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CAP'EM

Cycle Assessment Procedure for Eco-impacts of Materials

Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

Passive Performance Noise Light Heat Vent Cool Services Response

UH RIBA Part 1 Year 2 Lecture 6
Architects & Interior Design Architects

This Presentation on GBE:

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INTERREG IVB

Scope

- Quotes
- Principles
- Checklists for Task 2 submission in each of 6 topics
- Acoustics Noise/Sound
- Lighting
- Heating
- Ventilation
- Cooling
- Services Response

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INTERREG IVB

Quotes

- Fabric First > Services Last
- Build Tight > Ventilate Right
- Build Light > Insulate Right > Solar Tight
- Retrofit: No Insulation without Ventilation

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Cycle Assessment Procedure for Eco-impacts of Materials

Investing in Opportunities

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INTERREG IVB

Principles

- Fabric First
- Make the building do all the work
  - Why make a building that need to be heated/cooled if you don't need to
- Do not rely on energy intensive services to fix what you did not address
- Use services to only fill the gap that the building could not provide
- See: Service Response at end

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INTERREG IVB

Acoustics

Sound/Noise

Sources, Barriers, Distribution, Refection, Reverberation, Absorption, Dispersion, Attenuation, Shape of Space, Surfaces, Respond to Function, Quiet v Loud

Purpose of Acoustic Control

- Noise is sound in the wrong place, too loud, too distracting, etc.
- Noise can get about via air or via materials, direct or indirect by flanking through air gaps in construction
- Very hard surfaces reflect sound to reverberate for long periods making speech difficult to understand
- Highly absorbent surfaces make sounds disappear and not be heard
- Sounds from adjacent spaces may flank around partitions make concentration more difficult
- Excessive noise can create stress in the listener
- Using competent construction noise and sound can be reflected, isolated, absorbed, diffused, transmitted

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Cycle Assessment Procedure for Eco-impacts of Materials

Investing in Opportunities

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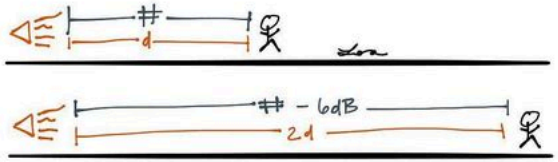
INTERREG IVB

Noise

- Consider the Sources:
  - Internal and external, inward and outward
    - External components of building:
      - solar shading, light shelves, ventilation grilles
  - Controllable v uncontrollable
    - Off site or on site
  - Mitigate or Adapt?
    - To prevent or to deal with consequences
  - Caused by other factors:
    - External wind pressure > Air leaky construction
      - Wind whistling through door and window frames
    - Internal Wind Pressure Buffeting
      - Rattling Components, doors, ironmongery

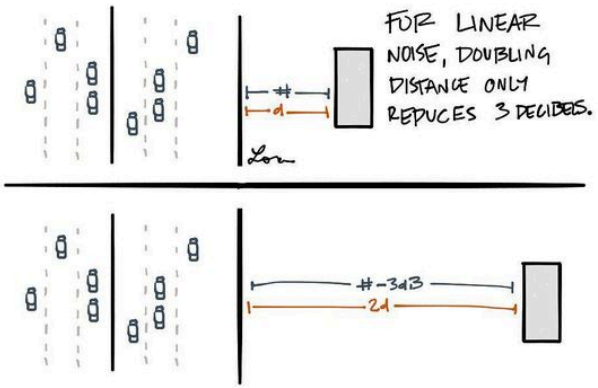
External noise issues can apply to internal too

SITE ACOUSTICS



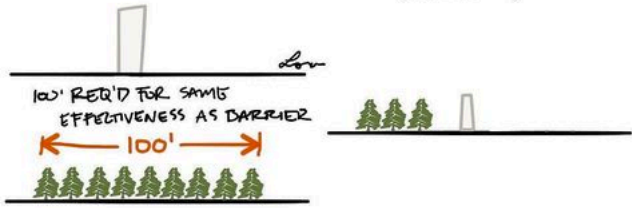
ON AVERAGE, WHEN SPACE DOUBLES, THE AUDIBLE SOUND DECREASES BY 6 DECIBELS.
(ONLY FOR POINT SOURCE)

SITE ACOUSTICS

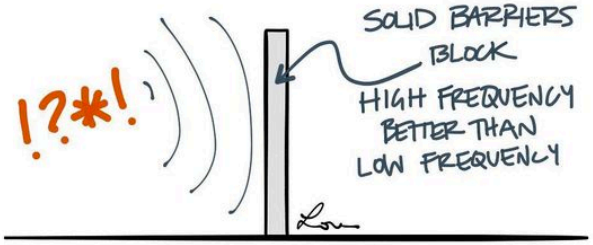


SITE ACOUSTICS

PLANTINGS ARE HARDER TO USE ALONE AS A SOUND BARRIER, BUT CAN ACCOMPANY SOLID BARRIERS.



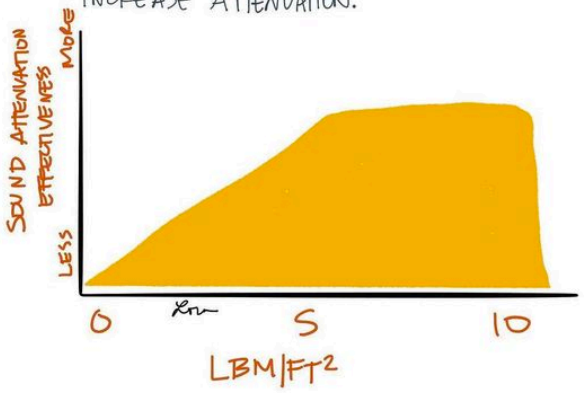
SITE ACOUSTICS



SITE ACOUSTICS

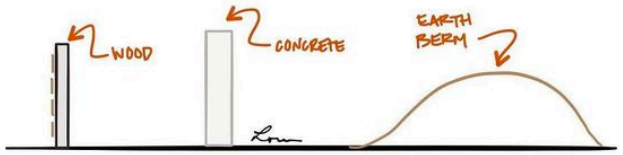
BARRIER DENSITY MIN 5 lbm/ft².

HIGHER DENSITY DOESN'T SIGNIFICANTLY INCREASE ATTENUATION.



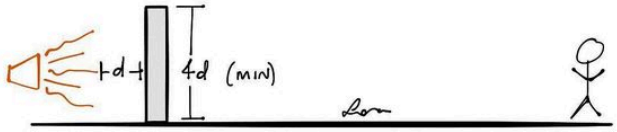
SITE ACOUSTICS

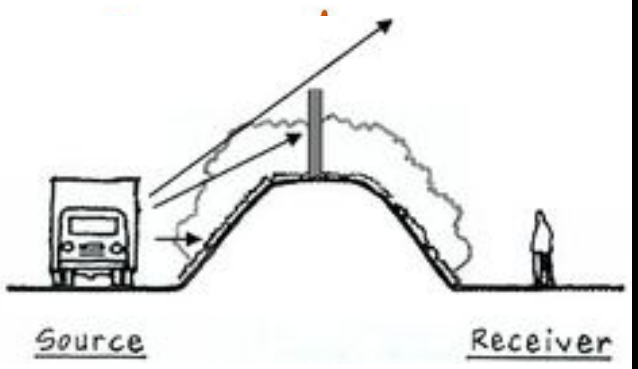
SOLID BARRIERS ARE MOST EFFECTIVE.



SITE ACOUSTICS

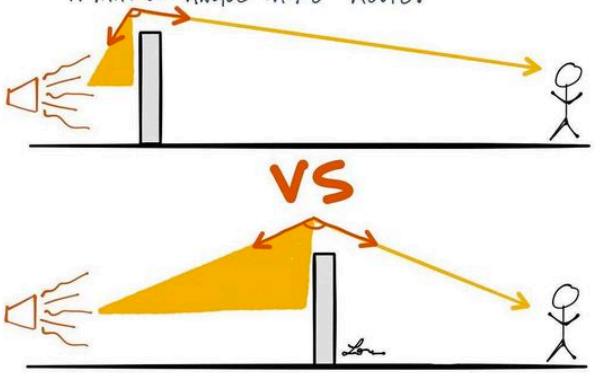
IF BARRIER IS CLOSE TO NOISE SOURCE, IT SHOULD BE 4X AS TALL AS THE DISTANCE TO THE BARRIER IS LONG.





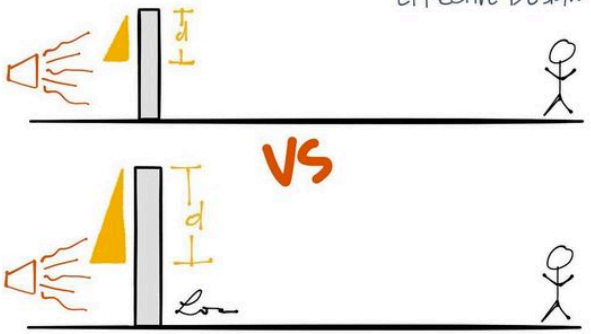
SITE ACOUSTICS

BEST USE FOR BARRIERS IS AS CLOSE TO SOURCE/PROTECTED SPACE AS POSSIBLE. IT MAKES ANGLE MORE ACUTE.



SITE ACOUSTICS

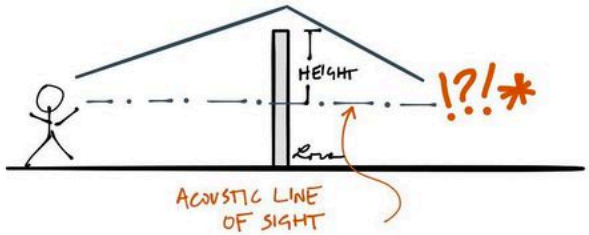
MORE EFFECTIVE HEIGHT = MORE EFFECTIVE DESIGN



SITE ACOUSTICS

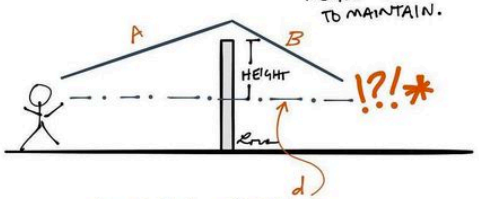
BARRIER EFFECTIVENESS DEPENDS ON:

- HEIGHT OF BARRIER
- DISTANCE
- FREQUENCY OF SOUND



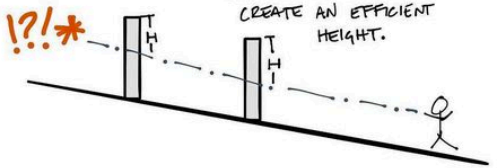
SITE ACOUSTICS

LEVEL GROUND → EFFECTIVE HEIGHT IS EASIER TO MAINTAIN.

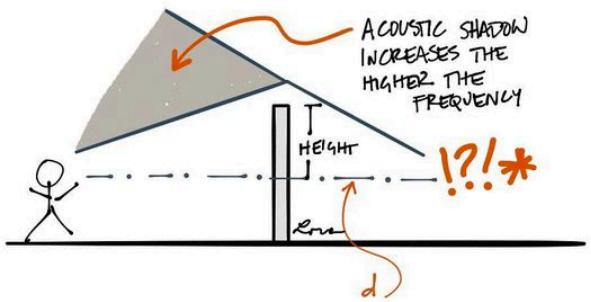


UNEVEN GROUND

CAN BE HARDER TO CREATE AN EFFICIENT HEIGHT.



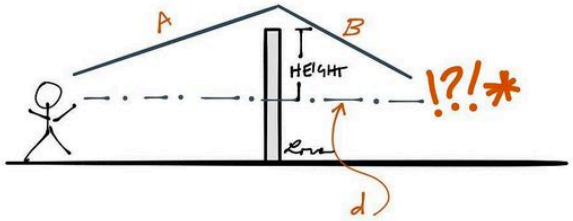
SITE ACOUSTICS



SITE ACOUSTICS

$$N = \left(\frac{f}{565}\right)(A+B-d)$$

DISTANCE IS IMPORTANT!



SITE ACOUSTICS

AN AUDIBLE DECREASE IN SOUND BY HALF TAKES A REDUCTION OF 10 DECIBELS.

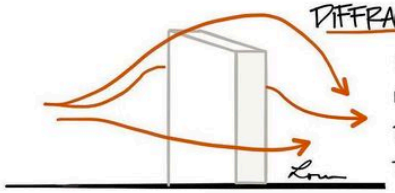
HALF SOUND

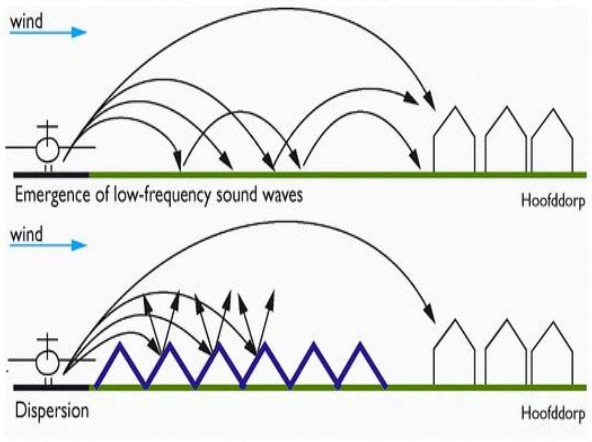
$\neq$ 70 to 35

$=$ 75 to 65
60 to 50 etc.

SITE ACOUSTICS

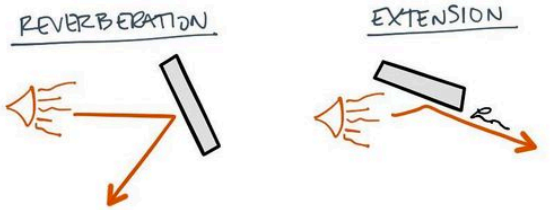
BARRIERS DON'T COMPLETELY STOP SOUND TRANSMISSION.





SITE ACOUSTICS

HARD SURFACES NEAR THE NOISE SOURCE SHOULD BE AVOIDED.

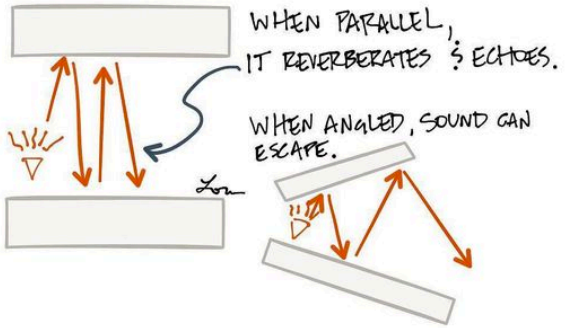


SITE ACOUSTICS

MITIGATING UNWANTED SOUND IS MORE EFFECTIVE THAN COVERING WITH WANTED SOUND.

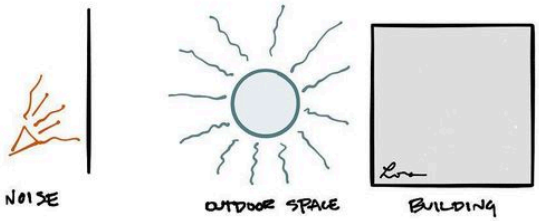
SITE ACOUSTICS

AVOID PARALLEL HARD SURFACES.



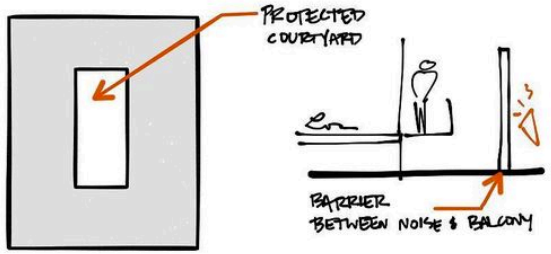
SITE ACOUSTICS

MASKING SOUNDS



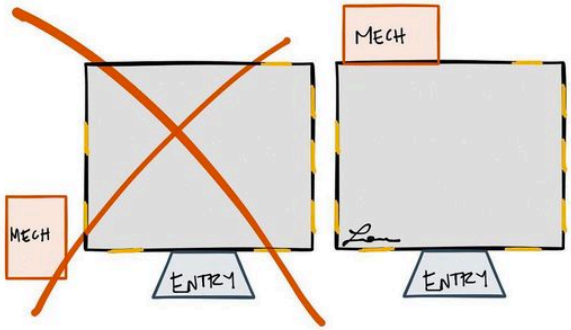
SITE ACOUSTICS

INTEGRATE INTO BUILDING DESIGN



SITE ACOUSTICS

MECHANICAL SPACES, LOADING DOCKS, SERVICE ENTRANCES

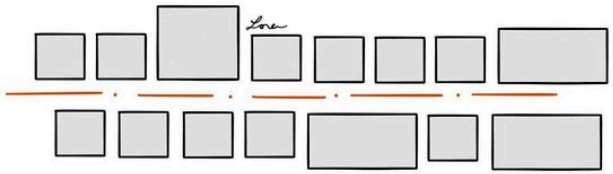


ORGANIZATION

CONCEPTS

[LINEAR]

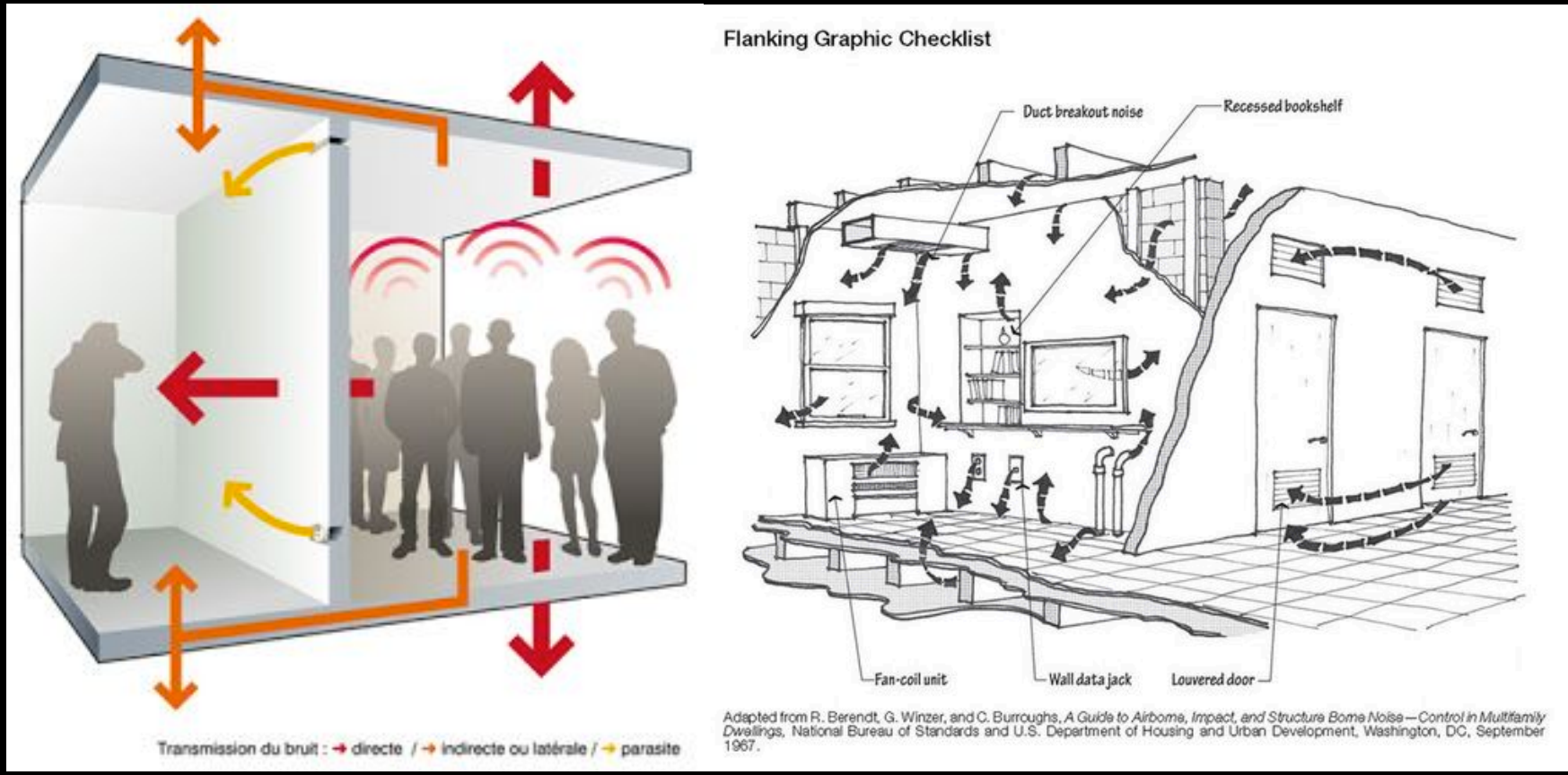
- IDENTICAL OR VARYING SIZE|SHAPE ANCHORED ALONG A SINGULAR LINE.
- CAN BE STRAIGHT, BENT, OR CURVED.
- EASILY MODULAR.



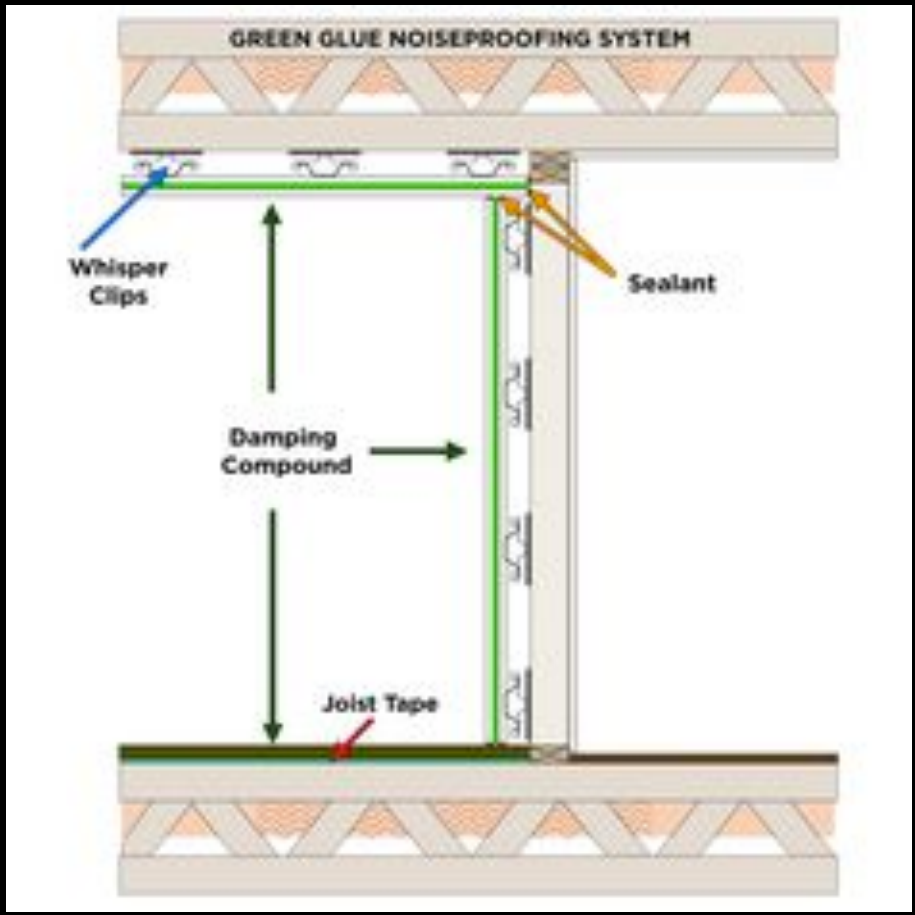
Respond to the Function

- Reading rooms need quiet concentration
- Entrance Halls are places of arrival, surveillance, orientation, rendezvous,
  - requires conversation: meeting, greeting, questions and answers
  - It will be a noisy space that can be accepted

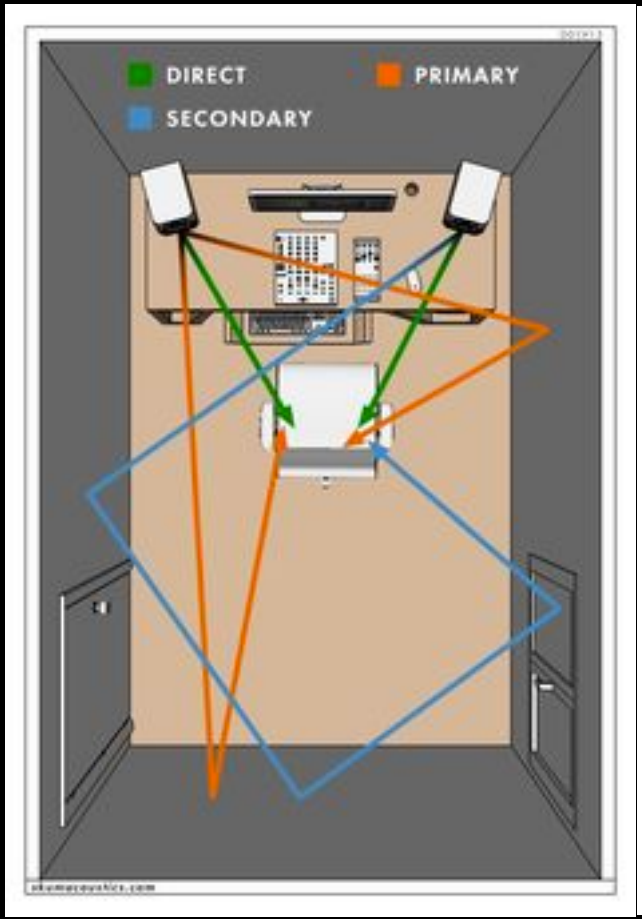
Internal Acoustics
Source > Route > Problem



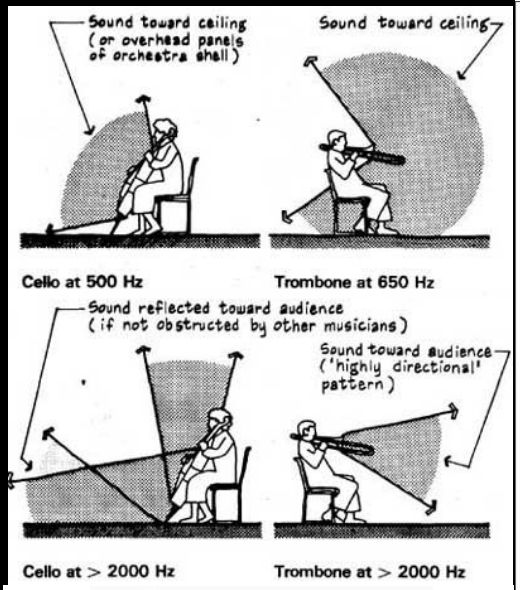
Internal Acoustics
Source > Problem > Solution

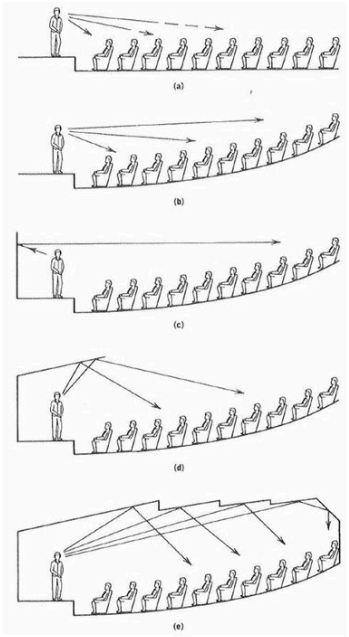


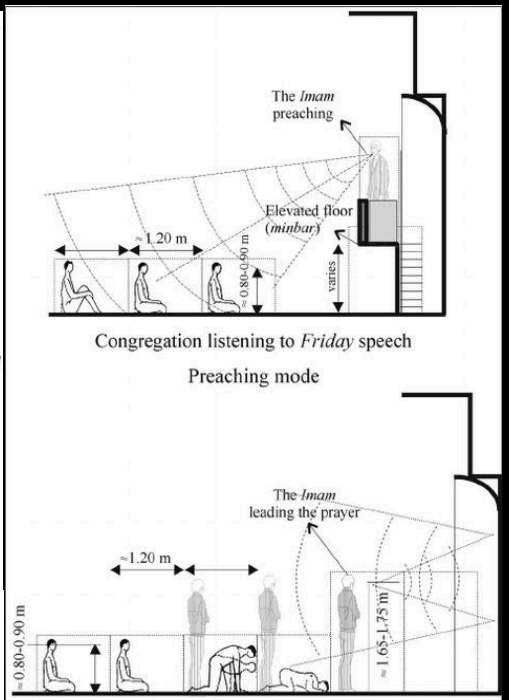
Internal Acoustics
Source > Problem > Solution

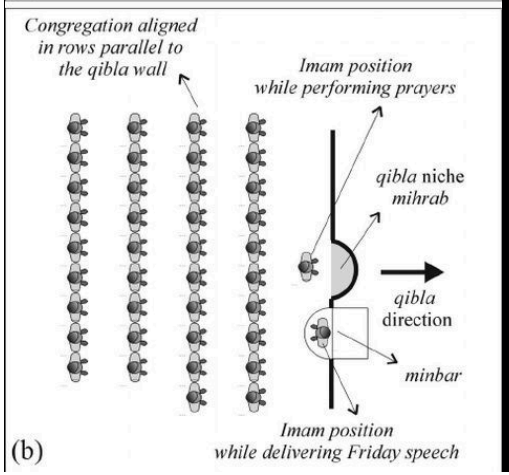


Source of Sound or Noise

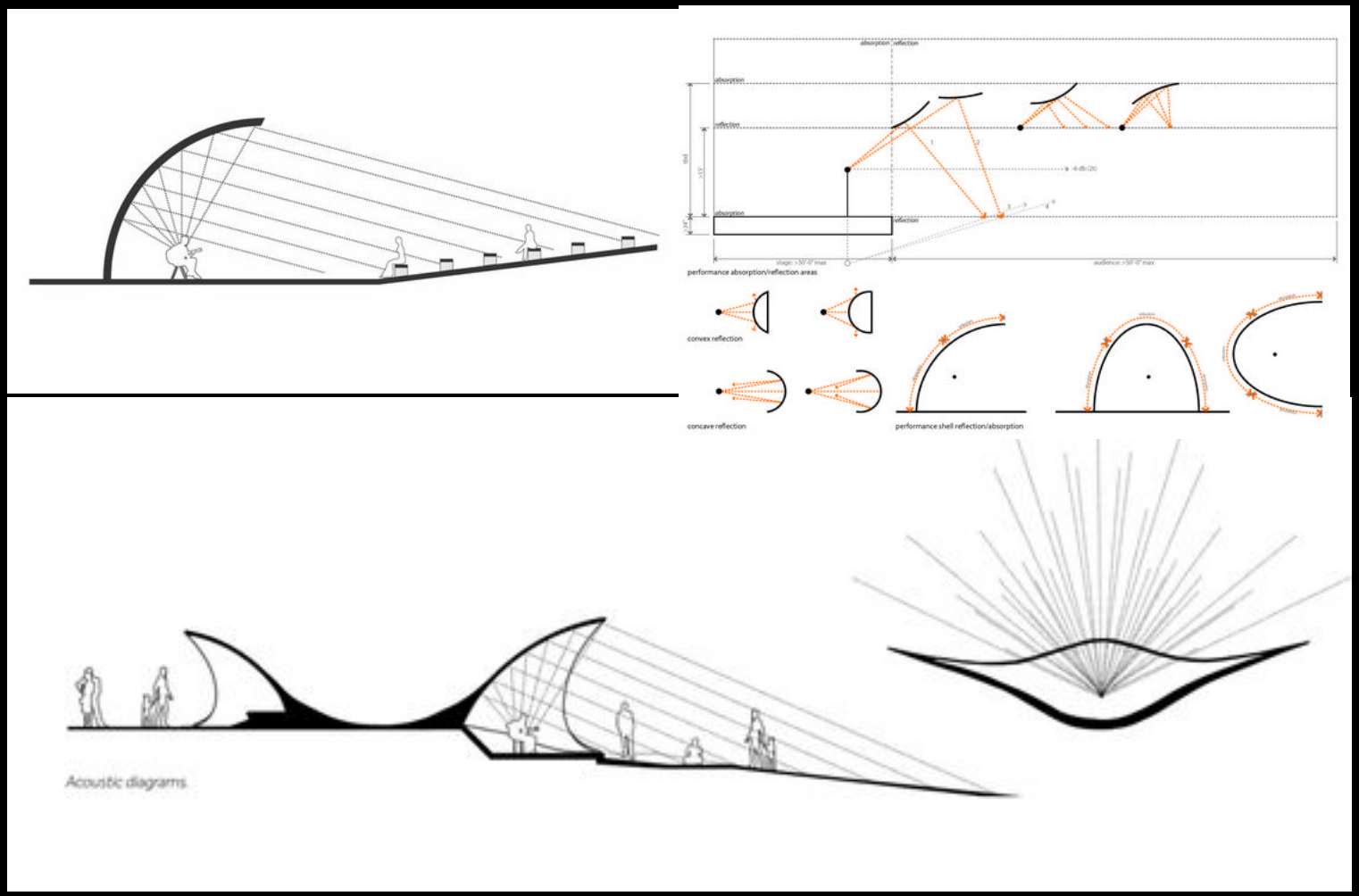




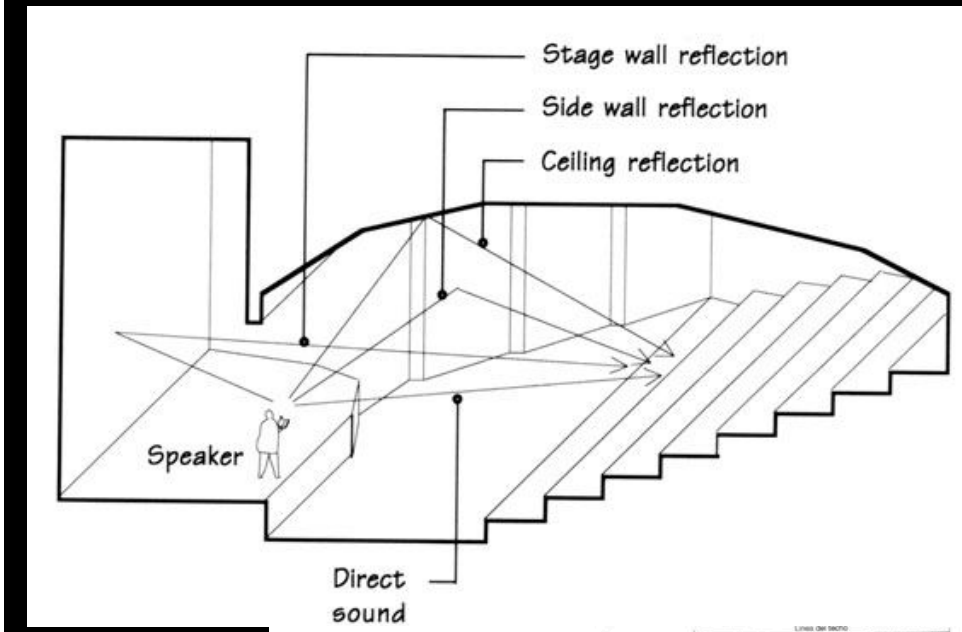


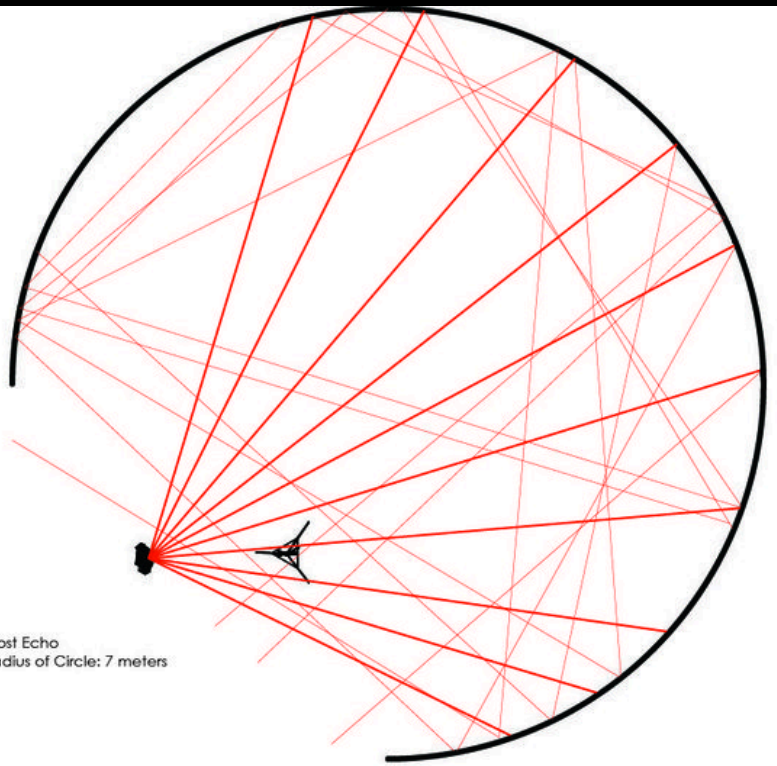


Acoustics of Shaped Spaces

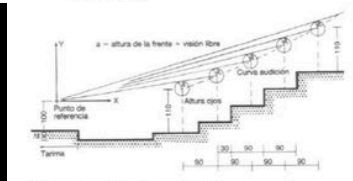


Acoustics of Shaped Spaces

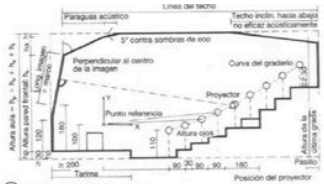




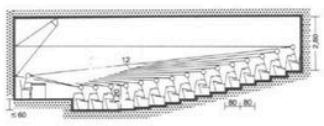
Most Echo
Radius of Circle: 7 meters



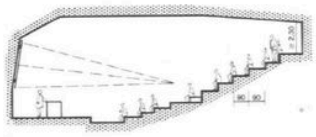
② Determinación gráfica de la curva de audición



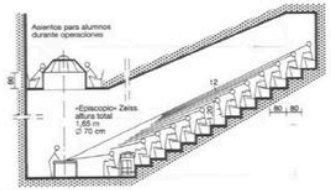
③ Sección longitudinal de un aula



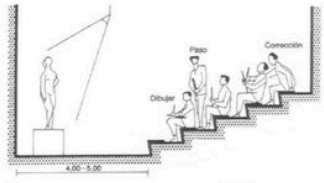
④ Forma normal de un aula



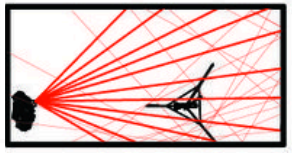
⑤ Aula de gran pendiente



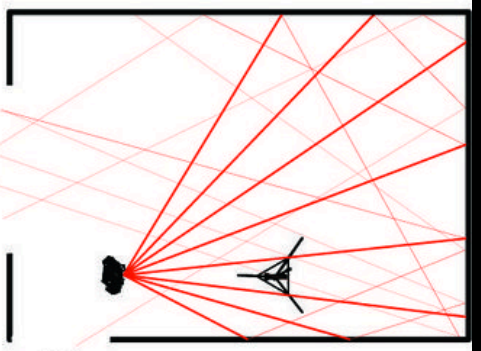
⑥ Aula para conferencias con mesa de demostraciones (Aula de cirugía clínica)



⑦ Escalonamiento en una sala de dibujo al natural, 0,65 m²/alumno

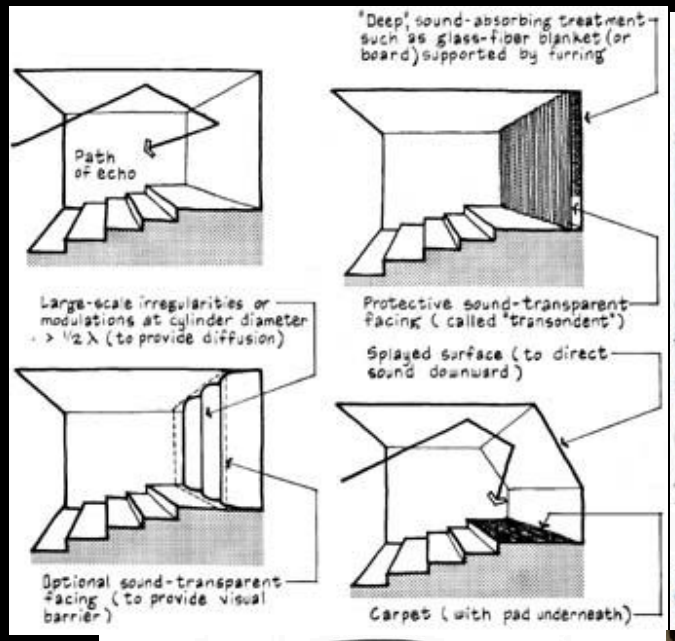


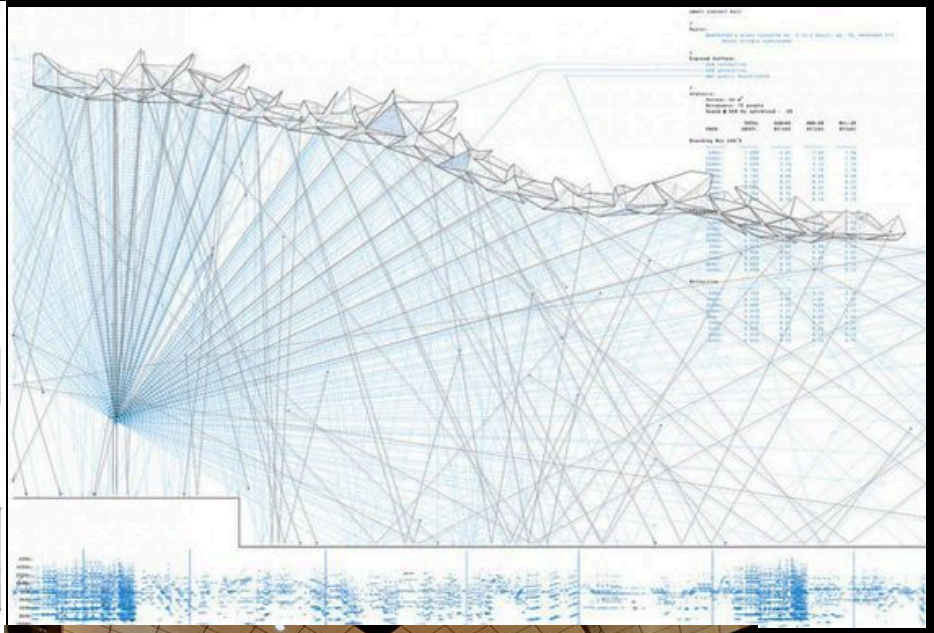
Medium Echo
Length: 4 meters
Width: 2 meters

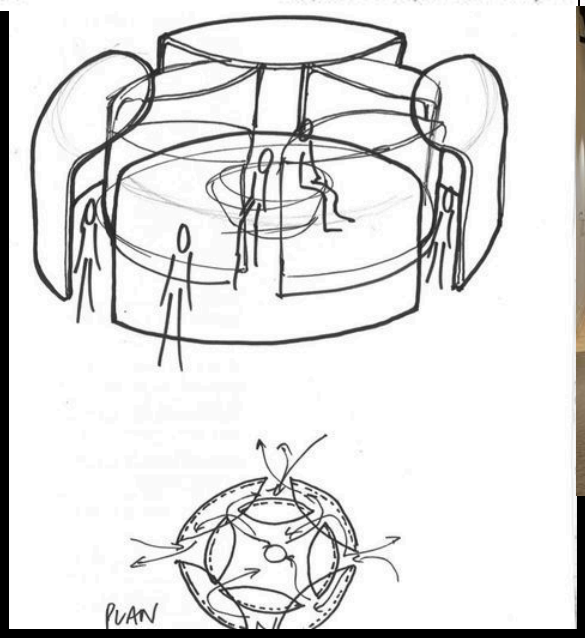


Least Echo
Length: 7 meters
Width: 5 meters

Modifying Acoustics of Spaces



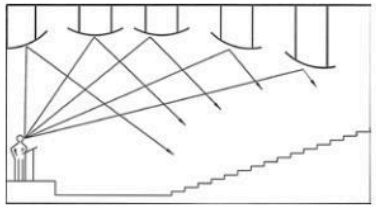




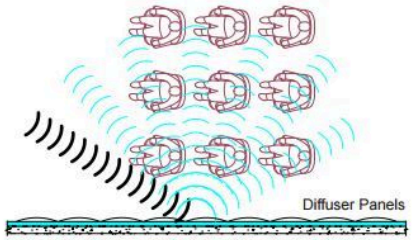
Reflection Absorption Diffusion Attenuation

Reflection/Diffusion

Another goal in Room Acoustics is to control sound reflections so that all listeners enjoy optimal sound quality. Controlling these sonic bounces, both in timing and direction, is an important part of the design for critical listening spaces, from recording studios to performance halls.



Reflectors that are shaped to disburse sound evenly across a broader area are called acoustic diffusers. Diffuser panels are engineered to be effective for selected frequency ranges. Properly located on walls or ceilings, sound quality can be optimized at all listener seat locations.



3

ACOUSTIC BASICS

1. Absorption

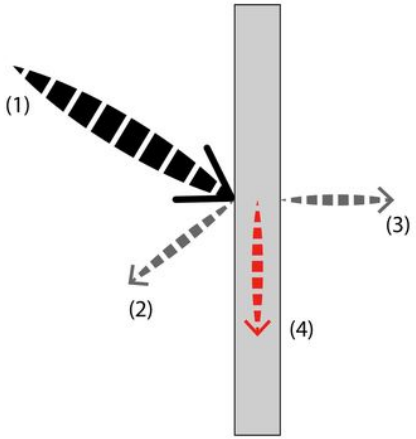
Sound is energy. To stop this energy from spreading, absorptive panels convert energy into heat through friction.
The **absorption coefficient** of a product will determine the level and quality of absorption. Absorption can be applied to fixed wall or ceiling elements.

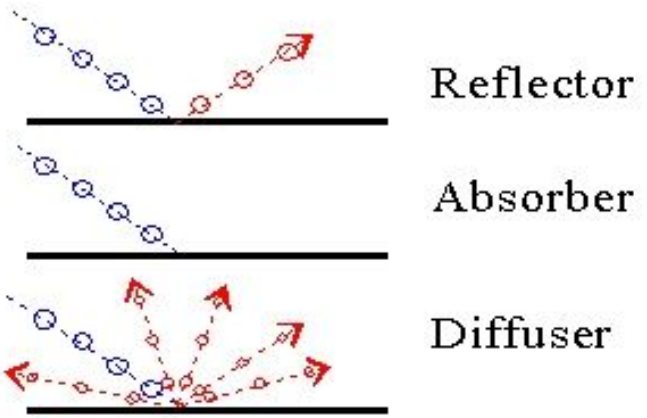
2. Diffusion

Sound that cannot be absorbed through acoustic treatments is scattered evenly back into the room. This spreads the sound more evenly, and maintains a live, vivid sound. Diffusion can be achieved by alternating different depths of absorptive materials and 3D shapes.

3. Attenuation

Vertical elements are used to block th sound transfer in between different spaces, "dampening" the sound. This can include the use of sound blocks, vertical ceiling panels, room dividers, or desk screens. Attenuation or sound dampening can help to improve speech clarity.





Acoustic materials

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Acoustics Assessment

- Regional/Local map and scales essential
- External noise sources: Airports, Roads, Plant
- Plans of whole (site or building) and indicate part
- Building Profile: Section of whole and part
- Source of external and internal noises, volume, distance, topography of route to site,
- Analysis: Plans Sections Elevations:
- Analysis of existing ventilation to be aware of
- Acoustic Analysis and your response
- Any internal enclosure and glazing
- Any interventions by you to provide Acoustic control
  - Background or task acoustics or both

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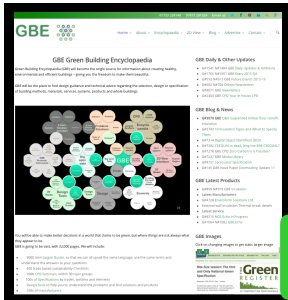
Light/Dark

Sunlight, Daylight, Moonlight, Artificial light, UV degradation, Dark, Black out, Control, Solar Control, Light Shelves, Reflection, Concentration, Refraction,



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Purpose of Light Control

- Light coloured roofs are used for albedo effect for solar reflection
- Excessive sunlight light contrasting with shade can lead to eye strain and headaches
- Sunlight brings heat which may be undesirable,
  - Receptions in sunlit atria can lead to excess sun tanning, sun-stroke, un-wellness
- Glare can be by reflections off metallic surfaces, on monitors (CRT in particular) reflective glass worse than matt glass
- Reflective surfaces can be used to advantage in light shelves to disperse light
- Glare can be from light fittings, through windows or solar shading, in peripheral vision
- Excessive light glare can lead to distraction potentially accidents and migraine
- Ultra violet light can degrade plastics/rubber materials, fading of synthetic colours
- UV filtration can prevent this in laminated glazing PVB interlayers, and surrounds in light fittings
- UV absorbent surfaces remove UV from sunlight on each bounce
- Highly absorbent matt black surfaces absorbs light
- Too much daylight can make projected images difficult to see
- Coloured surfaces distort the projected colours
- Mid tone grey surfaces are better for projecting images (black to white get = chance)
- High saturation pigmented (grey or silver) paints reflect colours accurately vividly
- Control of artificial light saves energy, not needed closest to windows
- Light off if no people present, proximity actuation
- Lights off in daylight, on at night time, if people present
- Use of sun pipes

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Light

- Sunlight Daylight Overcast Moonlight
  - Directional v Diffused v Filtered v Reflected
- Sunlight v Shade:
  - In spaces, on walls, floors; outside: facades, paving
  - Sunlight with heat: E>S>W (Northern Hemisphere)
  - Daylight without heat: N (ditto)
- Sundial Effect: Rising Panning Falling
- Shifting: Winter Equinox Summer
- Timing: Equator 6am-6pm Poles: 24hr night or day
- Colours: Red White Grey Blue
- Ultra Violet Light degradation of material
- Concentration: Walkie Scorchie

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Light Assessment

- North Point and scales essential
- Northern or Southern Hemisphere?
- Plans of whole (site or building) and indicate part
- Building Profile: Section of whole and part
- Exiting glazing positions, sized
- Window treatments if any (inside or out)
- Analysis: Plans Sections Elevations: sundial paths
- Shadow analysis: floors and walls, inside and out
- Your response to shadow analysis
- Any internal enclosure and glazing
- Analysis of existing light to be exploited
- Any interventions by you to provide light
  - Background or task lighting or both

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Heat

Sun paths, Solar Control: internal/external, Sunlight, Sun paths, Shadow, Solar access, Solar heat gain, Surface Thermal Mass, cyclical storage, overnight ventilation purging, Phase Change materials,

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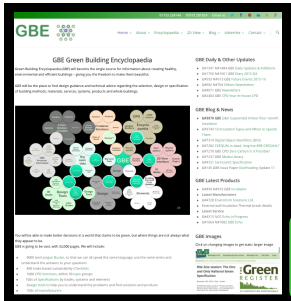

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Purpose of Heat Control

- Excessive heat can kill, 2003 heat wave
  - Sahara temperatures across Europe,
  - 20,000 people died in France,
  - 100s in UK
- 20% of UK homes overheat
  - Higher percentage of new homes overheat
  - MMC homes will choose wrong materials for insulation and overheat
  - Top floors overheat (LRC overheats)
  - District heating overheats corridors and flats/rooms
  - Significantly better insulation needed on all heat pipes
  - Solar Hear gain in glazed staircases over hears flats via corridors
- 80% of UK conservatories are heated squandering energy
- Phase Change Materials are rarely used effectively
- Save energy, save carbon, save costs

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Passive Heat

- North Point Essential
- Sunlight
- Directional v Diffused v Filtered v Reflected
- Sunlight v Shade:
- In spaces, on walls, floors; outside: facades, paving
- Sunlight with heat: E>S>W (N Hemisphere)
- Daylight without heat: N (ditto)
- Sundial Effect: Rising Panning Falling
- Shifting: Winter Equinox Summer
- Timing: Equator 6am-6pm Poles: 24hr night or day
- Colours: Red White Grey Blue

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Active Heat

- Lighting: lower wattage, common today
- Hot water: cylinder constant or as required, uninsulated pipes
- Heating: 16 hours of 24 hour day
- Cooking: Intermittent
- TV ITC Equipment
  - Standby modes 80%
- Fridge/Freezer: 24 hours
- Humans at rest 100 watts, some animals and babies less
- Olympic Athlete 2000 watts at peak
- Passivhaus: exploits it all, recycles heat only to warm fresh air coming in
- Mechanical Ventilation with Heat Recovery MVHR

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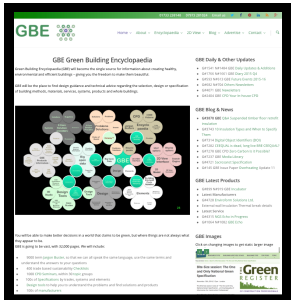
Heat Assessment

- North Point and scales essential
- Northern or Southern Hemisphere?
- Plans of whole (site or building) and indicate part
- Building Profile: Section of whole and part
- Exiting glazing positions, sized
- Window treatments if any (inside or out)
- Analysis: Plans Sections Elevations: sundial paths
- Shadow analysis: floors and walls, inside and out
- Your response to shadow analysis
- Any internal enclosure and glazing
- Construction Assemblies showing insulation and mass
- Analysis of existing heat to be exploited
- Any interventions by you to provide heat



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Ventilation

Passive Active Mechanical

Avoiding Air conditioning "Comfort Cooling"

Purpose of Ventilation Control

- Control Indoor Air Quality IAQ
- Control Humidity levels, Moisture Content of materials, minimise risk of mould
- Control Temperature
  - Remove solar heat gain warmed air
  - Cross ventilation
  - Overnight purging of thermal mass heat
- Control release or remove Smells
- Control VOC levels (off-gassing from plastics, synthetics, adhesives, paints)
- Maintain Life: Airtightness levels below 3 need deliberate and dedicated ventilation

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Passive Vent

- Open Windows and doors let fresh air in, to cross flow ventilate building
- Open roof lights/roof vents
- Stack effect up stairwells in summer
  - Need doors to close in winter
- Passivhaus: can be ventilated by opening windows but turn off the MVHR
- Conservatories attached to house need ventilation top and bottom and be closed from house (Building Regulations)

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Passive Interventions

- Passive vents actuated by humidity do not open for smells
- Clay finishes absorb smells and moisture
- High Titanium Dioxide coatings clean the air
  - But extremely high environmental impact to make it
- Essence of Cherry eats bacteria in the air
- Opening opaque vents in walls becoming popular
  - (insect grilles and security essential)
- Passive Ventilation with Heat Recovery
  - Existing Fireplace and Chimney
  - New duct inserted with PVHR cowl on top

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Active Vent

- BedZED cowels
- Wind pressure drives fresh air in
- Pushes stale air out
- Transfers heat-only from outgoing to incoming air

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Mechanical Ventilation

- Passivhaus: MVHR whole house system
  - Extract from Kitchen and Bathrooms
  - Input into Living and bedrooms
  - Circulate via corridor
- Extractors in Bathrooms and Kitchen (humidity smells removed but heat lost)
  - MVHR through walls are available too

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Ventilation Assessment

- North Point and scales essential
- Prevailing wind rose
- Plans of whole (site or building) and indicate part
- Building Profile: Section of whole and part
- Wind access to site, shadows, urban climate issues if applicable
- Analysis: Plans Sections Elevations:
- Your response to wind and shade analysis
- Any internal enclosure and glazing
- Analysis of existing ventilation to be exploited
- Any interventions by you to provide ventilation
  - Background or task lighting or both

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Cooling

Choose Passive Active Mechanical Ventilation

Avoiding Air Conditioning wherever possible

"Comfort Cooling"

Purpose of Cooling Control

- Remove excess heat and humidity
- Air conditioning is energy intensive to heat, cool and change relative humidity
- Depending on fuel source also carbon intensive, and probably 24 hours
- Rare books, photographic collections, exhibits, art or sculpture
- May need to be kept at a low temperatures and humidity to avoid mould growth
- Laboratories or chemical stores may need to be kept cool to avoid spontaneous combustion
- Food storage mountains need to be kept cool
- If the building fabric lets in solar radiation heat by using wrong materials with wrong decrement delay in the roof and E>S>W facades
  - the building will need to be cooled more on sunny days
- 100% fixed glazed facades need 100% air conditioning to control: heat and humidity from people, equipment and solar heat gains
  - Canary Wharf Tower: 1 million watts from people alone

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Cooling Assessment

- Previous Light/Heat/Wind assessments
  - (combine as 1 diagram?)
  - Heat sources than need to be cooled
  - Wind access to site, shadows, urban climate issues if applicable
- North Point and scales essential
- Plans of whole (site or building) and indicate part
- Building Profile: Section of whole and part
- Analysis: Plans Sections Elevations:
- Your response to:
  - Heat/Wind and shade analysis
  - Any internal enclosure and glazing
  - Analysis of existing ventilation to be exploited for cooling
- Any interventions by you to provide cooling
  - Background or task cooling or both

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Services Response

- Halve Demand: Improve passive measures: 50% reduction
- Double efficiency: effective controls: 75%
- Halve the carbon: Obtain energy from renewable sources: 87.5% reduction
- If your proposals cannot meet all the requirements in a passive way
- Provide the remainder by mechanical or artificial means

Purpose of Services Response

- Provide comfort conditions for occupants
- Reduce Energy Demand
- Reduce Carbon in that energy
- Fuel Autonomy
  - Reduce reliance upon external energy sources and their escalating costs
- Reduce Costs
  - Reduce Business Overheads
  - Reduce Home running costs

Services Response Assessment

- Justify their need
- Propose services needed to meet residual demand
- Ensure the services acknowledge each other and are integrated where important to do so
- Waste from one may be a resource for another
- Describe systems and their controls
- Describe their locations is scheme
- Integrate in floors and reflected ceiling plans, room elevations and roof if required

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Feedback

- These files are created by generalists with a big dollop of green flavour
- These files are updated from time to time
- We are not experts so from time to time these file may get out of date or may be wrong.
- If you feel that we have got it wrong please let us know so we can put it right

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- Brian Murphy BSc Dip Arch (Hons+Dist)
  - Technician and Architect by Training
  - Specification Writer by Choice
  - Environmentalist by Actions
- Greening up my act since 1999
- Founded National Green Specification 2001
- Launched www.greenspec.co.uk 2003
- Created: GBE at https://greenbuildingencyclopaedia.uk 2012 - 2019
- E BrianSpecMan@icloud.com
- Twitter: http://twitter.com/brianspecman
- LinkedIn: BrianSpecMan
- Facebook: BrianSpecMan http://www.facebook.com/brianspecman
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