More things to do with modal analysis data

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Our goal is both advancing fundamental understanding of instrument modal behaviour, evaluation of instrument quality and ultimately how to improve the playing and sound quality of instruments. At the VSA Oberlin Acoustics Workshop we have observed that the modes of assembled and strung instruments are often complicated and not always the same in all instruments even at low frequencies. Coupling of the internal air, substructures, symmetric and antisymmetric mode shapes and bridge modes can create new modes that may never be seen in isolation, becoming a component of a group of modes over a wide frequency range. We never see instruments that have exactly the same set of modes at above around 1 KHz, yet those we do see are combinations of simpler ones and arise according to their frequency and coupling strength. Curve-fitting of modes is a powerful tool but not the only way to process the data, and where there is high modal overlap, multiple couplings, and perhaps other factors, the results are often at best ambiguous.

Professor Colin Gough's FEA model has encouraged us to look at the corpus without neck/fingerboard or soundpost as this is closer to his set of basis modes. Renewed attention has been applied to free plates and plates with constrained edges that take us closer to the boundary conditions of a closed corpus but without the coupling effects of the other plate. This is part of a strategy to pick apart less amenable data into understandable components. Using derivatives of the interpolated mode shapes we can see them in terms of surface curvature rather than spatial displacement, demonstrating how transverse waves pack into available areas and do so persistently over wide frequency ranges. The same interpolated shapes can be processed to estimate net volume change, longitudinal dipole and transverse dipole components.

This is informative about radiation mechanisms; whereas (for violins) net volume change is the sole effective mechanism up approaching 1 KHz, it does not entirely fall off at higher frequencies. Likewise the corpus longitudinal dipole starts to become effective in the frequency range at which it occurs at around 850 Hz. Estimating the proportion of these component or basis shapes allows us to see where they fit in the radiation scheme and perhaps can be used to estimate wave speeds and stiffness.