ACOUSTICS
DESIGN IMPACTS
Talking Points

PARTNERSHIP INITIATIVE
INTEGRATED DESIGN LAB
at the Center for Integrated Design

Figure 1:
A technician installs biodegradable batt insulation made from plant roots that combines thermal performance, fire resistance and sound absorption.
Source: https://www.archdaily.com/889176/eco-friendly-insulation-offers-thermal-performance-sound-absorption-and-fire-resistance-at-the-same-time/

Keywords:
Design, classroom acoustics, reverberation, well-being, noise exposure, materials, job satisfaction, fatigue

CONTENT OVERVIEW

ACOUSTICS + DESIGN IMPACTS SUMMARY

Whether it be for connection or isolation, stimulation or serenity, acoustics' place in architecture is vital. Finishes, soundscapes, systems, and program are design considerations that cannot be overlooked if a space is to be comfortable, safe, and beautiful.

I. Finishes

i. Material and product selections have simple, but significant impacts on the performance of a space. Acoustic measurements (equivalent sound pressure level) were taken throughout a hospital ward continuously for one week to compare sound reflecting to sound absorbing ceilings.

	Reverberation time (s)		Equivalent sound pressure level (L_{Aeq})		Speech intelligibility (RASTI value)	
Area	Sound reflecting	Sound absorbing	Sound reflecting	Sound absorbing	Sound reflecting	Sound absorbing
Central area	0.8	0.4	57	56	0.72/0.68*	0.88/0.83*
Patient room 4	0.9	0.4	56	50	0.67	0.87
Patient room 7	–	–	56	51	–	–

–, not measured.
*Measurements performed in two different positions.

Figure 2: Comparison of sound reflecting ceilings vs. sound absorbing ceilings; acoustic measurements in three areas of a hospital ward (reverbaeration time, sound pressure level, and speech intelligibility)
Source: Blomkvist 2005

ii. Local government is thinking creatively about industrial noise mitigation while simultaneously interrupting waste streams.

   a. In Phoenix, more than 200 miles of highway have been resurfaced with concrete that utilizes pieces of old tires as sound dampening admixture, according to Doug Nintzel, spokesperson for the Arizona Department of Transportation. "It means millions of tires have been recycled and kept out of landfills"

   b. In Texas, "quieter concrete" is raked with grooves that run in the same direction as traffic and results in a drop of highway noise by 5.8 decibels on average, according to Emily Black of the Texas Department of Transportation.

iii. Emerging materials and products are continually being developed for high acoustic performance

   a. Scientists at the Mokpo National Maritime University in South Korea and the Korea Institute of Machinery and Materials have designed a sound resonance chamber that consists of two parallel plates of transparent acrylic plastic about 150 millimetres square and separated by 40 millimetres, rather like a section of double-glazing about the size of a paperback book

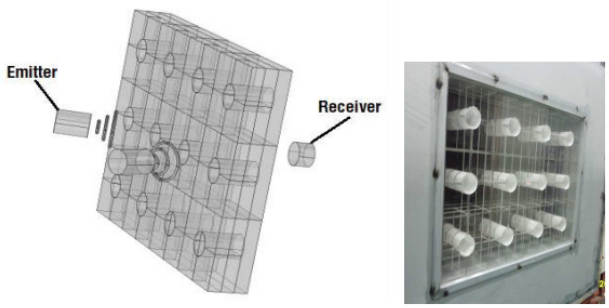

Figure 3: Assembly Detail of the acoustically insulated glazing system designed by MNMU and KIMM
Source: MIT 2013

Finishes Cont.

iv. Finishes have acoustic characteristics that further shape experience. Johannes Girardoni on Olson Kundig's design of The Infinite Room: "The finished lime plaster absorbs moisture just like adobe. It is breathing skin against which sounds reverberate eerily...people seated inside seem to get a heightened awareness of being alive because of the changing light and the acoustics...some guests slip inside to chant or meditate. Others cry when they can hear echoes of their own breath behind them, and still others beg to leave."

II. Soundscapes

i. Governments are shifting toward mandating or encouraging building that takes this into consideration
    a. The United Kingdom's Department of Health and Social Care wrote in their Healthcare Environment 2007 article that "Careful use of colour, light, texture and sound combine to create a healing environment...Designers should ensure that patient areas are located away from external sources of noise, such as road traffic since the healing process is slower when patients are exposed to noise for long periods... Noisy spaces, such as restaurants and day rooms, should not be located next to quiet spaces, such as bed areas"

ii. The ideal soundscape is one of a hi-fi environment, where "all sounds may be heard clearly, with whatever detail and spatial orientation they may have...hi-fi environments present a high degree of information exchange between its elements and the listener is involved in an interactive relationship the environment"

iii. Material and product selections have simple, but significant impacts on the performance of a space. Acoustic measurements (equivalent sound pressure level) were taken throughout a hospital ward continuously for one week to compare sound reflecting to sound absorbing ceilings

III. Acoustic Building System Design

i. Low-voltage electro-acoustic background sound system of proven quality that has been designed and installed by qualified professionals to improve "speech privacy". These systems are available in two types:
    a. Older-style "plenum systems" (i.e., installed above ceiling tiles and radiate sound upward into the plenum)
    b. "Direct-field systems" (these are installed in the ceiling plane and radiate sound downward into the occupied space

ii. Acoustic integration into building systems can do more than mask mechanical noise, it can also connect patrons of art and sporting events with the feats performed in front of, but far away from, them
    a. Of the Golden 1 Center, "absorbent and directional speakers offer better acoustics. The sound of on-court sneaker squeaks is piped in to luxury suites for an enhanced game-watching experience."

IV. Programming for Acoustic Control

Soundproofing specific rooms would allow hotel owners to have lively communal space as well as quiet private rooms. Clustering "quiet rooms" together in the hotel plan to create quiet-zone floors is a simple way to make these accommodations.

The simultaneous use of absorption materials, sound-absorbing screens and speech masking sound would produce the lowest STI, thus, best speech privacy in open-plan offices. The open-plan office lacked sufficient masking sound and absorption materials.

V. Over-Treatment

i. It is possible to "overdo" acoustic baffling A possible explanation of this effect is that the acoustic treatment of the office reduces the overall noise level and therefore cancels the masking effect of noise from sources at a distance

   a. Subjects perceived the noise in the constructed sound-absorbent office as louder than in the real open-plan office, even though the objectively measured sound level in the sound-absorbent office was lower

   b. Close sources become more apparent, which causes more annoyance, more disruption and an increase in dissatisfaction with noise in the space

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