An enduring characteristic of classic architecture is the beautiful statuary, relief ornamentation, columns and coffered ceilings. These beautiful features, coincidentally also provided useful sound scattering and excellent acoustics. This is evident in three of the renowned concert halls, namely the Concertgebouw in Amsterdam, the Musikvereinsaal in Vienna and Boston Symphony. Modern architecture lacks this intricate detailing and has evolved through a rectilinear era and is currently in a curvilinear or amorphous era. The acoustic fallout of these missing scattering elements is that modern rooms do not have good sound diffusion. What is needed are surfaces that complement contemporary architecture, the way that the afore-mentioned surfaces complemented classic architecture. In order to generate these modern sound diffusing surfaces, a software program called the Shape Optimizer was developed. The goal is essentially reverse engineering. Many acoustical products are created as a form follows function and architects have to find a way to integrate them into their designs. The Shape Optimizer allows the architect to propose a shape motif, e.g. a sinusoidal surface. Then this surface is mathematically described and the program evaluates, in an iterative manner, the thousands or more possible perturbations of this shape, which provide the desired sound scattering. To accomplish this, three things are needed. An accurate prediction method, a metric to evaluate performance and an intelligent search engine, which can quickly and efficiently navigate through the myriad shape possibilities. The prediction method utilized is a very accurate Boundary Element Method; the performance is monitored with a recently standardized metric called the diffusion coefficient, which characterizes how uniformly sound is scattered; and the intelligent search engine can be either a downhill simplex, which if you were in a mountain range quickly finds the lowest valley or a genetic algorithm, which is similar to human genetics in which the fittest shape survives.

Since current architecture is leaning towards curvilinear shapes, we will present three exam-
ples, which were treated with this type of shape.

The first example is a commercial theater called Cinerama in Seattle. The architect wanted an outer-worldly undulating ceiling in a state-of-the-art digital projection cinema. The final design and installation is shown in Figure 1. The architect was Boora Architects, Portland, OR and the acoustician was Harris-Grant Associates, Guilford, UK.

The second example involves a performance hall at St. Rose, in which the architect and acoustician requested curved wood shapes on both the walls and ceiling. This can be seen in Figure 2. The architect was Saratoga Architects, Saratoga Springs, NY and the acoustician was AVL Designs, Penfield, NY.

A third example is the Thomas Deacon Academy in Peterborough, UK. This is a very modern Sir Norman Foster Design and the we provided some curvilinear ceiling shapes upper left and right, as well as a amplitude modulated rear wall in the Lecture Hall, which mitigated the focusing effect of the concave rear wall. These shapes were intended to mimic the curvilinear shape of the exterior shown in the center of the image. The acoustician was Harris-Grant Associates, Guilford, UK.

This optimization approach, along with a thorough treatment of all that is currently known about sound absorbing and sound diffusing surfaces is presented in a reference text by the authors entitled “Acoustic Absorbers and Diffusers: Theory, Design and Application, Spon Press 2004”. The second edition is in press.