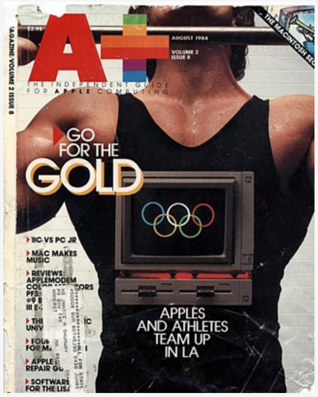
Ariel Dynamics Inc. Media Library - Article

Go for the Gold

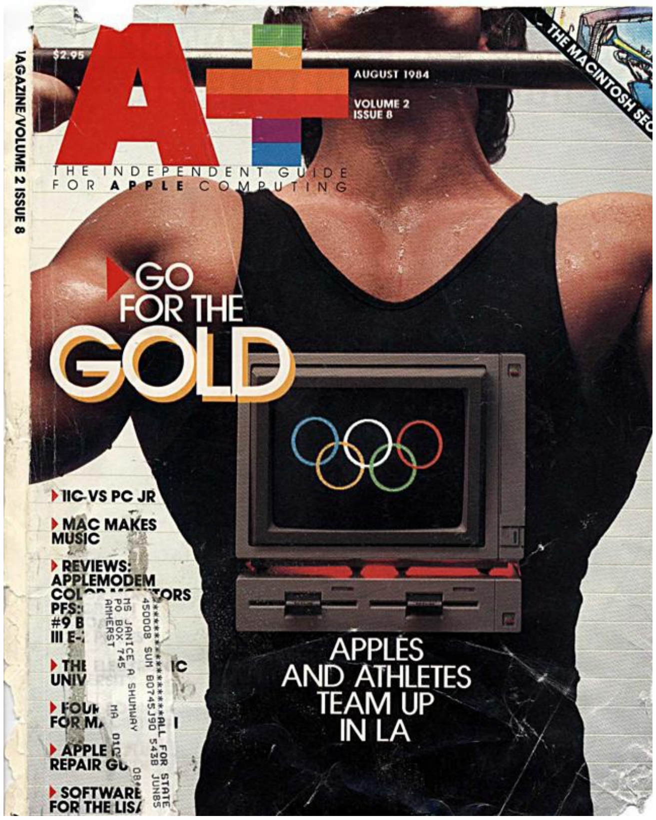
Pioneers of a new science in sports analysis-biomechanics-are asking this question. Apple II computers arc helping to answer it.

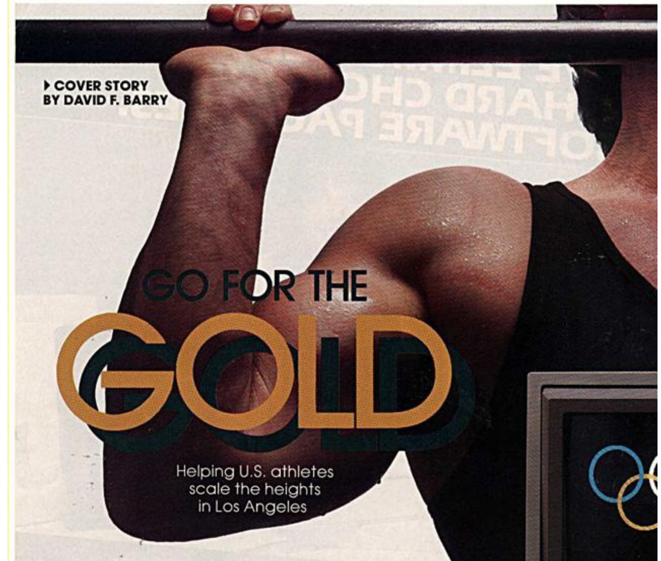


Code	**adi-pub-01170**
Title	Go for the Gold
Subtitle	Pioneers of a new science in sports analysis-biomechanics-are asking this question. Apple II computers arc helping to answer it.
Name	A+
Author	David Barry
Published on	Wednesday, August 1, 1984
Subject	ACES; APAS; Biomechanics; Capture; Digitize; Discus; Exercise Machine; Favorite; Force Plate; Media; Olympics; Performance Analysis; Science; Shoes; Sports; Studies; Volleyball
URL	https://arielweb.com/articles/show/adi-pub-01170
Date	2013-01-16 15:40:48
Label	Approved
Privacy	Public

This article by David F. Barry, published in A+ Magazine in August 1984, discusses the role of biomechanics and Apple II computers in enhancing the performance of Olympic athletes. Biomechanics, a field that combines the physics of motion with human anatomy, uses Apple II computers to analyze athletes' movements in great detail. The computers are linked to tracking devices, high-speed cameras, and force platforms to provide precise images and data of athletes' performances. The article highlights the work of Dr. Gideon Ariel, a pioneer in biomechanics, who uses digitization to convert athletic movement into highly precise, three-dimensional graphic images. The article also discusses how biomechanics has helped athletes like Edwin Moses, a hurdler, and Mac Wilkins, a discus thrower, improve their techniques. Ariel also used biomechanics to analyze team movements, helping the U.S. women's volleyball team identify weaknesses in their opponents' defenses. The article concludes by noting that while much of the digitization work is currently done on minicomputers, Ariel expects that microcomputers will soon be able to handle more of the load.

Below find a reprint of the 5 relevant pages of the article "Go for the Gold" in "A+":





COVER STORY
BY DAVID F. BARRY

GO FOR THE GOLD

Helping U.S. athletes scale the heights in Los Angeles

Olympic athletes: What mysterious qualities allow them, year after year, to stretch their personal limits and the limits of their sport? Pioneers of a new science in sports analysis—biomechanics—are asking this question. Apple II computers are helping to answer it.

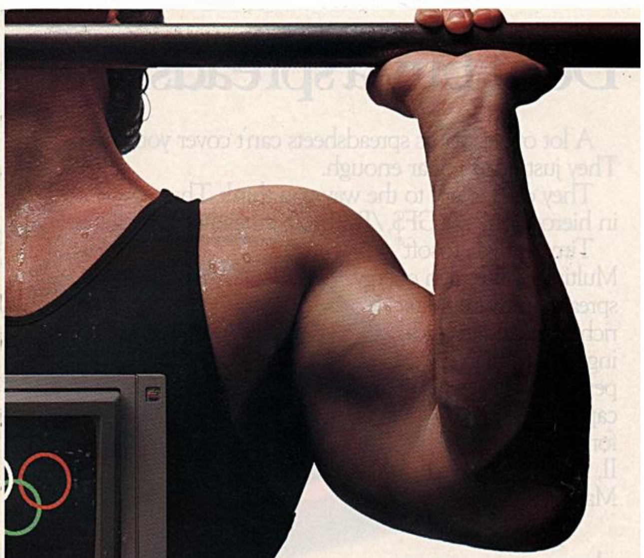
Biomechanics links the physics of motion to human anatomy. This summer, at the Olympic Games in Los Angeles, the U.S. Olympic Team will benefit from some pioneering work in biomechanics, and another high performer—the Apple II computer—is an important participant in that work. Linked to an array of highly sensitive tracking devices, high-speed cameras, and force platforms, the Apple II is providing scientists with the most striking images yet of Olympic athletes and the most precise details of their performance ever available.

"It is impossible for the human eye to quantify movement," says Dr. Gideon Ariel, one of the pioneers in biomechanics, who is chairman of the Olympics Board for Biomechanical Studies. The new science is based on the premise that the naked eye cannot capture the hundreds of moving parts of a body in motion. "The most important things in athletic performance—timing, relative speeds of dozens of limbs and body segments, changes in the center of gravity—must be weighed, measured, and compared to each other to be of any use."

Edwin Moses made his international debut at the 1976 Montreal Olympics. This hurdler not only stunned everyone by winning the 400-meter hurdles and capturing the gold medal, but he also beat his closest opponent by 8 meters, the longest winning margin in the history of the event.

Since then, Edwin Moses has gone

PHOTO BY DENNIS BETTENCOURT



on to win more than 100 races, without a loss, and he is now heavily favored to capture another gold medal this summer in Los Angeles. Intrigued by Moses' astonishing ability, Ariel took some digitized (high-speed, up to 10,000 frames per second) photographs in the hope of discovering its origin.

"Digitization" uses high-speed photography to convert athletic movement into highly precise, three-dimensional graphic images. The images reveal a wealth of information: the speed of the athlete's movement, the forces at work, and the angles or "displacement" at which the different parts of the body are interacting. In addition, scientists can study the entire movement at regular speed, slow motion, or as a frozen multiple image—from a top view, side view, or front view.

High-speed cameras first photograph a movement from at least two angles. The film is then projected ont "digitizer screen," a special screen t is similar to a small movie screen. T scientist, using a special magnetic p known as the Graf Pen, touches, on t screen, certain significant points on t athlete's body—coordinates—that a important to the movement.

The Apple II Plus computer (whi has recorded the coordinates) and Data General Eclipse minicompu team up to interpret the data in th impulses and project it onto a video d play as three-dimensional graphic i ages of the movement.

In the digitized photographs of M ses running the 400-meter hurdles, A el discovered a fascinating piece information. When Moses jumped o hurdles, his body rose no higher th when he was running. On a frozen m tiple image of Moses' complete acti down the track and over the hurdl

COMPUTER GRAPHIC BY ADELE ALDRIDGE

you could draw a straight line along the path of his head.

"You assume when he's going over an obstacle his head is going up," Ariel says. "But not so with Moses. That's why he's so great. He's basically running horizontally over the hurdles while all the other hurdlers are going vertically."

Though Moses is in a class by himself, up-and-coming hurdlers could gain some valuable insights into their sport by studying Moses' techniques.

Force Platforms and Apples

At the Biomechanical Labs in Colorado Springs, Colorado, and the Coto Research Center in Southern California, Ariel has linked Apple II computers to an ingenious device known as a force platform, a two-foot-square steel platform that is supported at each of its four corners by highly sensitive "strain gauges." The Apples immediately register any movement or force applied to the platform, which is so sensitive, says Ariel, that he can detect the pulse rate of a person who is merely standing on the platform.

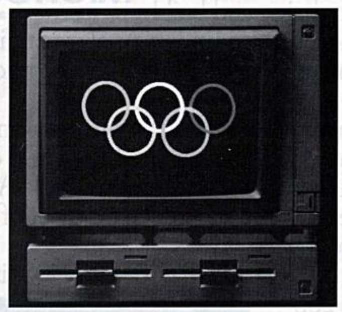
Race walkers, marathon runners, weight lifters, archers, and shooters are just a few of the athletes who have benefitted from the force platform. The athlete either steps up on the platform (in a stationary sport, such as archery) or runs across the platform (as in a mobile sport, such as running), and by completing an integral part of the movement while on the platform immediately provides scientists with a wealth of valuable information.

In Colorado Springs, weight lifters have learned more efficient ways to distribute their weight during a lift, thanks to the force platform. The platform, placed beneath the lifter as he goes through his motion, measures the forces on the lifter's shoe at each point during the lift. By feeding this information into the Apple, scientists can determine how much the lifter is shifting his weight from toe to heel as he lifts the weight. If his weight is too far off the "center of pressure" (the point on the shoe at which all the forces converge), he'll have difficulty lifting the weight. The position for optimal effort, the computer reveals, is when the lifter's center of pressure is nearest the athlete's natural center of support.

Says Mark Fenton of the Biomechanical Labs, "You can compare the differences in his own pattern. One day he is more successful than on another day. Why? What was he doing on one day that he isn't doing on another day?"

By comparing an athlete's effort either against his own performance or against an optimum standard, a scientist, in collaboration with the coach and the athlete, can suggest different techniques to improve performance.

Gary Scheirman, a biomechanical scientist in Colorado Springs, wrote many of the programs for the Apples. He believes that a scientist can most help an athlete by "identifying patterns of movement and quantity of movement." With an archer, for example, the scientist attempts to determine how stable the archer is by looking at nonessential movement that occurs before or during the shot and, if there is such movement, how much and what type it is.



The Apples immediately register any movement or force applied to the platform.

Rick McKinney, a national-champion archer who placed fourth at the 1976 Olympics in Montreal, has a good shot at the gold medal this summer in Los Angeles. Scheirman analyzed McKinney's performance by combining the force-platform analysis with that of another piece of equipment called Selspot, a Swedish device that uses infrared light to detect motion.

The Selspot process requires rigging LED diodes to selected parts of an athlete's body—for example, on an archer's bow sight or a weight lifter's bar. As the athlete goes through his or her motion, an electronic infrared camera searches for the diode at the rate of 200 times a second. Each time the camera finds the diode, it records the position. This information is then fed into the Apple, which produces a composite graph indicating all areas of movement.

"We learned from McKinney the importance of stability," says Scheirman. "This idea of stability was not always an accepted theory, since some coaches believed that movement was important in archery. But we're finding with the best archers in the U.S. that indeed they are very, very stable.

"We also looked at [McKinney's] position to be sure that his foot placement was correctly aligned with his center of pressure. We gave him information that he has been able to work into his stance."

Dr. Ariel has been working with computers and athletes for more than ten years. Ariel's success stories also include gold-medal discus thrower Mac Wilkins and the U.S. women's volleyball team, which, in the span of six years, has gone from unranked status to its current ranking as one of the top three teams in the world (alongside the traditionaly quicker and stronger Chinese and Japanese teams).

Applying Newton's Law

Mac Wilkins' first encounter with

Ariel came in November 1975, when the two met as part of a biomechanical study project commissioned by the U.S. Olympic Committee. After studying Wilkins' movement with the discus on film, Ariel discovered that in the movement toward the throw, Wilkins' front leg was absorbing energy that could go into the throw itself.

Citing Newton's law that every action requires an opposite reaction, Ariel says, "It's vital to have everything *stopping* in the discus. In the best throws we found a pattern. It is like using a fly rod, or snapping a towel. You have to decelerate the heavy parts—the legs and the trunk—so you can accelerate the light parts—the arm and the discus."

Wilkins' best throw until then had been 219 feet 1 inch. The world record was 226 feet 8 inches. Not long after putting Ariel's advice into practice, Wilkins set a new world record, tossing the discus 232 feet 6 inches. He then went on to win the gold medal at the 1976 Olympics in Montreal by throwing the discus 221 feet 5 inches.

Scientists can determine how much the lifter is shifting his weight from toe to heel as he lifts the weight.

Team Movements

Since biomechanical scientists often work with Olympic athletes who are near or at perfection in their sport, the need for improvement in technique is sometimes barely perceptible. On occasion, scientists study top Olympic athletes just to learn their techniques so that developing athletes can compare themselves and learn from the comparison.

Taking his theories a step beyond work with the movement of individual athletes, Ariel wondered whether or not he could determine—through digitization—a *team's* key weaknesses and strengths.

In 1981, he found his answer. At world competitions that year between the U.S. women's volleyball team and the top international teams at the time—China, Japan, and the Soviet Union—Ariel used high-speed cameras to photograph the matches. Later, digitizing the information at the Coto Research Center, he discovered some telling information about the patterns of movement of the opposing teams.

One illustrative sequence of play, showing Flo Hyman spiking into the Chinese team, revealed a recurring flaw in the Chinese defense, which occurred just before Flo Hyman actually spiked the ball. Ariel found that in anticipation of the impending spike—before Hyman had even touched the ball—the members of the Chinese team would commit themselves 90% in one direction. Since individuals cannot reverse their motion quickly once they have committed to a certain direction, Hyman could, in future games, take advantage of this situation and spike to the point where the Chinese team was the weakest.

"Since they are always doing the same thing," Ariel says, "we can tell her, 'make sure you spike to the point where they are the weakest.'

"This is how we are beating the Chinese, the Japanese, anybody in the world. When we play with them, using this kind of sophisticated statistical analysis, it's like playing poker with somebody and knowing what their cards are."

When the U.S. began winning international tournaments, the rest of the world caught on, and Ariel and his cameras were banned from the games. But not before volleyball-team coach Arie Selinger had gotten the information he needed.

Minis to Micros

Though Ariel's work in the early years began on minicomputers—and the brunt of the work continues to be handled by minis—Ariel is shifting more of the burden onto microcomputers, which can now do for $15,000 what it took $100,000 to do years ago.

Says Ariel, "The Apple is fantastic as an intelligent storage device. We use Data General minicomputers to do the actual calculations on the raw data, but because the process of digitizing takes hours and hours, there is no reason to start up the minicomputers, which are very big and power-consuming. Instead, we use the Apples to collect the information and store it on floppy disks. Then, after three or four hours of digitizing, we use a transfer program to dump the data into the minicomputer, which does the actual calculations."

Since plotting each movement coordinate consumes only about two bytes of memory, some of the digitization can be done on the Apple. But, for now, the need for more memory and higher graphic resolution to do more in-depth calculations requires collaboration with the minicomputer.

Down the road, however, with expanding memory and 32-bit processing, Apples—and micros in general—should carry even more of the load. Ariel envisions a time not too far off when college coaches will do their own digitization on microcomputers located in their offices.

In the meantime, an expected strong U.S. effort at this summer's Olympics in Los Angeles owes plenty to Apples and biomechanics. ✚