Virtual Education Lab: Overcoming number theoretic reflection phase grating limitations

The introduction of number theoretic reflection phase grating (RPG) diffusors in 1983, introduced quantifiable, broad bandwidth sound diffusers to the architectural acoustics community and made a significant contribution to the industry. Over the years since this introduction, RPG has continued its commitment to fundamental acoustics research and evolved the technology to further advance the state-of-the-art. In Figure 1, we illustrate three Problems with Solutions that RPG has implemented to overcome them.

The first problem is the limited bandwidth of a QRD. This is similar to the limited bandwidth of a single transducer. To overcome this, loudspeaker manufacturers use a combination of tweeter, mid-range, and woofer to provide a full frequency response. RPG overcame this problem by developing a fractal design, wherein the new Diffusing Fractal (Diffractal) contains nested, scaled diffusors to provide low, mid, and high frequency diffusion.

The second problem is related to the diffraction grating lobes caused by a periodic arrangement of QRDs needed to treat a given surface area. This problem is not specific to QRDs, in fact any periodic array will exhibit diffraction grating lobes in directions determined by the width of the asymmetric repeat unit. These grating lobes decrease the uniformity of diffusion. RPG solved this problem by developing an optimized, asymmetric diffusor, which can be modulated in accordance with an optimal binary sequence to create an aperiodic array (Modffusor), which is free from grating lobes.

The third problem of number theoretic diffusers is due to the fact that these devices exhibit specular scattering at integer multiples of the design frequency times the generating prime number. This occurs because at these frequencies all of the scattering, from the various quantized and integer related well depths, is in phase. This problem is overcome by using optimized, non-integer related well depths and curvilinear shapes, using RPG's Shape Optimizer software. In subsequent posts, we will describe each of these Problems and Solutions in greater detail.

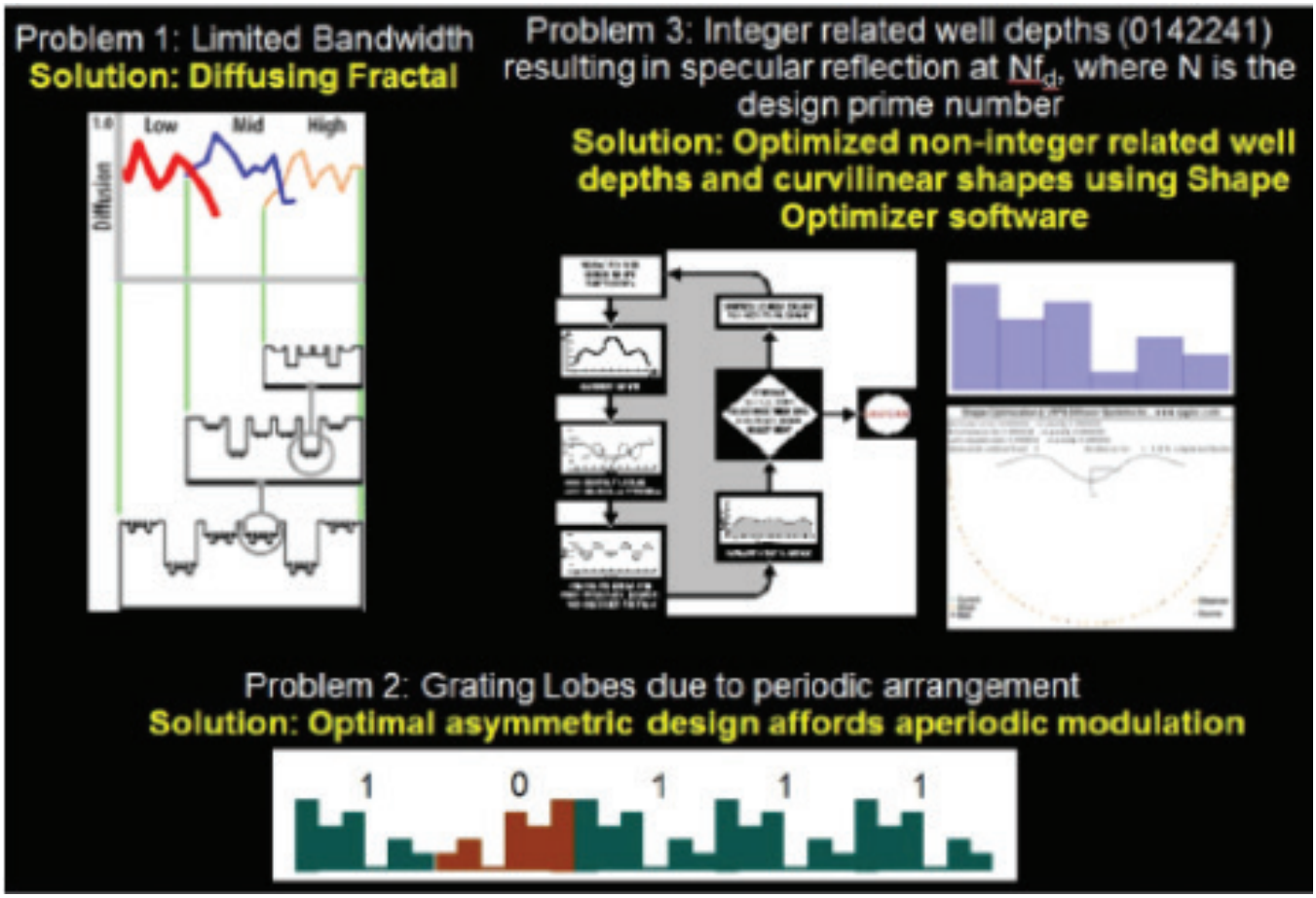

Figure 1. Problems and solutions associated with number theoretic diffusers.

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