Q: Acoustic seasoning (breaking in) new stringed instruments (Dennis Braun)

Many new instruments sound very "NEW" when first played but sound and play "better" after a few hours, weeks, &/or years of playing. It is widely believed that if the instrument is played extensively and with good intonation, it not only will improve in tone and playability, but take on the character of the original player. (Myth?) Historically, there is consensus that the instrument needs playing to open the tone and improve the playing character. But, what changes take place in the instrument which affect these changes. Is it vibration only? Is it vibration at specific musical notes and forces? Would simple vibration at any frequency have a similar effect or a detrimental effect. What does temperature and humidity cycling have to do with these acoustic effects. And perhaps the most difficult thing to answer is, does the instrument really take on the tonal and playing character of the original musician? I have some thoughts on these matters but no facts. There must be both extra and intra cellular changes in the wood structure. There may also be subtle changes in the glue joints of the instruments. What of the settling in and closer fit of the bridge, sound post, strings in the groves? Are their changes in the bonding of the varnish with the wood? What effect does the additional playing and vibrating stresses have on the shape of the wooden parts, the arching, the rib curvature? There are so many questions and so few real answers which can be supported with scientific fact findings. Hopefully, you will have more than a few thoughts on this subject.

All the best, Dennis Braun

A: (Knut Guettler)

Hi Dennis!
I have not personally been involved in this kind of research; to my knowledge the best documented report on this effect is the CASJ article from 1998 by Carleen Hutchins: "A measurable effect on long-term playing on violin family instruments" C. M. Hutchins, CASJ Vol. 3 No. 5 (Series II), May 1998, pp 38-40. Hutchins confirms here the assumption that breaking in has a major effect on the instrument's radiation and response, but she does not go in details about what the exact cause is, in terms of the parameters you are referring to in your question.

To make it easier for you to get hold of this report, I have added a page to my site: "Library", where I occasionally will provide copies of the literature relevant to my answers in this forum. Please go there and get Hutchins' text.

Knut

C: (Knut Guettler)

I was just notified about a somewhat more recent report on breaking-in effects: Ra Inta, John Smith and Joe Wolfe, "Measurements of the effect on violins of ageing and playing" Acoustics Australia, Vol. 33 April (2005) No. 1 - 25.

http://www.phys.unsw.edu.au/jw/reprints/IntaViolin.pdf

Both qualitatively and quantitatively these two reports show quite different results. I shall refrain from involving myself in a discussion on which is the more reliable, but one thing I find a bit surprising was the lack of reference in any of the papers to controlled humidity, a prerequisite, I should believe, for making fair comparisons.

C: (Dennis Braun)

Thank you Knut:

After reading the article, I do remember it from years ago. In fact, Carleen was helpful and in favor of the first model Bridge Vibrator I designed in 1990. Now that I am in semi retirement, there is more time to get back to the fun things in life, like violin acoustics!! HA!

A new BV has been designed several years ago and is now being tweaked for better performance and aesthetics. Having vibrated instruments for many years, it is clear that something is happening, but what specifically? Could the vibration regime be improved?

Too many questions, and not enough answers, but I do like the idea of having the lower air modes increasing in dB while at the same time, decreasing the delta between the A1 & B1 modes to ease response, etc. So something is happening which makes the body more flexible but the air resonances seem to stay the same but become more powerful. Interesting.

Attached is an image of the original BV and the newer design BV for cello. (There is also a new design for violin/viola) They can be connected to any audio source of your choosing. 10 watts RMS 8 ohms. I personally like full orchestra piano concerto or simple old fashion rock music. Something with a little percussive effect seems to really wake up the instrument.

I'm thinking of starting a study using several new violins vibrated with pure simple saw tooth notes beginning at the fundamental note of the instrument, then progressively going up the scale to the high harmonics of the instrument. This will be done on several instruments for 2 weeks. The next batch of instruments will have only a simple vibration device humm on the bridge. It would be interesting to measure the difference between these two vibration methods. My intuition is that the instruments will improve more when vibrated with all the notes. This would confirm Carleen's paper results.

Thanks again for providing the paper and your wonderful website.

All the best,
Dennis Braun
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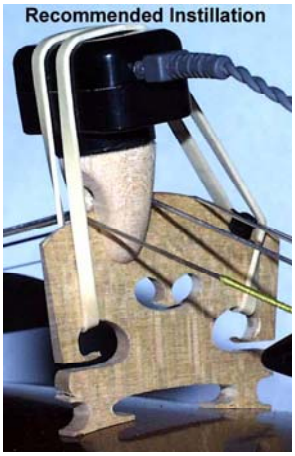

Original BV

New BV for cello.

Q: (Dennis Braun)

What are your thoughts about the type of acoustic signal would be best to open up new instruments? From over a decade of experience, something with percussive effect and lower frequencies help kick start the instrument quickly, often in as little as 2 to 3 days. But I am very interested in opening up the mid to high ranges of the instrument. Thoughts? Single notes, chords? Double-stop chords which would make the instrument pulsate?

All the best,
Dennis

A: (Knut Guettler)

I really don't know what kind of signal to use for break-in excitation. Your guess would be more qualified than mine, I presume... Maybe I would have tried white or pink noise, to excite all modes and frequencies simultaneously. I don't really believe in beautiful music to be played in order to have the violin understand what we expect from it...

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The following remark was written more than one month after my initial reply:

Giving it a second thought—as far as giving the instrument a "good massage" is concerned, I would suggest *white noise in pulses*, for the following reasons:

- **White noise** will excite all modes of the instrument simultaneously. One will thus save considerable time by using noise rather than sine sweeps, chords, or any other combination. As long as the instrument behaves fairly linearly, an activated mode should not be disturbing any of the others. They can all coexist. Reports (as well as my own experiments) have shown that (this kind of) non-linearity is rather low in string instruments, so in this connection I presume the issue of non-linearity can be neglected.
- **Pulses** imply that you also will be exciting *transients*, during which the wood will take other shapes than during the "standing-wave" type present in mode resonances (e.g., producing fewer nodes). "A different kind of massage" if you like. By exciting the instrument with white noise in pulses, one should get the optimal combination.

I see from your figure of the "Original BV" above, that the driver is placed between the G and D strings. I don't know if this position is a conscious or random choice from your side, but I really believe that it is the best one, as long as the excitation is vertical. For high frequencies, the sound post primarily acts like a fairly stable pivoting point, so you will find most of the motion at the bass-side leg of the bridge, which, in spite of the bass bar below, will be more mobile.

Without taking a standpoint to whether acoustical seasoning gives an effect or not, I provide a couple of .WAV files meant to be utilized for breaking-in excitation. It might be worthwhile giving them a try. The file "BREAKINSIGNAL (Caution).WAV", *which is <u>not</u> the file you should try first*(!), consists of MLS (Maximum Length Sequences) pulse sequences, each lasting 370 milliseconds followed by 130 ms of silence. The reason I write "Caution" in the file name, is that it has a bandwidth up to 22 kilohertz, which might be a little too much for some transducers. If using this file, special care should be taken not to overheat the transducer. In the second file, "BREAKINSIGNAL 30Hz-10kHz.WAV" the bandwidth is limited to ten kilohertz, which should be plenty for the task in questions. Outside the bandwidth, the spectrum is rolling off –12 dB per octave. Although the chance for overheating the

transducer is significantly reduced with this band-limited signal, one should in any case check the temperature by touching the electric driver during action.

Both files are available through the link “MLS files” at the “Discussions” page, and can be easily downloaded. They are zipped in a file with the name “MLS files.zip”, which can be downloaded as a bundle through right clicking.

The reason I include the first file, is that it provides the raw MLS over 16383 samples (i.e., 370 ms with sample rate 44100 Hz), followed by 5667 samples of silence (i.e., 130 ms), during which interval the instrument should have time to get quiet. (Notice: the room, in which the breaking in takes place, should preferably be relatively dead for this to happen.) This on-off sequence is then repeated twice per second. With this first file, which is merely a prototype, you have the possibility to adjust bandwidth, spectral profile, etc. to your preference, provided you have an adequate audio-editor program.

The advantage of utilizing MLS over other generators of “white noise” is that MLS gives uniform amplitudes also in the time domain, thus keeping the maximum-energy level as function of time somewhat restricted.

If you choose to use the MLS excitation files, please share your experiences with us!

Best regards!
Knut

Q: (Dennis Braun)

Good Morning Knut:

Thanks for the additional information. This intuitively makes sense. The MLS files have been down loaded and will be tried.

Now what remains to be done on my part is to set up an acoustics measurement rig which can reliably obtain accurate data. A good computer is available with a multiplexing sound card, a good measurement microphone, and Spectra Plus (Audacity, Stoppani software, & also Cool Edit) are available for signal analysis. Still left undone is the making of the instrument holder, bridge hammer mechanism, and impact hammer ($1,200!!!!)

I like your idea of using the white noise in pulses to excite the transients and get the body moving at the same time.

Attached is an image of the current setup to vibrate the instruments in the "acoustic spa" (actually a Riboni quad violin case. A Styrofoam "fish" cold shipping box will be obtained which seems large enough to modify into a proper acoustic spa which will be more sound proof. Additional ideas for the acoustic spa are to include live temperature and humidity measurements sent to an outside display, and possibly an automatic ventilation system in case the temperature raises above 32 C a small computer style fan will bring in fresh room air and remove excess heat. It may also be possible to include direct temperature sensors onto the acoustic transducers with alarms if the temp gets to high. In the winter time when the inside humidity levels begin to drop, an auto humidification system is also being studied for the acoustic spa to keep the moisture levels in the 40 to 50% range. Right now the humidity levels are in the high 70s to very low 80% range (Living right on the Med ocean has it perks and drawbacks). ?

Everything being studied and designed in the Bridge Vibrator and Acoustic Spa is with the premise to first "**do no harm**". Secondarily, the goal is to effectively acoustically season the instruments past their initial new "green" stage beyond what might be expected with additional curing of the varnish and arching shape changes caused by string pressure in the first months. How effective the project will be remains to be determined. If it is possible to season the instruments past their "green" childhood, then how far could or should the instruments be vibrated until they are acoustically stable?

To answer your question regarding the position of the original BV between the G & D strings on the violin bridge, this mounting position was chosen by deductive reasoning and experiments. As you stated, the greatest amount of physical movement is vertical in the bass bar region so the BV was placed in this area to maximize the energy output to this area. Careful measurements were made of the dB output at the A0 frequency of the particular violin using a frequency generator used in plate tuning and a Radio Shack dB meter. It was found that with the same amount of power input into the BV, the greatest dBs were measured when the BV was placed close to the BB side of the bridge.

Make Today Wonderful & A Blessing,

Dennis Braun

A: (Knut Guettler)

I can see that you are really serious about testing changes in violin response. You mention a good measurement microphone as part of the wanted equipment. If you don't already have one, I would rather buy a lightweight accelerometer (0.5 gram or less) before buying the microphone. You should look for high-quality accelerometers (PCB or Bruel & Kjær) with charge amplifiers, which occasionally can be found at eBay for a reasonable amount of money. Ebay even sells impact hammers. A microphone recording would very much be colored by the room, and is thus more difficult to administrate. The instrument itself is also extremely directive, which adds to the problem.

Concerning your audio-editing program, of the ones you mention I am most familiar with the Cool Edit, which is an excellent program for the kind of editing you will need. Particularly if you have the version Cool Edit Pro ver. 2.x, which provides scientific filters such as Butterworth and Chebychev. Of those, I most often use Butterworth, because it is ripple free in the transition band. Unfortunately, these scientific filters have been omitted in the "Audition" by Adobe, which is a follower up of the Cool Edit series.

Notice: regardless of which filter routine you use, split the filtering in two halves—one forward and one backward (reverse the signal before filtering the second time, and reverse it back after this filtering is completed). This ensures correct phase information.

You shall also be needing a program for performing “deconvolution”, preferably “Wiener deconvolution” in order to calculate the bridge impulse response correctly from the accelerometer and force hammer signal. I know of several programs of this kind, but am unaware of how much they cost. I shall be looking into it.

All the best,

Knut

P.S. One important aspect when making before- and after measurements, is humidity. A friend of mine, Anders Buen (acoustician and violin maker) has done some experiments to measure the effect of varying humidity on resonances, both in terms of frequency shift and amplitude. I am happy to be able to present some of his findings as an article under “Unpublished”. As you can see, humidity can cause quite noticeable differences. It is clearly a shortcoming in the two papers referred to earlier in my answers, that they do not mention this aspect at all. Controlled moisture conditions must be a prerequisite in future pre- and post comparisons.

Knut