Dancing Feet

Where biomechanics meets pathomechanics

Normally we associate the phrase 'biomechanics and shoes' with the athletic category where the study of the science relates to movements of the body and footwear during sports performance. Pathomechanics is often the extreme of athletic movement. It is the branch of sports medicine that determines the etiology, diagnosis and treatment of overuse injuries. It is a word used frequently in another branch of strenuous athletic endeavour where foot and ankle injuries are often career threatening - the classical ballet dance.

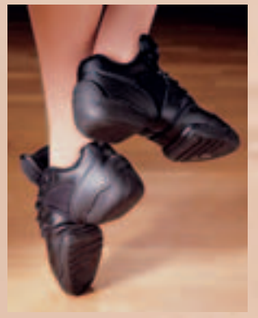
Although they are not exactly household brand names, footwear companies such as Bloch, Gaynor Minden, Grishko, Freed, Katz and Chacott control a category of footwear where even such mighty shoe companies as Wolverine, Bata or Nike fear to tread. That category is the dance. Even Capezio, the largest and best known dance shoe brand - based in New York City, is little known outside of specialised dance suppliers and aerobic studios. Dance is, however, a truly international category, with shoes being manufactured in such diverse countries as Russia, Australia, USA, Germany, Italy, Japan, Spain and England as well as in the major shoemaking countries of China and Brazil.

The biomechanics of footwear are not exclusively dominated by the sport shoe category. Orthopaedic and comfort shoe manufacturers, as well as the dance category have paid an increasing amount of attention to footwear testing and new materials in the past decade. In fact, several dance shoe brands employ full-time scientists and orthopaedic specialists who work on designing and researching anatomically improved shoes for dancers. Dr. Temeeshava at Grishko holds the only Doctorate of Science in dance shoe construction in existence. The Freed family is still deeply involved in its English ballet shoe business as are Eliza and John Minden of USA based Gaynor Minden. Italian-born Salvatore Capezio, the founder of the company that bears his name, actually took a ballerina for his wife. Talk about being married to the job.

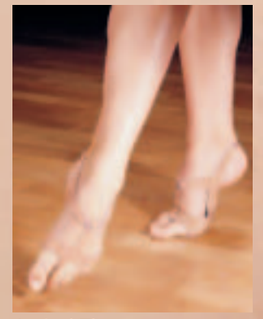
Almost as specialised as sport shoes, dancing shoes must have the same unique performance characteristics as in most sports disciplines to withstand strenuous athletic movements but, unlike sport shoes, dance shoes must be subtly disguised as everyday or character footwear to fit the scene. The major categories of dance are - Jazz/Swing, Tap, Ballroom, Clogging, Modern, Lyrical and, of course, Ballet and Pointe. Cheerleader and aerobic footwear are probably the closest crossover to sport/dance shoes. Several dance companies in fact make a jazz sneaker. The standard of this model seems to be the split-sole, high-cut design with flexible midfoot waist first introduced by Capezio.

Specialised shoes made for dance may be as simple as soft nappa leather gymnastic turn shoe constructions, as used in ballet, or as rugged as full-grain leather Flamenco high-cut boots with metal shank and taps on toe and heel. In Modern dance and Lyrical there is a piece of footwear used which can only be described literally as a foot glove. It is a piece of intricately cut soft suede that fits between the toes and under the ball of the foot to give the dancer maximum feel of the floor and at the same time prevent blistering. In most dance categories, traditional everyday footwear has been adapted by craftsmen into lightweight, flexible designs using leather, synthetic poromeric or fabric materials in the upper, with specific soling materials to meet the specifications of the dancer and particular dance surface used. For example, thin side split suede or bend leather is commonly used for soling on shoes used in ballroom dancing for the optimal amount of slide, with patent leather, nubuck and soft full-grain uppers. Men's upper styles for ballroom dancing shoes are still relatively basic and follow a CVO (circular vamp overlay) or one-piece toe design on semi-pointed lasts. This is the look that inspired the original Reebok aerobic design in the early 1980s. Ladies styles are a little more varied with closed toe or peek-a-boo toe, T-strap and sling-strap styles being the most common. Harder materials such as wooden heels and leatherboard, thermoplastic or expanded rubbers for soling on shoes are used for tap or clogging with or without a variety of metal heel and toe plates.

Clogging incidentally is not dancing in clogs. It is a dance category encompassing several sub-categories such as square dancing, Nordic, Irish, Scottish and English folk dances. Two of the most famous European clogging styles would be the ever-popular Spanish Flamenco style dancing and the German Schuh Plattler. These traditional steps are blended with American flatfooting, buck dancing, or in its most popular form, tap dancing, which owes its roots to black African steps. In addition to wooden heels and metal taps, acrylic soles may also be used to maximise the resonance on wooden flooring. (Another family business is known for its specialty footwear in this category - Steven's Stompers from Pennsylvania.)



Jazz Sneaker



Lyrical Thong

Women dance in heels from 1 to 3 inches in height. Men's heel heights are up to 1½ inches. Shanks and firm counters are mandatory in ballroom with a shorter shank being preferred in conjunction with the Cuban heel for Latin dances such as the rumba, samba and cha cha. Width fittings are also more common in dance shoes than in athletic footwear and at least one company (Toe-to-Toe) offers two size feet fitting, which is virtually unknown outside of orthopaedic footwear. Many dedicated craftsmen have added shoemaking innovations to the dance over the decades, Salvatore Capezio being the most prolific during his reign as a leading dance shoe designer from 1887 until his retirement in the 1930s. Two of his advances were the split-sole for independent forefoot and heel movement and the stretch insert in the mid-foot. Cushioning is important in most dance shoe categories because many wooden dance floors are built directly on top of concrete, making landing and clogging a bruising experience repeated over and over during rehearsals and performances. Most dance shoe categories tend to emphasise 'the feel of the ground' at the expense of cushioning the foot. In the past decade, however, shock-absorbing materials such as Poron and Sorbothane have been adopted into the dance category from athletic footwear.

The category of dance that requires the most athleticism, and engenders the most injuries by far, is Pointe in Ballet. Dancers have risen on their toes since ancient times, but the earliest documented performances with Pointe shoes took place in England and France between 1815-1830. Pointe shoes having started humbly in the early nineteenth century were made from fabric with layers of burlap and paper, saturated with glue. Original toe boxes were made from old newspapers. During the French Revolution, many dancers and choreographers left the Paris Opera to perform in England. One of these immigrants was Charles Didelot, who introduced the concept of a flying machine contraption that allowed dancers to stand briefly on their toes before being whisked upwards, creating the illusion of lightness as they portrayed ethereal, unreal characters in classical ballet.

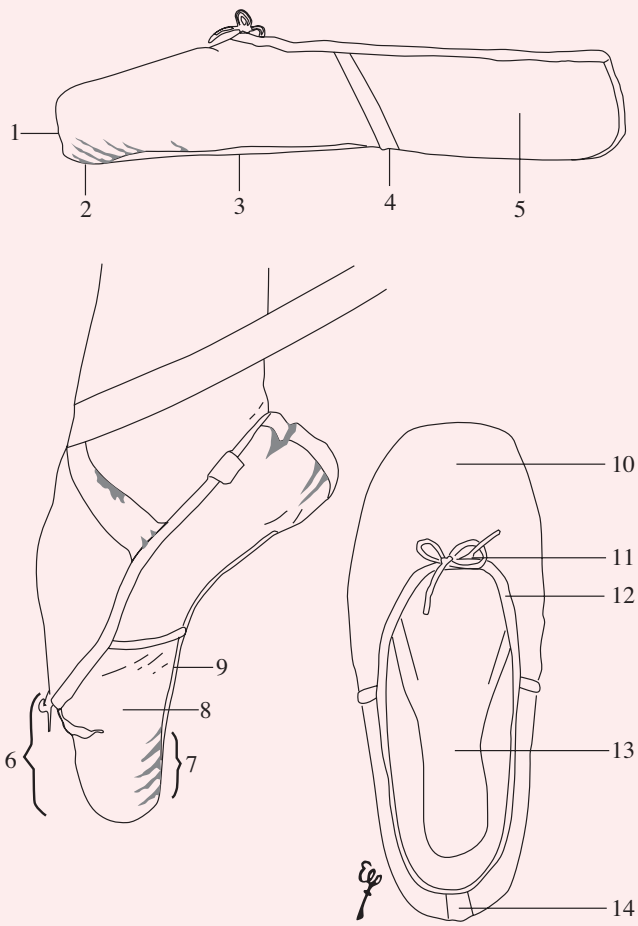
Ballerinas were schooled in an increasingly challenging technical vocabulary including multiple pirouettes, jumps and leaps. The attempt to dance on Pointe without the use of wires was a logical next step. Dancers soon discovered that by rising ever higher on demi-Pointe, they could balance on the ends of their fully stretched toes - giving the illusion of 'weightlessness'. At first, shoes used for dancing on Pointe appear to be nothing more than soft satin slippers, heavily darned at the tip. They had no box to protect the toes and featured a flexible leather sole that was supposed to support the foot. Darning along the sides and over the toe kept the slippers in place. They were essentially a one-sized tube of satin and leather that bound and squeezed the toes into a uniformly narrow point that had little relevance to the shape of the wearer's foot. The Italian shoemakers were the first to come to the rescue of the plighted ballerina, making a version of early Pointe shoes that had a flatter, sturdier base. They also had stronger soles and a box that was moulded with more substantial layers of fabric.

By mid-century, Pointe shoeboxes had become considerably harder in order to accommodate the technical demands of the dancer's biomechanical foot movements. In the process of creating harder shoes, however, shoemakers produced Pointe shoes with little flexibility, making it difficult for the dancer to have a sense of contact with the floor. In order to break-in these shoes for use dancers were often required to use techniques such as flexing the shoe back and forth, jumping on it, slamming it in a door, bashing it with a hammer, soaking it in warm water or alcohol, and scraping or scoring the sole. Finally, the shoe was often brushed with floor wax or shellac to give it a few extra minutes of life. All dancers sew on their own ribbons, which crisscross the ankles, keeping the shoe on and upright in the full-Pointe position. Such is the importance and necessity of a perfect fit that many specialised Pointe shoe manufacturers offer a fitting kit which consists of heel grippers, full sockliners, toe separators, box liners, various shaped cushions, vamp elastic and toe wraps. Also included as part of this kit is 'Invisible' elastic, a lace-like material that keeps Pointe shoes in place, and virtually disappears against tights.

Pointe Shoe

Men's and women's Ballroom shoes

The Anatomy of a Pointe Shoe (Schematic drawing)



(1) ***Platform of tip:*** *the platform consists of the area of the box on which the ballerina stands. Platforms may be oval, round or square, depending on how many toes the dancer prefers to dance on. The shape of the platform and the Instep are critical for fit and optimal performance. High and low instep refers to the space between bottom and top of the box. High instep offers more space vertically in toe area. Low Instep box has less space vertically in the toe area.*

(2) ***Edge of pleats (or feathers):*** *short pleats are used for fast Pointe work or long pleats for slow adagio work.*

(3) ***Outer sole***

(4) ***waist seam***

(5) ***quarter/heel***

(6) ***vamp:*** *top of the box that covers the toes and prevents the toes from rolling over. Vamp length is the distance between the drawstring knot and the edge of the pleats. The vamp length should correspond to the length of the dancer's toes.*

(7) ***Pleats or feathers:*** *is the underneath area of the box where the upper material is pleated and lasted under the sole.*

(8) ***Wings or supports***

(9) ***Shank or spine:*** *is the midfoot plantar support between the insole and outsole*

(10) ***Stiffened box or block:*** *layers of glued fabric surrounding the toes and ball of the foot.*

(11) ***Drawstring knot***

(12) ***Drawstring topline casing:*** *piece of bias tape (or gathering) stitched around the topline of the shoe to contain the drawstring*

(13) ***Insole***

(14) ***Back seam or stay:*** *Divides and covers the back quarters.*

The continuing evolution of contemporary ballet techniques led Pointe shoe manufacturers such as Frederick Freed to nonstop experimentation in succeeding decades. The result has been a wide range of Pointe shoe designs from extremely strong to ultralight, in a variety of styles that enable dancers to jump higher, move more quickly, and accomplish the increasingly difficult Pointe technique utilised by choreographers such as George Balanchine. His view on perfect Pointe shoes reads "The Pointes for girls have to be, I always say, like an elephant's trunk; strong and yet flexible and soft". A professional ballerina may use as many as twelve pairs of new shoes a week. Under average circumstances, a pair lasts for fifteen minutes of performing before being designated to class, rehearsal, autograph use or, most often, the trash can. This must be some sort of world shoe wear record. The continued dedication to the traditional art of Pointe shoe making as practised still by such icons in the industry as Freed and Gamba of London and Capezio of New York is to be admired.

Long criticised for their lack of innovation or attention to injury prevention, modern Pointe shoe makers like Gaynor Minden are increasingly using state-of-the-art materials to alleviate injuries for this special kind of athlete. Elastomers, high tensile strength nylon thread, shock absorbing foam and the latest perspiration wicking linings are incorporated into today's versions of traditional Pointe shoes. A wide selection of shanks and boxes vary in stiffness and styles from soft and pliable to firm and extra-supportive to accommodate both the professional and the beginner. Unbreakable shanks can be adjusted by simply heating them to perfectly conform to the longitudinal arch of the foot. Due to the tremendous athleticism of the ballet and its technique, no Pointe shoe or toe pad can possibly eliminate the risk of injury to the dancer. However, by understanding the biomechanics of the art, shoemakers can increasingly use innovation and space-age materials to build better footwear to help alleviate the problems associated with pathomechanics in ballet. Moving into the 21st Century, perhaps the traditional show business expression to wish good luck - "Break a leg" will literally be a redundant phrase.

Mel Cheskin