

# Building the Athlete of the Future

*Researchers are deciphering the biomechanics of motion and the chemistry of strength*

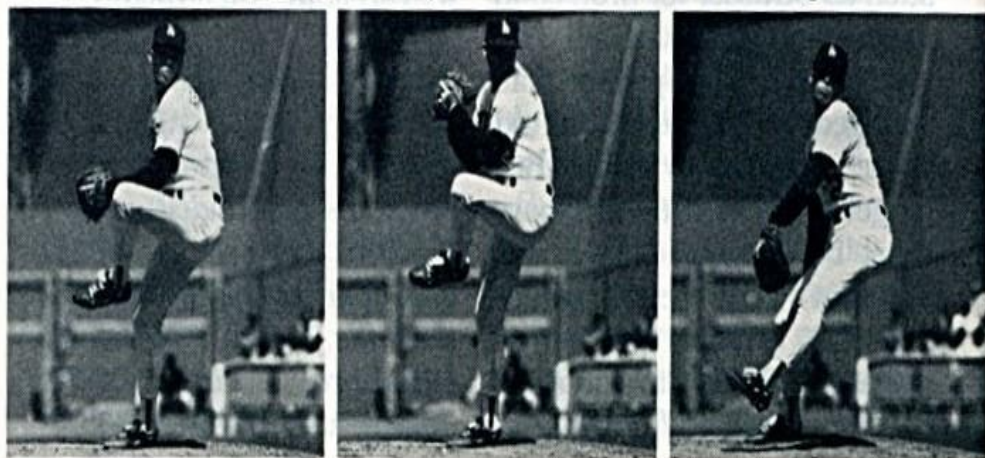
By Patricia Loverock

Adapted from the *Los Angeles Times Magazine*

**A** research subject by the name of Orel Hershiser appears on a movie screen in a hospital laboratory. Hershiser is pitching the ball for the sake of science, so rather than Dodger blue he wears only a baseball glove, shorts, socks, shoes, and an array of electrodes and wires. As he throws, the upper body that looks slightly skinny

on the mound is remarkably muscular and fluid. He uncoils and explodes across the screen in slow motion—frame by frame—hands, wrists, arms, trunk, hips, and legs flowing together in perfect synchronization as he winds up and lets the baseball go.

Sixteen-millimeter cameras are filming front, side, and overhead views of the pitch at



## ATHLETE OF THE FUTURE

500 frames per second. On an 8-foot-high console, 2,000-foot reels of quarter-inch magnetic tape record microprocessed signals from every twitch of Hershiser's muscles. An oscilloscope's electrical wave traces his muscular activity, and a printer simultaneously spews out a copy of the image appearing on the scope.

Hershiser's cooperation with the scientists at Centinela Hospital Medical Center is helping to define the path of athletic excellence to come. On film and on an electrical energy graph, Hershiser is part of a study of human movement that may enable doctors to understand how muscles function—and malfunction. The information they're gaining could allow them to diagnose and treat injuries without surgery and ultimately help prevent sports injuries. It's just

one of the experiments being conducted in biochemistry, biomechanics, psychology, and genetics that may change the way American athletes are trained, treated, and expected to perform in the next century.

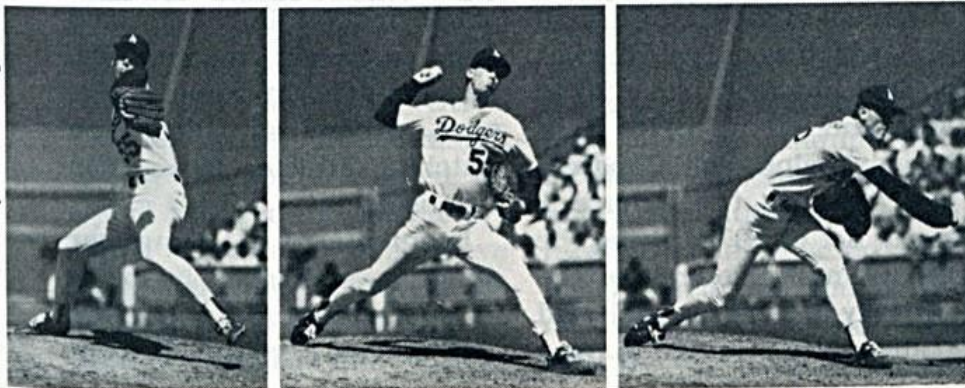
---

*Athletes are feeling the pressure to turn to science—not for steroids but for safe ways to reach their potential.*

---

Surprisingly, in this country “the whole idea that science has something to do with the performance of athletes is new,” says Harmon Brown, chairman of sports medicine and science for the Athletic Congress, the governing body for track and field in the United States. Americans, he says, have been slow to accept the idea of sports as a legitimate

Orel Hershiser, courtesy of the L.A. Dodgers



## ATHLETE OF THE FUTURE

---

focus for research. The Soviets pioneered the field before the 1952 Olympics; they traveled around the world to film outstanding athletes and study their training programs. Then in 1952, instead of just copying, they began designing their own research.

---

*The stunning performance of East-bloc athletes in the 1970s spurred the U.S. Olympic Committee to fund scientific research.*

---

The results were dramatically apparent in the 1972 Summer Olympic Games, when Soviet athletes, who just four years before had won 29 gold medals to the United States' 45, came away with 50 gold medals, besting the 33 won by the United States.

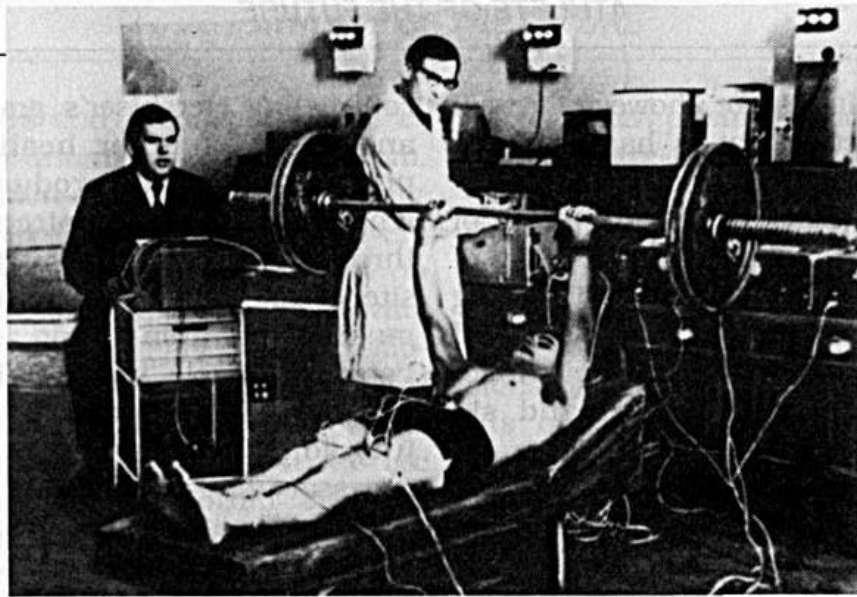
Equally striking was the improvement of the East German team, which won 9 gold medals in 1968 but took home 20 in 1972 and 40 in 1976. That showing helped jolt Congress into passing the Amateur Sports Act of 1978, giving the U.S. Olympic Committee the authority to fund research and create an organization to raise

money for scientific support programs.

As the U.S. sports-research program begins to bear fruit, it is changing the shape and psyches of American athletes, who are feeling increasing pressure to turn to sports science not for the quick fix of steroids and illegal performance enhancers but for safe, sophisticated ways to reach their potential. What follows is a sampling of the ideas and experiments that could help create the American sports superstars of the next generation.

The science of biomechanics is based on observation. Watch the body perform a movement, analyze that motion, and use the findings to adjust the next performance. Increasingly, scientists and coaches are using advanced technology to observe activity that is not readily visible to the eye, breaking a single motion into finer and finer parts and, theoretically, perfecting it. In coming decades, experts say, they'll be watching athletes move from the inside out.

Biomechanical computer analysis established its place in sports training when the U.S. women's volleyball team



*The Soviets were the first to use scientific technology in sports training. The electrodes attached to this weightlifter helped researchers understand how he used his muscles during each lift.*

won its first Olympic medal, a silver, in 1984. Head coach Arie Selinger gave much of the credit to Gideon Ariel, a biomechanics researcher and computer expert at Coto Research Center outside Los Angeles.

Using technology he developed in 1968 when he "married WordStar to 'Rocky,'" Ariel converted videotape images into colored stick-figure drawings that moved in three dimensions. The simple images on the computer screen allowed Selinger and Ariel to see what a trained human eye missed: the precise angle of the players' joints as they jumped, served, blocked, and spiked.

Movement of the joints is a clue to the workings of the muscles, showing which muscles are working the hardest and pinpointing possible weaknesses. Selinger and Ariel used the computer data to adjust the team's training programs and, Ariel says, to make medalists of what might have been a fifteenth-place team.

Such computer models are being used to answer specific questions—for example, how far do an athlete's hips move above the hurdles during a race? That information might tell a coach that the hurdler needed to lower his lead leg to clear the barrier more efficient-

## ATHLETE OF THE FUTURE

---

ly. It cannot, however, reveal exactly what is happening in the body. Providing that internal view is the next phase of sports biomechanics. Part of this effort is the study involving Hershiser, which analyzes and compares the movements of seven professional and six amateur pitchers.

---

*Hershiser learned that "no-pain, no-gain" can apply in the lab as well as in the gym.*

---

The Centinela scientists record not only a slow-motion visual image of Hershiser but also a map of the electrical impulses produced by his shoulder muscles from windup to follow-through. An active muscle will fire (transmit an impulse) frequently. A muscle that is working less hard, perhaps because of weakness or injury, fires less frequently. Once scientists know how the muscles fire when one of the best pitchers in baseball history throws a ball—and exactly which muscles are used in pitching—they can use that model to help treat pitchers who are injured or in pain. By

contrasting Hershiser's graph and those of other healthy pitchers with one produced when an injured pitcher throws, they can pinpoint the site of an injury by spotting muscles that aren't firing as a healthy muscle would. This will allow them to spot an injury long before surgery is necessary.

The "no-pain, no-gain" maxim applies in the lab as well as in the gym: Before the film is shot, a lab technician uses hollow needles as thick as toothpicks to inject fine nickel-chromium wires into eight sites in the pitcher's shoulder. At each site, a 22-inch-long wire is carried by the needle directly into the belly of the muscle, as far as an inch deep. (There is a cot in a corner of the room for those who faint during the process.) The technician gently pulls out the needles, but the wires remain. For a few seconds, the muscle aches—"it feels like a charley horse," says lab director Marilyn Pink—until the wires find a comfortable place to lodge. Once they do, they act as antennae, conducting signals to a radio transmitter Hershiser wears on a belt. The transmitter amplifies the sig-

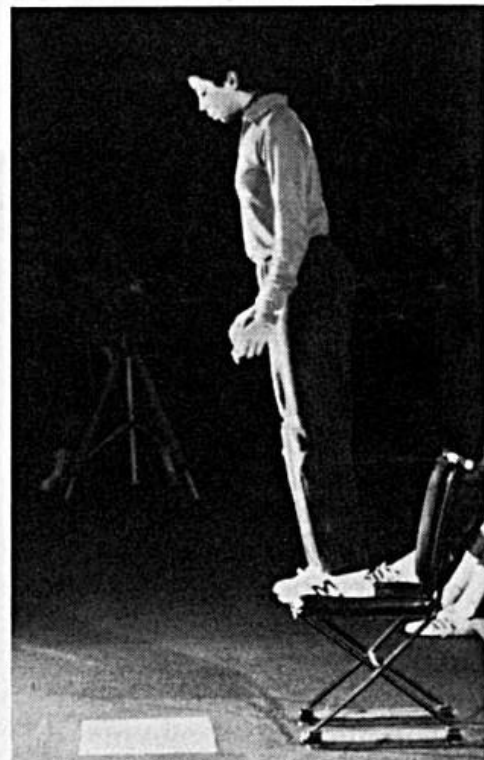
## ATHLETE OF THE FUTURE

nals and broadcasts them to an antenna across the room, which relays them to a receiver on the computer console. Every muscle twitch is recorded on tape, then appears as a glowing green jagged line on the oscilloscope screen. High, frequent peaks on the screen show the firing of the most active muscles; smoother sections with lower, less frequent peaks show when muscle activity is winding down or impaired.

"If you combine the patterns we get from the computer screen with the high-speed film, you can see how the muscles are interacting with each other," says Robert Gregor, an associate professor of kinesiology at UCLA who conducts high-speed film research on college athletes. "We can slow it down tremendously, and this allows you to go through the parts of the movement, quantify it, and provide an analysis that might be helpful in strengthening and rehabilitating." The goal: to be able to give athletes a kind of "instant replay" analysis so that they can make immediate adjustments in technique and training. The Dodgers are using the results of the recent-

ly completed pitching study to tailor injury-preventing conditioning programs, says Bill Buhler, Dodger head trainer.

Ariel hopes to give added scope to movement analysis by using holograms, three-dimensional laser images. Sitting in his office, he envisions a scenario from the 1990s: "If I want to see Carl Lewis jumping right on this table now, using laser technology, I could push



*On the floor is a "force platform" that will record how strongly this athlete rebounds from a jump.*