



# Computerized Footwear

How one man's mind is thrusting athletic footwear into areas which border on science fiction, but which are based on science fact.



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## Computerized Footwear: Revolutionizing Athletic Performance

In this article, Steve Lloyd explores the groundbreaking work of Dr. Gideon Ariel, a pioneer in the field of computerized biomechanical analysis. Dr. Ariel's research focuses on the application of computer science and Newtonian physics to analyze human motion, with the aim of enhancing athletic performance and equipment design.

Dr. Ariel's work has led to significant advancements in the design of athletic footwear. His research revealed that shoe efficiency, safety, and performance are closely tied to the biomechanics of the activity they are used for. This insight led to the development of the first anatomically and biomechanically developed running shoe, designed in collaboration with Pony Sporting Goods.

The shoe was designed based on data collected from high-speed films and a highly-sensitive force platform, which allowed for the analysis of the forces exerted on the shoe under actual performance conditions. The shoe features a unique sole designed to provide shock absorption and energy return, two qualities deemed essential for high performance.

Dr. Ariel's ongoing research includes the development of an inflatable running shoe, which promises to offer a perfect fit and improved shock absorption. This innovative approach to footwear design exemplifies the potential of computerized biomechanical analysis to revolutionize athletic performance and equipment design.

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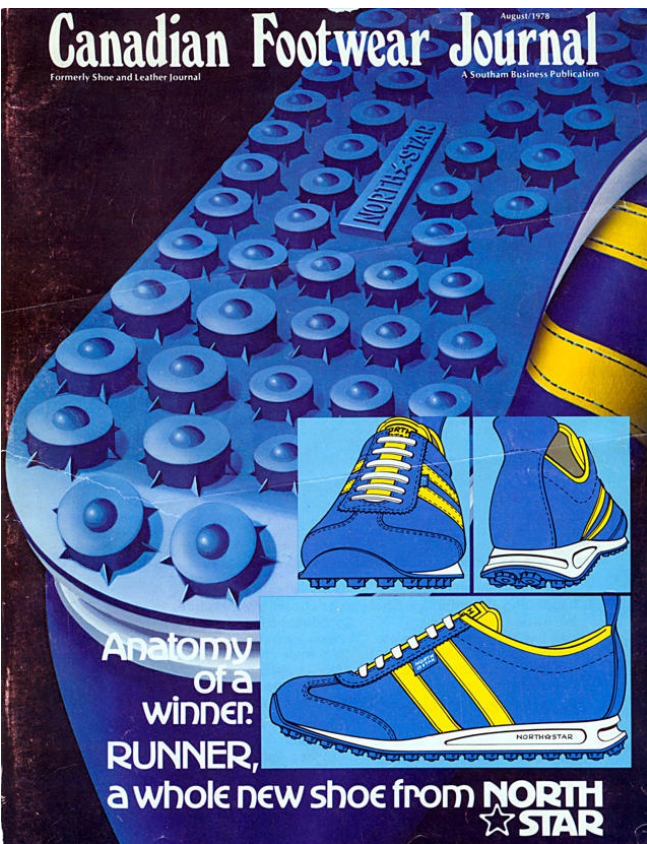
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Below find a reprint of the 4 relevant pages of the article "Computerized Footwear" in "Canadian Footwear Journal":





Anatomy of a winner: RUNNER, a whole new shoe from NORTH STAR

# Computerized Footwear

How one man's mind is thrusting athletic footwear design into areas which border on science fiction, but which are based on science fact.

by Steve Lloyd

Dr. Gideon Ariel, director of Computerized Biomechanical Analysis, Inc. and a consultant to the U.S. Olympic Committee, has been called the "Leonardo Da Vinci of sports." But while Da Vinci's studies of the human body were never fully appreciated by his contemporaries, Dr. Ariel is finding an increasingly receptive audience for his computerized analysis of human motion.

A pioneer at tying the science of motion into physical skills necessary to perform athletic feats, Dr. Ariel's studies are helping athletes perform better by revealing to them heretofore undeterminable deterrents to optimum performance.

But Dr. Ariel's work isn't limited to helping athletes discover motion efficiency. His computer has been and can be applied to the improvement through redesign of athletic equipment, including, but not limited to shoes, racquets, clubs, bats and balls, and perhaps most importantly, injury preventive and rehabilitative articles and research in sports medicine.

The 39-year-old native of Israel combines the esoterica of computer science with the old athletic standby: high speed, slow-motion and stop-action photography applied with the century old principles of Newtonian physics.

"By analyzing high speed films (as fast as 10,000 frames per second) frame-by-frame, using equipment interfaced with our computer, we calculate velocity, acceleration, direction and angle of forces on all body joints. From that a whole new dimension of data becomes available to us," Ariel says.

Ariel combined science with sport following his own late-blooming career as a discus thrower on the Israeli teams in the 1960 and 1964 Olympics. During his gruelling eight-hour training sessions he heard one coaching theory after another. During his undergraduate years at the University of Wyoming and at Israel's Wingate Institute as a physical education major, his skepticism of countless — and contradictory — coaching theories grew. When he enrolled for master's courses at the newly-established School of Exercise Science at the University of Massachusetts, Ariel not only put his own thoughts to work there as the track coach, but also plunged himself into the study of calculus, cybernetics, physics, kinetics, medicine and computer technology.

It was at the suggestion of the head of computer sciences at U-Mass that Ariel first toyed with the idea of combining computer analysis with athletics. When he discovered the method of transferring data into computer banks via electronic pen ("source plates"), Ariel installed a keyboard terminal in his home and refined his aims. By 1971, he founded Computerized Biomechanical Analysis, Inc. and secured his first contracts for testing athletic

equipment. It wasn't long afterward that athletes themselves came to Ariel for advice.

Ariel is by no means limited to giving advice on improving technique. Through biomechanics he has prescribed means of rehabilitation for injured athletes in many sports. He continues his association with the University of Massachusetts by further opening his computer banks to the study of animal behavior. He even talks of applying biomechanics to treatment for diabetics and weight watchers, or studies of concert musicians.

While Dr. Ariel uniquely brought together two sciences — biomechanics and computer sciences — it is important to state that his ability to do this was made possible by the collective efforts of many scholars and the technological advances of the past decade in the computer science.

Ariel's work in adapting the immense capabilities of the computer to bring biomechanical analysis into practical service has attracted increased attention in the sports and medical worlds.

Testimony to the tremendous potential of Ariel's work has been lauded by athletes including Mac Wilkins, Terry Albritton and Bill Schmidt; professional teams such as the Dallas Cowboys and the Seattle Super Sonics; the U.S. Olympic Committee, and the head of its medical staff.

Ariel's studies of the athlete in action have revealed that shoe designers unfortunately have overlooked the fact that shoe efficiency, safety and performance are inextricably tied to the biomechanics of the activity for which they are used. Too often, he has concluded, cosmetic features received consideration beyond that given the functional features of shoes.

"In essence," says Ariel, "all footwear, athletic specifically, cannot be evaluated separately from the 'athlete in the shoe.' Yet, this apparently is what has happened not only in shoe design, but in non-partisan evaluation and ranking of shoes by a major running publication."

Because Pony wanted a shoe for the runner, male and female, competitive racer or a recreational jogger, he was chosen to design the first anatomically, biomechanically developed and scientifically tested running shoe.

This shoe, as a result, is a radical departure from the norm in athletic shoe production.

"Usually bottom line dollars define product appearance and quality. However, Pony, a young and energetic sports shoe company, made a corporate commitment to quality of function rather than appearance through the unique science of Dr. Ariel," says Thom Gravelle, executive-vice president of Pony.

With this shoe, Pony, through Dr. Ariel's Massachusetts-based laboratory, has begun a directional change of sports shoe production forever.

How they did it is a fascinating story. →

## BIRTH OF A WINNER:



**1 The Original:** What do you do if you already have one of the best designed all-purpose training flats on the marketplace, a running shoe rated by *Runner's World* as the second best in mechanical performance? Well, if you are Pony Sporting Goods you do not stand back and pat your backs. This shoe, the Pony Runner, is now a distant ancestor in the rapidly changing world of athletic footwear. And the main reason is that for runners who are serious about their art — and how many are not these days? — there is a new generation of footwear in the marketplace. In their quest for the perfect sneaker, Pony, with the assistance of that ingenious New York scientist Gideon Ariel, is pushing the development of athletic footwear into areas previously only talked about. If that sounds far fetched, then maybe it will be more believable if you understand what happened when Pony took this shoe, along with others, to Ariel, one of the most brilliant minds in North American sport development. As director of Computerized Biomechanical Analysis Inc., and a consultant to the U.S. Olympic Committee, Ariel has been a pioneer at tying the science of motion into physical skills necessary to perform athletic feats. His efforts, however, are now being turned towards the improvement of athletic equipment, particularly footwear.



**2 The Testing:** The foot has a complex and highly efficient system of joints which helps give it tremendous flexibility, movement and weight-bearing capabilities. Moreover, 50 per cent of the bones in the human body are to be found in the feet, with each foot comprising 26 individual bones. During the act of running, the many movements of the body influence the position of forces on the foot and its parts, forces which are transferred to the shoe. Ariel decided that, since footwear must be designed to perform in stress conditions, it must therefore be analysed in realistic "action" conditions. Although this type of dynamic testing cannot be simulated in a laboratory, the use of a highly-sensitive force platform enabled actual running to be done in Ariel's test centre, where the forces were traced, measured and quantified immediately. High speed cameras producing slow motion cinematography were used in conjunction with the force plate to record the forces of "foot-strike" in different samples at every point of contact under actual performance conditions. The force platform, with the frame-by-frame evaluation of the motion picture film, fed data to a highly-sophisticated computer. When Ariel had all the information he felt was needed to begin his analysis, he moved to the next step in the complex process — the computer.



**3 The Analysis:** So delicate are the relationships between an athlete's moving parts they cannot be accurately analysed simply by looking at the slowest of stop-action film. A process of frame-by-frame, body-part by body-part assessment is necessary to make optimum use of film, a process that is excruciatingly time-consuming. It took Ariel about 10,000 hours over seven years to create the programs that instruct his computer. This painstaking preliminary work, however, now meant that he could quickly quantify information pertaining to the entire running motion, including the effect it has on the shoe. The resultant data yielded the instantaneous forces on the shoe as a function of time, providing data not only on the biomechanical behavior of the runner, but the critical information on how the physical construction and material composition of the shoe performed during actual conditions. Without this highly-developed process, Ariel felt the construction of a truly efficient running shoe could not be done. What he found when testing the Pony Runner was that the shoe, as it was, could not be refined sufficiently to produce the desired "ultimate" product. Ariel decided, under exclusive contract to Pony, to work to develop a shoe based upon the motion of the foot in relation to the body, and the stresses placed upon the shoe materials during a race.

## A SIX STEP SYSTEM

**4 The Development:** With this information, Pony's design and production engineers knew the structural requirements and materials critical to the creation of a running shoe which would most sufficiently provide the two qualities Ariel determined were absolutely necessary in an athletic shoe: *shock absorption* and *return of energy*. Ariel explains: "You see pictures of runners, it looks like they're landing on their heels, but they are not. The good ones don't. They flick the foot down flat at the last instant. Too many companies were making wonderful heels and the best runners weren't coming down on them." What Ariel knew from his studies was the slight, but powerful, rotation of the foot which occurred during each contact with the ground in an athlete's stride. Different areas of the sole were performing different functions, yet nearly all athletic footwear, including Pony's original Runner, had uniform soles with some type of grid pattern or nipple affect. Pony designers, working with Ariel, slowly developed a sole with two distinct features, each conceived to provide the shock absorption and the return of energy deemed invaluable for high performance. They changed the shoe's construction by using two sole materials, realigned the nipple pattern on most of the contact surface and added a "traction grid" on the inside of the sole, where motion study showed the runner used his power during each stride.



**5 The finished product:** With the addition of a lightweight, durable upper and the familiar Pony chevron symbol, the company has what they feel is the most sophisticated racing shoe on the market. The heart of these shoes, though, is that Ariel-conceived sole. There are two versions of the shoe, the training model (shown) and the racing model. The trainer is slightly heavier and more durable than the racer, because it will be needed for those long, gruelling practice sessions. The racer is expected to be used for exactly that — racing. The VSD sole (patent pending) is, by the way, endorsed by Jim Bush, the head track and field coach of the University of California at Los Angeles (UCLA). All of this research, presumably, cost money, but Thom Gravelle, executive vice-president of Pony, is adamant that athletic footwear prices will not skyrocket because of it. He said at the beginning of the year: "Our strategy is to market the finest athletic footwear at prices that will give the retailer a decent profit margin for a change, and yet give the consumer quality products at prices which are not outrageous. The Racer, he thinks, will fill that hope and then some. Reaction to the shoe has been favorable, but it will have to prove itself in the future."



**6 The future:** While Pony and other companies struggle to keep their product at reasonable prices, the research and development continues. But where will it lead? What future refinements will athletic footwear undergo as producers scramble to come out with the most "modern" shoes? Well, the quest for the perfect sneaker may one day be over. Ariel, in his continuing work for Pony, is developing — are you ready? — an inflatable running shoe. Someday, an athlete will simply slip the liming of the shoe over each foot, fill it up with air, and presto, a perfect fit. He may not even have shoelaces to tie. More importantly, Pony points out, the shoe will be good for his feet, absorbing shock better and reducing the likelihood of shin splints and blisters. The research for this shoe has been going on for more than a year now, and company officials expect another year-and-a-half before they will be ready to take orders for the shoe. The inflatable shoe will be lighter than the conventional model and may only come in four sizes — small, medium, large and extra large — because the shoe will mold itself to the foot. Ariel envisions the shoe as having a valve that will accept the nozzle of a can of compressed air, and can be released to deflate the shoe. Laces will be replaced by an elastic band. If the shoe works, and sells, what will be the next step in footwear development? Ariel just might have some secret ideas on that subject — but he's not telling.



