Acoustic Design: Rooms and Walls

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Design Activity	Acoustic Issue
#1 Siting a building in a favorable acoustic environment	Sound transmission in a free field
#2 Designing indoor spaces for the proper acoustic environment	Sound absorption and reflection
#3 Designing adjacent spaces for acoustic independence	Characteristics of sound transmission in materials

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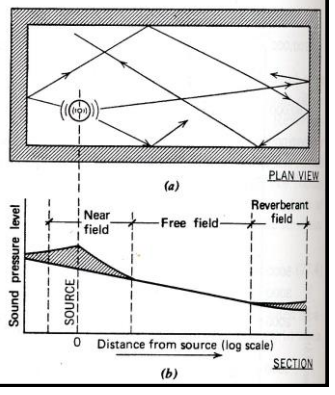
Rooms & Reverberant Fields

May have 3 fields
…or fewer…



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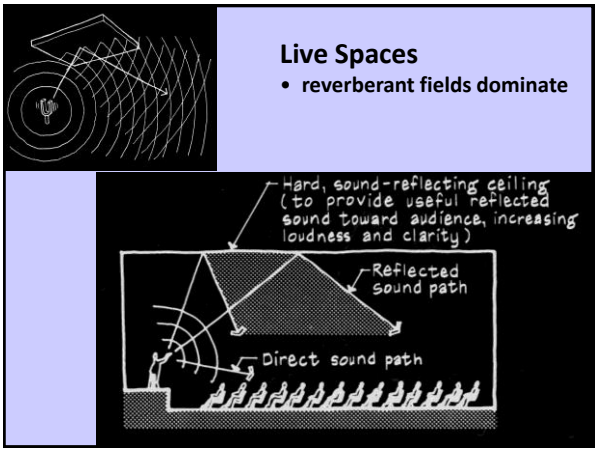
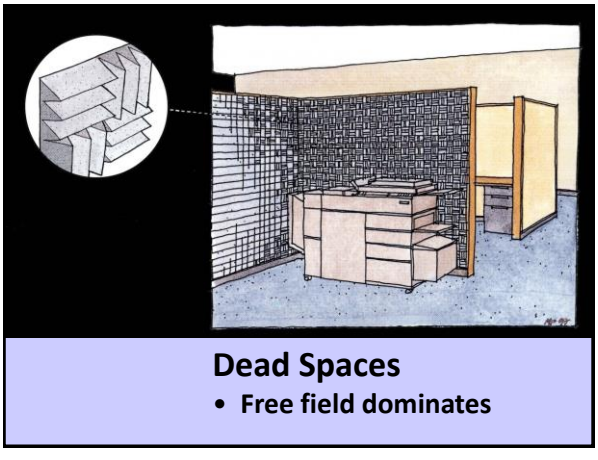
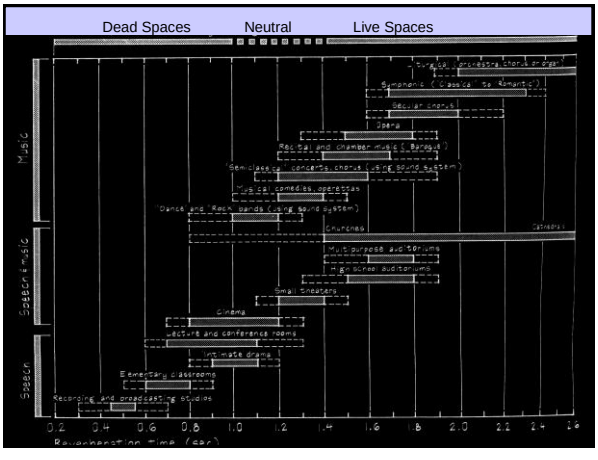

Live Spaces
• reverberant fields dominate
Hard, sound-reflecting ceiling (to provide useful reflected sound toward audience, increasing loudness and clarity)
Reflected sound path
Direct sound path

4


Dead Spaces
• Free field dominates

5


Dead Spaces
Neutral
Live Spaces
Music
Speech
Speech + music
Symphonic (Classical to Romantic)
Secular chorus
Opera
Recital and chamber music (Baroque)
Semi-classical concerts, chorus (using sound system)
Musical comedies, operettas
Dance and Rock bands (using sound system)
Churches
Cathedrals
Multipurpose auditoriums
High school auditoriums
Small theaters
Cinema
Lecture and conference rooms
Intimate drama
Elementary classrooms
Recording and broadcasting studios
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6

6

Room acoustic goals

Silence—a monarchy of sound	Lecture halls, auditoria, churches, theatres
Quiet—a democracy of sound	Libraries, offices, restaurants, design studios, lobbies
None—an anarchy of sound	Factories, grocery stores, fast food outlets, indoor swimming pools

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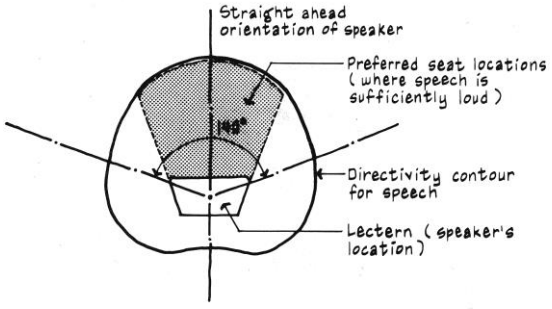
Auditorium Plan with Speech Contour Overlay



Shape Silence Goal Room to match sound projection

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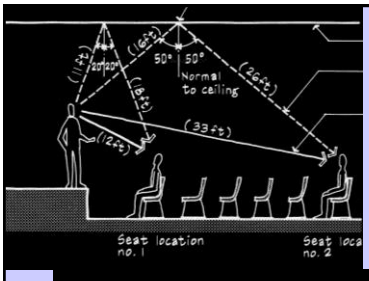

Use reflected sound to enhance communication…

Sound Path Difference (ft)	Time Delay Gap (ms)	Listening Conditions
< 23	< 20	Excellent for speech and music
23 to 34	20 to 30	Good for speech, fair for music
34 to 50	30 to 45	Marginal (*blurred*)
50 to 68	45 to 60	Unsatisfactory
> 68	> 60	Poor (*echo* if strong enough)

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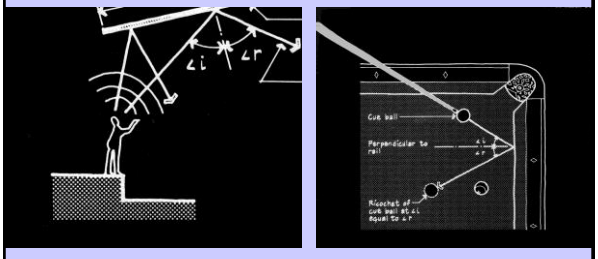
Sound Wave Reflecting Angles

- Draw a line perpendicular to reflecting surface
- Incoming angle = reflected angle



Billiards—Acoustics analogy

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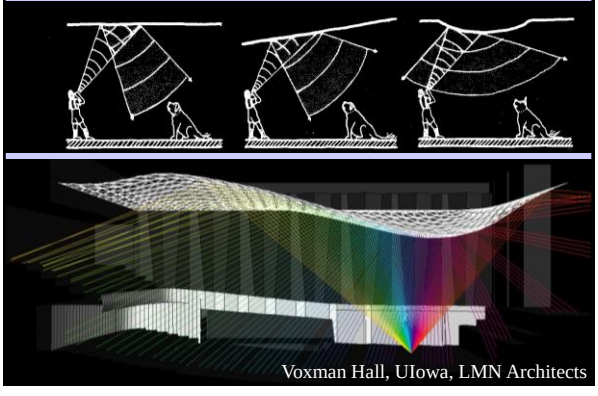
Orientation and shape affect reflection…



Voxman Hall, UIowa, LMN Architects

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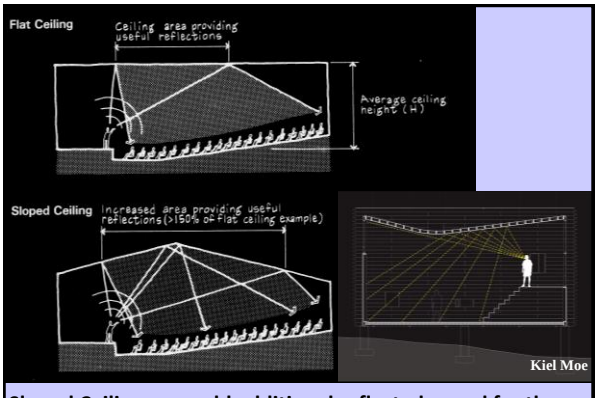

Sloped Ceilings can add additional reflected sound for those sitting in the back rows—or not.

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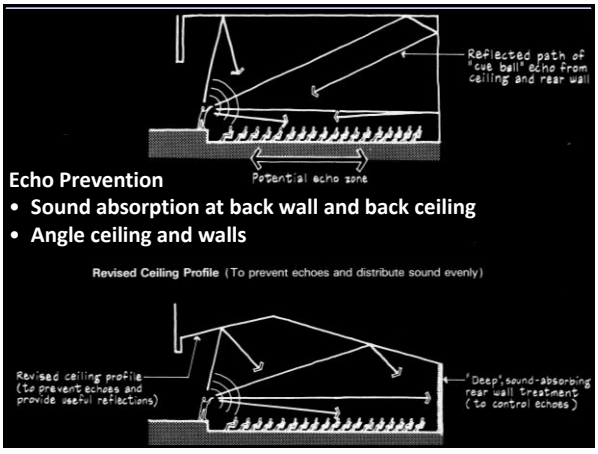

Echo Prevention

- **Sound absorption at back wall and back ceiling**
- **Angle ceiling and walls**

Revised Ceiling Profile (To prevent echoes and distribute sound evenly)

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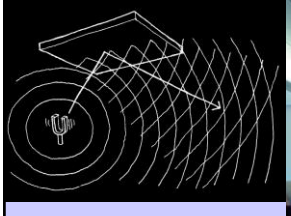
SURPRISES



This room's beam enables odd acoustics by amplifying a phone conversation 30 feet away while nearby conversations are drowned-out by white noise.

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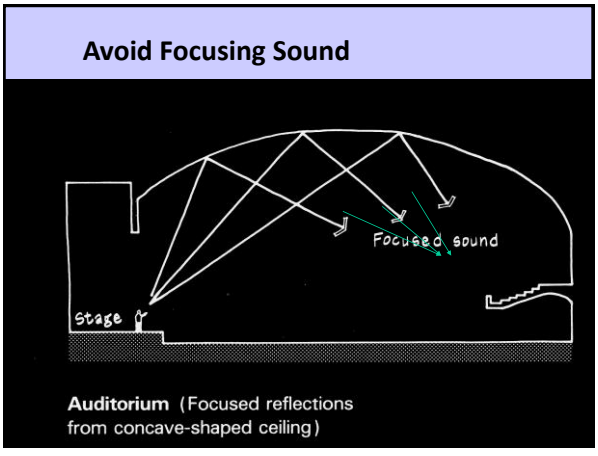
Avoid Focusing Sound



Auditorium (Focused reflections from concave-shaped ceiling)

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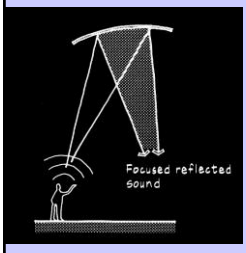
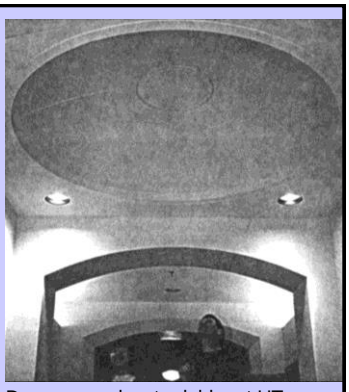
SURPRISE Focusing





Dome over elevator lobby at UTexas produces surprising sound levels.

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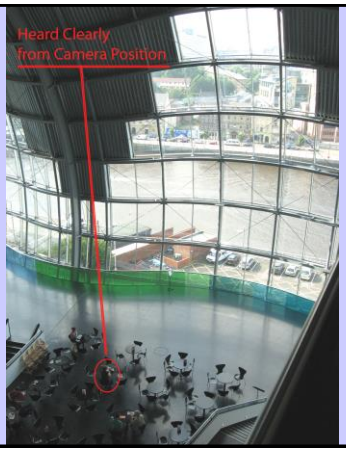

The Sage –Foster

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Isolation--tricky

Marin County Courthouse, Wright

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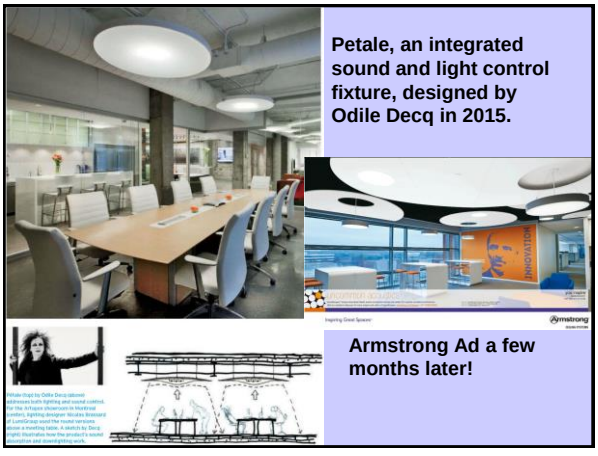

Petale, an integrated sound and light control fixture, designed by Odile Decq in 2015.

Armstrong Ad a few months later!

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Blue Moon Brewing Co., Denver by Roth Shepard

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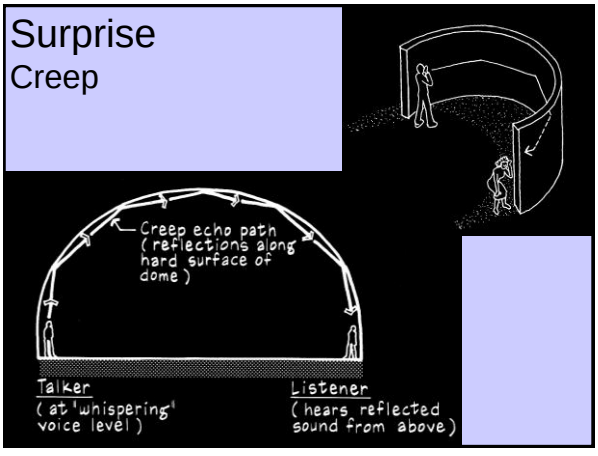
Surprise
Creep



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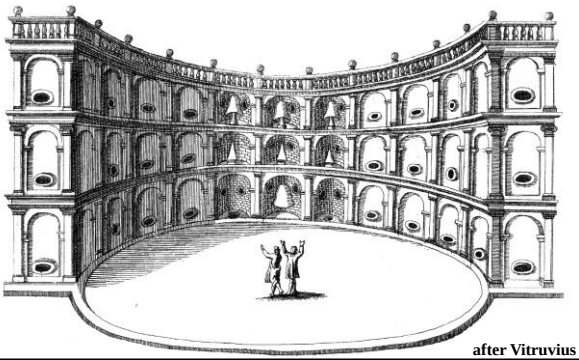
Resonance Chambers

- Absorption (Hemholtz)
- Projection (Bandshells)



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Noise Attenuation Strategies (for sites and rooms)

- Distance
- Zoning
- Absorption & Diffusion
- Isolation
- Masking
- Barriers (math lecture)

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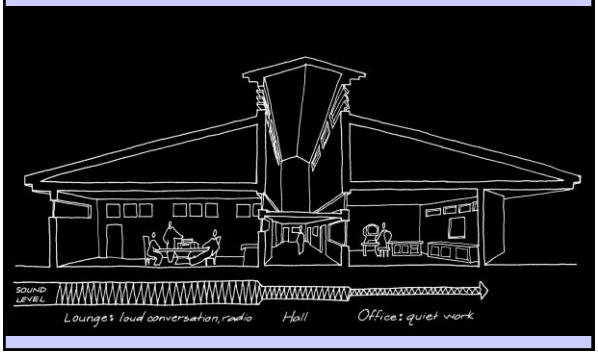
Zoning



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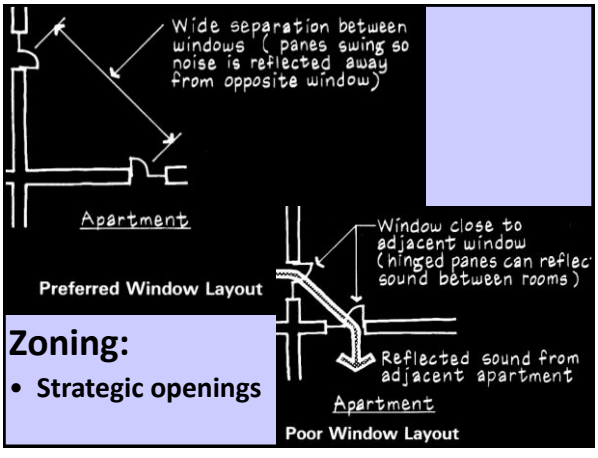

Zoning:

- **Strategic openings**

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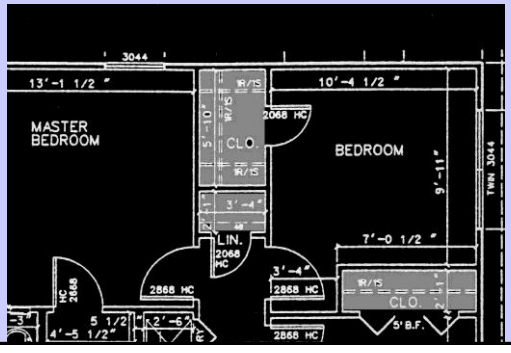
Zoning:

- **Buffering**



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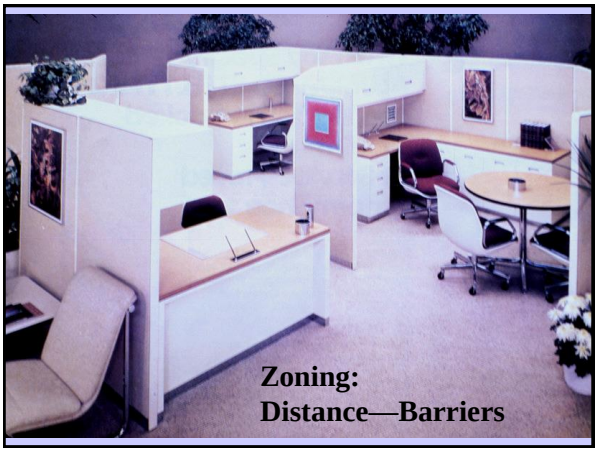

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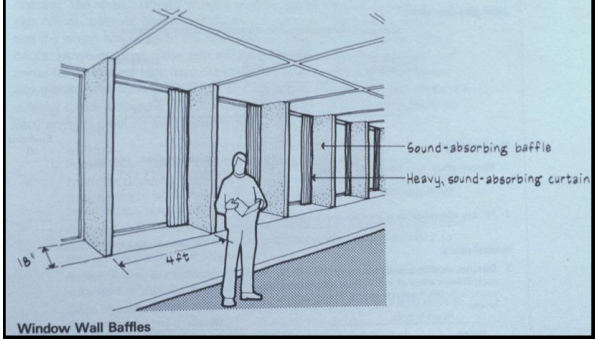
Absorption and Diffusion

5. Closure panels that extend partial-height barriers to walls (see below)
6. Tilted or sloped wall surfaces



Window Wall Baffles

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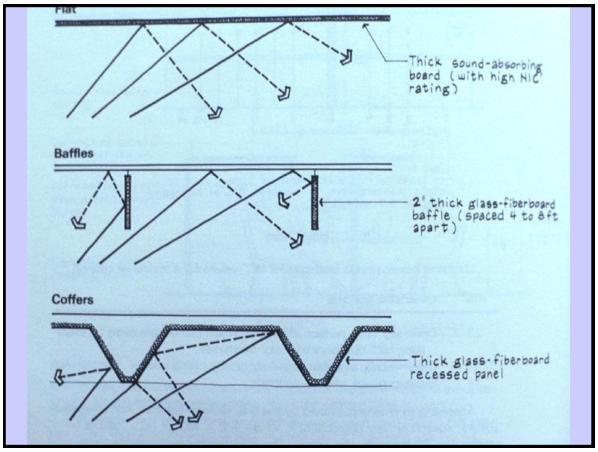

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Bateson Building

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1970s
products

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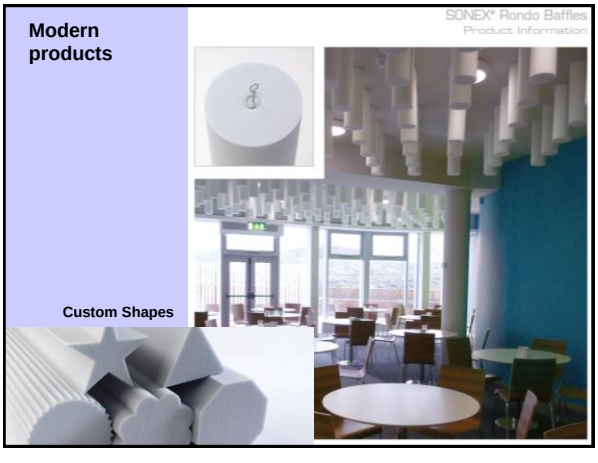
Modern
products
SONEX® Rondo Baffles
Product Information
Custom Shapes

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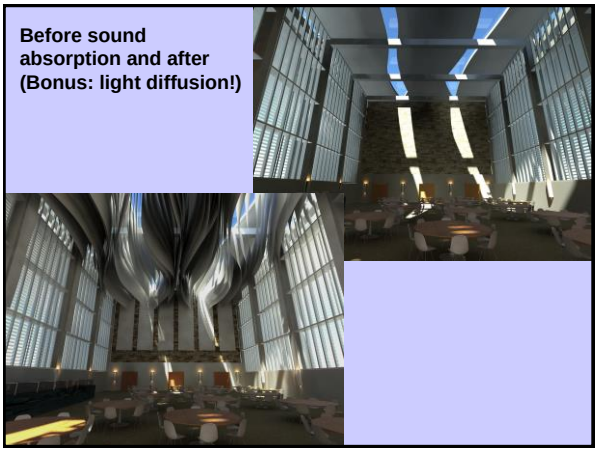
Before sound absorption and after (Bonus: light diffusion!)



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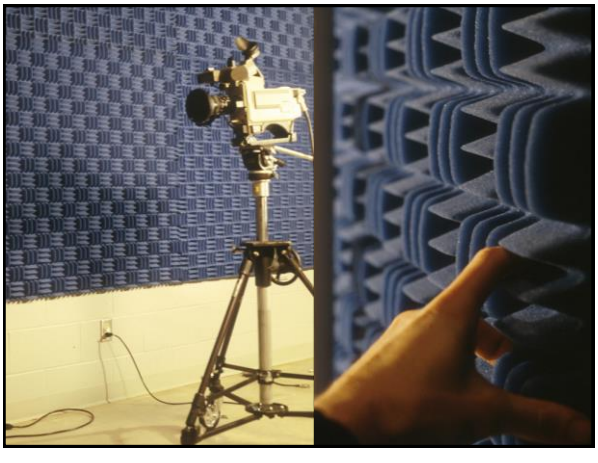

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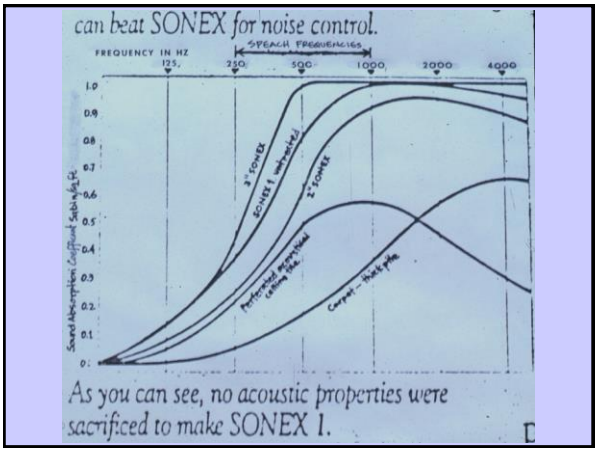

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Other absorbent materials…

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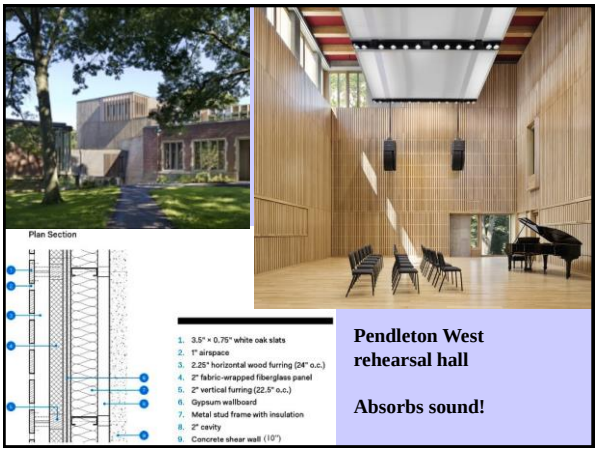

Pendleton West rehearsal hall

Absorbs sound!

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Café @ the Building Centre, London

Two absorption strategies!

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Diffusion

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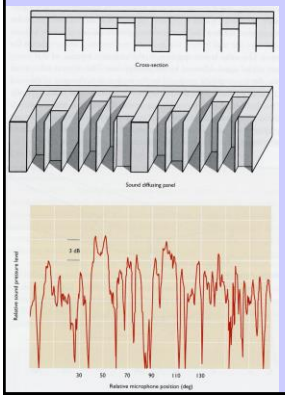
Design of room absorbers and diffusers can be complex…



Admin Aud photo!

Prime Root Diffuser

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Thamesmead Library Project—Arch 454 Spring 2018

Adam Harfman, Adilyne Nolan, & Deona Swager

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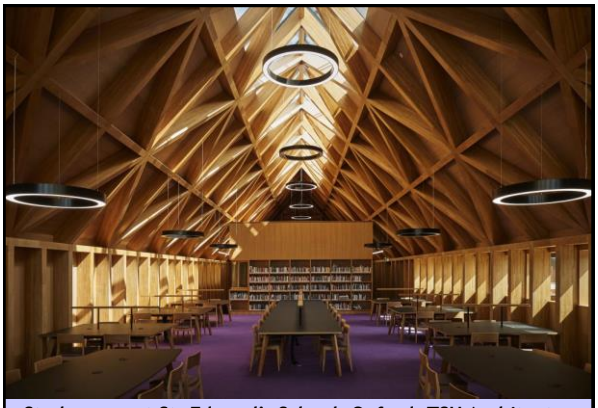

Study room at St. Edward's School, Oxford, TSH Architects

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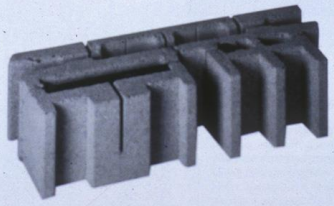
SOUND BLOCKS

An acoustician tells how to get the best acoustical performance from concrete masonry units, through careful specification and detailing

by Neil Thompson Shade



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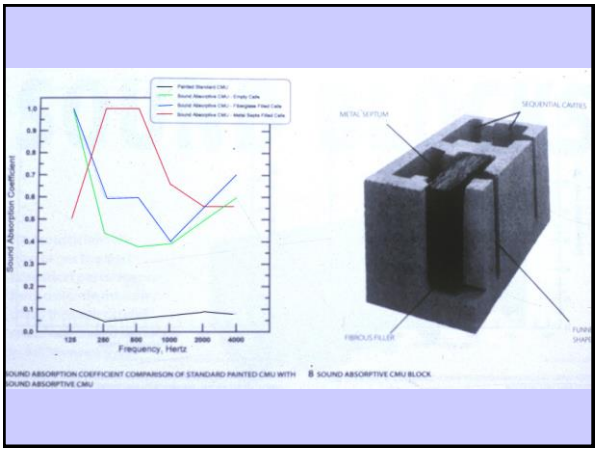

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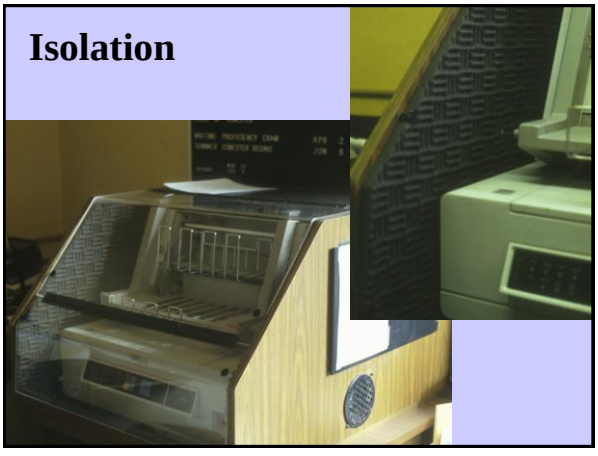
Isolation



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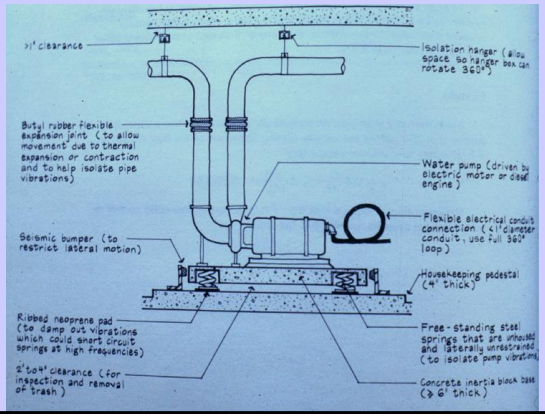
Isolation--straightforward



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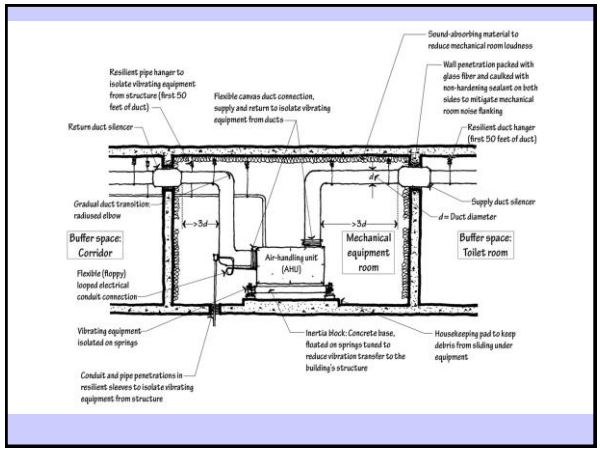

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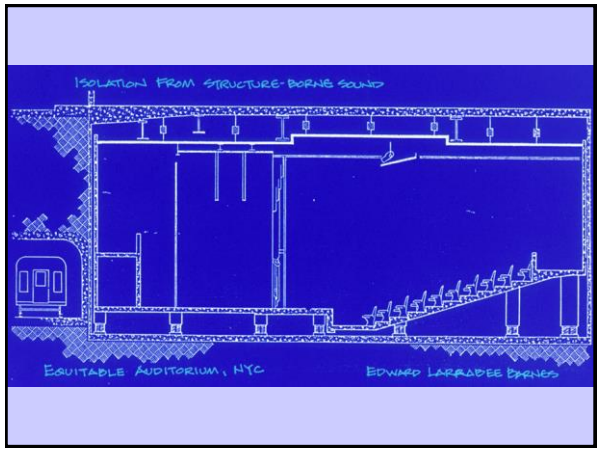

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Surprise and Synesthesia

- Hearing sound as color

Next time…the math…

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