What is the Effect of Corner Treatments on TL Performance?

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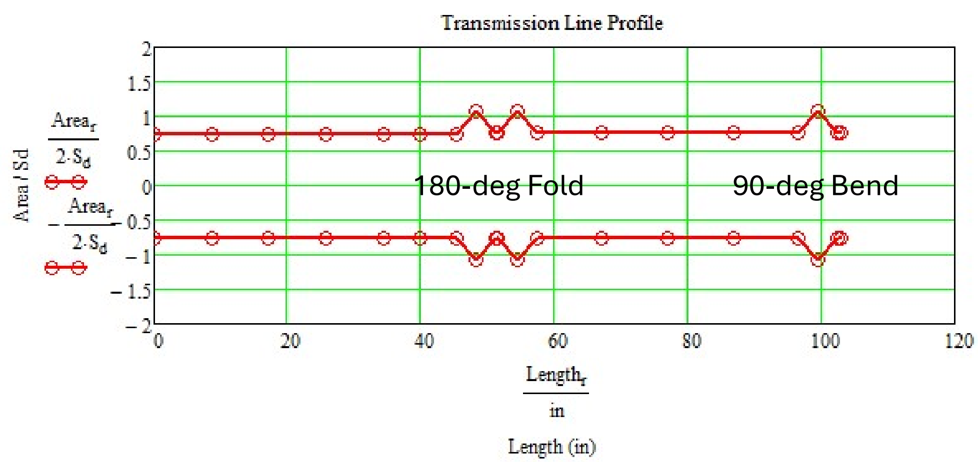
Introduction

The results presented in Part 3, of my series of presentations about the Satori TL design, included a new Advanced Corner Modeling method for analyzing folds and bends in TL enclosures. By defining a set of parallel paths traced around the fold or bend, a low-pass filter was formed that rolled off the terminus output as frequency increased. With this new way of modeling folds and bends the impact of corner treatments, such as rounded or 45-degree inserts, can also be evaluated. The Advanced Corner Modeling method has been updated to simulate these two options for corner treatments and the impact on TL performance has been calculated.

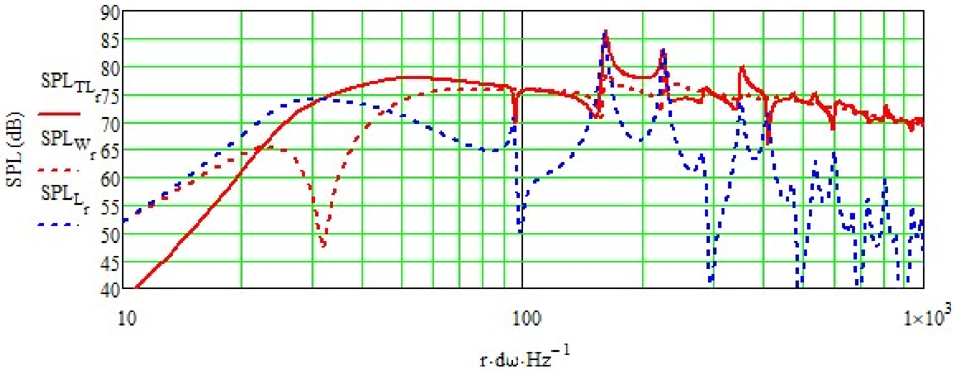
There is always debate about the importance of corner treatments in TLs, hopefully this short presentation can shed some light on this often-discussed topic.

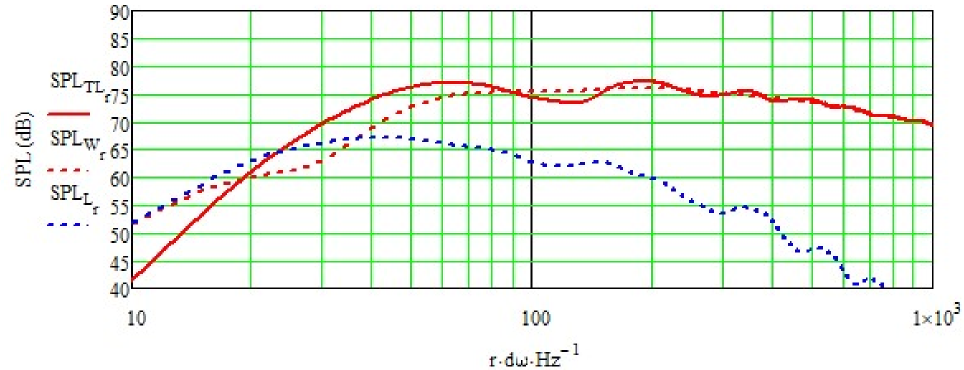
Geometry Definition

To simplify the problem so that just the impact of corner treatments would be studied, a straight constant cross-sectional area TL was used. The Satori WO24P-4 was modeled in an ~100-liter volume tuned to the driver's resonant frequency. The woofer was offset to 1/3 of the length and 0.5 lb/ft^3 of fiber stuffing was placed in the first 2/3 of the length. The Satori TW29R and the passive 2nd order crossover were retained in the MathCad models.



Baseline TL - SPL Results



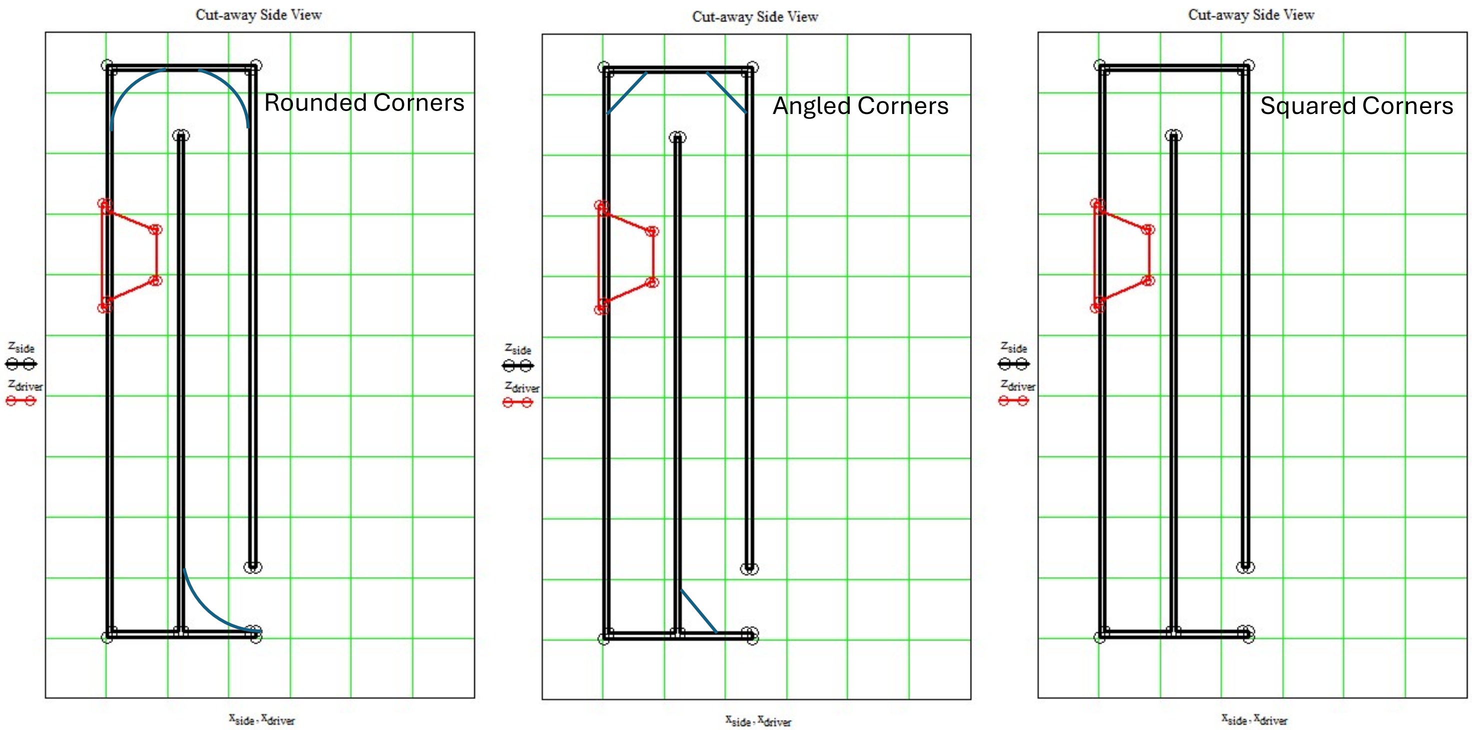


These results **do not** include the Advanced Corner Modeling method. The empty and stuffed TL SPL curves show the peaks, nulls, and resulting ripple expected. The solid red curve represents the combined SPL response while the dashed red and blue curves show the driver and terminus SPL responses, respectively. All SPL results are calculated in an anechoic environment at 3 m on the tweeter axis and include the baffle step and the low-pass crossover.

The empty TL's SPL response has peaks and nulls associated with the fundamental standing wave at about 32 Hz (1/4 wavelength) and the harmonics at 96 Hz (3/4 wavelength, which is almost eliminated by the driver's offset), 161 Hz (5/4 wavelength), 225 Hz (7/4 wavelength) and so on.

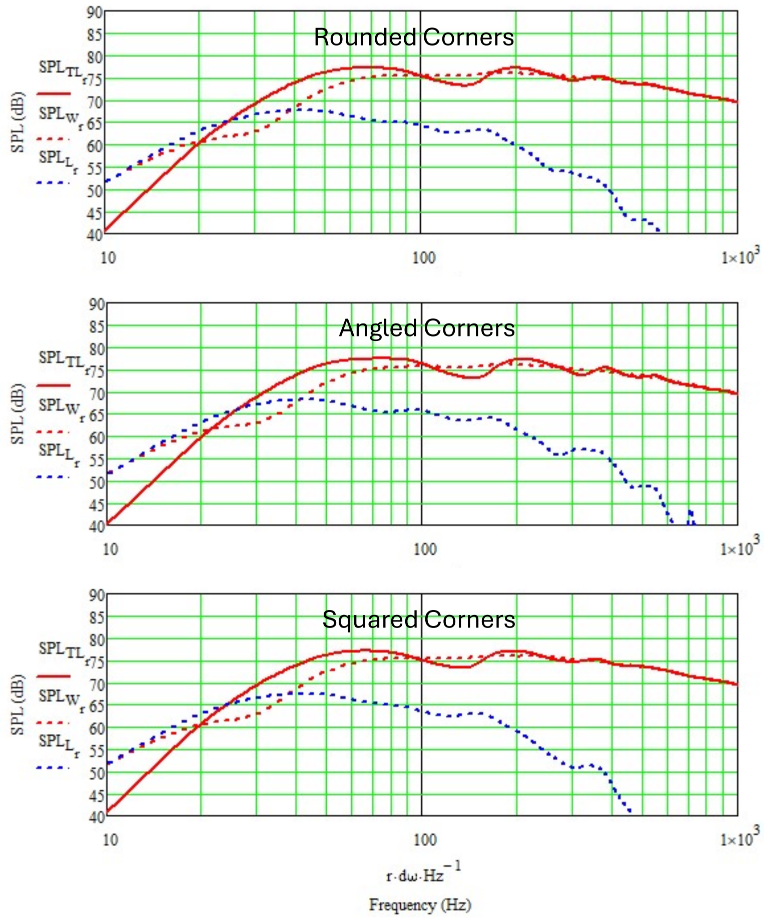
The stuffed TL's SPL shows that most of the peaks and nulls have been mitigated by the fiber stuffing. Some amount of ripple is retained in the SPL curves to help demonstrate the impact of using the Advanced Corner Modeling method.

TLs with Advanced Corner Modeling Method



Three corner geometries were modeled and the TL's low frequency SPL outputs calculated.

Advanced Corner Modeling SPL Results



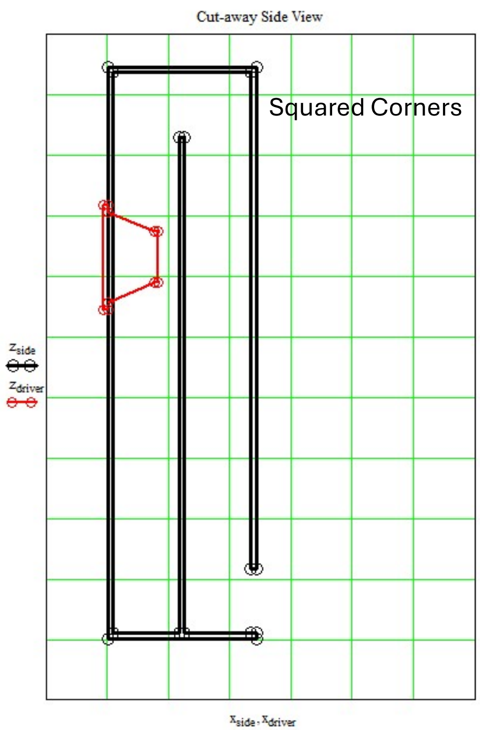
For all three geometries the low frequency (below 100 Hz) SPL responses are essentially the same. Corner treatments have no impact.

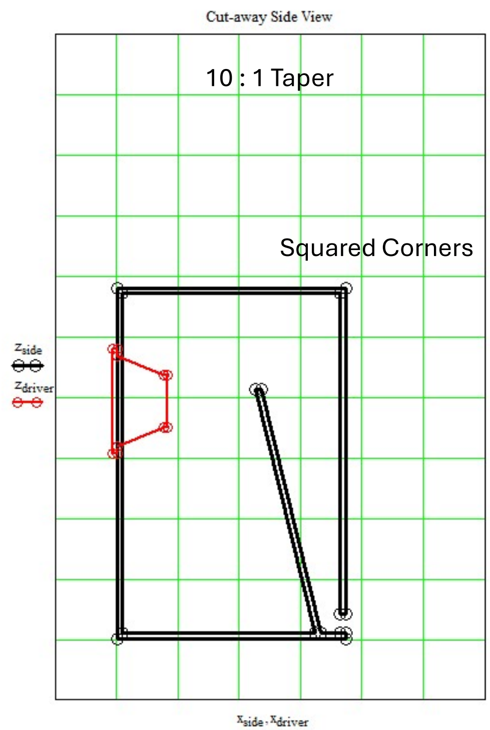
The top plot shows the results with the corners filled with rounded inserts, tracing along the centerline of the TL the cross-sectional area is constant for the entire length. However, the inner and outer path lengths going through the fold and the bend are different. This produces the rolled off terminus output compared to the baseline SPL results, right-hand plot, on slide 4.

The middle plot calculates the SPL results with 45 degree inserts at each corner. Again, there is a rolling off of the terminus response and the ripple in the combined SPL response is a little less compared to the baseline results. The inner and outer path lengths are very similar to the rounded corner’s lengths.

The bottom plot shows the results without corner inserts. This geometry produces the largest difference in the inner and outer path lengths and the largest terminus output roll-off. As a result, the ripple in the combined SPL result is also significantly reduced.

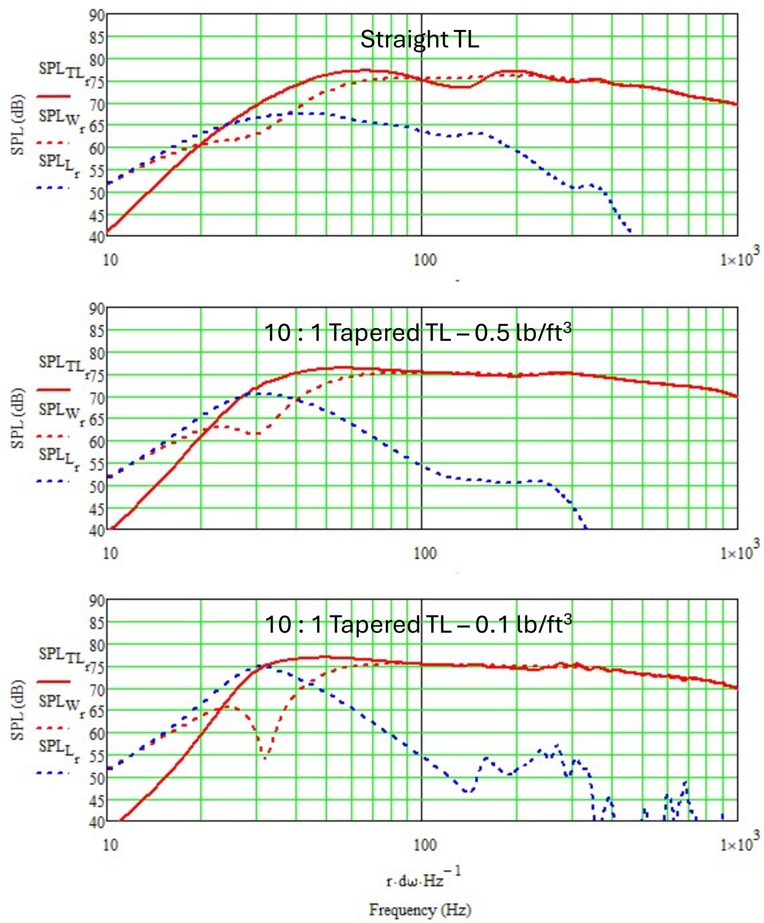
TLs with Advanced Corner Modeling Method





To maximize the difference in the inner and outer path lengths, tracing through the 180-degree fold, a 10 : 1 tapered TL was modeled. This is an equivalent TL, the tuning frequency and internal volume are the same as the straight TL.

Advanced Corner Modeling SPL Results



The top plot is the same as the bottom plot on slide 6. A straight TL with an offset driver, without corner treatments, and a fiber stuffing density of 0.5 lb/ft^3.

The middle plot shows the impact of using an equivalent tapered TL. The larger difference in the inner and outer path lengths in the 180-degree fold increases the terminus output roll-off. As a result, the ripple in the combined SPL result is also significantly reduced. If the ripple is being controlled by the corner geometry, it follows that the density of fiber stuffing can be reduced.

The bottom plot reduces the fiber stuffing density by a factor of five. The ripple in the combined SPL response is still controlled. However, the low frequency combined SPL response now extends almost 10 Hz lower before rolling off at 24 dB/octave!

Final Thoughts/Speculations on Corner Geometries and TL Performance

- I don't see any acoustic benefits to adding rounded or angled inserts into the corners of a folded TL. Maybe additional structural reinforcement is the goal, but it comes at the expense of low frequency and passband acoustic performance.
- Again, the low frequency benefits of a tapered TL are demonstrated. Less ripple, less stuffing required, deeper bass for the same tuning frequency.
- Reviewing some of the commercial TL geometries that use foam for damping recognizing that in Part 4 it was shown that foam was not as effective as fiber stuffing at damping standing waves. The commercial TL products tend to be straight TLs, without driver offset, with many folds along the extended length, and significant amounts of foam lining the walls. I am now wondering if controlling the low frequency and passband performance is more a function of the number of folds than the foam lining.
- Do a series of folds increase the "order" of the low-pass filtering of the terminus SPL output? I am speculating that each additional fold will filter out more of the higher harmonic standing waves resulting in a smoother combined SPL response. Probably less damping is required (so foam works) resulting in deeper bass extension. Something to consider in my next design, particularly if it is a folded BLH enclosure (really an expanding TL).