



Consumer/Home/Recreation

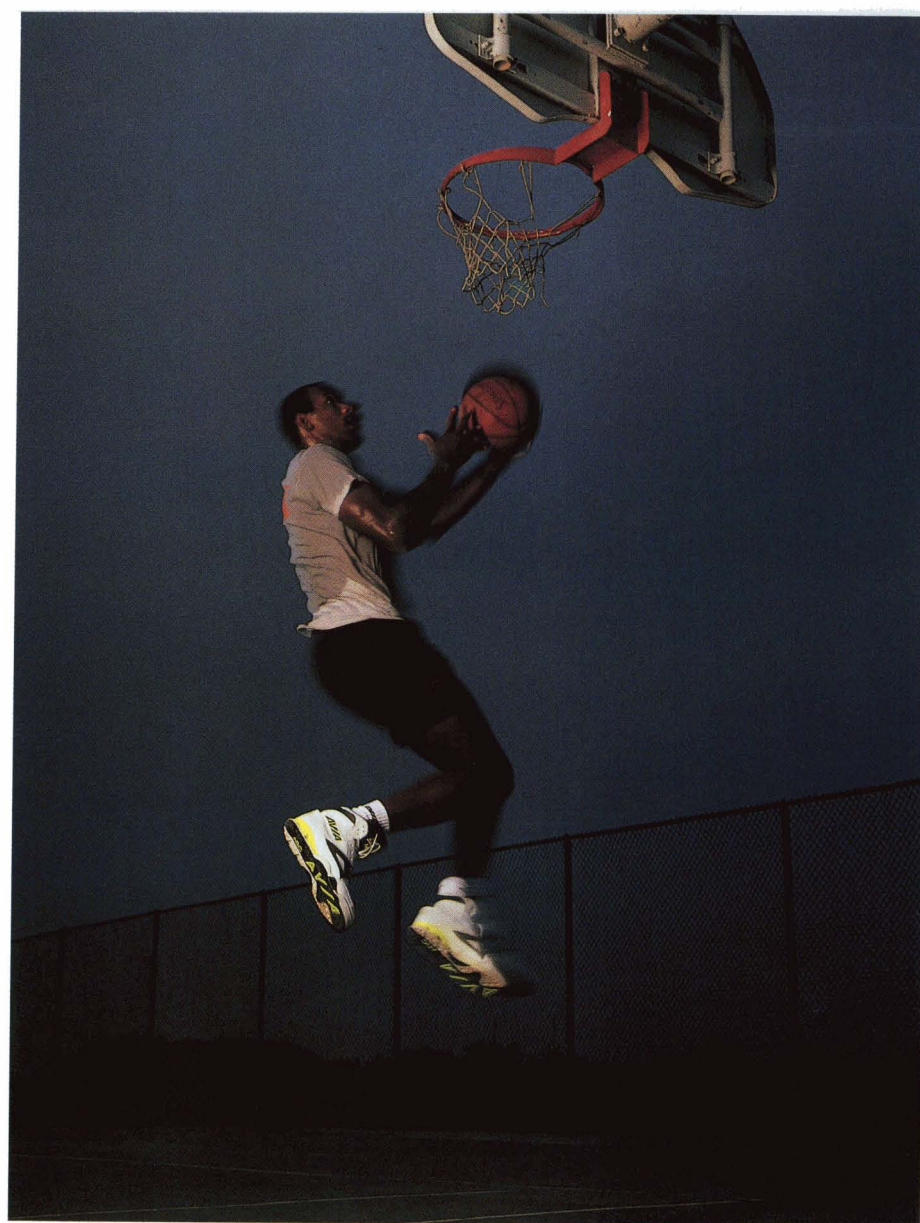
## Spinoff from a Moon Suit

*An advancement in athletic shoes heads a selection of technology transfers for consumer, home and recreational use*

Manufacture of athletic footwear is a big business and an extremely competitive one. Shoe producers spend millions annually on research and development, searching for the innovation that will give them a competitive edge in style or performance, for example, superior shock absorption or extended durability under stress.

Compression Chamber shoes get extensive testing under conditions simulating actual use. Below, an AVIA research technician is impact-testing shoe components and completed products to determine performance characteristics, such as cushioning and resilience.

One company—AVIA Group International, Inc., Portland, Oregon, a subsidiary of Reebok International Ltd.—created a major shoe advancement through application of space technology. The resulting product component,

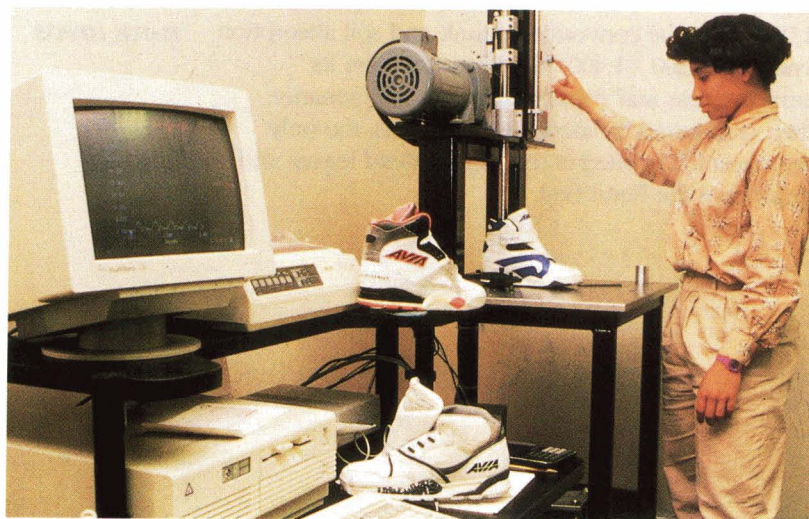


National Basketball Association star Clyde Drexler puts AVIA Compression Chamber shoes through a workout. The shoe, designed to retain its performance properties over a longer life span, is an adaptation of NASA space suit technology.

known as the AVIA Compression Chamber™ midsole, was introduced to the market in October 1990.

In the latter 1980s, AVIA initiated a project to eliminate the unwanted compression or breakdown that occurs in athletic shoes and causes loss of cushioning. AVIA contracted with Alexander L. "Al" Gross of Lunar Tech, Inc., Aspen, Colorado to design an advanced shoe that would retain its shock absorption, stability and flexibility properties over a substantially longer lifetime.

Al Gross turned to space technology, as well he might, being an aerospace engineer who has won a number of awards and citations for his work in space suit design, including NASA's Apollo Achievement Award for his contribution to man's first exploration of the Moon. Gross worked with ILC Industries, Dover, Delaware, during and after NASA's Apollo lunar landing program, eventually becoming lead design engineer. ILC was then — and still is — the NASA prime contractor for design and manufacture





of all extravehicular space suits worn in the Apollo, Skylab, Apollo/Soyuz and Space Shuttle programs.

Al Gross' basic approach to designing the advanced shoe was to eliminate foam materials from the midsole, because such materials are subject to cushioning loss due to the repeated vertical force of body weight. Gross explains:

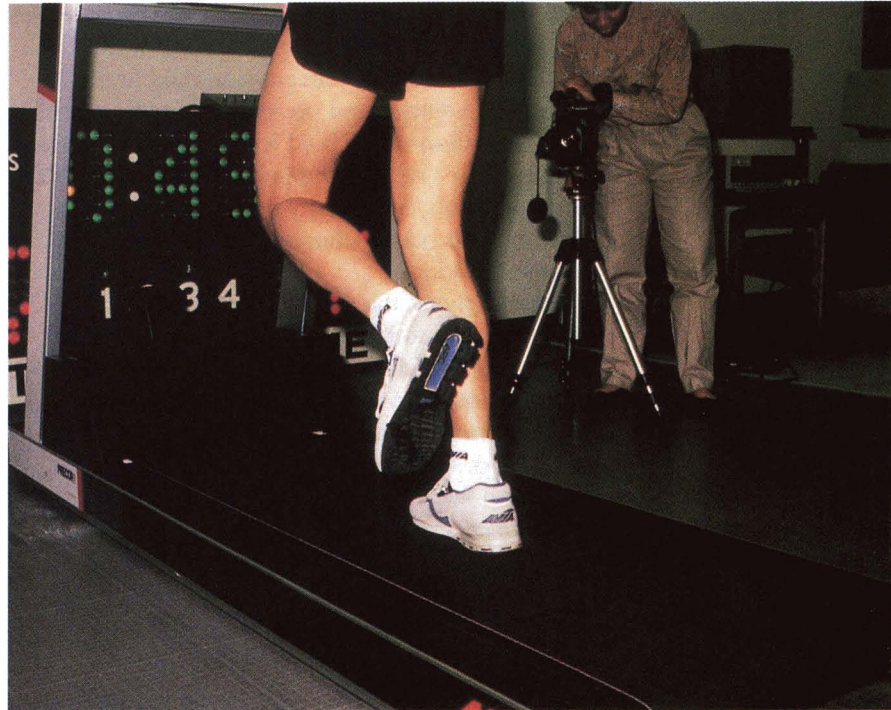
"During use, athletic shoes will experience forces up to six times body weight. These forces begin to reduce the performance benefits of shoes after only one use and result in a loss of designed function. Structural walls of foam materials will become damaged from repeated excessive loading, resulting in a completely rigid system that will no longer compress when loaded and will thereby lose cushioning capability." Elimination of foam in favor of a fatigue-free mechanical system, Gross decided, was the answer to the superdurable shoe AVIA wanted.

A task force composed of Al Gross supported by AVIA research, design and development personnel agreed upon a solution: a "rigid/flexible" system similar to a pressurized space suit.

Being pressurized, the space suit is rigid — but it must have sufficient flexibility to allow the astronaut to move. The big challenge is to provide astronaut mobility at the joints. The answer, in the Apollo Moon suit and later suits, was the "convolute system," a series of bellows in the joint areas that expand and contract (compress) every time a motion is made. By layering or combining materials, and varying the shape, size and the number of bellows, space suit designers can vary joint flexibility.

The space suit technology was applied to the AVIA shoe project. The task force created an external pressurized shell, with horizontal bellows for cushioning and vertical columns for stability; by varying the shape, number and thicknesses of shell materials, and the styling lines within the shell, the designers were able to "tune" the stiffness and cushioning properties of the midsole.

Creating a stress-free environment to ensure durability demanded a single-piece part, without weld lines or cement seams. To meet that requirement, AVIA and Gross adapted another NASA technology — a stress-free "blow molding" process originally employed to get superior impact resistance for the Apollo lunar helmet and visor. The Compression Chamber task force was not able to eliminate foam entirely. Made of duPont's strong but lightweight Hytrel® plastic, the shell is filled — for



stability — with a low density polyurethane foam, but the foam provides little of the cushioning function. The lower density foam offers a weight saving up to 10 percent of a shoe's weight.

In durability tests at Penn State Center, the Compression Chamber midsole was subjected to stresses equivalent to 400 miles of running and it showed no visible signs of wear or structural fatigue. Compression Chamber footwear was initially available in basketball and cross training shoes, but AVIA plans 1991 additions to the line.

The blow molding process, never before used in the footwear industry, allows AVIA to configure the Compression Chamber differently for each specific sport. Mechanical cushioning is also an industry first and AVIA plans to take it further. The Compression Chamber, company officials say, is a "first step" toward a completely foamless, non-fatiguing, mechanical midsole that will not wear out.

Above, a running subject is filmed by high speed photography for studies of foot motion.

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