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Part I

I've been thinking this month I should talk about fretwork...The hard part about doing an article like this one is there are several concepts that interlock. I'll do my best to present the information in a linear fashion. But there will be a few spots where I'll need to repeat some points that help bond ideas together.

I should say as a starting point that most of my clients want high performance in one form or another. Yes there are a few who want high action and like to fight their instruments. But primarily my client base wants instruments, which are adjusted to be highly responsive to subtle changes in touch because that affords a wider spectrum of available tones simply coming from your hands. That grade of performance requires an obsessive approach to the level of execution coming off the bench.

For the moment please forgets everything you know. OK, let's start from scratch with no assumptions.

Funnel Vision: Think of a fret board as a simultaneously radiused and slightly concave plane. It's radiused (arched) from the bass edge to the treble edge, and concave from the nut up to the end of the board. Perhaps the easiest visual reference would be to imagine the outside of a trumpet's bell but stretched way out.

Compound Radius: In most cases there will be a slightly compound radius unless someone deliberately makes the board's radius consistent from tip to tail. A compound radius implies the arch at the first fret will be greater than the last fret. A lower number radius is more arched; a higher number radius is flatter. I know that seems counter intuitive, but it's basic geometry. A smaller circle has a more dramatic curve than a larger circle. Try stacking two plates of different sizes on top of each other so their edges meet at one point. You will see what I am saying illustrated very clearly.

Radius Affects Perceived Stiffness: Many people find more arch is easier to play chords and a flatter board is more sympathetic to extreme string bends. That is because strings will not choke on a flatter board. Although many people assume flatter is better, this mantra can be taken to an extreme. When boards are very flat bending can feel stiff. Granted the notes don't choke, but the physical act of bending the note requires more muscle. For the most part I've

found people are happiest with a 10.5" or 12" radius at the 12th fret going out to a slightly flatter radius at the last fret. There is a noticeable glide effect when bending on a steep to mid range radius and there appears to be greater friction on the very flat boards. To most people extra light gauge strings will partially negate the sensation of friction on a flatter radius.

Action Height Affect Feel: I've also noticed a correlation to action height and perceived stiffness in relation to bends. When the action is too low many people have a hard time executing bends. How many times have you heard someone say "I like to get under the string when I bend"? Whether they realize it or not, what they are really talking about is this: When a string is high enough off the board that it will be suspended into the meat of our fingers, we don't have to grip as hard to maintain control over the string when bending. If a player has to forcefully grip the string in an exaggerated way so it will not slip out from under his/her fingers, that increased force means greater friction of the string pressing against the frets. Friction equals resistance, resistance feels stiff. OK enough of that part for now....

String Load: The tricky part about necks and frets is what happens once the strings are on. All necks flex differently under load. For argument's sake let's say the average load of a complete set of strings at standard pitch is roughly 90 pounds of pull. That's a lot of force to exert against a thin length of wood. Most necks have an adjustable reinforcing rod. Hopefully the rod was installed in a manner that allows some corrections to counter the constant load created by strings. Now some necks are more flexible than others and not all truss rods are as effective as we might like. On top of that, a truss rod produces a very generic adjustment. No truss rod regardless of design will move the board and frets in a uniform way.

Neck Flex and Truss Rod Effects: In most cases, rod adjustments dramatically change the fret alignment in two ways. First, along the length of the neck from the first to last fret which is obvious and easy to measure. Secondly, a rod adjustment will also change the alignment of each individual fret going across the board's width. So far no one has come up with a way to change this fact.

There are a few key elements at work here.It's a little complex, but for the moment these are the most basic terms I can break it down to:

1) Each string based on it's gauge and length requires however many pounds of pull to achieve pitch.
2) Each string is a different gauge and pitch. That means the load on any neck along the length of each string is different.
3) Wood is not uniform in density and most necks are made of at least two pieces of wood. Let me explain this in greater detail. Any single piece of wood will have harder and softer areas. So although we can say harder areas will compress or flex differently under load than softer areas; it would be unreasonable to make blanket statements about what will happen. The reason being is that we cannot isolate the individual components once a neck is assembled. However, we can say due to variations in density and the effects of stratification (when pieces of wood are glued together) we can measure necks and demonstrate they do not flex under load or respond to truss rod adjustments in a uniform manner. Additionally, how the board presents itself under load will be different than how it looks without load. If this stuff is starting to make your head

hurt, you are not alone...
5) Some fret wire is harder than others. This will also influence how a neck will flex under load.
6) The size, shape, thickness, and material that inlays are made of also impacts the rigidity of a neck.
7) Depending on the neck set angle, head stock angle, how much of the neck/fret board is supported by the body, how thick the neck is, how thick the board is, which way the grain is running in both the board and the neck, what style of rod(s) is (are) being used, how well the frets fill the slots in the board... blah, blah, blah...All these little details impact how much the neck will flex under load and where. Yes, I said where, don't think for a second that necks flex in a uniform arch along their entire length....OK, take a breath, get a beverage for I know if this was presented to me in one dose back when I started, either my eyes would glaze over or I'd run screaming into the night....But don't freak just yet, there is more....

More stuff to lay awake at night over...Necks are not static. They will compress, distort, and change over time.Partly due to the constant force of sting tension and partly due to the influences of: climate, humidity, alkaline content of perspiration alone, and the chemical reaction of how a player's perspiration reacts with the strings and fret wire which in turn affects the wood.

In the last few of paragraphs I've described a series of elements that will all impact how an instrument changes over time. In the most basic terms, because of the outside forces an instrument is subject to, stringed instruments want to misbehave...But this natural tendency can be controlled and turned to your advantage.

I promise, I will get back to talking specifically about frets in a few moments. But first I need to lay out some observations which help things fit together.

Care and Feeding: Think of an instrument's first one to three years after being manufactured as "the infant mortality period." By that I mean, if an instrument is going to go bonkers, odds are it will happen in the first thirty-six months. Some instruments will change more than others. This has nothing to do with brand, model, or the types of wood. It's simply fair to say a neck/board will go through more changes during the infant mortality period than it will after that window has passed. So why call it the infant mortality period? It's simple, everyone with children knows in the first three years they have to watch a child's health like a hawk. After that although it is still imperative to care for your child, the probability of sudden fatal illness diminishes. As grim an analogy as that is, I know you won't forget it, and that was the point.

If I did not paint a graphic picture some people might rationalize it's better (or at least less expensive) to let the instrument run amok for one to three years.
That method usually has less than stellar results. And considering what instruments cost, why not protect your money with an ounce of prevention.

Let me emphasize this concept one more way. Wood develops a memory. It will respond to the physical and climactic elements/forces it is subjected to. It is far more effective to give a new instrument three maybe four setups or basic adjustments a year during the first thirty-six months than to let it settle without guidance or with minimal guidance. Trying to bring an instrument under control after it's already developed bad habits is like trying to quit smoking. If

we keep tweaking a new instrument back to the point of optimal adjustment, odds are high it will settle there. I've seen several hundred instruments start off being quite wild and then settle down to be great stable money makers with two setups and one or two rod adjustments throughout the year. That type of attention will keep it playing in top form and prevent bad habits.

Granted it's a matter of perception and what level of performance any given player may deem acceptable. However, I can tell you with few exceptions, once a player gets used to an instrument tuned like a Ferrari, they are not too jazzed about going back to driving a Mini Van. Additionally, it doesn't take much effort to raise the level of performance when you are starting with a clean slate.

Back To The Really Geeky Stuff: There is a direct tie between optimal fret alignment and the perceived stability of an instrument. What I've said above still holds true; new instruments shift around more than older ones. Instruments will go through more dramatic changes in the first one to three years... blah, blah blah. However, if the person doing your frets is skilled enough to do extremely accurate work; odds are very high that the incremental changes your instrument goes through will not have you running back to the repair shop. Accuracy will keep the buzz and dead spots away. However, knowing how to simultaneously put a great feel in the instrument's playability will keep you satisfied.

I've played guitars that have had fretwork done by some other guy that is technically beautiful, no buzz, no problems, but the instrument felt sterile as if it had no life. I've also played guitars where they felt great but nothing sounded right. I'm bringing this up because so many people obsess about accuracy without realizing there is more to the equation that elevates some instruments to being amazing.

So how does this translate into perceived stability? A few paragraphs back I was going on about how truss rods do not move necks in a uniform manner. The point being even though a rod changes how a neck is flexed under load; meaning what position of relief it rests in when tuned to pitch. This rod adjustment will also alter fret alignment going across the radius of the neck. Not that the fret spacing changed and they were no longer parallel." But the relational alignment from fret to fret along the length of each individual string will have changed. This occurs because no neck will flex in a uniform manner. If the amount of relief changes more than a few thousands, odds are the fret alignment across the neck will move enough to create slurred notes and limit sustain if not producing actual dead notes all together.

Zen Master: Help us Obi-Wan... So at this point someone's ability to level frets with great accuracy and their instinctive awareness of the differences between relaxed and loaded becomes a big factor. Most people who are very good at doing fretwork realize necks lay out differently with strings on/tuned to pitch, and strings off/no tension. The rod introduces distortion in the board in both states (loaded and relaxed). As luthiers, we must learn to anticipate what the neck will do in varying states of stress.

Look for Part 2 in next week's issues of GJD.