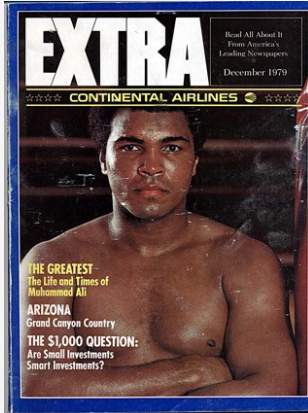




Athletes Turn to Science

Because of Dr. Gideon Ariel, athletes and athletics will never be the same



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Author: Kay Cassill

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Synopsis: This article discusses the work of Dr. Gideon Ariel, a pioneer in the field of biomechanical analysis. Ariel's company, Computerized Biomechanical Analysis, Inc., uses technology to analyze and optimize human motion, with a particular focus on athletic performance. The company has worked with world-class athletes, sports teams, and equipment manufacturers to improve performance and safety. Ariel's work has revolutionized the way athletes train and perform, shifting the focus from traditional coaching methods to a more scientific approach based on data and analysis.

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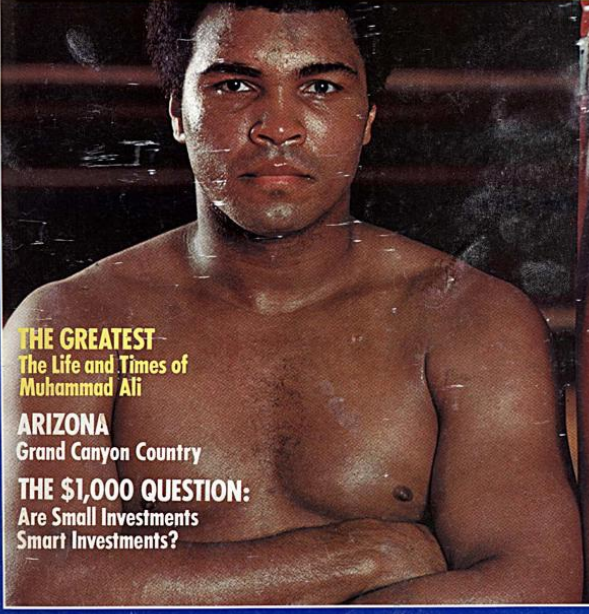
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Athletes Turn to Science, Not Coaches, for Help

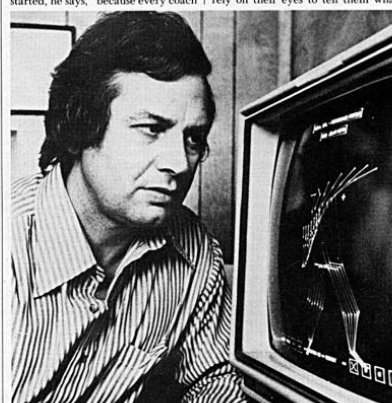
by Kay Cassill—Because of Dr. Gideon Ariel, athletes and athletes will never be the same. Ariel, who is in the business of analyzing human motion, operates out of a small office tucked inconspicuously between Erik's Giant Subs and a Radio Shack on Route 9 in Amherst, Massachusetts. The sign on the door reads: "Computerized Biomechanical Analysis, Inc." Inside, the low hum of computers blends with discreet canned music. It could be almost any business office anywhere.

But Gideon Ariel and CBA are anything but anonymous. Terry Albritton, the world champion shotputter, knows about them. So does Mac Wilkins, the world discus champion. The Kansas City Royals, the Dallas Cowboys and the U.S. Olympics Committee know all about them, too.

CBA, the world's first research firm created to analyze and evaluate the dynamics of human motion, was founded in 1971. One of the company's earliest projects was to find practical applications of these dynamics for the treatment of muscular dystrophy patients. Since then, Ariel and his associates have worked on development of industrial and sports equipment and in the areas of consumer and industrial safety.

These projects led to the brainstorm that makes athletes the world over regard Ariel as an Israeli version of the Wizard of Oz. Once he realized that engineering mechanics could be applied to the human body, he was off and running.

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82 EXTRA/DECEMBER 1979

SPORTS (continued)

was going on. But the human eye cannot quantify movement.

Ariel, now a United States citizen, has been in the States for fourteen years, but his Israeli accent remains pronounced. "The most important things in athletic performance—timing, relative speeds of dozens of limb and body segments, changes in the centers of gravity—must be weighed, measured and compared to each other to be of any use," he continues. "Since you cannot see the forces with your eye, the best a coach can do is describe what a move is supposed to look like."

After earning a Ph.D. in exercise

'We can optimize the human body.'

science from the University of Massachusetts and a post-doctoral degree in computer science, Ariel turned to a third field. "I didn't see," he explains, "why you couldn't apply engineering mechanics to the human body, so I began to study all the engineering I could get."

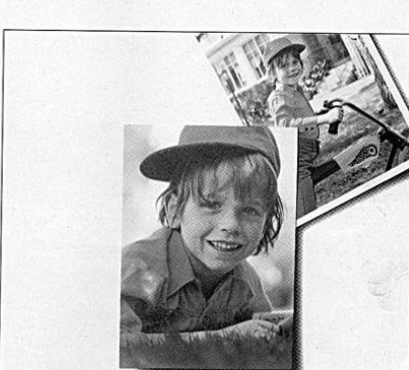
Then one of his professors suggested he put the computer to work analyzing the data he was accumulating. "I had used computers for statistical analysis, but that was all. To discover the computer could be used as a tool to analyze the human body—that was a revelation. It fascinated me."

Ariel, still athletic at thirty-nine, springs from his chair to answer the telephone. He remains task-oriented, in spite of his vice-presidency of CBA, Inc., his adjunct professorship in exercise science at the University of Massachusetts and his recent appointment to the directorship of research in biomechanics and computer science for the U.S. Olympic Committee. The plans for the 1980 and 1984 games are in the making.

Very well, then, Ariel helps make "bionic athletes." How?

He starts with slow-motion cinematography, recording the motions of the athlete during performance. These images are then projected on a

two-foot-square wall screen. With the use of special tracing equipment (a Model GP-3 Graf-Pen Digitizer), he marks the joints and the lines between them in sequence, then he feeds this information into a high-speed computer. The computer digests it all and comes up with a series of stick-figure pictures. A frame-by-frame, body-segment-by-body-segment analysis allows him to capture the stance of the athlete's body at the very moment of



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EXTRA/DECEMBER 1979 85

SPORTS (continued)

until now too many things happened too fast during the athletic performance. When a javelin thrower is about to release the javelin, the sheer complexity and velocity of his movement kept us from understanding—from seeing—what was going on."

His speech is peppered with engineering talk of forces, counterforces, points of stress and arcs of swinging motion, and with anatomical terms like bone, sinew and muscle. His precise but rapid enunciation accelerates when he talks about how his work with the Olympic Committee

Athletes the world over regard Ariel as an Israeli version of the Wizard of Oz.

has increased the pace of his life. "It's a once-in-a-lifetime chance, so I'm devoting the major portion of my time to the task."

Ariel might be negotiating a sports-equipment deal in Berlin on Monday, addressing a sports-medicine convention in New Orleans on Thursday, then flying out to California to check out the results on an Olympic athlete's performance, with stopovers for lectures at various sports symposia in Flint, Michigan, Chicago or South Bend, Indiana.

The equipment jam-packed into CBA's back-room laboratory could be straight out of a *Six-Million-Dollar Man* episode. Everything seems to be wired to everything else. There are dials, platforms, counters, pressure platforms, oscillating circuits and projectors. We're at the computer screen watching a green stick figure crouch, spring, str-r-r-e-t-c-h.

"With swimmers you have two kinds that start—the stretch start and the grab start," Ariel says. "We don't know yet which is best. We want to find out which one generates the most force in the direction of the swim. It could be complicated because sometimes just the fact that you land in the water at a certain angle will give you force. But we can figure it out—how

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EXTRA/DECEMBER 1979 87

the water and the angle of entry affects this.

What did he do for discus-thrower Mac Wilkins?
 "He was photographed in action with high-speed cameras. From the photos, we analyzed his throw. We told him his front leg was absorbing energy that could go into the throw. We discovered a pattern in the best throws. Instead of continuing the throw with a follow-through motion, we said he should decelerate the heavy parts of the body—the legs and

'We use the computer . . . to predict the ultimate human performance in each event.'

the trunk—while he accelerated the lighter parts—the arm and the discus. If he did that, we said, he could be the world record holder. Within a week, he broke the world record by fifteen feet. Very unusual. He said we changed all of his philosophies about throwing."

With shot-putter Terry Albritton the problem was similar. "He was bending his knee, but that was wrong. He needed that front leg to be like a solid block to throw from. We told him, he changed it and then put the shot farther than he ever had before."

Ariel is positively gleeful, as if he'd done it himself.

When it comes to analyzing motion, it appears there is little CBA, Inc., won't tackle. The firm helped the Kansas City Chiefs study the performance of their linemen and the Kansas City Royals study the throwing techniques of their pitchers.

Sports-equipment companies come to Ariel for all sorts of answers.

"Take golf, for instance. Spalding wanted to know more about the characteristics of a golf club—how it behaved in use," he says. "Now, all golfers do not swing in the same manner, but the principle of mechanics governing the swing is true for all golfers. Let's say you want the most velocity upon impact. You can create

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it by using your body segments correctly. You cannot use the arm and then the trunk. You always have to use the trunk first and then the arm. Knowing how these should accelerate, how they should combine is what counts. We came up with some answers for Spalding."

He's worked on developing a better running shoe for Uniroyal, an artificial turf for another firm, and, again for Spalding, he came up with a higher-bouncing tennis ball. Then there were the wobbly basketballs.

"We were asked to design a better one. The manufacturers were wondering if the geometric center of the ball coincided with the center of the mass. If not, it would have a looping effect.

"If you don't distribute the mass correctly you have a problem. Say a few panels on the ball are heavier than the others. Then the geometric center will not be the same as the center of the mass. You get a wobbling of the ball. We took films of people throwing a basketball. It didn't behave as it

should have—it didn't follow a parabola. When we discovered this we helped them create a symmetrical ball."

He puts his sneakered foot on a platform—a \$25,000 force plate—in the middle of the room. It transmits

his bones and the speed of the film frames, we can calibrate how much distance is covered per second," he says, totally absorbed in the possibilities.

Because of the precision and variety of CBA's machines and the way

The most important things in athletic performance must be weighed, measured and compared to each other to be of any use.

readings of four kinds of pressure—vertical, forward, sideways and twisting—to an oscilloscope charting the forces in footstrike in different shoes at every point of foot placement. He is as serious as if he were reading an electrocardiogram.

"Knowing the angular displacement of a runner we can calculate the displacement of his ankle, hip and knee joints. If we know the length of

they are linked together ("that was the hardest part"), his knowledge is also working toward the prevention and treatment of injury in sports. Recently he analyzed a film of the Dallas Cowboys in order to tell them if their injured players were returning to normal patterns.

But it's in the use of his small, new \$60,000 computer that Ariel reaches furthest into "bionic" athletics. By

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putting a flexible disk that holds nearly a million bits of information on an athlete in the computer, Ariel can work out an individual program for him. If it weren't for the fact that film takes time to develop, he could give that athlete instant playback so he could correct himself on the spot.

"We can optimize the human body," he says, not visibly disturbed by the suggestion that he's getting into artificial intelligence. "Every body has some kind of capacity. The thing is, an athlete doesn't always use it correctly. Let's say he releases the ham-

'Discus-thrower Mac Wilkins said we changed all of his philosophies about throwing.'

mer at ten degrees lower than he should. The hammer will land about ten feet closer. He had the capacity but didn't know what angle was most efficient for his system to release it.

"We can calculate that. But we try out the change on the computer first, before we ask the athlete to do it. The athlete can watch himself doing it in different ways right on the computer screen. We can get them to do their best, at their present physical state. After that, we can create a training routine, tell them to lift weights, do certain exercises."

Are there no limits?
 "Of course. There is a limit to man. But we use the computer for figuring out all kinds of simulation techniques in order to predict the ultimate human performance in each event."

Among the more far-out requests CBA, Inc., has received are some that have come from the government. The National Bureau of Standards wanted to know what forces were required to shake up a ketchup bottle. Also, what forces it takes to strike a match. ▶

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