Virtual Education Lab: Overcoming grating lobes due to periodic arrangement.

The final solution to improving reflection phase gratings is related to removing the integer related well depths associated with a number theory sequency, which result in the diffusor transitioning into a reflecting panel at integer multiples, n, of the prime, N, times the design frequency f_0, (nNf_0). The integer related well depths for simple QRD based on a prime 7 are 1,4,2,2,4,1. If you know the depth of well sequence number 1, you know t hem all. For this diffusor with a design frequency of 500 Hz, the diffusor will transition into a reflector at the flat plate frequencies of 3500 Hz, 7,000 Hz, 10, 500 Hz, etc. This is illustrated in a very old overhead projector transparency in Figure 1. This happens because at these frequencies all of the walls are scattering in phase and the uniform diffusion is nullified.

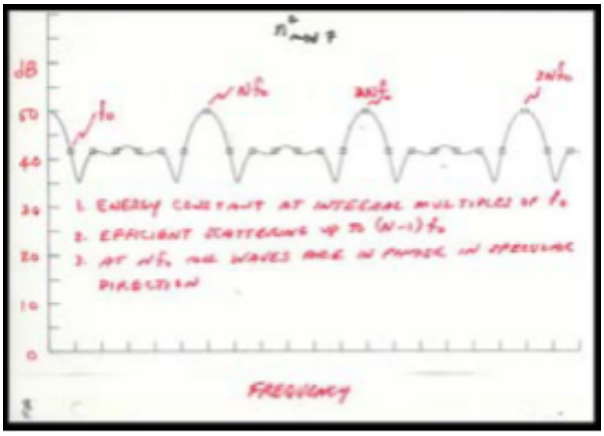

Figure . Flat plate frequencies at nNf_0

To determine an improved well depth sequence, we created a wave based Boundary Element Method software called the Shape Optimizer. The flow chart for the Shape Optimizer is shown in Figure 2. It is an iterative search for a well depth sequence that provides a satisfactory diffusion coefficient.

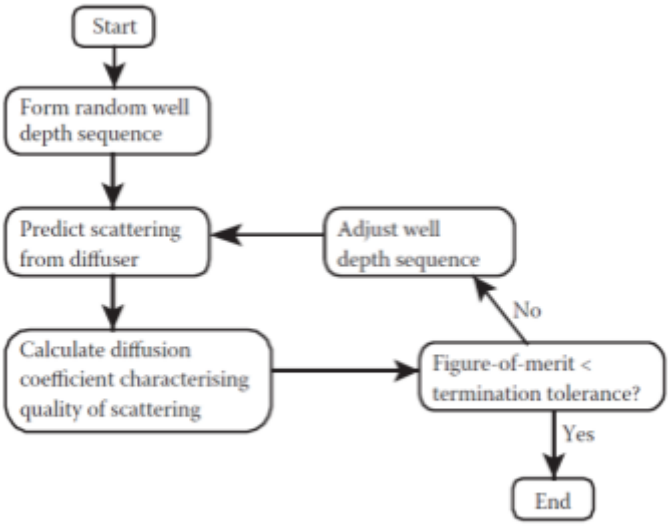

Figure . Shape Optimizer flow chart.

This optimization process produces an asymmetric non-integer related well depth sequence. Thus, we eliminate the flat plate

To do this iteratively requires the following:
1. A validated BEM prediction model.

2. A diffusion coefficient to measure quality of scattering, based on ISO 17497-2.

3. A robust optimization algorithm, like the downhill simplex, to change the well depth sequences.

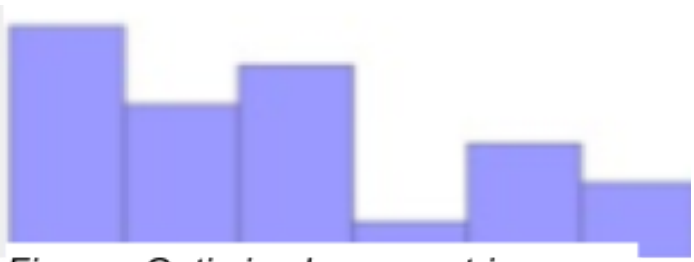

Figure . Optimized asymmetric diffusor with non-integer related well depths.

problem, but also and importantly we produce an asymmetric diffusor that can be modulated according to an optimal binary sequence minimizing grating lobes.

This concludes a description of how it is possible to remove three important limitations of a number theoretic diffusor. In the next post, we will review this evolution and present the improvement in the diffusion coefficient that has been possible.

Peter D'Antonio

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