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CONTENTS

THE PLAYING PARTS OF THE BOW: FOCUSING ON THE STICK

Benoit Rolland

Saturday, November 16, 2002, 2:30 pm

Albert Mell: In 1970 a bow-making school was established at Mirecourt under the direction of Bernard Ouchard. Its purpose was to select and train gifted young craftsmen to become the nucleus of a future generation of bow makers who were to revive and revitalize the great tradition of French bow making. The school was discontinued after Ouchard's death. However, during this brief 10-year period, 19 bow makers were trained.

Twenty years ago Étienne Vatelot, in speaking of the school, named three graduates as being the finest talents on the current bow-making scene. He was referring to Benoit Rolland, Christophe Schaeffer, and Stephane Thomachot. We all know how accurate Vatelot's evaluation was.

Benoit Rolland was a member of the first graduating class of the school. At the young age of 25 he was designated Meilleur Ouvrier de France. Mr. Rolland describes himself as a musician who was detoured into bow making. He attended the Paris Conservatory for a year and a half, studying composition and solfeggio. After years of piano study he switched to the violin, which he still plays. He was only 15 when Bernard Millant offered him the chance to be in the first class at the newly constituted bow-making school.

Mr. Rolland uses pernambuco wood to make beautiful bows that are renowned for their playability. But he is also the inventor of a bow made of synthetic material that is marketed under the name of Spiccato. These bows are intended to satisfy the needs of players who are not able to afford bows by him and his contemporaries, let alone those of the 19th-century makers whose bows are now collectors' items.

A few minutes ago I was talking to Philip Injeian, who said, "You know, when people take up a bow, they do two things. First, they look at the head; then they look at the frog. But what about the stick that is in between?" I think that is what Mr. Rolland will be talking about: the stick in between.

Benoit Rolland: Have you ever tried to photograph a bow? I mean, a whole bow as it is being played, seen close enough to show technical features? The result is usually disappointing. A bow is perhaps one of the last attractive things on earth that does not photograph well. Catalogs and reference books are illustrated with frog head twin-sets, but imagine a book lining up chopped-sticks (Figure 1). Hard to identify, aren't they?

Experts have found few words to describe this go-between, the stick. They mention the color: chocolate-like or orange. They mention the general shape: round or octagonal. Its overall flexibility, possibly its elegance, or some knots.

It's like driving from New York to San Francisco: everybody pictures where you start and where you will arrive, but rarely what is in between. Here is the road: long stretches of flat land, a couple of mountains, valleys. . . . Though you intend just to go straight, you have to choose among different possible roads.

Let's look into the components of a stick that give a bow its character and playability (Figure 2). Everything in a bow, but the stick, hides a mechanical purpose under an ornamental feature. The playing part of a bow is the stick. The whole stick gives tension to the hair, not only the button mechanism. The hair is an essential part of the bow, and we must link the hair with the concept of the stick. The stick complements the arm muscles trained to play the violin, and some of the vibrations find their way in a continuity, from wood fibers to muscle fibers,

Acoustically, the stick is a generator and receiver of vibrations in this quartet: bow, body of the player, string, and body of the instrument. The vibrations circulate in all possible combinations rather than in a fixed, linear sequence.

When discussing the components of the stick, I like to stress that the player's—and also the maker's—training adds the dimension of perception to the otherwise strictly physical understanding of the stick.

In the August 2002 issue of the *Strad*, Anders Askenfelt summarizes where the scientific research in the matter of bows currently stands. Askenfelt is always precise when describing the settings and limits of the measurements taken, which is extremely valuable. My talk takes off from his observation that we will probably not progress in our knowledge about bows by taking more measurements, but rather by refining our modeling of them. He acknowledges that "the existence of ultimate bow dimensions seems to be an illusion," but hopes that we can

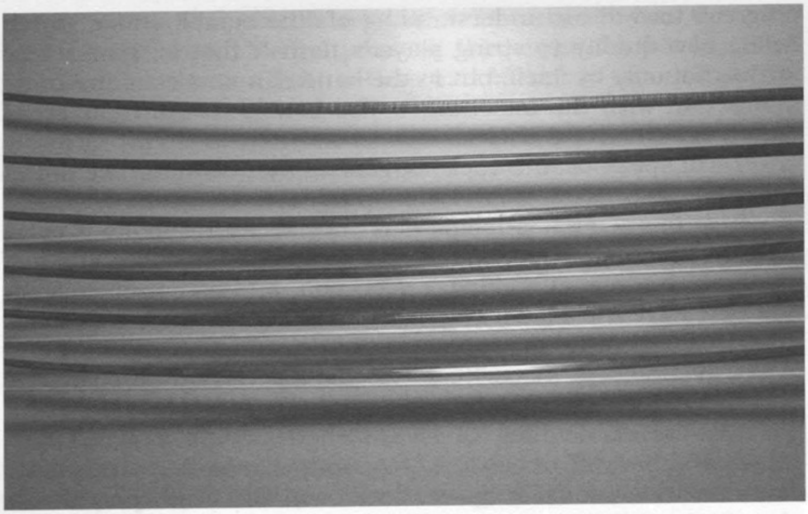


Figure 1

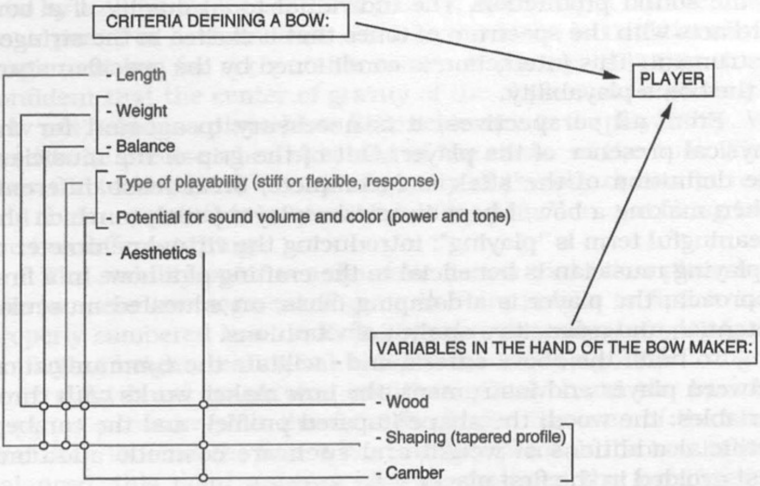


Figure 2

progress toward an understanding of "the combinations which define bow quality in string player's terms": that is, how a bow works, not only by itself, but in the hand of a musician and in its interaction with the instrument. The bow is to the violin what breath is to the vocal chords.

I will speak of "the stick" in general, not detailing the differences between violin, viola, cello, and double-bass sticks. We are investigating general principles as they apply throughout categories. The data I use come from observations in three areas of my work: traditional making, restoration, and carbon-fiber technology. I have tried to identify the relevant parameters in a functioning bow in order to properly transpose our traditional art into a new technology. In particular, I give special attention to the question of the camber, a burning question, as you know!

The criteria defining a bow are length, weight, balance, type of playability (stiff or flexible, responsive or not), potential for sound volume and color (power and tone), and aesthetics. Of the six criteria, two (length and weight) are tightly fixed within a few millimeters or grams. Balance is absolutely central but nobody means the same thing by "center." Playability has no fixed rules and is determined by choice; playability combined with aesthetics is the signature of the bow, and directly influences the profiling of the stick. Playability is the first step toward creating the quality of the sound production. The individual tonal quality of a bow interacts with the spectrum of tones that it excites in the stringed instrument. This interaction is conditioned by the specific nature of the bow's playability.

From all perspectives, it is necessary to account for the physical presence of the player. Out of the grip of the musician, the definition of the stick is incomplete, or at least different. When making a bow, I have in mind a playing stick in which the meaningful term is "playing": introducing the virtual parameter of a playing musician is beneficial to the crafting of a bow. In a first approach, the player is a damping mass, an educated muscular potential, and a sensitive analyst of vibrations.

To fulfill the above criteria and facilitate the communication between player and instrument, the bow maker works with three variables: the wood, the shape (tapered profile), and the camber. Artificial additions of weight and such are cosmetic additions best avoided in the first place.

This gives you a glimpse of the complex network of interactions that governs the making and ultimate personality of a bow. We shall now look into these criteria one by one.

Length, weight, and balance. The length of bows has been determined empirically. It is a perpendicular projection from the axis of the strings to the extremity of the stretched arm of the player, while the violin is resting on the shoulder or the cello between the knees. In that position, the longest usable length of hair is the only one that matters and therefore determines the length of the bow.

The first question one hears about a bow is, "How much does it weigh?" I indeed know more than one musician who is sensitive to differences of less than two grams. But putting a bow on a scale tells you nothing of relevance. All depends on the location of the gram. Balance matters more than weight, and we will return to this idea.

The weight of the bow as we know it (58 to 61 grams for a violin bow) was also empirically figured. Just as 0 degree Celsius is the point at which water turns into ice, our reference weight is the minimum weight needed, for a bow resting on the balance point, to activate the vibration of the string without applying muscular pressure. If the bow is too light, the string will not vibrate properly; if the bow is too heavy, it will be hard to articulate. In both cases the muscles of the musician will be needlessly tired. I did experiments with synthetic fibers that allow us to control the shape and weight. It seems that under 54 grams a string does not behave correctly.

Let's go back to this gram that a musician will tell you ruins his life (Figure 3). Often, violin makers check the balance of a bow by looking for its center of gravity, balancing it upside down on a pen. For a violin bow, 26.2 centimeters is traditionally a magic number for a reputable center of gravity. However, I am confident that the center of gravity of the object-bow (meaning: a bow not held by a player) has little relevance to its playability. We need to be precise when speaking of the center of the bow. What does the term mean? Center of gravity of the object-bow at rest, and "balance point" (what I call "stability point") in a working bow are two different things.

The stability point is a dynamic notion that takes place in a narrow, sensitive segment (Figure 4). Here is how to find it in a properly cambered bow: hold the bow horizontally in front of you at playing height, resting the head of the bow on your left finger, your right hand in playing position; gently bend the bow by applying pressure with the right forefinger: the area of the stick that then touches the hair is the stability point. If the bow is well balanced, this point appears half-way between the forefinger in good position on the stick and the head of the bow. You will immediately notice if the bow has some unevenness or defect in camber, as the stability point will appear off center.

Once we look at a bow in the hand of the musician, rotating around the axis of the wrist, it is clear that any weight added or removed between the thumb and the head modifies the playing balance and shall be noticeable in the head area. One gram at

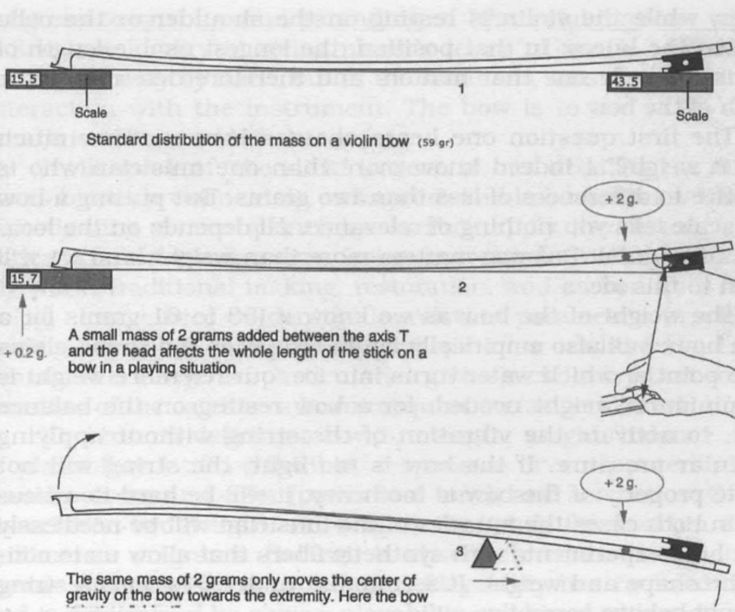
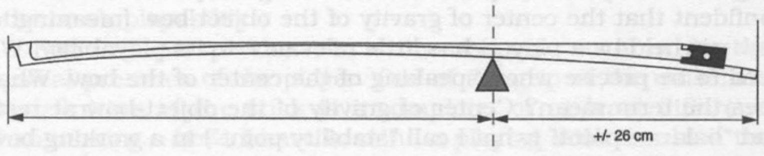
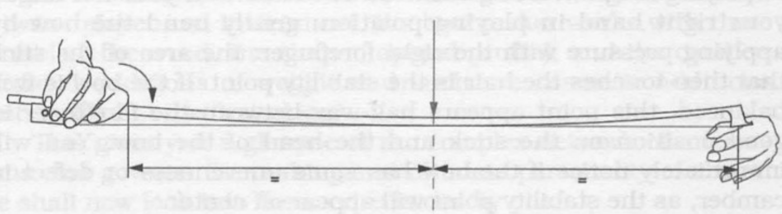


Figure 3



Center of gravity of an inoperative object "bow"



Stability point of the playing bow

Figure 4

the tip matters much. Not enough weight and the bow may be unstable; too much weight and it will require additional effort from the musician. A change in weight around the frog will again be felt in the governing of the head, even if changes in the frog area, where all the strength of the musician stands, are less sensitive.

The ideal point for *sautillé* is at the same place as the stability point. At this center of stability of the dynamic bow, the total mass of the bow rests in balance over the strings and, when held between two fingers, naturally bounces on the strings. The player feels no fatigue.

Yet, do not count on the *sautillé* to figure the stability point as several other factors interfere in the passionate relation of the musician with *spiccato* or *sautillé*. For one thing, the musician will instinctively look for a *sautillé* point at the place he or she used to practice it with a previous bow. Each bow has a different ideal *sautillé* related to its camber. Though *sautillé* only represents about 10% of bowing in the typical repertory, musicians see it as a priority. It is true that quick bowings are often a source of problems on stage, but it is also a sign that the bow is a tool of acrobatic performance and speed. Mechanically, musicians look for reliability (a stick that would not collapse or twist), speed, and easy articulation. Listening to sound quality comes second, after the sensation of comfort is met.

Nevertheless, it is difficult to pencil out stability points as a number of peripheral elements can modify them: musicians' grips vary from fractions of centimeters; textures of skin and sweat influence how one holds the bow; differences in weight and muscular power affect the grasp and therefore the balance. The ideal would be to customize the balance of a bow for a player.

Wood, profile, and aesthetics toward the character of the sound. The goal is set for comfortable playing, which is a prelude to the best sound production. When a musician tries a new stringed instrument at your shop, pay close attention to how comfortable he/she is with the bow. It can be easily noticed when a player first grasps a bow, shakes his/her wrist to check weight and balance: tension or relaxation immediately comes across his/her body in a glimpse. Every time comfort is experienced, we notice an optimization of the power and quality of the sound from the instrument. The sensation of muscular comfort naturally releases energy and awareness of the musician to minute details in sound production.

We now have to figure the shaping of the stick and how to maintain the pressure and vibration that arise between hair and strings. In essence, pernambuco and ebony are the best suited woods since they have a very low damping, which also allows a slow decay of the vibration. Once the entire stick is set in vibration, the frog plays a part. Different pernambuco woods have different responses, but roughly speaking we are in the best possible world. Though playing a bow contradicts this quality, the damping seriously increases as soon as a player holds a bow. This right away shows that we have to work with more parameters than just density and good wood.

The ideal sounding bow would have a virtual stick: no mass in itself and no joint mass from a player holding it, as any mass would slow down the vibration. Not to say, of course, that we resolved the need of a certain weight for starting the vibration and allowing sensations when playing. Ideally, once the vibration is generated by the hair-string interaction, it should circulate fast along the stick, to the arm of the player, and return to the body of the instrument at the same intensity. In theory, a carbon fiber bow should be a better bow as the vibration runs faster along the carbon fiber than along the wood fiber. The drawback is an acidity and brightness of the sonority due to a vibration hitting a hard material. I had to use other techniques to resolve this problem in my Spiccato bow. For lack of a virtual bow, the carbon fiber experience showed that, in the transmission, the development of the color of the sound was significant, besides the damping. Even though the stick is not an acoustical device by itself, it is a stimulator of vibrations in such a way that its own properties influence the production of sound.

The aptitude of a wood to convey vibrations seems to be linked to the organization of the cells and fibers and to the various components of the wood (cellulose, resin, and so forth) more than to its density. This vibration has an impact on the sound volume and color of the stringed instrument by stimulating different sections of its spectrum. We shall see later that the quality of the vibration in a bow is not a direct feature from the wood to the stringed instrument, but is one of the components, in addition to profile and camber. And once again, an exceptional wood does not, by itself, make an outstanding bow.

Likewise, the density of the wood does not necessarily means stiffness or softness of a bow. It simply allows more range for the work: a dense wood gives you a chance to make a thin bow without diminishing the weight, or on the contrary, to obtain heavier bows without increasing their section. Denser woods are particularly appreciated for making high-quality octagonal sticks (sculpting sharp edges, working slim but powerfully).

An octagonal bow often seems elegant and thinner than it actually is; the cut facets reduce the mass compared to a round stick of same section between edges (Figure 5). We reach, with bows, an area of great precision and perception. We already noticed the sensitivity of musicians to a difference of one or two

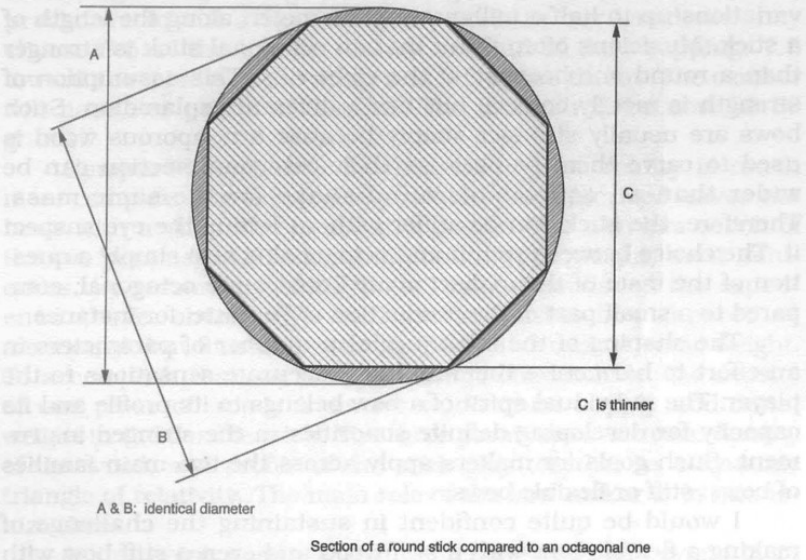


Figure 5

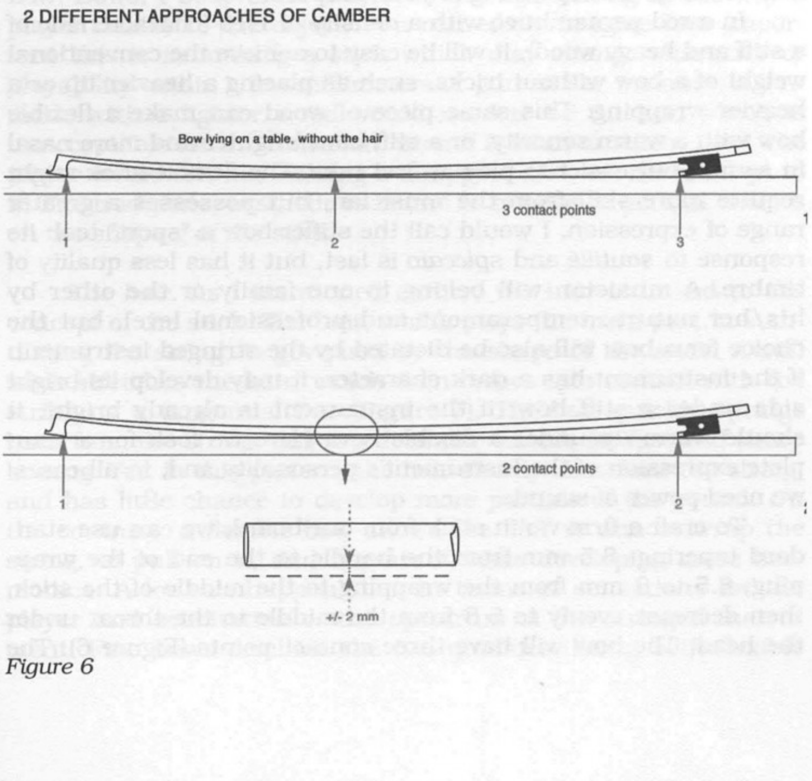


Figure 6

grams. As for the profile of a bow, the human eye is sensitive to variations up to half a millimeter in diameter, along the length of a stick. Musicians often think that an octagonal stick is stronger than a round one because of the eight ribs. This assumption of strength is mostly correct, but has a different explanation. Such bows are usually stronger simply because a nonporous wood is used to carve them or because their octagonal section can be wider than an equivalent round shape for the same mass. Therefore, the stick can be stiffer without letting the eye suspect it. The choice between round and octagonal is also simply a question of the taste of the maker: many Tourtes are octagonal, compared to a small part of the production of Peccatte, for instance.

The shaping of the stick juggles a number of parameters in an effort to harmonize them and give accurate sensations to the player. The individual spirit of a bow belongs to its profile and its capacity for developing definite sonorities in the stringed instrument. Such goals for makers apply across the two main families of bows: stiff or flexible bows.

I would be quite confident in sustaining the challenge of making a flexible bow with a stiff wood and even a stiff bow with a soft wood. This would not be my first choice, but a good organization of the fibers and grain of the wood, combined with an appropriate tapering of the stick, could overcome the initial character of the log of wood. The ideal, of course, remains to find the wood exactly corresponding to your purpose.

In a red pernambuco with a density of 1.10 (characteristic of a stiff and heavy wood), it will be easy to achieve the conventional weight of a bow without tricks, such as placing a heavier tip or a heavier wrapping. This same piece of wood can make a flexible bow with a warm sonority, or a stiff bow, brighter and more nasal in sound, but easier to play at first take. The flexible stick might require more skill from the musician, but possesses a greater range of expression. I would call the stiffer bow a "sport" tool: its response to *sautillé* and *spiccato* is fast, but it has less quality of timbre. A musician will belong to one family or the other by his/her natural temperament and professional level, but the choice for a bow will also be dictated by the stringed instrument: if the instrument has a dark character, it may develop its bright side under a stiff bow; if the instrument is already bright, it should warm up under a flexible bow. Here we look for a complete expression of the instrument's personality and, in all cases, we need power of sound.

To craft a firm violin stick from our board, we can use standard tapering: 8.5 mm from the handle to the end of the wrapping, 8.5 to 8 mm from the wrapping to the middle of the stick, then decrease evenly to 5.8 from the middle to the throat under the head. The bow will have three contact points (Figure 6). The total weight will average 61 or 62 grams. Using as a standard procedure to cut a flexible violin stick in our wood, we may choose 8.5 at the handle, 8.0 by the end of the wrapping, 7.5 toward the middle of the stick, and 5.5 at the throat. The camber will have two points of contact. The weight will be now 58-59 grams.

Compared to these conventional figures, reality is much more complex. The theoretical process I just described leaves two bows with a difference of about 3 grams. One wonders which of the two parameters, the tapered profile or the weight, most influences the personality of the bow. I have reproduced the experience above, obtaining a stiff and a flexible bow tapered as mentioned, but finishing with two bows of the exact same weight. To accomplish that, we need to change one variable: the density of one piece of wood. A denser wood must supply additional weight in the flexible stick. The three parameters of mass, density of the wood, and profile of the stick play together in a dynamic triangle of relativity. The main role of the bow maker is to harmonize them.

At this point, aesthetic requirements extend far beyond mere ornamentation. Tradition decided the overall aesthetics of a bow long ago. As for violins, functional necessities are optimized in a design pleasing to the eye. Musicians picture how a fine bow should look and have an inner image of the ultimate profile of a bow. Bows, I believe, have a lot to do with fencing in the way a player relates to the object. You can easily imagine how important this is in making a stick which may change character or playability within a few millimeters or grams! For instance, a bow made with a lighter wood would need to be thicker, which is unacceptable for the musician, even if it is an excellent bow! The player would feel like holding a lamppost and will never adapt to it! The traditional aesthetic is bound to impose structural choices on the shaping of the stick.

The hair. As I mentioned earlier, the hair is linked to the concept of the stick. The hair, which plays the main part in stimulating the string, is governed by the shape of the stick. A stiff stick stretches the hair, which then comes into contact with the string on a tangential line (Figure 7). The bow quickly springs back from the string: this is a desirable feature for fast and sharp bowing. Yet, in this pattern, the hair shortly abandons the string, and has little chance to develop more partials of the sound. On the contrary, a flexible bow allows the hair to almost wrap the string, to pull on it, and liberate it while developing more harmonics. A lot can happen then in terms of sensations for the player and solicitation of the spectrum of the stringed instrument. Fine bows combine the two qualities, being both flexible

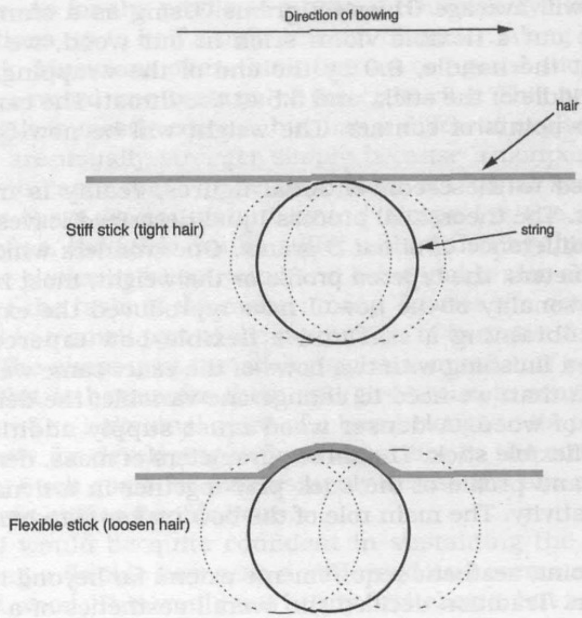


Figure 7

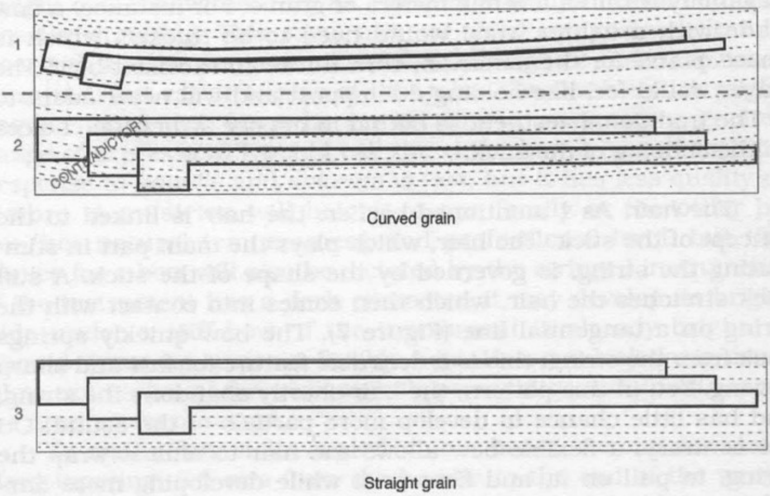


Figure 8

and responsive.

As we speak of the importance of the hair, I would like to share a few experiences. Horse hair is, up to now, irreplaceable. The elasticity of this material is perfectly adapted to the interaction between bow and strings; it comes back to its original shape after a stretch, while the breaking point is low enough to prevent excessive stretching; the porosity of the fiber retains perfectly the rosin, despite increasing the surface sticking to the string. Looking for a synthetic substitute for horse hair, I came across a number of patented inventions, none of which was suitable. I saw a bow haired with aluminum thread: its total lack of elasticity made the stick uncontrollable; a clever German patent proposed a spun synthetic thread, but it could not retain the rosin. I tried to combine Kevlar and nylon threads without any convincing results.

The camber. Once upon a time, the bow was not cambered. The Baroque bow was unstable as the hair stood too far from the stick. Tightening the hair by the mechanism of the screw increases the tension of the stick as well, but it also pulls it away from the hair. If the stick is well cambered, the bow gains three qualities: the convex shape of the stick increases the tension applied to the hair; the curve of the stick remains as close as possible to the hair; and the stick, from a pole, turns into a spring

Camber is a simple concept. The thinner the stick is, the more camber should be applied; camber increases along tapering in order to compensate for it. One reference: the axis of the stick should be perfectly parallel to the line of hair at maximum tension of the bow. There is no secret! It is, in theory, such an obvious part in a bow that the design of the camber is the first line drawn when creating a mould for synthetic bows. A nice curve on a computer screen!

It is fortunate that the concept is so clear as camber is one of the most significant elements for the quality of sound. It is something that I noticed on historic bows and could check systematically with my carbon fiber experiences. Applying three different cambers (light, moderate, and accentuated) to three identical sticks, identically tightening the hair (so it stands one centimeter under the stick) gave three different characters to the sound. The bow awakening the richest and warmest sound in the instrument is the least cambered. Yet, if the camber is too light, the bow becomes almost unplayable: it would work for triple strings but be too slow for *staccato*. On the opposite end, a bow excessively bent is unstable on the string, indeed, uncontrollable.

But camber almost never works! You know, there is a bad side about attractive ideas: apparently simple, yet so deceptive! First of all, a camber should be even. The need for homogeneity is contradictory to the fiber structure of the wood that is never perfectly even though homogeneous. Once again, the fiber structure of pernambuco is one of the most suitable to retain the memory of a camber. The homogeneity goal is also contradicted by our traditional way of bending a stick. In an ancestral gesture, the bow maker first heats up the wood over a flame or embers, and then forces its bending by pressing segment after segment on the corner of the bench: how better to create nice angles? It is one of the beauties of the craft, sublimating contradictions to polish a smooth curve that shall give its voice to a violin.

A number of different options are in use: in particular, cutting out of the wood board an already curved stick (Figure 8). Tourte and Peccatte cut many of their sticks according to the first type shown here. Voirin and Sartory favored the third type of cut. The third type wastes less wood. In this type of cut, the stick is entirely bent under the combined action of heat and mechanical pressure. In the first type, the fibers of the wood are already naturally bent and the thermal bending is limited to half a camber. The natural elasticity of the wood fiber supplies the flexibility. The second type of cut is not recommended as the cut contradicts the grain line. The first type gives more sensuality and smooth elasticity. The third type creates a more resilient bow.

Bending is a complicated art. The underlining idea is to imprint a memory of shape in the wood. It can be difficult to reverse the curvature of a wood overheated in the first place. A stick cut along already curved fibers shall not lose more than the complement of camber brought by thermal bending, if it ever loses camber in time. Here again choices are dictated largely by the personality of the maker, as no option is fully satisfying.

As the market for carbon fiber bows is booming, I should give a few practical tips about camber in synthetic bows. One motto: be careful with re-bending synthetic bows. They are not designed to be heated again once they are in shape, and there is a risk of breaking the links between fibers and resins. The resins can easily deteriorate. You might not see the damage, invisible to the eyes sometimes, but the bow has entered a crumbling process. The bow may also suddenly soften in your hands if you pass a certain point of heat, called T.G. point, which is different for each formulation. The loss of camber may happen randomly in certain synthetic bows after 10 or 20 years and is hard to repair. This is why I installed a camber mechanism inside the stick.

Over centuries, the cambers of bows suffered many modifications. Sticks were often bent again, in one or two spots or more, to try compensating for some discomfort or weakness in the response of the bow. Sometimes the bow partially lost its camber because of a weakness in the structure of wood itself.

Yet, those punctual re-bendings caused more problems than they solved. For one thing, they disturb the original evenness of the curve. Old bows are now like palimpsests, those Medieval manuscripts with many stories written on top of each other. It is one of my current endeavors to read and reinstall original cambers in valuable bows, analyzing all the parameters which define a playing stick and looking for the evidence that time left to us.

Even after this long talk, a lot remains to be said. A bow is a complex muscle of wood and everything in it relates to the sensibility of the musician, to his/her body, and perception of the stringed instrument. No wonder musicians so often have a passionate relation to bows! I once heard Isaac Stern demonstrating a Brahms concerto with his usual virtuosity. Everything was Brahms and Stern to perfection. The only peculiar feature was that he played a borrowed three quarter violin! Yes, but he kept his own bow!

Thank you for your attention. Are there any questions?

Joseph Regh: At the balance point on your diagram when you took your measurements, it seems that the hair is loose at that point with the frog in its most forward position?

Mr. Rolland: It is the bow in the playing position.

Mr. Regh: The hair is in contact with the stick on one of your diagrams. If you make the measurements with the bow actually in playing position, then the measurement of the balance point would be different.

Mr. Rolland: Yes, it would be a little different.

Mr. Regh: So which way do you measure?

Mr. Rolland: The bow with the tension of the hair.

Mr. Regh: Most makers I am familiar with make the octagonal stick first, and then they will take the corners off and make it round. In your diagram you have an octagonal stick cross section and put in a circumscribed circle. The actual way in which you should look at it would be in an inscribed circle because if you have an octagonal stick and you remove material, the largest diameter should be the inside of the octagon, not the outside. Is that correct?

Mr. Rolland: Absolutely. But just to compare the two sections, the section of the edge of the octagonal compared to the diameter of the round.

Mr. Regh: What if you draw the circle inside of the octagon?

Mr. Rolland: On the circle it is outside for the sake of comparison.

Mr. Regh: So you are not implying that there is more mass in a round stick than there is in an octagonal one. That is where I get confused.

Matt Weedling: You said Tourte and Peccatte used sticks that were cut out to follow the grain in a curved manner. What did you base that on and how can you tell? Do you feel that other makers of that period were doing that as well?

Mr. Rolland: I think Tourte and Peccatte were typical of most bow makers of this period. They cut their stick out of a board already bent, or half way. I call that half cambered. Going up toward the frog, it is more evident that the stick had been cut like this. I think since the beginning of the 19th century bow makers preferred the straight sticks. It is weird to see a Sartory cut like this, already bent.

Mr. Regh: If you cut a stick out of a board in which the fibers are curved, you would be able to make a stick that does not require additional camber, let's hypothesize. That means when the bow is finished, there are no internal stresses in the wood. When you take a straight stick and camber it in small sections, in each of the sections, once you heat the stick to a temperature where the lignin softens and you can bend the stick, stress is introduced. The inside of the curve will be under compression, the outside of the curve will be under tension. And it cannot relieve itself because when you come to the cold section, the lignin is hard. When the area cools down, you go to the next one and the next one. So when you camber a stick, you form segments of stressed wood. Is that a condition that has any impact on the quality and playability of the bow?

Mr. Rolland: Yes, I noted that with this type of cambering, the bow is more elastic.

Mr. Regh: Then you have a bow that is cut out of curved wood?

Mr. Rolland: Absolutely.

Mr. Regh: In my bow making, I heat the entire stick to a temperature at which the lignin is soft along the entire stick. Then I cool it down in a shaped form, and when it gets to room temperature, it maintains the camber. But the temperature of the stick gets so high that the lignin is soft, and all the fibers can laterally relieve all of their stressors. When I go to the very end of my stick, which is squared off before I put them in the oven, the button will not fit anymore because the fibers actually move. So I have to recut my nipple surface to fit my button.

Mr. Rolland: That is a very good process.

Mr. Regh: So that would be a process that would be equivalent to cutting a bent stick right out of a board?

Mr. Rolland: Probably.

Mr. Regh: Do you have any experience comparing one against the other?

Mr. Rolland: Some. I did an experiment in the past and I agree with you, it is very close to the already bent source stick.