The Athletic Arms Race

Does better equipment heighten competition or ruin the game?

by Mike May

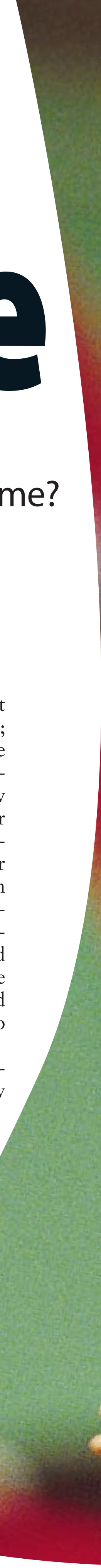
For decades, world records in speed skating were broken by tiny increments, sometimes only one or two hundredths of a second. Suddenly, in 1997, records plummeted by full tenths of a second at a time. Even more startling, virtually unknown skaters were crushing the favorites. The reason: the clap skate. This new piece of equipment carved time off every lap. The skate caused an avalanche of tumbling records at the 1998 Winter Olympics in Nagano, Japan. In the first round of the men's 500 meters, Italian Ermanno Ioriatti set an Olympic record. A few minutes later American Casey FitzRandolph broke Ioriatti's record. Next, Canadian Kevin Overland surpassed FitzRandolph. Finally, Japan's Hiroyasu Shimizu beat Overland. In the men's 5,000 meters, the world record fell three times in less than half an hour.

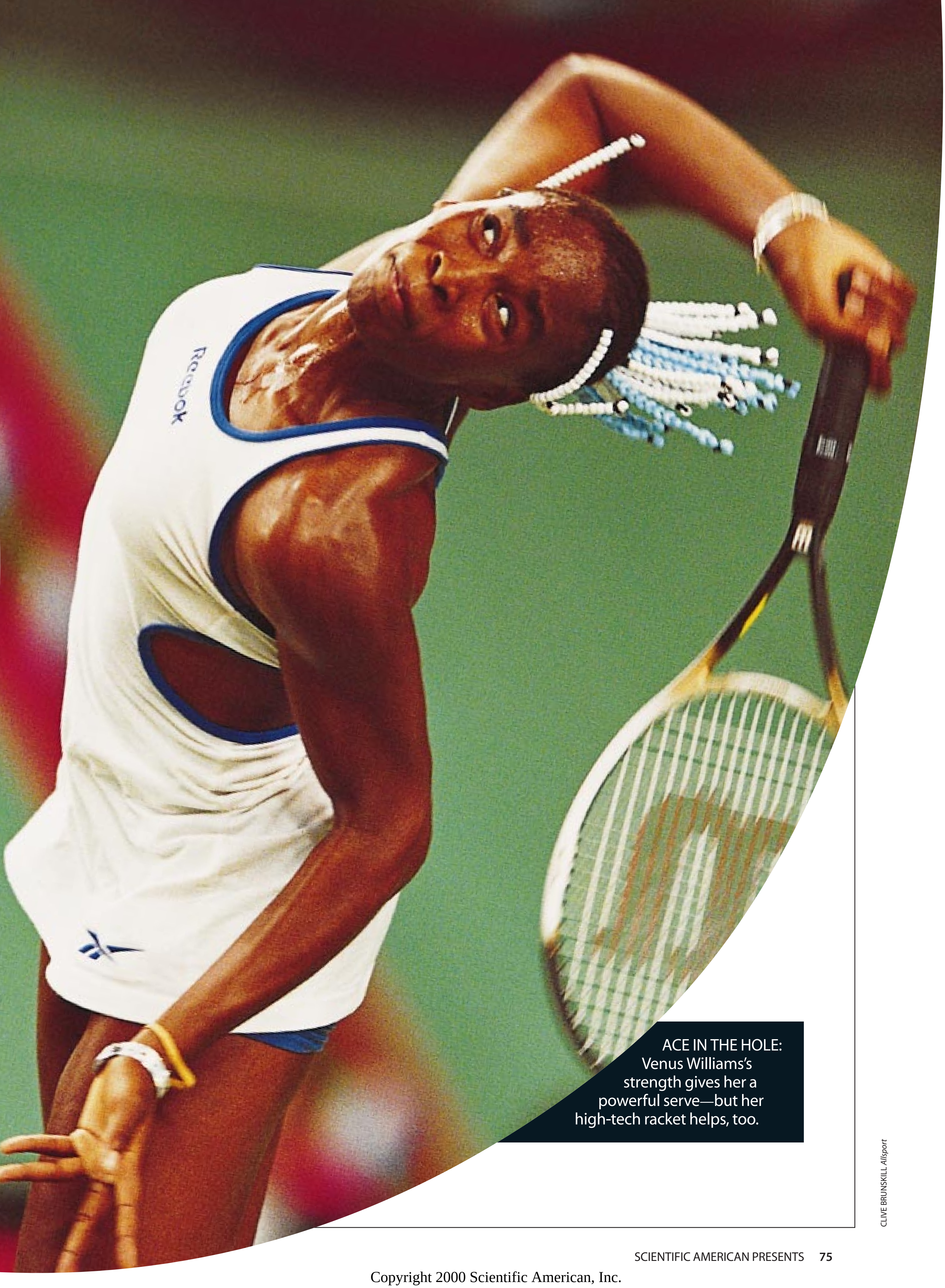
Spectators could actually hear speed skating change. A traditional skate—a steel blade attached rigidly to a boot's toe and heel—makes a swooshing sound with each stride across the ice. But a passing clap skate creates a rhythmic clatter. The key change is a spring-loaded hinge that connects the blade to the boot's toe. Beneath the heel, the blade is free to swing away from the boot. When a skater's heel begins to lift up at the end of a stroke, the hinge lets the back of the blade stay on the ice until the foot is raised high. The clap sound comes at the very end of the stroke, when the rear part of the blade snaps back into place. By keeping the blade on the ice longer, a skater gets more push for each stroke, propelling him or her faster. The concept of clap skates had been around for nearly a century, but it made its debut among top skaters at Nagano, spurred on by a host of athletes and scientists from the Faculty of Human Movement Sciences at Free University Amsterdam.

Despite the blazing times, the new skates did not suit everyone. Some skaters took to them fairly easily; others felt like babies learning to walk. "The first time you step onto the ice, you almost fall over," FitzRandolph says. Competitors can't simply strap on the new skates and tear through records. In a few cases, lesser skaters who had quietly trained with the new technology before the Nagano Games had an edge over faster rivals who hadn't gotten used to the equipment soon enough to use it during competition. The skate requires a different stroke, one that pushes more forward and from the toe rather than to the side and from the heel. Although FitzRandolph is comfortable in clap skates now, he admits, "I really like the old skates." But no one dreaming of gold can go back to the previous technology.

The clap skate illustrates a fundamental tension between innovation and sport. Competitors continually look for a technological edge, from faster skates to harder-hitting baseball bats. Likewise, manufacturers persistently enhance equipment in a scramble to win more market share. Governing bodies are thrust into the role of negotiators, hoping to preserve a sport's intended challenges in the face of an athletic arms race.

At first glance, technological advancements seem beneficial, because in most sports incremental improvements can distinguish winners from losers. But taken to the limit, better equipment can reduce or even eliminate the role of athletes' abilities, conditioning and cunning. As Nadine Gelberg, who specializes in sports at Harris





ACE IN THE HOLE: Venus Williams's strength gives her a powerful serve—but her high-tech racket helps, too.

CLIVE BRUNSKILL *Allsport*

QUICK CHANGE: At the 1998 Winter Olympics in Nagano, favorites who stayed with a conventional, rigid blade (*top*) were bested by lesser skaters who had switched to the new, spring-loaded clap skate (*bottom*).

BONT SKATES (*standard skate*); STEVEN SUTTON *Duomo* (*skater*); CHRIS TROTMAN *Duomo* (*clap skates*)

Interactive, a market research firm, explains, "Sports are essentially about a challenge, and there's a particular set of skills necessary to meet that challenge. The question is: When does innovation usurp the skills necessary for the challenge?" Tennis could devolve into a serving contest if advanced rackets propelled balls at such blinding speeds that no one could return them. A golf ball designed to self-correct its flight down the fairway would no longer test a golfer's accuracy.

On the other hand, Gelberg points out, technological improvements can widen the participation of youth and women in some sports. And certain advances, such as better running shoes, do indeed simply improve the fair contest between athletes. In essence, sporting equipment should be good but not too good. Technology should not change the basic nature of a game. The real disagreement is over where to draw the line.

OVERGUARDING THE GOAL

The National Hockey League had to draw a few lines recently after controversy over goalie equipment. The NHL hired Dave Dryden, a star goalie from the 1970s, to help. "Over the years," Dryden says, "the focus of goaltenders had changed from wearing equipment to protect themselves to wearing equipment that fills up the net." Some goalies were wearing jerseys so oversized they looked like capes. Did this make it harder for opposing players to score? "Yes, absolutely," Dryden says. "For the player coming in at the goal and trying to find a spot to shoot the puck, there really weren't a lot of spots left."

In 1998 the NHL ruled that a goalie's equipment could protect only the goalie, not the goal. The rules laid down specific limits for a jersey. It can't be wider than nine inches at the wrist, 29 inches at the chest and 30 inches at the hips. From front to back, it must be no more than 14 inches, and length is limited to a maximum of 32 inches. The changes also limit goalie pant legs to a width of 11 inches at the thigh. As for padding, the rules say only that it must be form-fitting; no bumps or ridges can be added to increase size.

Although NHL officials meant to even out the challenge between scoring and defending, the balance might be swinging to the scorers. "The goalies are saying to me, 'Jeez, Dave, the pucks are coming a lot harder now than they used to,' " Dryden relates. The fastest shots now surpass 100 miles per hour. Dryden expects the league to look soon at the construction of hockey sticks to determine whether they launch the puck too hard. Another technology battle might lie just ahead.

THE HAPPY NONHOOKER

Technology really appeared to overshadow an athlete's skill in 1974, when Fred Holmstrom and Daniel Nepela patented a new golf ball. They made the dimples on the poles of the ball shallow, leaving a deeper band of dimples around the equator. If the ball was teed up with the ring of dimples in the vertical plane and then hit, it experienced reduced aerodynamic forces along the undimpled sides, which made it less likely to hook (veer left, for a right-handed golfer) or slice (veer right). The manufacturer, PGA Victor, called the ball the Polara, but the press dubbed it the "happy nonhooker." To be approved for competitive use, golf balls must face Frank Thomas, who runs the U.S. Golf Association's testing facility. Automated driving machines and accomplished golfers hit the Polara and a host of other balls. "The Polara corrected itself in flight," Thomas says. Consequently, the USGA banned it and developed a symmetry standard: a ball must not be made or intentionally modified to have flight properties that differ from those of a spherically symmetrical ball. The ban triggered a series of court battles in which PGA Victor claimed that the USGA and the Golf Ball Manufacturers Association teamed up to inhibit sales of the new ball. In an out-of-court settlement, the USGA paid the manufacturer $1.4 million, but the ball remained banned.

Thomas explains the need for USGA rules: "If you know exactly where the ball is going to go, instead of going to the next tee you might as well go ahead 250 yards to the middle of the fairway, and start from there." Still, he adds, "we don't want to stifle innovation, because if we specified exactly what every piece of equipment had to look like, golf would be boring as all get-out. So we allow people to innovate, but not to the detriment of the challenge that makes golf so attractive."

Today the USGA tests golf balls indoors on a 70-foot range. An automated system tracks a ball's movement once it is struck, which reveals its initial velocity. A computer simulation then determines the ball's lift and drag properties and calculates how the ball would fly. In a recent batch of tests, the USGA banned a dozen balls out of 1,800 because they would go too far.

To develop long-flight balls, manufacturers examine both design and materials. For example, they can alter the shape and size of a ball's dimples, which can reduce the aerodynamic drag on the ball, making it go farther. Some experiments suggest that hexagon-shaped dimples produce less drag than round ones do. Moreover, materials used in golf balls have changed dramatically, from the boxwood used before the 14th century to today's synthetic core and cover. Manufacturers experiment with many materials in search of ones that are bouncy enough to make a ball travel far but also durable enough for the rigors of the game. Yet they know that their balls must pass Thomas's test, so balls cannot always exploit every technological advantage.

SOARING SPEARS

Aerodynamic improvements also altered an ancient event, the javelin throw. The wooden rod hadn't changed much until the early 1950s, when American Dick Held made metal javelins. East German Uwe Hohn was the first to break the 100-meter barrier with Held's creation, throwing 104.8 meters.

Held's javelins had greater surface area, and the center of gravity was moved back toward the thrower, which created considerable lift. But the spears

SLY FASHION: Over the years, NHL goalies have sported increasingly wider equipment to block more of the goal, as seen by comparing Minnesota's Gump Worsley (*left*, early 1970s) and Buffalo's Dominik Hasek (1990s). In 1998 the league limited jersey size and pad shape.

LONDON LIFE-PORTNOY/HOCKEY HALL OF FAME (*left*); DAVID SANDFORD *Hockey Hall of Fame* (*right*) tended to descend nose-up, often skidding on landing, making it virtually impossible for officials to determine precisely where they hit. Consequently, the International Amateur Athletic Federation instituted a new rule: to be counted, a thrown javelin had to land point-down.

Further complications arose once throwers changed their style. U.S. Olympian Tom Petranoff says, “Everybody thought that throwing a javelin at 30 to 32 degrees was optimum, but when we started throwing them at 25 or 24 degrees, these things went screaming out. I threw a javelin 110 yards. It still blows me away.”

Officials decided the new javelins were flying dangerously far. At a Grand Prix final in Rome in 1985, Petranoff threw a javelin that soared to the right and touched down at a winning 92 meters but then bounced and took off again. The projectile shot across the track and speared a board right below the IAAF officials. The next year, the IAAF pushed the allowable center of gravity in a javelin four centimeters forward. Petranoff’s throws dropped by 40 feet. The modifications also essentially forced throwers to return to old techniques, in which finesse means less and brute strength means more. Now, Petranoff says, “people with power can get away with murder.”

SPAGHETTI, ANYONE?

Technology has also altered the balance of finesse and power in tennis. Anyone who once played the game with a traditional wooden racket and has tried a modern, high-tech version knows what has changed. Today’s large, light rackets let even amateurs send the ball over the net more easily and with greater power.

The arms race in tennis began in earnest in 1977, when a double-strung racket, which employed two sets of strings that did not touch, hit the professional circuit. A plastic coating on the strings made them look like spaghetti, so the rackets were dubbed “spaghetti strung.” The separated sheets of strings let the ball sit on the racket longer during a stroke, helping a player put considerably more topspin on the ball.

The invention unleashed a string of upsets that year. At the U.S. Open, Michael Fishbach, who was ranked 200th in the world, beat Stan Smith, who was seeded 16th. Georges Goven, a relatively unknown French player, beat the commanding Ilie Nastase at a tournament in Paris. Nastase quickly switched to a spaghetti-strung racket and defeated Guillermo Vilas, ending the latter’s 50-match winning streak. Soon after, the International Tennis Federation banned spaghetti stringing.

Radar guns at international competitions have shown that other inno-

No Return

Tennis rackets have gotten larger, tighter and lighter, making serves and passing shots faster. Shown here from left are a wood frame (1948), doubled-up “spaghetti strings” (1977, the year they were banned) and a carbon-fiber frame (1999).

WILSON SPORTING GOODS (*left and right*); ALLSPORT (*center*) vations in rackets and balls—in combination with athletic skills—continue to drive up serving speeds. The composite materials in rackets allow them to be lighter and cover a wider area yet withstand the tension of being tightly strung. The result is a bigger sweet spot for hitting hard, accurate shots and higher-velocity serves. A few pros, notably John McEnroe, have complained that the rackets threaten to transform tennis into a game of blistering serves that only incredible returners like Andre Agassi can handle. The technology improvements that bring more amateurs into the sport might destroy their interest in the professional game if matches turn into strings of one-shot points.

UNFAIR WAY: The Polara golf ball had vanishing dimples at its poles, which reduced a duffer's hook and slice. An ordinary ball (*right*) has uniform dimples all around. The USGA forbade the Polara's use in competition in 1977.

NADINE GELBERG *Harris Interactive (left)*; MIKE NEVEUX *Corbis (right)*

BANNED BATS

For many Americans, one of the most obvious consequences of technology emerged in Little League baseball in the early 1970s, when the ping of aluminum bats started replacing the crack of wood. The metal bats provide an economic advantage because they don't break like wood ones do. But for the players, aluminum bats pack more punch. They are lighter, so a player, especially a child, can swing faster, sending out harder hits. And manufacturers can move an aluminum bat's center of gravity toward the knob, which also increases swing speed. Finally, the ball rebounds better off the aluminum, again adding power to the outgoing sphere. James A. Sherwood, director of the Baseball Research Center at the University of Massachusetts at Lowell, says, "The sad part is, it's like the technology is beginning to control the game more than the players' ability."

Aluminum bats never affected Major League Baseball, where they are banned. But they raised a ruckus in the National Collegiate Athletic Association. To protect fielders, NCAA officials want to prevent aluminum bats from hitting too hard. To do that, they turn to Sherwood. His facility includes a Baum Hitting Machine, in which motors collide a baseball and a bat at computer-controlled speeds. The device then measures the ball's rebound. In the past, an aluminum bat hit a ball about 10 miles an hour faster than a comparable wood bat did. The NCAA ruled recently that an allowable aluminum bat can hit a ball only as fast as a 34-inch, 31-ounce wood bat can. According to Sherwood's results, with a pitch speed of 70 miles an hour and a bat-tip speed of 85 mph, a ball takes off at about 96 mph.

Following suit, other organizations are also instituting similar rule changes. For instance, the National Federation of State High School Associations is developing a rule mandating that a 34-inch wood bat and a 34-inch aluminum bat hit the same. It is apparent, however, that manufacturers and players will continue to seek a technological edge. Perhaps manipulating a bat's center of gravity will create an advantage. "Here it's kind of technology versus technology," Sherwood adds. "I have the machine that can catch it, but they may find a way to circumvent the machine."

LAYING DOWN THE LAW

The athletic arms race involves many factions. Players want better performance. Professional team owners and college recruiters crave improved records to attract more fans and make more money. Manufacturers pursue bigger market share by producing "better" products. It is therefore up to governing bodies to limit technological advances enough to preserve a sport's integrity. The question is how best to do that. Some officials confront advances one by one, writing a new rule to outlaw each specific device. Market researcher Gelberg, however, thinks that rules should protect specific skills. The USGA's symmetry rule is a good example: it outlaws any ball—not just the Polara—that performs in a certain way. Experts such as Sherwood and Dryden are helping baseball and hockey in their pursuits of equally useful rule changes.

If governing bodies take on technology case by case, it will leave them constantly open to new attacks. "The problem with ad hoc design standards is that you're going to get a new design tomorrow that will have the same impact on the game, the same impact on challenge, and it's going to be permitted because that particular design was not banned," Gelberg warns. She says defending skills, rather than limiting individual innovations, is the way to go.

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FURTHER INFORMATION

THE BIG TECHNOLOGICAL TENNIS UPSET. J. Nadine Gelberg in *American Heritage of Invention and Technology*, Vol. 12, No. 4, pages 56–61; Spring 1997.

CLAPSKATES AT NAGANO: WORLD RECORDS TUMBLE IN SPEED SKATING. T. L. Allinger in *Sportscience News;* March/April 1998. At www.sportsci.org/news/news9803/clapnagano.html