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DOCTOR OF DIFFUSION

PETER D'ANTONIO TALKS STUDIO DESIGN, 40 YEARS OF RPG, AND A LIFETIME OF SCIENCE AND SOUND

Doctor of Diffusion

Peter D'Antonio Talks Studio Design, 40 Years of RPG and a Lifetime of Science and Sound

By Tom Kenny

Today, anybody from anywhere in the world can pick up their phone, download an app or visit a site, enter a few numbers, wait a few minutes for a recommendation, click on a package of acoustic materials, and a week later, once the packages arrive and the panels, cylinders and clouds are placed on the walls and in the corners, their personal studio immediately sounds better.

Results, of course, will vary depending on the quality of the app, the amount of data entered, the boundary limits of the space, materials in the walls, floor and ceiling, speaker location, whether there is follow-up measurement included, and dozens of other factors. Still, the simple fact that the sound and performance in a personal space can be dramatically improved by entering a set of data points is remarkable.

This didn't just happen overnight, or because some kid in Silicon Valley had an idea. It's all possible because of science. Real science. Decades of theory, test and measurement by a relatively small number of individuals at universities, in laboratories and at home. Dr. Peter D'Antonio is one of those individuals—but he's also a scientist who plays bass guitar. His name is not always included when conversations turn to the great studios of the world and those who designed them, but when the top studio designers get together, D'Antonio has a seat at the head of the table—though his humble nature and sociable personality would likely force him to get up and move down near the middle, among his friends.

Over the past 40 years, following the establishment of RPG Diffusor Systems in December 1983 and through his ongoing collaborations with the world's top studio designers, D'Antonio, as much as any single person in professional audio, has helped to shape the look, feel and performance of the modern recording studio.

This year, D'Antonio is earning his just recognition, with a 40-year anniversary celebration of his original company, a highly anticipated AES Paper presentation later this month, and the honor of receiving the prestigious Wallace Clement Sabine Medal from the Acoustical Society of America for "contributions to the theory, design and application of acoustic diffusers."

It's been quite a ride. D'Antonio never planned to study acoustics or become the world's leading expert in diffusion, or what he sometimes calls "the scattering of sound."

Born and raised in a middle-class, working-man Italian neighborhood of Brooklyn, his interest in music was nurtured by his mother and uncle, both outstanding vocalists, he says. He played in bands in high school, gigging through the summers at a Long Beach club, developing an early fondness for harmonies and doo-wop.

Then, admittedly having never reallya pplied himself in school, he went to college, majoring in physical chemistry at nearby St. John's,followed by a graduate degree in infrared spectroscopy, with a minor emphasis in crystallography. A professor recommended him for a job at the Naval Research Laboratory, and in 1968 he moved to Washington, D.C., leaving his musical life behind. Then in 1970, he lost his wife in an accident.

To deal with the loss, D'Antonio says, he slowly began to bring music back into his life, hooking up with a neighbor to jam and write. They built a rudimentary, single-room studio in his house and dubbed it Underground Sound. The songs got better, the playing got better, but the recording quality was noticeably lacking. In the early 1980s, D'Antonio proposed building a better studio, one with a separate control room and proper isolation. At the time, he was still working at the lab and had zero knowledge of acoustics—studio, architectural or otherwise—but he was a scientist, he could figure it out.

And that's where we begin this month's special *Mix* Interview.

So this lifetime spent in acoustics all began because you wanted better recordings? There were some good studios out there in 1983.

I had a typical two-story, suburban neighborhood home with a sub-basement that would work as a studio, but I had absolutely no idea how to build one. I hadn't thought about acoustics for one second of my life before that. How do we even soundproof this room? I went through the literature, like all scientists do, and found you have to float the room and all that good stuff. Then we spent about two years on the construction, the AC, the plumbing, the air conditioning, the wiring—everything by ourselves.

The problem was there was no control room. For a lot of studios at that time, the speakers were still hanging from chains and the rooms were not symmetrical, which you need for an effective soundstage. I had seen a booth at another studio and that's when I thought, "Well, how do we design a control room?" I went to the literature, and there was absolutely nothing. All I found were articles on how so-and-so had a hit record and used this kind of speaker, and

then everybody copied that design.

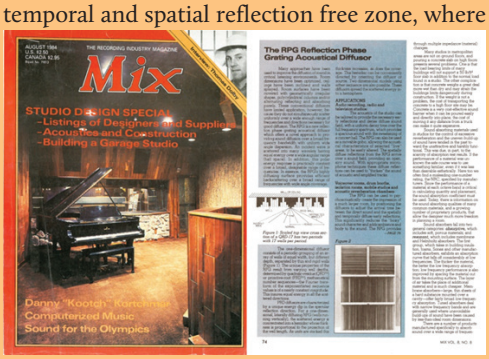
Then I came across an article by Don and Carolyn Davis and it actually sounded scientific, talking about the principles of Live End Dead End. They were using a device that I had never heard of, developed by Richard Heyser, called time delay spectrometry. Richard worked at Jet Propulsion Laboratory and he was a brilliant guy who was interested in audio. He would measure loudspeakers for audio magazines, and he developed this hardware that originally had about 15 pieces of gear with wires and everything. Then Crown built it into what was called the TEF Analyzer.

I built a room and implemented Live End Dead End. I put absorption on the front wall and a bare back wall, but when I listened to the room, it was very disappointing. The interference between those strong specular reflections and the direct sound was severe.

What did you do?

I decided to take the approach of, "What if I just came down from Mars? What would I do?" So I started researching concert hall design. There's an important aspect of a concert hall in that you have the direct sound, and then there's a period of time, which is called the initial time delay, before the reflections come in from the side walls. I say side walls because in the early concert hall designs, the ceiling was a lot higher than the width of the room, so the first reflections that came into the room came from the side, but because the speed of sound is finite, it takes time to go from the stage to the side wall to the audience—this initial time delay. How can I get an initial time delay in a small room when there is a short time delay between the speaker and listening position?

That's when I came up with this idea of a temporal and spatial reflection free zone, where I splayed the sidewalls out so that the reflections from the loudspeakers hit the sidewalls and went to the back of the room. It didn't come to the listening position. Then I also slanted the ceiling vertically at an angle so that those reflections would go to the back of the room. That has become the signature of all control rooms to this day—but now that sound is going to bounce back and cause problems at the listening position. How do I constructively control that real-world dance? The answer was diffusion.



The August 1984 issue of *Mix*, featuring the first industry article on the new RFZ/RPG.

So the back wall of the studio in your basement is what led to RPG Diffusor Systems?

[Laughs] You could look at it that way. During my research, I came across an article by Manfred Schroeder in *Physics Today*'s October 1980 issue. It described reflection phase grating (RPG) diffusors that were capable of uniformly scattering sound, and I realized that these diffusors were 2-dimensional periodic versions of the 3-dimensional periodic crystal lattices I had been studying as a diffraction physicist at the Naval Research Lab, using x-ray crystallography. That led me to further research and my first acoustical presentation at the 74th AES Studio Design Session C in October of 1983 in New York. To my surprise, Manfred Schroeder presented the leadoff presentation.

Anyway, because these diffusors scattered the sound and because the reflection was not in one direction, all of the energy in that reflection was now distributed to all of the reflections. So the sound that came back to the mixing position was attenuated, but the sound remained in the room, The room remained ambient.

I needed to control those reflections to create the reflection free zone. I realized that the diffusor in the back of the room was sending sound out over a semicircle in the back of the room, and a lot of the sound was hitting the sidewalls, so I made the sidewalls reflective and they reflected the sound back to the listener at 55 degrees, so when you go into a room that has reflections diffused on the rear wall, you get a sense of envelopment. I didn't realize it at the time, but we had created what's called passive surround. That's when the high-end audio community became really interested in diffusion.

Do you mean studio owners, studio designers, other acousticians?

Don Davis was at my AES presentation, and after the meeting, he introduced himself, saying that he taught acoustics and that he and his wife Carolyn had these traveling roadshows around the country. He invited me to their next meeting in Dallas, the first on LEDE, and asked that I bring my diffusors. I thought, "Okay, this is great"—but I didn't have any.

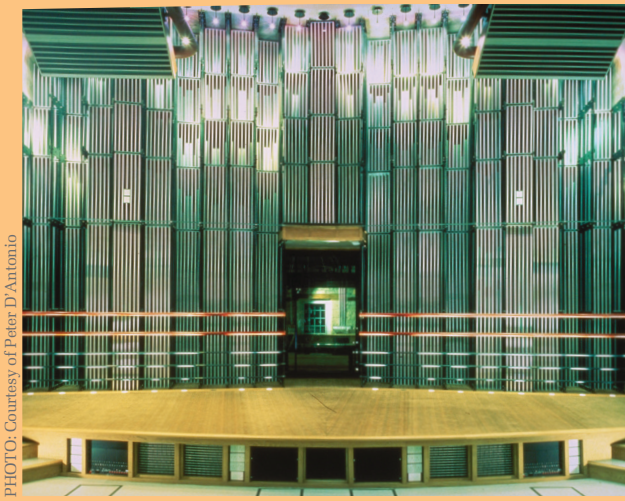


PHOTO: Courtesy of Peter D'Antonio

Real World Studios, designed by Harris Grant Associates, diffusion by RPG.

We built two—and they were big. We shipped them to Dallas for the Syn-Aud-Con event, where they had a TEF Analyzer. That was the first measurement of the time response of these units. As we measured, I thought, "Wow! That's what they should do!" What intrigued me was that we could actually see on the screen all of the reflective sound—when it arrived, what level it was. I thought this was fantastic. Bob Todrank and Don Davis were there. They basically befriended me and introduced me to the world of acoustics.

Bob owned Valley Audio in Nashville at the time and he said, "You know, I got this job for the Oak Ridge Boys in Hendersonville, and I like what you're talking about. You want to collaborate with me?" I said, sure, though at the time, I really couldn't manufacture anything. I basically provided him with plans, and in 1984, the Oak Ridge Boys' studio was the first commercial project to incorporate RPG Diffusors. The next Syn-Aud-Con meeting was held there, and that's where I met Russ Berger. The first studio he did with RPGs was called Tele-Image. We put a whole array of 4311s in there, and that became a really successful room. I also met Neil Grant at that Oak Ridge Boys event—later, I would do Peter Gabriel's Real World Studios with Harris Grant in the UK, and Neil became probably my closest friend.

PHOTO: Courtesy of Peter D'Antonio

PHOTO: Courtesy of Peter D'Antonio

Blackbird Studio C, designed by George Massenburg with diffusion consultation by RPG.

You still didn't have a product, though, correct?
By the time of Real World, we did, but at the start, they were all custom to a project. The first units that I built were four feet wide and about two feet deep, and included 43 wells with a one-inch width. I called them the 4311 and started building them in my home.

FTo fabricate these diffusers, all you need is a rigid surface, so I wound up using plywood because it had to have multiple layers and it worked. The biggest problem was I had to divide the wells, which had varying depth, to create waveguides that did not interfere with one another, by using dividers from the face of the unit to the back. Each well then reflected the sound back at a different time.

That constructive interference is what creates the diffusion. In theory, the dividers should have been infinitely thin, so I decided to use metal. I found a local vendor of sheet aluminum, and my oven handled the annealing. I was manufacturing in my carport, which I eventually converted to a garage.

The reflection phase grating was different. It wasn't the first form of diffusion—you had columns, balustrades, coffered ceilings, all kinds of surfaces that scattered sounds. What made the reflection phase grating unique was that it was invariant to the angle of incidence and invariant to the frequency, to a certain extent. I did a lot of research to modify the design of the diffusers over the years, because the original RPG was essentially like a midrange speaker. I eventually developed a high-frequency, mid-frequency and a low-end diffuser, but they all incorporated the RPG form. This Diffractal was patented in 1987.

Two views of the diffusion surrounding the Meyerhoff Symphony Hall stage, with and without orchestra.

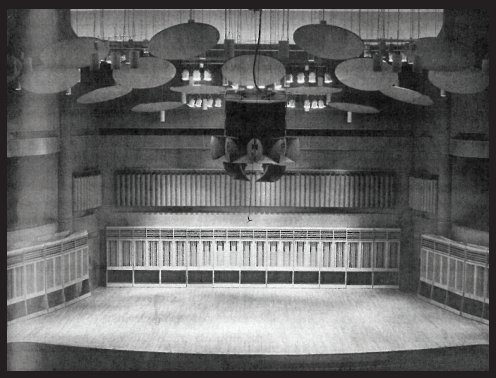
PHOTO: Courtesy of Peter D'Antonio

Concert Halls and Stage Acoustics

I had met Jack Renner, one of the founders of Telarc Records, and he did a lot of classical recording. He would be recording a symphony orchestra and they were monitoring in the green room or in a closet or hallway. I would send him some of our products just so they could hear what and how they were recording on the concert stage. Then one day, I get this call from Meyerhoff Symphony Hall, home of the Baltimore Philharmonic, saying, "You guys are down here sometimes and some of your boxes found their way on stage, and the musicians are saying they can finally hear one another. They just love these things. They put them all over the stage." I said, "Well, that's interesting."

When I went to the Meyerhoff and looked at the stage, I said, "Well, I think I know what the problem is." Acousticians are very, very protective of the projects that they design, and I'm a consultant and didn't really know these people, though I got to know them very well later on. I told them that the theater wanted me to take some measurements and improve the stage acoustics. They ended up okay with it, as long as I didn't touch their work.

I took my test machine, and I rented an omnidirectional loudspeaker and placed it around different locations on the stage to simulate the different instruments—say, first violins, cello, etcetera, and I put the microphone in different places. I didn't know anything about a symphony orchestra playing with different instruments. I sat in the different locations, starting with the basses. I realized from the analysis of the data that, for example, when the percussion hit the snare drum, it would reflect off these massive sidewalls. They had these large doors, entry doors, where they brought different instruments and things onto the stage. So what the conductor was hearing was the reflection off the sidewalls, and it was almost as loud as the direct sound. He essentially had no idea where the direct sound was coming from.



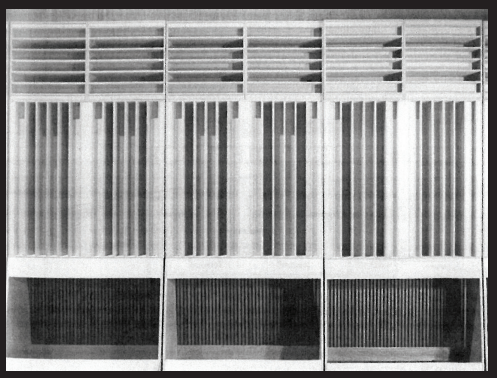


PHOTO: Courtesy of Peter D'Antonio

I thought, 'Okay, we have to diffuse those sidewalls' and then the rear wall was just flat, so we needed to get some diffusion there. We used whatever we had, if I remember, with aluminum dividers, and then on the side walls, we put a plexiglass cavity because there is a large area on the side of the stage for people to look at the orchestra. I wanted to reflect the sound of the violins from this plexiglass reflector over to the middle of the orchestra. We put diffusors on the back wall and put in these plexiglass reflectors—and I wrote a paper about it.

Previously, I made up a questionnaire and gave it to musicians at the Meyerhoff before we implemented the change. Then they filled it out again after we implemented the change and there was close to a 100 percent average improvement in the perceptive qualities. I guess the chronology of RPG is that we went from studios to broadcast video to high-end audio, and then to performance venues. Later, we ended up doing the back wall of Carnegie Hall.

That conductor, by the way, was David Zinman, a very famous conductor. He gave me the best compliment when he said that I "had made coming to work a joy."

PHOTO: Courtesy of Peter D'Antonio

Rue Boyer studio in Paris, home to Mix with the Masters, designed by WSDG with RPG diffusion.

developed and available sound diffusor.

And then everything flowed smoothly and here we are 40 years later!

[Laughs] Well, we did have a few products now, but I had been doing a lot of theoretical predictions, and as RPG continued to grow, I really felt the urgency to verify all of that experimentally, for a variety of reasons. First, scientists like to verify things, but also I wanted to eventually develop a diffusion coefficient that could be used alongside the absorption coefficient. I needed to develop an experimental method to measure and document their performance so they could be specified by acousticians and added to the acoustical palette.

I began a systematic program of experimental measurements, using the TEF analyzer, beginning in large sports facilities, then my son's high school gymnasium. When we wore out our welcome, we developed a new scale-model measurement system called a Goniometer, which was another example of how my experience in crystallography led to a development in acoustics. This research eventually led to the current ISO 17497-2 diffusion coefficient measurement standard published in 2012.

Right after I developed my capability to measure a polar response, I got a call from the editor of the *Journal of the Acoustical Society of America* asking me to referee a paper by Trevor Cox, a recent graduate on the topic. I read it and thought, "Oh my God. This is an incredible paper. Unbelievably creative. Trevor wrote a boundary element code, that was a more accurate theory than my simulations, because the wavelength of a sound is a million times bigger than the wavelength of electromagnetic radiation. It was a wave based theory to solve the wave equation.

Without diving into the science, this relationship with Trevor eventually led to the co-authorship of three reference books on acoustics, development of software that would eventually lead to a virtual goniometer and the formation of NIRO and REDI Acoustics, and, of course, the co-efficient, which now allows us to predict the performance of a future space as accurately as we could measure it.

We haven't even talked about Real World, Hit Factory, Blackbird Studio C, Jungle City, the just-opened Rue Boyer in Paris, or any of the hundreds of projects you've contributed to. I've been fortunate in my life, working with such talented and creative designers. Don Davis, Bob Todrank, Chips Davis, Neil Grant, John Storyk, Russ Berger, Doug Jones, Neil Muncy, Bob Skye, Martin Pilchner, Chris Pelonis, and most recently, Wes Lachot—I've learned from all of them, and I consider them all friends to this day.

You just turned 81, and you're celebrating 40 years of RPG. You got a late start! But it doesn't seem like you're slowing down all that much.

Well, I sold RPG Diffusor Systems in 2016. The new owner launched a new entity known as RPG Acoustical Systems. We added the Acoustical Research Center with a 285 cubic-meter rev room, a new Goniometer and a 7-ton, 25-foot-long long impedance tube. I also formed a new company with John Storyk and PK Pandy called REDI Acoustics, to develop new software to optimize the design of critical listening rooms, called NIRO.

But if I were to look back, I'm most proud of the fact that we now know how to design, predict, optimize, measure, characterize and standardize the performance of scattering surfaces. While there is still much to do, there is a general consensus that a solid theoretical and experimental foundation has been laid, and diffuser performance can now be quantified and standardized, and that diffusers can now be integrated into contemporary architecture, taking their rightful place along with absorbers and reflectors in the acoustical palette. The future holds exciting possibilities, and we're looking forward to the next 40 years!■

PHOTO: Courtesy of Peter D'Antonio

D'Antonio sailing in Sydney Harbor with his fiancee, Lea Ann Pelleschi.

PHOTO: Courtesy of Peter D'Antonio

Dr. Peter D'Antonio at home, flanked by his sons. At left, Peter Christopher D'Antonio, Building-Sector MEP Consultant Focused on Energy and Carbon Management, Bowman Consulting, and at right, Michael D'Antonio, Ph.D., power electronics engineer, SpaceX.