HEELLESS SHOES

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CONCEPT: SHIFTING THE LOCATION OF REACTION FORCES.

Heelless shoe design has been a subject of interest in both the athletics and fashion shoe industries over the years for health and safety as well as aesthetic reasons. Heelless shoes have sparked great interest because they are designed in a manner such that the outer sole does not have a heel like in a normal pair of shoes as shown below.

Figure 1. Heelless running shoes by Heallus

Figure 2. Heelless sandals by designer Antonio Berardi

BACKGROUND:

When someone buys a pair of shoes, he/she ensures that the shoes are well suited for the activity that they will be used for e.g. walking, running, sports, dancing, etc. All these activities involve the suspension and landing of the foot. The foot therefore has three different structural purposes during these actions:

- Upon landing, it acts as a shock absorber.
- It acts as support member during landing and taking off,
- And finally, it acts as a spring for launching or stepping off surfaces.

Many foot injuries are associated with the previously mentioned activities because of the shoes worn, landing and take off motion patterns and also the surface with which the feet interact. Some research shows that most people land on the heels of their feet and then push off the ground with the forefoot. While such foot action may seem quite natural, it reduces the shock absorbing capacity of the foot thus leading to various injuries. Excessive rear foot striking results in a sudden increase in vertical ground reaction force, R, when the foot contacts the ground. This is the primary cause of most running overuse injuries (repetitive strain injuries). Most professional athletes and faster runners however, strike the ground with the forefoot first rather than with their heels. Forefoot landings have thus been proven to offer a very efficient landing pattern during landing and stepping off. Heelless shoes combine various structural concepts including both statics and dynamics, such as coupling effects brought about by a rocking see-saw effect seen in some heelless running shoe models, vibration reduction (shock absorption), and equilibrium. The fundamental principle applied in heelless shoe design is the shifting of reaction forces from the ground by concentrating the weight of the shoe wearer entirely towards the front of the shoe. This improves the overall stability of heelless shoes.

<u>HEELLESS SHOE DEVELOPMENT:</u>

Athletics Industry:
The athletics industry has been developing and is still developing the heelless shoe concept to reduce strain related injuries associated with heel landing impact, experienced by athletes, by encouraging forefoot landings and step offs.

Fashion Industry:
The heelless shoe concept in the fashion industry was first heard of more than 5 decades ago. The fashion industry has employed the structural concepts applied in heelless shoe design in a more interesting manner and as expected, the fashion industry has developed heelless shoes for purely aesthetic purposes.

<u>DESIGN OF SHOE STRUCTURE:</u>

Heelless shoes function by shifting of an individual's weight towards the forefoot of the shoe by virtue of the elevation at the heel area. For really high heelless shoes, the shoes are custom made so that the shoes provide sufficient support based on the wearer's weight and height. Altogether a large ground reaction force is required at the front of the shoe to balance the individual's weight.

Ground reaction, R = Weight of Individual, W

The absence of a heel is compensated for by a base support for the whole foot which comes in the form of a sole plate. Accordingly, the choice of material and mid sole design require due consideration so that the shoes offer adequate flexural strength as well as shock absorbance/attenuation (similar to a damping system) as these affect the loading of the system (foot and shoe) during motion which is a critical factor for heelless shoes. When the individual is stationary the system is in a state of stable equilibrium if the shoes are relatively low (running shoes) and in unstable equilibrium if the shoes are high (the fashion heelless shoes). Also, a thin and relatively rigid portion underlies what would have been at the heel of the shoe and the corresponding portion of the inner sole to support the foot's heel. This rigid portion is elevated above the landing surface; its function is to inhibit heel landings and strikes.

FOOT ACTION:

During forefoot landings, the landing forces are applied generally to the *dynamic* front part of the foot, or forefoot, comprising the toes and the ball of the foot simultaneously. Muscles within the foot and the general skeletal structure position the arch of the foot so that it acts as a shock absorbing spring during impact between the forefoot and the support surface. Furthermore, stepping off from the forefoot without initial heel contact increases efficiency because no effort is required to rotate the foot from the heel to the toe. Forefoot landings also reduce the strain on the musculoskeletal structure.
Shoe makers attempt to overcome the injuries associated with heel landings by providing padding at the heel to provide some shock absorption. While this does in fact reduce the shock, the impact on the heel can still be three or more times the shoe wearer's weight during jogging. Therefore, 'reasonable' levels of padding would not provide sufficient shock absorbance because their efficiency pales in comparison to the shock absorbing properties of an individual's forefoot.

Figure 3. Heelless running shoes

Figure 4. Heelless shoes designed in the late 1950s by designer Pinet

<u>A COMPARISON OF REACTION FORCE LOCATIONS BETWEEN HIGH HEELED SHOES AND HIGH HEELLESS SHOES:</u>

The weight of an individual is transferred to the ground through the area of the sole of shoes in contact with the ground. Likewise, the ground reaction is transmitted through the area of the shoe in contact with the ground.

For heelless shoes, all the weight is concentrated at the front of the shoe and an equal and opposite ground reaction is transmitted through the forefoot. For flat shoes and heeled shoes however, the ground reaction is transmitted through both the front part of the shoe and the heel in contact with the ground.

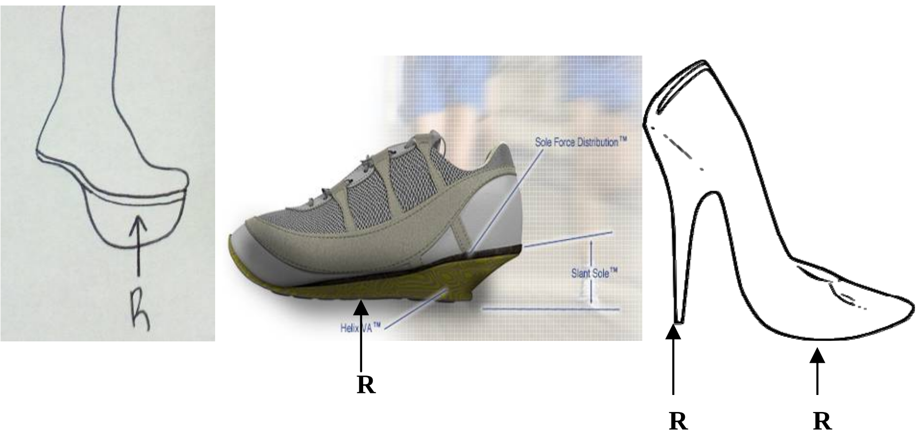

Figure 5. Reaction force locations for high heelless shoes, flat heelless shoes and heeled shoes

Despite the concept being highly innovative, heelless shoes have some flaws as listed below:

- The shoe wearer must remember to land on his/her forefoot.
- The heelless shoes with a lower profile (i.e. the running shoes) do not prevent heel landings despite the design's primary goal being to encourage forefoot landings.
- The shoe wearer would be prone to revert to heel landing when he/she becomes fatigued/distracted or preoccupied.

MORE ILLUSTRATIONS:

Figure. 6 -'Heelless shoes with a non-functional 'heel' attached for cosmetic reasons.

Figure.7 - Models on the Nina Rici 'Fall 2009 collection' catwalk.
Surprisingly none of the models fell on the catwalk except for the occasional wobble; which is an experience shared by every woman that owns a pair of heels. The wobbling is attributed to the height of the platforms as well as the individual; a taller individual is bound to have more problems with wobbling than a shorter person.

AND THE DAMAGE IS...

THEY may be the height of fashion, but Posh Spice's heel-less boots (left) have received a low rating in terms of safety.

A spokesman for the British Chiropody and Podiatry Association said: 'I certainly would not recommend these shoes. The heel is there to stabilise. When you elevate the rear of the foot it makes you lean forward, which is bad for both the back and the foot.'

And a spokesman for the Chartered Society of Physiotherapy said: 'Anyone wearing them would have to completely adjust their gait pattern, missing out on nearly two-thirds of the natural gait cycle.

'If [Posh] were to wear this sort of style for anything more than a short red-carpet walk she could suffer from foot pain, ankle pain, knee pain, spinal pain and neck pain on a permanent basis.'

Figure 8. Comment on Heelless boots by Chiropody and Podiatric Association.

Figure 9. Victoria Beckham, with husband, in a pair of 'made to fit' Antonio Berardi heelless boots.

'Shoe designer Berardi says the radical design does not cause the wearer any pain. 'They are perfectly balanced,' he said. 'When the girls come for fittings, they look a bit daunted, but by the end they say it's just like wearing a regular shoe. They are graceful and there is a ballerina nature about them. Having a heel is really just psychological.' They are not dangerous because you would have to lean quite far back before you fell over.' - *The Daily Mail Online*

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