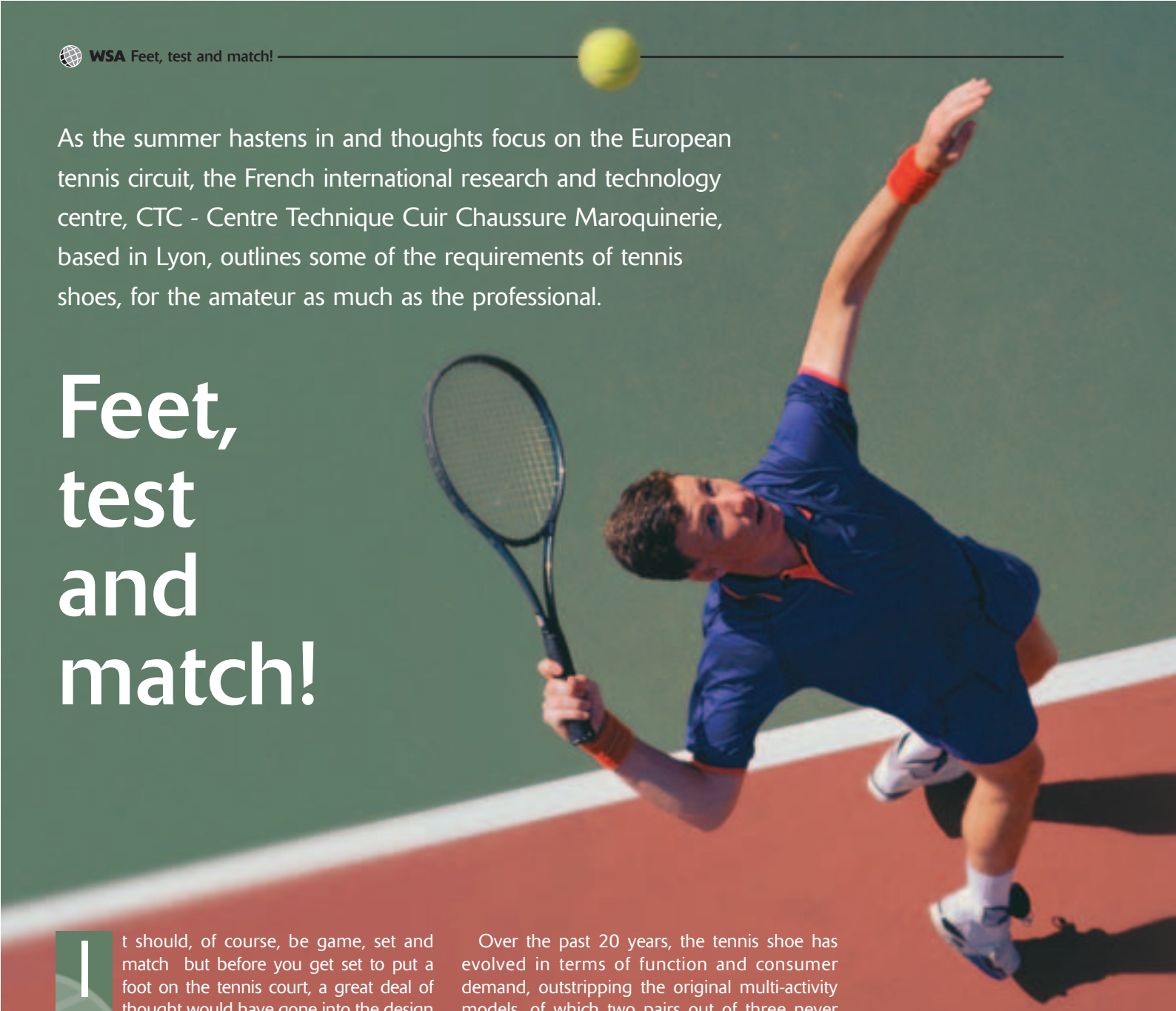
As the summer hastens in and thoughts focus on the European tennis circuit, the French international research and technology centre, CTC - Centre Technique Cuir Chaussure Maroquinerie, based in Lyon, outlines some of the requirements of tennis shoes, for the amateur as much as the professional.

Feet, test and match!



It should, of course, be game, set and match but before you get set to put a foot on the tennis court, a great deal of thought would have gone into the design and construction of the tennis shoes you will be relying on to upstage your opponent across the net. Watching the Grand Slam events around the globe and particularly the majors, such as the French Open and Wimbledon, it becomes apparent that the different surfaces on which the top tournaments are played must affect the performance of the footwear. The top tournaments, with their tremendous TV coverage, also have a serious impact and influence on the sales of tennis shoes and it could be argued that what happens at Roland Garros in Paris must affect the sales of some two million pairs of tennis shoes a year in France.

Nowadays, the bio-mechanical revolution has turned the concept of the sports shoe on its head, and the concept of tennis shoes in particular has changed beyond recognition. In order to respond to a players personal characteristics and different surfaces, shoes must now undergo numerous tests and trials, in a short period of time, if companies want them to succeed in the market.

Over the past 20 years, the tennis shoe has evolved in terms of function and consumer demand, outstripping the original multi-activity models, of which two pairs out of three never came close to a tennis court during their lives.

The tennis shoe now acts as an interface, a filter between a surface (characterised by its nature, its hardness, and its slide) and the athlete (whose swing has been dissected and for whom weight, age and the level of fitness must be considered).

Not surprising, then, that the tennis shoes on offer are broken down into specific segments according to surface and player compatibility. The shoe must be adapted to the surface, whether it be hard, synthetic or grass.

For an aggressive game, based on attacking which involves many lateral and forward and backwards movements, the principal properties required of the shoe are to be lightweight, to give support, to push the energy to the front of the foot, and flexibility.

For a classic game, based on control, research indicates that the main criteria for a shoe are comfort, shock absorption, stability, control and support.

Finally, for long and repetitive training sessions, the important criteria for a tennis shoe are durability, stability and, very importantly, comfort.

A demanding activity

Next time you are watching a match, take the time to study the footwork and the stresses placed not just on the player's legs and feet, but also on the shoes themselves. It could be argued that only the tennis ball itself suffers more stress. The game of tennis combines sudden stops and starts, from running forwards, backwards and from side to side, to stopping dead. All of these elements demand movement and mean that it is necessary for the shoe to offer protection in terms of shock absorption and support. Amongst the multiple discoveries made in bio-mechanical research, the peak of impact is probably the most notable one made in the history of the sports shoe.

A study of the vertical component forces in reaction to the ground show that the presence of a peak impact, the shock to the heel versus the hardness of the ground, is equivalent to three or four times the body weight when running (it is up to ten times the body weight when locking the leg to kick a football).

In short, up to 20 metres/second, this peak impact goes totally unnoticed by the player. Imperceptible in real time, an accumulation of micro-traumas can lead to an injury surfacing several weeks or months later.

Too fast to be perceived by the human organism, the responsibility for protection falls to the shoe to anticipate the shock of the player's heel hitting the ground.

In the game of tennis a compromise must also be found with lateral stability, as cross-court moves require lateral movements that create forces of two or three times the body weight. This demands a high level of lateral support.

Now, with the introduction of shock absorption, this has led to the need for increased suppleness and an improvement in the thickness of the soles which can reduce the level of stability.

Static weight distribution

Static weight distribution is also a point that needs consideration in a tennis shoe. When static (weight is distributed on both feet) 50% of the body weight is focused on the calcaneum (in the heel) and 17% on the metatarsals 1 and 5.

When serving or during propulsion, the player principally uses the front of the foot. When receiving, stopping or pivoting the body, the pressure is focused mainly on the internal metatarsals.

The support on the heel, under the metatarsal palette and the big toe, therefore, has to be given great consideration. The shoe must not create

hard areas in these zones that are synonymous with discomfort, blisters and corns in the long term.

Tendonitis in the foot, particularly in the Achilles tendon, occurs frequently in tennis players. Elevating the heel in relation to the front of the foot is one response to this problem.

Finally, hard surfaces accentuate the wear and tear on the shoe and therefore demand a sole that is adapted to this.

A technical product

The tennis shoe must support the whole of the foot. Different elements allow it to fulfil this function:

A firm counter, fitting the heel and respecting the asymmetry of the height of the ankle bones at the back. The toes must be well-contained at the front, and have firm lacing over the instep.

A shoe mounted on the right axis contributes greatly towards lateral support.

Shoes assembled from a direct moulded sole reduce lateral deformities in the ankle area. The ankle area is an important element: it contributes to the suppleness, the lightness, and the robustness of the shoe in relation to support and comfort.

To keep the foot injury free and comfortable requires the shoe to absorb and remove the moisture produced during a tennis match. It is the first rule of cleanliness translated into physio-mechanics, that in order to assure a time span of one hour without a sensation of damp or wet the shoe must have an absorption capacity of 60 mg/cm^2 (NF G 62-002).

Once captured and absorbed, moisture must be allowed to evaporate, so the functions of breathability and permeability are reliant on the construction of the ankle area. This is often one of the weak points of tennis shoes, for example, made of coated or dyed leather or in synthetic material, breathability is compromised. And the addition of perforations in the flexible zones of the foot, whilst adding little to the level of breathability, act as a pressure cooker for the shoe, transforming it into a veritable breeding ground for micro-orgsanisms.

To support the joints, a shock absorbing heel is recommended. In technical terms, tennis shoe manufacturers have by and large already resolved the problem of shock absorption. Currently available models absorb (on average) 20% of the shocks in the heel. A comfort layer based on PU or EVA is often a good sign of shock absorption properties.

To assure stability, the sole must not be too thick, so as not to limit the leverage in the joint under the sub-talar joint, from where the inward and outward movements are controlled. The sole must not have edges that are too thick, as this would exacerbate the speed and magnitude of over balancing, both internally and externally, when the foot is in extreme, unnatural positions. The sole must not be too soft as this could lead to it collapsing during use and result in excessive instability. A support cup in the heel also adds extra comfort for the foot.

Adequate support to the arch of the foot via the shank allows the foot to move more naturally. In order to improve the dynamism and the attack of a player, elastic materials and components must be integrated into the sole, especially at the front of the shoe. As far as suppleness is concerned, it is best placed at the points where the foot bends.

The sole tread pattern must be adapted to suit the court surface. Ridged chevron contours are advised for hard and synthetic courts. Spiked contours are better suited to the impact from hard courts.

The materials used in the sole are also fundamental to the performance and, once again, vary depending on the surface of the court. On synthetic surfaces, the lateral movements and sliding of the player create temperatures in excess of 120ºC between the shoe and the ground! Therefore, the material has to be able to withstand these high temperatures. Its resistance to wear and tear is therefore now tested in terms of thermo-abrasion and no longer just abrasion.

Numerous tests can replicate the effects of professional usage on tennis shoes but could you also not claim that tennis shoes are, in effect, excellent examples of personalised protective equipment?