




# Can an exotic new racket improve your game?

## Biomechanical analysis of tennis rackets

	<b>Code</b>	<b>adi-pub-01224</b>
	<b>Title</b>	Can an exotic new racket improve your game?
	<b>Subtitle</b>	Biomechanical analysis of tennis rackets
	<b>Name</b>	Popular Mechanics
	<b>Author</b>	Robin Nelson
	<b>Published on</b>	Tuesday, May 18, 1976
	<b>Subject</b>	ACES; Discus; Exercise Machine; Favorite; Legal; Media; Science; Shoes; Sports; Studies; Tennis
	<b>URL</b>	<a href="https://arielweb.com/articles/show/adi-pub-01224">https://arielweb.com/articles/show/adi-pub-01224</a>
	<b>Date</b>	2013-01-16 15:40:50
	<b>Label</b>	Approved
<b>Privacy</b>	Public	

The article by Robin Nelson discusses the technological advancements in tennis rackets and their impact on the game. The author notes that the surge in tennis players over the past five years has led to an atmosphere of technological innovation. However, he argues that the importance of these advancements, particularly in racket design, is often overstated. The article explores various claims made by racket manufacturers, such as the supposed benefits of composite construction, reduced wind resistance, and vibration damping. The author consults various experts, including tennis pros and engineers, who largely debunk these claims. The article concludes that while more research into tennis-related injuries is needed, poor stroking technique, not faulty rackets, is the leading cause among amateur players.

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Below find a reprint of the 4 relevant pages of the article "Can an exotic new racket improve your game?" in "Popular Mechanics":



The best weapon for a winning game may not be costly model you've wanted

If you haven't been through racket section of a tennis pro or large sporting goods store recently, it may surprise you to find an array suggesting that NASA physicists are trying to reconstruct medieval armor. The tennis ball being invaded by technology, the current focal point being ultimate "weapon" of the game racket.

Only five years ago, you chose between a wood or metal racket paid about \$35 for a top-line, professionally endorsed model. You can walk into a tennis spec store and easily pay as much as \$200 for a racket that may not only give you a significant lift to game, but could actually incur your chances for a serious case of tennis elbow. The price of some 30 ml Americans into tennis in the

# Can an exotic new racket improve your game?

by Robin Nelson  
POPULAR MECHANICS

PM photo: Bob Go

a formal Israeli Olympic discus thrower, heads a Massachusetts firm called Computerized Biomechanical Analysis. By computerizing the images from high-speed motion-picture film of various athletic activities, Ariel can analyze performance and utilize computer simulation to predict the results from adjustments or improvements in both technique and equipment. He helped Spalding design a new tennis ball, and those studies have prompted him to look more closely at tennis rackets.

Besides talking to Ariel and other researchers, I also consulted such tennis experts as Vic Braden, the psychologist-tennis pro who runs a California complex known as the Tennis University and has become one of the country's best-known teaching theorists, and Roy Emerson, the Australian champion who has won more major tournament singles and doubles titles than any other male player and now spends much of his time teaching. As a result, I reached one primary conclusion concerning tennis rackets: Their importance to the average player's game is entirely overstated. What follows is a rundown of the most common misleading impressions.

■ My selection of a tennis racket is critical to my game. In the words of Vic Braden, "the selection of a racket is way overplayed. Everything is already over-engineered, and by that I mean there isn't a player on the face of the earth who can play up to the potential of any good, modest racket—wood, metal, what have you."

■ My racket doesn't give me enough power. Any 10-year-old with a reasonably well-coordinated swing can hit a tennis ball from one end of the court to the other with good pace (speed) on it. Whippy metal rackets offer a trampoline effect that can add speed to a shot, compared to a stiff wooden racket, but is it relevant? "The average player's over-whelming problem," says Vic Braden, "is not generating more power but controlling the power he or she already has. Racket designers talk about increments on the order of four miles an hour now—it's meaningless."

■ Then maybe I just need a heavier racket. Probably not. You remember the formula for kinetic energy—mass times velocity squared over two. You gain a lot more power by increasing velocity rather than weight. That "macho" type at the tennis club with the heavy racket has forgotten that Mickey Mantle swung one of the lightest bats on the whole Yankee team.

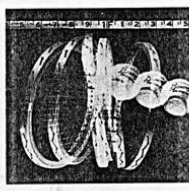
■ Okay, how about a new racket

with less wind resistance? Ads for rackets with a divided throat or a "slimmer profile" make much of low wind resistance and are a classic case of those minuscule increments Braden talks about. They never go into exact figures or factors. Besides, swinging a racket with any upward or downward component to add spin to a shot changes the angle of attack to the resisting air away from 90° and farther dissipates the infinitesimal advantage—it could

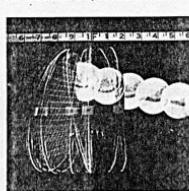
Photo: ProGroup, Inc.



Metal racket, shows flex in MIT photos.



Laminated wood racket showed the largest flex in tests for Tony Trabert Division.



Graphite, in ProGroup's Tony Trabert C-6 model, appeared strongest with least flex.

even result in a divided-throat racket having more "wind resistance."

■ Forget power, then. I want one of the new rackets that will give me more "touch," more "feel." Good luck. Gideon Ariel's studies at CIA showed that a tennis ball makes actual contact with any conventionally strung racket, under normal playing conditions, for only 3.7 to 4.2 milliseconds. It takes a nerve impulse approximately 50 milliseconds or more to get from your hand to the cortex of your brain. In other words, the ball is long gone before you "feel" it, and as far as your being able to "control" the ball while it's on the racket, that's pure fantasy.

■ I'll change my strings, or loosen them, for more control. More mythology. Ariel's tests also showed that even when loosely strung rackets were involved, the composition of the racket frame more often determined differences in how long the ball resides on the racket face—and on some of them it was less time than with tighter stringing. Bernard Kaminitz, who developed a unique stringing pattern for the Pancho Segura Sweetspot racket, used a computer to analyze the behavior of strings very closely. He claims extensions of residence time by as much as a factor of 10 on his string pattern (remember, we're still talking milliseconds) and the ball is still gone before you can react to it.

■ In his work, Kaminitz also coincidentally exploded one of the most widely held misapprehensions in tennis: Gut strings are more resilient than nylon. "Gut and nylon have nearly identical coefficients of elasticity," says Kaminitz, "and elongation under strain is also the same. If there is a difference that could affect play, it's only in the surface of gut strings which are rough on a microscopic level, and keep the strings from moving as much as nylon, and therefore dissipating energy through friction." A substantial difference? "Not at all," says Kaminitz.

■ Graphite and composite rackets resist torque from off-center shots. That'll help my game. A stiffer racket, whether graphite or graphite fibers, will give less twist when the ball strikes away from the dead center of the strings. However, more of the initial shock of that twisting force will be transmitted to your elbow, and doctors who have studied the problem say torque is a major factor in the tendon and muscle inflammation we call tennis elbow. Tennis professionals, who play most frequently, have not rushed in great numbers to

(Please turn to page 242)

## FASTEST INDY EVER!

(Continued from page 241)

Foat to Indy this year? Well, no one knows that A.J.'s got the stuff to be either the first man to go over 200 mph at Indy or the first man to win a fourth Indy 500. Or both.

### Janei Guthrie's car

Let's be thoughtful that the famous four-cylinder Offenhauser engine is dead, consider the fact that Roger McCluskey eased his Lightning-Only up to 198.7 mph in tire tests last summer. That car, by the way, has been sold to Rola Voldstedt for Janet Guthrie to drive. This could be the year that Tony Hulme's team to abandon that famous and dramatic line, "Gentlemen, start your engines!"

McCluskey will be at the helm of a brand-new Lightning, as will two-time winner Bobby Unser. The new Lightning cars were designed by the Roman Shobdytsky who did the current crop of Eagles for Dan Gurney (but not the new one), and there could be as many as seven of them at the track this year.

### The Wildcats

Not be left out are George Bignotti's creations. They're called Wildcats and will be driven by Wally Dallenbach and 1976 USAC National Champion Gordon Johncock. Gordon, Indy winner in 1973 in a Bignotti-prepared Eagle, had the Sinmatt-sponsored car in the middle of the front row last year so it's a proven fast car.

"They're going to go 200 mph at Indy, but it won't be during May," says Bignotti. "I think it'll be during the off-season when the weather's cool. Unless it's a very cool day, I don't think we'll see 200."

### More blown engines

Mount everybody agrees that the removal of the pop-off valve during the race is going to mean more blown engines and less car-to-car dicing because a driver can dial up a little more boost to whiz away from somebody who's closing. But at the same time, he risks overrestraining his engine.

And 200 mph? Well, it could happen. But it's going to take an optimum day—cool, no wind—and a perfect lap to do it.

But the driver who does it will carve a special place for himself in the record books. And there are going to be at least a dozen drivers at Indy this year shooting for that record. ★★

## TENNIS RACKETS

(Continued from page 96)

graphite or composite rackets.

■ But pros always hit the ball with the center of their racket strings. Tennis racket manufacturers seem to think so, but the pros themselves often disagree. "Hardly anybody, amateur or top tournament professional, can consistently hit a ball with the center of the strings," says Vic Braden. "It's so unusual that I remember years ago when Pancho Gonzales and I walked into the Chautauque Tennis Club one day both of us stopped in our tracks because Rafael Osuna, the great Mexican catching the ball dead center time after time. That's very rare."

■ Then I should play with the racket my favorite pro uses. There's no telling, but it's certainly not critical. Your favorite pro could probably play and win with any of a dozen rackets. Some do, almost; Swedish star Bjorn Borg uses a Bancroft racket when he plays in the U.S., a Donay model in his European appearances and a Slazenger in Australian tournaments, because he gets paid hard cash for it. In addition, professionals often string their rackets very tightly; the same racket more loosely strung for an average player's game is a different animal.

■ Graphite rackets "damp" vibrations. Their manufacturers make that claim, but it's relative and perhaps, depending on the particular racket, even false. One of the problems is that manufacturers' best test rackets that are firmly gripped by a vice-like support, and the reaction to shock is entirely different than it might be in actual play.

"In play," notes Gideon Ariel, "the racket and the player's arm rotate as a unit from the shoulder, and among other things this establishes the racket's center of percussion at somewhere down on the shaft, near the throat, not in the center of the strings, on the so-called 'sweet spot' because the ball strikes any racket at a point other than the center of percussion, vibration patterns resonances result, and the behavior of the racket's center of percussion is often unpredictable. In our computer simulations showing vibrations transmitted to the racket grip, some of the graphite rackets vibrate more than other kinds."

Right now, there is so much disagreement on the role of vibration in tennis elbow, and investigation is in such a preliminary stage, that the player pretty much has to experiment for himself if he is prone to the condition. ★★

The medical profession tends to recommend a flexible (metal) racket to absorb initial shock; researchers after the initial shock, after the ball has left it, may be more of a factor in causing tennis elbow than the impact itself. When it comes to vibrations, "similar" materials—metals—are least effective in damping, and actually amplify vibrations, the impact that will cause tennis elbow than "dissimilar" materials tend to damp them. Few are more effective than that natural composite of cellulose and resin we call wood. ■ But wood rackets get worn out, mushy, after a while. Maybe so, but it takes a lot of hitting tennis balls before that will happen. Roy Emerson tells participants in his tennis clinics a favorite story about the great Aussie player of 30 years ago. John Bromwich, "Iromwich played with a beat-up old wood racket stringed like a fishnet," says Emerson, "and won with it, much to the dismay of his sponsor, the Slazenger people."

"One day, after running through an opponent, 6-0, in the first set, he broke a string on the old bat and they rushed a new one out to him. Bromwich easily closed out the second set, 6-1, but when he lost that one game you could see his expression change. Barely maintaining control of himself, he finished the match, stormed off the court cursing his 'sloppy new racket' and then immediately threw it away."

For most of us "intermediate" (or struggling to be) tennis players, the point should be clear. Of the several courses open leading to improvement in our play, buying a new racket seems to offer the lowest percentage, hitting the ball, even perfectly, is after all only part of the game. And while more research into tennis elbow and related conditions is sorely needed, all authorities agree that poor striking technique—not faulty rackets—is the leading cause among amateur players.

"In our studies among hundreds of students of the game," says Vic Braden, "I've found only one occasion where a significant improvement in play can be related to equipment. That's when you break your racket and have to borrow one. Quite often there's an immediate lift to your level of play; we attribute it to relaxation—the pressure's off, you can't be expected to perform well with a racket you're not used to, and so forth. We also find this lift lasts as long as it takes you to go out and buy a racket just like the one you borrowed, then you're back to your old game again."

In tennis, it seems, technology is no panacea. ★★