Subject: Re: H290C Horn/Waveguide
Posted by Wayne Parham on Tue, 03 Dec 2013 22:32:04 GMT
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There were several influences that drove my decision to create this horn. The most important one was an observation that radial horns having relatively constant horizontal directivity sounded best to me. Objectively, they had smooth response and uniform horizontal directivity. Their physical features were much like modern waveguides, having no sharp edges in the flare.

The H290C is very much like a radial horn of similar size, except that its OSEC flare profile is defined as the hyperbola created from a line drawn tangent to an elliptic cylinder or oblate spheroid:

When I first heard about this flare profile, I began to study it and found this shape was used in other disciplines as an antenna, horn, lense or other waveform radiator. This is an important "litmus test" for me, because the most successful ideas tend to be used in all engineering fields. Where I see things in just one field (and especially in audio), I am skeptical. Audio is saturated with fads and misguided pseudo-science, some even coming from big names in the industry. But this isn't one of them, and devices created using this profile provide fairly clear advantages.

However, the advantages are only found if (and this is a big "if") the waveguide/horn is properly built. Just having this basic shape isn't enough. Just like you can make a good exponential horn or a bad one, or even more so a good conical horn or a bad one, this flare profile has a few "sweet spots" and a bunch that aren't so hot. One is well advised to model the horn, optimizing it for best response and beamwidth/coverage. It isn't a "given" that this particular profile can be used no matter what exit angle is desired. Some work well, but some, not so much.

That was the basis for the last post, just above. It gives a feel for a well designed horn, and one that isn't optimized as well. Both have the same coverage pattern, but one has significantly more ripple.

More information:

The Sound Field and Radiation Impedance of a Hyperbolic Horn, by Vincent Salmon. This is the classic paper defining "Salmon family" horns.
The Webster Equation Revisited, by Sjoerd Rienstra. Another look at the famous 1P model, and it's limitations.
Reply to "How Horns Work", an overview on horns based on elliptical coordinate systems by Earl Geddes.
The horn-feed problem: sound waves in a tube joined to a cone, and related problems, by P. A. Martin. This paper looks at the interface between planar source and waveguide, and it invites a study of other disciplines, such as waveguide/horns used for electromagnetic radiation.
Geometrical representation of the fundamental mode of a Gaussian beam in oblate spheroidal coordinates, by Barbara Landesman. This paper looks at the fundamental propogation mode and higher-order modes when using devices based on oblate spheroidal coordinates.

A New Mathematical Model for a Propagating Gaussian Beam, another look at wave propogation through OS devices by Barbara Landesman
The Paraxial Approximation, an explanation of the concept.
Optimum Horn Mouth Size, by Don Keele. A paper written that speculates there is an optimum horn mouth size. It suggests that the radiation is neither planar nor spherical, but something in between.
Wave Propagation and Radiation in a Horn: Comparisons Between Models and Measurements, by Eveno, Dalmont, Caussé and Gilbert. Further study of the planar versus spherical radiaton models, a comparison showing differences.
Input impedance computation for wind instruments based upon the Webster-Lokshin model with curvilinear abscissa, by Thomas Hélie, Thomas Hézard and Rémi Mignot. This paper models horns and waveguides using an improved 1P approach that accounts for visco-thermal losses at the horn walls.
Computer Simulation of the Acoustic Impedance of Modern Orchestral Horns, by A. Benoit and J.P. Chick. A study of computer models used to calculate horn impedance. It proposes using a 3D element model rather than a 1P transmission line model for greater accuracy.
A Modeling and Measurement Study of Acoustic Horns, by John Post and Elmer Hixson. An exhaustive study of models and measurements, and of comparisons between them, seeking to refine models. Both 1P and 3D approaches are explored. It discuses propogation modes in some detail, from primary to high-order modes. Appendix A discusses Electromagnetic and Acoustic analogies, which I think is always important. I personally look for things that span across multiple disciplines, because truly good approaches always do.
Horn Loaded Loudspeakers, by Richard Morgans at the Department of Mechanical Engineering, University of Adelaide. This is another very elaborate study of various approaches to using mathematical models to simulate horns, and comparing them with actual measurements.