Subject: Re: My personal opinions of various design philosophies
Posted by Wayne Parham on Mon, 25 May 2009 04:35:40 GMT
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Norris Wilson wrote on Sun, 24 May 2009 12:40Regarding the 3kHz collapse of the vertical beam pattern created by the 40 degree angle of the horns that you use in your designs. I am wondering if the size of the throat of these horns, the H-290 being 1" as a example, have any effects on this 3kHz beam-width collapse point?
The significance of the ~3kHz point is that's where the 90°x40° horn begins to gain pattern control in the vertical plane. It is related to the mouth size and the flare profile of the top and bottom walls.

The size and angle of the compression driver exit sets the pattern at very high frequencies. The typical 1" exit driver has a "stub" - a short tapered pipe between the phase plug and exit orifice. The taper is 8° to 10°, so from about 14kHz upwards, the pattern narrows to this angle. None of the waveguides are able to retain their beamwidth above this point.

Larger compression drivers shift this narrow beamwidth range down, respective of their exit orifice. A 1.4" device begins to narrow to exit angle at approximately 10kHz and a 2" exit device narrows to exit angle around 7kHz.

Norris Wilson wrote on Sun, 24 May 2009 12:40As you know, I have the Beyma constant directivity TD-250 1" horns with 90 degree by 40 degree dispersion angles.

There is a bump, or slight rounded over protrusion with a flat side that is positioned on each side of the throat of the horn. This protrusion is positioned about 1.5" in front of the horn throat where the CD attaches. Would this protrusion be a diffraction slot that you feel introduces discernible distortion in the bandpass?
This is a diffraction slot, same as the JBL 2370 and many other horns. It can sound spitty, but it does have one advantage: The beamwidth stays high even through the top octave. The edges on each side of the throat provide a diffraction edge that bends the wavefront, keeping the pattern wide even at high frequencies. If it's really important that the top octave have a wide pattern, that kind of horn will do it for you.

One thing the diffraction-free designs can't do is to maintain beamwidth up high. At some point

conicals and radials that don't have a diffraction slot in the throats begin to beam. This is because the horn isn't setting the pattern anymore, the compression driver is. Without a diffraction slot, the exit angle of the taper in that little stub becomes the significant feature of the waveguide/horn at high frequencies.

You may remember I showed you a version of my wood horn where I had added a diffraction slot to the throat. I did this specifically to experiment with different acoustic devices, to measure and listen and find out what I liked and what I didn't. I didn't like it with sharp edges, but actually found I liked the one I showed you, which had mildly rounded edges. It didn't sound harsh yet provided wide beamwidth all the way up through the top octave.

That horn went through a lot of versions in the prototyping stage. I had in mind a horn with mildly collapsing DI in the vertical and constant directivity in the horizontal, and with a perfectly matched throat to horn transition. I also wanted edge rounding, and a large enough mouth to support freespace operation, since the horn is decorative and would not be baffle mounted. However, the mouth could not be so large that the center-to-center spacing would put vertical nulls too close together, like a round horn does.

I tried one version with straight walls on both sidewalls and the top and bottom, only radiused from the throat transition and at the mouth edge. This is basically the same as the Peavey Quadratic throat horn or the JBL PT waveguides. It was pretty good, but one thing I didn't care for was the region where the horn gained vertical pattern control. It makes a lot of ripple there. I think that's because the horn goes from a very wide pattern to very narrow in the vertical, then after rippling a bit settles down to a fairly constant beamwidth.

The problem is in that transition region, because it creates so much ripple, right around 3kHz. I'd rather have the directivity collapse be more smooth. In a sense, what I'm saying is I don't want constant directivity in the vertical from a horn this size because it cannot be done until midband, so the directivity transition causes problems.

I tried another horn shape with straight sidewalls and an exponential curve on the top and bottom, with a last couple inches closest to the mouth radiused more like a tractrix horn. The sidewalls were radiused from the throat for a smooth transition from driver exit to horn body. Basically, the sidewalls were like a quadratic throat horn or PT waveguide, but the top and bottom walls were exponential, like a radial horn. The mouth exit was radiused like a tractrix.

I liked this one quite a bit, because it provided constant 90° beamwidth in the horizontal plane and smoothly collapsing directivity in the vertical. This one has nice smooth response and good polars. The vertical beamwith was about 50° around 2.5kHz and about 30° at 10kHz. That's a nice usable beamwidth, and its smoothly collapsing DI prevented ripples in the passband.

A third variant has the same curve on the side walls as the cross-section of an oblate spheroid. Top and bottom walls were made same as the previous horn. The mouth exit was radiused, same as the others. This is the shape I ultimately chose.

The differences between the horn with oblate spheroidal side walls and the one with straight side walls were pretty subtle. You could see small response differences, but nothing huge. Each had it's own signature, but both were winners. In the end, I chose the oblate spheroidal profile because I think it makes the most sense. I would have been satisfied with the straight walled version, but the OS shape was better.

Norris Wilson wrote on Sun, 24 May 2009 12:40Taking the Four Pi design as an example using the JBL 2226 as the woofer, and Eminence H-290 as the horn mounted in the baffle per your latest version. Could an 8" to 10" diameter midrange driver that is baffle mounted above the treble horn, and crossed in around 250Hz to 300hz from the 2226 with a shallow sloped filter, be retrofited to work properly under your design premise using the vertical nulls? I guess you could say this would be a W-T-M vertically stacked baffle arrangement.
I suppose you could do that, but the traditional WMT with a midhorn in the middle does exactly what you want. It provides pattern control via horn directivity and the null angle is set by vertical