A very few years it seems, throughout the biomechanical era, a new concept is introduced into the sport shoe market along with medical, empirical and anecdotal evidence to help athletes perform more efficiently and injury free. Mostly, these innovative concepts are mere 'blips' on the overall marketing radar screen or are reintroduced in revised form years later. However, occasionally these medical devices, once validated in a biomechanics lab, can become huge successes

Q-Angle – brought to market

A good example would be the introduction of the Varus Wedge into running shoes in the early 1980s. During the running boom of the late 1970s, it was noted in podiatry treatment rooms and in kinematics studies, that many runners tended to overpronate or simply – roll too far over the medial side of their foot and shoe, causing multiple stress injuries to the knees and lower anatomy. Hence, the introduction of a 'pronation control' feature into footwear that has become standard in the running shoe industry today. Devised by Dr. Steve Subotnik, a Californian podiatrist, as a sloping midsole, the Varus Wedge was introduced and first commercialised by Brooks, then followed in its myriad and multi-patented forms, by almost every running shoe brand on the planet.

A different angle on the marketplace

The latest innovative entry into the footwear market caters strictly for women. Like overpronation, Q-Angle is not an innovation in itself but a biomechanical correction for an exaggerated natural motion of the human body. The quadriceps angle or Q-Angle, as it is known, has been recognised for years and is well documented in medical and anatomical literature. Female and male anatomy is very different; one difference occurs at the hip where a woman's femur angle differs significantly – by between three and four degrees -- from a man's.

Morphology studies have substantiated that a woman's pelvis is wider and this changes the angle at which the kneecap tracks over the end of the femur. This more exaggerated angle makes women more susceptible than men to serious knee injuries and patellofemoral pain problems. This is most evident in sports activities such as jogging, soccer and basketball where numerous studies have indicated that women patients with anterior knee pain have more exaggerated Q-Angles than pain-free individuals.

Having established that a greater Q-Angle in women makes them more susceptible to knee injury, the next study was undertaken to evaluate the relationship between a greater Q-Angle and the effect at foot strike. If the actual femur angle could not be changed at the hip perhaps a correction or compensation could be built into a shoe at foot strike. As it happens, much of this work has been performed at the University of Michigan in Ann Arbor, and at the biomechanics laboratory at Michigan State University in East Lansing. Researchers at Medsport at the University of Michigan found that women tend to rely more on their front quadriceps muscles to stabilise the knee during physical activity than the stronger hamstrings behind the thigh. Mounting research indicates that a woman's knee is not simply a smaller version of a man's knee. The differences involve the bones, ligaments and tendons of the joints, says Dr. Aaron Rosenberg.

Taking the pressure off

Studies performed by Dr. Benno Nigg, director of the Human Performance Laboratory

at the University of Calgary, have concluded that shoes that take over certain (gait) functions, so that some of the muscles don't have to do the work that they would normally do, can provide intrinsic stability. And because small muscles usually have a lever arm that is smaller than the joint, loading is reduced when these muscles are active. This should have an effect on performance. Similarly, Jeff Pisciotta, senior biomechanical researcher at the Sports Research Laboratory at Nike headquarters in Beaverton, Oregon, found that relative to running shod on a hard surface, barefoot running on grass resulted in differences in timing of foot contact, pressure progression pattern, distribution of contact area, magnitudes of peak pressures, foot angle relative to surface just prior to contact, metatarsophalangeal joint range of motion, and range of plantar flexion right before toe-off. "The foot was in control," observed Pisciotta. "I had thought variables at the knee would have changed due to lack of cushioning, such as more flexion for shock absorption, but all the changes were at the foot and ankle. That made us start thinking that when you put a shoe on, it starts to take over some of the control."

Hypothesising that by correctly aligning a woman's foot at heel (or midfoot) strike, more control would improve performance and lessen patellofemeral pain, researcher Ray Fredericksen, at Michigan State University, took a different approach to the subject, looking at it from the feet up. In his biomechanics laboratory, kinematics photography indicated

Women generally have wider hips, a lower centre of gravity, higher arches and longer toes than men. Sports shoe design must begin to reflect that.

University of Nebraska at Omaha

that women tend to remain on the lateral border of the foot during transition from heel strike through midstance to toe off. Fredericksen, who has had considerable shoe experience, experimented with devices both in shoes and inserts to better align the woman's foot at heel strike and through midstance transition. He found that by slightly changing the angle of foot strike and stabilising the foot

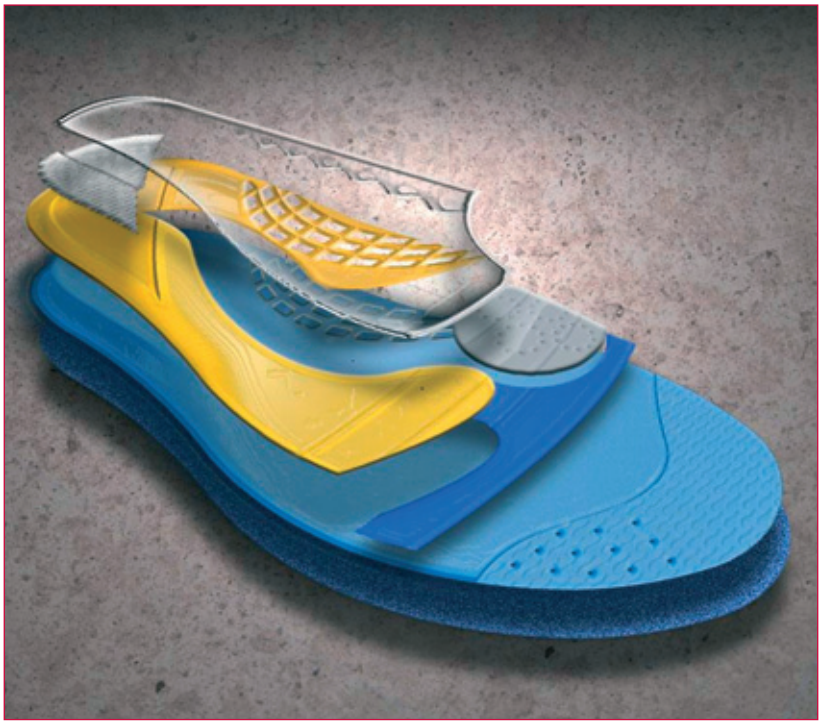
through pronation there was an apparent relationship between Q-Angle and the lessening of anterior knee pain for runners.

Every theory and series of supporting scientific data usually has a 'champion.' In the case of the commercialising of Q-Angle, Fredericksen, who also conducts biomechanical shoe testing on behalf of Runner's World magazine, presented his data and Q-Angle theory at medical and Podiatry seminars over a ten-year period. Finally, these results led to the patenting of two shoe innovations, one as a midsole device currently being marketed by Merrell (a division of Wolverine World Wide), and the other as a specific woman's orthotic being marketed by Spenco Medical Corporation, headquartered in Waco, Texas.

Merrell has adopted the Q-Angle patent in the midsole of its trail running shoe range. The moulded sole takes into account that women generally have wider hips, a lower centre of gravity, higher arches and longer toes – in addition to a wider angle between the hip and the knee (Q-Angle). This means that women are more likely to supinate, roll on the outside of the foot, before compensating by over-pronating by shifting their weight over to the medial side of the foot. This can lead to hip, knee and back problems. Merrell have varied the stiffness of the midsole device, called Q-Form, with the idea that the sole guides the woman's foot into a more centralised position. Thicker EVA foam has been used to support the woman's higher arch, and a softer area eases the pressure on the metatarsal heads. Finally, the flex or break path across the sole has been repositioned to account for women's longer toes and to distribute pressure across the ball of the foot.

Inserting an angle

As an orthotic or more specifically an OTC (Over the Counter) insert feature, the designers at Spenco Medical Corporation had to adopt a different approach to achieve a similar effect inside the shoe. The challenge is to do this within the limited thickness of a shoe insert. A specially designed cradle has been employed using different densities and materials to change the angle of the foot inside the shoe. Being closer to the foot, it is easier to control motion and stability during static or dynamic foot movements than from outside the shoe. Spenco developed and tested the Q-Factor especially for women with a five degree compression deflection from that of a man's or unisex insert. Spenco's patent is based on the logic that to facilitate childbirth, the female pelvis is wider and more rounded than a man's – resulting in a greater Q-Angle from the pelvis to the knee. This increased angle contributes to poor body alignment resulting in pressure on women's knees, hips and back.



Sports footwear manufacturers such as Merrell and Spenco are starting to introduce Q-Angle technology into their products to make them more suitable for women to wear.

Spenco

Spenco's Q-Factor insole with patented Q-Angle technology addresses this issue. It is designed to support the foot to better balance and align the body, helping to reduce the risk of injury. The Q Factor insole helps support two key areas – under the medial (inside) arch and along the lateral (outside) edge, extending to the metatarsal region of the foot. By supporting these areas of the foot, the Q Factor helps to slow down the rate of pronation while controlling the severe midfoot supination effect that most women demonstrate. The continuous support around the back of the heel provides additional stability. Spenco has developed two versions of the Q Factor insole: one as a cushioning insole – which includes additional cushioning in the heel and forefoot to provide targeted comfort and relief at the metatarsal heads and under the heel – and with a narrower heel fitting to better address narrower fitting women's shoes. The second Q Factor insole version, to be introduced later this year, will focus on maximum control and stability with less cushioning.

A deeper heel cup and a stronger supporting cradle have been incorporated to accomplish this effect. As an interchangeable sockliner, both the Spenco Q-Factor inserts can be used in most sport, hiking and comfort categories of footwear.

With two companies already promoting the benefits of addressing stability and correct alignment in women's sport shoes with the Q-Angle concept, it cannot be long before other versions of the newly 'commercialised' biomechanical principle appear in various categories of footwear for women.