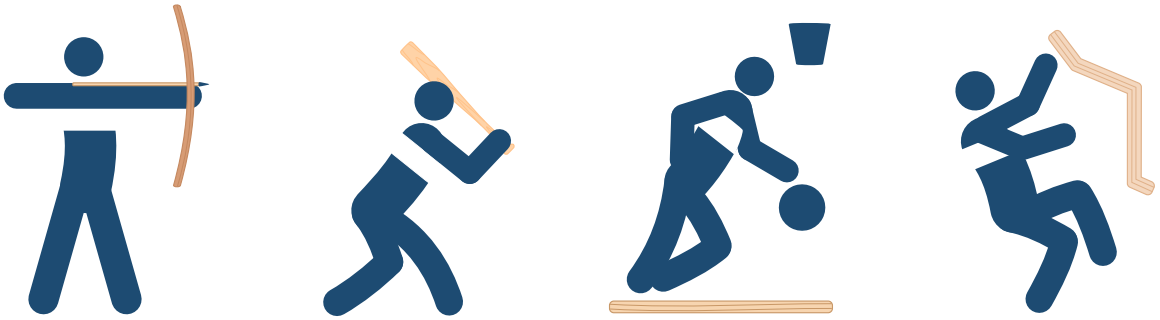
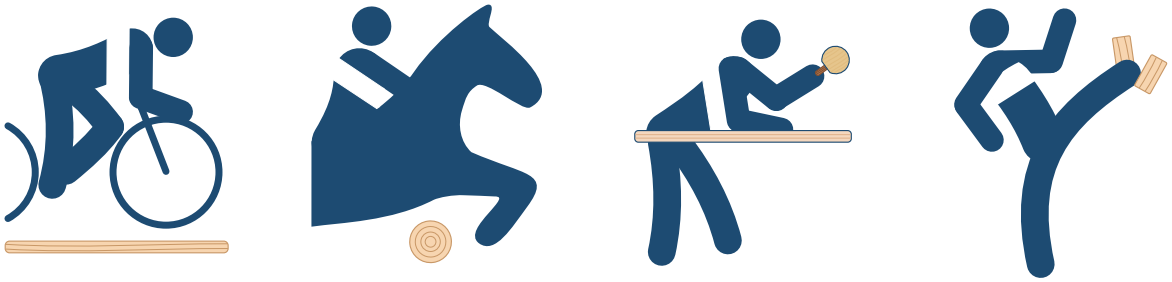


WOOD IN SPORT EQUIPMENT

HERITAGE, PRESENT, PERSPECTIVE



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The icons represent some of the sports considered in the book (including all sports would have resulted in too small images for proper visualization). The wooden equipment is outlined by the colors of the wood species from which it is made, and by lines representing the grain of wood and the characteristics of the relative wood-based products.

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WOOD LAMINATE TENNIS RACKETS: INSIDE THE MANUFACTURING OF AN ICONIC SPORT ITEM

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Wooden tennis rackets have continuously evolved from the origins of Lawn Tennis in the 1870s until they left the scene in the 1980s (ITF 2019). In the early years, tennis rackets were handmade by craftsmen who bent solid wood, mainly ash, into shape. This was particularly appreciated for its favorable mechanical properties, including its remarkable flexibility.

Rackets made of solid wood were however heavy and subjected to warping, such as twisting. This, together with other needs such as strengthening the frame and improving the aerodynamics, led to the development of wood laminate rackets. In this sense, let us remember that the wooden frames had to withstand not only the stress due to impact and swing during play, but also the permanent loads applied by the tensioned strings.

The first versions of wood laminate rackets date back to the 1930s, when they were made of small laths of wood (again, mainly ash) bent into shape and glued. Starting from the 1940s, veneers were overlaid and bonded with synthetic adhesives to obtain multiple layered frames, based on the rotary cutting and curve lamination production technology. The layered composition made of sound veneers with parallel grain (as a kind of *ante-litteram* LVL) enabled to enhance the strength of the wood and leveled out the performance of the rackets. In addition to ash, the wood of other species began to be used in those years. The International Tennis Federation (2019) reports the use of maple, sycamore and hornbeam in the main frame; hickory in the outer layer, to provide wear resistance; beech and mahogany in the throat and handle, for aesthetic purposes; obeche in the shaft, to reduce the overall weight.

The period from the 1940s to the 1960s can be considered the golden age of wood laminate rackets. Overall, wood was by far the dominant material from the 1870s to the 1960s, with minor fractions of steel or aluminum appearing here and there (Taraborrelli 2019). From the 1960s, steel, aluminum and composites began to be increasingly introduced, and their use further increased in the 1970s and in the 1980s. By the end of the 1980s, wood laminate rackets had become obsolete: composite materials began to dominate the market, their reign stretching from the 1990s to the present day. This evolution is due to the high performance and lightness of composite materials (i.e., carbon fibers), and to the technology advancements that enabled their efficient and cost-effective processing.

MANUFACTURING OF WOOD LAMINATE TENNIS RACKETS IN THE 1980s

The state of the art in the 1980s can be considered the point of arrival of a century-long evolution, and thus the most advanced level of wood laminated racket manufacturing. In those years, several companies produced a great variety of rackets worldwide. In this sense, the manufacturing process described herein can be taken as a general reference. The process was reconstructed by contacting an Italian manufacturer that supplied wood veneers to one of the main global producers of wood laminate tennis rackets at the time.

The mill bought roundwood of noble hardwoods on the market. As already mentioned, ash, beech, hickory, hornbeam and maple were among the most used and appreciated woods. The same type of raw material was also used for producing working tools handles,

thanks to its elasticity and capability to withstand repeated stress (fatigue resistance).

Logs derived from the basal part of the trunk. Their quality requirements were similar to those of logs intended for the slicing of fancy veneers. Top-quality material was used, where anomalies such as large knots, end shake, fissures, and rot were not admitted. Straight grain and regular width of the growth rings were especially important. Assortments were between 4.5 and 6-8 m long to the purpose of obtaining raw pieces with multiple lengths of 150 and 200 cm, which were the lengths of the final strips. The required mid diameter of logs was at least 35 cm to ensure adequate yields.

As in the slicing process, logs were initially left for some days in tanks full of water at 65-70 °C. This was intended to "soften" the wood, to ease and make the following manufacturing phases more uniform. At the end of the immersion period, the logs were extracted from the tanks, cut to length, debarked, and rotary cut by a lathe. Veneers of different thicknesses, as a rule from 1.5 to 2 mm, were obtained.

The veneers were then dried in a tunnel dryer that reduced the moisture content up to 3-6 % in a few minutes. They were successively stored until the achievement of the equilibrium moisture content with the environmental humidity of the plant. When ready, they were cut into strips of a few centimeters wide. Each strip was visually graded, based on a specific production disciplinary to remove the unacceptable characteristics.

The flexibility of the strips was also tested. This was performed, according to the standard UNI 6483, by piling drilled disks of various diameters on a metallic planchet (FIGURE 11.1, left). The size of the testing cylinder depended on the thickness of the veneer strip to be tested. The test was considered passed when the sampled strip curved in its center, matching the cylinder's surface, without showing any beginning of rupture. Finally, strips were packed and sent to the mill's customer that carried out the further processing.

At the customer's plant, the rackets were bent into shape on apposite molds and bonded by means of thermosetting synthetic adhesives (FIGURE 11.1, right).

FIGURE 11.1 Left: device used to test the flexibility of plywood and veneers. Right: multiple-layered raw blocks were assembled, cut, and finished to obtain the final wood laminate rackets (images, not to scale, R. Zanuttini).

The shaped frames where then drilled to enable putting the strings through. The process was completed by rounding the sides, applying handles coating, painting and finishing. After the final inspection, the rackets were placed on the market through their specific commercial channels (FIGURE 11.2).

FIGURE 11.2 Wood laminated tennis rackets were produced in a wide variety of shapes and colors. Clamps were used to contrast warping during storage (image F. Negro).

Overall, wood laminate rackets can be truly considered iconic sport items, both for the diffusion that tennis has had worldwide, and for the great number of units produced over the decades. It is no surprise that nowadays they maintain a relevant interest as pieces of furniture (for instance hung on walls) and as collector's items. The Museum of Rackets located in Baldissero d'Alba, Italy [1], is a remarkable example in this sense.

The value of wood laminate rackets depends mainly on the years of production, the model, the state of preservation and the professional players that used them. Starting from a few Euros, prices can reach extremely high levels, as often happens in sport memorabilia. Furthermore, in the past years a world-renowned company placed a limited edition of a handcrafted wooden racket on the market, as a collector's item. Made of lime, walnut and balsa wood combined with graphite, it was presented as a sort of connection between tradition and innovation.

Finally, while playing tennis with wood laminate rackets has become obsolete, it is to note that wood has not entirely left tennis courts. Wooden net poles (typically made of ash wood) are in fact still used on grass courts. Other than sustaining the net and withstanding the load of the net tensioning, they have a relevant aesthetic function. Their appearance, in fact, dialogues with that of the grass, suggesting the image of a natural environment.

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REFERENCES

ITF 2019. History of rackets and strings. International Tennis Federation, www.itftennis.com [accessed on 26 January 2022].

Taraborrelli L, Grant R, Sullivan M, Choppin S, Spurr J, Haake S, Allen T (2019). Materials have driven the historical development of the tennis racket. Applied Sciences 9: 4352.

UNI 6483:2011. Plywood. Bending test [in Italian].

[1] www.museodellaracchetta.com [accessed on 02 February 2022].