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But This Goes to 11...

Welcome to the world of bass rigs.

Before we continue, here are a couple of loudspeaker myths we'd like to disprove:
Myth #1 – bass frequencies need space to develop because of their wavelength so you can't hear lows close up. If this were true every pair of headphones would need to be 40' wide! To hear a sound of any wavelength you don't need enough space to hear the whole wave, you simply hear the changes in pressure at your eardrum and the rate of change defines the frequency whilst the magnitude of the change defines the loudness.
Myth #2 – big speakers like 18"s 'throw' the bass so you don't hear the lows onstage but they hit the audience and drive your soundman mad. It's impossible for any loudspeaker to 'throw' sound – the SPL is always highest right at the edge of the enclosure and then it drops by 3dB for each doubling of distance in the near-field (the near-field is really close up, like inches) and then 6dB for each doubling of distance in the far-field. If that's the case, you may ask, why did you notice this exact phenomenon when you used a 1x18" at a gig? On stage you couldn't hear yourself, then you walked out into the audience on a long lead and you sounded great.

The first reason comes back to something we covered a couple of months ago – polar response: The larger the sound source (i.e. the size of the speaker array) the worse the dispersion of midrange and treble frequencies. Consequently although your sound may have punch and clarity down at knee level (typical 1x18" size) that punch and clarity is beaming straight past your knees and none of it is getting up to your ears. Although a typical 4x10" will have the same beaming problem, the vast majority of 4x10"s will have much greater treble and midrange output vs bass output, to the point that on-axis the sound is quite bright and midrangey, so once you move off-axis you can still hear yourself, plus the attack of the tweeter often found in these cabs will cut through thanks to the tweeter being a small source with good dispersion.

The second reason goes back to something we covered in one of our earliest columns – boundary reinforcement and cancellation: All too often we bassists end up in that exact wrong spot, where the direct sound from our rig meets the reflected sound from our rig via the surrounding walls, floor and ceiling and cancels out to a surprising degree in the lower frequencies. Walk out into the room and because you're further from the walls behind the rig the chance of standing in a deep low frequency null is vastly decreased.

One of the peculiarities of our ears is that we find it hard to lock onto deep clean bass output if there aren't associated midrange and treble frequencies outlining it, and this situation is particularly bad when things are LOUD. Step away from the stage and it all gets quieter and you start to hear more of the HF content and those two things help you hear the bass – hence the misconception that the soundwave hadn't formed properly and thus was inaudible up close.

So what's the solution if you're stuck with a cab containing a single large speaker for a gig? Lift it off the ground or tilt it back so it's pointing at your ears. And place it right up close to the nearest walls so you only get boundary reinforcement and not cancellation.

The sceptic may have one remaining quibble: "So what's a long-throw PA cab then, if 'throw' is mythical?" The use of throw in this context is to do with the dispersion of a loudspeaker, usually a horn midrange/tweeter. Big audience = long 'throw' = narrow dispersion. Small audience = short 'throw' = wide dispersion. Simple.

Auditory Masking – the bass player's nemesis

One of the great challenges of being heard and sounding good in a band is caused by an issue called 'auditory masking'. This is where a loud sound can hide a quieter sound, the classic example being a guitar hiding a bass. In reality it isn't simply the guitar's sound hiding the bass, it's the component frequencies that make up the guitar's sound hiding the component frequencies that make up the bass's sound. Let's take a classic rock example where the guitar is riffing on an open E power chord and the bass is playing steady open E eights. Our table over the page shows the harmonic (non-percussive/undistorted) content.

In this table we've shown the first thirty harmonics that

"You will need your bandmates to give you space or the evils of frequency masking will defeat you!"

Bass note frequency	Guitar root frequencies	Guitar fifth frequencies	Guitar octave frequencies
41	82	123	164
82	164	246	328
123	246	369	492
164	328	492	656
205	410	615	820
246	492	738	984
287	574	861	1148
328	656	984	1312
369	738	1107	1476
410	820	1230	1640
451	902	1353	1804
492	984	1476	1968
533	1066	1599	2132
574	1148	1722	2296
615	1230	1845	2460
656	1312	1968	2624
697	1394	2091	2788
738	1476	2214	2952
779	1558	2337	3116
820	1640	2460	3280
861	1722	2583	3444
902	1804	2706	3608
943	1886	2829	3772
984	1968	2952	3936
1025	2050	3075	4100
1066	2132	3198	4264
1107	2214	3321	4428
1148	2296	3444	4592
1189	2378	3567	4756
1230	2460	3690	4920

make up the open E on a bass guitar and the open E, second fret A-string B and second fret D-string E that make up an open E power chord (root, fifth, octave) on the guitar. We've also highlighted the frequencies that are unique to the bass guitar – these are the ones which are least easily masked by the guitar's output. The louder the guitar is compared to the bass, the wider the masking effect of its output, so rather than just identical frequencies being masked, nearby frequencies are also masked. And if you look at the table you'll see that none of the bass guitar's frequencies are all that far from the guitar's.

Fundamentally it isn't about the fundamental

One assumption you may make from this table is that if you want people to hear the bottom in your sound then you need to focus on the 41Hz output – however that would be wrong! The reasons are threefold: Firstly, the strings on a bass and on a guitar are rather short compared to the wavelength of their lowest notes. This means that the fundamental (41Hz open E on bass, 82Hz open E on guitar) is relatively quiet compared to the other harmonics. As you play higher up the instrument the fundamental becomes a greater part of the sound but down on those lowest notes most of the bottom comes from the 2nd harmonic (which is an octave higher). Secondly, very few bass guitar cabs have significant output at 41Hz – even the very deepest responding cabs are 3dB down by that point and many are as much as 10dB down (half as loud) or more – and also very few (skinny stringed) guitar cabs have much output at 82Hz (big Marshall 4x12"s have a hump a bit above 100Hz and then the output drops fairly quickly, whilst open backed cabs start dropping quickly from above 200Hz as the lows from the back-wave cancel the lows from the front-wave). And thirdly, as we discussed last month, our ears are pretty rubbish at hearing those very low frequencies. So the end result is that the bottom of the bass happens more around 80Hz than 40Hz and fortunately the guitar tends to be pretty quiet around there.

Midrange is your friend

The other key point you may (correctly) assume based on this table is that a lot of what's happening with a bass guitar is in the midrange – look at how densely packed the table is between 200Hz and 1000Hz for a single low note on the bass and compare that to a single note on the guitar. Once you figure in that in many bands the guitars will be spending quite a lot of time higher up the neck (as will the bass but probably not as far up the neck and/or across onto the thinner strings!) there really is an enormous amount of midrange space which we should be claiming for ourselves. But if you don't want a volume war to escalate you will need your bandmates to give you space or the evils of frequency masking will defeat you!