Training the Olympic Elite

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This article, "Training the Olympic Elite" by David M. Stewart, discusses the evolution of Olympic training from ancient Greece to the 1984 Summer Games. The article highlights the scientific advancements in sports training, particularly behind the Iron Curtain in the 1970s. The U.S. Olympic Committee's Elite Athlete Program is discussed, which applies technology, biomechanics, psychology, physiology, and medicine to training methods and equipment development in various sports. The article also features Dr. Gideon Ariel's biomechanical analysis work, Dr. Mitchell Feingold's research on cycling biomechanics, and Dr. David Martin's work on long-term physical monitoring for track and field athletes. The Elite Athlete Program's future beyond the 1984 Olympics is also discussed.

Below find a reprint of the 5 relevant pages of the article "Training the Olympic Elite" in "Southwest Magazine":

Training the Olympic Elite

By David M. Stewart

From ancient Greece to the Iron Curtain on to Los Angeles, Olympic training has evolved as a high-powered science.

A generous interpretation of Greek legend would establish Milo of Croton as the founder of scientific Olympic training. Milo created a crude weight-lifting program to build his strength for athletic competition—every day, he lifted a newborn calf (later graduating to a fully grown ox) over his head in a kind of primitive press. He won six Olympic championships during the sixth century B.C.

Sports science has advanced quite a bit since Milo, and great strides were made in the 1970s. But most of the progress seemed to be made behind the Iron Curtain and with stunning results. At the 1976 Olympic Games in Montreal, the U.S. team took 34 gold medals, while the East German and Soviet teams combined took 78. There were suspicions of wrongdoing—pumping up athletes with steroids, for example—but they were unfounded. Researchers in the Soviet Union had been publishing studies of their work with athletes in their own scientific and medical journals since the early seventies, and the East Germans had established a sports-medicine institute in Leipzig. Their work didn't include surgical reconstruction or the use of undetectable drugs. Also, a few American scientists and doctors had been keeping track of this activity and had at least begun to study athletes scientifically.

Tom Byers, who runs the 1500 meters, is wired and plugged in as he undergoes treadmill test.

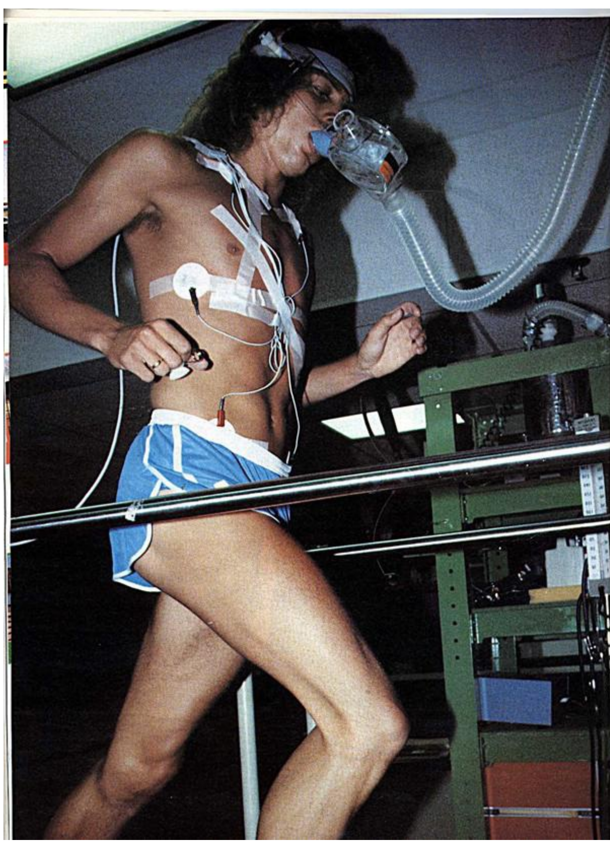
But not until about two years ago did the U.S. Olympic Committee come up with a systematic approach to sports science, the Elite Athlete Program. This project involves a comprehensive application of technology, biomechanics, psychology, physiology, and medicine to techniques, training methods, and equipment development in five sports (only three of which are discussed here): volleyball, cycling, track and field, fencing, and weight lifting. The program is based at the Olympic Training Center in Colorado Springs, Colorado, but research centers in many parts of the country are contributing resources, time, and expertise to the effort.

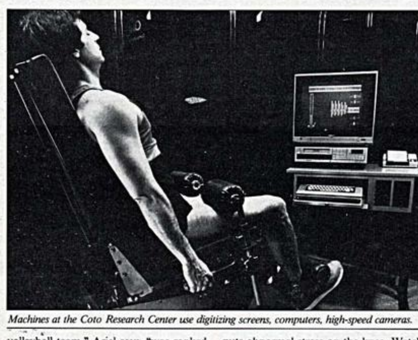
Dr. Gideon Ariel is the force behind one of those satellite facilities, the private Coto Research Center near Trabuco Canyon, California. Ariel's specialty is biomechanical analysis. He uses high-speed cameras, digitizing screens, magnetic pens, and computer graphics to record and quantify the mechanical aspects—vectors, angles, forces, and torque—of athletic performances. By applying mechanical principles, he can detect subtleties that may help to perfect an athlete's technique.

Ariel begins his work by filming an athlete in action from up to three angles—behind, in front, and above. The cameras roll at 64 to 200 or more frames per second, freezing tiny instants of action. The processed film is projected on a digitizing screen, and Ariel traces the athlete's limbs frame by frame with a special magnetic pen; a computer processes this information and turns it into simulated, three-dimensional stick figures that move electronically on a graphics monitor. From this, Ariel and the computer can examine the whip of the shoulder, the spring in the ankle, the rotation of the waist, and other variables that determine the quality of performance. More importantly for the athlete, the computer can also simulate a slight change in technique. So rather than depend on hunches and educated guesswork—"basically witchcraft . . . all opinion," he says—Ariel can tell an athlete what he is doing right or wrong, suggest video-tested changes, and show what results the changes could produce.

Ariel has an impressive success record, one of his greatest successes being the U.S. women's volleyball team. The team had lost consistently for years before Ariel came along. He went to work with his cameras and computers, filming and digitizing the team's international opponents and studying their strategies. His analyses yielded recommendations on the best ways to spike the ball, set up plays, and work as a team.

It was up to the women to put the new knowledge to work, and they went at it with enthusiasm. "The women's





Gideon Ariel

Machines at the Coto Research Center use digitizing screens, computers, high-speed cameras.

volleyball team," Ariel says, "was ranked fortieth or forty-fifth when we started, and now they're the best in the world." He also thinks the women will take the gold at the Los Angeles Games. "They will win because they are ready," he says.

Ariel sees his use of computer analysis as a long-overdue aid to coaches. "In athletics, we are one hundred, even one thousand, years behind," he asserts. "We're looking at performances one at a time and telling an athlete what he's doing right and wrong. If you go to five coaches, you're sure to get five different answers." That's not enough, says Ariel: "The human eye is the best observing mechanism in the world, but the computer is the best memorizer and calculator. I combine the two."

Biomechanics has also been employed by the U.S. Cycling Federation. Dr. Mitchell Feingold, a podiatrist from San Diego, works on the clinical aspects of cycling biomechanics, especially lower-extremity (foot) research. One of Feingold's concerns has been with cyclists' physical abnormalities. "We want to see how these affect the performance of the cyclist and what we can do to redirect abnormal biomechanical forces caused by, say, a pronated foot or some other anomaly in the legs or feet," he says.

"These abnormal forces take their toll on cyclists," adds Feingold. "When the foot compensates for the abnormality, it puts abnormal stress on the knee. Watch [U.S. team member] Mark Gorsky, who has normally functioning legs and feet, on high-speed film. His knees go up and down, frame by frame; there's no deviation. But watch some rider who pronates [rotates a joint forward and toward the midline] a lot, and you'll see that the knee not only goes up and down but from side to side. That's inefficient—like riding with the brakes on—and you can do it, but you're going to work harder. Riders can also develop knee problems." Feingold can treat most abnormalities with orthotics, hard, orthopedically designed pieces of plastic that slip into the shoe to provide support and to control and redirect abnormal foot and leg functions.

Feingold also put the cyclists on a regimen of flexibility exercises. The cyclists were extremely inflexible, he says, and in a demanding sport such as cycling, inflexibility can cause stress injury. In flexibility training, the cyclists gently stretch their muscles in order to increase a limb's range of motion around a joint. Also, the exercise physiologist tries to come up with the ideal range of motion for each joint; for example, Feingold told the cyclists that when they ride, they should start with the foot perpendicular to the leg and then move it up 20 degrees to form a 70-degree angle with the shin. Says Feingold, "Every cyclist who has made this adjustment has had a significant decrease in stress-related injuries and h
found cycling smoother, more efficient.

Physical stress isn't the only kind
stress athletes deal with—there's also t
emotional stress that results from t
rigors of competition and training. It's I
Andy Jacobs's job to help members
the cycling team manage this stre
Jacobs, one of the country's few Ph.I
in sports psychology, became the te
psychologist a couple years ago af
working with the national junior team
Colorado.

"Basically," says Jacobs, "what I do
deal with the mental side of competiti
concentration, motivation, self-estee
attitude, attention span, stress mana
ment, coach-athlete relations." This
mostly one-on-one work—Jacobs
someone the athletes can talk to. Jaco
also uses visualization to help a biker.
have a cyclist picture himself on his bik
says Jacobs. "I'll have him picture t
whole race, from start to finish. Wh
he has pain or trouble concentrating,
have him stop and work through the
problems."

After Jacobs, Feingold, and th
colleagues have gotten the cyclists pa
physical and mental problems, a team
engineers works to put the team in
cycling suits and onto bicycles tru
worthy of them. Chester Kyle, profess
of mechanical engineering at the Univ
stiy of California at Long Beach, has be
working on making cycling clothing a
components more aerodynamic. Aerod
namic quality is important because
sprint-racing speeds of 30 to 40 miles
hour, 90 percent or more of a cyclis
energy goes into simply cutting throu
the air. Cut aero drag and you cut ra
times.

Much of Kyle's research has been do
at Texas A&M University, where abo
$800 will buy you an hour in the footba
field-size wind tunnel. It was in front
Texas A&M's massive, four-blade pr
that Kyle and codesigner Paul V
Valkenburgh tested several shapes for t
Olympic helmet. Their final choice, whi
will be manufactured by Bell Helmets
Norwalk, California, was a teardro
shaped headpiece made of fiberglass; th
tests showed it to be the most aerodynam
helmet in the world. (It is also equipp
with an Olympic first, one that may n
make it past the judges: a built-in F
radio receiver for one-way communicati

with the coaching staff.) To make the Olympic racing bikes more aerodynamic, Kyle and his associates have been developing or adapting flat spokes, teardrop-shaped rims, and nearly flat or recessed nuts and bolts. Mike Melton, of the Huffy Corporation, using results from Kyle and company's wind-tunnel research to guide his efforts, is working on frame designs using ovular (egg-shaped) tubes and smaller overall sizes.

These details barely scratch the surface of the work being done in cycling by the Elite Athlete Program. The cycling program, directed by Dr. Ed Burke, a physiologist, may be the most comprehensive of the programs, partly because it has received so much financial help from the Southland Corporation, which built the new 7-Eleven Olympic Velodrome (a cycling track) on the California State University campus in Carson, California. Everyone involved in U.S. cycling has great expectations. As Andy Jacobs says: "We haven't won a medal in cycling in seventy-two years, and we are at a point now where we have a chance at four, maybe even five, medals. We've never had a chance like this before."

It is probably in track and field that sports medicine is most prominent. Dr. David Martin of Georgia State University has been working with athletes for years on long-term physical monitoring, and a couple of years ago, at the invitation of California State University at Hayward track-and-field coordinator Dr. Harmon Brown, he hooked up with the Elite Athlete Program. Martin monitors seven runners' training regimens for possible over- or under-training and advises them and their coaches on how to avoid fatigue. "The whole idea," Martin says, "is to help these athletes understand themselves. They've got sports-car bodies, but they've never studied the owner's manual."

Martin uses blood tests to measure lactic acid in the bloodstream after exercise. Lactic acid, a waste product formed during anaerobic (nonoxygen-using) exercise, slows down muscular responsiveness and causes the runner to feel tired. If the exercise is taken too far, acid accumulates, stops the muscles altogether, causes pain, and forces the athlete to wait while his circulatory system mops up after his overindulgence. One of the goals of training is to improve aerobic fitness—to expand the athlete's oxygen-using capacity—in order to delay anaerobic energy burning. Blood tests provide an instant evaluation of the effects of a workout, thus allowing for instant modification and experimentation.

"The best way to determine whether training is bringing beneficial results," Martin points out, "is to use each athlete as his or her own control and to test the athletes at different phases of training." This is the purpose of periodic treadmill and Cybex testing, in which the athlete is tested for strength, aerobic endurance, and muscular symmetry.

The treadmill is equipped to monitor oxygen consumption. The athlete runs on the treadmill with a mask over his face, and Martin collects and analyzes the expired gases for carbon dioxide, which indicates how much oxygen the athlete used. The goal is to measure "maximum oxygen uptake," the amount of oxygen the athlete can use while running full tilt. Lately, though, some researchers have suggested that it is not this full-tilt uptake that runners need to know but rather the "anaerobic threshold," a point just below maximum oxygen uptake which prevents the runner from going into oxygen debt and accumulating lactic acid. "Athletes seem to have a sixth sense about how to get the most out of their bodies at 'race pace,' " Martin says, "and we try to measure that as an additional parameter of performance capabilities."

The Cybex, manufactured by Lumex in Bay Shore, New York, was designed mainly for physical therapy, but it is also perfect for some kinds of athletic work. (Martin uses it to test anaerobic performance, knee-joint integrity, and strength.) Cybex is an isokinetic dynamometer: a machine that measures dynamic muscular forces exerted at a constant velocity, limb against resistant bar. Tom Byers, an Olympic hopeful from Scottsdale, Arizona, who runs the 1500-meter race, has been testing with Cybex for about two years and credits it with helping him win second place—fifteen one-hundredths of a second behind the winner—in the 1983 national championships. Byers' initial tests showed that his left leg was stronger than his right. "Anything more than a five-percent asymmetry," he says, "makes you prone to injury. When I first started testing, I had a twenty-three-percent asymmetry between my hamstrings, so I was prone to pulling or straining one of those muscles." With his coach, Len Miller, Byers developed a weight-training program to work the right leg up to equal strengh. So far, they've gotten the asymmetry down to 9 percent, he reports.

Other members of the track-and-field team are working back where we began, at the Coto Research Center, with Gideon Ariel. He is training athletes in the throwing events (particularly shot put and discus) with a computerized exercise machine. "We can program the machine to train under different kinds of stresses," he says. "It loads the athlete's muscles to a particular angle, at a particular strength. So it's training not only the muscles but also the nervous system." Volleyball players use it too. "It's experimental now," adds Ariel, "but we're having tremendous success with it."

The Elite Athlete Program officially ends when the 1984 Olympics do. But the work will go on, and there is a chance that the program itself will be extended after a September 1984 evaluation. "I hope the project continues," says David Martin, "assuming that more funds come as a result of our success in the Games." In any case, Mitchell Feingold and Dr. Bob Gregor, a UCLA biomechanician who is also involved in the program, will be doing more extensive cycling work, using high-speed filming and a sophisticated electronic testing bike, at UCLA. "I'm shooting for January 1986, when we have the world championships in the U.S. for the first time," Feingold says. "I think then you're going to see the East Germans and the Soviets interested in what *we're* doing. And all this stuff adds up, one year to the next." Chet Kyle and his associates will be working on still better bikes and bike clothing. And much the same kind of activity will be going on in the other events that are part of the Elite Program, whether the program is extended or not.

So the Elite athletes have their sights set on the gold this summer. But neither the medals, the medical marvels, nor the electronic gadgetry should distract them from what Andy Jacobs says is the point of it all: "What I try to emphasize to all these men and women is not winning but setting their own personal goals and striving for them." Gideon Ariel agrees, and he thinks the athletes are up to it. "These athletes are very intelligent people," he says. "They will persevere to become the best." ◢