Diffuse Reflections

The Newsletter for Progressive Acoustics Research

Volume 4, Issue 2, 1998

Introducing RAYNOISE
A state-of-the-art room simulation and auralization program now offered by RPGsoft

IN THIS ISSUE

"For room modeling, BEM calculations are still much too time intensive. The most prudent approach at the moment is geometrical acoustics. To bring this technology to the architectural acoustics community, LMS appointed RPG® as its North American distributor for RAYNOISE, a powerful acoustic modeling and analysis system."

©1998, RPG DIFFUSOR SYSTEMS INC.

DIFFUSE NEWS

We invite you to visit RPG's new web site at: www.rpginc.com

Dr. Peter D'Antonio
President/CEO

As we have mentioned in the past, RPG® is committed to providing the acoustical community with an ever expanding selection of AcousticTools® to expand the acoustical palette. Because computer processing power continues to increase steadily, RPG® now feels that the time is right to offer consultants a tool kit of optimization, simulation, and auralization software. We formed our RPGsoft department to provide this product range and support. Our first software offering is the Room Optimizer®, a Windows 95 program that automatically optimizes the locations of listener, loudspeakers and acoustical surface treatment in a rectangular room.

To provide surface shape optimization for walls, ceilings, canopies, and acoustical shells, we offer the Shape Optimizer as an in-house collaborative design service that is part of our CHAOS™ program.

The boundary element method (BEM) is unquestionably the most accurate method to predict scattering. RPG® has been collaborating with LMS Numerical Technologies (formerly NIT) for several years now, using SYSNOISE, to model our scattering surfaces. For room modeling, BEM calculations are still much too time intensive. The most prudent approach at the moment is geometrical acoustics. To bring this technology to the architectural acoustics community, LMS appointed RPG® as its North American distributor for RAYNOISE, a powerful acoustic modeling and analysis system.

Raynoise uses advanced hybrid image model/pyramid tracing methods to predict the sound field produced by multiple sources at any location in closed, open or partially open spaces. RAYNOISE automatically handles complex interactions such as multiple reflections from different surfaces and the effects of coherent and incoherent sources. Special methods enable diffusion, diffraction and transmission to be modeled. All of the objective measures, such as reverberation time, definition, lateral energy fraction, STI, etc. can be shown in phase or frequency animated color contour maps, deformation or vector maps. The program also displays nth-octave and narrow-band spectra, echograms, and ray path history. Results can be combined with anechoic wav recordings to produce stereo auralizations. The program interfaces with other CAD programs and mesh generators. Geometry meshes can be imported as DXF files. Layers are also imported to simplify surface material assignment.

SEMINARS

Mix SoundPro Seminar, NY **June 26, 1998**

Dr. Peter D'Antonio will participate in a panel, chaired by Bob Hodas, to discuss the challenges of urban recording studio design.

AES, San Francisco, CA **Sept. 26–29, 1998**

Dr. D'Antonio will discuss the various forms of acoustical distortion, in a panel chaired by Russ Berger.

ASA, Norfolk, VA **Oct. 16, 1998**

Dr. Peter D'Antonio will chair a session on the Characterization of Scattering. The session will review the development and characterization of scattering surfaces over the past 20 years.

RAYNOISE SEMINAR **Oct. 19, 1998**

RPG® will host its first computer room modeling seminar at RPG's Upper Marlboro, MD facility following the Norfork ASA meeting. Manu de Geest of LMS Numerican Technologies and Dr. Peter D'Antonio will describe the program and discuss examples.

Research & Development

NEW DIFFUSION PARADIGM

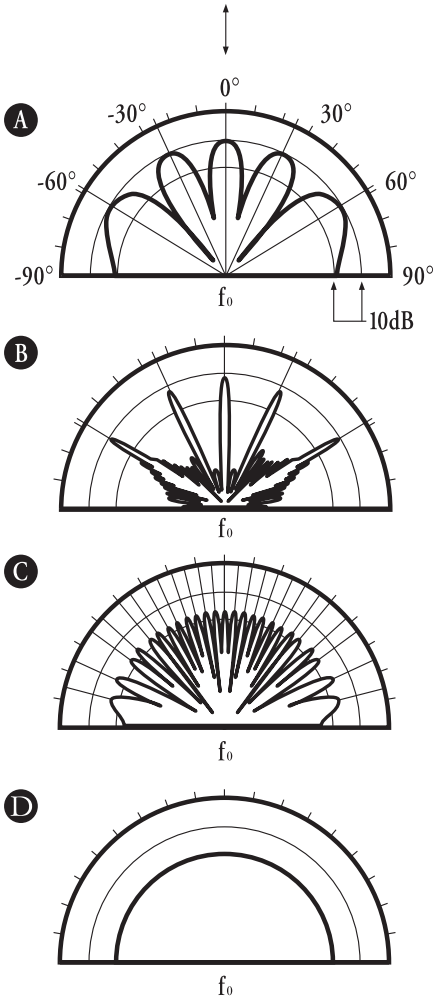


Figure 1. Simulation of QRD polar responses for a) N=17 2 periods, b) N=17 25 periods, c) N=89 2 periods, d) uniform diffusion paradigm

In 1983, RPG® introduced the first commercial reflection phase grating (RPG) diffusors based on Schroeder's ingenious suggestion of using periodic sequences with flat power spectra. Scattering from any periodic sequence is characterized by scattering into well-defined diffraction orders or directions (light radial lines in Fig. 1). The diffraction directions are determined solely by the size of the repeat unit, which is equal to the product of the number of wells, N, and the width of a single well, w. To insure that the scattering in these diffraction directions is uniform, Schroeder suggested sequences, such as quadradic residues, that exhibit a flat power spectrum. The polar distribution of the scattered energy about the diffraction directions (width of the lobes) depends on the number of periods. It can be seen in Fig. 1a that scattering from 2 periods of a QRD with 17 wells at the design frequency f_0 is distributed into 5 broad lobes at 0^0, $+/-24^0$, and $+/- 59^0$. As the number of periods increases from 2 to 25 (Fig. 1b) the scattered energy in the far field is concentrated into narrower diffraction orders. To approach uniform diffusion, shown in Fig. 1d, a number theory diffusor must be based on a large Nw product to produce many non-evanescent diffraction directions. Thus, in Fig. 1c, an increase in the number of diffraction orders by a factor of 5 is seen when the number of wells is increased from 17 to 89. The number theoretic diffusor has proven to be an extremely powerful tool in architectural acoustics, however, there is room for improvement.

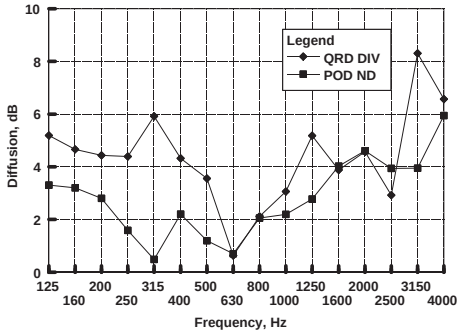


Figure 2. Comparison between the diffusion parameter (zero ideal) for normal incidence of a QRD with dividers and a POD with no dividers

In Vol. 3, Issue 1, a new shape optimization technique was introduced. RPG® is now proposing a new generation of phase optimized diffusors (POD) based on the paradigm of uniform scattering, as shown Fig. 1d, instead of the flat power spectrum of the number theory diffusors. These new diffusors are designed by combining multi-dimensional optimization techniques with boundary element predictions, which are more accurate than the far-field Fraunhofer theory of the number theoretic diffusors. In addition, these new diffusors can be designed with or without dividers between wells. The uniformity of a polar response (shown in Fig. 1), can be quantified by its standard deviation. The uniform diffusion response in Fig. 1d would have a standard deviation of zero. In Fig. 2 we illustrate how phase optimization can be used to lower the standard deviation of a POD with no dividers and provide superior diffusion compared to a traditional QRD® with dividers. In this example, a POD without dividers was optimized for normal incidence up to 1,250 Hz.

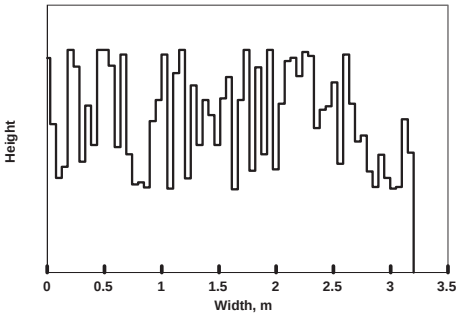


Figure 3. Right half of a symmetrical 125 step phase optimized diffusor

RPG® provides this optimization service to acoustical consultants as part of our collaborative CHAOS™ program. In Fig. 3 we show the right half of a 21' (6.4 m), 125 step, symmetrical, phase-optimized diffusor designed for the rear wall of a performing arts facility. It was optimized for random incidence between 100 - 4,000 Hz. To provide this service, RPG® requires the source and receiver positions, desired coverage, and allowable width and depth.

Diffuse Applications

MULTICHANNEL MUSIC FORMATS

In Vol. 4, Issue 1 we introduced our CineMusic Home Theater system and described our "high-tech" looking CineMusic I Home Theater. In this Issue, we would like to discuss the two current 5.1 surround formats and acoustical zone treatment. The 5 stands for three front speakers (Left/Center/Right (L/C/R)) and two surround speakers (left rear and right rear). The .1 refers to the band-limited sub-woofer effects channel.

DIPOLE SURROUNDS: In the THX format, the surrounds are dipoles located on the side walls to the left and right of the listener. THX feels this arrangement simulates the commercial cinema experience in which there are several monopole surrounds distributed on the rear and side walls.

MATCHING SURROUNDS: In 1994, the International Telecommunication Union, Geneva, Switzerland, published their BS 775-1 recommendation for multichannel sound systems with and without picture. In this setup all loudspeakers are equidistant from the listener and lie on a circle with the listener at the center. The left/right front speakers are 60^0 apart and 30^0 from the forward direction. The left/right surround speakers are 140^0 apart and lie 110^0 from the forward direction. RPG's Room Optimizer™ software provides quick setup Wizards for both of these formats. The illustration shows the L/C/R speakers and both the dipole surrounds and the floor standing matching surrounds, along with the ITU specified angular configuration.

To discuss acoustical surface treatment, it is convenient to conceptually divide the room vertically into thirds and discuss the importance of each room boundary. In the illustration, we show the two approaches together to save space. This design is actually supported by many surround processors and may be called 7.1. The illustration also suggests acoustical zone treatment consisting of Spatial (diffusive), Image (absorptive/diffusive) and Bass (absorptive low-frequency) Tools.

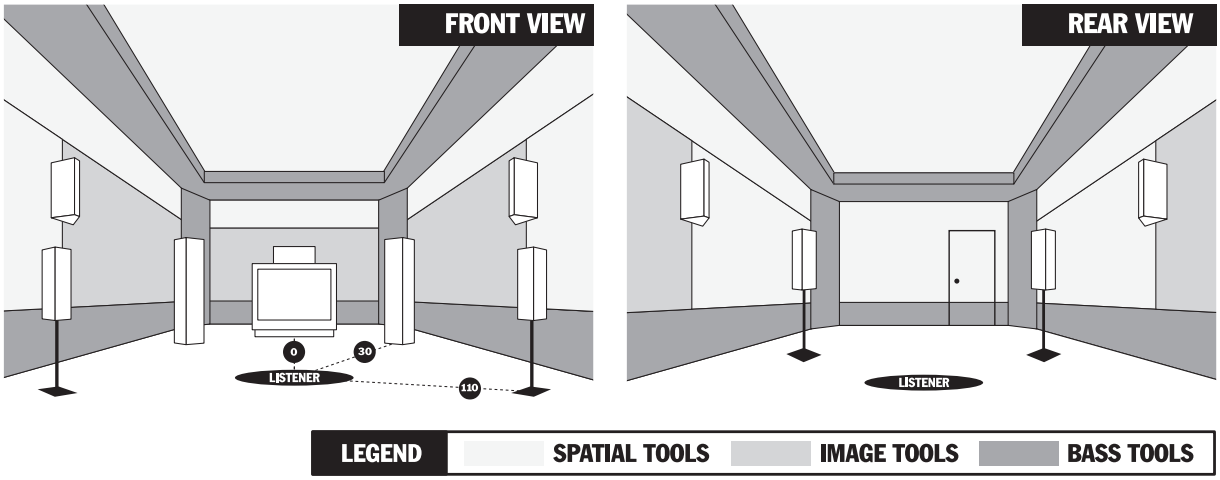
FRONT WALL: The front wall should be absorptive down to the low-frequency limit of the subwoofers, as this surface will be needed to control omnidirectional low frequencies from main and subwoofers. Any of our Image Tools can be used in conjunction with our membrane Bass Tools. The lower third can be made anechoic. The mid and upper third should receive 4" or more of absorptive treatment. For dipole surrounds the upper third may be reflective or treated with a Spatial Tool to scatter the forward directed dipole sound. A Bass Absorbing Soffit System (B.A.S.S.) is very effective at the ceiling/wall intersection.

SIDE WALLS: The lower third can be treated with Bass Tools or made reflective. The mid third is absorptive (Imaging) between the loudspeakers and the listening position, to provide good imaging and intelligibility, and diffusive (Spatial) between the dipoles and rear wall, to control flutter and contribute to envelopment. The upper third is diffusive (Spatial) and the B.A.S.S. is used at the ceiling/wall intersection.

REAR WALL: The lower third is typically used for low-frequency membrane absorption (Bass Tool). The mid and upper third are diffusive over a broad bandwidth (Spatial Tool). Again, the B.A.S.S. is used at the intersection of the ceiling and wall.

CEILING: The perimeter B.A.S.S. on the ceiling/wall intersection is used to frame a diffusive ceiling treatment (Spatial Tool).

CORNERS: All corners utilize membrane or pressure-gradient, low-frequency absorption Bass Tools.



Project Profile: Starstruck Studios

Gallery Control Room Diffusion Wall with custom ceramic Diffractal® elements

The Cherry Room

DESIGN TEAM

Neil Grant, President of Harris, Grant Associates, Iver, Bucks, UK

Starstruck Studios management appointed Neil Grant to lead a design team charged with developing an international studio complex in Nashville. Grant drew on his 15 year relationship with RPG® to develop innovative products that have produced a visually striking and successful studio. Slip cast ceramic diffusor tiles, tooled in England, were assembled into the Gallery diffusion wall. DFR72 panels were integrated with lights, mirrors, and ceramics while FlutterFree® panels were integrated with lighting. Grant commented that "in every case, we had the fullest assistance from the RPG® principals at the Factory in either further developing the RPG® diffusor products with new materials, such as our chosen ceramics, or re-combining standard units into new architectual forms. No other manufacturer has shown this level of confidence in their technology, or has been able to gain our respect as consultants in a similar way."

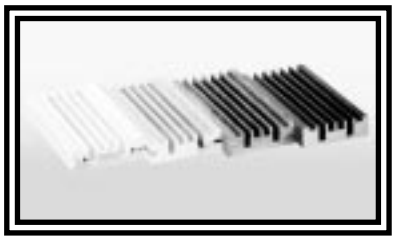
CLIENT

Robert De La Garza, Vice-President & General Manager of Starstruck Studios, Nashville, TN.

"Starstruck Studios has built two world-class state-of the-art recording studios in Nashville. When discussing acoustics with our designer, Neil Grant of Harris, Grant Associates, the subject of diffusion entered the picture. We chose the RPG® Diffractal® and FlutterFree® for our new cutting edge recording facilities. These products have proven time and again to be the perfect choice. We have received rave reviews for having great acoustics in our new rooms and attribute RPG® with contributing to the equation."

PRODUCTS

DFR72 Diffractal®



FlutterFree®

RPG DIFFUSOR SYSTEMS, INC., 651-C COMMERCE DRIVE, UPPER MARLBORO, MD 20774, PHONE: (301) 249-0044, FAX: (301) 249-3912, E-MAIL: INFO@RPGINC.COM, INTERNET: WWW.RPGINC.COM