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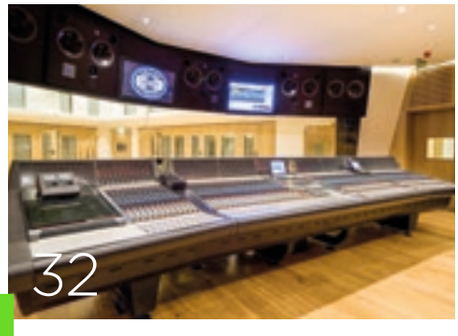

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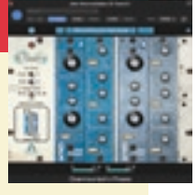


Affordable acoustic analysis – finding NIRO

NIGEL JOPSON gets his ultimate room REDI

You want to build a mixing or critical-listening room and your experience as a production pro means you've already selected a monitoring system and equipment, and you also have a good wiring team and trustworthy builders. You want the optimum design within the limitations of your structure, but the thought of hiring an architect, and 'buying into' someone else's vision conjures up rather too many £££ signs. Alternatively... you're an installer, acoustician or system implementer; you know all the constraints you face with a client's building, what you'd really love is a black box to feed all the information in, to receive an assessment of the optimum splay of the walls, angle of the ceiling and the ideal complement and tuning of absorbers. These are perennial problems in our industry, and now some very well-respected names in audio have come up with an innovative acoustic analysis service. REDIacoustics have designed some cool software, and named it NIRO (Non-cuboid Iterative Room Optimization).

The faces behind REDI certainly have the experience to inspire confidence in whatever NIRO finds. Dr. Peter D'Antonio pioneered the recording studio diffusor industry and invented a wide range of novel fractal and optimised diffusing and absorbing surfaces, for which he holds many trademarks and patents. There can be few engineers and producers from the '90s who haven't sat in a great control room with an RPG diffusor on the back wall. D'Antonio was the brains behind RPG, and has teamed up with

/ **From left: Dr. Peter D'Antonio and John Storyk**

John Storyk, founding partner of WSDG, a global architectural acoustic consulting and design firm, and PK Pandey, founder of Guitar Center's GCPro B2B division, Symphonic

Acoustics, and Boston's Mad Oak Studios.

Architect Storyk is a legend, having started his career designing Jimi Hendrix's Electric Lady Studios, with subsequent credits ranging from NY's Jazz at Lincoln Center performance complex to studios for Jay-Z, Bruce Springsteen, Alicia Keys, Whitney Houston, Green Day and Paul Epworth (The Church Studios, *Resolution* V13.8). "The NIRO process is by far the most robust tool we have identified for accurately predicting acoustic anomalies in a small environment and at the same time optimising the most correct geometric arrangement of boundaries and listener/speaker configuration — particularly for low frequency behaviour!" he told *Resolution*.

D'Antonio continues the story: "John Storyk has always been supportive of my research, so when I had more time after I sold RPG, I wanted to focus on the projects that I'd never quite fully finished — one of them being to finally make a design system for critical listening rooms. When I started RPG in 1983 control rooms were really not very well scientifically designed. Different producers had hit records and then everybody would copy their rooms. Around a decade or so ago, we developed an image model called the 'room sizer and the room optimizer', which does something like NIRO (but not to the same extent) on a rectangular room, not taking into account the impedance of the wall surfaces and not taking into account the low frequency absorbers that were necessary."

To address the modal resonances and speaker boundary interference at low frequencies, a wave acoustics solution, the Boundary Element Method (BEM) is used. At mid and high frequencies, geometrical acoustics will control interfering reflections.

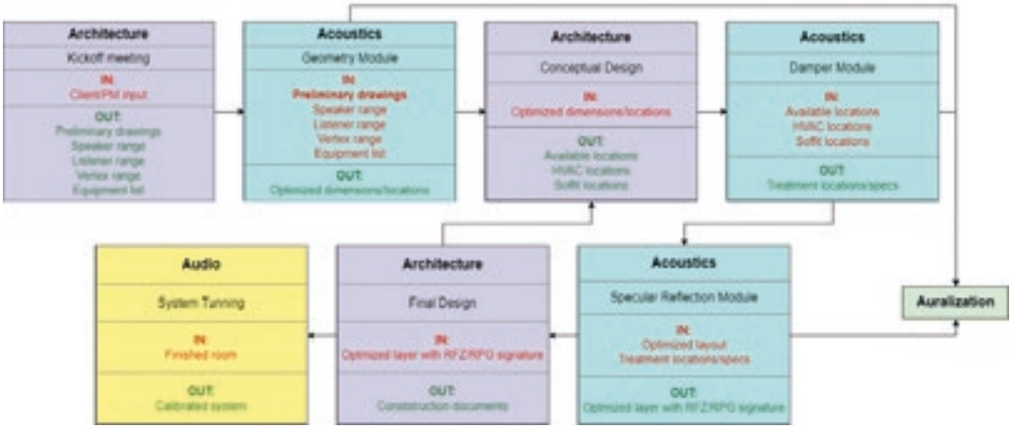
"You can divide the control room into two frequency domains," reveals D'Antonio. "There's a transition point where the modal aspects of the room transition into statistical reflections and we call that the Schroeder frequency, after Manfred Schroeder, one of the greatest acousticians. In order to deal with problems below that transition frequency, you have to use wave acoustics because the audio wavelengths are so long."

Indeed, the 17 metre wavelength of sound in air at 20Hz is considerably longer than any control room most of us have worked in.

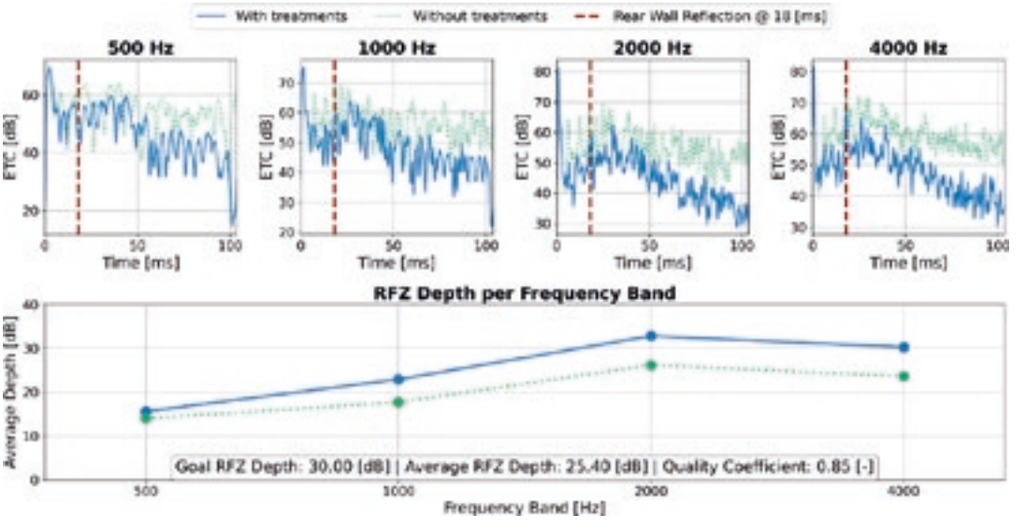
"With loudspeaker-tuning approaches, all they are doing is essentially ruining the frequency response to accommodate problems in the room. So that may work alright if you've only got a project studio and you can't make any modifications to the room — it gets you a little closer — but the 'holy grail' is to make the room neutral and then allow people to adjust the room to suit their taste."

Over the years acoustic designers have used a simple square root equation for cuboid rooms — but that only really works when you have perfectly reflecting boundaries, all the modes are excited and all the modes are heard. This occurs with a speaker and listener in opposite diagonal corners. Unfortunately, this is not how we listen to music! It's necessary to use wave acoustics to solve low frequency modal issues. Additionally, as long ago as 1948 it was shown that when you have a loudspeaker in a particular location, you have the equivalent of another imaginary loudspeaker across every boundary. As D'Antonio explains, what you're ultimately hearing in a listening room is the coherent information from both sources.

"Not only do you have modes, but you have speaker boundary interference. Then there's another issue, which is the uniformity of the temporal decay — most audio pros have seen the loudspeaker waterfall plots. Together... all these form a monster problem for acousticians to solve."



/ **NIRO Process: Architecture, Acoustics, Audio & 'Auralization'**



/ **Frequency plots, before and after acoustic treatment**

The 'black box' studio designers dream of

The software for NIRO was written in Python, an open-source computer language, with REDIacoustics' senior acoustic engineer Rinaldi Petrolli handling the coding. Petrolli has a degree in acoustic engineering and is a collaborator for PyTTa (Python in Technical Acoustics), an open-source library that allows users to make and evaluate acoustic measurements within a Python language interpreted framework. NIRO has three main modules: an iterative Geometry Module that relies on BEM (Boundary Element Method) to predict a room's modal response, and an iterative genetic algorithm to simultaneously determine the optimal room geometry and positions of speakers and listeners.

"We have an animation on the REDIacoustics website that gives you some idea of these hundreds of changes," explains D'Antonio. "As the geometry changes, we monitor the steady-state frequency response, and we monitor the speaker boundary interference. The geometry module only affects those frequencies below the Schroeder frequency, because that's where the room modes are, and that's where the speaker boundary interference is. The principal goal of the geometry module is to eliminate dips in the frequency response, which cannot be mitigated with acoustical treatment."

NIRO's 'Damper Module' operates to minimise the influence of interfering specular

/ Acoustic research centre, containing the 24' long, 7 ton, 2'x2' impedance tube used to verify resonators

reflections and to further minimise modal emphasis and temporal ringing, using new Acoustical Parametric EQualizer (APEQ) modules — fine-tuned acoustic treatments specific for each problematic frequency. Their complex surface impedances are calculated, using the Transfer Matrix Method and validated by impedance tube measurements.

D'Antonio explains the parametric metaphor: "Everybody's familiar with an electronic parametric EQ. You can adjust the Q, the gain and frequency. We wanted to develop a sort of acoustical parametric equalizer, so you add an acoustic absorber that removes energy at the various frequencies of interest. In the damper module we use a predictive approach and an experimental approach. The predictive approach uses a procedure called the Transfer Matrix Method, with which you can predict the frequency, the absorption and the impedance of a resonator, which can then be manufactured. I've just finished completing the design and the fabrication of an Acoustic Research Centre at RPG," reveals D'Antonio. "We have a 24ft long impedance tube, 2ft by 2ft. We can test these resonators that our software predicts, and we can verify if they actually resonate with predicted performance."

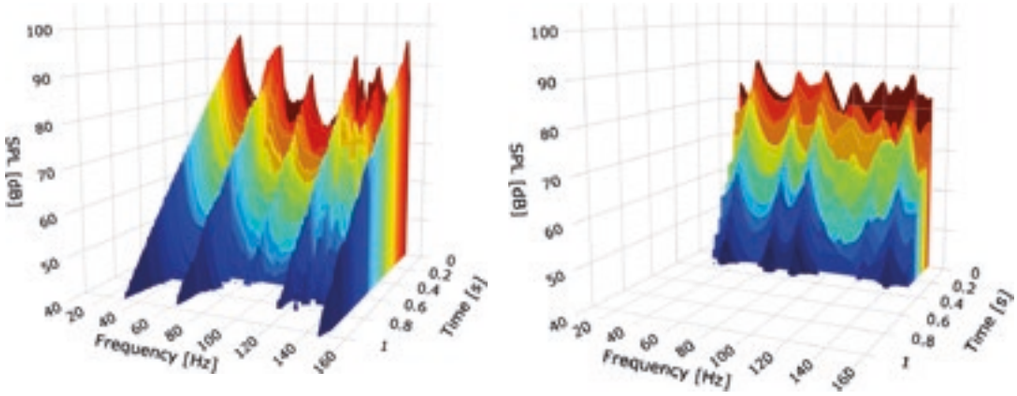
The final NIRO module is a geometric acoustics reflection module, to identify interfering reflections at the listening positions. While there are several software suites already in use by acousticians to perform such calculations, Peter emphasised to us that the unique aspect of NIRO was its ability to perform hundreds and hundreds of iterations of room shape, to deliver the optimum result for each project.

"Having the ability to predict the performance of the room before it's built is quite unique. One of the things that the boundary element program gives you is a pressure plot of the room. It shows you where the nulls are, where the high-pressure regions are, so you know exactly from the calculation where to put all of the absorbing elements. An acoustician will receive a very extensive report. They get the results of every single module. So, if they can change the geometry [of their room], we provide them with architectural drawings."

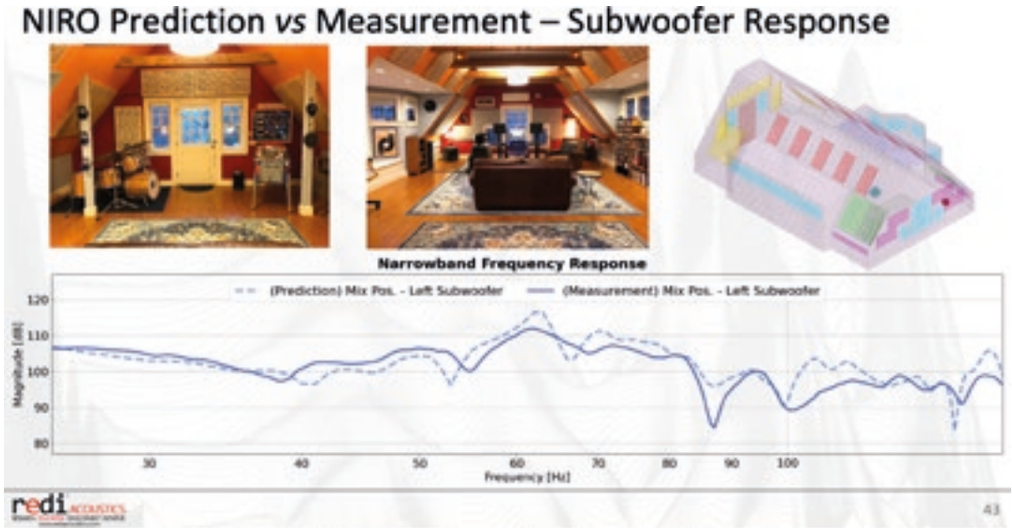
Who can benefit from the service?

The NIRO predictive design service will benefit a range of clients who need to commission high-end listening environments, including musicians, engineers, audiophiles and home theatre owners. A sample 41-page report is

/ Abbott Road Studio, Boston, showing treatment panels (inset)



/ Temporal decay successfully controlled without introducing dips in the frequency response



/ Predicted vs. measured for the Abbott Road subwoofer

available to download from the REDIacoustics website, and very comprehensive it is too. The positioning and construction of wall elements, traps and absorbers is specified in great detail, along with treatment recommendations and construction details for each item. Predicted frequency response charts and decay spectrum responses for the mix position are illustrated, together with pressure distribution at listener ear-level for the entire room. This allows an experienced acoustician or designer to further expand the report into a fully developed set of construction documents — or at the same time, permits a DIY approach for production pros interested in tackling the fabrication of their own custom damping modules. In future, the plan is for there to be several 'certified manufacturers', providing treatments that can be integrated with NIRO designs.

In fact, the information was so detailed, I began to think that the NIRO report must be rather expensive. Not a bit of it.

"REDIacoustics offers this analysis as a fixed-fee service and delivers a detailed analysis and recommendations report. Turnaround time for this service is usually within a week or so after all the critical information for a project is obtained. Fee structure depends upon the exact nature of the project variables, but to date has never exceeded $5,500USD. REDIacosutics is continuing to optimise this software as well as explore multiple solution sets for APEQ's (Acoustic Parametric EQualizers) — in other words applied surface treatments. Stay tuned for more research and development on that front!"

REDIacoustics' NIRO is, effectively, the 'black box' that ordinary studio-builders have dreamed of for many years. The NIRO program has been successfully utilised in nearly 80 projects over the past two years, several already completed and installed. An early example of NIRO's success is illustrated by the renovation of Abbott Road Studio in Boston, owned by engineer Rob Jaczko, whose credits include Warren Zevon, Don Henley, Bruce Springsteen and James Taylor. The fact that REDIacoustics is helmed by two respected pioneers of acoustic design is reassuring, and NIRO is sure to take its place as an answer to one of audio's most bothersome questions: "I basically know what I want with my new room — can you recommend someone good who can sort out the acoustics — for a reasonable budget?"

www.rediacoustics.com