Hunting for the wolf!

They are an unfortunate fact of life for cellists: Pitches that respond only with great difficulty and tend to waver periodically when playing at piano levels. Their howling, oscillating, pulsating sound is what gives them their name: Wolf tones. Even high-end violins frequently have problematic notes of this sort.

For the cello, the standard wolf eliminators available commercially are more or less effective. But there is no such remedy available for the violin. As a general rule, the only solution is to perform a tonal adjustment on the instrument (which usually involves adjusting the soundpost). This is effective in solving the wolf-tone problem only in cases where the frequency of the problem resonance can be shifted so it lies between two semitones. However, the disadvantage of this approach is that a) the entire tonal structure of the instrument is altered and b) the results tend to be haphazard even after hours of fiddling with the instrument.

What is the true cause of wolf tones and are there any systematic remedies available? A wolf tone arises due to the large dynamic mobility of the corpus when its resonances are excited. In the main corpus resonance, more energy is taken away from the string vibration than the bow can supply. The vibration of the string is disturbed to such a large degree by the strong corpus vibration that it collapses. However, since the bow is continuously acting on the string, the string vibration will build up again. But it excites the corpus again and causes it to vibrate at its main resonance. This resonance then builds up to such strong vibration amplitudes (which are coupled via the bridge back to the string) that the vibration of the string breaks down again. This repeated sequence of vibration buildup followed by vibration collapse (which is repeated about 7 to 10 times per second and thus lies at the most disruptive frequency in psychoacoustic terms) offers an acoustical explanation for the “howling” of the wolf tone.

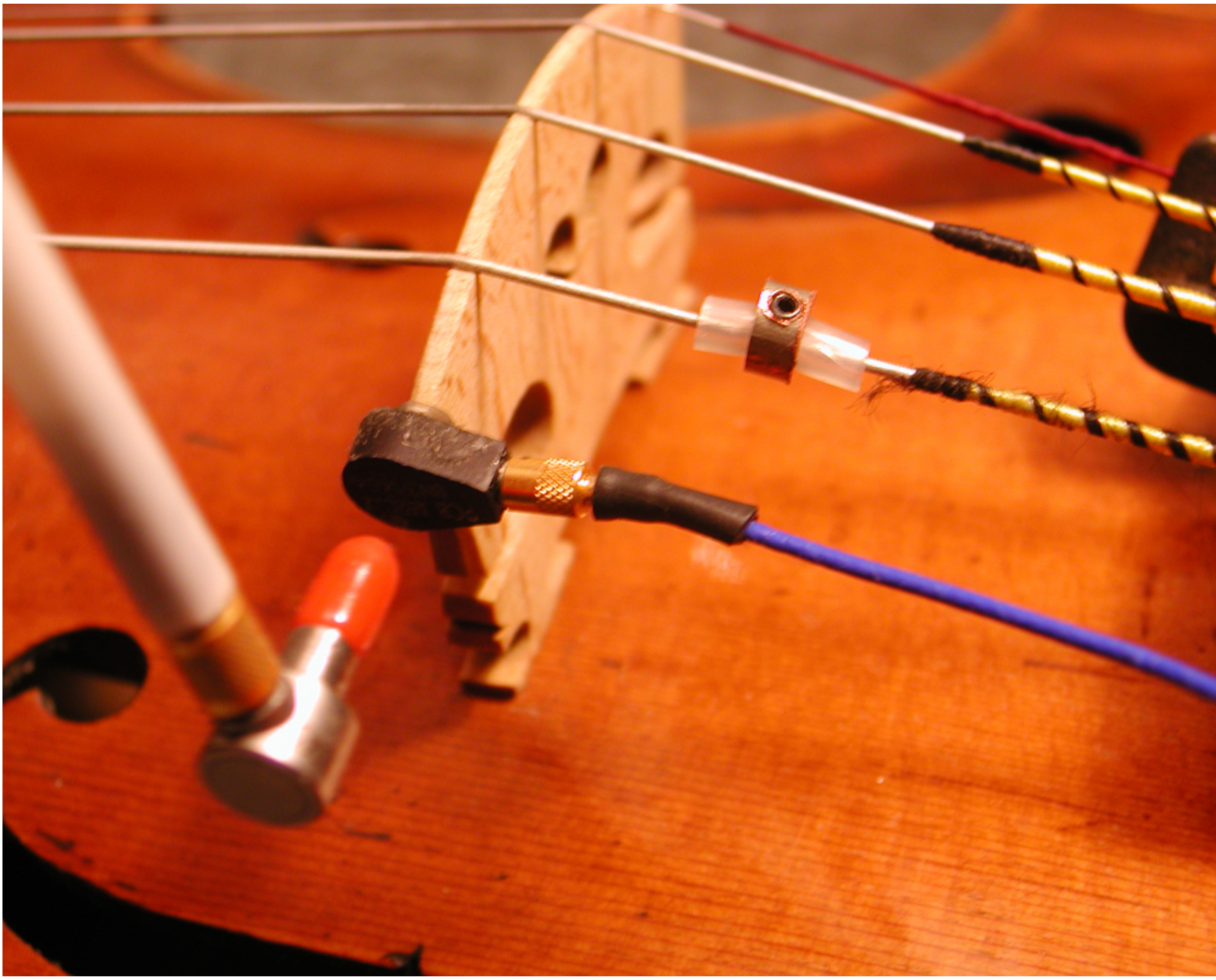


Fig.: Measuring the transfer function of a violin for use in adjusting the wolf-tone attenuator

We use a smart little device to get around “wolf problems" of this sort: By analyzing the individual resonance profile of the violin, the resonant frequency of the eigenmode of vibration which is causing the wolf tone is determined first.

Then, in the area of the freely vibrating string between the bridge and the tailpiece, an anti-resonant tube is installed with just the right damping and mass. The length of the tube must be set with a precision on the order of 1/10 mm in order to create a resonance system that is capable of “communicating” with the wolf-tone frequency. This tuning process is monitored and optimized through repeated measurements of the transfer function at the bridge. Besides the mass and damping, the position of the anti-resonator also plays a role in the tuning of its resonant frequency. The reason is that the position determines the effective “spring stiffness” and thus the dynamic restoring force of the tube. It can be reproduced exactly after a string change since the musician is provided with a customized template for the instrument.

Fig.: This anti-resonator developed in the laboratory of the Martin Schleske Master Studio for Violinmaking eliminates the wolf tone in violins.

The wolf-tone attenuator will be effective only if the mass, restoring force and damping are precisely adjusted. A painstaking process of this sort is aided by spectral analysis and measurement of the vibration response (transfer function). An acoustic log created in the acoustics laboratory of the Martin Schleske Master Studio for Violinmaking serves as a useful guideline for custom creation and checking of the anti-resonator. So far, the overwhelmingly positive feedback from violinists plagued with wolf tones has been very encouraging. It shows that relatively small measures can have a large effect in musical terms.

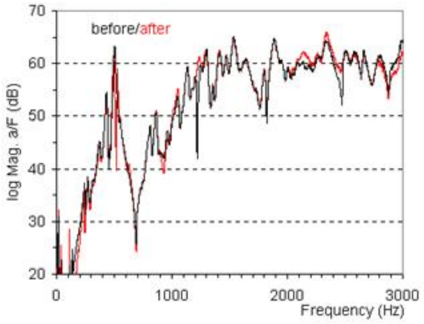
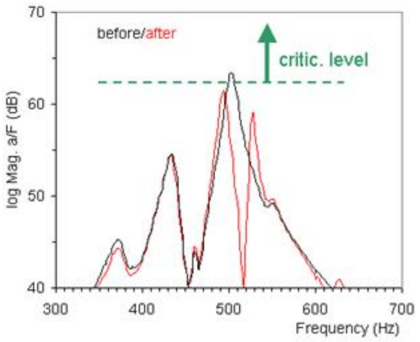


Fig.: Measured transfer function (input admittance at the bridge). Black: without, red: with anti-resonator. We can see clearly how the anti-resonator cuts the problem resonance. This brings the wolf-tone resonance down under the critical vibration thresho



A frequency zoom for the figure above.

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