Virtual Education Lab: Does the uniform scattering from a semicylinder remove the comb filtering produced by specular reflections from a flat surface?

What happens when a reflector is not flat but a semicylinder? The scattering properties of a semicylinder were reviewed in DR 220609, where the experimental 2D boundary plane goniometer was compared with simulations from VIRGO. This excellent agreement is reviewed in Figure 1. Since the scattered energy is uniformly distributed, does this mean a semicylinder is a good diffuser? These plots tell only part of the story, i.e., the scattered spatial response. They do not show the temporal response. When the delayed scattered sound combines with the direct sound, it forms the total field, which is what we hear. In Figure 2, we compare the impulse response and total field frequency response (scattered plus incident) for a flat panel and a semicylinder of the same width, where the width is a factor of 10 or more greater than the incident wavelength, i.e., satisfying the specular reflection condition. In Figure 2 (top left), we show the incident direct sound, the reflected sound, and the small negative magnitude edge diffraction, between 10 ms and 12 ms. In Figure 2 (top right), we show the direct sound and the reflection from the semicylinder. The reflected sound for the flat panel and the semicylinder is similar, with the exception that the reflected sound from the semicylinder is attenuated slightly, due to spatial dispersion.

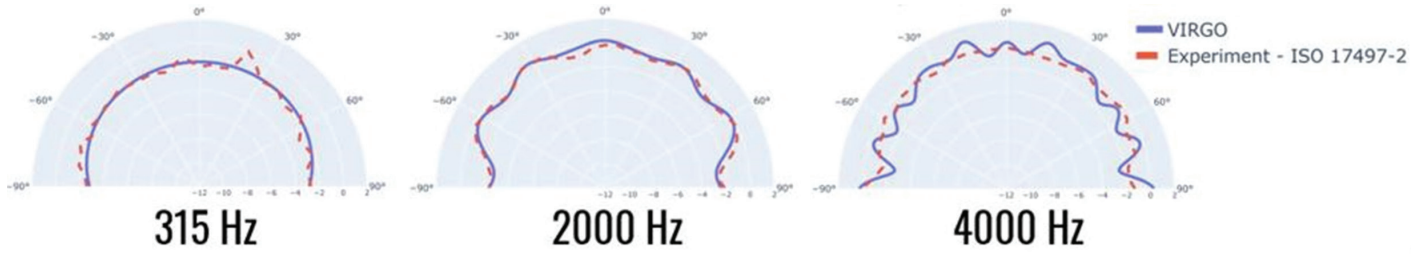

Figure 1. Polar response of a semicylinder at three octave band center frequencies.

In Figure 2 (bottom left), we show the comb-filtering response for the flat panel and the semicylinder (bottom right). While the scattered sound from a semicylinder produces uniform spatial scattering, it still produces comb filtering similar to that generated by the flat surface, however, with a smaller minima and maxima magnitude variation.

Since an architectural acoustic design may require coverage for a larger area than one semicylinder, we could consider the use of several periods of a semicylinder. In DR 220609, we also illustrated the diffraction lobes generated by periodicity and their negative effect on the diffusion coefficient. One possible solution is to introduce aperiodic modulation, a topic we will discuss further in our pending discussion, when we move from reflection to diffusion.

This is a brief review of the comb filter produced by a semicylindrical surface. For a more thorough discussion, please refer to my book with Prof. Trevor Cox called Acoustic Absorbers and Diffusers: Theory, Design, and Application, 3rd Ed., CRC Press (2017).

In the next post, we will describe the scattering from another departure from a flat panel, namely a triangle or pyramid.

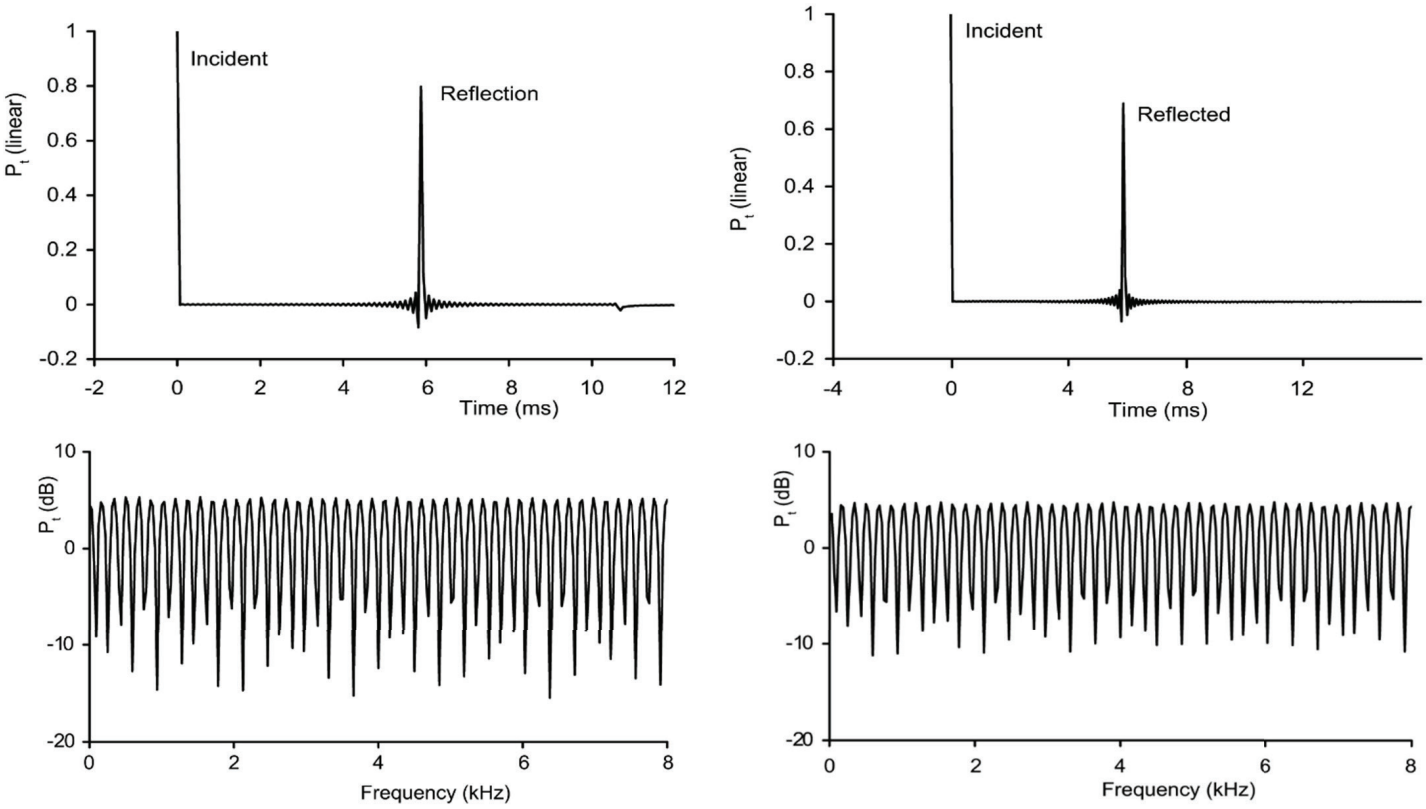

Figure 2. Top: Incident and reflected time response; left flat panel, right semilyinder. Bottom: Comb-filtering; left flat panel; right semicylinder.

Dr. Peter D'Antonio
Director of Research
Acoustical Research Center