ADVANCED MATERIALS IN SPORTS: An Advantage or Ethical Challenge?

BY SHARON KAY STOLL, KEITH A. PRISBREY, AND F.H. FROES

"If the goal of sports is competition and winning, advanced materials will continue to improve the equipment so that less efficiency, fitness, and skill are necessary to play."

FOUR BUSINESS BUDDIES have been playing golf together for 20 years. Each Saturday, they wager lunch on the outcome of the game. Fred is grossly overweight and unfit, is the least skilled of the group, and has had to buy lunches about 95% of the time. He also suffers the slings and arrows of his buddies' competitive barbs.

One day, he learns about advanced materials in golf clubs and balls that will improve his game markedly. In fact, when he tries the new clubs, his drives increase by about 25 yards, and with the addition of new composite balls, he picks up accuracy. He decides that all is fair in love, war, and golf, and never divulges his secret. He invests big bucks and gets the best equipment on the market. For the rest of the summer, Fred is highly successful; his golfing buddies are amazed at his improvement; he gets to razz them a bit; and they buy the majority of lunches. One might argue that Fred cheated slightly, but he has been the goat for 20 years. He deserves to win a little.

The Freds of the world no longer have to be the goat. They now can lower their scores significantly without a whole lot of skill or fitness. Advanced material design in equipment technology has changed the sporting experience to one in which many individuals can succeed without much talent or training. A good deal of the drive for developing these new technologies has to do with competition—that is, advanced materials can help people win. The question behind all of this, though, is whether the purpose of sports is about gaining advantages and getting even, or about people participating, enjoying, and improving their motor skills, as well as their overall health and fitness.

Advanced materials with mechanical and physical characteristics well in excess of those exhibited by conventional high-volume materials such as steel and aluminum alloys have contributed significantly to the heightened performance of athletes and recreational players. Specifically, sports equipment materials have been vastly improved in strength, ductility, stiffness, temperature capability, forgiveness (fracture-toughness and durability), and low density, which have revolutionized the world of athletics.

What does this mean for, say, the amateur tennis player? No longer does one need to spend hours developing skills or fitness. The traditional tennis racquet was originally made of wood, with a somewhat awkward and clumsy feel. The head was small and, when the ball made contact, there often was a resounding resonance through the racquet to the player's forearm. In order to be effective and to hit the ball accurately, one had to have a certain level of motor skill.

However, all of that has changed for the novice or recreational player. New technology uses piezoelectric fibers to convert mechanical energy into electrical energy for sensing ball impact, and microchip control circuits that react to the ball by stiffening the racquet and dampening vibrations. What results is a counterforce in the throat of the racquet within the first millisecond of ball impact. This provides more power than a conventional racquet that bends and vibrates upon impact. In fact, it is said that the racquet hits the ball and the player is just along for the ride.

Advanced materials have revolutionized the composition of skateboards, surfboards, skis, snowboards, javelins, golf clubs, golf balls, tennis racquets, football helmets, playing surfaces, baseball and softball bats, *ad infinitum*. The carbon-fiber vaulting pole permits a pole-vaulter to soar up to 18 feet. Javelins with spiral tips enable the thrower to reach dazzling distances. Golf balls with special dimple patterns and core design improve loft and spin so even a novice player can hit at least 400 yards. Stiffer carbon-fiber racquets reduce arm vibration and larger heads increase surface area in tennis, squash, and racquetball. Bicycles with new types of wheels and leg positions can increase speeds up to 60 miles per hour. Discuses with weight distributed as close as possible to the perimeter help the thrower to increase accuracy and distance.

If the goal of sports is competition and winning, advanced materials will continue to

Sixteen-year-old David Robertson uses a TiSport BB titanium wheelchair—specially designed to be lightweight, easily maneuverable, and stable—to play basketball for the Lakeshore Lakers of Birmingham, Ala.

improve the equipment so that less efficiency, fitness, and skill are necessary to play. If that is the purpose of the sporting challenge, consider how advanced materials affect a human being as he or she participates in a variety of sports.

Enter ethical reasoning, which is taught today at the University of Idaho and other higher institutions to develop evaluative methods for those sports, physical education, and various other fields. Ethics in this context means making decisions where right and wrong, should and should not, and help and harm are at stake.

Ethics refers to human responsibility and, by itself, the word is neutral in value. People practice ethics and hopefully try diligently to achieve high standards of morality in dealing with others. Professionals should be concerned with ethical conduct. To do so requires us to ask: What is good or valuable about the activity and how can we distribute that good or value to others? Competition is good, but should it be the ultimate goal?

An ethical reasoner takes a further step. If competition and winning are the goals, then sports ultimately can mutate to "equipment" playing the game, with humans as the mere operators. What is good for humans becomes the basic ethical question. If sports is considered "good" participation for humans and played with simple considerations of justice (fair play) and beneficence (doing good), it will enhance both the thrill and fun of competition (the four golf buddies) as well as the level of safety.

For all performers, the bottom line of ethics in sports is directed toward helping the performer improve fitness, skills, and health, rather than results. The value lies in performing well and not about the final score.

Some might argue that advanced materials democratize sports, allowing the less-talented and athletic, and even persons with handicaps, to get in the game or on the playing field. Athletes with handicaps now can participate efficiently and effectively in numerous activities never available before to them because of advanced materials. We definitely would want a paraplegic to be able to utilize the most-advanced materials, and not a wooden prosthesis device.

Yet, the questions of harm do arise if the goal is to win, and the benefit for the performer is completely ignored. The good is minimized if no fitness, skill, or health considerations are prerequisites for participation. For instance, harm can result to participants who haven't trained in physical fitness or motor skills before performing the sport. Consider also the effects to the sport if such technology were introduced as electronically guided darts, heat-seeking missiles for grouse-shooting, solar energy-enhanced bicycles, and golf balls with terrain-following mechanisms that automatically find the lowest local elevation on a putting surface—the bottom of the hole.

Another consideration of help or harm is the potential danger the equipment built with advanced materials may pose to the players or spectators. Take, for example, the javelin. From the ancient Olympic games to the modern era, the purpose of throwing a wooden javelin was about fitness and skill. During the modern era, the javelin composition changed to make the projectile lighter and more aerodynamic. Finesse was still required to make it float correctly. Then, in 1984, advanced javelin design changed this perspective in such a way that potential harm could occur at the elite level. In the manufacturers' quest for higher and farther, no one seemed to understand how an elite athlete might affect the distance with this new composite material javelin. When East Germany's Uwe Hohn deftly projected a new engineered javelin more than 100 meters in the 1984 Olympic Games, the javelin became a danger to spectators and other athletes "safely" warming up on the far side of the stadium. The ruling body, the International Amateur Athletic Union, took little time in banning the new design, which had led to a dramatic increase of 20 meters in the world record. Similar problems have occurred in softball, baseball, and golf.

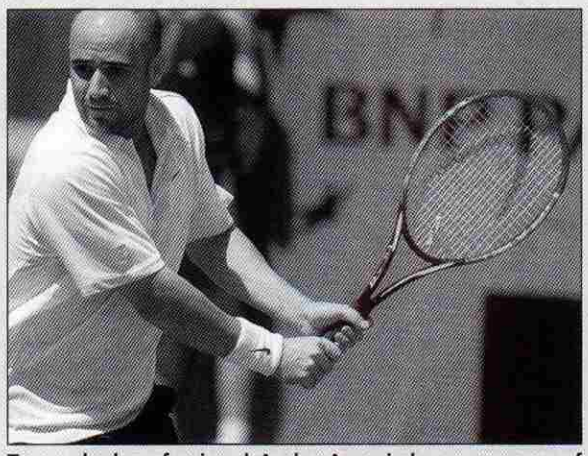
Assuming that the argument about good is faulty and that results or wins are the ultimate

and best purpose for advanced sporting materials, the goal becomes to spread the opportunity to win to as many as possible. An ethical dilemma arises when "just distribution" is threatened by the high cost of advanced materials in sporting equipment. New designs in most sports are more expensive than the older designs, and advanced composite materials are not available to individuals throughout the entire world. In fact, many of the designs are limited to countries with economic advantages. This obviously limits "good" distribu-

Cutting-Edge Equipment Saves the Weekend Warrior

Advanced materials in athletic equipment—at least from a purely personal perspective—is the greatest godsend to sports since, well, the invention of the Zamboni. As a fan and sportswriter, watching the best athletes in the world better able (way better!) to ply their trade is indeed a treat. For the weekend (and late weeknight) warrior, however, advanced materials also deserve a very special place—in our equipment bags!

Having long ago given up my aspirations to play professional baseball (I was going to replace Willie Mays as the center fielder for the San Francisco Giants); and since the best part of my basketball game was razzing the opposition from the bench (all aboveboard, too; no cursing); and considering that my glory days on the gridiron (translation: two-hand touch during recess) took place three decades ago, my hands-on experience with advanced materials is limited to a pair of athletic endeavors that are as different as two sports can be: ice hockey and tennis.

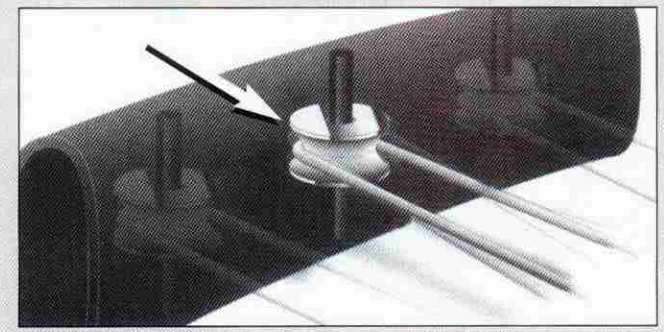


Top-ranked professional Andre Agassi showcases one of Head's new "Intelligence" line of tennis racquets.

Let's be clear on this right from the start. My season-best in hockey is six goals, and only two of them touched my stick—deflections off my helmet, facemask, elbow pad, and chest protector accounted for the other four tallies. (Hey, what can I say, the old axiom is true: go to the net hard and, once you get there, stay there!) That was five years ago. Today, I'm too old and too slow to play forward, so I've dropped back to defense, where my deficiencies are compensated for by always being paired with our team's best back-liner. I have one goal in the last half-decade, an empty-netter that just barely trickled in when I slammed the puck as hard as I could off the nearboards after the opposition had pulled its goalie in the final seconds while pressing for the tying goal.

As for tennis, I took it up last summer as a way to pretend I was staying in shape during the hockey off-season. The most surprising aspect of the racquet sport is the amount of pain involved, as opposed to life on the ice. After a game of hockey, I'm thoroughly exhausted, but nothing hurts (excepting the times I broke my leg and partially tore my ACL). After tennis, though, I walk like Walter Brennan in "To Have and Have Not." Both knees and ankles ache to no end. My shoulder and elbow? Don't even ask. Good thing I'm from the Bobby Riggs school of tennis—bloop, bloop, then bloop some more. And, in one of those unexplainable nuances of the courts, on the rare occasion I get to really pound the ball up close to the net, my backhanded slam is much more devastating than my forehanded version. (Now, if I could just figure out how to serve backhanded.)

Back on the ice, though, my epiphany concerning advanced materials came about four years ago. (Quick sidenote: While I've always loved hockey and played street hockey around the clock as a kid, I never even put on a pair of skates of any kind until I was in my early 30s.) Anyway, my first pair of skates finally were wearing out. They were good blades, but they definitely were for beginners. Somehow, I had muddled my way through that stage and was ready to purchase a pair of *real* skates. I wisely settled on "the pumps," a collaborative effort between longtime hockey equipment manufacturer CCM and Reebok Inc. To ensure a proper fit, the skates, after lacing, were to be inflated via small pumps located on the side of the skate and in its tongue. Aside from the perfect fit, the incredible thing to me was how light they were—almost like a pair of new sneakers. While I was not about to be confused with Rocket Richard or Pavel Bure, I certainly was flying all over the ice as never before. (My teammates even kiddingly implied that the league might mandate drug testing if I ever had another game like that.)



On Wilson's Triad Hammer tennis racquet, "rollers" (arrow) replace conventional grommets, allowing the strings to move more, providing a trampoline-like energy transfer to enhance return speed.

Fast-forward to the present. After years of good use, I finally needed a new helmet, gloves, and sticks. The lumber I played with has always been a source of a great many laughs in the locker room. Despite my revelatory experience with skates, I stubbornly stuck with my way-too-heavy sticks as a matter of principle. Long a proponent—but not a practitioner—of the style of play exhibited by the Eastern Europeans, I was delighted when, upon the dismantling of the Berlin Wall, a myriad of Soviet hockey equipment flooded the shores of America. I promptly bought three Russian hockey sticks (replete with foreign words up and down the shaft), only to discover upon use that they felt uncomfortably similar to two-by-fours. Still, I remained resolute. Heck, I figured, if the players of the USSR could lug these babies around while piling up Olympic gold medals, so could I. Moreover, I reasoned, I was so bad that it didn't matter what kind of stick I used. After all, except for that empty-netter, I'd never scored a goal from more than 10 feet away from the twine.

Boy, was I wrong! While I was not about to invest in one of the graphite or fiberglass state-of-the-art versions that can run well over $100, CCM's new Vector and Heat lines—used by NHL standouts like Mark Recchi, Mats Sundin, and Joe Thornton—proved to be a revelation. Wielding something so lightweight (but sturdy) gave me the sort of feeling a sprinter must have when he runs a race minus the ankle weights he's worn for days. Both sticks have wood shafts and a rounded-off surround-grip design, providing a perfect feel while allowing me to improve my stick-handling (although I had nowhere to go but up in that regard).

The Vector's shaft is reinforced by graphite, while the blade is composed of an all-new Texalium Matrix Composite, a shimmering silvery substance that makes your stick look cool while producing a stronger and stiffer blade. The Heat blade, meanwhile, is made of ultrathin white ash with a fiberglass

tion of results. Even in economically competitive countries, technology can be so pricey that many individuals must seek sponsors to partake in the "good."

Ethical dilemmas abound. While advanced materials in sporting equipment provide good, as defined by various benefits, for paraplegic athletes, the materials are costly and become available only to wealthy individuals. Advanced material design of wheelchairs has grown to include a chair for many sports, including basketball and even tennis. For the latter, chairs are built with sharply slanted back wheels so the athlete can move quickly from side to side. In basketball, forwards have high seats, while guards have more slant in their chairs in order to turn quickly. Bike-like wheels, the use of aerospace carbon fibers and titanium, and computer-aided design of the suspension are expensive. Top wheelchairs cost approximately $2,000-3,300 each. Moreover, the prosthetic devices used by elite paraplegic runners that allow them to be catapulted forward more efficiently than two human feet cost up to $7,000. Participation for these athletes is good, but limited to those who have the resources.

Apply this ethical reasoning again to the case of Fred and the golf game. What harm was done and what help could have occurred? Fred may have been better served had he taken the money for the new clubs and spent it on losing a few pounds, taking some lessons from a pro, and enrolling in a fitness program, then rethink the value of telling the truth. As it was, he lied to his friends, swindled them out of their lunch money, and supported a hoax for the summer. Of course, one could argue that his opponents also could have purchased advanced material clubs—with advanced clubs, they, too, could be overweight, unfit, less skilled, and deceptive—but such a comment is probably quite unfair. Advanced technology brings many benefits to all participants. Athletes are able to enjoy improved performance and ease of skill acquisition with these new materials. Any athlete or recreational player can attest that advanced materials make the motor skills easier and safer to accomplish with a lot of fun thrown in. There is no greater thrill than realizing that a difficult skill that appears to be beyond attainment can be conquered with a little help from advanced materials.

Back to the main premise: What is the purpose of sports? Hopefully, it is about people participating, enjoying, and improving their motor skills, physical fitness, and overall health and wellness. What is good and valuable about sports, how it can be distributed to the most people, and how unfair advantages and physical harm can be minimized by new designs and materials must be continually asked as technology advances. Then, reasonable compromises can be reached and the potential good of technology in sports can be enhanced. ★

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wrap to give it the durability needed for aggressive play. (In my case, this means slashing at forwards' skates as they zoom by. Don't laugh, I once tried this "tactic" along the boards on the opposition's ringer, an imposing bruiser who skated like the wind. He promptly pushed me away with one hand while using his other hand to grab my stick and snap off the blade as if it were a twig. Pretty scary!)

Now, whether out of desperation or not (and in my case, illegal stick use is pure desperation), you have to expect to be treated in kind. Consequently, I upgraded my gloves to JOFA 8800s. (Ninety-nine percent of NHL players wear at least one piece of JOFA protective equipment. By the way, JOFA is a sister brand of CCM, both under The Hockey Company umbrella.) Its mid-cuff length and polypropylene protection in the fingers and backrolls provide unmatched safety while maintaining a lightweight feel. Moreover, the split-finger design enhances your grip, and the lock-thumb innovation prevents that vital digit from hyperextending.

Hockey players, in case you haven't already figured it out, are a strange breed—and we're not just talking about the crazies in the NHL. The guys in the men's recreation leagues in which I play easily qualify, too. Call it bravado (or stupidity), but, if not required by the rules, many would compete sans helmet. Not me. I'm the type who would wear a catcher's mask under my full face-shield if it would just fit. So it was with great relief that I heard about CCM's new X-Ray Helmet Series, the see-through headgear that comes in translucent red, blue, electric green, or black. (It's this season's official helmet of the East Coast Hockey League.) Padded to the hilt, this cranium crown has three features my old headgear lacked: ear protectors, a tool-less adjustment mechanism that stretches the helmet from a size seven to seven and five-eighths (who says I have a big head?), and a Pro-Lok strap in the back that prevents the helmet from pushing forward over the eyes. The funny thing is, before I put on the X-Ray, I'd never really taken any potentially damaging blows to the head. But in my first two games with it, I took a monster elbow to end all elbows, and one of my earlier slashing victims—hockey players never forget—bounced my head off the ice with a check that deserved to be highlighted on "NHL Hits of the Week." Luckily for me, each hit left me momentarily dazed, but ultimately unbowed. However, I'm still trying to figure out if my new X-Ray is a lifesaver or a magnet for headhunters.

Thanks to its extra padding and rock-solid shell, the X-Ray hockey helmet from CCM helps ward off concussions that can be brought on by crushing blows to the head.

Happily, there is no such thuggery on the tennis court. Rather, we gentlemen (and ladies—I don't want to slight my doubles partners) of the court are in search of two things in a tennis racquet: power and comfort. It didn't take long to find both in a pair of just-off-the-drawing-board racquets, the Wilson Triad Hammer (part of the Rollers line) and the Head i.S9 (part of the Intelligence line).

The problem, it seems, has always been that the power generated by the head at impact creates a shockwave that travels down the handle to your arm. Yet, what if the head and the handle never touched? And what if they were buffered by a polymer—used to earthquake-proof buildings in California—that isolates shock and absorbs all the force from impact? And what if this unique—as in all other racquets are one piece—tri-component racquet was strung with Adrenaline, a high-energy five-layer synthetic gut? And what if the center core of polyester microfibers cupped the ball on the strings longer at impact, thus improving feel? Well, then, you'd be playing with the Triad Hammer, which also boasts Wilson's roller technology, whereby "rollers" take the place of conventional grommets in the racquet head, allowing the strings to move more, thus providing greater energy transfer—sort of a trampoline effect.

Like the Triad, Head's i.S9 resembles an oversized snowshoe, but is as light as a badminton racquet. Also like the Triad, the 9's sweetspot is seemingly on whatever part of the strings you hit the ball. The frame has tremendous stability, and the strings stiffen during impact, assuring ultimate power and dampening. No wonder Head's catchphrase is "smarter racquet, better game."

I know one thing, when I hit the court and pull out either one of these beauties, opponents and onlookers alike are oooh-ing and ahhhing at my equipment. When you hit and move like I do, any advantage, psychological or otherwise, is always welcome.

—Wayne M. Barrett
Managing Editor