GOVERNING BODY PRIORITIES IN TENNIS SCIENCE RESEARCH

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The purpose of this paper is to describe key projects developed by the ITF Technical Centre to understand the characteristics of tennis equipment and their effects on the Rules of Tennis. These projects involve the ball (spin and aerodynamics), racket power and surface (friction). While each of these projects provides valuable information, it is not as useful in isolation than it is together, when an overall view on the combined effects of different combinations of tennis equipment on the nature of tennis can be established.

KEY WORDS: tennis, equipment.

INTRODUCTION: In 1997, the International Tennis Federation (ITF) – the world governing body of tennis – set up a Technical Centre, a key aim of which was to conduct research and testing programmes on tennis equipment in order to establish the effects that equipment has on the nature of tennis, and to ensure that equipment-related rule changes are based on sound scientific information, rather than speculation. Since that time, the Technical Centre has developed into the world's leading tennis science research centre in equipment evaluation.

The mission statement of the Technical Centre is based on a philosophy of balancing the effects of technological advances in tennis equipment with the desire to retain the traditional character of the sport. To achieve this mission statement, the characteristics of equipment must be fully understood and, perhaps more importantly, the potential future effects of any current trends must be predictable. This paper describes key ITF Technical Centre projects.

PROJECTS: Ball spin: Tennis is characterised by heavy topspin shots, the effect of which is to generate an aerodynamic 'lift' force that makes the ball return to the ground faster than a non-spinning ball. Hence, the application of spin allows players to hit the ball harder and still land within the court boundaries. The magnitude and effect of spin has received relatively little attention, despite its effect on tennis stroke production.

To understand how spin is generated, and establish the spin-generating capacity of racket/string combinations, the ITF constructed a spin rig (Figure 1), which consists of (1) a cannon that fires a ball onto a racket at various angles and spin rates, and (2) a high-speed video camera and software that automatically tracks the ball and measures the spin generated by the racket and strings. Analysis software facilitates the comparison of strings (Figure 2).

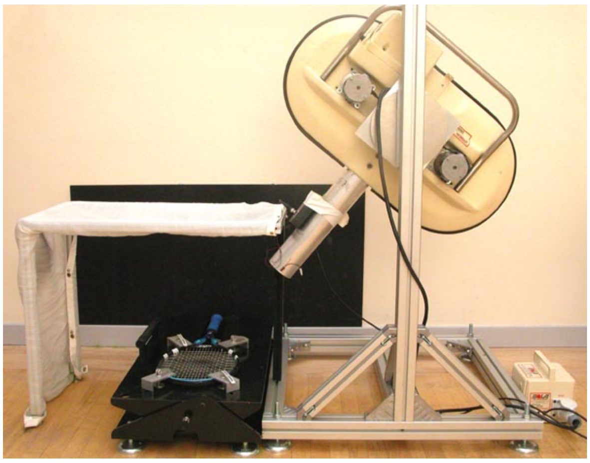

Figure 1. The spin rig.

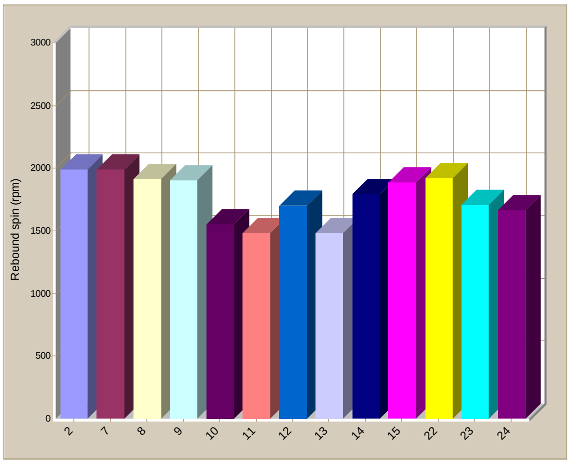

Figure 2. Rebound spin for selected strings at 60 lbs tension and an inbound spin of 3000 rpm

Aerodynamics: Having established the spin-generating characteristics of strings, the effects on ball trajectory must be quantified. The ITF uses a wind tunnel to measure the aerodynamic forces generated by tennis balls at realistic speeds and spin rates determined by the spin rig (Figure 3).

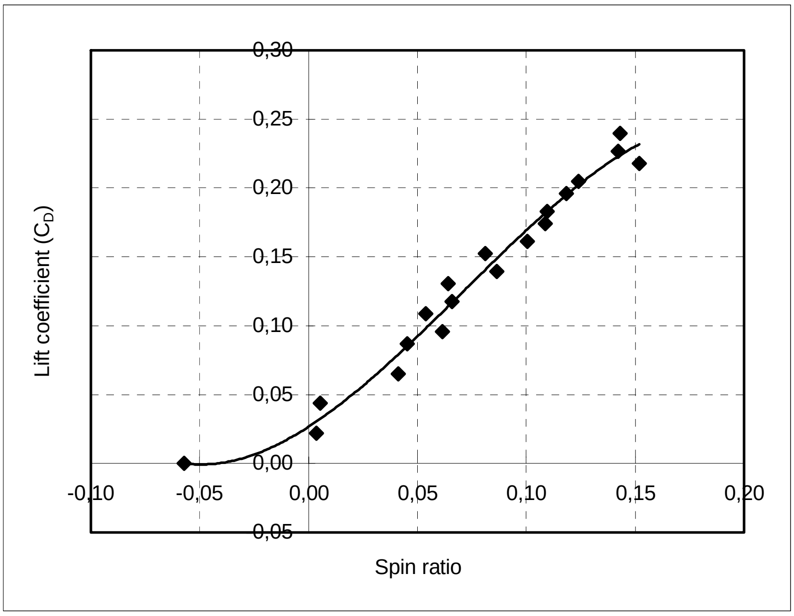

Figure 3. Lift coefficients at a range of spin ratios

Surface testing: The Technical Centre operates a Court Surface Classification Scheme, which categorises tennis surfaces according to their 'pace'. Each surface that has been classified has been given a surface pace rating (SPR) that is based on the frictional interaction between the ball and surface. This is established by projecting a ball onto a surface and measuring the inbound and outbound velocities using a ball cannon and Sestée device (Figure 4). Using the calculations (and assumptions) of Brody (1984), SPR is expressed as a function of the coefficient of sliding friction (μ), as shown in equation 1:

$$SPR = 100 \times (1 - \mu) \quad (1)$$

In practice, most tennis courts have SPRs of 20-50, with clay courts generally being the slowest surface type, and carpet and grass surfaces being regarded as among the fastest. The concept of pace allows manufacturers to measure the performance of their products, and customers to quantify their requirements.

Figure 4. The Sestée.

Racket power: The change in racket material from wood to aluminium and, then to graphite, is commonly regarded as one of the most significant changes in tennis. The modern racket is not only stiffer and bigger than its predecessor, but also lighter, all of which have an effect on

the nature of tennis. For example, novice players make fewer mishits as a result of the larger head size of the modern racket. It is the ‘power’ of modern rackets, however, that has attracted most attention. Increased stiffness means that less energy is lost in bending the racket during impact, but it is the mass of the racket which is the hidden key to the power cabinet. A racket with less mass or, more correctly, moment of inertia about an axis through the grip and parallel to the string plane, can be swung faster, which is the main factor affecting shot speed, and allows top players to serve at speeds up to 150 mph (240 kmh).
The Technical Centre uses a purpose-built racket power machine (known as the MYO) to measure racket power (Figure 5). A motor spins a racket in the vertical plane to make contact with a ball dropped from above, and the post-impact ball speed is measured using light gates.

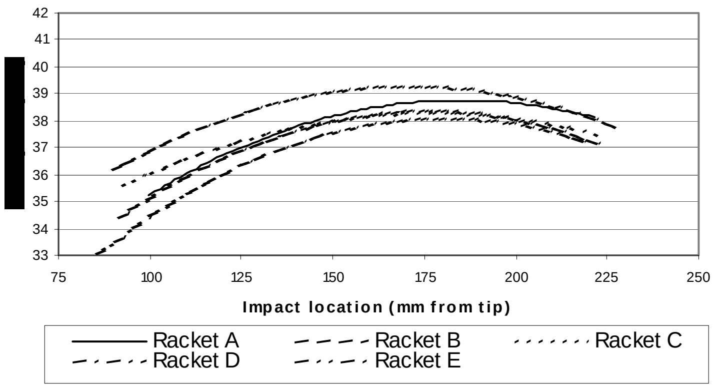

Figure 5. The MYO

Figure 6. The relationship between impact location and post-impact ball speed for an impact speed of 30 m/s

Example graphs of post-impact ball speed for a range of current rackets is shown in Figure 6. It can be seen that some rackets are capable of producing higher ball speeds than others, and that the profile of ‘power’ along the long axis of the racket is not the same for all rackets. This project will continue to benchmark racket power and monitor trends in power over time.
Tennis GUT: While the projects described above have helped to provide a detailed understanding of the characteristics of individual items of tennis equipment, it is arguable that their combined effects must be understood if the mission of protecting the nature of tennis is to be realised. Thus, a software package called Tennis GUT that combines data from each project and allows a simulation of a full shot, and thus the combined effects of tennis equipment has been written (Figure 7).

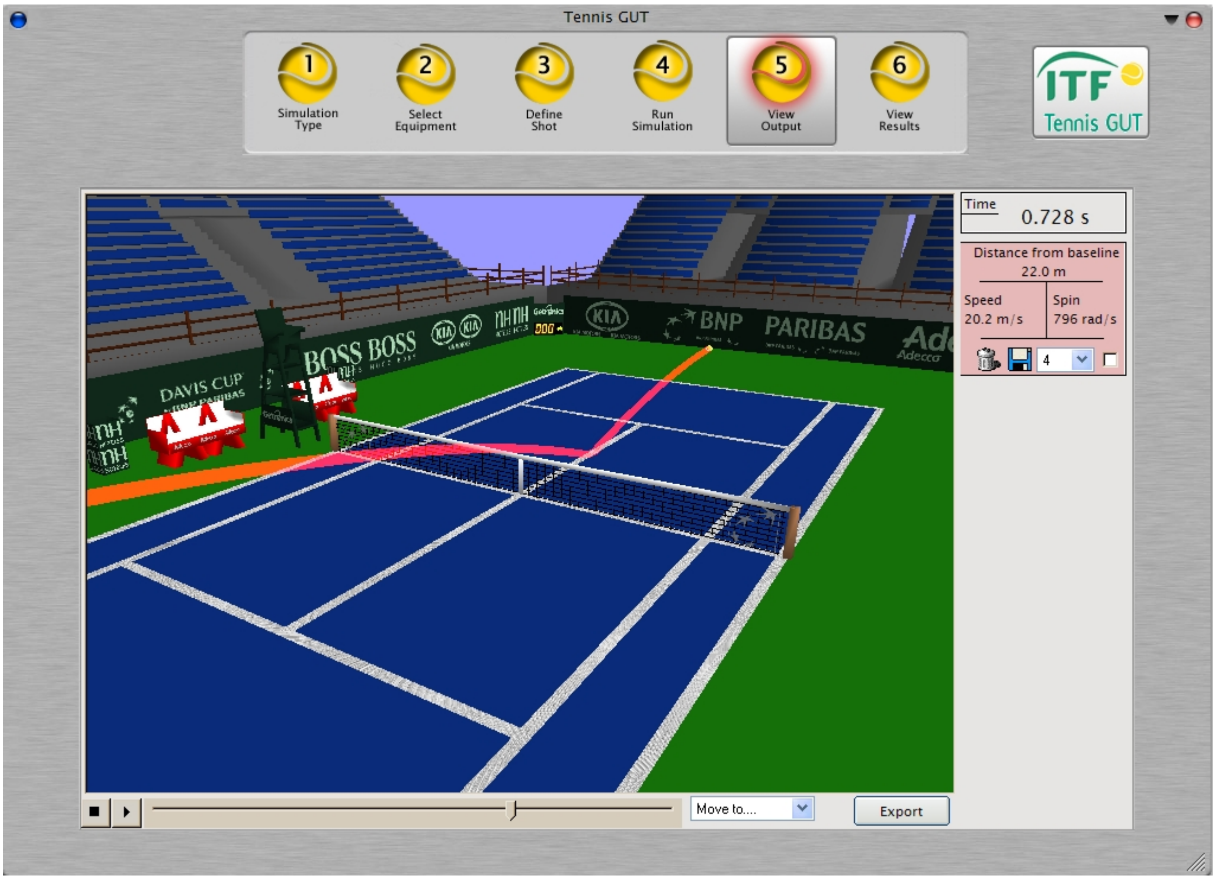

Figure 7. Tennis GUT.

CONCLUSION: This paper describes the key ITF Technical Centre projects that are designed to facilitate the understanding of tennis equipment and its effects on the nature of tennis. It is through judicious use of information generated by these projects that the Technical Centre will continue to pursue its mission statement.

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