The Bow: Linking Musician and Instrument

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Illustrations of bows in instrument catalogues typically show the head and the frog. While this focus certainly points up the style and ornamentation of the bow, it obscures its mechanical function, which depends on the stick. Because sticks are illustrated less often, they remain underestimated.

A beautiful stick is not only a delight for the eye – a sensual sculpture that brings to mind Constantin Brancusi's *Bird in Space* – but also a technically complex form. Bows are of such importance that musicians in France have developed their own vocabulary that is used in parallel with the bow makers' lexicon. For instance, makers speak of the *tête* (head) but players use *pointe* (tip), a fencing term.

The sticks of violin, cello, viola, and double bass bows share the same basic properties. When I create a bow, I imagine the stick during playing – and "playing" is the operative word here. The bow remains an incomplete concept until it is held by a player. The playing position is integral to the balance of a bow: the player's body absorbs much of the vibration and instantaneously analyzes it in order to provide an appropriate muscular response. Good instrumentalists seek a way to get the sound they want, whatever the chosen bow, but this choice can either free their playing or constrain and hamper it. A bow should always directly convey the musical intention.

An analysis of the character of a bow must consider length, weight, balance, stability, playability, power, and sound quality. The wood of which the bow is made, the shape given to it, the characteristics of the hair and its relation to the stick, and the camber interact in complex ways to create this character as well as the visual aesthetics of the bow.

Length and Weight

After a long period of evolution, the length and weight of bows were standardized to within a few millimetres and grams. The length of a bow corresponds to the maximum hair length usable by the musician, with arm extended. The minimum weight is defined as the smallest mass capable of causing the string to vibrate with no external pressure: 57 to 62 g for a violin bow.

The heavier the bow, the greater the strain on the musician's arm: my experiments using synthetic bows to replicate a body of data have shown that most violin strings respond poorly to a 54-g bow, and that players are sensitive to differences of less than two grams. However, weighing a bow to detect the "extra gram" makes little sense; what counts is the location of that extra gram. Mass added or subtracted between the button and the tip will obviously alter the balance of the bow; the musician will perceive this difference as being near the head.

Balance and Stability

The balance of a bow is more important than its weight. To assess balance, archetiers often locate the centre of gravity by balancing the bow, stick side down, on a pencil. However, the balance point of a motionless bow is a poor indicator of its playing quality. A bow in use is dynamic; how it handles in motion involves two factors: balance and stability. The balance of a bow is a result of its shaping; it can be felt in the musician's arm as soon as the bow is grasped. The stability depends on the camber. The taper and curve of a bow are closely linked and interdependent;[1] artificial additions of weight along the stick are never satisfactory. When a well-shaped and correctly cambered bow is held in playing position, its centre of stability will fall midway between the index finger and the tip.

The balance point is also the sautillé point – the point where a bow lightly held with two fingers bounces naturally on the string without strain. The precise position of the balance point varies slightly from one bow to another, but when musicians change bows, they tend to seek the familiar bouncing point at precisely the same spot on the new bow, even if it is awkward. Although sautillé accounts for scarcely more than ten percent of all bow strokes in the concert repertoire, players consider it a priority. This focus points to another indispensable quality: agility. Bows must be fast and nervous, and they must afford ease of articulation, particularly with present-day stage performance and contemporary music.

Playability, Power, and Sound Quality

There are no fixed rules for defining a good bow, but playability and power must be properly equated. Playability is the degree to which a bow is both firm or flexible and unlively or responsive. Refined French bows are known both for their suppleness and for their truly powerful sound. A stiffer bow manifests a more aggressive personality with a rapid response in sautillé and spiccato; it produces a more brilliant timbre that can brighten a dark-toned instrument. A more pliant bow draws out a warmer sound; it will often afford a broader range of expression but will also place greater demands on the performer. Musicians prefer one type or the other, depending on their playing style and technique.

The stick has no acoustic power but its properties influence the volume and tone colour of an instrument insofar as these properties awaken different parts of the range. The stick generates and drives the vibrations that flow through the bow, the body of the performer, the strings, and the body of the instrument in myriad ways. The clarity of this concept and its mastery by the bow maker are decisive to the finished product.

Factors to consider in constructing a bow include wood, shaping, hair, and cambering. Each blank used to make a stick is unique and bow-making techniques vary widely. By analyzing a few splendid examples of their trade, archetiers have sought to establish rules and laws as avidly as luthiers once pursued the formula for the perfect varnish. Unfortunately, such calculations will not produce a bow that is any better than one made from a traditional template. A first-class bow is the result of a complex balance of well-mastered elements rather than a list of preset factors. Fundamentally, the bow is to the violin what breath is to vocal cords.

The Wood

Pernambuco, an extremely hard, dense wood, is ideal for making bows because it has a low damping ratio and allows vibrations to abate slowly. This quality is significant because vibratory absorption or damping increases when the bow is held by a musician. In theory, carbon fibre should be a better material because vibrations will pass through it more quickly, but the hardness of carbon produces a more biting, brilliant sound. Thus, low damping is not all-important; the ability of the material to develop tone colour must also be taken into account.

Density alone is not sufficient to describe the capacity of a wood to transmit vibrations; this capacity is largely influenced by the grain of the wood and by its cellulose and resin components. Bow makers who take the time to meticulously select and prepare their wood will carve only pieces that have a straight and regular grain. High-density wood does not necessarily make a firm bow, but it does give the bow maker more latitude. In a comparison of bows made of lightweight wood and bows made of hard, dense wood, an equal weight of dense wood will produce a narrower bow; inversely, if the two bows are equal in diameter, the bow made of dense wood will be heavier. Thus, dense woods are good for making exquisite octagonal sticks that are slender but powerful, with sharply defined edges.

Stick Shape

Many musicians believe that octagonal sticks are stronger than round ones because the angles of the facets act as reinforcements. They are right about the strength, but the reason is a little more complex. Octagonal bows are generally stronger because they are cut from firm, non-porous wood; an optical illusion created by the facets makes the sticks appear thinner than they actually are; this gives the bow maker more options for carving a robust bow.

Bows appeal to our senses in the extreme. As noted above, players are sensitive to weight and vibration. In terms of the profile of a bow, the human eye commonly perceives variations of 0.5 mm or so along the stick. A musician's relationship to a bow has much in common with fencing. The entire history of bow making has been guided by one philosophy: to optimize the functional capacities within a fundamentally elegant form. This constraint imposes inescapable structural parameters on stick making. The challenge for bow makers lies in the interpretation of these parameters. Aesthetic requirements go far beyond simple ornamentation.

The playability of a bow and the quality of its vibrations depend not only on the chosen wood but also on the shape and camber of the stick. Shaping and cambering a stick can even improve the initial character of a piece of wood. A growing demand through the post-baroque period for greater hair length led to the development of longer bows, which, in turn, led to a gradual tapering of the stick toward the head to offset the additional length. The farther out the musician's arm extends, the more difficult it is to sustain the sound: it is more difficult to exert constant pressure when playing at the tip. Consequently, sticks that are lighter and more flexible at the head will facilitate playing. As the taper becomes thinner, the bow maker must strike a delicate balance between lightness and firmness.

The Camber and the Hair

The hair that causes the string to vibrate is intrinsic to the concept of a bow. When the hair is tightened by turning the button, the entire stick is engaged. When held taut by a firm stick, the hair touches the string tangentially in a straight, rapidly bouncing line – a quality sought for fast, precise bow strokes. In this configuration, the hair lifts away quickly and has little time to develop the overtones of the instrument. Conversely, the hair of a supple bow "envelops" and pulls the string, producing overtones. The finest bows are those that are at once supple and spirited. Despite numerous attempts at substitution, there is still no satisfactory alternative to horsehair. Its characteristics serve the interaction of string and bow perfectly: horsehair springs back to its original length after stretching; its breaking point prevents excessive extension; its porous fibres hold rosin; and its peripheral barbs increase the points of contact.[2]

I have discussed the balance and centre of gravity of a bow seen in profile. But these factors must also be considered by sighting along the stick from the frog to the head, as bow makers do when verifying the overall line of a stick and its distance from the hair. The greater the stick-to-hair distance at the balance point, the less stable the bow. Yet there was a time when bows were nothing but hair and stick, with no camber. The mechanism that tightens the hair inevitably pulls it away from the stick; the baroque bow was unstable because the hair was too far from the stick.

There are three advantages to cambering a stick: the convexity increases the hair tension, the incurved stick remains as close as possible to the hair, and the stick becomes a spring. The theory of cambering is simple: the wood is imprinted and made to memorize a shape. Achieving this is infinitely more complex.[3]

Bow makers throughout history have developed various techniques based on the initial choice of how to cut the stick from the blank: straight and parallel to the grain or already curved. In both cases it is vital to master the relationship between the taper and the camber and to consider the evenness of the curve. The irregular structure of wood fibres and the traditional cambering method make this control difficult. The bow maker heats the wood over embers or a flame and then shapes the curve by carefully pressing the stick, point by point, against the edge of the workbench, never creating an angle.

Over the centuries many historical bows have been recambered to correct weaknesses or to allow for more comfortable playing, to the extent that they are now like palimpsests – medieval manuscripts on which one text covers another so that only indistinct traces of the original remain.[4]

A great bow is a bond between a musician's emotion and the stringed instrument, a link that ceaselessly evolves with music and new styles of playing that music.

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NOTES

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1 For a detailed procedure for documenting bow stick graduation and representing its relation to balance point and camber, see Elizabeth Vander Veer Shaak, "Measuring and Graphing Bow Graduations, Low Point, Camber, and Balance Point," 1:405–19. *Ed.*

2 For a detailed discussion on the properties and roles of horsehair and rosin, see Florence Billaud de Kerret, "Properties of Horsehair and Rosin," 1:513–34. *Ed.*

3 See Michael Yeats, "Camber," 3:77–80; Sylvain Bigot, "Recambering and Straightening Bows," 3:81–91. *Ed.*

4 For further discussion of historical camber and the reasons for recambering, see Sylvain Bigot, "Recambering and Straightening Bows," 3:81–91. *Ed.*