

Collegiate Case Study

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USA TODAY Snapshots®

Marathoners come from all over

Sunday's New York City Marathon has an expected starting field of 30,000 runners, nearly one-third of whom come from the Big Apple. The breakdown of NYC Marathon runners from major cities across the USA:



Source: New York Road Runners

By Ellen J. Horrow and Quin Tian, USA TODAY

10 Hardest Things To Do In Sports: Part II

Sports teams are big business in the U.S. from sporting goods product manufacturing to the technology and science that governs the athletic training regime to the travel movements and government sponsorship on the international scene. USA TODAY's "10 hardest things to do in sports" series profiles the 10 most challenging endeavors for athletes from the perspective of the athletes themselves, the average viewer, and the scientific expert. This set of case studies examines these sports from a variety of disciplinary perspectives: business; scientific disciplines; physiology and health; education; and even political science/international relations.

Cover Story

26.2-mile run tests body, mind

By Gary Mihoces
USA TODAY

No. 7 on USA TODAY's 10 hardest things to do in sports is running a marathon in two-plus hours. Here's why it's hard, from a scientific perspective, from an expert athlete's perspective and from an average joe's.

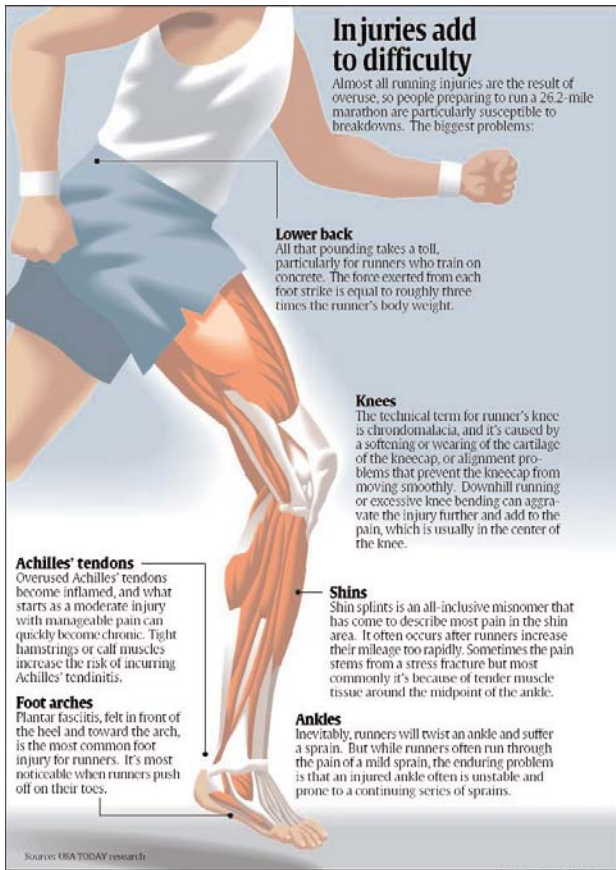
There are 26.2 reasons why running a marathon is hard -- as in 26.2 miles from start to finish.

Scientific explanation

"There is no downtime. You are the machine," says physical therapist Jim Wharton of New York-based Wharton Performance, which trains world-class athletes and weekend warriors.

Marathoners run on hard streets. Wharton says the impact of each stride is three to four times a runner's body weight, transferred from ankles to knees to hips.

AS SEEN IN USA TODAY SPORTS SECTION, FRIDAY, FEBRUARY 21, 2003, PAGE 3C



Elite marathoners train at high altitude, where thinner air prompts the body to produce more red blood cells to carry more oxygen to muscles. They also do speed training at lower altitudes, where they can run faster.

Wharton says it takes five to 10 years to develop a top marathoner. They run 100 to 150 miles a week, which makes resting periods critical.

On his trips to Kenya, Wharton has seen that nation's elite marathoners. "You don't see them going to the mall. . . . They're not standing around. They're in a horizontal position at rest, or they're napping, or they're eating or they're running."

The debate about the difficulty of the marathon, much as the running, swimming and cycling components of the associated triathlon, doesn't center just on the physical aspects. "Motivation, confidence and mental toughness are necessary," says Stephen Russo, director of sports psychology at the University of Pittsburgh Medical Center Health System, co-sponsor of the Pittsburgh Marathon.

In the pack, he says, some might choose to disassociate themselves from the pain by thinking of their taxes or singing a song in their head.

But he says research shows elite runners don't disassociate: "They somehow can manage to stay focused on their running and their stride and their pace. In some ways, your elite-level runner can withstand pain better and can actually function better when they're in pain."

Yes, even the elite feel the pain. But as Russo notes, "They don't have to deal with the pain for as long because they finish faster."

About 450,000 Americans (60% male) ran marathons in 2002. But there is no rule you have to keep running the whole way. Wharton says the accomplishment of just going the distance, no matter how, can leave people "feeling good about themselves."

When Khalid Khannouchi won the London Marathon last year, he didn't do any walking: He set a world record of 2 hours, 5 minutes and 38 seconds.

Five-hour marathoners can participate in the same event, "but in a sense you're light years away from the event he is running," Wharton says.

On his record run, Khannouchi averaged 4 minutes, 47 seconds a mile, 71.75 seconds per quarter mile. Try running such a lap around a quarter-mile track. Imagine keeping that pace for 105 laps, the marathon distance.

Hardest Sports Case Study

AS SEEN IN USA TODAY SPORTS SECTION, FRIDAY, FEBRUARY 21, 2003, PAGE 3C

Toughest part of marathon is training

Expert's opinion

Khalid Khannouchi, who grew up in Morocco and became a U.S. citizen in 2000, has the two fastest times in the history of the marathon, covering the 26.2 miles in 2:05:38 and 2:05:43.

Q: How hard is it to run a marathon?

A: "It's a combination of discipline, hard work, harshness of weather. The most difficult part is keeping your focus for a long period of time. The time I like to prepare for a marathon is four months.

"Marathoners seem either to be training or getting ready for the next workout. You wake up every morning and you know what you have to do. You have long mileage to accumulate. Sometimes you're already tired from your last two or three workouts. You still have to wake up, have the motivation and go outside and do the training. It makes it hard if the weather is really bad.

Involving your body in all these things, it's easy to get hurt. When you get injured, you can get really frustrated. With all the running and pounding, it can happen any day. It's one of

the toughest things. You have to be lucky to have full, safe training. If you can't have that, you will never run a fast marathon."

Q: What's the most important thing about running a marathon?

A: "I always learn something new. The key is you have to be patient mentally and physically. Control of emotions is important. I've found a lot of people can't do that, even if they are professionals. You have to run smart. Sometimes I run in the back of the (lead) group, five to 10 seconds behind. I'm pacing myself and body the way that suits me to run better. That's difficult to do sometimes."

Q: What secrets have you learned that help?

A: "You always set a goal, but you can't have too high an expectation. If you know you can run 3 hours or 3:30, don't think about 2 hours 40. You can think about that in four, five years if you stay healthy. And you have to train smart. You don't go over your limit. Even professional athletes, we make huge mistakes by overtraining or not doing the right things like stretching or strengthening."

Training is tough on the body, but finishing the race is worth it

By Tom Weir
USA TODAY

Average joe

"Big toe explodes; turns purple."

That's a note from my daily training log of 1980, the year I dedicated to achieving my lifelong goal of breaking 2 hours and 30 minutes in the marathon.

That I beat that with two seconds to spare at the Boston Marathon is almost lost among the training-log pages that read like an autopsy, detailing shin splints, tendinitis and assorted purplish parts. The races were easy. The training? Brutal, especially if you're obsessed with running fast.

My best stretch covered 485 miles in five weeks. My typical 100-mile week:

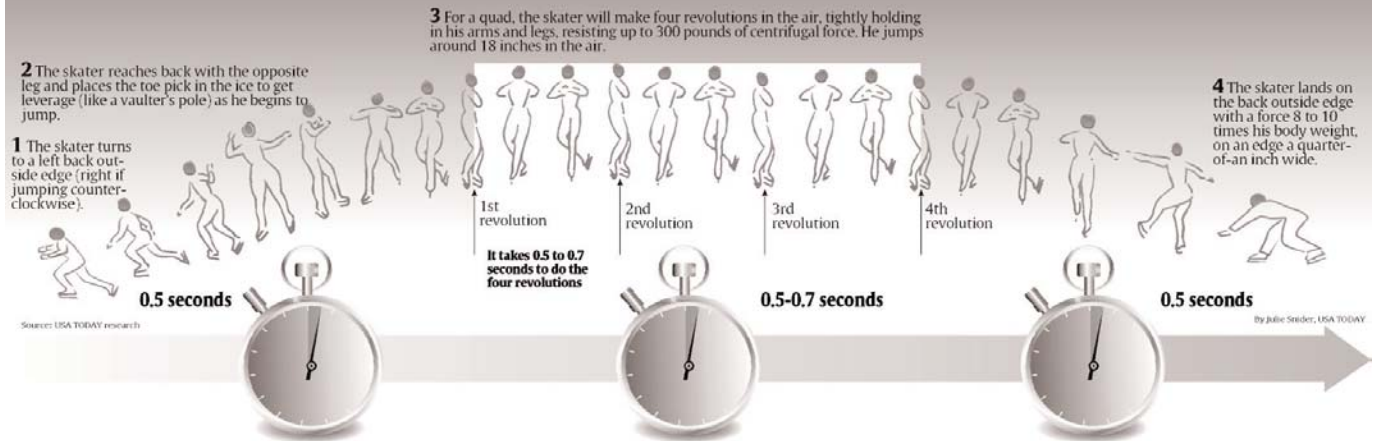
- ▶ Monday, 11.5-mile easy jog in the hills.
- ▶ Tuesday, 20 miles in the hills, 6:52 pace per mile.

- ▶ Wednesday, easy 7-mile morning jog, and 7 miles at night at 5:45 pace.
- ▶ Thursday, five 1-mile runs on the track, at sub-5-minute pace, plus a late-night jog, a total of 19 miles.
- ▶ Friday, 15.5 miles, at 6:28 pace.
- ▶ Saturday, 6-mile jog.
- ▶ Sunday, 7.5-mile race at a 5:15 pace, plus pre- and post-jogs, for 14 miles.

Two-plus decades later, I don't run. My Achilles' are shot, and just about every running pal from my prime has a similar debilitating malady. But I still miss those purple toes.

AS SEEN IN USA TODAY SPORTS SECTION, MONDAY, FEBRUARY 24, 2003, PAGE 3C

The quad toe loop is a delicate balance of height and rotation



Quadruple jump can throw you for a loop

No. 6 on USA TODAY's 10 hardest things to do in sports is landing a quad in figure skating. Here's why it's hard, from a scientific perspective, from an expert athlete's perspective and from an average joe's.

By Gary Mihoces
USA TODAY

Like so many figure skating maneuvers, the "quadruple toe loop" has a curious name. But once you've seen one, you grasp the degree of difficulty.

Scientific explanation

"Think about all the people who can barely slide around the ice on skates. Then think about how you have to skate, jump, spin around four times and then land and look graceful," says Deborah King, an assistant professor of exercise and sports science at Ithaca (N.Y.) College.

King, who has researched skating biomechanics for the U.S. Olympic Committee, says skaters typically jump about 18 inches high during a quadruple

toe loop. They stab the toe of their left skate into the ice and use it like a pole to vault. The four revolutions are completed in 0.5 to 0.7 seconds, King says.

"The whole key is to get the optimal combination of height and rotation," she says. "If you concentrate too much on getting height, you've totally messed up your rotation. So it's really a fine balance."

One key is to keep your arms and legs as tight as possible to your axis of rotation, the imaginary line running straight up and down your body.

"There is a lot of centrifugal force pulling their limbs out during these rotations. They have to be able to maintain that tight rotation position," she says.

"Then they must have the strength to control the twisting on their skate and trunk when they land."

Only male competitors accomplished the quadruple toe loop in competition until Dec. 14, when 14-year-old Miki Ando of Japan executed a clean quadruple



By Robert Hanashiro, USA TODAY

ple salchow during free skating at the Junior Grand Prix final in the Hague, Netherlands.

Hardest Sports Case Study

AS SEEN IN USA TODAY SPORTS SECTION, MONDAY, FEBRUARY 24, 2003, PAGE 3C

Goebel says to let your body take control

Expert's opinion

Tim Goebel, the reigning Olympic bronze medalist, became the first American to land a quad in competition in 1998. A year later he became the first anywhere to land three quads in one program, earning the nickname "Quad King."

Q: In the world of sports, how hard is it to land a quad in figure skating?

A: "It's hard. It's like getting a halfcourt shot in basketball. Only a handful of people can do that."

Q: What's the most important thing about being able to land a quad?

A: "The timing. Every jump has a certain timing, but if you're off on a quad, you're going to splatter."

"It's such a split-second thing."

Q: What secrets have you learned over the years about landing a quad?

A: "I just had to stop overworking it. You need to just let your body do it. Unless you're in a sport like skating or gymnastics or diving, it's hard to explain, but less is more."

Double's hard, let alone trying triple or quad

By Amy Rosewater
Special for USA TODAY

Average joe

In 12 years as a skater, I was thrilled to land doubles. I didn't even attempt triples. Just to land a double required a blend of speed, timing and mechanics, which for me only came together on rare occasions.

Only one woman in the world has landed a quad in competition, and that just happened in December.

Suffice it to say, I was not that woman.

That's why I have covered the Olympics and have never competed in them.

But this, I realized, is the whole point of the story -- to explain why the skating world goes gaga over quads. Imagine having the power and quickness to propel yourself off the ground, then spin four times in the air and somehow have the poise to maintain your balance as you land on a one-eighth-inch blade across a sheet of ice. To skating fans, seeing a quad is as exciting as a Hail Mary, a walk-off grand slam or a hole in one.

When I worked in Cleveland, I stopped by the Winterhurst Ice Rink to do a feature on a local skater. As she was practicing, I couldn't help but notice a young tyke

whizzing by landing triple after triple. I was mesmerized. As soon as the session ended, I pulled aside one of his coaches, 1960 Olympic champ Carol Heiss-Jenkins. "Who is this kid?" I asked. It was Timothy Goebel. Age 11. Who knew then that he would be anointed the "Quad King?"

If skating were basketball, I would have been watching LeBron James. And Dick Vitale, not to be confused with Dick Button, would have been hyperbolizing his every move, baby.

Perhaps Goebel's practices would have been broadcast on pay-per-view.

Years later, Goebel became the first American to land a quad, and he's landed an incredible 63 in competition (including pro-ams) and as many as three in a 4 1/2-minute program. Some of the top men in the world have never landed one in a major competition.

A few weeks after Goebel moved from Cleveland to train with Frank Carroll in California, I stopped by his old rink and it seemed so quiet. The quads had jumped out of the building.

Amy Rosewater jumped at the chance to pretend she competed in the Olympics rather than covered them.

AS SEEN IN USA TODAY SPORTS SECTION, TUESDAY, FEBRUARY 25, 2003, PAGE 3C

You have to see 130 mph serve to return it

No. 5 on USA TODAY's 10 hardest things to do in sports is returning a 130+ mph serve over the net. Here's why it's hard, from a scientific perspective, from an expert athlete's perspective and from an average joe's.

By Gary Mihoces
USA TODAY

During the men's final at the 2002 U.S. Open tennis tournament, Pete Sampras smacked his serves at speeds up to 132 mph.

"At 130-140 mph, you are pushing the limits of the human being's ability to return the ball," says Howard Brody, retired professor of physics at the University of Pennsylvania and longtime tennis researcher.

In that U.S. Open final, Sampras won three of four sets against Andre Agassi -- considered the best in the business at returning serves. Sampras' powerful serve, clocked as high as 135 mph in earlier rounds, was pivotal.

Scientific explanation

Brody says the radar guns used to clock serves measure the speed of the ball as it leaves the racket. Fortunately for returners, air resistance and the friction of the bounce slow the ball.

"As a general rule of thumb, the ball, when it crosses the opposite baseline, is going at about half that (initial impact) speed," says Brody, co-author of a new book, *The Physics and Technology of Tennis*.

That still means the returner has only about a half-second to react and hit the ball.

Return has many factors

By Gary Mihoces
USA TODAY

Andy Roddick, ranked No. 6 in the world, is a 20-year-old rising star in American tennis. Roddick not only returns serves on the greatest stages but also dishes out one of the faster serves. Last year he registered the fastest ever at Wimbledon, 144 mph.

Returning a tennis serve

On a 130-mph serve, once the ball is struck, it is traveling at 191 feet per second, and the distance it has to go from server to returner is 78 feet.

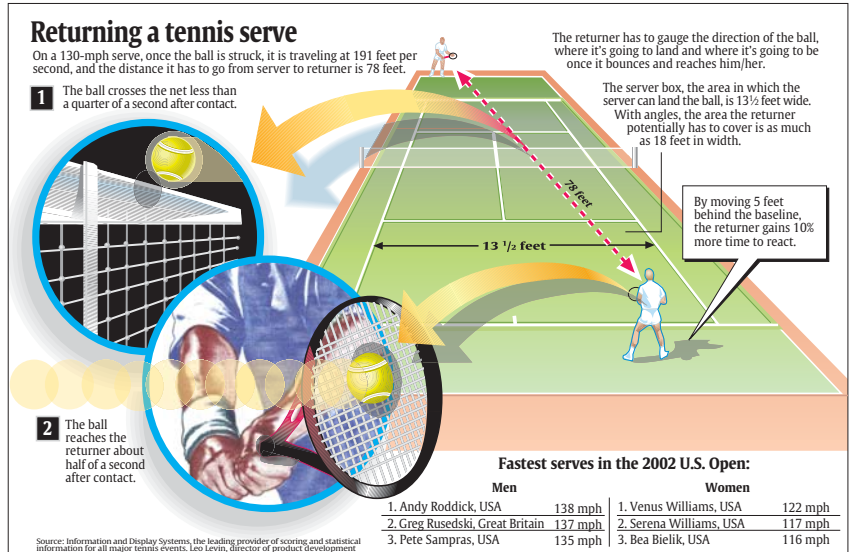
1 The ball crosses the net less than a quarter of a second after contact.

2 The ball reaches the returner about half of a second after contact.

The returner has to gauge the direction of the ball, where it's going to land and where it's going to be once it bounces and reaches him/her.

The server box, the area in which the server can land the ball, is 13½ feet wide. With angles, the area the returner potentially has to cover is as much as 18 feet in width.

By moving 5 feet behind the baseline, the returner gains 10% more time to react.



By Suzy Parker, USA TODAY

Good returners "have incredibly good eyesight," Brody says. "They can pick the ball up earlier off the racket. The sooner you pick up the ball, the more time you have to do something about it."

The fuzz on the ball slows the serve down, but the same fuzz also enables the server to put topspin or sidespin on the ball -- the fibers mesh with the racket strings, giving the hitter more control.

With the dominance of the serve in the men's game, Brody advocates using a slightly larger (by 6%) ball, which he says would slow down the game. "The way things are going, every year the servers get better."

Q: In the world of sports, how hard do you think it is to return a 130+-mph serve?

Expert's opinion

A: "I'd say it's pretty high up there on the list. Being able to return a serve at that speed is one of the biggest things that separates the professionals from the recreational players. It's not just about the power. There are different spins and

Hardest Sports Case Study

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placements, so the pure speed is only one of your worries.

"If you watch the best players, placement can be as deadly as speed. At the pro level, serving is as much about tactics as power. I'm not sure it's that sophisticated for the casual players, and 130 is still a pretty high mark. I've gotten into 140s a few times, but it isn't that common yet."

Q: What is the most important thing about being able to return a 130+-mph serve?

A: "Probably the most important thing is to stay quick mentally. If you get discouraged and your mind starts to wander, then the serves start flying past you."

Q: What secrets have you learned that help?

A: "It helps to have a short memory. You have to be able to brush off a bad loss to compete the next week. It's similar with a big serve. You have to be able to focus on every one, so you can't get down about one that gets away from you. I suppose it's the same thing when you're trying to serve and you mix in a double fault."

Want to be a good returner? First, try looking the part

By Rachel Shuster
USA TODAY

Having played college tennis in the days before women received athletic scholarships, I won't dare pretend I've faced a 130+-mph serve. Now, 129 mph . . .

Average joe

It really doesn't matter. What's most important, in my humble opinion, is how you fake out your opponent with the supreme confidence in yourself. This can be served up in two acts:

► The twirl.

No, you needn't have been a baton expert as a child. But take some time before heading off for the courts to let that racket and your palm become one and the same.

For a right-handed player, left hand rests under the neck of the racket, fingers of the right hand curl around the grip -- and give it a whirl.

Your proficiency in the twirl shows opponents how nonchalant you are about that impending serve,

even if you're nothing but a bucket of quaking jelly inside.

► The rock.

No, I'm not bringing Dick Vitale into this arena, too (although his daughters are excellent tennis players).

By "the rock," I mean your motion as you await the serve. To simulate, recall your most impatient moments, how you might shift your weight from one leg to the other. Now crouch and try it. (For my Jewish brethren, merely call on your "davening" or praying stance, the back-and-forth sway as you commune with the Almighty.)

To cap off your rock, look down to the ground every so often, then back up and bore in on your opponent.

It's that change of pace between nonchalance and steely nerves that'll set you apart.

So is this a foolproof plan for returning serve like John McEnroe?

You can't be serious!

But you'll sure look good trying.

USA TODAY sports assignment editor Rachel Shuster played No. 1 singles and doubles at then-Division III State University of New York at Stony Brook, 60 miles east of -- and many moonballs from -- the U.S. Open.

Serving up aces

In his four-set victory against Andre Agassi in the 2002 U.S. Open, Pete Sampras knew his powerful serve would be critical. A statistical breakdown of Sampras' serve:

- Percentage of first serves put in play: 87 of 152 (57%)
- Aces (no return) on first serve: 28
- Percentage of second serves put in play: 52 of 65 (80%)
- Aces on second serve: 5
- Points won when first serve put in play: 70 of 87 (80%)
- Points won on second serve: 34 of 65 (52%)
- Fastest serve: 132 mph
- Average speed of first serve: 115 mph
- Average speed of second serve: 103 mph

Source: U.S. Open

AS SEEN IN USA TODAY SPORTS SECTION, WEDNESDAY, FEBRUARY 26, 2003, PAGE 3C

Physics rules: Hit ball square

No. 4 on USA TODAY's 10 hardest things to do in sports is hitting a golf ball straight and long. Here's why it's hard, from a scientific perspective, from an expert athlete's perspective and from an average joe's.

By Gary Mihoces
USA TODAY

The rules of golf are set by the United States Golf Association and the Royal and Ancient Golf Club of St. Andrews, Scotland.

But when the club head strikes the ball -- a collision that lasts less than 1/1,000th of a second -- entirely different rules apply.

"The correct technique is essentially determined by the laws of physics and the limitations of the human body," says Theodore Jorgensen, retired University of Nebraska physics professor and author of *The Physics of Golf*.

Jorgensen, who celebrated his 97th birthday in November and worked on the atomic bomb project during World War II, published his book in 1994. Although it's in its second printing, he is the first to acknowledge it's not for everybody.

"Whether a person can get anything out of my book depends on their background. A person who doesn't know anything about physics can't get anywhere with it," he says.

Scientific explanation

Indeed, his book discusses such matters as "inertial torque," "angular acceleration," "wrist cock angles" and "Lagrangian coordinates." This is definitely not one of those picture-filled books on how to improve your game. In fact, it has no pictures at all, only physics diagrams and mathematical charts.

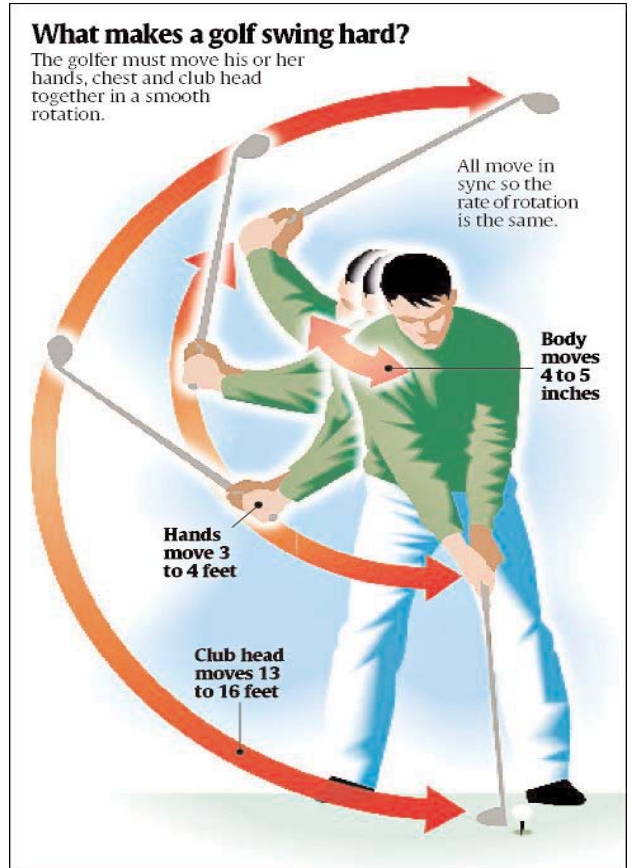
But it scientifically addresses what separates good shots from bad ones.

For example, when a ball is struck, it begins to spin as it leaves the club head. The spin is caused by the ball sliding up the grooved club face as it is struck.

If the ball is spinning along a horizontal axis (think of a level line running sideways through the middle of the ball), it will travel straight, Jorgensen says.

What makes a golf swing hard?

The golfer must move his or her hands, chest and club head together in a smooth rotation.



Source: Brad Redding, PGA

By Bob Laird, USA TODAY

"But if you hit it a little bit crooked, the axis is not horizontal, and that's going to give you a hook or a slice, depending," he says.

For a right-handed golfer, if the axis tilts to the right, it produces a slice right. If it tilts left, it produces a hook left.

From Jorgensen's book: "In order to hit the ball so that its spin has a horizontal axis, the club head should be exactly square to the intended line of flight and the club head should be moving exactly along the intended line of flight at impact."

Easier said than done. And Jorgensen notes, "Even Tiger Woods hits behind the oak trees sometimes like everybody else."

Although golfers always seem to be looking for better clubs, Jorgensen says the key remains a better swing. "A guy told me he'd gotten a new driver to get rid of his slice," he says. "The only problem was now he had a hook he couldn't do anything about. But somebody made a pile of money off of him."

Hardest Sports Case Study

AS SEEN IN USA TODAY SPORTS SECTION, WEDNESDAY, FEBRUARY 26, 2003, PAGE 3C

Learning at young age is best path to success

Expert's opinion

Curtis Strange grew up the son of a teaching pro and began playing golf at 7. He won the NCAA championship and 17 events on the PGA Tour, where he was the first to earn \$1 million in a season. He was among the PGA Tour's leaders from 1979-89 and won U.S. Open titles in 1988 and '89.

Last year he captained the U.S. team in a Ryder Cup loss to Europe. He is ABC's lead golf analyst.

Q: How hard is it to hit a golf ball long and straight?

A: When you grow up in the game as most touring pros did, I don't think it's

all that tough. To me, tough is trying to do something that you're not trained to do.

Q: What's the most important thing about hitting a golf shot?

A: Coordination. I continue to be amazed by Tiger Woods, who swings the club at 125 mph and still hits the ball straight.

Bobby Jones (in the 1920s) was the first man to swing the club with a lot of speed and generate a lot of power. The golf swing has evolved from him. Today we have a lot better athletes, but to make all those movements with the body and deliver the club square to the ball is pretty impressive.

Q: What secrets/tips have you learned over your career?

A: There was no one secret. If you learn the game when you're young, you never get far off.

My swing changes depending on what day of the week it is. I know when I go to the first tee I'm not going to top the ball. I'm going to hit it out there, and it will come down in pretty good shape.

The shot might not look good to me or the other pros, but to the rest of the world it's going to look pretty good.

Lessons, practice can't deliver great swing, but they help

By Jerry Potter
USA TODAY

I've always made the art of hitting a golf ball a lot more difficult than it is. Maybe that's because of the things I've been told by those in the know.

"I can't make you a good player," said Ken Lindsay, who would become president of the PGA of America. "You started too late in life."

"You can't be a Thoroughbred," said Claude Harmon, one of the better teaching pros ever, "but I can make you a racing mule."

At the conclusion of Harmon's school, I received a certificate that pronounced me a member of the Society of Racing Mules. And for more than 20 years I've plowed though golf like an old mule.

I've taken so many lessons that I'd rather try to teach myself. I've asked

pros so many questions that sometimes I know their answers before they give them. And I've hit so many practice balls that I think that's really the joy of the game.

To the casual fan, one pro's swing might look the same as another's, but it's not. Pros repeat their swing, which makes it easier for them to play around their flaws.

Hall of Fame pro Betsy King once said to me, "You can't buy a golf swing." She's right, but she didn't say that you couldn't buy equipment that fits the swing you have.

Pros have been altering their clubs to fit their swings for decades, and in the last 10 years that advantage has been passed down to recreational players. Modern technology -- lightweight shafts, perimeter-weighted irons and

oversized metal drivers -- has made the game more enjoyable for everyone, especially if the equipment is custom-fit.

Blending the swing and the equipment is time-consuming, but I remind myself of the words of Norman Bryant, an old pro from Mississippi, who said, "Boy, I can show you the golf swing in 10 minutes -- and you can spend the rest of your life trying to learn it."

USA TODAY golf writer Jerry Potter is doing just that.

Average joe