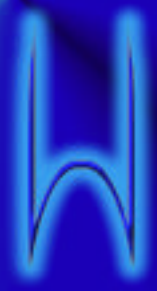

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A FEW BASS NOTES

BY

JOHN F. ALLEN

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A FEW BASS NOTES

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Concert halls, opera houses and movie theatres have more in common than one might think. First and foremost, they are all places where symphony orchestras are heard. They are all rooms where the music is typically played at one end and heard by an audience at the other end. Delivering the lowest bass frequencies is a challenge in both concert venues and movie theatres, but the reasons differ.

In a concert venue, bass is produced by the live orchestra's largest instruments (perhaps including an organ) spread out in an orchestra pit or over a stage. A stage can be some 60 feet wide and 30 feet deep or more. The orchestra's floor (as well as an air space beneath it) is very important. If too hard or stiff, the floor will fail to resonate and support the sounds of the instruments.

In today's modern cinemas audiences regularly hear symphonic scores played through loudspeakers. When one compares the large size of an orchestra (a sound producer) and the smaller size of the loudspeakers (the reproducer), we immediately see one of the reasons that bass in so many movie theatres sounds so phony, unnatural and is often described as "boom box" sound. The speakers need to be much larger that they typically are -- and by large I don't mean the size of the cabinet. To accurately reproduce the large, powerful and complex wave fronts of bass sounds, whether they be from music or sound effects, woofers need to have large radiating areas. One direct radiator woofer with two 15 inch drivers has a combined radiating area of about 1.6 square feet. Just ask yourself how many .8 square foot paper cones would it take to replicate the wave fronts coming from a symphony orchestra on a 60 foot wide resonant stage?

The answer is quite a few -- more than we are likely to find in most cinemas by far.

If we believe the job of a bass speaker is simply to deliver a peak sound pressure level in the middle of a room, we can easily compute the amplifier power required based on the speaker's sensitivity and the distance involved. The subwoofer systems in today's motion picture theatres are supposed to deliver a peak level of 115 dB SPL in the center of the room. This peak is to be the first arrival and not include the contribution that may or may not come from the reverberation in the room.

Consider a dual 15 inch subwoofer with a sensitivity of around 95 dB. This means that when one watt is sent to the speaker, it will deliver a sound level of 95 dB, one meter from the front of the cabinet. Such a woofer will therefore need 26,910 watts from the amplifier to deliver 115 dB SPL in the middle of a 100 foot long theatre. If one is a good sound system designer and adds a 6 dB safety margin, the power required becomes 107,540 watts. These impossible power requirements plus the tiny radiating area of a single such woofer are the reasons we need larger woofers and so many more subwoofers. As we can see, bass is a very big deal in sound.

While the output requirement of main screen speakers is only one-tenth that of the subwoofer(s), the bass range of the music they play is the same. While some may think that lots of large woofers are needed just for the loudest low frequency sounds, the same is true for the most subtle. Low frequency wave lengths are the same whether the sound is loud or soft. Therefore we need to be sure that both the main screen speakers as well as the subwoofers are large enough to do the job -- and oh yes, survive for years doing so. There is one thing a sound system designer can be sure of: if the low frequency drivers fail, it is the designer's failure as well. In well designed systems, the drivers should never fail due to the demands of the sound.

Once we understand the acoustic power that's needed, we need to also consider the quality of the reproduced bass that we are delivering. When sitting in a movie theatre, and because they have their own distinctive sound signature, we find ourselves thinking "there are the subwoofers" every time they're active, we are listening to a sound system that isn't doing its job very well. In fact, we really shouldn't be aware that we are listening to loudspeakers at all, just the natural sound of the program.

In concert halls and theatres, the bass is typically produced at the front of the room. It then needs to be preserved and delivered to the audience. This is where the room itself comes in. When we listen to music outdoors we hear almost no bass because there is no room enclosure to preserve it. Indeed our own back yard is also the world's largest anechoic chamber. This gives us a clue about auditorium acoustics. If the acoustics are too dead, the bass will suffer. Because cinemas are places where speech intelligibility is paramount, the acoustics of movie theatres need to be much less reverberant than we find in good concert halls. In the best halls the bass is preserved with hard walls, lots of irregular reflective surfaces and a reverberation time of around two seconds. Two seconds would be disastrous for movie theatres where we try to keep the reverberation time to 1/2 second or less. Yet there is still hope.

For the best lowest-distortion and natural bass in motion picture theatres, we need enough low frequency radiating area. In small theatres, we can live with about 6 square feet per woofer. Large theatres (indeed all theatres to be really honest) are best served with woofers and subwoofers that have around 10 square feet of radiating area each. This at least gets us in the ball park for music and effects. Properly powered, we will now have respectable bass reproducing systems.

Low frequency wave lengths are the same whether the sound is loud or soft

In my opinion, the acoustics found in many modern theatres are too dead. The argument has been that this improves intelligibility. This is indeed true. But there comes a point when adding more expensive absorption becomes detrimental. While many theatre sound systems can be unintelligible, it's usually the fault of the sound system and not the room. After all, if you can understand a live person in an auditorium but not a film's dialog, it's obviously not the room.

To preserve the lowest frequencies in cinemas without compromising dialog intelligibility, acoustic absorption should be placed where it can do the most good without diminishing the bass. This would be the wall behind audience and the ceiling. If the sound system is good enough, the side walls can be allowed to be less absorptive to allow more of the quality of the bass sounds to arrive at the listener's ears.

My final bass note concerns the floors. In both conventional and stadium auditoriums, I have noticed that theatres with wood floors exhibit inferior bass quality compared to those with concrete floors. Concrete appears to be the best choice. Carpeting the aisles is preferred, of course, but not under the seats themselves.

Sound systems designed with these guidelines in mind will deliver superior bass without trouble for decades.

John F. Allen is the founder and president of High Performance Stereo (hps4000.com) in Newton, Mass. In addition, he has served as the sound director of the Boston Ballet. He is also the inventor of the HPS-4000® motion picture sound system and in 1984 was the first to bring digital sound to the cinema. John Allen can be reached by E-mail at johnfallen@hps4000.com.