optimally, within a second or two. Certainly, it takes some practice, but eventually the art of coming to a stop on ice becomes second nature to hockey players.

Biomechanics plays a role here. Depending on each player's height, weight, and skill level, his or her stopping motion will vary. For example, a lighter player may be able to stop more quickly than a heavier player simply because a lighter player may be more nimble and able to execute the stopping motion more quickly. But along with biomechanics, physics plays a role here as well.

held there by centrifugal force. The player helps maintain centrifugal force because the blade is swept in a tight circle. Certainly, the wraparound goal takes some deft skating and stick handling. Finally, catching the goalie by surprise, the player pokes the puck into a corner of the net.

The Slap Shot

When executing the slap shot, players need to load energy into their sticks. To accomplish this, the stick must hit the ice first before hitting the puck. The friction created by sliding the blade across the ice serves to pull back on the stick, causing the stick to arc. In fact, during the typical slap shot the stick may bow as much as 30 degrees. When the blade comes into contact with the puck, the kinetic energy stored from the bowed stick is released and—*pow*—the puck takes off.



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