Guitar Tuning Nightmares Explained
(Part 1 of 2)
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Everyone who's had *tuning nightmares* during a recording session, raise your hand. Gee, that's just about everyone, isn't it?

As a guy who's been recording guitar bands for 14 years now, I have to admit to a problem: I have painfully accurate awareness of tuning. This means I hear tuning discrepancies some people might not notice consciously; other people might just feel slightly uncomfortable without knowing why. Many of us who are engineer/producers have this blessing/curse. As a wee lad, I would turn on the radio and find myself thinking "Wow... Hendrix is out of tune there!" or "Rod Stewart's way sharp on this whole song" or "Why is that organ part so out of tune with the guitars?" And some classical orchestra music drives me nuts for this reason. Yup, a curse.

In less-commercial pop music (i.e. “indy rock”) you can get away with more, if you’re good. Sonic Youth and Pavement just wouldn’t be the same if they were always in perfect tuning… but not many bands are capable of trumping imperfect tuning with their sheer force of personality, and you shouldn’t assume your band is one of them.

In the studio, of course, my ear for tuning is a blessing… but if I get fatigued, it can transform into the Beast That Ate The Session, as my ears start playing tricks on me. I finally resolved to learn as much as I could about potential "tuning nightmares" so I could better defend myself.

To begin with, it is essential to grasp one iron-clad fact, or you will go insane:
It is impossible to ever get any fretted, stringed instrument "perfectly in tune". Nope. Can't be done.

Once you understand this, you can start dealing with the implications. Your life will become easier. I'll come back to this in a moment. Let's talk tuners.

THE INFERNAL MACHINES

Once in a blue moon I still get a band that actually doesn't use 'em. Yeah, hard to believe, and this becomes tuning nightmare #1 when someone wants to do an overdub a few days later. Tuning by ear to the tape can be damned difficult, especially with the crazed noisy bands I often work with. I generally beg such a band to reconsider their tuner aversion, at least for the few days they are in the studio with me. Seems pretty obvious, right? (The single, amazing exception to this has been the band Zen Guerrilla, with whom I've made

two albums entirely tunerless. Their tuning sense is so uncanny that I learned to just let 'em alone.)

I encounter three kinds of tuners: the kinds with little meters with needles that move (make sure you hold them horizontal!), the kind with rows of flashing LEDS, and those “strobe” types with a moving wheel and a flashing light. I haven't seen a strobe tuner in years, and never liked 'em much, though they work well if you can figure 'em out. Oh yeah, then there's those silly little "pitch pipes" like a mini-harmonica... avoid!

The most common moving-needle types are the Boss Chromatic ones, and they're pretty good, but here's a tip: the input jack is soldered directly to the internal circuit board, and these solder joints ALWAYS crack eventually, which makes the tuner act "intermittent," with the needle jumping up and down. I have resoldered more of these in the studio than I can count; the plastic case comes apart easily, and you can resolder the jack in seconds. If you have one, check it: it may not be a "bad guitar cable" that's been frustrating you.

The little ones with flashing red and green LEDs that are often called "stage tuners" are rarely accurate enough for studio use; their only advantage is that you can read 'em without stooping and squinting. Hit that green LED, and you're done, right? Maybe. Some are OK. The cheaper moving-needle tuners are really not so great either. In my opinion the truly greatest innovation in tuners is the 19-inch-wide, single-rackspace multiple-LED type that you can read from clear across the stage. Korg makes some good ones. I finally had to buy one of these super-tuners for studio use; they are wonderful, deadly accurate machines. More on this in a moment.

SOME TUNING TRICKS

Here's another tip to make your life easier. You know how when you plug a guitar in and pluck a string, sometimes the tuner needle (or LED display) wavers back and forth and drives you crazy? And you have to pluck it every which way before getting a "good reading" which finally "settles down?" Do these three things:

1) switch your guitar to its rhythm (neck) pickup, if it has one;
2) roll your guitar's tone knobs all the way off, to remove all the highs; and then
3) pluck the open string right over the twelfth fret, not over the pickup. Try it; you'll be amazed.

Why does this work? Here's a quick physics refresher. The sound of a string being plucked is composed of a fundamental tone (the "note" itself, which also happens to be the lowest and loudest tone made by the string) mixed with a series of increasingly higher-toned, lower-volume harmonics, starting with the octave (or "2nd harmonic") and then going on up to include higher tones that are NOT all octaves. Each harmonic corresponds to the length of the string divided by a whole number. The harmonic overtones are referred to by these numbers, and they correspond to those little "nodes" or dead spots on the strings where you can lightly place your fingers and get little chimey sounds. The 2nd harmonic or "octave" spot is exactly halfway along the string, right over

12th fret. The 3rd harmonic corresponds to one-third the length of the string, and can be found over frets 7 and 19, the 4th harmonic can be found over frets 5, 12 and 24 (or right over the neck pickup), the 5th harmonic over frets 4, 9 and 16, etc.

Several things to note:
1) The harmonics that are "powers of two" (2nd, 4th, 8th) are all octaves of the lowest, or "fundamental" note. To a tuner, they are the SAME note.
2) All the other harmonics represent DIFFERENT notes. It's the unique combination of fundamental plus these various harmonics that give any instrument it's particular character or timbre.
3) How you pluck the string, where you pluck the string, and where the pickup is located under the string, determines the blend of "fundamental vs. harmonics" that you hear. Pluck it near the bridge, and you get a twangy sound with lots of high tones. Pluck it near the middle, and you get mostly a deeper, more "pure" tone. Pluck it hard, and that initial burst of energy will cause more high harmonics. Put a pickup near the end of the string (at the bridge), and it will pick up more of those high harmonics; put it closer to the middle, and the fundamental tone will come through louder.

So… *What is the tuner looking for?* The fundamental note of the string, and nothing else! All the other tones made by the vibrating string "confuse" the tuner, making it indecisive. Roll off your highs, use the rhythm pickup, pluck near the middle... and just mail me a check, thank you very much. (Important: remember to switch everything BACK before you start playing the next song!)

Here's another tip for tuning acoustic guitars that don't have built-in pickups. Go find a pair of headphones, any old kind. AKG 240s work great. Put the headphones "on" the guitar body, sort of straddling it front-to-back, near the hole. Plug 'em into the input of the tuner. It looks silly, but the headphones will act like a microphone.

THE REAL NIGHTMARE BEGINS

Consider a rock band with two guitars, bass and a keyboard guy with a Rhodes or Hammond. It is possible everyone will have their own tuner, and know how to use it. But after you roll tape, you discover that someone is out of tune. They all check their tuning and everyone announces that their tuning is fine. Then they all look at you (the engineer) accusingly. What to do? Start removing variables.

When I got my first "TEST CD" (a handy thing everyone should have) it had some tuning reference tones which were pure A440Hz, etc. I was able to run these pure notes into some typical guitar tuners. One thing you should know is that CD players are very, very speed accurate. They are not perfect but for our purposes here, close enough. What I found made me very sad. Aside from some tuners having more "slop" in them, some of them have slight calibration differences. Yes, one tuner's "A" may be slightly different from another tuner's. (Close enough for "live," you understand.) Lesson: in the studio, have everyone use the same tuner. It slows things down a bit in the short run, but it's worth it.

OK, probably things are better now. But maybe they aren't. One guitarist is still consistently out of tune on the recording. He checks again, and says everything is fine. You borrow the guitar and check it yourself with the same tuner, and it looks wrong to you. Who's right?

The problem is that different people, using the *same* tuner, can tune in different ways. In order to see why, you need to understand another bit of the physics of vibrating strings. It took me years to realize this. Plug a guitar into any old-school moving-needle tuner, and pluck a string. You'll see the needle shoot up and OVERSHOOT the note and then settle back down. I always assumed that it was just a bit of springiness in the meter itself. It's not! The string itself is actually SHARP in the first instant after you pluck it. This is NOT some artifact of the tuner detecting the extra harmonic content during the initial attack of the note. No -- *it's actually the fundamental note of the string that goes sharp!*

This effect was explained to me once, though I don't recall the detailed "why" of it. However, those giant rack-mount LED super-tuners reveal it clearly. The essence of it is these things:

1) the harder you pluck a string, the sharper the note of the *initial attack* will be;
2) the lower the tension on the string, the greater this effect; *and,*
3) the higher up the neck you go on the frets, the less this effect.

High strings hardly do it. Low E on the guitar will do it like crazy. Bass strings can be hell. Thinner gauge strings tuned to a given note will do it more than thicker strings tuned to the same note, because they have less tension on them. If you listen, you can hear it when you pluck a low E string hard: you can hear it go "BWOWWWW" as you watch those flashing LEDS shoot all the way over to the right and then pull slowly back over to the middle. By the time the note has truly, completely "settled down," it has almost died away.

A hell of a lot is implied by this universal behavior of a vibrating string. First of all, which *part* of the string's sound should you be trying to tune to? Somewhere right after the pick attack? Or somewhere right near the end, when it has settled down? If one guitarist is an impatient sort, and tunes near the beginning of the plucked note when it has barely settled down, and the other guy tunes using the very end of the decay of the note, the impatient guy will end up sounding *flatter*, at least on his low strings. There's no right answer to this, except to be consistent -- or have the *same person* tune all the band's instruments using one single tuner. Sometimes, in the studio, that person is me; it's easier than trying to explain all this.

There's another implication. Imagine you're a rock guitarist or bassist. You're playing some fast punk rock tunes, with lotsa 16th notes. Your picking hand is going chug-chug-chug-chug, or gung-gung-gung-gung, on the strings, rapidly and forcefully, for maybe an entire song. So... which part of the note are people hearing the whole time? Just the SHARP part, the initial attack. No string ever rings long enough to 'settle down" to that note you were seeing on the tuner. The only time that "in tune" note will ever exist is at

the very end of the final ringing power chord at the end of the song! If you're a heavy-handed pick player on the guitar or bass, you are going to sound slightly sharp the whole time. If you use light gauge strings, you will be even sharper. A heavy-handed pick player on the bass can easily be 10 or 15 cents sharp the whole time, no matter how carefully he uses the tuner! (I find this to be the case about 40% of the time when recording rock bands.)

And, because the low strings do this "sharping-on-the-initial-attack" thing *more* than the high strings, the harder you play, the more out of tune the guitar will sound with *itself*. Since it's hard to tune to the "attack" of the notes though (cuz that sharp instant goes by so fast) a solution I have employed often (with aggressive rock players) is to intentionally flat the E string a slight amount, and maybe the A string a slightly lesser amount. Strum the guitar gently, and it sounds wrong. But SCHWANG on it really hard, repeatedly, and it will sound dead in tune each time, at least until you let it ring for more than a few seconds. It's important to know how it is going to be played!

A pattern I have observed repeatedly through rock music history: guitars and vocals, the loudest musical components, will seem fine, but bass will be sharp, and the keyboards will seem flat. Wind instruments may seem flat too. If you listen to a lot of garage records from the 60s, and even a lot of well-known classics from the 70s and 80s, you will notice this over and over, now that I've called your attention to it. (Sorry!) What's actually happening is, the keys are fine, the guitars are sharp, and the bass is sharper. Keyboard instruments, for the most part, do not respond to attack the way strings do, except acoustic pianos to a very small extent (cuz they do have strings!). Many, many times, when overdubbing vintage keyboard parts later on top of guitar rock, I have had to slow the tape speed by several cents to bring the recorded guitars down into tune with the keys. Modern Studers and Otaris are great for precise varispeeding. ADATs can do it too. ProTools (at this writing, at v5.1) is not so great; the internal VSO has rather coarse intervals of 7 cents at a time, which is pretty inconvenient, though Digi might have fixed this by now. Thankfully, modern electronic keyboards have fine-tuning controls on them.

If I'm faced with a planned non-live situation where everyone is counting on serious overdub architecture, I'll try to save doing the keeper bass track until after all the guitar tracks have been laid down. Do you want to have to retune each of the 14 guitar tracks by ear to match a pre-existing badly-tuned bass, or retune 1 bass to match 14 pre-existing guitars? This completely goes against my preference for keeping the "live" rhythm tracks when possible, but sometimes that's just how the cookie crumbles. These days I take it for granted that the bass might end up sounding sharp, no matter what tuning contortions I go through in advance. You don't know until there are other instruments, actually playing the song, to compare with. I just accept it, and then we tune the bass to the track by ear later and recut it, or run the "live" bass track through a harmonizer and bring it down a few cents. (“Of course, now with ProTools you can blah blah blah...” Yeah, I know.)

If you ever work with one of those bands who tune their guitars down impossibly low and use light strings, you can lose your mind, because the tuning becomes a continuously moving target. And that doesn't even take into account that the harder the strings are

squeezed against the neck, the sharper they can sound, or that some people pull back on the neck when they play chords, flexing the neck backwards and sharping all the strings.

Here's another tip, just to compound the confusion: many guitars will change their tuning very slightly depending on whether the player is sitting down or standing up. Sit down, and the neck is sticking out, being pulled downward by gravity. Tune it. Leave it plugged into the tuner. Now stand up, and make an E chord with your hand. While doing this, check the tuning of the E string on the tuner. If it's any kind of bolt-on neck like a Strat, you may see the low E string go visibly flat as soon as you stand up!! The middle of the guitar actually "sags" a tiny bit as you support some of the weight at the end of the neck with your fretting hand. It doesn't mean the neck is loose -- it means guitars are more flexible than you realized.

All of this is enough to make the producer/engineer very gray indeed. But we're not done…

(end of part 1)

(Jack Endino is a Seattle-based freelance record producer/engineer who has made 200+ records in ten countries over the last 16 years, including some you've probably heard of. Check him out at **www.jackendino.com**)

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