

**The challenges of athletic footwear design:  
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The three main needs of athletes are performance, injury protection and comfort. Footwear enhances performance through increases in traction and biomechanical efficiency. Footwear protects the foot at the interface with the ground and the entire body against the forces resulting from repeated feet-ground impacts. Footwear can also reduce injuries by correcting for the locomotor system static structural misalignments. Footwear uppers, insoles or sockliners being considered upper elements, are responsible to maintain the feet over the shoe soles. Uppers fit is most important to athletes' comfort.

Athletes' needs as well as their relative importance are defined by the 'critical' maneuvers performed during sporting activities. 'Critical' maneuvers are maneuvers that must be performed to succeed in a sport and/or maneuvers that have been linked to the highest incidence of injury observed in that sport. Focus group research and surveys help to identify critical maneuvers. 3D motion capture systems, force platforms and pressure insoles are used to study the critical maneuvers associated to different sporting activities. The results of these studies lead to design criteria that are shared with designers and developers. Prototypes are created and evaluated using the same batteries of biomechanical tests to assess how well they meet the design criteria. Therefore, footwear designed for different sporting activities can readily be differentiated. Gender, skill level, and environmental conditions add further requirements upon footwear design thus allowing for differentiation even within a given sporting activity.

Footwear intended for use in multiple sporting activities represent non-trivial design challenges. Typically, such designs lead to shoes that feature some level of compromise to address the competing requirements of each different sporting activities. This holds true even within a sport when injury protection and performance needs conflict, or when different injury protection needs require somewhat contradictory solutions. Considering running footwear as an example, it is generally believed that shoes currently designed to offer maximal cushioning lack rearfoot stability and vice-versa, shoes designed to resist injury inducing excessive rearfoot motion lack cushioning. Yet, recent research and novel design approaches have shown that the magnitude of the compromises in footwear design can be significantly reduced if not eliminated.