Subject: Unity horns???? what is a Pi Speaker horn?
Posted by Matthew on Sun, 24 Apr 2005 00:23:30 GMT

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I want to build a unity horn or something that will offer the same Sound Quality and SPL ablities (SQ needs to be as close as possible to the unity)This is a suggestion from thylantar who's been helping me:"Why not build some Pi Speaker horns? Wayne will giveyou the plans. He offers different designs, horn and not.http://audioroundtable.com/PiSpeakers/Just ask. I don't remember which product line is the big horn."So I posted here... can you guys tell me a little about your Pi speaker horns???? and what's the difference between that and a unity horn

Subject: Re: Unity horns???? what is a Pi Speaker horn?
Posted by Matthew on Sun, 24 Apr 2005 01:16:38 GMT

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Wayne or anybody could you email or post some info about your pi horns?? maybe even email me plans???THANKS!

Subject: Re: Unity horns???? what is a Pi Speaker horn?
Posted by Wayne Parham on Sun, 24 Apr 2005 01:28:36 GMT

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If you are interested in Unity horns, you might bring them up on the High Efficiency forum because I do not use them. The Unity device is a horn that Tom Danley came up with that has midrange and tweeters sharing the same flare. It's an interesting concept, but since several drivers fire into a common chamber, their interaction is highly coupled and phasing in the overlap range is extremely critical. It's a delicate balancing act, tenable at low frequencies but more unlikely as the crossover frequency goes up. In its best trim, everything is right on the edge and any shifts in operational parameters due to component tolerance, age or power heat cycles can throw it off. The midrange drivers not being loaded at the apex necessarily cause more internal reflections

some reading here, because there is a lot of information. After you have looked around a while, I'd be happy to respond to any specific questions you have.

Subject: Re: Unity horns???? what is a Pi Speaker horn?
Posted by Bob on Sun, 24 Apr 2005 03:03:34 GMT

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What about time alignment?

if that's what you mean. That's the main goal - Make sure there are no destructive nulls formed by the interaction between adjacent drivers within the coverage pattern. If this isn't done properly, then there will be a spiked dip in response within the pattern, usually somewhere within an octave

Speakers are designed so that this doesn't occur. Response is uniform over a wide horizontal arc, usually larger than the rated 90⁰, and through at least a 40⁰ vertical arc. Above and below the forward lobe, HF output is greatly reduced because it is outside the pattern. There are nulls that form outside the pattern, but they are of little consequence.I have never liked the phrase "time alignment" when applied to loudspeakers. Discussions about time alignment take the same tone as Pogue carburetor discussions. It always seem to get some people real charged up, but I think it means different things to different people. True time alignment in 3D space isn't possible, it's just not the way things work.A loudspeaker is reactive by its very nature. Not only is it electrically reactive - which would make phase/time jiggle in two dimensions - but it is also acoustically and mechanically reactive, as well as having some effects that are variables in 3D space. That means it is simply not possible to be time aligned.If you make the "alignment" goal be +/-90⁰ phase at a position or range of positions, then you've got something you can achieve. In my opinion, that's what is really important because it's the way to prevent having destructive nulls. But I don't consider +/-90⁰ phase shift as being time aligned, although I'm sure that others do. I guess you could say it's a matter of defining what you call "alignment."You can do some things in the electrical realm that would modify phase in a productive way, and you can reduce phase shift on-axis. This may or may not be audible. What is definitely audible, however, is interactions between adjacent drivers that cause destructive summing in the crossover region. This is usually avoided on-axis, and with careful design, can also be mitigated off-axis to some degree. In my opinion, one of the best "advanced" loudspeaker design goals is exactly that: To reduce the effect of off-axis nulls by moving them far off-axis, as far outside the pattern as possible.The idea is to make a nice large forward lobe that is acoustically pure, and to reduce sound output outside this area as much as possible. Sound radiated outside the forward lobe is contaminated with bands of nulls and side lobes, so naturally the spectral balance is poor. A listener moving in this area perceives a phasey sound. Sound radiated at large angles is usually unwanted anyway, because it serves little useful purpose, generally adding only to unwanted reflections. This is particularly true of sound radiated at large vertical angles, certainly in domestic hifi environments.That brings

models through the uniform directivity cornerhorns are designed to provide uniform 90⁰x40⁰ coverage with no nulls in the pattern. I believe this is the most useful pattern for domestic hifi environments. It's wide enough to cover the room, and relatively narrow vertical angle covers the listening area without causing ceiling slap. The horn reduces HF output at large vertical angles, and that's exactly what I want it to do. It has a nice wide horizontal coverage, which creates

uniform spectral balance throughout the room.

What will the unity horn offer me from a sound quality point of view over a different design where the HF horn is seperated from the midrange horn? Is this a worthy project for a DIY'er to try to get the best sound or is it a novelty project because the midrange, tweeter exit the same horn and if you add some woofers, the bass exits the same horn.I'm trying to get non-biased feedback, i.e., if you ask a unity horn user sure they will say it's great, I figured that you would be the person to ask for a honest opinion.

The Unity concept is interesting but I think it tries to solve one problem by doing something that introduces two more problems. It may be that in prosound applications, its benefits outweigh its liabilities or it may just be a marketing strategy that isn't particularly useful compared with other prosound designs. I don't know, and I don't care to speculate. I do not think it is the best approach for high fidelity sound in domestic environments.

The way I see the Unity horn, the idea is to place the midrange and tweeter very close together, arranging them within the horn in such a way that the off-axis nulls are outside the pattern in both the horizontal and vertical axis. That is of course a worthy goal, something anyone seeking constant directivity over a large bandwidth strives for. Its strength is the close grouping of drivers, something like a coaxial arrangement. But its weaknesses are that the midrange drivers are placed in the side walls of the horn, where their wavefronts collide with the adjacent and opposing side walls and the apex of the horn. This causes multiple reflections in addition to the desired wavefront travelling forward. The midrange side holes are also a discontinuity for the tweeter expansion, which causes unwanted reflections for it too.

The first Unity horn I encountered did not even solve the problem of maintaining constructive interaction within the pattern. There was a pronounced null that caused a sharp 15dB notch at 4kHz. To me, this was unacceptable, since the stated benefit of having this configuration was to provide an acoustic source that acted like it came from a single radiator having constant directivity. The notch clearly exposed the multiple drivers as a summing anomaly.

This would be a difficult speaker configuration for a DIY'er, I would think. You're juggling a lot of things. You have to position the midrange and tweeters and make the crossover provide

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summing on-axis. That's the first step. The coverage pattern cannot exceed the angle of the nulls, which is the second step. If summing is constructive on-axis, then it should remain good out to the edge of the pattern. Nulls should not be allowed to form within the pattern. The third step is to do something to mitigate the problems of discontinuities from the sidewall holes and the internal reflections that result. Each of these steps have to be done simultaneously, so it's a juggling act. You'll need a lot of empirical "cut and try" testing, or a heck of a good FEA program to analyze all the stuff going on.

By the way, in addition to the claims of time alignment, some people have been given the idea the Unity horn generates no nulls outside the pattern. Some are saying the Unity is immune to the things that cause lobes and nulls to form. This is not true. I suppose there is an attraction to "silver bullet" ideas, but the truth is even if you have a single point source horn, lobes and nulls still form outside the pattern because of mouth diffraction. Summation between multiple drivers isn't the only cause, so even if you were to obtain perfect summation in 3D space, lobes separated by nulls form in the far field because of Fraunhofer diffraction.

Diffraction pattern from a square mouth

Subject: Re: Wayne
Posted by Adrian Mack on Wed, 27 Apr 2005 15:10:53 GMT
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As for a 'worthy' project, it is if thats the sort of thing that intriges you. IMO the unity horn seeing as it only offers time alignment from 300Hz to about 4Khz (if I recall correctly), is not something which you should get caught up in. As a DIY project, it is a very difficult task and those that have done it have put hundreds of hours of tweaking into it because the positions of the drivers has to be very precise, and getting phase cancellations at the throat from the multi-drivers is a big problem when attempting it as a DIY. As Wayne said, what you should aim for is flat response and phase alignment within a specific margin. EG: +/- 90degrees. This is something you can achieve with seperate horns. The concept of the unity is appealing and I'm sure Tom Danley's unity horn does sound very good, but you can achieve a system which sounds just as good by other means. But in answer to your question, I would not try it as a DIY project unless you have heaps of spare time, good measuring equipment and the money to try dozen's of combinations of different compression drivers and middrivers and xover configurations to get it right.