



# Computerized Biomechanical Analysis Inc.

The first Company in the World to provide biomechanical analysis to Industry and Sports.



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| <b>Code</b>         | adi-pub-01205   |
| <b>Title</b>        | Computerized Biomechanical Analysis Inc.  |
| <b>Subtitle</b>     | The first Company in the World to provide biomechanical analysis to Industry and Sports.  |
| <b>Name</b>         | Computerized Biomechanical Analysis Inc.  |
| <b>Author</b>       | Nancy Cohen   |
| <b>Published on</b> | Saturday, June 1, 1968  |
| <b>Subject</b>      | ACES; APAS; Biomechanics; Brochures; Digitize; Discus; Exercise Machine; Favorite; Force Plate; Golf; Media; Olympics; Performance Analysis; Products; Science; Shoes; Sports; Studies; Tennis; Track and Field |
| <b>URL</b>          | <a href="https://arielweb.com/articles/show/adi-pub-01205">https://arielweb.com/articles/show/adi-pub-01205</a>   |
| <b>Date</b>         | 2013-01-16 15:40:49   |
| <b>Label</b>        | Approved  |
| <b>Privacy</b>      | Public  |

The article discusses the work of Computerized Biomechanical Analysis, Inc., the world's first research company dedicated to scientifically analyzing and evaluating human motion dynamics. Founded in 1971, the company initially focused on improving athletic performance. By 1974, it expanded its scope to include the development and improvement of sports equipment and industrial products, as well as research supporting governmental agencies concerned with industrial and consumer safety. The company uses a computer-digitizer complex to analyze total body motion, providing precise data on body and segmental centers of gravity, segment velocities and accelerations, forces, moments of force and inertia, timing between body segments, and the contributions of each body segment to the total body motion. The company's research has broad applications, including the design and precision engineering of sports equipment, prosthetic devices, and selected areas of medicine and rehabilitation.

## Computerized Biomechanics: A New Era in Sports Training

This article discusses the use of computerized biomechanics in sports training, particularly in preparation for the 1980 Moscow Olympic Games. Dr. Gideon Ariel, a PhD holder in exercise science, is using computers to analyze the body segments of U.S. athletes. The system involves taking regular films of athletes in training, which are then analyzed using high-speed computers to determine the efficiency of their movements.

The technique has been used before, but the 1980 team may be the first group of American athletes to have their analyses fed into a computer to program their training regimens. The system has been met with some skepticism, but Dr. Ariel believes it will prove effective in improving athletes' performance.

The article also discusses the potential of computerized biomechanics in other areas, such as designing exercise equipment and rehabilitation devices, and analyzing the motion of handicapped children. Despite some controversy and legal issues, Dr. Ariel's work is seen as a significant step forward in sports training.

## Article Synopsis

In the early 1970s, Dr. Gideon Ariel, founder of a company in which he owned a 50% share, was accused by Dr. Ricci of advancing too quickly in his field before completing his degree. Dr. Ricci threatened to withhold Ariel's PhD degree unless he relinquished ownership of his company to Dr. S. Plagenhoef. However, Dr. Ricci denies these allegations.

Ariel was hired by the exercise science department in 1974, despite opposition from Ricci and Plagenhoef. His job was to teach two exercise science courses, complete and publish research, and obtain research grants from the business community. Ariel's work for Universal Company led to a \$39 million lawsuit, in which he was accused of

fraud by Arthur Jones, owner of Nautilus Co., Universal's largest competitor. The case was settled out of court.

Another lawsuit was filed against Ariel and the University of Massachusetts in 1974 by Dr. Elizabeth Ebacher, who claimed the university hired Ariel without giving adequate public notice or initiating an affirmative action search for candidates. This case is still pending. Ariel's employment with the university ended in 1975, which he attributes to jealousy over his success and innovation.

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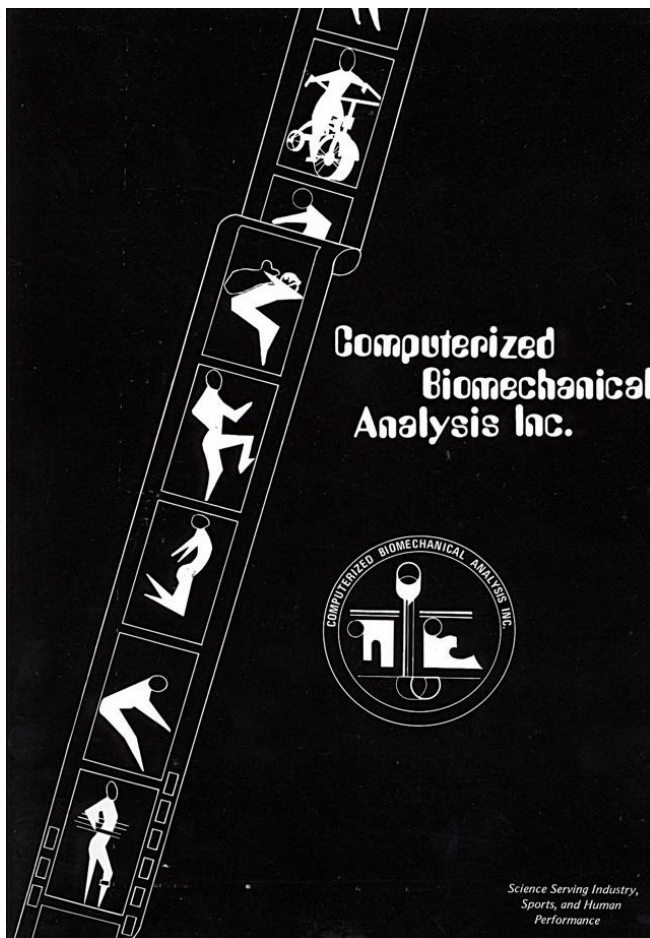
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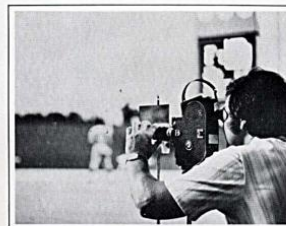
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Below find a reprint of the 36 relevant pages of the article "Computerized Biomechanical Analysis Inc." in "Computerized Biomechanical Analysis Inc.":



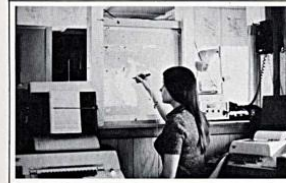
## Science Serving Industry, Sports, and Human Performance

Computerized Biomechanical Analysis, Inc. is the world's first research company created specifically to scientifically analyze and evaluate the dynamics of human motion. Founded early in 1971, CBA initiated its work in the area of improving athletic performance. By mid-1974, CBA was involved in the development and improvement of sports equipment and industrial products as well as in research supporting governmental agencies concerned with industrial and consumer safety.



### Research Techniques

Kinetic analysis of human motion utilizes a computer-digitizer complex which allows analysis of total body motion by means of slow motion cinematography, special tracing equipment, and the high speed computer. Comprehensive software applications provide precise output in the form of body and segmental centers of gravity, segment velocities and accelerations, horizontal, vertical, and resultant forces, moments of force and inertia, timing between body segments, and the contributions of each body segment to the total body motion. Now the ordinary practice of trial and error estimates can be replaced by accurate, scientific data.



### Applications

Although inquiry and research continue to unfold new avenues for the application of biomechanical analysis, already the high speed processing of massive amounts of data made possible by the computer and appropriate software programming has expanded the applications of the science of biomechanics to virtually limitless dimensions. In addition to human performance, CBA has provided data necessary in the scientific design and precision engineering of sports equipment, prosthetic devices and in selected areas of medicine and rehabilitation. Similarly, areas where force and motion prevail, such as athletic performance, physiological processes and therapeutics, can be evaluated, modified, or improved.

*Demonstration of this unique application is available within our modern laboratories located at 316 College Street in Amherst, Massachusetts 01002 - Telephone (413)256-0486*

# Computerized Biomechanical Analysis

## HISTORY OF C.B.A., INC.

The company's history dates back to early studies in body measurements by Wilfred Dempster, who assisted Dr. Stanley Plagenhoef, University of Massachusetts, in his early efforts to develop this program for human motion analysis. The basic computer program used, was written by Myron Curtis, Bowdoin College. It has since been expanded and modified by Dr. Gerald Calkins, C.B.A. research scientist and Carl Pedersen, C.B.A. computer programmer. Practical applications to sports activities was initiated by Gideon Ariel, Department of Exercise Science, University of Massachusetts and further fostered by Kenneth T. Weinbel, Department of Athletics, Dartmouth College.

The Dartmouth College Computer Time Share System was selected to service the program and the Hanover, New Hampshire community to serve as a home base for the C.B.A., Inc. operation. The cooperation and capabilities of the Kiewit Computer Center and Dartmouth College personnel, were instrumental in this decision.

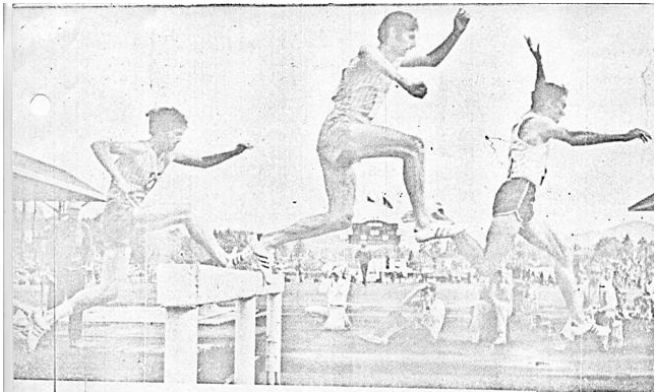


## THE C.B.A. SYSTEM

The computer and our own designed, complex, in-put hardware, have reduced sixteen hours of anatomical tracing to thirty minutes and twenty hours of slide rule work to ten minutes. This has made complex whole body motion analysis a practical commercial commodity, instead of a limited laboratory project.

C.B.A., Inc. has advanced its computer program to such a high degree of sophistication, that it will undoubtedly be many years before anyone can hope to develop the equal capacity for producing such quality data.

Continual research and development by C.B.A. personnel, will guarantee continued leadership in the field of biomechanical analysis and related endeavors.

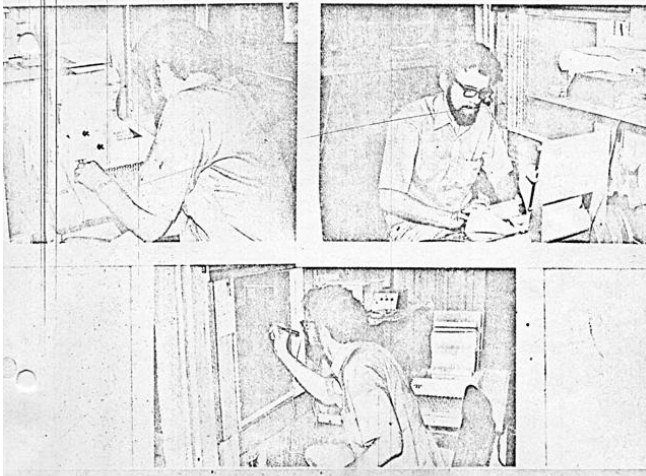


**TRACK and FIELD:** C.B.A., Inc. has received grants from the United States Track and Field Coaches Association and the United States Olympic Committee, to biomechanically analyze the performances of the athletes who will compete for the United States Olympic Team, as well as the other world class performances, of the athletes, at the Olympic Games in Munich, Germany.

Data is continually being collected for research in the development and improvement of track and field performances and equipment. The track world is being made aware of the data through submitted articles for track and field publications.

The C.B.A. system of whole body analysis will be presented to the Congress of Science (held in conjunction with the Olympics) by Mr. Ariel, when in Munich.

Analysis have been conducted for athletes, with improvement of performance, the objective. The results were vividly noticeable. (refer to Gideon Ariel's article)



**PROFESSIONAL and COLLEGE ATHLETIC ORGANIZATIONS:**

Professional and college athletic staffs recognize the values of whole body motion analysis in their overall programs. C.B.A., Inc. is presently designing an analysis program which will allow these organizations to ascertain the best possible physical fitness programs for their athletes, as well as to conduct periodic fitness level examinations, in an effort to reduce injuries and aid in the player's overall play efficiency. Included in the program are sections for: efficiency predictability, skill efficiency evaluation and correction programs for loss of skill efficiency during the progress of a season and/or the playing tenure of an athlete.



(Illustration of a classic knee injury)

**SYNTHETIC PLAYING SURFACES:** C.B.A., Inc. believes that the conventional methods of characterizing the properties of polymere compounds used in artificial playing surfaces are inappropriate. For example, the durometer hardness (really a stiffness measurement) may bear no relation to the stiffness of the material under dynamic impact.

To overcome this problem, we have developed a test system which will allow measurement of properties of compounds under dynamic conditions. An electro-hydraulic servo system is being used to load specimens at desired cyclic speeds. A strain gage load cell has been built to measure the resistance to deformation under these conditions. The output from the test system is a load displacement graph displayed on an oscilloscope. This output can then be used to determine:

- a. dynamic stiffness
  - b. hysteresis or damping efficiency
  - c. usable deformation
  - d. bedding down resistance for the compound under investigation
- The force data we obtain from motion analysis can be utilized with this testing procedure to produce information relative to shock absorbtion, surface stiffness (durometer), recovery rate of the material and energy absorbtion.

There is no doubt that the information revealed will be helpful in the development of superior playing surfaces. The potential is unlimited.....

**GOLF'S EQUIPMENT REVOLUTION**

**BALLS LEAT GO FARTHER, LIES THAT HIT STRAIGHTER**

**ATHLETIC EQUIPMENT:** Manufacturers of athletic equipment are finding whole body analysis a new concept and aid in the design and improvement of their equipment. C.B.A., Inc. is currently engaged in research with a leading manufacturer of golf equipment. The project is intended to lead to better and more accurately designed golf clubs. The ultimate may very well provide custom clubs for players, based upon the analysis of their personal golf swings.

C.B.A. has already assisted the industry with research in ball spin and ball bounce properties as well as impact studies on tennis rackets.

C.B.A. is also involved in research for the development of athletic shoes as they relate to performance and running and playing surfaces. The total body motion analysis is computerized to obtain the magnitude and direction of force on the shoes for each activity as well as the total body center of gravity corresponding to the force data. This means that the force distribution on the shoes can be ascertained. The resultant data will enable the manufacturer to develop the most scientifically designed product on the market today.

**Turf Makers Fail To Agree on Injuries**

WASHINGTON (UPI)—Two manufacturers of artificial turf disagreed Tuesday at a congressional hearing on whether it is possible to tell if there are more serious injuries on grass than on turf. Gene Troy, enterprise manager for Monsanto's AstroTurf, told a House subcommittee probing the safety of artificial turf that studies show AstroTurf "does not accelerate or extend the rate of injury" as had been claimed by witnesses Monday. Troy added, "data and information from our customers indicates that severe injuries occur with less frequency on our product than on natural grass."

But James F. Higgins, manager of the Recreation and Athletic Products department for 3M Co., declined specifically to claim his company's Tartan Turf was safer than grass. "Very candidly," said Higgins, "we believe definite conclusions are hard to draw, first, because to our knowledge, there are no standards for natural turf... those standards by which to achieve measurements of comparison."

He also said that 3M believes it is "difficult—almost impossible—to say that an injury occurring on synthetic turf would not have occurred on natural turf."

Higgins admitted that early promotional brochures several years ago described Tartan Turf as specially designed to reduce knee and ankle injuries caused by cleats catching in natural sod.

"We later withdrew this statement, not because we thought Tartan Turf would not reduce injuries, but because we realized the statement implied that data was available by which a valid injury comparison between synthetic turf and natural turf could be made."

Re: Higgins statement. It is because they do not know the forces involved. C.B.A. can determine the forces. By determining impact force and absorbtion qualities of the surfaces, during a fall or injury, we can determine how much force can be absorbed by the surface and its cause and affect on the injury in question.

**PROSTHESIS RESEARCH:** C.B.A., Inc. is involved in extensive research in the development of prosthetic devices. Whole body analysis is the only true way to obtain data for the design of an artificial device to assist man in body motion. By knowing the forces involved as well as the contribution of each body segment to the desired motion, a device can be developed, eliminating the archaic "trial and error" method. The potential of analyzing human motion for standardizing percentage disabilities is of tremendous interest to those people in the Veteran's Administration and insurance companies involved in the disability and rehabilitation programs.

Computerized Biomechanical Analysis of Track and Field Athletics  
Utilized by the Olympic Training Camp  
For Throwing Events

Gideon Ariel  
Assistant Coach  
University of Massachusetts

This past summer (1971) at the Olympic Training Camp conducted at Dartmouth College, a computerized biomechanical analysis was done on the performance of each weight event man in attendance. The results were vividly noticeable by coaches and athletes. Several athletes were able to affect immediate improvement in their performance by making changes as warranted by their computer analysis. Others were able to return to their respective colleges armed with the scientific data and knowledge necessary for an intelligent approach to develop their own personal program for improvements. Events and Athletes: Discus-Michael Hoffman, Larry Kennedy, Stanley McDonald; Hammer-Robert Marcessian, Steve Doustremont, Lawrence Hart and Alfred Paliwoda; Shot-Put-Samuel Walker, Bruce Wilhelm and Erich Hardaway; Javelin-William Schmidt, Michael Lyngstad and James Stites. All found the program very beneficial. For instance, Hoffman's analysis revealed a flaw, and he immediately uncorked throws 10 feet better than ever before.

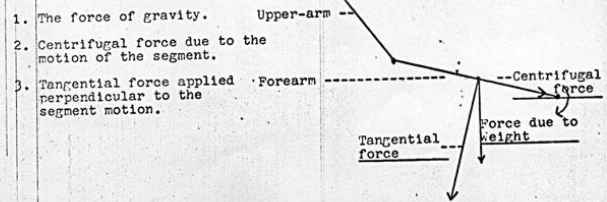
This biomechanical analysis provides a new approach to track and field athletics which was made possible by the collective efforts of many scholars and the technological advances of the past decade. Slow motion cinematography is used to record any desired motion and then special tracing equipment enables data to be processed directly by a high speed computer. The appropriate programming results in a segmental breakdown of information of the whole motion. Data obtained includes the total body center of gravity, segment velocities and accelerations, and joint forces and moments of force. A unique feature allows the interpretation of the data to show the significance of contribution of each body segment to the whole motion. Other available information shows 1) the positions of maximum velocities and accelerations, 2) the magnitude of the muscle action at each joint, 3) the vertical and horizontal forces at all joints and at the ground contact points, 4) the timing or coordination of motion between the body segments, and 5) the differences due to body-builds. The combination of the moments of force, the interrelated patterns of the body segments, and the task performed give a measure of the efficiency of the motion.

This information may be useful in any track and field event to improve performance and to aid in finding optimization of performance.

The scientific principles underlying the analytic technique:

The segments of the human body form a link system. The laws of physics apply to any link system in motion regardless of whether the system is a human or machine. The different segments of this link system in the human body are the foot, shank, thigh, trunk, shoulders, upper arm, forearm and the hand.

When the link system is in motion such as in any track and field event, there are specific forces acting upon each segment of the total link system. For example, if we analyze the forces which acted on a swinging forearm, the following forces would be obtained: (Fig. 1) These three forces would act upon any segment in motion whether in the human body or another object.



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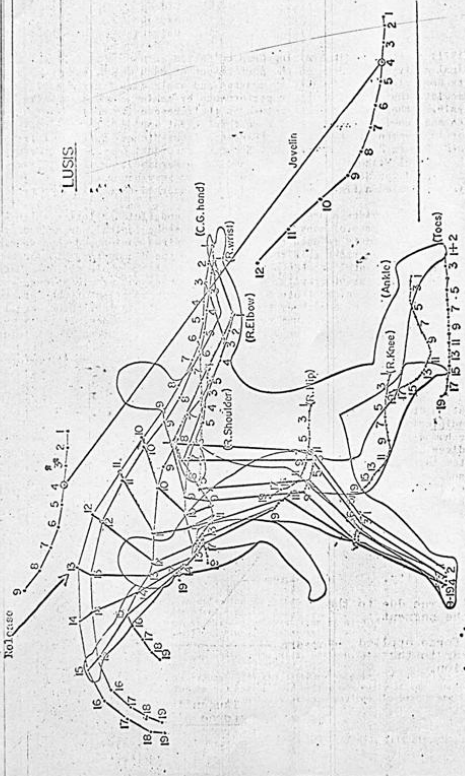
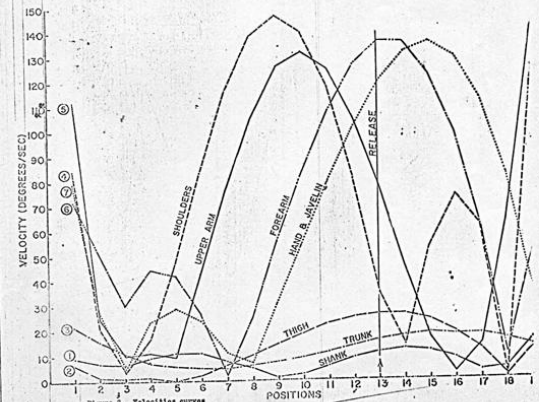
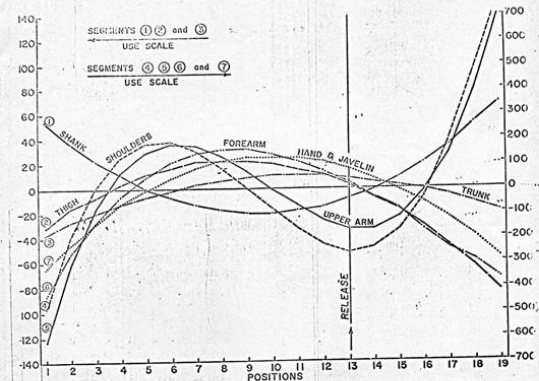
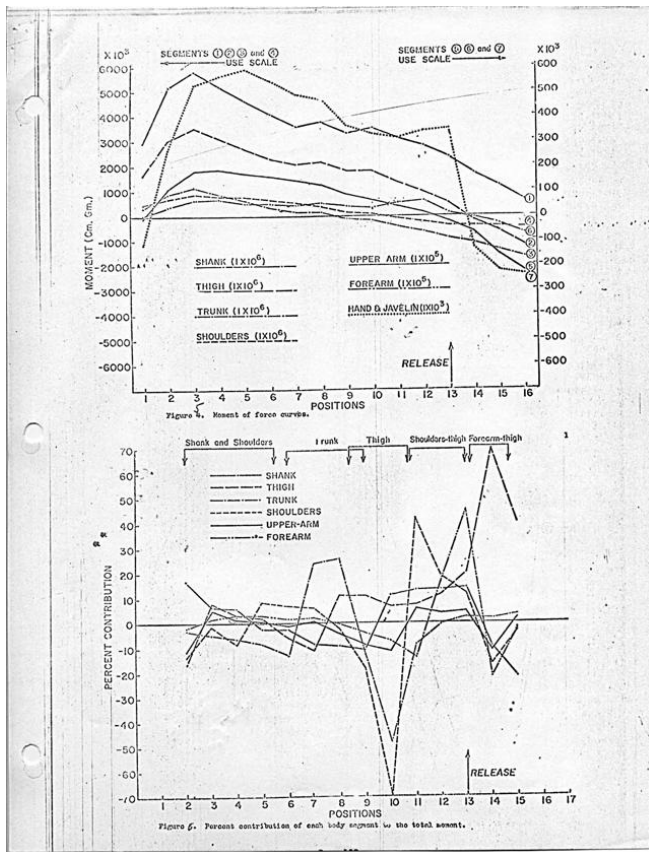


Figure 2. Free Body Diagram of the Javelin Thrower.



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Interpreting moments of forces:  
 Following computation of the different forces, moments of force are calculated. The moments indicate dominant muscle forces and the effect of one segment on the adjoining segment. If muscle action is moving a segment in the clockwise direction, it will be attempting to move the adjoining segment in the counterclockwise direction; thus, in any track event one segment may have detrimental effects upon the adjoining segment which will not be observed by the human eye. Correction of such an inhibiting effect could be done only by moment analysis. At times the moments of one segment are so large that they will be the dominating muscle force at the segment, producing a dominant muscle action at this adjoining segment just opposite to that which might be expected. This was found to be true in the long jump where hip extension is so great that the knee flexors are dominant even though the legs are straightening. By controlling this effect one may produce an ideal jump such as the case with Beamon's jump at the 1968 Olympic Games.

The relationship between maximum velocities and accelerations are important in technique analysis. This timing can be determined by the present program. In the best throws of implements such as in the shot, hammer, javelin and discus, it was found that the velocity of the last segment should be at its maximum close to the release (not at the release) even though the deceleration of the segment begins prior to the release. This rapid deceleration of the last segment just prior to release increases the force. This fact indicates the stabilizing of the joints of the body for the instance of release. A good throw requires a link system which is properly timed and coordination of accelerations and decelerations of all body segments are in a sequence of action from the left foot to the right throwing hand that produces maximum velocity of the right hand. To achieve this goal, the use of optimum positions of anatomical strength must be considered as well as the proper use of the body's link system.

This kind of information cannot be obtained by the eye, or simple analysis of film. The possibilities of application of this computerized biomechanical analysis technique to track and field athletics is far reaching. This method might provide a breakthrough in the field of coaching. The element of doubt is removed and the uncertainty of trial and error is replaced by accurate, scientific data, a welcome change by all who seek perfection.

If the human body had only one segment, then coaching would be very easy since only three forces would act upon it. However, the human has more than one segment and in some track events as many as 9 segments are considered in the analysis. Universal laws affect a link system so that each segment in motion has aforementioned three forces. There are additional forces due to the influence of segments on each other. For example, when a link system consists of two segments, such as the upper arm and the forearm, then we have gravity, centrifugal, and tangential forces acting upon each segment and additional 3 forces resulting from the influence of the first segment upon the second. In a link system of seven segments such as in the shot put throw a total of 84 forces are involved in each sequence of the throw.

When a coach analyzes a particular event, he tries perceptually to maximize the resultant force consisting of many forces which act upon the body through the sequence of the performer. This perceptual analysis is not very accurate since guessing is involved. Presently, coaches have to rely on personal observation as their main means of evaluating and improving performance and technique. Past experience and trial and error have been the prime tools in coaching. Imitation of successful athletes has, more often, been the only available gauge. Many coaches have many mechanical aids such as high speed cameras, closed circuit television etc. which aid their efforts. However, there still exists the void of true scientific data related to each individual athlete and his specific performance. It is almost impossible to make accurate decisions about motion, just from observation. Whether or not an athlete is using his body efficiently to have a good performance, cannot be determined by visual observation alone.

Using the present technique, velocities, accelerations, forces, moment of forces and percent contribution of each segment in the body to the total performance can be determined utilizing the high speed computer.

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Barnaby Kalan  
 Computerized Biomechanics

What can separate an athlete from a champion?  
 Body segments -- and whether or not these segments are used most efficiently. Dr. Gideon Ariel, who holds a PhD in exercise science, will be using computers to analyze the body segments of U.S. athletes training for the 1980 Moscow Olympic Games.

Dr. Ariel and Dr. Irving Dardik, head of the Olympic training camp in Squaw Valley, California, are developing a system where each athlete preparing for the games will have regular films taken of them. These films will be flown to Amherst, Mass., where Dr. Ariel has his laboratory -- Computerized Biomechanical Analysis Inc. (CBA).

Dr. Ariel will project the films -- frame by frame -- onto a screen, plot the angles, joints and lines of motion. Using the laws of physics and high-speed calculations made possible by computers, Dr. Ariel will have a printout and diagram showing how well that athlete is throwing, jumping, sprinting. . . even kayaking.

It won't be the first time computerized biomechanics have been used to help Olympic athletes. Dr. Ariel started CBA in 1971 near Dartmouth College. That year the college was hosting the 1972 Olympic training camp.

But the 1980 team may be the first group of American athletes to have their analyses fed into a computer to program their training regimens.

(more)

Biomechanics -- page two

Computerized analysis? Computerized training? This may sound a bit inhuman.

"It remains to be proven," said Ken O'Brien, head track and field coach at the University of Massachusetts. O'Brien has had ample opportunity to see computerized biomechanics applied to training.

A few years back one of O'Brien's students was considering the shot put or discus, and asked Dr. Ariel about the possibilities. The student had previously concentrated on running events.

"The guy wasn't big, just fast and had potential," Ariel said. "The computer showed he could do it so I knew he could throw over 190 feet, regardless of what people said."

Ariel, 38, and a former Israeli Olympic discus and shot putter in the 1960 and 1964 Games, studied computer analyses of world champion throwers and compared them to the student. A tight training program, designed to emulate the style and segmental efficiencies of the greatest, produced results.

"I'd bet with O'Brien, I'd tell him, 'this weekend he'll throw 172 feet.' O'Brien wouldn't believe it, but that guy did it and eventually broke a New England record," Ariel said.

This type of training -- computerized analyses of wasted motion coupled with a training program to reduce those inefficiencies -- is what Ariel hopes to do on a regular basis for the 1980 Olympic team.

"The Germans used biomechanics ten times as much as the U.S. in 1976," Ariel said. "Now the U.S. is catching on, but we're already late. . . a year behind everyone else."

(more)

In 1975 Ariel analyzed seven throwers participating in the Olympic javelin training camp at the University of Seattle, Washington. Each thrower's performance was compared to Soviet world record holder Janis Lasis. Each athlete was shown diagrams, the computer analysis and given a recommendation based on the data.

A typical recommendation might sound like: "The computer indicates that Keith does not stop his front leg before the release. . . the hips are decelerating between frames 9 and 10, which is just prior to release, however the deceleration of the hips should occur earlier, at approximately position 6."

If Dr. Dardik and Dr. Ariel have their way, films will be taken at regular intervals of virtually all athletes training at the Squaw Valley Olympic camp.

"The exact intervals haven't been worked out yet," Ariel said. Conceivably, slow-motion films of performances would be taken once every month and flown to CBA in Amherst for analysis. The results would be sent via telephone hookup to California and stored in the memory of a computer identical to the one in Dr. Ariel's lab.

The U.S. Olympic Committee has already set aside a grant for the computer analyses, according to Ariel, who will be director of biomechanics. CBA will work in conjunction with the Universal Co. in California to design special training equipment. The target date for starting analyses is around June, Ariel said.

(more)

At the Squaw Valley camp, athletes will follow a prescribed training program mapped out by computer to improve their specific muscular or coordination weaknesses.

"The coaches won't have to be there at camp continually," Ariel said. A labor-saving device, perhaps. It is likely that many coaches won't be breathing a sigh of relief when reading about this.

"I think some coaches will feel threatened," O'Brien said. "Right now it seems like a chemistry professor or someone like that is trying to tell them how to coach," he said.

"It's a great tool, theoretically," O'Brien said, stressing that the ability to sit down and study a great but distant athlete like Lasis is a "big plus." You can have a quantitative measure of the world's best performances right there, O'Brien said, so you can say, "Look, at that moment Lasis' arm isn't moving at all," and your local athlete can compare his style to a champion's.

"I think coaches are used to sticking with things that have worked for them," O'Brien said, adding that biomechanics requires a lot of time and energy to understand -- not to mention having the resources to pay for it.

"But I think as soon as he (Ariel) can take it and utilize it over a period of time and show it's effective, then coaches will be knocking at his door," O'Brien said.

Dr. Ariel claims he's contributed to two world records with his techniques, in discus and shot put. Mac Wilkins, 1976 gold medal shot putter in Montreal, supports his claim.

(more)

"Basically, he changed my whole concept on how to throw an object," Wilkins said in an article for Newsday. "I used to think that when you throw something, you have to put as much energy, as much speed, as you can into the direction of the throw. However, Gideon Ariel showed me that it's equally important to have deceleration, a stopping action," Wilkins said.

Ariel caught on to this notion of deceleration while filming athletes at the 1972 Munich Olympic Games. He noticed that the East German shot putters would slam their front foot into the ground upon release. He pointed out what he thought was a mistake in style and the Germans politely thanked him for his advice. The next day, they were still doing it the same way.

Later, a computer analysis showed that when the body's throwing segments, such as forearm, wrist and hand, are experiencing maximum acceleration, the rest of the body's segments are doing to opposite -- decelerating. This information in graph form (see diagram #2) shows how much other body segments contribute to the final throw.

These and other minute yet crucial factors are not visible to the human eye, Ariel said. For example, a small change in shot putter Randy Matson's center of gravity -- noticeable when comparing practice throws with competition tosses -- cost him five feet in distance. The computer analysis showed he momentarily lost firm contact with the ground just prior to release.

(more)

Perhaps the most spectacular aspect of Dr. Ariel's work is his ability to take computer diagrams and data for a champion and simulate the greatest world record humanly possible.

"In effect, it gives the optimum performance by an athlete beyond which there would be damage to muscle and bone tissue," Ariel said.

Some of the results are fascinating. 1936 triple gold medal winner Jesse Owens actually ran as fast as modern-day sprinters, Ariel claims. Owens was handicapped by the cinder track he ran on, compared to firmer artificial surfaces today. A difference similar to a top sprinter running on sand versus an average runner on a hard surface. The ultimate 100 meter dash? About 9.6 seconds, according to Ariel, (see diagram #3.)

The ultimate high jump? Eight feet ten inches. Ariel claims that arm and leg forces generated by Soviet former world record holder Valery Brumel, 1968 Olympic champion Dick Fosbury and current world record holder Dwight Stones, are all about the same.

But Brumel wasted much vertical energy with his straddle-style jump. If he were to flop, Fosbury-style, he would top current world records, according to Ariel. What's more, should modern high jumpers adopt a forward style flop, they could potentially develop the near nine foot jump.

Ariel's analysis of Bob Beamon's world record long jump at Mexico City in 1968, showed a near-perfect human performance. At best, a human being could only add two or three inches onto Beamon's 29 ft. 2½ in. jump, Ariel said.

(more)

Applications are nearly limitless -- the only question is what to analyze first. His research firm is currently working on about a dozen projects at once. They're helping design exercise equipment, designing a human-powered vehicle, analyzing the punting, passing and blocking efficiencies of the Dallas Cowboys plus research into tennis balls, racquets and other athletic equipment. Ariel has used computerized biomechanics to analyze the motion of handicapped children and to design rehabilitation equipment and prosthetic devices, too.

He once planned to house CBA's equipment in the athletic department of the University of Massachusetts. Departmental squabbles and hiring difficulties made him rent the present facilities in Amherst.

The narrow office is sandwiched between a cafeteria and an electronics parts store. There are no machines whirring or flashing lights when you walk in. Chances are, no one is in the front waiting room, a green-carpeted, couched chamber with a picture of former Olympian Bill Toomey greeting President Ford up on the wall. Toomey is now a marketing aide for Ariel in California.

In the back room desks are cluttered with computer printouts. The few employees present are likely to be sitting quietly, staring into cathode ray screens at lists of data.

"Ten years ago this computer would have cost a million dollars," Ariel said, pointing to a chest-high blue cabinet. "I got it for about \$50,000."

Ariel said he started CBA in 1971 with five dollars, and built up the business project by project. Much of his early work with CBA was done while Ariel was completing his PhD in

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exercise science at the University of Massachusetts.

"Gideon seems to be the type of person who can pursue very many things with great intensity," Coach O'Brien said. Ariel commuted between Amherst and Dartmouth College during those early years, when CBA was located in New Hampshire. He still has a computer terminal in his Belchertown, Mass., home to keep in contact with ongoing projects.

CBA is now a million-dollar-a-year operation, according to Ariel. In addition to the mini-computer, CBA houses about \$35,000 worth of force platforms and another \$80,000 worth of graphics, digitizing equipment and computer terminals.

"I don't think anybody in the world has the equipment we have," Ariel said.

A class of undergraduate exercise science students, from nearby UMass, came walking out of the back room, a little dazed, thanking him for the tour.

"Students come in here and don't want to leave," Ariel said. "Their text books are already dated, maybe five or six years behind. In here they see the source of information in the field, rather than a secondary source," he said.

Recently Al Orter, the only man to win medals in four consecutive Olympics, ('52, '56, '60, '64, <sup>discus</sup>) asked Ariel if a computer analysis could answer one important question: Can I make a comeback?

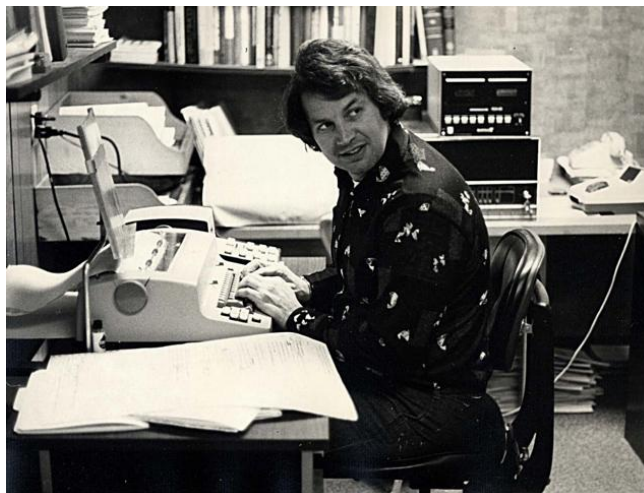
"It was the first time this caliber of athlete came to me to discuss optimum possibilities," Ariel said. It will require a lot of analysis to determine if Orter is physically capable of competing in the 1980 Olympics or if three years of

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training would be wasted effort, Ariel said. Either way, he'll do the analyses free of charge, as he has done for many amateur athletes who cannot afford the expensive computerized procedures.

Training methods for the 1980 Olympic Games may prove more than a testing ground for Dr. Ariel and computerized biomechanics. Hopefully the United States will demonstrate a financial willingness to push our athletes -- along with the rest of the country -- into the space age.

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*Valley Advocate*

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Gideon Ariel Profile

"People in this university are so vicious, jealous and arrogant. . . it's a society of rotten people," said Gideon Ariel, a former assistant professor at the University of Massachusetts, as he sat back on a couch in his Amherst office of Computerized Biomechanical Analysis Inc. (CBA).

"Young, aggressive new scientists, with new ideas, are expelled," he said. "Those who want to rock the boat, which is a sign of progress, they are the ones who are expelled," Ariel said. Ariel received his PhD in exercise science at UMass.

Earlier that morning, Feb. 22, Ariel sat in Hampshire County Superior Court while slander charges against him for \$50,000 were dropped. His accuser, Benjamin Ricci, one of Ariel's former teachers of exercise science at UMass, and Ricci's lawyer, were not present in court.

"As far as I was concerned, it wasn't personally worth pursuing it farther," Ricci said several weeks later. "My issue was resolved." That issue, according to Ricci, was an "unfortunate charge of anti-semitism. . . which I don't hold and never did."

The court action left Ariel one step closer to erasing the controversy that forced him to leave the exercise science dept. at UMass two years ago.

Still to be scheduled for Superior Court is Ariel's suit against Dr. Stanley Plagenhoef, also one of Ariel's former teachers. Ariel claims Plagenhoef stole equipment from CBA in 1973, when Plagenhoef quit working for the company. Plagenhoef asserts Ariel owes him back pay and stock in CBA.

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"It's been a painful year. . . up to now," Ariel said, relaxing on his office couch.

In the past three years Ariel has been party to three lawsuits, including a \$39 million suit for fraud. He entered UMass' exercise science dept. in 1974 as an assistant professor, amid a hiring policy controversy.

Since then, Ariel has become director of biomechanics for the U.S. Olympic team, traveled all over the world presenting his research and built CBA into a million-dollar-a-year-operation.

"Dr. Ariel is a world renowned specialist in his field," according to a letter written by William Farrell, president of Universal Resilite, a firm which manufactures exercise equipment. Universal hired Ariel in 1974 as a consultant to do computer analyses on a new exercise machine they were developing.

Yet this August, when a grant from the National Institutes of Health runs out, Ariel's last official connection with the University of Massachusetts ends.

Ariel blames personal attacks against him in the exercise science dept. for his break with UMass. Had it not been for the brouhaha, Ariel's firm would have been set up in the basement of the Boyden building, as part of UMass' School of Physical Education.

"That's the way I had originally planned it," Ariel said. In 1974 he contemplated moving some of CBA's valuable equipment from their first offices in Hanover, New Hampshire, to Amherst.

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Hanover was within access to Dartmouth College's computing center, which had the only adequate computer potential at that time, Ariel said.

In the spring of 1974 Professors Ricci and Plagenhoef publicly opposed Ariel's appointment as an assistant exercise science professor. Ariel's lawyer advised him to hold off the move into Boyden, and Ariel rented what turned out to be the present location for CBA, on College Street, Amherst.

Plagenhoef gave three reasons for opposing Ariel's appointment, in an April 27, 1974 letter to exercise science dept. head Harry Campney. He charged:

- That Ariel misrepresented himself as a "professor" in an athletic journal, before his appointment as an assistant professor at UMass;
- That Ariel had been listed in commercial literature as having a PhD in computer science;
- That Ariel had used the same paper for dual publication.

Ariel responded that the dual publication was a mistake for which he was not directly responsible. In a June 5, 1974 letter to UMass Vice Chancellor Robert Gluckstern, Ariel said an oral presentation he gave before an athletic association was reprinted in their journal, without his knowledge.

William Farrell, Universal Resilite president, has admitted being at fault when listing Ariel PhD in "computer science" in a Universal brochure.

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The pending court action with Plagenhoef involves more than slander. Ariel is suing Plagenhoef to get back more than \$5,000 worth of camera and other equipment that Plagenhoef allegedly took when he left CBA in 1973.

Plagenhoef is countering Ariel for back pay of approximately \$25,000 for work he did for CBA in 1972. Yet a statement of fees due, sent to Ariel and dated June 30, 1973, contains charges for repairs on a UMass movie projector that Plagenhoef used. The statement also contains fees for work Plagenhoef's sons, Garry and Tom, did for CBA.

Plagenhoef has refused to comment on this matter, while awaiting court action.

All this is history, but it may be affecting one student right now, Avraham Melamed, the UMass swim coach. Melamed is a former member of the Israeli Olympic team and a survivor of the 1972 Munich Massacre.

Gideon Ariel is also Israeli and a former Olympic discus thrower for Israel. The slander charges dropped Feb. 22 were brought by Ricci against Ariel for calling him anti-semitic.

Ariel discussed the incident in a June 5, 1974 letter to Vice Chancellor Gluckstern.

"... a few days before his meeting with Dr. Arbib (then computer science dept. chairman,) Dr. Ricci called me to the conference room at Boyden and told me: 'You Jews are all alike.' Dr. Ricci hit my 'achilles tendon' and immediately I put a copy of his own publication in his mailbox with 'Is that a double publication? Your anti-semitic remarks will not stop the distribution of these publications' written across the top."

Dr. Ricci claimed this accusation was distributed to Governor Francis Sargent, University President Robert Wood plus various faculty and students. Ariel asserts it was a private communication, only to Ricci.

Ariel now claims that Avraham Melamed is the third Israeli PhD candidate in a row to be harassed by certain members of the exercise science department.

The first was Elimelech Schochat in 1968, according to Ariel.

Ariel says he also ran into trouble. From the June 5, 1974 Gluckstern letter:

"In the early part of 1972 I was accused by Dr. Ricci of 'jumping too fast in the field before completing my degree.' He was referring to a company, which I both founded and owned a 50 percent share in, and told me that if I did not relinquish ownership to Dr. S. Plagenhoef that he (Dr. Ricci) would not allow me to have the oral examination for my PhD degree and, therefore, would not graduate."

"Absolutely false," Ricci said recently in reference to the charge. "There's not even a shred of evidence in that," he said.

Avraham Melamed's completion of his PhD has also been delayed, according to Ariel, by repeated failings by only one faculty member on his comprehensive examinations.

"I saw the answers," Ariel said, "and they were excellent." Ariel claims Melamed was failed only by Ricci.

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"For we Israelis it's a one-shot deal. We come over here with \$50 for an education. We can't go running home to Philadelphia for money if things don't work out," Ariel said.

"Between you and me, I don't know what interest Dr. Ariel would have in Melamed," Ricci said recently. When informed of their common ethnic background, Ricci replied, "Personally I don't think that should be an issue. . . I don't think that way."

Gideon Ariel was hired by the exercise science dept. in 1974 by a 4-0 vote, despite Ricci and Plagenhoef's opposition. A school personal committee upheld that decision, plus the decision to bypass an affirmative action search for other qualified candidates.

The job was tailored for Ariel. Two graduate assistantships, worth approximately \$3800 apiece, were used to back the exercise science dept.'s share of the salary. The computer science dept. paid the other \$7600 portion of Ariel's \$15,200 approximate salary, because Ariel was to work within both departments.

He was hired to: 1) teach two exercise science courses; 2) complete and publish research, and 3) perhaps the primary reason, to seek out and obtain research grants from the business community, something Ariel had been successful in doing up to then. In addition to several grants, Ariel had worked as a consultant for Universal Company.

His work for Universal entangled Ariel in the \$39 million suit. In 1975 Arthur Jones, multi-millionaire owner of Nautilus Co. -- Universal's largest competitor -- paid for a nine-page advertisement in the November 1974 issue of Athletic Journal.

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Jones wrote the ad himself and titled it, "Criminal Fraud. . . Or Unbelievable Stupidity." Jones called Ariel a fraud and attacked the concept of "variable resistance" which Ariel had developed for a new line of Universal exercise machines.

There was also a personal attack.

"Gideon, I was worried about you; I thought you were guilty of criminal fraud. . . so I asked your professor if it was really possible for you to be stupid enough to believe your own claims. And he assured me that you were. . . he told me that you were so dumb that you were capable of believing almost anything," wrote Jones. That professor, invited by Jones to a trainers convention in Kansas City, was Stanley Plagenhoef.

Universal went to an outside research firm and verified Ariel's results. Jones settled the case out of court with Universal and Ariel.

"We're good friends now," Ariel said, "and CBA is doing research for Nautilus as well."

Still another suit was brought against UMass and Dr. Ariel in October, 1974. Dr. Elizabeth Ebacher, a UMass exercise science graduate, sued the university for hiring Ariel -- without giving adequate public notice of an open faculty position or initiating an affirmative action search for candidates. This suit is still awaiting Superior Court scheduling.

The computer science dept. half of Ariel's 1974-75 salary was paid from a three-year grant from the National Institutes of Health.

"Thus, granting the waiver (of an affirmative action search,) is tantamount to a three-year appointment," Ricci was quoted as saying, in a Sept. 11, 1974 UMass Collegian article.

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History has proved otherwise. The state-funded portion of his salary -- the two exercise science assistantships -- ran out in 1975. Ariel remained with the university only through the NIH grant and the computer science dept. In August, that ends.

"That's why I lost the job," Ariel said, claiming he was too innovative, too successful, and others perhaps grew jealous. That's why one of his former engineering teachers, Paul Tartaglia, also lost his university job, Ariel said.

"Paul designed cars and energy-saving methods of making cars all back in 1971," Ariel said. Tartaglia now works for CBA.

"That's what you have to go through to be successful," Ariel said. "And the taxpayers support it. . . it's the system, it enables a non wave-maker to continue."

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