Principles of Modal Tuning ï Course Content

Session 1: Modes of Vibration and Frequency Response Curves

Strings and how they drive a guitar
What is a "mode of vibration"? Technical explanation
Visualising modes of vibration using Chladni patterns (demonstration)
Correlating modes of vibration to frequency response curves (FRCs)
How FRCs define the sound of a guitar (mostly!)
How to measure FRCs, demonstrated on participantsôguitars
Examples of FRCs for generic guitar families (flamenco/classical/steel string etc.) and how they differ
Analysis of the distinguishing features and modes of the different guitar types

Session 2: What controls mode frequencies and why are “good” frequencies “good”?

Introduction to Simple Harmonic Motion
Analysis of spring/mass systems and how they relate to guitar function
Response curves for a simple driven oscillator
Introduction to mechanical admittance/impedance
Coupling of components; coupled vibrations
Selecting target mode frequencies; which and why
Selecting the spread of mode frequencies

Session 3: Requirements of a guitar as a static and dynamic structure

Static requirements:
How much bridge rotation under string load should be allowed?
How to measure rotational stiffness (demonstration)
Static stiffness design (EI for the soundboard)
Analysis of EI for a range of historic instruments

Dynamic Requirements
Hearmon's formula for orthotropic plates, defining vibrational frequency
Wood properties that need to be measured
Principles of wood property measurement

Session 4: Material Properties and Guitar Design

Wood selection: Using the wood you have rather than the wood you'd like
Static testing of wood properties (theory and practical demonstration)
Dynamic testing of wood properties (demonstration)
Physical requirements of the test piece (flatness, smoothness, shape)
Q testing (Discussion)
Back bracing schemes
Top bracing schemes

Session 5: Moving from “as built” to “to design”

Efficient guitars ï when and why to adjust guitar resonances
Principles of resonance adjustment - adding/subtracting mass/stiffness.
How to influence one mode and not another
Placing the main top resonance
Placing the main air resonance
How to use bridge mass, edge thinning, back plate stiffness, side masses, sound hole size etc. to trim resonances

Session 6: Virtual design and build followed by open session

Virtual design and build: testing your knowledge on when to use these techniques during the design and build phases

More depth on anything the participants want to look at
(This is frequently the most valuable session for students)
e.g. Recent innovations in guitar design
Principles of nut and saddle compensation
Software set-up assistance
Repeats of demonstrations
Testing of student guitars