Initial Voicing

I do initial wood testing to tell me which tops and backs are good enough to take through the "initial voicing" process. The initial wood tests are done without changing the raw condition of the sets as they come from the supplier. I want to be able to send them back if they don't measure up well enough to be useable. I've returned master grade top sets that looked beautiful, but just didn't have the acoustic potential to make really good instruments.

Testing rough wood that hasn't been surfaced, and varies in thickness, width, and length, means that there are small errors in the stiffness and density numbers, and larger errors in the Q test numbers. Consequently I use those numbers as a rough guide, and make final selections after initial voicing.

I do my initial voicing in three steps:

~ Joining up.

~ Rough cutting to shape, and routing to the finished shape of my larger plan on a vacuum chuck pattern.

~ Thinning on a drill-press with John Gilbert's sanding disc until the lowest resonance (the monopole) on my "voicing form" comes down to the frequency I want.

I'm currently taking my tops down to a monopole frequency of 75 Hz. If I'm looking to make instruments that are finally voiced somewhat higher, I'll stop at 80 Hz. For that "deep bass" sound, I go on down to 70 Hz.

At this point all the sound boards and backs are sized to the same plan, and surfaced to the same finish, so the errors in measurement that occurred in testing the raw sets are eliminated.

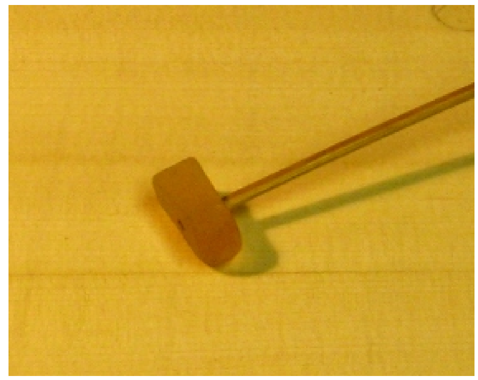
Now I weigh them, and run a response curve with the magnetic driver and Spectra Plus, to get accurate average Q numbers, "total power" numbers, and to see where their higher resonances have occurred.

Notice that I'm not paying much attention to their final thickness. When someone asks how thick I make my sound boards, I say 70 to 80 Hz (;->)...

The most dramatic differences occur in the weights of the initially voiced sound boards. In the batch of 17 in the photo, the weights went from 105 grams to 139 grams, a 32% difference. The European spruce tops went from 109 grams to 139 grams, and average Q's went from 49 to 70, a 43% difference.

What makes these variations more remarkable is that these tops were pre-selected for their very good test scores as raw wood.

My voicing form approximates gluing the top to sides.

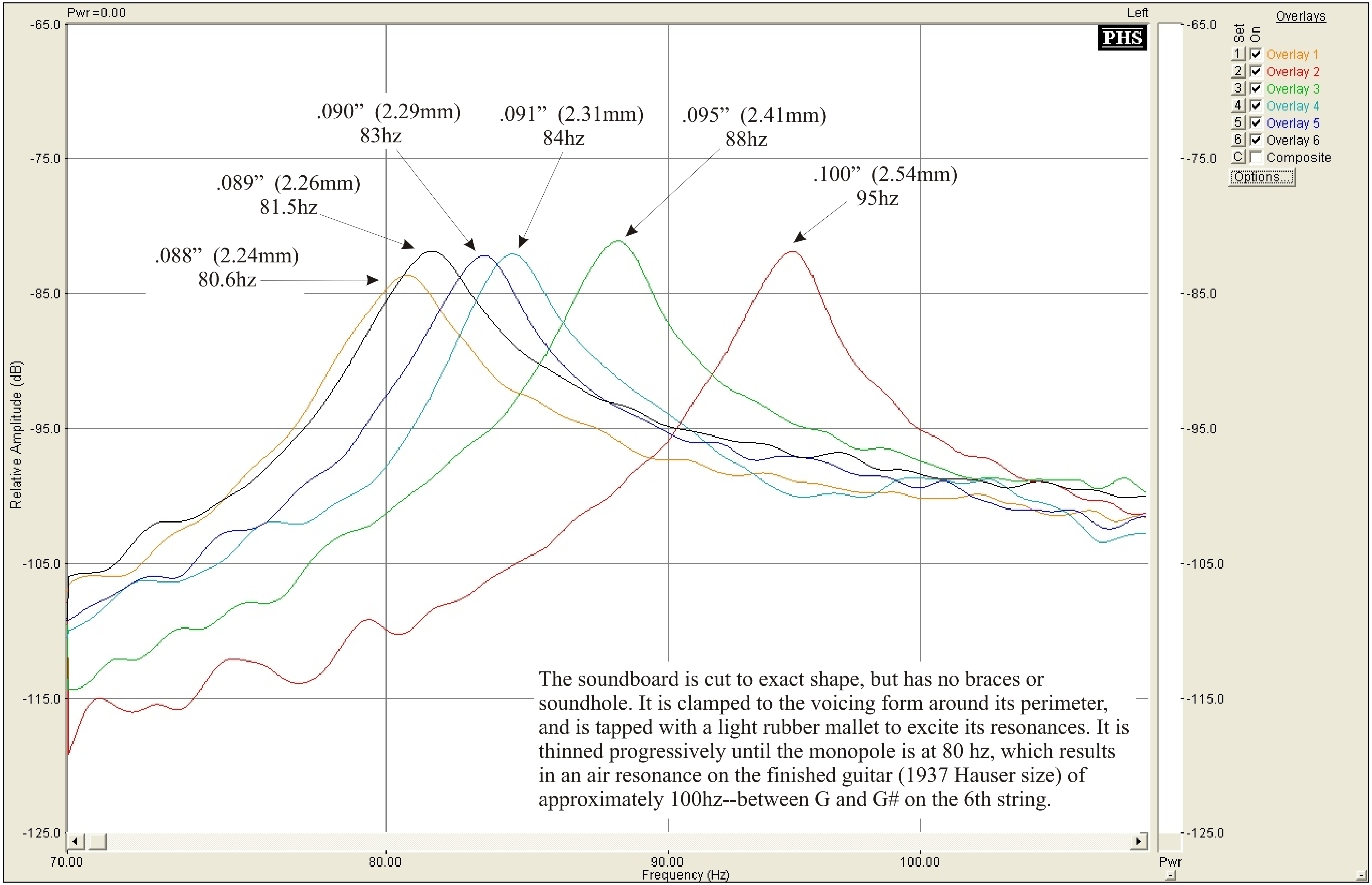


This little rubber "sledge hammer" is made from a "Super Ball", which saws and drills surprisingly easily. Its low mass, and super resilience, make for minimum contact time with the top. Bamboo skewer a for handle.

16 tops thinned to a 75 Hz monopole, with one cedar top taken down to 70 Hz for a "larger" classic.

The 6 sound boards chosen for the current batch– 2 western red cedar, 1 redwood, 3 Euro-spruce

Initial voicing of a Euro-Spruce soundboard using Spectra Plus



The soundboard is cut to exact shape, but has no braces or soundhole. It is clamped to the voicing form around its perimeter, and is tapped with a light rubber mallet to excite its resonances. It is thinned progressively until the monopole is at 80 hz, which results in an air resonance on the finished guitar (1937 Hauser size) of approximately 100hz--between G and G# on the 6th string.

Response Curve Setup

When the monopole of the top or back (a.k.a. plate) checks out by tapping, I run a "response curve" for a more accurate picture of all of its resonances.

Note! Any old PC, any old amplifier, and any old microphone can be used. Only basic equipment is needed to run Spectra Plus, and give us useful data.

A small rare earth magnet is stuck to the plate with double sided tape at the "semi-sweet" spot. That's a location that excites all the main resonances about equally. A coil, from a relay, is located directly over the magnet, and is connected to an amplifier. This effectively turns the plate into a loudspeaker. I drive the iron core out of the coil to improve its high frequency response.

The Spectra Plus program contains a signal generator that generates a sine wave (pure tone) audio signal that can be set to sweep over any given audio range, at whatever speed you choose. I most often set it to cover 65 Hz to 1320 Hz in 2 minutes.

The computer audio output goes to the amplifier, which boosts the signal enough to drive the plate to quite audible levels. As the sweep signal passes through the plate's various resonances, there is a marked increase in the sound level that you hear.

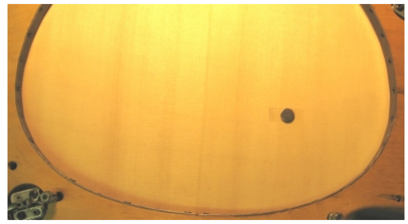
The microphone picks up the sound output from the plate, and sends it to the computer's audio input. The computer displays a graph of the volume along the vertical axis, and the frequency along the horizontal axis. **The result is an acoustical "fingerprint" of that plate.**

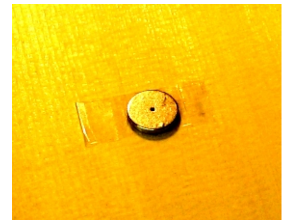
The resonances displayed on the graph correspond exactly to the patterns that the poppy seeds make when checking to see which vibrational mode is producing a resonance.

Once you have run a response curve, Spectra Plus can tell you the exact frequency, volume level, and Q of each resonance. It also calculates the "total power" output of the plate.

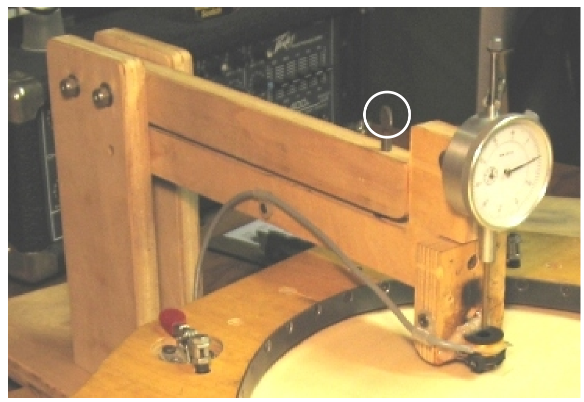
I save each response curve as a .wav file, and can call it up at any time, and replay it. Spectra Plus allows you to display up to six response curves, in different colors, at the same time. Differences in the acoustic qualities of different tops, backs, and partially finished and completed instruments can all be compared.

My final voicing procedure I do by taping the back on the almost finished instrument, and tracking the effects of changes in bracing heights and other adjustments. The back can be taken off as many times as necessary.





I use this type of double sided tape for a number of things, as it is very thin, and easier to remove than double sided carpet tape. Note that the end is folded over for easier removal.



The arm that holds the coil also holds a dial indicator for checking the coil to magnet spacing, which is critical for accuracy of the sound level values. There is a thumbscrew adjustment--in the white circle--for adjustment. Coil and magnet separation is .100".

Plunger down for measurement

Plunger up for clearance--note alligator clip holder

The microphone hangs at 18 inches above the center of the lower bout. This is not a critical distance. The main thing is to keep all your settings the same when you decide what works, so that subsequent tests can be compared to older ones.

"I get by with a little help from my friends..."

Thanks to:

Brian Peterson--Microphone

Tom Culbertson--Amplifier

Don Bradley--
Signal generator

The top of the voicing form has a piece of surgical tubing inlaid into it's perimeter that is inflated to 40 psi. This puts the same pressure around the plate, regardless of its thickness.

I'm working on a simpler version that just uses two pieces of plywood with cork lining. I'll be checking it closely for repeatability--stay tuned (;->)...

Ok, so what does all this mucking about with numbers tell us? It tells us in considerable detail the physical and acoustic characteristics of the wood that goes into a particular instrument. When one turns out especially to my liking, I can come really close to duplicating it by choosing a top and back that have similar profiles, and doing the final voicing of the resonances the same.

Having this much information about the tops and backs that I have in stock also makes it possible for me to choose what seem likely possibilities for a particular sound.

In the current batch of 6 instruments there is a wide variety. I have long wanted to duplicate the sound of an old style cypress flamenco with short sustain, so I'm making two "ultra-lights". Two lightweight Euro-spruce tops--each at 115 grams--will go on them, with a rosewood bridge at 18 grams on one, and a Spanish cedar bridge at 11 grams on the other. With the control I have for matching up the other materials that go into these guitars, I should be able to tell how the different bridges affect their tone qualities.

For contrast, I'm making my "standard" cypress flamenco with a 130 gram Euro-spruce top, a rosewood bridge, slightly thicker sides, a heavier neck, and a heavier back. All three flamencos will have their main resonances adjusted to the same frequencies during the final "taped-on-back" voicing process, so it should be possible to tell the effects of light and heavier weight construction.

The two 65cm scale, cedar topped classics should be quite different guitars. Both with Indian rosewood backs, they will be a "standard" size (1937 Hauser), and my "larger" more modern sized model. The standard size will get a very light 105 gram sound board, with average Q's of 57. The larger model will have a 113 gram top with average Q's of 67.

I'm expecting the standard model to be rather brighter, and with shorter sustain than the larger model. Also, the larger model will be finally voiced to have it's air resonance a full step lower than the standard model at 90 Hz---between F and F# on the 6th string. It will have rather "deeper" bass than the standard size.

The 6th guitar is a flamenco "negra" with old Brazilian rosewood back and sides, and a redwood soundboard. It should be very bright indeed since the rosewood and redwood are both very high Q, well up into the high treble region. Sustain should be rather long, appropriate for this type of instrument, as this redwood is rather dense. It comes out of the initial voicing process at 130 grams, with average Q's of 67.

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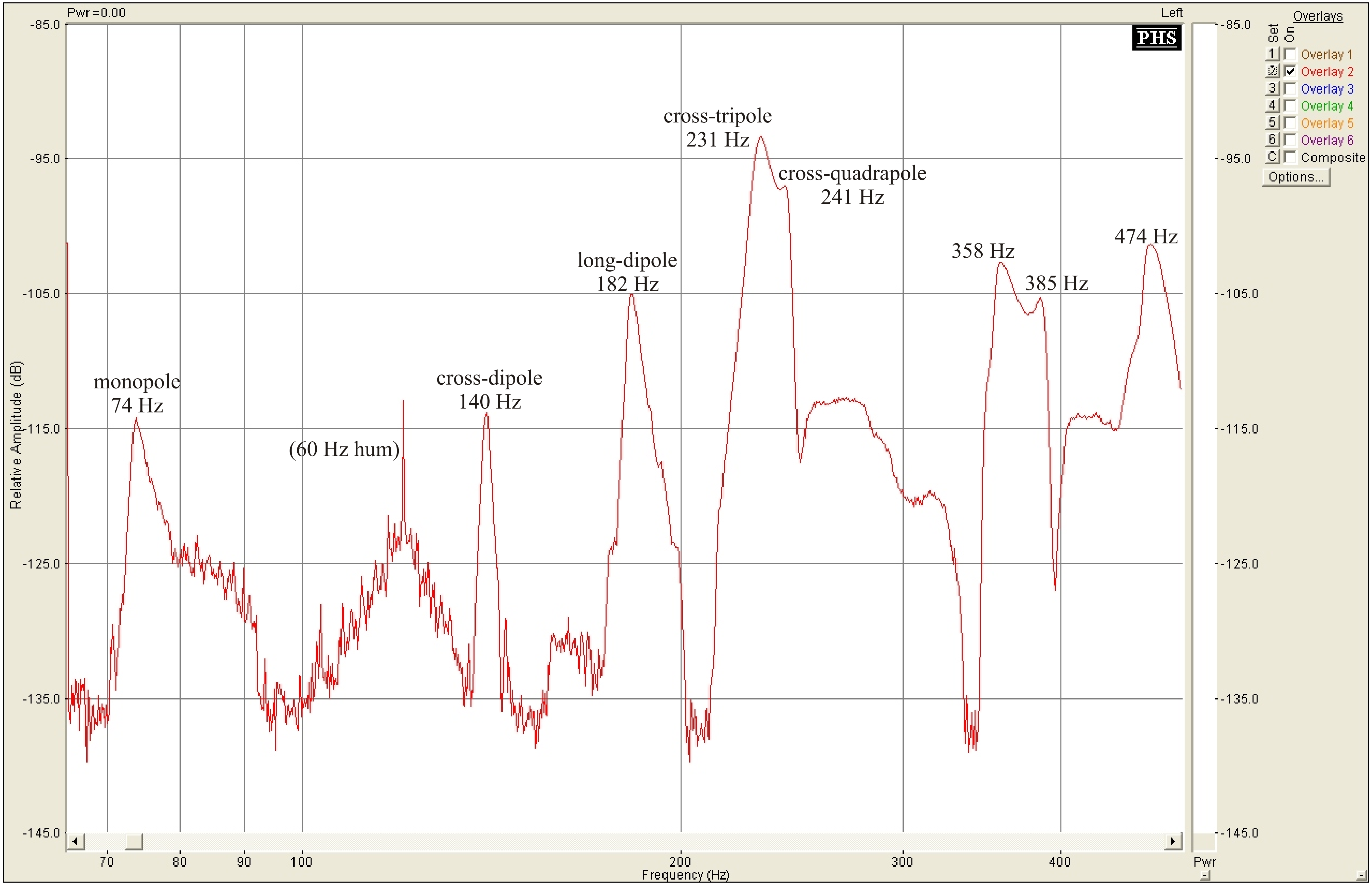

Response curve for Euro spruce sound board #938 mounted on voicing form, and driven with magnetic driver by Spectra Plus. The first five resonances are identified. Note that the lowest one (monopole) is at 74 Hz. This top will be used on a guitar with an air resonance voiced to 95 Hz.

In the end, what the player says is all that matters.