Virtual Education Lab: What happened next?

My involvement in this story occurred when I read an article by Manfred Schroeder, who was pictured on the cover of the October issue of Physics Today in 1980, Figure 1, in which he described these new reflection phase gratings. At the time, I was working in a completely different field as a diffraction physicist in the Laboratory for the Structure of Matter at the Naval Research Lab in Washington, DC. This lab was distinguished for the seminal work of Nobel laureate Dr. Jerome Karle, who solved the phase problem used to determine crystal structures from x-ray diffraction patterns. Upon reflection, it became apparent that these RPGs were essentially periodic 2-dimensional "crystals," with a finite number of repeats, as opposed to a crystal with infinite periodicity. Since I was familiar with the crystallographic x-ray theory used to determine the structure of 3-dimensional crystals, I understood the content, Figure 2. I presented this research at the 74th AES Convention (1983) in a Studio Design session which Manfred Schroeder was the invited speaker, Figure 3, where I met him for the first time! Upon further research, together with my colleague John Konnert, I published my first acoustics paper, describing the design and calculation of the 3D polar responses from periodic phase gratings (The reflection phase grating diffusor: design, theory and application. P. D'Antonio, JH Konnert, Journal of Audio Engineering Society 32 (4), 228-238 (1984)).

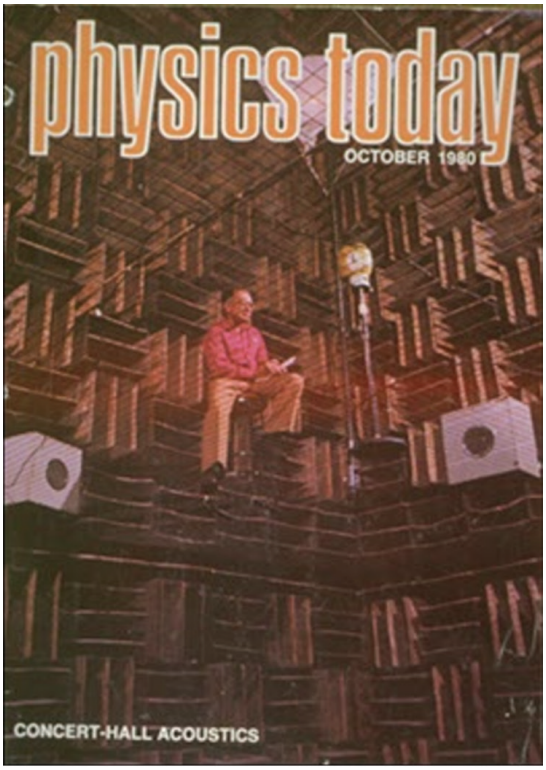


Figure 1. Manfred Schroeder on the cover of Physics Today

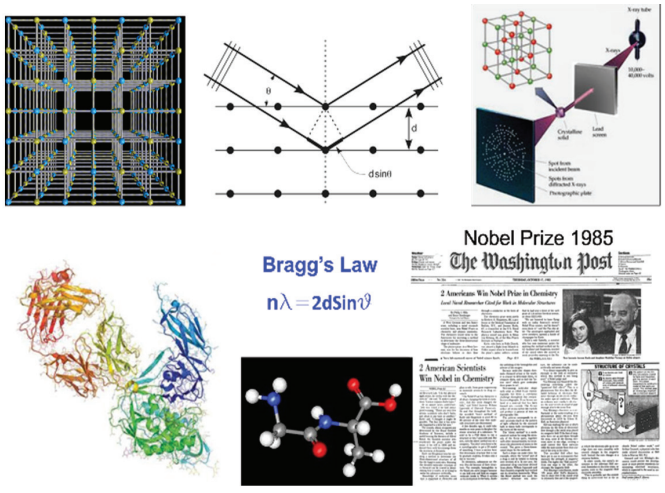
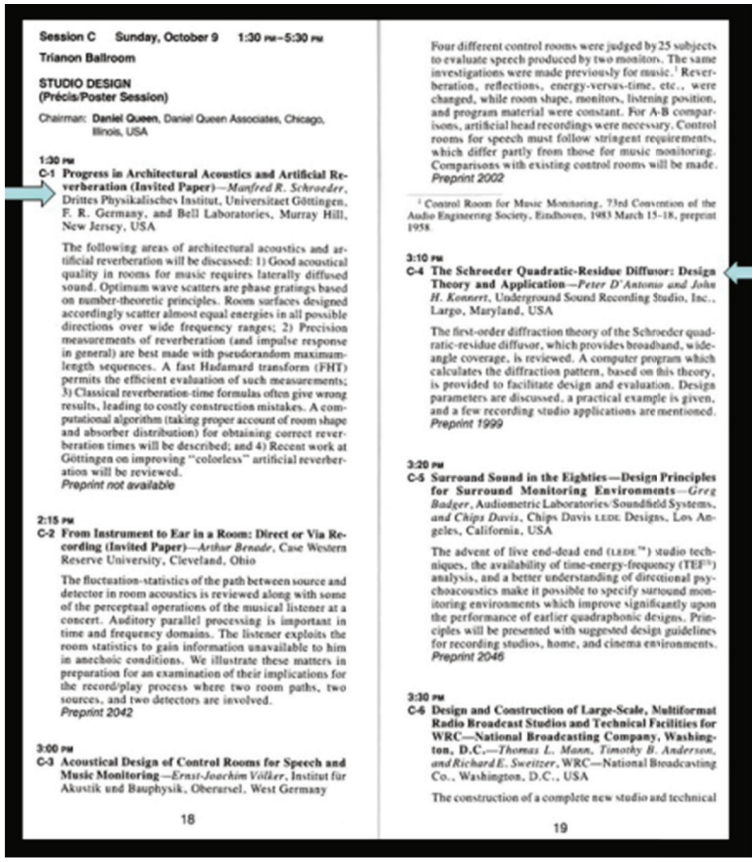


Figure 2. Schematic collage of how x-ray diffraction from periodic crystal lattices is used to determine the structure of matter at the Naval Research Laboratory

The important similarity was that Bragg's law, which determines the diffraction directions, ϑ, from the crystal plane spacing, d, and wavelength, λ, was equally applicable to the RPGs by reflacing 2d with the period width Nw, despite the fact that the wavelength of sound is a billion times larger than x-rays.

$$\sin\vartheta = \frac{n\lambda}{2d} = \frac{n\lambda}{Nw}$$



Session C Sunday, October 9 1:30 PM–5:30 PM

Trianon Ballroom

STUDIO DESIGN
(Précis/Poster Session)

Chairman: **Daniel Queen**, Daniel Queen Associates, Chicago, Illinois, USA

1:30 PM
C-1 **Progress in Architectural Acoustics and Artificial Reverberation (Invited Paper)**—*Manfred R. Schroeder*, Drittes Physikalisches Institut, Universitaet Göttingen, F. R. Germany, and Bell Laboratories, Murray Hill, New Jersey, USA

The following areas of architectural acoustics and artificial reverberation will be discussed: 1) Good acoustical quality in rooms for music requires laterally diffused sound. Optimum wave scatters are phase gratings based on number-theoretic principles. Room surfaces designed accordingly scatter almost equal energies in all possible directions over wide frequency ranges; 2) Precision measurements of reverberation (and impulse response in general) are best made with pseudorandom maximum-length sequences. A fast Hadamard transform (FHT) permits the efficient evaluation of such measurements; 3) Classical reverberation-time formulas often give wrong results, leading to costly construction mistakes. A computational algorithm (taking proper account of room shape and absorber distribution) for obtaining correct reverberation times will be described; and 4) Recent work at Göttingen on improving "colorless" artificial reverberation will be reviewed.
Preprint not available

2:15 PM
C-2 **From Instrument to Ear in a Room: Direct or Via Recording (Invited Paper)**—*Arthur Benade*, Case Western Reserve University, Cleveland, Ohio

The fluctuation-statistics of the path between source and detector in room acoustics is reviewed along with some of the perceptual operations of the musical listener at a concert. Auditory parallel processing is important in time and frequency domains. The listener exploits the room statistics to gain information unavailable to him in anechoic conditions. We illustrate these matters in preparation for an examination of their implications for the record/play process where two room paths, two sources, and two detectors are involved.
Preprint 2042

3:00 PM
C-3 **Acoustical Design of Control Rooms for Speech and Music Monitoring**—*Ernst-Joachim Völker*, Institut für Akustik und Bauphysik, Oberursel, West Germany

Four different control rooms were judged by 25 subjects to evaluate speech produced by two monitors. The same investigations were made previously for music.[1] Reverberation, reflections, energy-versus-time, etc., were changed, while room shape, monitors, listening position, and program material were constant. For A-B comparisons, artificial head recordings were necessary. Control rooms for speech must follow stringent requirements, which differ partly from those for music monitoring. Comparisons with existing control rooms will be made.
Preprint 2002

[1] Control Room for Music Monitoring, 73rd Convention of the Audio Engineering Society, Eindhoven, 1983 March 15-18, preprint 1958.

3:10 PM
C-4 **The Schroeder Quadratic-Residue Diffusor: Design Theory and Application**—*Peter D'Antonio and John H. Konnert*, Underground Sound Recording Studio, Inc., Largo, Maryland, USA

The first-order diffraction theory of the Schroeder quadratic-residue diffusor, which provides broadband, wide-angle coverage, is reviewed. A computer program which calculates the diffraction pattern, based on this theory, is provided to facilitate design and evaluation. Design parameters are discussed, a practical example is given, and a few recording studio applications are mentioned.
Preprint 1999

3:20 PM
C-5 **Surround Sound in the Eighties—Design Principles for Surround Monitoring Environments**—*Greg Badger*, Audiometric Laboratories/Soundfield Systems, *and Chips Davis*, Chips Davis LEDE Designs, Los Angeles, California, USA

The advent of live end-dead end (LEDE™) studio techniques, the availability of time-energy-frequency (TEF®) analysis, and a better understanding of directional psychoacoustics make it possible to specify surround monitoring environments which improve significantly upon the performance of earlier quadraphonic designs. Principles will be presented with suggested design guidelines for recording studios, home, and cinema environments.
Preprint 2046

3:30 PM
C-6 **Design and Construction of Large-Scale, Multiformat Radio Broadcast Studios and Technical Facilities for WRC—National Broadcasting Company, Washington, D.C.**—*Thomas L. Mann, Timothy B. Anderson, and Richard E. Sweitzer*, WRC—National Broadcasting Co., Washington, D.C., USA

The construction of a complete new studio and technical

18 19

Figure 3. Program of the 74th AES Convention Studio Design session in 1983 in New York

This new surface was coincidentally interesting to me, because I am a musician and was building a new studio to record my original compositions. Quite amazingly, these new surfaces were what I was searching for to uniformly diffuse the sound from the rear wall of my new control room and complement the new design I developed utilizing a reflection-free zone surrounding the mix position!

In the next post, I will describe the first measurements of the time response from an RPG.

Dr. Peter D'Antonio
Director of Research
Acoustical Research Center