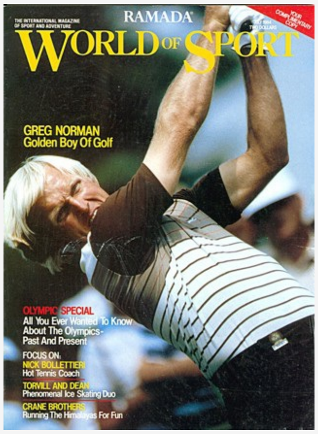
Enter the Computerized Competitor

The Dawn of a Digital Future for Sports?



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The article by Steven Slon discusses the increasing role of computers in sports, from training athletes and advising coaches to forming team strategies. It highlights the potential benefits and drawbacks of this technological integration. While some see computers as tools to enhance human athletic performance, others fear they may reduce competition to a numbers game or even replace humans in sports. The article also explores the field of biomechanics, where computers analyze high-speed films of athletes' movements to improve performance. However, the author notes that the human element, such as motivation and intuition, cannot be measured or replaced by computers.

The article discusses the use of technology and computer analysis in improving the performance of athletes. It highlights the Elite Athlete Project, which uses computer analysis to study athletes and help them improve their performance. Examples include hammer thrower Dave McKenzie, sprinter Calvin Smith, and high jumper Louise Ritter, who all saw improvements in their personal bests after implementing changes suggested by the computer analysis. The article also discusses the use of formation analysis in team sports, using the US Women's Volleyball team as an example. The team went from being ranked 45th in the world to being in the top five, largely due to the use of technology. The article concludes by discussing the limitations of computer analysis, emphasizing that while it can provide valuable insights, it cannot replace human intuition and adaptability.

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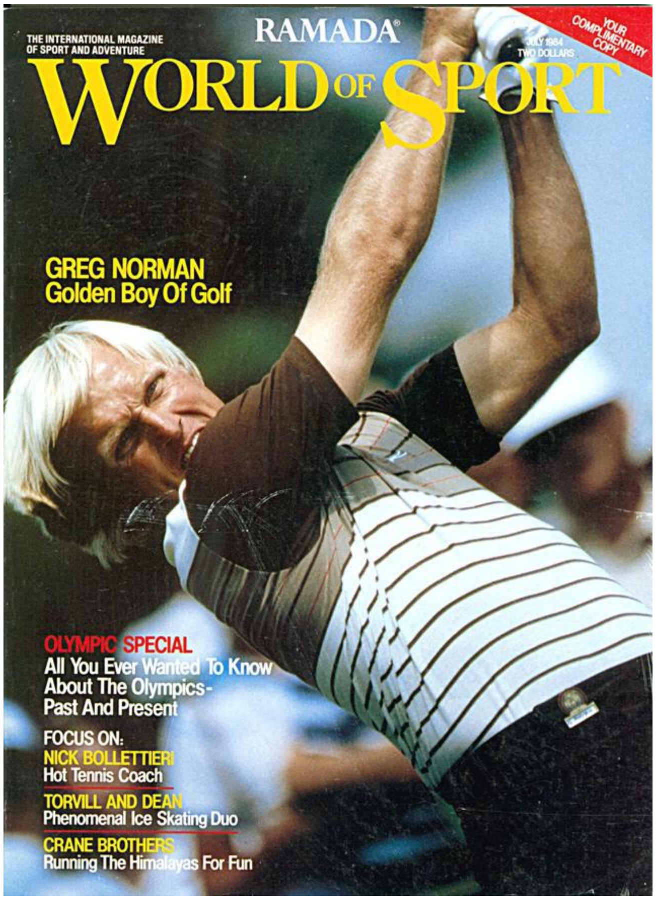
Below find a reprint of the 10 relevant pages of the article "Enter the Computerized Competitor" in "World of Sport":



ENTER THE COMPUTERIZED COMPETITOR

THE DAWN OF A DIGITAL FUTURE FOR SPORTS?

BY STEVEN SLON

It's finally happened. The machine has arrived in sports and it's here to stay.

You can say what you like about the innate superiority of the human form, human judgement and human skills, but computers are training athletes, teaching coaches and forming team strategies. Some welcome computers as tools that will help bring out the best in human athletic performance. Others fear that computers will reduce competition to a battle for percentages and, in the long run, even replace humans on the playing field.

There's an episode of the popular sci-fi TV show, *The Twilight Zone*, that predicts just such a future for boxing. In Rod Serling's somber vision, the brutal sport has been judged too dangerous for humans. By law, only robots may get in the ring and duke it out. In the story, a down-and-out handler — himself a former boxer from the days when humans fought — has gotten his nearly-obsolete robot a fight with a newer fighting machine. He knows his robot will be destroyed by the new model, yet he needs the money he'll get for the fight. So, he disguises himself as a robot and enters the ring himself — and, of course, he gets battered to oblivion.

This show might be said to epitomize the fears of sports computerphobes. Will computers, robots, or men with computer parts make mere human competitors obsolete? Perhaps anticipating just such a danger, some sports people have been known to react violently to the presence of a computer on or near the playing field.

Several years ago, Earl Weaver — the volatile (and now- retired) manager of the Baltimore Orioles — was approached by his young second baseman, Dave Johnson, about the batting order. Johnson, who had studied computer sciences, wanted to bat second, and he brought to his manager a printout of a new batting order that showed why he was best suited for the number two spot. His line up was based on up-to-the-minute batting averages, on-base percentages,

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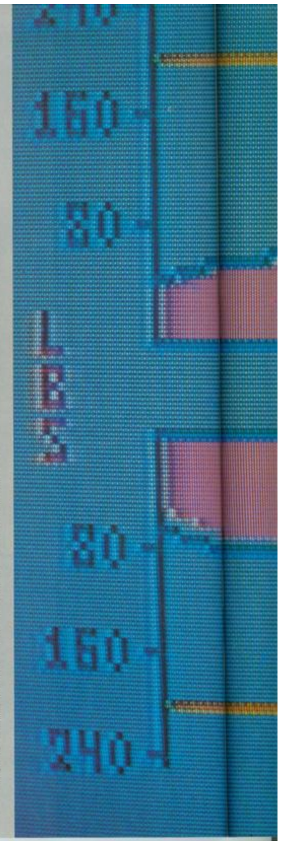
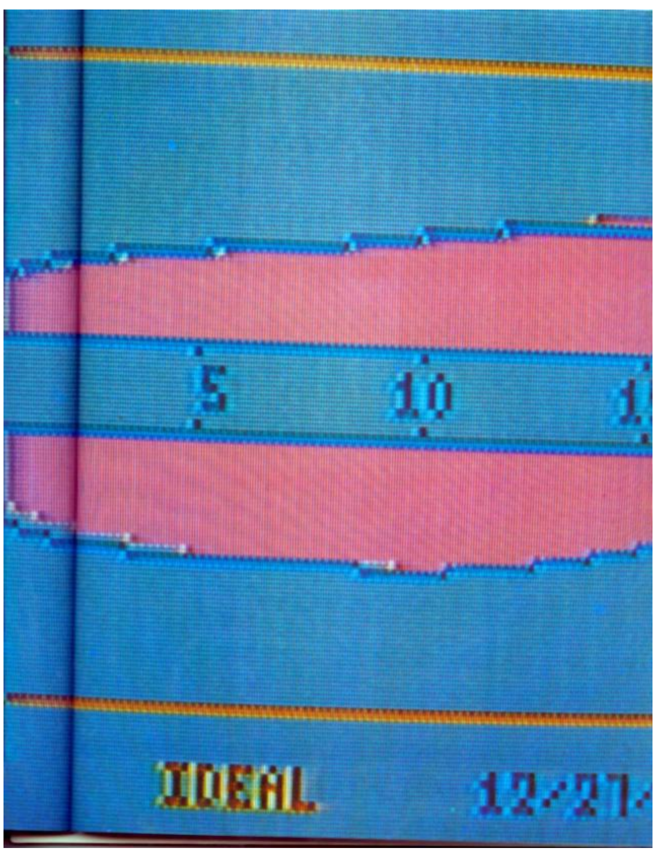




right or left-handedness of the batter, past performance of each batter against today's opposing pitcher and so forth. Weaver took one look at the printout and tore it up. Today, Weaver has been put to pasture in the bland world of television sports commentary. And Dave Johnson has just become the manager of the New York Mets. Whether even the mightiest computer can help this perennial last-place team remains to be seen, of course. But, whatever his results, Johnson and his computer are in, and Weaver and the old guard are out. Many other major league baseball managers are already working closely with computers.

An outspoken supporter of computers in sports, Gideon Ariel, Ph.D., director of the Coto Research Center in California and chairman of the Biomechanics Committee in the Sportsmedicine Division of the US Olympic Committee, goes so far as to suggest that the remaining Earl Weavers of sports are living in the dark ages. He predicts: "What you will find more and more is that sports in the future will rely on science, rather than guessing and witchcraft."

But why do we want or need science and machinery in sports? The answer, in a word, is winning. Finding a way to shave a half second (or even less) from a 100 meter dash time, could mean the difference between a new world record and an unremarkable finish. Being able to identify your baseball team's perfect pinch hitter, say, against Steve Carlton — in the ninth inning with two outs and a man on third and given the contours of Shea Stadium — could mean the difference between winning and losing. If computers can give a coach even the slightest edge, he's going to want one.

How can computers make these differences? As Ariel explains it, computers are no more than tools for processing huge amounts of information. They provide a kind of super storage depot for a coach's know-how: "Human beings are creative, but we have terrible memories. Computers are dumb, but their memories are perfect."

For that 100 meter sprinter, the computer can analyze filmed or electronically monitored data about stride length, stride speed, and many other factors essential to speed, to help him or her find ways to get better results. For a baseball manager, the computer can coordinate data about the odds of an event taking place, given past performance. Here, it's a predictor in a game where the goal is to maximize winning chances.

No coach could cope with such an unwieldy volume of data without computer help. But does the very reliance on data signal the death of human intuition in athletic contests? After all, computers can only consider past events. They are incapable of seeing an athlete's talent to adapt to new circumstances — or even more important — to see that greatest athletic talent of all, the ability to rise above one's own limitations.

Bob Ward, P.E.D., is the conditioning coach of the Dallas Cowboys football team. He rejects the notion that computers provide the only precise means of coordinating delicate training information, and he feels that many reports have exaggerated the computer's worth. "Not that science isn't valuable in sports," says Ward. "But, intuitively, we comprehend very easily what is true, right and effective."

GIDEON ARIEL

Front, side and rear views of a computerised hurdler.

Like it or not, the 1984 Olympic games will signal the dawn of Ariel's digital future for sports. According to Charles (Chuck) Dilman, Ph.D., head of the USOC's Elite Athlete Project, the US team is spending more money on computer research than ever before — especially as its use dovetails with other disciplines in sportsmedicine. It's not that Rod Serling's view of the world has come true. Computers won't be receiving any gold medals, but, because of them, according to Dilman, some athletes will.

Over the past few years, computers have been searching for flaws in the movements of discus throwers, runners, race walkers, jumpers and numerous other Olympic athletes. Computers are also devising team tactics, determining conditioning techniques, and even planning the diets for American Olympians.

At the heart of the use of computers in sports is a kind of human engineering called biomechanics. The most visible figure in this field today is Gideon Ariel, though he is far from alone.

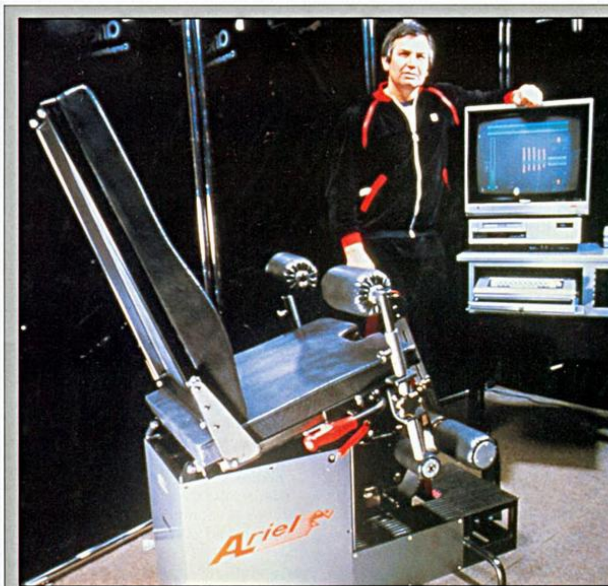
Biomechanics is the study of body movement and the physical relationships between the different body parts that are reponsible for movement. At his Coto Research Center in Trabucco Canyon, California, Ariel works with TV tennis instructor Vic Braden in the study of the tennis stroke and with the US Women's Volleyball team, which is headquartered there, on both individual skills and team strategy. Ariel is himself a former discus thrower and has a special interest in track and field. Before becoming a US citizen, he competed on the Israeli team in the Rome and Tokyo Olympics. (His personal record is 56 meters.)

He explains that computers can help improve the performance of an athlete by analyzing high speed films of his movements. "Let's take the high jump," he says. "Obviously you want to defy gravity by exerting a vertical force. The human body is made up of segments. You find what is the interplay between these segments creating a vertical force. You find where an athlete has to exert a particular force at a particular time."

On the computer screen, the filmed motion of the athlete is translated into a series of movements of a stick figure that is proportioned like the athlete under study. Ariel can watch the stick figure go through its motion, and then try to find ways to get better results: "You try to maximize these vertical forces and see what happens to the bio segments. Then you are able to find ways to perfect the motion of the different segments. Maybe you see that if you move your arms a little faster, the vertical force is greater."

So, then the coach goes out to the field, armed with his printout and tells the athlete to try moving his arms a little bit faster and see if he gets higher. It doesn't always work. The computer model cannot perfectly translate the human form into a stick figure. And, even more problematic, there are limitations to what the software can prescribe. It cannot, for example, lengthen the athlete's legs or move his shoulders to a different position. "You cannot create a model that is unrealistic," says Ariel. "So you are working only within a range of possibilities."

It is also hard to teach an athlete the precise change that the computer has called for. To solve this problem, Ariel has developed a series of what he calls 'smart' computerized exercise machines, which he is marketing commercially. Unlike 'dumb' exercise equipment, which require that the athlete adapt to a pre-set pattern, Ariel's machine can train specific muscles and can actually teach an athlete a new motion: "Let's say I know a discus thrower should extend his arm starting at a certain velocity and end up at another velocity," he says. "I can program the machine to force him to do this. By repetition, he learns, and he has immediate feedback on the video screen, so right away he sees where he



Gideon Ariel standing beside the 'Smart' Exerciser.

should be and how close he is to the ideal."

In the course of analyzing athletes in motion, biomechanics has influenced training procedures and altered our understanding of numerous sports. For example, it used to be that long jumpers were taught to strengthen their calves for the last push from the board. But close study reveals that the best jumpers don't fully extend their toes until they are two feet from the board. "Far more important than the jumping leg is the free leg," says Ariel. "It and the torso accelerate as the planted leg decelerates. Then the jumping leg is yanked off the ground. That leg isn't pushing, it's trying to catch up."

Similarly, biomechanical analysis uncovered a flaw in the logic of many baseball pitching coaches. It was known that much of the power of the throw is generated by the flicking of the wrist just before the ball is released. Logic said that strengthening the wrist muscles would increase power. But high-speed films showed otherwise. While studying the Kansas City Royals' pitching staff in the late seventies, Ariel discovered that "The wrist snaps far faster than any muscle can contract. It just goes along for the ride, so it is absolutely useless to train the wrist."

Biomechanics has also demystified hitherto unknown aspects of certain sports. In ice hockey, for example, it used to be a marvel that the great shooters could generate so much force with their slap shots. It didn't seem physically possible to derive such tremendous puck speeds from merely swinging the hockey stick. Computers solved that mystery: The hockey stick hits down on the ice behind the puck, bends back and then snaps forward, whipping the puck with a tremendously amplified force.

Forward looking athletes have been interested in computers for some time now. Perhaps the most dramatic story involves Al Oerter, the four-time Olympic discus champion who, in 1977, called Ariel at his headquarters and talked about returning to the sport. "He was so nice on the phone that I had to say yes," Ariel recalls. "He told me, 'We competed in the same games.' But I didn't even make the final."

Three years later, the 44-year-old Oerter had thrown the discus 27 feet farther than his best gold medal distance, 212-6, and he got a spot on the 1980 US Olympic team. The team never went to Moscow, of course, so Oerter is still talking about trying out for the US team in 1984.

"It's basic physics," says Ariel, explaining how he's helped Oerter — now in his late forties — to overcome the deficits of aging and and be able to compete with 20-year-olds and younger. "We know that for the discus to go so far it must leave the hand at a certain velocity and a certain angle. So we work backward. For the discus to have that velocity, then the hand must have that velocity. For this to happen, the forearm must be moving so — then the upper arm, the torso, and so on down to the feet."

GIDEON ARIEL

Dave Laut testing his leg strength on the Computerised Exercise Machine.

Ariel also worked with discus thrower Mac Wilkins. Wilkins recalls that the lesson of his computer printout astonished him at first: "I had to begin to change my whole conception of throwing. I used to think I had to put as much speed as I could in the direction of the throw."

But Ariel explained to him that it was whipping action, not sheer speed, that counted the most. As he explains, "In the best throws . . . 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."

In addition, the computer uncovered a flaw in Wilkins' delivery. He was absorbing needed energy in his front leg. With a model that was based on Wilkins, the machine calculated that he was capable of throwing the discus 250 feet. His best before coming to Ariel was 219'1". At the Montreal games, he threw the discus 232'6" for a then world record and a gold medal.

Today, according to Paul Ward, P.E.D. coordinator of the USOC's Elite Athlete Program for throwers, Wilkins is a sure bet to represent the US. He continues to throw in the 230s.

The actual method of athlete analysis is going through revolutionary changes with each passing year. When students of biomechanics first began using computers to compile data, they did it with special high-speed cameras that shoot thousands of frames per second, from as many as three different angles. The high speed films of athletes in motion would be shown, one frame at a time, on a device called a Graf-Pen digitizing screen. On the screen, researchers could trace the essential parts of the image from the film using a magnetic pen. It was the computer equivalent of tracing paper.

The animated stick figures that resulted could — at the twist of a joystick — be rotated in a three-dimensional simulation. (You could even get a top view.)

Although this process made possible a kind of detailed analysis that had never before been possible, its execution — particularly the tracing of the thousands of individual frames of action — was cumbersome.

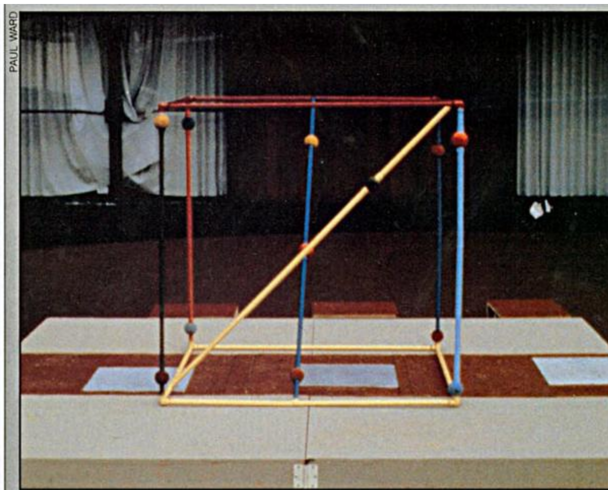
Enter Charles (Chuck) Dilman, Ph.D., head of Biomechanics and Computer Services for the USOC. The focus of Dilman's work is the USOC's Elite Athlete Project, which selects top Olympic contenders and studies them under a magnifying glass. The full array of sports medicine and computer sciences are called into play to mold these top specimens into the best competitors possible.

Of the 34 Olympic sports activities, Dilman has narrowed his own field of study to seven (decathlon, cross country skiing, ski jumping, ice hockey, archery, shooting, and race walking), and his headquarters serve as a clearing house for the leaders of biomechanical research in the other fields at universities around the country.

Under Dilman's guidance, computer analysis of Olympic athletes is moving out of the laboratory and into the field. Instead of translating filmed motion by hand into figures on a computer screen, it is now being done electronically by a process called Sel Spot motion analysis. In this method a series of infrared LED lights send signals via a video camera into a computer. As the athlete moves, a three dimensional form moves simultaneously on a monitor nearby.

An LED signal attached to the arm of an archer, for example, will transmit the tiniest deviation from a true motion. Video moniters in the field can indicate the flaw instantly and chart his progress.

PAUL WARD



Reference marker for Computerised Biochemical Analysis and set up for Computerised Force Plate Analysis.

That ability to provide rapid results and feedback is the computer's most valuable feature, according to Dilman. As he sees it, the more rapid the results, and the less interpretation required, the better. He'd even like to cut out computer experts from the chain of information: "One day," he says, "you will see computer training devices that coaches can use without technicians to analyze athletes in the field."

The weakest link in the chain of monitoring, analysis, feedback and change, is the last one, Dilman feels. He points out that it is incredibly difficult to teach an athlete to make a subtle change in his or her style. Humans do not make precise movements, and cannot be programmed the way machines can to make slight, precise changes, since so much of what the athlete does is by feel. Says Dilman, "What we still need to do is provide a better mechanism to correct weaknesses."

At present, he is finding that a combination of psychology and computer analysis provide the best results. When he finds a weakness, he gives the athlete a visual image to help him correct the flaw. "For example," Dilman explains, "a common problem with race walkers is a slight asymmetry between the right and the left legs. They may have an abrupt impact with the left leg, causing a braking action, and be smooth with the right. We would have the athlete in question watch films or videotapes of himself in slow motion. Then we would tell him to visualize the smooth-landing right leg and imagine that the left leg is landing that way."

Dilman also believes that the computer's use in sports can and will extend well beyond biomechanical analysis. "I see the computer as a tool for monitoring training," he says. "Just as the business manager and the accountant keep track of their data with the help of computers, so can the coach. The computer makes it possible to know what are today's training results compared to yesterday's, to compare the progress of the last three months to the last six months and to chart the results."

Another part of the Elite Athlete Project involves measuring the athletes' organic capacities. An athlete can only push him or herself so far before the muscles begin to use more oxygen than the body can supply. The goal is to identify the point just before that happens so that an athlete can expend maximum energy and still replenish lost oxygen. But each athlete has a different maximum efficiency point. To find it, they run on treadmills, wired to computers that will instantaneously identify when they've gone beyond this point — called the anaerobic threshold. The computers also spit out information about fluctuations in their respiratory rates, pulse rates, blood pressure, body temperature and more.

Part of the purpose of this study is to try to identify the particular physical requirements for given sports. That knowledge could make it possible to predict a would-be athlete's best sport, given his or her raw physical endowments.

The inevitable question is — will computers someday be used to select talented athletes as early as grade school to begin training for the sport they are best suited to?

"I don't think so," says Dilman thoughtfully. "Not in this country. I can't see picking a 7-year-old because his heart volume is large and training him to become a long distance runner."

Instead, Dilman foresees that testing physical potential could be part of a counseling service to young athletes, much the way psychological tests can now provide career counseling. "You might be able to tell a would-be tennis player, 'Look, you don't have the build for it. You've got the body of a weightlifter.' And then the athlete could still make a choice."

Dilman explains that such a person might make a great tennis player, despite the computer's projections. That's because such testing could never be foolproof: "The biggest variable we can't measure is motivation. Some of the Elite Athletes, for example, are physically talented, but not super-talented. Yet they possess an unmeasurable something extra, the will to succeed."


GIDEON ARIEL

Tracing athletic motion from the screen onto the computer.

"One of our Elite middle distance runners, for example, is not very flexible. Flexibility, we have found, is very important to the runner. If we had tested him as a child, we would have told him he was not cut out to be a runner. But, he's got a tremendous will, and he evolved a style all his own to suit his body — and he's successful."

The Elite Athlete Project studies the athletes as research models, but its primary purpose is to get tangible results. A number of our top Olympic contenders have seen improvements in their personal best marks under the program:

• Hammer thrower Dave McKenzie upped his personal mark by 32 feet. One of those responsible for McKenzie's improvement is physicist Rocco Petitto who studied films of the more successful East European hammer throwers and found that Europeans spun four times and leaned forward as they made the throw where Americans only spun three times and leaned backward. McKenzie changed accordingly and set an American record of 243-11 in June of 1982. (Still, the top Europeans throw the hammer 30 feet farther.)

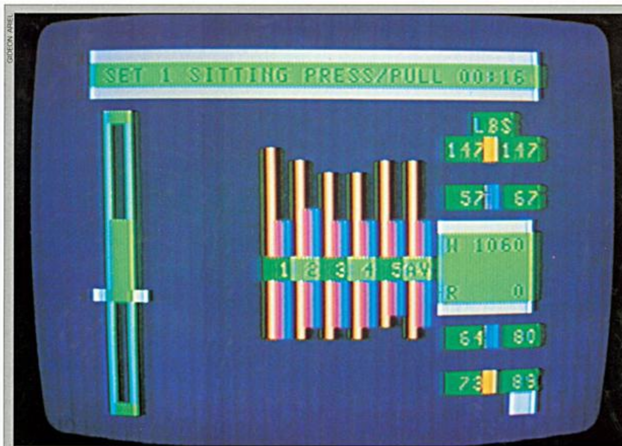
• Sprinter Calvin Smith learned from the computer that he altered his stride to an almost flat-footed one over the last few yards of a race. After identifying this problem, Smith focussed on keeping his footing light. Last July, he set a world record of 9.93 in the 100 meter dash at the National Sports Festival in Colorado Springs.

• High jumper Louise Ritter has been ranked first or second in the US since 1978 and her personal best is 6 4-3/4. In the Elite Athlete Project she learned that she would generate more horizontal velocity if she began her takeoff a little earlier. Her coach, Bert Lyle, comments, "I think it (the computer analysis) has been of tremendous value."

While the most measurable results of computer analysis may involve individuals, computers can also help teams 336 to work better together. This use of computers to study a team as a working unit is called formation analysis. One of the most successful uses of formation analysis involves the US Women's Volleyball team that resides at Coto Research Center. A few years back, the team was ranked 45th in the world. Today it's in the top five. Many say it is the best. In 1982, in the finals of the World Cup, it narrowly lost to Peru on Peru's home court. As Gideon Ariel not-too-modestly remarks, "The reason for the team's improvement is basically technology."

Ariel explains that the essence of formation analysis is seeing the patterns. "You film a game using two cameras. Then you interface with your computer by digitizing the action, tracing the movement of every player at particular locations."

Now the software takes over. Ariel and his team have devised programs that look for gaps, holes, overlapping defenses. As he describes it, "The computers do work we call density analysis." They find out what is the movement, where is the movement, how fast is the movement and what is the reaction of the players to balls hit to various locations. Based on this analysis,



GIDEON ARIEL

you can tell where a person has a vulnerable point, or where a combination of people (the team) have a weakness. Then you train to hit them at their weakness. Also, you learn your team's weakness and you train your team so that your weakness can be minimized."

Ariel pauses to let this sink in. Then he adds, "It's like a poker game where you can see your opponents' cards."

Ah, but is it sporting? Ariel thinks so. In fact, as he describes it, computer information merely raises strategy to a higher level. He points out that you cannot cover all your weaknesses, but, knowing them, you are better equipped to make strategic decisions. Knowing precisely where you are weak would be especially beneficial to a pro team at draft time. The tendency is to want to pick the best all-round player available, but, Ariel says, "The first draft choice for a particular team could be the worst for another."

Of course draft choices and trades are rarely based exclusively on a player's talent. Selling power may be more important. No problem. A player's financial usefulness to a team, just like his physical usefulness, can be calculated by computer.

Take a step into the office of National Economic Research Associates in New York's World Trade Center and peer into their Hewlett-Packard 3000 computer video display. Lou Guth, the Senior Vice President of NERA throws a floppy into the drive and calls up FAMS (Free-Agent Market Simulator). You're greeted by ever-polite written instructions: "Welcome to NERA's NBA free-agent market. You can select any leading NBA player and see how much he would be worth to a team that you choose." (This software is user-friendly to a fault.)

Before Moses Malone was picked up by Philadelphia, in 1982, FAMS judged that the team with the most to gain by his acquisition was the New Jersey Nets. A complex series of calculations took into account the Nets' then-current offensive statistics and then added Malone, figuring that he would raise the team's winning percentage by 50 percent and draw an additional 5,695 spectators per game. Valuing each ticket sale at $12.50, including parking and concession-stand earnings, Malone would have brought the Nets nearly $3 million extra per season, according to FAMS.

Of course, to the computer, Malone was only a composite of his rebounds, field goals, free throws, etc. His ability to adapt to a new team — the 76ers, for example, where another star offensive talent was already in place in the form of Julius Erving — could never have been predicted. Before Malone signed with Philadelphia, FAMS figured that his presence on that team would bring in 59,000 more fans per season — less than one thousand more per game. No team would scoff at the additional revenue this would bring, but to pay Malone a salary in the neighborhood of 2 million per year would have been bad business.

Except the 76ers did sign Malone for a whopping salary. And Malone did alter his style to support Erving, rather than stealing the show. And the 76ers did win the championship in 1983, and currently are among the leading contenders in 1984. Along the way, ticket sales increased tremendously.

That's where computers fail. You could say that they are only human. Er, well, it's that they simply have no way of calculating the human potential to adapt and change. Without doubt, the machine can process past performance data like crazy and project it over any future course that you want. But there will always be limits.

Still, Earl Weaver was wrong to tear up that printout. Precisely because computers cannot actually think for you, there is no reason to fear them. Especially not as long as humans are intelligent enough to know when intuition must override the computer's decisions. The trick will be to keep a clear perspective — that is, to remember who programmed the computer in the first place.

As Bob Ward puts it, "I'm all for the computer, but not at the expense of the greatest computer of all — the human mind." ■