Towards a more musical violin varnish

The construction of a new violin, viola or cello is brought to completion with the application of the varnish. As the Hill brothers correctly noted in their book on Stradivari [Hill, W. Henry et. al: “Antonio Stradivari – His Life and Work” (1644- 1737), New York 1963], the varnish can never compensate for faulty construction of the instrument. In my opinion, however, there is no doubt that when properly applied varnish can enhance the sound (and when improperly applied it can ruin the sound). Existing literature on the subject of violin varnish provides little insight into the desired acoustic properties of good varnish. Accordingly, this article will attempt to shed some light on certain acoustic effects of violin varnish.

Acoustic objectives

In my opinion, good violin varnish should influence the wood as follows:

a) Low damping (ideally a decrease in damping compared to untreated wood). In spectral terms, a decrease in damping reduces the width of the resonance peaks while increasing their magnitude. In musical terms, this will increase the dynamic range of the instrument.
b) The largest possible increase in the ratio of the speed of sound to the density. This results in an increase in the musical modulability and flexibility of the instrument’s sound (for details on this subject “Vibrato”):

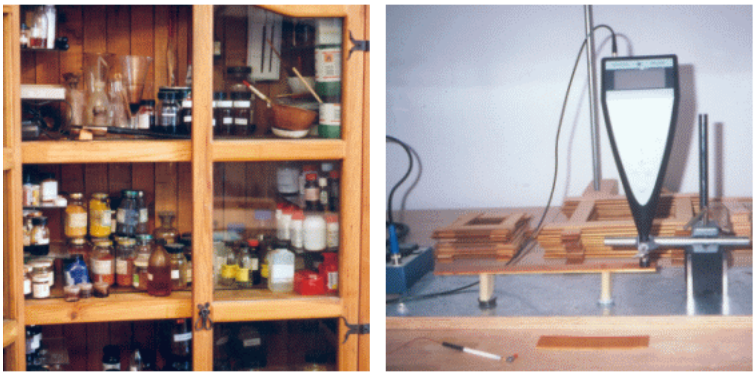


Abb.: Lackschrank mit Einzelsubstanzen und Messung lackierter Probestreifen im Meisteratelier für Geigenbau Martin Schleske

The increase in the ratio of the speed of sound to the density is equivalent to an acoustic improvement in the material itself. It becomes possible while retaining the eigenfrequencies (which determine the tonal color) to potentially work with lower plate strengths and thus lower mass coefficients. This increases the acoustic efficiency of the instrument and thus its dynamic reserves.

Production of varnish

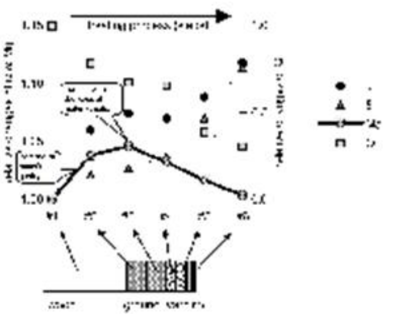
Since the eigenfrequencies as well as the resonance damping can be altered considerably in some cases by the wood treatment (primer and varnish), it is important to be aware of the influences associated with the varnish. Application of the varnish (primer, sealer, coats of varnish, etc.) involves a number of different steps and coatings. Accordingly, we must consider the acoustic properties of the intermediate steps and not just the final product. Why? Because certain intermediate steps could have a negative acoustic influence which is compensated to a certain extent by subsequent steps but still spoils the overall result. The presence of any detrimental intermediate steps cannot be ascertained through a simple comparison of the final product and the untreated wood. Instead, we need to analyze the individual coating steps involved in the production of the varnish.

Since each of the intermediate steps requires a certain drying time and all of the acoustic effects can vary over time, the best way to study the acoustic aspects of varnish production is with a series of wood test strips. The number of strips (not including the untreated reference strip) should equal the number of intermediate steps. The first strip will contain only the first treatment, the second the first and the second treatment and so on. The last strip contains all of the treatments.
After each strip has been allowed to dry for a suitable length of time, the resonance method (measurement of the resonance properties of the first bending mode of vibration of the strips with free-free boundary conditions) is used to determine the changes that occurred as a result of the treatments in the speed of sound c, density δ and resonance damping Q for all of the strips compared to the original untreated state.

For more detailed information about the resonance method, please click on the following link

In addition, the change in “material quality” ($Mq=c/\delta$) as a result of the treatment is computed for each strip. These changes compared to the untreated wood can now be plotted as a function of the treatment steps (see the following diagram).

Example: The following figure shows a varnish treatment diagram as described above (test strips = spruce with a thickness of 3.0 mm and grain orientation lateral to the longitudinal direction).



A representation of the acoustic development of violin varnish

Caution:

The values shown here have been compensated for climate: Since any climate-related influence on the treated strips will also affect the untreated control strips, all of the measurement results are divided by the “untreated” control values. This is a way of compensating for the influence of air humidity or temperature fluctuations.

The diagram shows that the varnish used in this example had a limited positive influence: Based on the large

increase in the speed of sound (+7.4%) compared to the simultaneous increase in density (+2.7%), the first two treatment steps (ground) significantly boosted the acoustic material quality (+4.6%). However, the next treatment step 4 (application of a layer of rosin oil) lead to an excessively large increase in the density which causes a decrease in the material quality. This means we are essentially giving back much of the positive effect of the primer (steps #2 and #3).
A similar phenomenon occurs with the subsequent coats of fatty oil varnish. At the end (step #6), we have a material quality that is comparable to the original wood due to the nearly identical increase in the speed of sound (+11.8%) and density (+11.4%). It would have been better if we could have maintained the original trend (with the increase in the speed of sound exceeding the increase in the density). This would allow us to use somewhat lower plate strengths in the white violin which would have the effect of decreasing the mass coefficient and increasing the acoustic efficiency. After having been shifted downwards through adjustment of the plate thickness graduation, the eigenfrequencies (which are critical in determining the tonal color of the instrument) are then compensated by the subsequent application of varnish.

Practical issues

With our own varnish solution, we have regularly observed an eigenfrequency increase which is roughly constant over the entire frequency range on the order of a few percent compared to the unvarnished instrument.

In contrast to the rather problematic varnish example described above, we have tested varnishes which greatly reduce the damping compared to untreated wood.

Further reading

For more examples, see the article “Acoustic analyses of violin varnish”:

Bibliography:

• Martin Schleske: “Der Einfluss typischer Geigenlacke auf die Resonanzeigenschaften der Geige” [The influence of typical violin varnishes on the resonance properties of violins]. Journal “Das Musikinstrument”, Vol. 39, Issue 2-3 / Feb.-March 1990, pp. 129-135.
• Martin Schleske: “On the Acoustical Properties of Violin Varnish”. CAS Journal Vol. 3, No. 6, (Series II), November 1998.

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