DiffuseReflections

The Newsletter for Progressive Acoustics Research

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ProFoam™ revolutionizes the shape, look, and performance of acoustical foam by incorporating a Variable Depth Air Cavity (VDAC™) in the first stacking profile foam.

IN THIS ISSUE

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For up to the minute information, we invite you to visit RPG's new web site: http://www.rpginc.com.

DIFFUSE NEWS

Dr. Peter D'Antonio
President and CEO

Growing Pains

What's in a name? While our name once fully described our company's product line, today it represents only a portion of our business. RPG still leads the industry in innovative diffusing products, but we have also pioneered many other new sound and noise control products in addition to offering leading-edge optimization, prediction, and auralization software. In fact, our products, sales, and services are uniformly distributed among sound diffusing, absorbing, variable acoustics, performance, and software systems.

While you may have only thought of RPG for diffusing products, please take a moment to visit our ever-expanding web site (www.rpginc.com) and explore the myriad range of products that form our new All-Acoustic Product Line:

Pre-Engineered Modular Products: RPG offers the widest range of diffusing, absorbing, variable acoustics, and performance products in the industry. Use these as acoustical building blocks to create the intended design.

Optimized Custom Surfaces: Take advantage of RPG's new in-house Shape Optimizer software in conjunction with our collaborative CHAOS program to provide just the right Arcousthetic™ shape for each project

RPGSoft: We now offer a growing number of optimization, prediction, and auralization software tools to allow you to take advantage of the virtues of virtual acoustic design.

Electronic Architecture: If your multipurpose room acoustics must vary between speech and organ recitals, we offer electronic architecture for variable acoustics enhancement.

Standards

RPG's diffusion coefficient research originally began as part of our in-house sponsored Disc Project and eventually became part of the AES SC-04-02 working group, which I have chaired for several years now. To accelerate this research, RPG co-funded an international research grant with the Engineering and Physical Sciences Research Council of the UK. This research is being carried out by Trevor Cox, Tristan Hargreaves, and Y. Lam at Salford University, Manchester, UK and by our research staff at RPG. Jens Holger Rindel and Michael Vorlaender are also co-chairing a new ISO/TC 43/SC 2 Building Acoustics working group (WG 25) to define the random-incidence scattering coefficient for a surface and describe a suitable measuring method on test samples. SC-04-02 and ISO WG 25 will hold a joint meeting at the ASA/EAS meeting in March 1999 in Berlin. This should be a very productive meeting and we hope to see you there.

Education

Education has always been an important activity at RPG. For the past 10 years I have been an adjunct professor at the Cleveland Institute of Music. Undergraduate students have contributed significant research in performance and practice room acoustics. We are now investigating anechoic recording of musical instruments for auralization research.

Recently I began teaching in the Peabody Conservatory of Music Masters Program. Topics include sources of acoustic distortion, the acoustic tool palette, characterizing diffusing surfaces, room acoustic measurements, and auralization.

On November 6th Dr. Christopher Jaffe and the students of his new Sonics in Architecture class at Rensselaer Polytechnic Institute, Troy, NY visited RPG for an acoustics seminar and a tour of our research and manufacturing facilities.

R P G ®

Research & Development

OPTIMIZED FRACTAL DIFFUSORS

In our continuing effort to expand the acoustical palette of aesthetic and quantifiable scattering shapes available to the architect and acoustician, we now turn to fractals.

Fractals are self-similar: as a surface is magnified a similar looking surface is found. Consequently, each surface revealed by different magnifications should be capable of scattering different frequency ranges. We have previously taken advantage of the self-similar property of fractals by combining it with the uniform scattering of the QRD®. This has yielded the amplitude modulated diffusing fractal called the Diffractal®. In this study we investigate methods to optimize the actual shape of fractal surfaces that are not necessarily self-similar, but statistically self-similar. This is mathematically referred to as self-affine.

Optimization techniques are much more efficient when the number of parameters required to represent a surface are reduced. Fractal construction techniques can be adapted to form systems that represent complex shapes with few defining parameters, so they should be capable of being optimized. We examine two techniques for constructing fractal or fractal-inspired diffusors. The Fourier Synthesis method has been tested in an effort to relate scattering quality to surface profile. The Step Function Addition method has been developed to allow complex surfaces to be represented by only a few shape parameters. This has enabled these surfaces to be optimized for the best diffusing performance.

Fourier Synthesis

Fractal surfaces can be constructed from spectral shaping of a Gaussian white noise source. Figure 1 is a schematic showing how the surfaces can be generated. To acousticians, such a scheme is likely to be more familiar as a time signal filtering process. The Gaussian white noise is

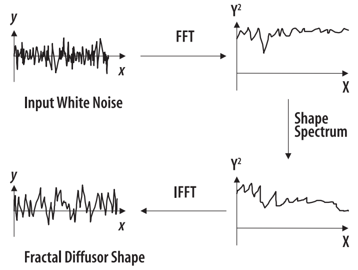


Figure 1. Schematic diagram showing Fourier synthesis construction technique

passed through a filter, which is implemented using simple Fourier techniques. The decrease in spectral content per octave is characterized by the gain of the filter at each frequency. The filter gain A (f) is given by:

$$A(f) = 1 / f^{\beta/2}$$

Where beta =1 for 1/f or pink noise, beta =2 for Brownian motion or brown noise . If there are M points determining the Gaussian white noise, then there is a need for M+1 parameters to define the shape. For the surface shapes considered here there will be a few hundred parameters. A problem arises when trying to optimize such surfaces as the number of parameters to define the shape will be too large.

Step Function Addition

To overcome this obstacle, another fractal generation technique has been used which enables the reduction of the number of shape determining parameters. Brownian

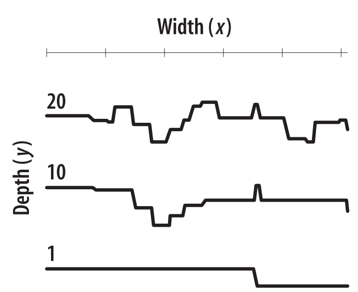


Figure 2. Fractal generation by step function addition. Bottom line: 1 step function, middle line: 10 step functions, top line: 20 step functions

motion can be simulated by a series of randomly displaced step functions. It is not always as mathematically pure as a Fourier Synthesis technique, but more simply enables the reduction of the number of parameters required to represent the surface shape. To get proper Brownian motion requires the addition of an infinite number of step functions. Each step function has random amplitude and the position of the step is a random position somewhere along the width of the diffusor. The displacement of the diffusor from a flat surface *y* at a distance *x* along the diffusor is given by:

$$y(x) = \sum_{i=1}^{\infty} B_i f(x - x_i)$$

$$f(x) = \tanh(\gamma_i x)$$

$$\gamma_i = \frac{1}{i^{\varepsilon}} \ldots 0 \le \varepsilon \le \infty$$

$$B_i = \frac{1}{i^{\alpha}} \ldots 0 \le \alpha \le \infty$$

This has reduced the number of independent parameters to N+2, the set of displacements *xi* and the amplitude decay rates *a* and *e*.

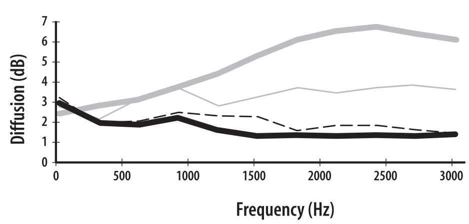


Figure 3. Diffusion parameter for four surfaces at a 60° angle of incidence. Zero is ideal. The surfaces are as follows:

Plane
Arc of a circle
Optimized fractal
Optimized curved surface

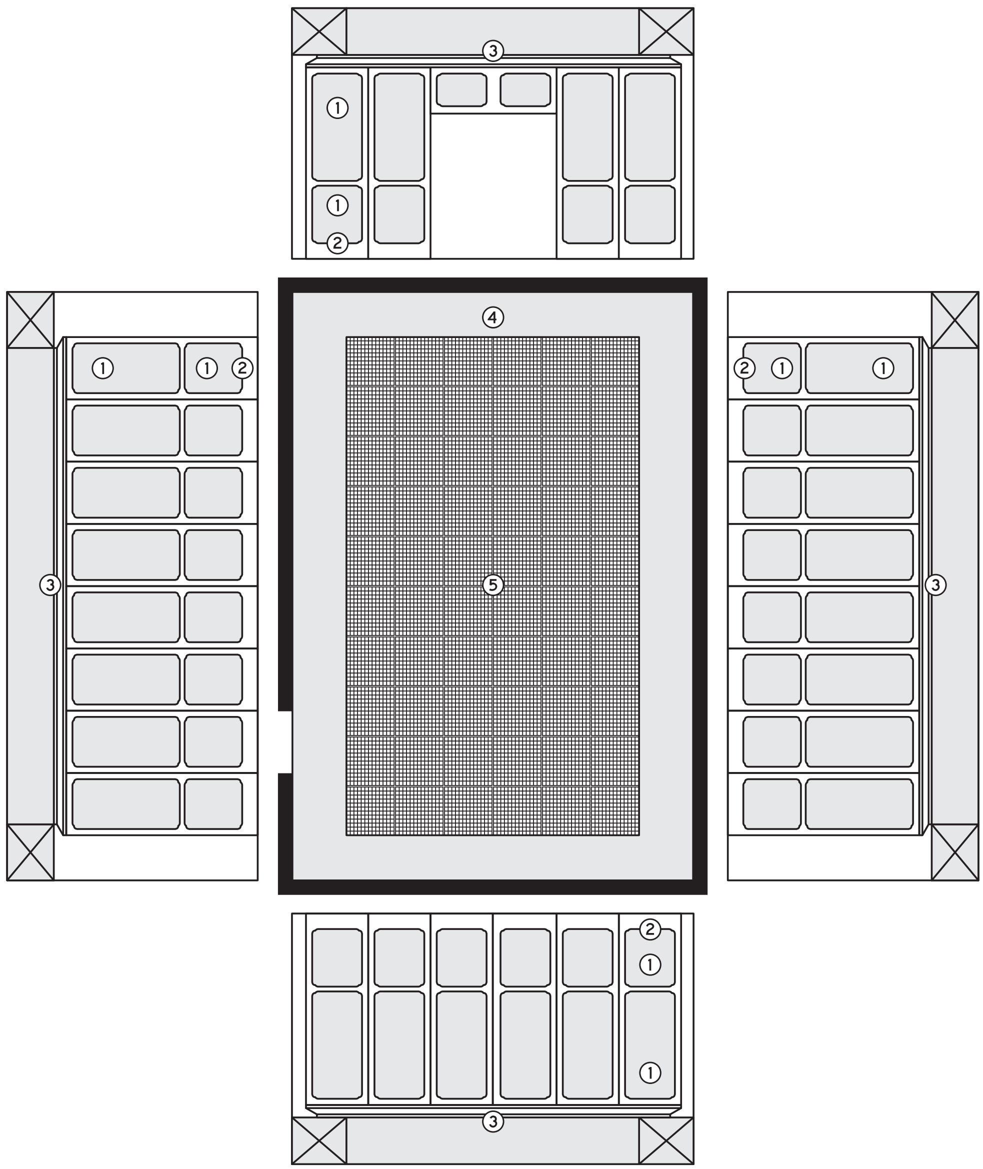
Figure 3 illustrates that the diffusion performance of the optimized fractal is comparable to the optimized curve and better than an arc or planar surface. Therefore, the optimized fractal may be considered as a new shape in the acoustical palette.

CINEMUSIC III

We have described CineMusic I, a high-tech design in which all of the acoustical elements are exposed. CineMusic II uses a stretch fabric to conceal all or part of the acoustical elements. CineMusic III is yet another approach to conceal the acoustical functionality using pre-fabricated cabinets that may contain any acoustical element or hardware. Decorative upholstered panels are attached to the cabinet face to conceal the contents. The final appearance is akin to a fabric paneled room with exposed hardwood molding, as shown in Figures 1 and 2.

There are two benefits to the CineMusic III system: ease of installation and flexibility. Installation costs can amount to a significant portion of a home theater project, so minimizing this expense is important. Since all of the acoustical elements are placed within a cabinet, all the installer has to do is attach firing strips to plumb the walls and attach the cabinets.

Flexibility is another key issue. Since the acoustical elements are all interchangeable in the mounting cabinets, they can be changed at any time. Therefore, if the acoustics need to be modified, acoustical elements can simply be relocated or replaced by removing the decorative fabric face panel. In addition, the decor of the room can easily be changed by replacing the fabric on the face panel.



(1) Upholstered Face Panel (2) Mounting Cabinet (3) Crown Moulding (4) Bass Absorbing Soffit System™ (B.A.S.S.) (5) Skyline® Array

▲ **Figure 1. Plan and elevations for CineMusic III. In this illustration all acoustical elements are concealed behind the decorative fabric panels.**

◀ **Figure 2. A rendering of CineMusic III illustrating how the fabric-paneled wall system integrates with the screen, hardware, ceiling and Bass Absorbing Soffit System™.**

Project Profile: MasterMix

Hank William's Mastering Room at MasterMix. Photograph by James F. Wilson courtesy of Russ Berger Design Group.

Ken Love's Mastering Room at MasterMix. Photograph by James F. Wilson courtesy of Russ Berger Design Group.

DESIGN TEAM

When MasterMix owner Hank Williams envisioned his new mastering facility, he called upon the creative sensibility of the Russ Berger Design Group to secure a functional and attractive design for the space. Virtually across the street from the old facility, MasterMix's new incarnation was built from the ground up and reflects the owner's commitment to Nashville's thriving music scene.

By incorporating RPG Skyline® and Omniffusor™ diffusion elements in the design of the mastering rooms at MasterMix, RBDG was able to acoustically tailor each room for their intended purpose while maintaining maximum flexibility. This also allowed RBDG to provide a pristine listening zone for the mastering engineers as well as a broad area behind the mastering position where clients and others in the room could listen critically and make artistic and technical judgement with confidence.

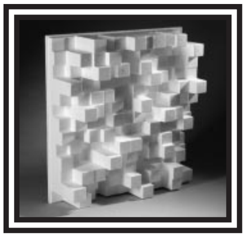
Johnson Knowles, Russ Berger Design Group

CLIENT

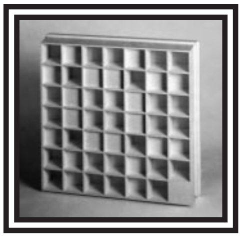
Back in 1983—when we built our first rooms—I remember how difficult it was to remedy some of the acoustical conditions. It took a lot of trial and error to overcome these problems. At that time I was told of a company that was working on building pre-fab solutions to acoustical problems. When we started our new building in 1997 we had any number of well made, well designed RPG products to select from—products that enabled us to achieve the sonic soundscape that we imagined.

Hank Williams, Owner and President of MasterMix

PRODUCTS



Skyline®



Omniffusor™