loudspeaker. The woofer is loaded by a midrange horn and also reflex tuned for bass.The reason I only use 12" and 15" direct radiating midwoofers with horn loaded tweeters is directivity is matched at the crossover point. Any smaller than that and I would need to shift the crossover higher to match in the horizontal plane. That would be fine except this shift causes the vertical null angles to grow smaller.The radiating pattern of a cone loudspeaker approximates a rigid piston in that it collapses to about 90° at the frequency where diamater equals wavelength. Of course, the diameter of interest is measured across the radiating surface, not the entire loudspeaker. Another factor is the cone shape, which contributes to directivity somewhat. In general, I find it is closest to think in terms of matching directivity in the horizontal plane within a half-octave or so of the wavelength equals diameter rule. In other words, if crossing a direct radiating midwoofer to a 90° horn, 15" woofers should be crossed over around 1kHz to 1.5kHz, 12" woofers from 1.2kHz to 1.8kHz, 10" from 1.8kHz to 2.4kHz.The problem with going to midwoofers smaller than 12" diameter is the crossover point has to go up to around 2kHz or higher. When you do that, the vertical nulls draw closer together. The smaller driver allows closer center-to-center spacing, and that helps, but not enough. When you run the numbers, you usually find it hard to widen the null angles beyond 15°. I prefer a little wider angle than that, with 20°

the midhorn. In this case, the horizontal directivity is matched by the horn, not by collapsing DI.

crossover. This provides matched directivity through a wide bandwidth.