<u>BISSINGER RESEARCH ARTICLE PRECIS</u>

The articles by George Bissinger included here deal with some measured violin properties of direct relevance to the violinmaker. These articles are written in technical-ese for a technical journal and have been reviewed professionally by at least one reviewer for technical correctness. [The radiativity measurement referred to so commonly is simply the amount of sound pressure at some distance per unit force applied at the bridge.] This does not necessarily mean they are uncontroversial and/or orthodox. Let me briefly describe why they are relevant to makers (in chronological order):

a) The *violin bridge as filter* article (2006) shows: i) how the bridge moves for some low, mid, and high frequency modes (fig. 2) and how the soundpost foot is semi-fixed only for a very few low-frequency modes, contrary to the general view. (Note that these modes have had the contributions of other modes subtracted mathematically. The Operating Deflection Shape however, which is the **sum of lots of modes at a particular frequency** might very well show very little motion); ii) The BH hill near 2.4 kHz is not very sensitive to bridge tuning (figs. 9 and esp. 10) but the region from 2.7-4.2 kHz is quite sensitive and show how strongly the rocking mode frequency affects the filter properties of the bridge. Tuning the bridge allows the maker to vary the overall radiativity (sound) profile in the 2.7-4.2 kHz region.

b) The *Surprising regularity between plate modes 2 and 5 and the B1 corpus modes* article (2007 or 2008) looks at: i) the Dunnwald 10-violin subsets and wonders why the old-italian violins seem to have such regular 1st corpus bending mode frequencies $B1^-$ and $B1^+$. The Schleske 1996 experiment where the plates were graduated in stages and the violin assembled and tested was then reanalyzed and interpreted to show that while tuning plates indeed had little effect on corpus mode frequencies, the real lesson was that the rib stiffness is the dominant stiffness in determining $B1^-$ and $B1^+$ frequencies; ii) how the plate mode 2 and 5 frequencies are related to the B1 mode frequencies, especially the frequency differences (see fig 10). The empirical trendlines or experimental data can be used to estimated the B1 mode frequencies, providing makers with the ability to control B1 mode placement (but ribs are important!). Tuning plates shows up most strongly in the B1 mode frequency **difference** – if plate modes 2 and 5 are more widely different in frequency than usual, then $B1^-$ and $B1^+$ will be also.

c) The *VIOCADEAS Project: Structural acoustics of good and bad violins* article is an annotated, slightly altered version of a 2008 paper summarizing the vibration and radiation measurements made in the East Carolina University Acoustics Lab during the National Science Foundation sponsored VIOCADEAS Project. The violins tested had a wide quality range and by examining various measurements some significant differences emerge between the bad and the excellent violins. The first-ever true 3D broad-range vibration measurements showed a lot of in-plane motion in the bridge island, with motion along the line of the bridge feet peaking near 2.4 kHz, an “interesting” coincidence with the BH peak? There was a significant difference between A0 strength in bad and excellent (3 old-Italian) violins, with relatively strong A0 being a hallmark of excellent violins. (The next article provides a crucial experimental link between the B1 mode frequencies and the strength of A0, the only strongly radiating mode in the violin's lowest octave).

d) The *Structural acoustics of the violin radiativity profile* article (2008) provides: i) a model for how to vary A0 strength by linking it to the B1 modes. A paper I published in 2007 with Earl Williams and Nick Valdivia showed that the B1 modes had very significant volume changes and drove a lot of air through the *f*-holes. Remarkably about half of the measured sound from the violin for these B1 modes came from these *f*-hole volume flows. These in-phase air motions are just what A0 a Helmholtz-like cavity mode creates and suggest that the B1 modes drive A0, a result supported by a standard network model of the Helmholtz resonator with wall motion allowed. See fig. 2 for empirical VIOCADEAS radiativity data and fig.3 for some Meinel 1937 radiation data as plates were thinned; ii) this article also shows how to build up the entire radiativity (sound) profile from low to high frequencies (fig. 9) using the soundpost, impedance matching, bridge filter effects and the plate critical frequency components to sum up to the overall profile. This article provides the first structural acoustics model to offer insights into the influence of various components over a wide frequency range which, when combined, make up the violin radiativity profile.

Some Bissinger URLs

NATURE http://www.nature.com/news/2008/081002/full/news.2008.1147.html

Drumstick Acoustical Society of America talk (drumstick = 1D violin) http://www.aip.org/148th/bissinger.html

Strad 3D Acoustical Society of America talk http://www.acoustics.org/press/153rd/bissinger.html

New York Times http://www.nytimes.com/2006/11/28/science/28acou.html

American Physical Society http://www.physicscentral.com/explore/action/fiddle-research.cfm