Technology and sporting footwear: The next ergogenic aid?

S.J. Bartold* The University of South Australia

Sports footwear has changed enormously in appearance over the past few years. If we are to believe the manufacturers, there has also been significant change in the function of athletic footwear. Why is it then, that despite obvious cosmetic differences, the main features incorporated into most "cutting edge" footwear, are based on technology that is 20 years old?

This is the second of two papers exploring some of the important issues in athletic footwear in the 21st century. It will examine the impact of research and science on shoe design, with a special emphasis on biomechanics, the specificity of individual sports to design, materials technology, new trends and paradigms and the influence of marketing. Exciting new concepts are being proposed as our understanding of human movement and performance improves. It now seems possible that athletic footwear can be designed to enhance normal foot and leg motion in a way that may not only improve performance, but have a meaningful impact on overuse injury. But is technology going too far? Can footwear really make an athlete run faster, jump higher and longer, spin a soccer ball or kick a football further. Yes it can, and it is, and in the coming years, we must be vigilant to ensure that pure design technology does not place the athlete at risk, in the eternal quest for improved performance.

Let us consider some of these issues in detail:

- Motion control vs motion enhancement – for many years, particularly in relation to running shoes, we have been told that motion control strategies are a fundamental requirement for foot and leg stability in gait. This has been based on the assumption that foot overpronation is a key issue in relation to injury. Consequently, design parameters have evolved to reduce "overpronation", by way of "blocking" or "controlling" this motion, especially during the first 25% of the stance phase of gait. However, whilst overpronation has been strongly implicated in the generation of a multitude of lower limb injuries by a plethora of authors, the mechanism by which this occurs has still not been established. Furthermore, current research indicates that "control" of rearfoot pronation may be much less important than enhancement of the foots' normal auto-support mechanisms, which function primarily via the midfoot and forefoot. Indeed, blocking contact phase pronation may significantly interfere with normal foot function.
- Proprioception/Sensorimotor issues– athletic footwear is, by nature, quite bulky. We now understand that an interruption of the peripheral afferent signal from foot to brain can significantly affect task performance. In short, any footwear that removes proprioceptive feedback has the potential to severely affect the delicate psychophysical feedback loops that allow us to make the minute adjustments to muscle contraction responsible for effective and injury-free running. This is also important in relation to total energy expenditure and response to

fatigue. Design parameters that reduce the weight and bulk of running shoes are therefore seen as critical. In addition, new research tells us that stimulating the tiny nerve receptors on the sole of the foot may improve proprioception and play an important role in improved performance.

- When is a running shoe a cross training shoe, and when is a cross training shoe a tennis shoe? There has been a disturbing trend recently with some companies, toward similarity of design across a range of shoes for different sports. Is the concept of a cross training shoe valid, or should we come clean and recognise that the biomechanics of most sports vary enormously, and that this must be reflected in shoe design? Take trail running and tennis for example. A biomechanical analysis of these sports will reveal few similarities. Why then do some manufacturers insist that one shoe can do the job for many sports? Meticulous research and scrupulous design methodology are the key to functional footwear in this example. Trail running has demand for design parameters that recognise the demands of the braking (downhill) and acceleration (uphill) requirements of the sport. In addition, the shoe must make allowances for the uneven nature of the support surface, and therefore flex in a completely different manner to any other type of shoe. Research tells us that tennis, on the other hand, is a very symmetrical sport in terms of foot function. This is true of open or closed stance players on both forehand and backhand strokes. Lateral protection is arguably the most important design parameter in this instance.

How much should a shoe flex? In the past, we have been taught that a shoe should be relatively inflexible, especially through the midfoot, if it is to be considered “stable”. This philosophy is perhaps in response to the time-honored technique of building shoes to react to a very simple foot model. Typically this model would comprise 4, or at best 5 joints. However, this is not even close to a real foot, which has in excess of 30 joints. If we were designing footwear for robots, then these models would work well”– but we do not function like robots, and we certainly do not walk or run like robots. The foot is quite flexible through the midfoot, a section regarded as vital to not only link rearfoot to forefoot, but also functionally to allow effective propulsion after heel lift. Very inflexible footwear, especially those with massive dual density midsoles extending into the midfoot, will severely interfere with normal foot motion. The trend in the coming years will be toward increasing midfoot flexibility and function.

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