Panel Discussion: Innovation in Bowmaking

YUNG CHIN, JOSEPH REGH, RODNEY MOHR, JOHN ANIANO, AND JOHN E. GRAEBNER

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Fan Tao, Moderator: We're going to resume our discussion of all the interesting questions that arose in the three preceding talks plus any other topics that arise. I think this session will probably be highly interactive. I have asked Yung Chin to lead the panel discussion.

Yung Chin: We've heard various things during the three lectures this morning; some were new. It became clear to me that there are different approaches to the subject. I come from a traditional way of making bows. I do things by trial and error, as you heard. I work with a lot of very well-known players, and that's how I've learned. I think that is the same with Rodney.

Then we have someone like Joe Regh, who has talked about the science involved in bowmaking. That's foreign to me, but we both are pursuing the same goal. It appears that the top bowmakers are starting to use the information generated by John, Norman, and Joe in their processes of making. I think we're seeing more consistent bows. Bowmakers have always been treated like second-class citizens, but now that there's this research with bows, hopefully we'll be able to progress.

First, you heard my brief historical account of the evolution of bow design. This was followed by John Aniano's discussion of how a bow works. Then John Graebner demonstrated how the theoretical camber–taper relationship has been verified experimentally. We're hearing a lot about camber, the curve of the bow. As illustrated in my lecture, bows made prior to the last part of the 18th century had a concave curvature, which was superceded by the modern bow with its convex curvature.

Does anyone have an alcohol lamp handy or can borrow one and bring to the table here? I want to make various camber adjustments. I hope I won't scorch or break the stick. After each adjustment I want Greg Ewer to play his violin with the bow and then ask both him and you if you can hear the difference.

Although John G. probably has not experienced much of this, all four bowmakers on this panel have experienced these differences in playability and sound production. I want all of you to hear and see this, and then we will start a discussion centered on camber. I had never seen John Aniano's presentation previously, but I do concur with a lot of what he has to say. Particularly for the stick, the choice of material is extremely important on high-end bows. There is no substitute for a high-grade piece of pernambuco. You can't make a great sounding bow out of a so-so piece of pernambuco. There are physical characteristics that one would like the stick to possess. I would ask Joe to begin our discussions about the wood itself, what to look for.

Joseph Regh: It is, of course, one of the most intriguing, complicated questions: how to select wood that will consistently make high-quality bows. I am coming from a different direction, looking at both violins and bows. I have been working in the sciences since I was 14 years old and I have a particular way of looking at something. My way of learning is to understand and form a model in my head, and then I will never forget. I do not learn individual facts and pieces of information, but I learn connections between things.

When I first started getting involved in bowmaking, I was intrigued by the methods that were used by bowmakers—not only those who were crafting individual bows, but also those who mass produce bows—the complex methodology they used to select their wood. I remember walking through a shop in Germany, a mass producer of fine bows, where they turned all the sticks to the same round diameter. Then they brought them up to a selection room, where a master bowmaker would spend up to two hours to characterize them, limited only by his becoming fatigued. He assessed

the quality of the sticks by flexing them and then sorting them into various bins. When it became time to make a bow, they would pull a stick out of the appropriate bin and fabricate the stick. Generally, the quality of the bow tracked with the selection of the wood.

So one of my first studies was to understand what quality of wood is important and then measure parameters. What I found is that the density of the wood and the stiffness of the wood, two of the interesting parameters for a bowmaker, actually tracked. There is a very tight relationship between them, which means that you can substitute one parameter for another. You use the one that is most easily measurable, and then you use the characteristics that are implied by the measurement for your actual bowmaking.

I published what I learned, and I think most every bowmaker in the world today uses the flotation method to quickly separate the floaters from the sinkers, with the sinkers being the ones that most bowmakers are interested in.

So my approach is to understand relationships, in this case between density and stiffness. Once you understand that, you can extrapolate to develop methods for doing things.

The other thing that interests me is evaluating the physical characteristics of finished bows in terms of their playability and appearance, and then removing those processes that are not necessary to be exercised by a master and have them done by machine tools. Some of you have read my book coauthored with Joseph Kun, who had a similar approach. We feel that if the work usually done by apprentices or helpers in the shop was done in a controllable manner by a machine, then only the final steps in the bowmaking process require the skills of a bowmaker. That is my approach to bowmaking. I have well-characterized wood; I know exactly where to go to make a high-quality bow at any given time.

There are particular items, and I guess Yung is about to demonstrate these, that I do differently. One is cambering the stick. The cambering of the bow generally is done in little sections over an alcohol flame or some other heat source. You bend one section and then let it cool down, then you go to the next, etc., continuing all the way across the stick until the stick has the curve that you want it to have. I had great difficulty doing that at first. I try not to burn sticks. I twisted them. I didn't heat them enough and I bent them—and they broke on me. I had a lot of failures and became frustrated and thought of quitting.

Now I form the shape of my stick in a mold that has the curvature that I have designed. I take that metal mold and put it into a huge oven. I monitor the temperature rise of the stick, and when it reaches a certain point that I know is correct, I pull everything out. I let it cool to room temperature and when the stick comes out of the mold it has precisely the shape that I engineered it to have. There is no flexing, there is no spring back. Temperature control is very, very important.

The major difference in the outcome due to my method, in contrast with what most bowmakers do, is that after the time in the oven the sticks are totally stress free. The temperature along the entire length of the bow is high enough that you get lateral shifts of fibers. Before I put a stick in the oven, I turn the nipple seed at the end of the stick. Since it's done in a lathe, the end is precisely square. Then when I insert the button, it fits precisely.

When the stick comes out of the oven, the nipple surface is no longer square, which means that the fibers have translated along the length of the stick where the outer fibers of the curve are now further back, and the inner fibers stick out more. Every nipple surface is consistently a different shape, telling me that the fibers have actually shifted along the entire length of the bow, and all the stresses are relieved.

In the case of a traditional camber, you heat a small section, and on the inside of the curve the fibers are compressed. On the outside of the curve, you have the fibers under tension. Then when you let the stick cool down, these stressors are frozen into the stick. You then go to the next section, you do exactly the same thing, and when the bow is finished, the inside surfaces will be under high compression and the outside surfaces will be under high tension.

Whether or not that has an impact on the playability of the bow, I haven't found out yet because it's a very complicated question. But I would predict that after 1,000 years, if you were to examine one of my bows and a bow cambered in the traditional way, you would find the traditional one straight again, and my bow will still be curved the same way that it was when it left my oven.

To summarize, I take a different approach to bowmaking. I apply science as much as I can, and I try to simplify the process to the degree that I get involved only with those steps that are important to the ultimate performance of the bow.

Mr. Chin: Regarding my original question, Joe, what are the physical properties that you look for in a raw piece of wood?

Mr. Regh: For a violin bow, that issue is most restrictive. I typically make violin bows with a specific gravity of ~1.05 to ~1.2, maybe 1.22. There is wood that has a higher specific gravity, but it does not have greater strength, greater stiffness. The reason why it has a higher density is because it is loaded with the coloring material, the purple dye, that one can extract from pernambuco. That will lend mass, it will increase the specific gravity, but it does not lend strength. I find that wood to be ideal for viola and cello bows, mostly cello bows. I've made some of my best bows from this wood that is intrinsically chocolate colored.

You cannot achieve the stiffness requirements by controlling the thickness and the mass of the bow at the same time. You can either get the right weight or you can get the right stiffness, but you cannot get both.

Mr. Chin: Rodney, what do you look for in wood?

Rodney Mohr: Part of what I look for is the pore structure in the wood. I try to see the length of the pores, their diameters, and how many there are. I also think about what style of bow I'm going to make. If I'm going to make something that is like a Sartory bow, I'm going to use wood that is like the wood that Sartory used.

For cello bows, as Joe said, you can use those denser woods. For bass bows it's quite interesting. Pernambuco sticks that are quite a bit lighter with density below 1.0 g/cm^3 can be used to make quite good bass bows. So if you've got a nice selection of wood, you can find a bow that will work with each different kind of wood that you have.

John Aniano: I've been working with a number of alternative woods. About half of my bows now are being made using wood other than pernambuco. I've found, as Yung has suggested and as Rodney alluded to, that the length of the pores is an indication of the strength. I think that the internal friction of a bow is related to the length of the pores. If you have very cross-grained wood, beautiful curly wood, it's not necessarily going to get you a high-end violin bow.

As Rodney suggested, I don't think you can make a very good violin bow with a pernambuco stick density much less than 1.0 g/cm^3. Maybe as low as 0.98 or 0.97 g/cm^3, but I don't think you can go much below that and have success. However, for cello bows and probably double bass bows, I think it's good.

Sue Lipkins has said that in making bass bows for her clientele she much prefers heavy, very dense wood. Maybe that's changed, but I know she has said that in the past.

Mr. Tao: Can you comment on the consequences? You each have said that you choose this or that, but you have not elaborated on the negative consequences of choosing the opposite of what's optimal.

Mr. Aniano: If you choose a piece of wood that doesn't have a large enough Young's modulus or density that is too great, in order to get that narrow region of ultimate strength for a violin bow, along with ultimate weight and ultimate balance, you can plane away and you simply won't get the desired strength, you won't get the proper balance. There's just nothing that will work properly.

Keep in mind, too, that violins can also have very tight parameters, such as how far the back length can deviate from 14 inches. The size of violas, on the other hand, has a huge range, from 15 to 18 inches.

Audience Member: Who cares?

Mr. Aniano: Violists care. There are very dark sounding violas and very bright sounding bows, the full range. I think that you can choose alternative wood materials, and pernambuco of vastly different types, and get away with that as a bowmaker. Unfortunately, there are not as many violists as violinists in an orchestra, so you have a limited clientele. You have to think about what you're trying to make. You want to make a very bright sounding stick for a bright sounding violin. You might want bright or dark for viola, cello, and double basses.

Mr. Tao: John, when you showed one of your slides in your talk about the importance of material selection and the hierarchy of camber, taper, squareness, and material, you said the material affects predominantly the sound and not the playability. When you choose the wood for a typical project, are you actually choosing for the sound? Are you thinking in those terms, or are you looking at the material in terms of the particular camber and design that you're building?

Mr. Aniano: I think that you would generally look at the piece of wood and ask, "Is this wood going to be a bright sounding wood, or is it a dark sounding wood?" Then I'd consider the density of the wood. If it is too dense, then I couldn't possibly make a violin bow out of it. So if I think it will be bright sounding wood and it's more dense than I'd like to have for a violin, unless I want to make a really bright sounding viola bow, I might make a cello bow out of that wood.

Mr. Chin: John just alluded to bright sound and dark sound. There is such a thing, but there are also parameters for this. I find that, in addition to camber, even with making modern bows, there are certain parameters that bows have to have, and if you go outside those parameters, they won't work.

Head height, for example, is crucial. If you have a great piece of wood and you alter it, say, by two-tenths, you will get a very different sounding bow. Height of the frog, also. Robert Seletsky has written a fascinating article concerning the features of early bows. It includes a discussion of the length of the bow in different periods, which is important. But one thing he does not consider much is the height of the head. I also alluded to something about the radius behind the head, which definitely has an effect on how the bow plays.

Mr. Tao: Can you elaborate on that effect now? You teased us with it.

Mr. Chin: That is something that's been around for quite some time. We're talking about this radius right here. As you saw on John's slides, he had a Dominique Peccatte bow. He stretched the head one way and then stretched it another way and then asked about what that does for the sound. A bow will produce a certain kind of sound, and then you can change it a little bit. I will demonstrate this when I recamber some things, and I will move the stick left to right also.

Consider the bows of Étienne Pajeot, a very stylish maker who used a lot of different models. He is one of my favorite makers. If you take the models that most people like, made in 1830 to the 1840s, the radius is larger here. What does that do for playability? It gives you a certain kind of stiffness. And if we took the same bow and we had a sharper radius here, you would get a bow that would speak a little faster. You would hear that the width of the spiccato stroke would be slightly narrower. You would hear a cleaner articulation.

The X factor in all of this, of course, is the player. I think that bowmakers and instrument makers should take more time to understand playing, how one holds the bow, for instance. I'm going to talk about the bow, not the fiddle. I just had a conversation with Joe Curtin and he mentioned somebody who is a wonderful player. If you have the ability to work with very good players, even if you have to go out of your way, you should do it. You will get tremendous feedback from these players, much more than from a player of a so-so level. I am not criticizing one who can't play as well. But if you want to know what is the best, then you do have to try to deal with the best players. They can give you a big education.

Now let's consider the Voirin model. Voirin worked for Vuillaume for 15 years. I think he started in 1855 and left in 1870. For me, Voirin made his best playing bows when he worked for Vuillaume, and those were not the model that everybody now associates with Voirin, which is his later beautiful feminine model.

Those models, the early ones, show the influence of a Simon-type head, and they're shorter and more powerful. Later on Voirin's model has a smaller, more feminine head with a stronger inner radius and more camber, especially behind the head. What did that do for playing? Greg will demonstrate that in a moment. It gives you a bow that speaks quicker. You get a crisper articulation. But did it really help legato playing, meaning on the string playing? I'm not certain. I have never heard a great sounding bow that has a strong camber right behind the head.

And what does "great" mean? Number one: power of sound. Also, being able to do a lot of different kinds of bow strokes, which music is about. Music is about variation of color. It's not just one thing. It's not just about power.

Now, I want Greg to play something simple. Then I'm going to recamber the bow. We're going to keep talking while the bow cools down, and then we'll come back. Greg will play the bow again, and I'm going to ask you to listen for certain things.

So let's go with this first bow, this is the so-called Cramer bow. You will again play some Bach. On first and then off. First time when you draw, I want you to play on. I want you to also go for power. [Violinist plays] Now, play off the string. [Violinist plays]

We'll do this bow first. We've heard a little bit about materials. We've heard a different kind of approach. I've heard Joe talking about his

way of making bows for close to 20 years, and I still haven't learned it, but I've always felt there's something here that I can learn. And the question is how we can learn from each other and take this information and put it together.

Mr. Aniano: I want to muddy the waters rather dramatically on material selection. I've had two instances where I've had players bring me bows, one by Nicolas Maire made out of amourette, which is unfigured snakewood, with nickel-silver trimmings on the frog and adjuster. I rehaired the bow and noticed that it was incredibly weak, I could barely do a decent rehair on it. You could just barely get the hair evened up. When the player came back, I asked him how does this bow play. And he said, "This is the best bow ever made in the world." He was a teacher at one of the conservatories. He played on a Peter Guarneri violin, and I asked him to play it and show me what he could do, and he could do anything he wanted to with this bow. It's made of a piece of wood that I never would have selected for making a bow. I never would have made a bow that weak. So it shows you that there are people who can do amazing things with some of the bows that you would never make.

Now, there was another bow, supposedly by Simon, which was made out of a piece of wood that looked like Swiss cheese. There were more pores than there was wood. The owner actually wanted to make a copy of this bow, and I was so intimidated by it that I declined to do it.

So there are two examples of anomalous bows made of two completely different kinds of wood with which a famous maker was able to make a decent bow, and certainly there were players that liked them.

I have a comment about the Lucchi Meter. We've been using the Lucchi Meter for only the past 25 years. Previously, bowmakers didn't have that measurement tool available to them to help grade their wood. One of my good friends who is a bowmaker said, "Before I got my Lucchi Meter and started checking all my wood, I had a thousand sticks to make bows out of, and now I only have 200." And he said he couldn't make a good bow out of anything that was under 5.2. I asked him if I could buy every single stick he had that measured 5.2.

So it's easy to restrict yourself to wood with which you can make great bows, but you can make really good bows out of some of the other woods, too.

Joshua Henry: Yung, you said you've never heard a great sounding bow that had lots of camber behind the head. Can you expand that statement a little further to include the height of the head? I want to know if those factors are related.

Mr. Chin: The Tourte brothers were considered, and probably correctly, to be the ones who really standardized "the modern bow," heights of the head, material, use of the ferrule, etc. They worked with the greatest players of the day who came to Paris. As legend goes, Tourte worked with Viotti, which I think is quite possible. However, I think they also worked with other musicians in Paris.

Let's not forget the German bowmakers as well as the English. Musicians and bowmakers did travel around, so it was possible for bowmakers to see what was going on.

To come back now, so we have a Tourte bow with a kind of a square head and certain measurements. Of course, in the beginning, the camber was a little bit straighter here on the ends, a little bit more at that period. And then there was a transition to the round model roughly in the period of 1860–1870 and then moving over to the Voirin model, which is mostly this rounded model.

The height of the head, what does it do for the sound? Let's take a maker that most people know, Eugène Sartory, certainly one of the most important makers of the 20th century. He started making bows on his own in 1892 and continued until he passed away, roughly right after the Second World War. However, I have never "heard" a great Sartory bow. I don't want to sound like I'm criticizing, but why do I say that? I'm comparing them to the great bows that I know, including a number of great Tourte bows. John G. talked about the Nicolaus Kittel bow, which may be one of the greatest sounding bows. If you have a lower head, such as seen on a Voirin bow with a lot of camber, it doesn't seem to pull a big sound. Voirin's bows can produce a very pretty sound, they can articulate extremely well, but I guarantee you they won't fill up the big hall, not like the great bows by Tourte and Peccatte and some other bows with slightly higher head heights. Of course, there's the aspect of the frog also.

There are many factors involved, as John alluded to, and it's not an illusion. The player, the instrument, and the bow—when you have a good marriage of these three things, you've got a point

there. It's very complicated. John, Joe, and Norman and John have conducted experiments to characterize bows. I maintain from the outset that you cannot separate these three things to try to understand how a person uses a bow. We can do a certain kind of analysis. You saw the machine that Norman designed for measuring bows, and I think it's wonderful.

If we go into the music hall, we might take a very good late Sartory bow, the best Voirin bow, and the best Tourte bow. With an equally fine player, a player who can use all of these things, I'm quite certain that the Tourte bow will sound better.

If the head is low it is possible to get a certain kind of power this way, vertically. Everybody knows about vertical playing. But you can achieve the same kind of power with a bow with a slightly higher head if you move the bow perhaps using the speed element in the stroke. That's what I've seen being over 25 years working with string musicians. If they can afford them, there's a reason why these great players use these old bows.

I think the level of making today is quite high. Some of the bows produced by the best of the modern bowmakers, made with what I consider ideal wood, will become equally as good as some of the great old bows. I am absolutely positive of this, even though I may not be around to see it.

Mr. Curtin: As bowmakers, when you see a particular violin that you like, love, or dislike, do you get ideas about what sort of bow would set it off best?

Mr. Chin: Let's just say we have a dark sounding violin. Let's leave the player out of it right now, because the player is the uneven thing in this. Then we take an aspect of what kind of wood is going to complement that sound. Do we want to have a dark sounding violin, do you want to make a bow that produces a dark sound with it, or do you want to complement that with something that pulls and makes the violin sound a bit brighter? It is possible for the bow to bring out higher overtones along with a certain body to the sound.

I think most of us try to look at the wood stock and consider what's going to work with a particular violin.

Mr. Regh: I don't want to pour ice water on many of the ideas you heard today, but on the general approach to understanding a bow or an instrument, I work from the other end. A violin is an amplifier, and it amplifies non-uniformly. It has its own pattern imprinted on the output after it is stimulated by a bow, which is stimulated by a player. The instrument will only amplify the signal that is inputted into the instrument. And how does the signal get into the instrument? It gets into the instrument by a bunch of bow hair that is traveling back and forth across a string.

So I go back to the origin, where it's all happening. The conclusion that I have come to so far is that I don't understand how it works, and I've never met anybody who does. If you go back to fundamental principles, we really don't know how a bow works. We do have some very specific ideas, and the work that I'm involved with is trying to understand how that interface works. There are a few models that I have explored, and I find some strong correlations with only one parameter. I know all the testing and all the bending and all the measuring that is done by every bowmaker alive. I do the same measurements, and many more, and I tabulate all that data on every bow that I own and every bow that I have ever made. I put that all in the computer. Then I have a violinist play one of my bows and ask, how do you like this? The player will make a comment, and then I try to get goodness or rejection correlated with this huge database that I have. I calculate correlation coefficients that tell me whether the correlation is significant or insignificant.

Well, 99 out of 100 times, it is insignificant. I make a bow; I give it to a player, and the player can't praise it enough. Perhaps he doesn't want to spring the money, but he does like it. Then I give that same bow to another player, and he hates it. He would never consider buying it. Now, when I make bows, I don't make bad bows. I only make good bows. I start with the finest materials. I use the limits of my craftsmanship. So from my intention in making the bow, I intend to only make good bows. On the user end, there is a totally different reaction.

So after having looked at many bows and having had players play them and try to correlate the player's reaction to the physical data that I have taken, I come to the conclusion that most of the things that we consider important are either unimportant or we don't understand how they are important.

There is one parameter that I have found has the highest correlation coefficient when I ask players to try a bow, and that is the tension of the hair in the finished bow. That is the tension of the hair at the point where the player feels comfortable,

and the variation the bow allows in hair tension from bottoming the hair to the stick. There is a range of tension that the bow is capable of producing. That is a static phenomenon. When you hear violinists play with a bow that has a weak spot somewhere, there is a real physical explanation as to what happens there.

Mr. Chin: I would like Greg to play on this bow to which I have added more camber now that it has cooled down. This bow was made of ironwood, Swartzia, and it took a long time to heat up and heat down. (If this doesn't work, I'll do it on the pernambuco.) So, Greg, could you play the same thing? [Violinist plays] When you drew the stick just now, does it feel more solid toward the tip?

Greg Ewer: It does feel much more stable.

Mr. Chin: When you make your bow changes, particularly at the head, is it a little bit quicker on the change? [Violinist plays]

Mr. Ewer: Yes, it's a little quicker.

Mr. Chin: Now, play with spiccato bowing. [Violinist plays] Is the spiccato stroke itself not as wide?

Mr. Regh: You're leading the witness.

Mr. Ewer: All things considered, the bow is actually easier to play. I didn't do this kind of a stroke the first time. What I feel is slightly more and easier articulation with more stability.

Mr. Tao: Would you say the bow is more efficient?

Mr. Ewer: Yes. I was worried about my skills earlier.

Mr. Chin: Who made the violin you're using, may I ask?

Mr. Ewer: This violin was made by Charles Ervin, a friend in Taos, New Mexico.

Mr. Chin: Was this difference pretty clear to hear to everyone? If it wasn't, I want to know also, because that's always interesting.

Now I'm going to do this with a pernambuco bow, because I don't need to take as much time to heat it up. So please play something now on the string again for us. [Violinist plays] Now tighten the bow adjuster a couple of turns and play it again. [Violinist plays]

Does everybody hear the difference? It's a different quality. Something Joe was alluding to about the hair tension, which I've never heard before. There is something to this. It has a very big impact.

Now, please play something by Mendelssohn. [Violinist plays] Now play a spiccato passage. [Violinist plays] Now, I'll make a change to the bow. Joe, continue your discussion, and when this cools down, we'll return to this.

Mr. Regh: We were talking about the significance of hair tension. After many approaches and many attempts to find correlations, I got frustrated. I figured the only way to do this research project is to have many players play a fixed set of bows and rank them.

So I made 15 bows, attempting to make each an outstanding bow. I numbered them and measured and documented all the properties I could think of. Then I presented these 15 bows to good players. I asked them to first adjust the bows to their preferred tension. Then try each bow and make fine adjustments until finally they are satisfied with the tension of the hair. I then measure that hair tension in each bow. When all 15 bows are set up to the liking of the player, I then ask them to play on any instrument, as long as it's the same instrument, and rank the bows from 1 through 15.

I then take that preference, that ranking, and correlate it against all my scientific data and my physical measurements, looking for correlation factors for the preference of that player. When that player thinks a particular bow is the best of the lot, what characteristics does it have that correlate with that choice? Of course, you cannot draw conclusions from one single player, so I try to get as many players as I can. I think today I have engaged about 14 players. Each time I get feedback, I get a ranking. I do the individual player correlation, and then I add that player's ranking to all the other rankings and I get an average ranking, and I do another correlation.

I have not been able to get a strong correlation with the ranking of any specific parameter except bow hair tension. Interestingly, what I do find is that the data characterize the player equally as well as it characterizes the bow. If I give a player the same bow to play, every player will use a slightly different tension, depending on their preference and playing style.

Out of the 15 bows tested, there were four

bows that everybody liked, and there were four bows everybody disliked. For a player that may not be very comfortable except for telling you which bow you ought to buy. But from a scientist's perspective, it is an ideal playpen. It is perfect because there are two populations that have proven to be different in their performance, and I can now do more detailed studies and find out why.

So, my work is primarily centered on understanding how the bow works. If you think hair tension is important, you need to consider what hair tension implies. If you tighten the hair between two points, you've got a fixed number, but when played you don't have a static condition. You have a dynamic performance. You have a bow where the hair and the stick are constantly in motion and the hair tension constantly changes at a very high frequency.

Mr. Chin: So that you can hear this, adjust the tension to be as you prefer it and play the Mendelssohn again, please. [Violinist plays] Now play the spiccato passage. [Violinist plays] That appeared to be easier for you. Previously, the bow was coming back at you.

Mr. Ewer: Yes. The spiccato was a lot easier, but the legato was actually a little less predictable. There was one bow change toward the tip that it didn't re-engage when I went up-bow, and a couple times I thought I was about to get a little bit of a whistle.

Mr. Chin: So that means I'm fired. When such a situation occurs, I spend more time working on this. This is a lot of fun, and I think we should try to continue this.

Alexandr Hendruk: I have made bows for quite a while, and I would like to relate to some ideas Rodney mentioned. I gave up after an experience similar to this, presenting a bow made with pernambuco, very foamy looking, a clunky stick, but harmonically done, tapered, everything fine, and found it to be a great sounding stick with good articulation. So after a few experiences like that, I start thinking differently. I gave up the idea about a perfect bow working for everybody in a perfect way, and started thinking about the whole thing as a system, violin, bow, and player. I don't know if anybody else has considered the same idea or would support building the logic of getting these three things together in an optimum way.

Usually, musicians buy their instrument and then they look for a bow. Usually, they are willing to sacrifice playability if necessary to obtain the sound they desire from their violin. That's a common approach. However, my advice is to first find a bow that works perfectly for the hand without much work.

Mr. Chin: I'd like that. We'd sell more bows. However, when someone is going to spend a lot of money on a violin, like $200-$300,000, they usually buy the fiddle first. But you bring an interesting idea.

This morning we've have been considering a number of different facets. I hope that we continue this and use this session today as a model. With more time, we could bring more ideas to the table. I think that we should do this again.

Mr. Tao: It looks like we will do it again, because there are many more interesting things to explore. At the VSA/Oberlin Acoustics Workshop we started with the instrument, the violin, but in recent years we realized, as the panel has stated, that it's really a musical system. We shouldn't study the violin in isolation. The player is, of course, paramount, but also the violin and bow. And as a string designer, it is obvious to me that the qualities of the strings also need to be included. We really have to study the musical system, player-instruments-strings-accessories, as a whole.