Dear Fellow Luthier,

I was checking the stats on our website to look at the activity since I posted our first newsletter, and I was astonished at the number of downloads of our November 1958 journal: literally thousands. Was this bot activity? If so, why November 1958? I read the issue to see what could have caused flurry of interest, given that these are not searchable texts.

I have no answer, but an article that caught my eye was a letter from well-known early violin physicist, F. A. Saunders, who discusses his and Carleen Hutchins' approach to plate gradation, which is pretty much what I described in the last Newsletter; they were the pioneers of this technique. (See my review of Hutchins' biography in this issue).

Reading some other ancient issues (I can't remember which one), I saw a discussion of whether one can *raise* a tap tone by removing material. This would be nice to do; usually thinning plates is a one-way trip to lower tap frequencies, and possibly the garbage can. I set about a simple experiment to understand the problem...

Chris Waltham - President, VMABC.

The BC Sound Post

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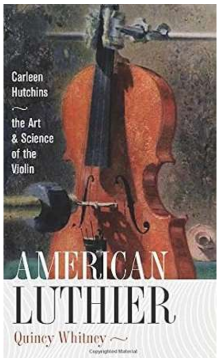


American Luthier: Carleen Hutchins – the Art and Science of the Violin

Quincy Whitney

ForeEdge (2016)

312 pp.

ISBN 978-1611685923

I wrote this review 10 years ago, but it ties in with what I was saying earlier. Unfortunately, the book is only available on amazon.com, not amazon.ca.

I came to the musical acoustics of string instruments late in my career and missed meeting Carleen Hutchins, but as I got to know the field it became clear that for most of the second half of the twentieth century, she was the dominant force in Violin Acoustics.

Hutchins' life was, by any measure, remarkable. A Cornell-educated biology teacher and amateur violist with an outdoors background of Girls Scouts, she took up lutherie to occupy herself while expecting her first child, training herself in the school woodshop. She carved the scroll of her first attempt, a viola, in the maternity ward. Later, juggling motherhood and lutherie, she would cook for her two young children an egg each for breakfast with a three-hole poacher and use the third hole to warm her glue pot; anyone who has used animal glue will gasp at the thought. In hospital, while being treated for breast cancer, Hutchins met Dr. Virginia Apgar (of APGAR test fame), also a violist, and struck up a life-long friendship. The pair of them pulled off the now-famous heist of a piece of curly maple shelving in a hospital telephone booth that Hutchins fancied for a viola back. The shelf was replaced at dead of night with an equally attractive but acoustically useless piece of maple that Hutchins had fashioned for the purpose with a dovetail saw on a toilet seat in the adjoining ladies room. Such was Hutchins' no-nonsense, get-on-with-it manner.

It was when Hutchins met retired Harvard physicist Frederick Saunders in 1949 that she set forth on her life's work. Saunders had been experimenting on (whole) violins, and Hutchins suggested that to make any progress you had to work with the individual plates, and that *she* could make the plates. In the absence of a useful mathematical model of the violin soundbox (an absence that persists to this day, although fluid-structure coupled finite element analysis is coming close) the only way to make progress was to build hundreds of instruments with variations in a dozen or so geometrical parameters. Needless to say, this was a Herculean task. Over the next five decades, Hutchins built over 300 instruments, mostly by herself, and concurrently taught herself the physics. Her most famous products were several "Violin Octets" each consisting of eight newly-designed instruments capable of maintaining a violin-like tone with string tuning covering five octaves, while overcoming many of the centuries-old vibroacoustic issues with the traditional viola and ‘cello. This she achieved by careful scaling of the three most important air-body modes of the classical Cremonese violin.

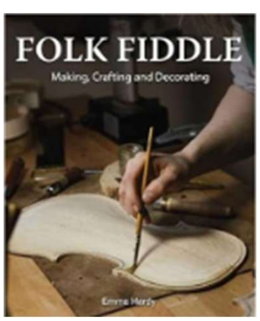
Apgar and Saunders were just two of many distinguished people who bonded with Hutchins. She plainly had an ease with the accomplished, and after a while, she no longer had to seek them out – they beat a path to her door (literally, as she operated out of her own house): luthiers, physicists and musicians (like Yo-Yo Ma and Leopold Stokowski, to give two world-renowned examples).

All of this enormous effort and accompanying heartbreak and triumph is captured in great detail by Quincy Whitney, who interviewed dozens of people in the USA and various European countries while researching the book. The story is interspersed with vignettes on historical topics that set the scene for Hutchins’ acoustics work. Whitney also peers into the obscurantist world of luthiers and violin dealers - upon which Hutchins did so much to shine the light of day - and the still-vexed issue of the relative quality of old violins and modern products of science-guided construction, which can differ in cost by two orders of magnitude.

I have some quibbles - mostly points that should have been caught by an editor. Firstly, although the book is intended for a non-expert audience, occasionally words and phrases pop up out of nowhere unexplained, like “Helmholtz mode” or “JASA” (the Journal of the Acoustical Society of America). On the other hand, some of the physics explanations would confuse a lay person, e.g. “the rush of air exiting through the f-holes [amounts to a] 10 mph wind”; *I* know what Whitney means, but a person expecting to place a hand over a violin f-hole and feel a draft would be disappointed.

Since her death, Hutchins’ fame seems to have faded somewhat, at least in part because of the failure of the conservative musical community to embrace her new instruments; this was always going to be a tough sell. Thus, *American Luthier* is a timely work, and I recommend it to anyone interested, however casually, in musical acoustics, or in Hutchins’ extraordinary life.

Book Review



Folk Fiddle: Making, Crafting and Decorating

Emma Hardy

The Crowood Press (2026)

144 pp.

ISBN 978-0719846724

This book is billed as an illustrated guide for makers of “standard” violins who fancy stepping outside their comfort zone and going a little wild on decoration in the tradition of folk instruments, while preserving the sound quality of their usual handiwork. The author is a luthier, based in Sheffield (UK), who has years of experience designing and building violins with different body shapes, carving scrolls with animal head and other design variations on the Cremona standard, and applying artwork and calligraphy to the violin bodies.

There is a strong environmental thread running through Hardy's work, which draws inspiration from nature, history and traditional craft. Being sceptical of the unquestioned primacy of spruce and maple in the Cremona standard, she has experimented with alternative woods, both for acoustic and visual appeal. This I like, having myself made instruments out of even more off-the-beaten-track woods like paulownia and balsa, although definitely for acoustic rather than visual/aesthetic reasons.

The book doesn't assume much prior knowledge of lutherie, but a beginner would need a more standard text to start from absolute scratch. There are plenty of details here that even a more experienced practitioner would benefit from being reminded of. I particularly like Hardy's attention to grain direction, with clear diagrams, in all three directions (particularly for the neck); sometimes this information is hard to dig out of other texts.

Going beyond standard violins, there are details, diagrams and excellent photographs of fancy scrolls, f-holes, decoration, inlay, veneer, and the ebony dust method of inscribing calligraphy (and gold leaf!).

There are tables of measurements for both standard violins, and also 5-string instruments, which are less easy to come by. There are also chapters on pochettes, resonant fiddles, varnish and setup.

The author delves into mechanical properties like moduli of elasticity and sound speed. However, one important aspect of acoustic wood is not dealt with, and that is its anisotropy; wood behaves differently in all three directions (longitudinal, radial and transverse). Wood is an orthotropic material; it takes nine quantities fully to characterize its elasticity. Spruce especially is highly anisotropic; the speed of sound in spruce along the length of a violin is over three times the speed across its width, a fact which has important implications for the shape of the instrument. I feel this is an important factor to consider when selecting of alternative woods. Chapter 5 of the USDA's venerable Wood Handbook is an excellent source of data.

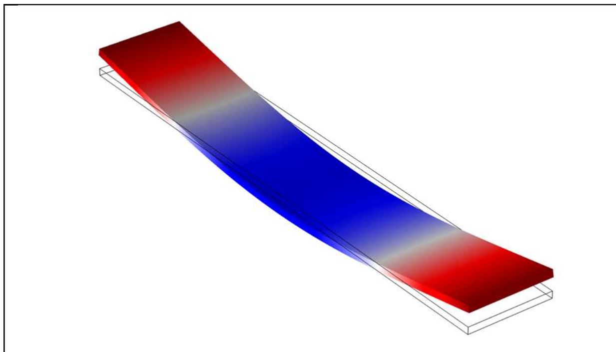
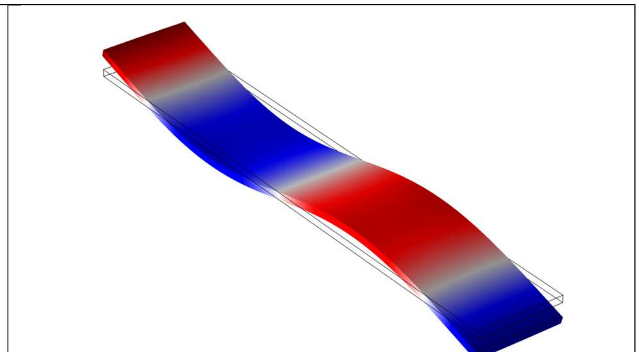
On the other hand, lutherie is not an exact science. Trial and error has worked well for many centuries.

In summary, the book is a compact, well written survey of many possibilities for going beyond the Cremona standard. It is an interesting and worthwhile read. Even for conservative luthiers (look over the fence, guys!).

Article: Can you raise the tap tone of a plate by thinning it?

Violin plates have so many defining parameters I did not know where to start, so being a recovering physicist, I attempted to answer a simpler question: can one raise the vibration frequency of a simple bar by thinning it in some way?

Let's start with a uniform freely vibrating bar, which is a well-known example taught in university acoustics courses.

	
Lowest vibration mode, frequency f1.	Second lowest vibration mode, frequency f2.

To see the animated gifs, go to: https://www.acs.psu.edu/drussell/Demos/Flexural-Bar/flexural.html

Why do these bars (and plates) vibrate when tapped?

Vibration is always about some kind of mass (inertia), and some kind of spring (the "restoring force", that tries to regain equilibrium after a disturbance). Reducing the first or increasing the second increases the vibration frequency and vice versa.

The greatest springiness of the bar is where the curvature is the greatest for a given mode of vibration. (Actually, it is the *curvature of the* curvature – a "fourth order differential" - that supplies the stiffness, but in this instance, it amounts to the same thing). The relevant mass is the part that is moving the most, which is usually at the edge for a lightly held bar or plate.

Imagine these bars are cross-sectional strips across a violin plate being tapped. The white parts are the nodes, where there is no motion. The deepest coloured parts are antinodes, where the motion is maximal.

The experiment

I made four identical-ish wooden bars (of fir, 20 x 2 x 1.2 cm, 29 g) and measured the vibration frequencies by holding lightly at a node and tapping an antinode (as one would with a violin plate). All four examples had essentially the same masses and frequencies. The ratio f2/f1 was about 2.5, close to the textbook value for a perfectly uniform bar of $5^2/3^2 = 2.78$.

Thinning the bars

I thinned the bars in stages in four different ways, keeping track of the mass (see fig. 1):

A: uniformly

B: ends progressively chamfered

C: applied a drum sander at the centre

D: applied a drum sander at the nodes of f1.

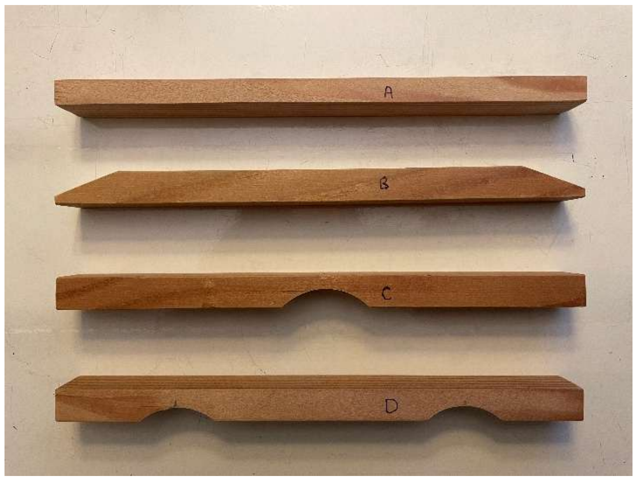


Fig. 1: Bars after final thinning. The grain is parallel to the plane of the paper.

Results

The results of changing the shape of the bar by removing material (and thereby reducing the mass) are shown in Fig. 2. In each case, I started at 29 g. I thinned the A bar (red lines) uniformly to about 23 g, and the tap frequencies dropped considerably. Then I chamfered the edge off the B bar (blue lines) in three stages to less than 27 g, and in each case, the tap frequencies rose by up to about 15%. I then took a drum sander to the C bar (orange lines) and took progressively larger bites out of the centre. The tap frequencies dropped, especially f1. For bar D (green lines), both frequencies dropped again, but the reverse of C: f2 dropped more than f1.

Plainly, only chamfering the ends of the bar will increase its vibration frequency.

A: Thinning the bar uniformly reduces its vibration frequencies. I the case of a bar, thinning it reduces the mass, which tends to raise the frequency, but it reduces the stiffness of the spring much more, and so the frequency still goes down.

B: Reducing the mass by several % by chamfering the ends increases the frequency by 10-15%. The part of the mass, which is doing the most moving, is at the ends. The springy bit in the middle is untouched, so we are essentially not changing the spring but decreasing the mass: the frequency rises.

C: The opposite of bar B. Moving mass stays the same, stiffness drops, frequency plummets. This is how marimba and xylophone bars are made. When f2/f1 has nice integer ratio you get a mellow harmonic tap sound. The ratio is 3 for a xylophone (octave and a fifth) or 4 for a marimba (two octaves).

D: The effect is similar to bar C but much larger for f2 – which has two antinodes (springy bits) close to the thinning – than for f1.

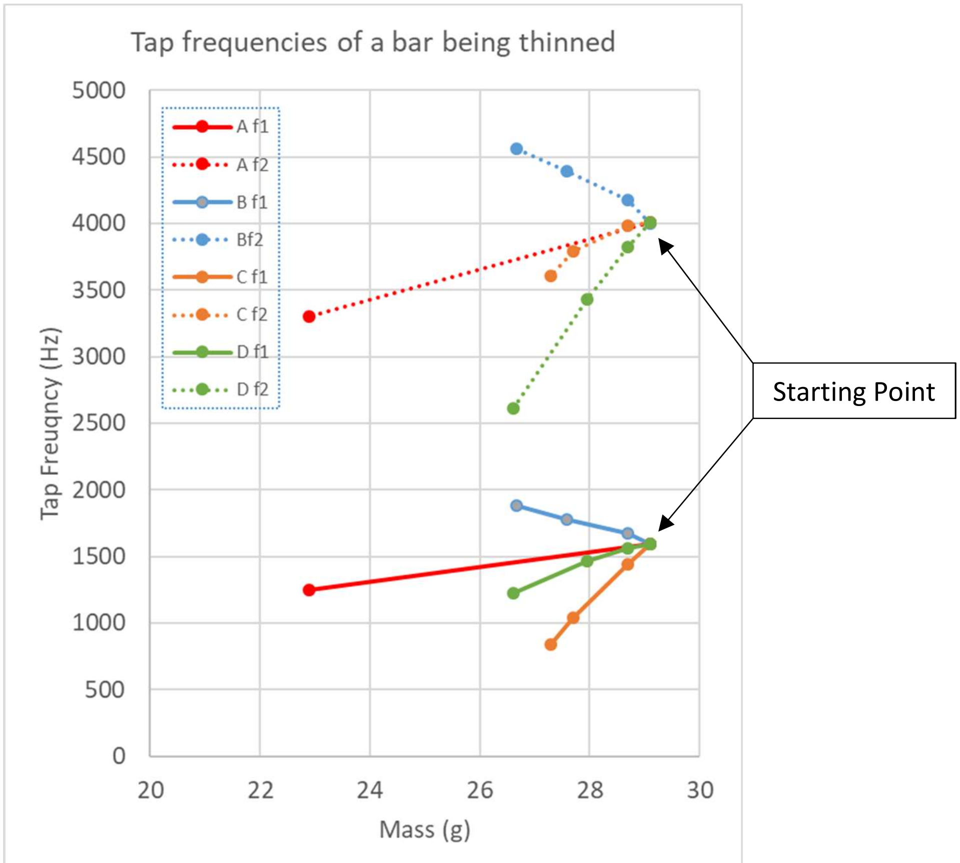


Fig. 2: Vibration frequencies of bar with various degrees of thinning (determined by the mass).

Conclusion

I have not done this experiment on anything looking like a violin plate, but I strongly suspect the only way to *raise* a tap tone by removing material is to do so at the edges. In fact, it has been said that the thin channel at the edge of a violin plate has the effect of making the plate-rib connection look almost like a hinged joint, rather than a clamped one, which facilitates the plate vibrations and thus increases the radiated sound.

Of course the relationship between free plate vibrations and those when the plates are glued onto the ribs is a very complicated one, as I noted last time. However, whenever a problem gets too complex, it is best to start with something simple that you have a chance of understanding, and this may shed some light on the more complicated issue.

If any of you are adept at increasing tap tone frequencies of a violin plate after apparently thinning too much, I would love to hear your story.