ORIGINAL
OSWALDS MILL AUDIO

WHY HORNS?

In another part of the About section (On the History of Audio) I describe how horn loaded loudspeakers were the first to be used in audio, and why they were later abandoned. Our project at OMA is to reverse this course.

Let's start with loudspeakers, because that is ultimately what you listen to in an audio system.

A loudspeaker is a transducer- it transforms an electrical signal (like music or speech) into the physical movement of a cone, or diaphragm- basically something that will move air and make a sound wave.

It's a very simple system, and you do it yourself, albeit organically; an electrical signal from your brain is sent to your vocal chords, which move and make sound, which is hopefully intelligible.

If you put a megaphone to your lips, that sound is far louder, and will carry much further, too. You've increased the efficiency of the system exponentially with the horn. Because the horn makes your voice so much louder, you won't shout yourself hoarse. The same thing happens when a horn is added to a loudspeaker- the speaker can relax and not strain, and this is extremely important for good sound.

Regular loudspeakers, such as a cone in a box, or even worse, electrostatic or planar speakers, are incredibly inefficient. A typical speaker (85dB/1w/1m@4ohm) is .1% efficient! That means that for 1000 watts input, you get exactly 1 acoustic watt output. An acoustic watt is actually a lot of sound, but compare
a horn loaded loudspeaker, which can easily be 60% efficient (108dB/1w/1m@8ohms) or 600 times more sound from the same input as the regular box speaker.

Imagine we have two loudspeakers, a conventional one (the 85dB one) and a typical high efficiency horn speaker (105dB/1w/1m @8ohms).

To reach a realistic sound level of 96dB at one meter, the conventional speaker needs 50 watts of power. The horn speaker needs less than half a watt.

Many solid state amps produce 500 watts or more, so power is not so much an issue (except on peaks in music, which can easily reach the maximum of even a powerful amplifier). The problem is thermal. When you pump hundreds of watts of power into the incredibly thin wire which is the voice coil at the end of the speaker cone, it gets very hot. This heat causes "thermal compression' which creates distortion as sound gets louder.

This compression is never an issue for horn speakers used in the home (it can be in a rock concert).

For any speaker to make sound, it must move air. The movement of the cone or diaphragm, forwards and backwards, creates the sound wave, and a critical fact is how much the speaker has to move to make the desired level of sound.

If we stood 6 feet apart in a swimming pool and I wave my hand towards you underwater, you will feel a vague wave of pressure. If I have a 2 foot long, 4" diameter pipe, and I hit my hand against one end of the pipe while aiming it at you, you will feel a much stronger wave. The pipe couples my hand to the water far more effectively than simply waving it, because without the pipe the water goes everywhere, not just where I want it. This is exactly the difference between a normal direct radiator speaker and a horn, which is just a flared pipe. The cone in a regular speaker also has to move a much greater distance to create the same sound pressure as the horn. And when the cone moves, it does not instantly stop when the signal does. It can't- it's a moving thing with mass and inertia, and so it oscillates back and forth, the more so depending on how much it has to move in the first place. Imagine a recording of a drum thwack. The speaker cone moves out to convey the strike, then backwards, and keeps doing so even though the drum strike is over. Since horns and high efficiency drivers have to move so much less to convey the same sonic information, they stop moving quicker. The sound does not get smeared, seems more real, more lifelike, faster.

In a room, a conventional box speaker produces sound which travels in all directions. Some sound wraps around the speaker and heads towards the rear wall, some goes to the ceiling, the floor, and the side walls. Some sound also reaches you directly; this is called the "near field" which is defined by a predominance of direct sound over reflected sound which reaches you later. Reflected sound, if delayed enough, does not sum with the direct sound, and the result is confusion for your brain. If the room is very reverberant, you have echoes and a complete loss of intelligibility. People with normal speakers often go to great lengths and expense to acoustically treat their rooms with absorption to combat all these reflections.

With horns, this problem is greatly reduced. One thing that horns do so well is direct the sound to where you want it. If you aim the horns where you sit, the vast majority of sound gets to you, not the rest of the room. This gives horns a much larger "near field" and that improves imaging (less reflections means more specific stereo image) and lets your brain relax because it doesn't have to figure out what to do with reflections, Crosstalk cancellation is also far better, for the same reason (that's a complicated subject in itself).

Horns in general obviously have a lot of important advantages over conventional speakers, but not all horns are created equal. In the audio world, many horns have acquired a reputation for sounding "shouty", colored or nasal. Indeed that can easily happen if the horn is not properly designed, but the real culprit is the practice of curving the walls of a horn, like a trumpet, to increase the efficiency while reducing the overall size. If you blow into a megaphone, which has straight sides and a very open throat, the sound is loud and clear. When you blow into a trumpet, with a tiny, constricted throat the sound is much louder, but also sounds like a trumpet. The megaphone is a conical horn, the only type made by OMA. In fact, OMA is the only hifi company in the world making conical horn loudspeakers. Every other company uses curved horns. One reason why conicals have been overlooked is size. A conical horn is much larger for the same bandpass (the frequency that the horn covers) than a curved horn. In an industry obsessed with reducing size, conicals have never even been on the map. But only conicals can have a completely natural presentation of music, and also "constant directivity." This term refers to how even the dispersion of sound is within the field defined by the shape of the horn. So if a conical horn has a flare of 60 degrees, and you walk around in front of it in that segment of space, the sound will be constant, even as the frequency goes up and down. Curved horns do not have this quality, which is why you usually seem them pointed directly at the listening chair. As the frequency goes up, the horn "beams" and the sound becomes focused like a laser, so if you are not sitting right where the two beams come together, you will miss part of the music. You don't have to have your head locked in a vice to enjoy OMA speakers. Everyone in front of them gets to enjoy the same sound.

All speakers require an amplifier, to increase the electrical signal coming from the source, whether it be a microphone, a record player, CD or DAC. The amplifier has to have enough power to drive the speaker to the desired sound pressure level (SPL).

Amplifier power is given in watts, and SPL is measured in decibels (dB) The decibel scale can be very confusing, because it is not linear, it is logarithmic. Every 3dB increase in level (SPL) which is pretty much the smallest db difference you can hear, requires double the power from the amplifier. And if you want to double the perceived level of sound, that requires a 10dB SPL increase. That extra 10dB will require ten times more amplifier power. If you listen at a normal level of 88dB, for example, and you want to turn the music up to a loud 98dB, that demands an amp go from say 50 watts of output to 500 watts. Musical peaks, such as with symphonic orchestras or in rock can exceed 20dB. That would most likely put your amplifier into red line territory.

What this means in reality is that with conventional speakers you must have enormously powerful amplifiers to play at the same level as a tiny amplifier with a high efficiency (horn) loudspeaker. The big amplifier will still be struggling while the little one will be happy. This has some very significant implications.

Because solid state amplifier power has only gotten cheaper (especially with the new Class D switching amps) speaker manufacturers have reduced the efficiency of their wares which allow a small woofer to produce very low bass (important for marketing and magazine reviews) and have an equally small package. Solid state amplifiers are designed to produce brute power, they don't have the finesse, detail and lifelike quality of the best tube amplifiers, especially the triode tube ones which are typically under 10-20 watts. These amplifiers are designed with the first watt as a foremost priority- that is the watt you will be listening to most of the time (with horns). The rest is reserve.

There is a world of difference between the first watt of a SET amplifier (single ended triode) and a 100 watt plus solid state or even tube amplifier. It's only with horns
that you get the full beauty and impact of the best sounding amplifiers.

A further consideration when pairing a speaker with an amplifier are electrical parameters which never get proper coverage in the magazines or online. Besides impedance, the "damping factor" presented to the speaker by the amplifier is a significant factor in sound quality and especially, bass reproduction. A speaker actually forms an electrical circuit with the amplifier, it's a two way street, so to speak. Every woofer has a "damping factor" which is the force necessary to restore the woofer to equilibrium after movement. The amplifiers output stage can have a very wide range of damping factor.

Low efficiency speakers get a lot of bass from little woofers by making them move a great distance, which means they need a very loose "suspension" the surround of the cone that allows it to move and keeps it in place. Such woofers need a high damping factor to make them behave.

High efficiency
woofers are larger, have stiff, light paper cones with big magnets and move very little. They need very low damping factor, which is typically what SET and other low power tube amplifiers offer.

While the complexity involved in assembling a horn loudspeaker system may seem daunting, the results when successful far surpass any other loudspeaker technology.

Dynamics are one of the most important attributes in what makes reproduced music sound real, for example. Amazingly, in the audio world with all of its tests like frequency response, acoustic and electrical phase, waterfall plots of time domain response and so forth, there exists no test for dynamics.
Horns are the only type of speakers with
realistic dynamics.

With horns, problems with room acoustics are dramatically reduced.

The range of amplifiers that can be used with
horns
is limitless. Distortion is radically reduced. The sound is spellbinding.

But of course, there is one more thing to consider. Horns can be beautiful like no other speaker.

PLAGERIZED
AUDIO NOTE POST

ON THE IMPORTANCE OF HIGH EFFICIENCY LOUDSPEAKERS

This newsletter is based on an essay by Jonathan Weiss, founder of Oswald Mill Audio (QMA). QMA and Audio Note appear to share some common philosophies when it comes to crafting World's Finest Audio.

A key difference however is that QMA focusses on the craft of horn-loudspeakers, while Audio Note found a way to create high efficiency loudspeakers which do not exhibit the limitations of horn-loudspeakers (size and directionality among other things).

However, both QMA and Audio Note agree that high-efficiency loudspeakers are key to good sound. Here is why...

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It's a very simple system, and you do it yourself, albeit organically; an electrical signal from your brain is sent to your vocal chords, which move and make sound, which is hopefully intelligible.

Regular loudspeakers, the vast majority of loudspeakers, are incredibly inefficient. A typical modern 'high-end' speaker (85dB/1w/1m@4ohm) is .1% efficient! That means that for 1000 watts input, you get exactly 1 acoustic watt output. An acoustic watt is actually a lot of sound, but compare
the Audio Note HE loudspeakers, which are 4% efficient (98dB/1w/1m@8ohms) or 40 times more sound from the same input as a regular box speaker.

Imagine we have two loudspeakers, a conventional one (the 85dB one) and a typical high efficiency Audio Note loudspeaker (96dB/1w/1m @8ohms).
To reach a realistic sound level of 96dB at one meter, the conventional speaker needs 50 watts of power. The Audio Note speaker needs only one watt. The HE versions only 0.6 watt.

Many solid state amps produce 500 watts or more, so power is not so much an issue (except on peaks in music, which can easily reach the maximum of even a powerful amplifier). The problem is thermal. When you pump hundreds of watts of power into the incredibly thin wire which is the voice coil at the end of the speaker cone, it gets very hot. This heat causes "thermal compression' which creates distortion as sound gets louder.

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