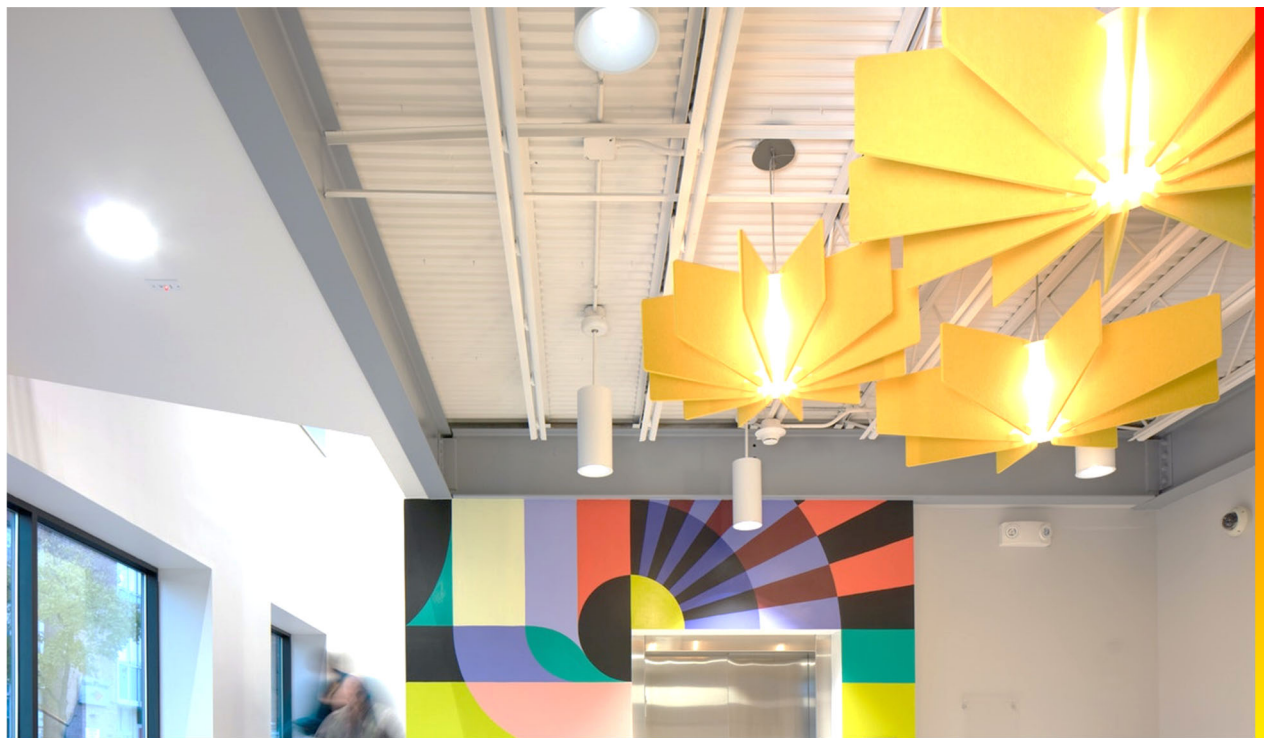




Acoustic Lights

Dr. Paresh Shravage



Alfa Acoustics
Silence through Science

An ISO 9001:2015 Company

Acoustic Challenges -

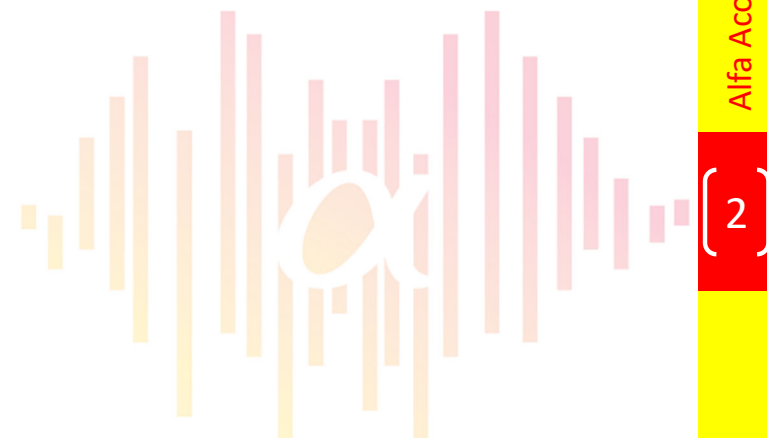
- Unfinished elements: ceiling or walls
- Larger windows in building and glass wall office or conference room
- Harder surfaces especially for flooring and walls
- Removal of cubicles and wall partitions to create open office areas



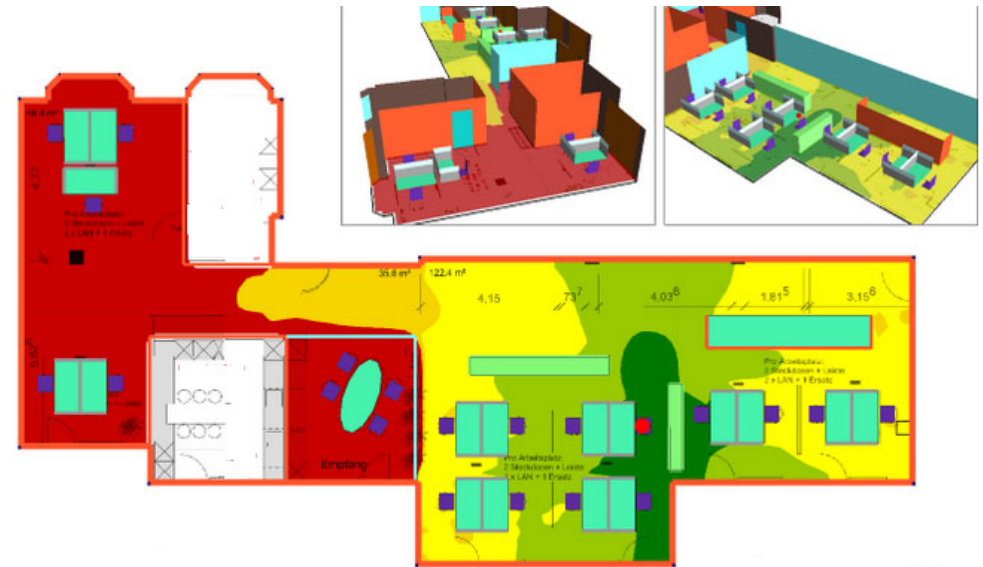
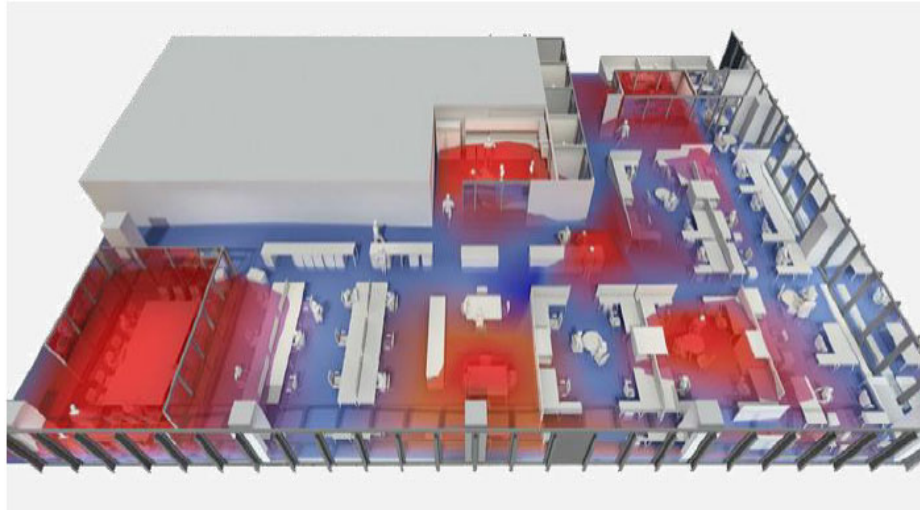
Noise levels

Typical open office > 60-65 dB

Indian Restaurants & Bars $\approx$ 80-100 dB



Noise Level Maps-



- **Environmental Noises:** HVAC, office machines, poor sound masking
- **Peoples voices:** biggest contributor to “unwanted noise”
- **Restaurant Noises:** Dishes, Cutlery, Ice machines, soda machines, espresso machines and other equipment
- **Acoustics integrated in WELL & LEED Standards**
 - ✓ OSHA Permissible exposure limit = 90 dB
 - ✓ OSHA Action level @ 85 dB



New Standards Recognize the Need for Better Lighting and Noise Control-

WELLv2™



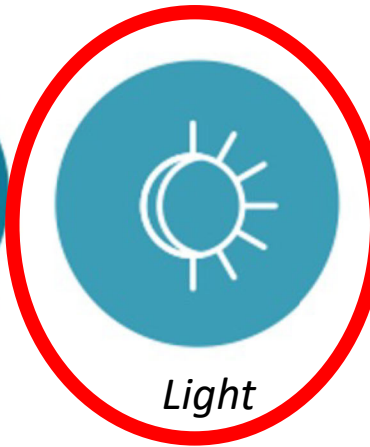
Air



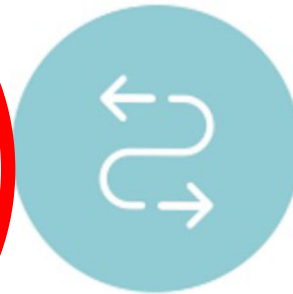
Water



Nourishment



Light



Movement



*Thermal
Comfort*



Sound



Materials



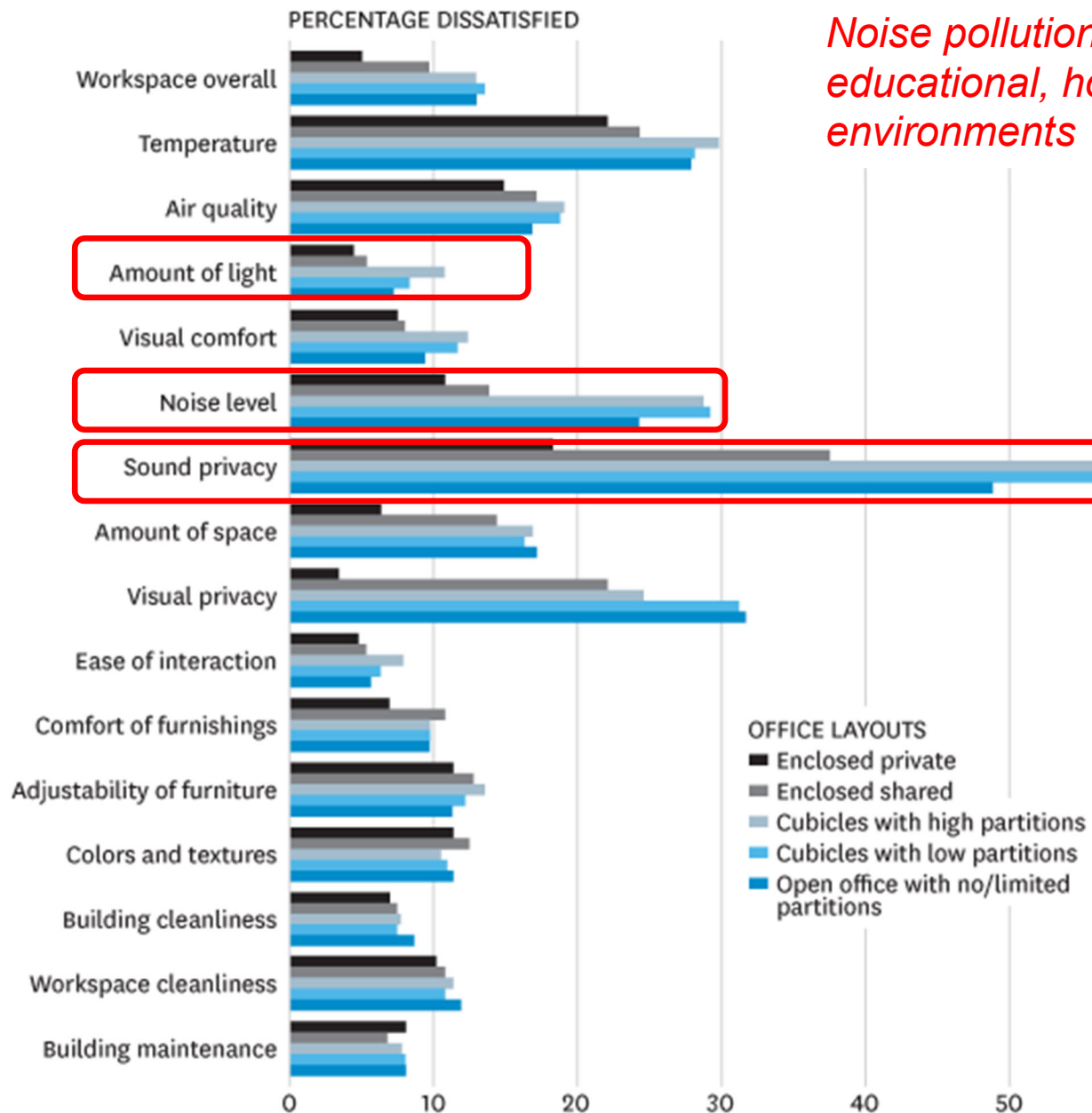
Mind



Community

New building standards recognize the need to provide both good lighting and good acoustic performance

Open Plan Offices : Work Comfort - Psychological



Noise pollution is a big problem in offices, educational, hospitality and some healthcare environments



“Studies indicate that approximately **80 percent of office workers** believe that their productivity would increase if their working environment was more acoustically private.”

“**A 300 percent increase in perceived ‘worker satisfaction’** was reported as a result of the reduction in noise levels from conversational noise.”

American Society of Interior Designers; Armstrong World Industries, Inc.; DynaSound, Inc.; Milliken and Co.; Steelcase, Inc, 2005.

Effects of Noise - Physical

Comfort & Perception

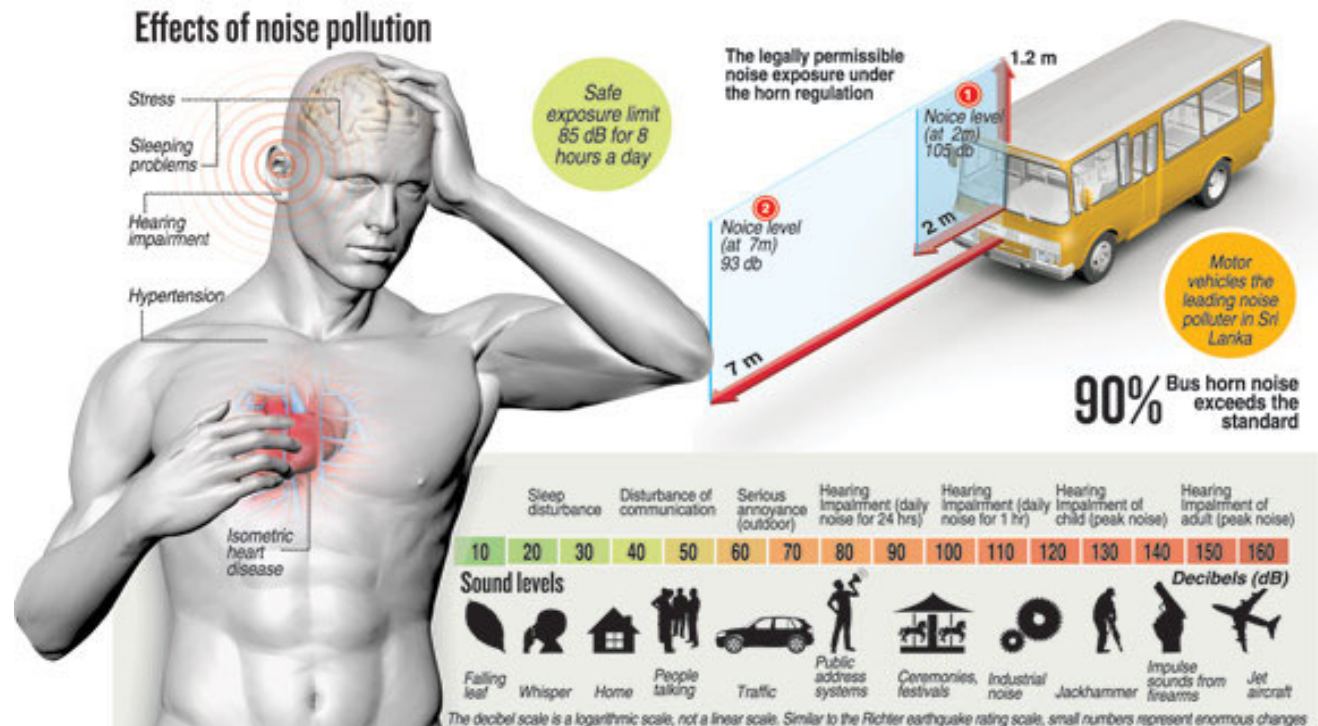
- Pleasant vs. discomfort
- Perceived product image
- Perceived product quality
- Purchasing criteria
- Environmental noise

Safety

- Fatigue
- Reduced sensitivity
- Reduced concentration
- Risk for accidents
- Reduced balance

Health

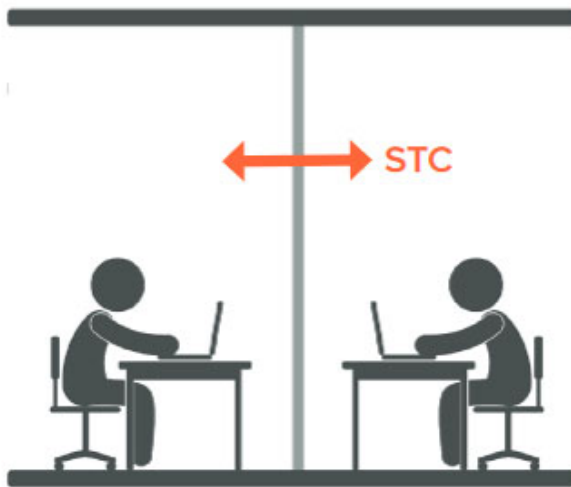
- Abdominal & chest pain
- Lower back pains
- White finger syndrome
- Hearing loss



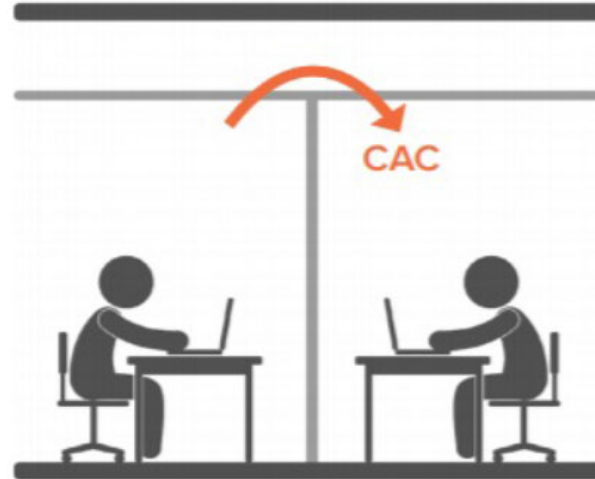
Types of Noise Problems –Open Office

There are 3 types of noise problems:

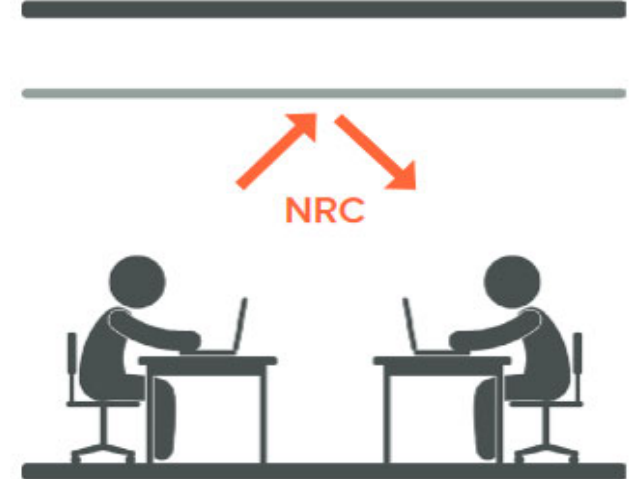
- Sound that is transferred through walls/barriers
- Sound that travels from one room to the next through the ceiling plenum
- Sound that bounces off the ceiling and reflects back into the space



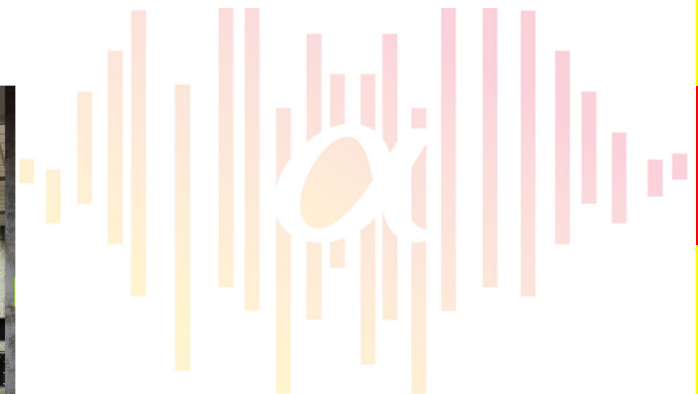
Sound transferred through walls =
Sound **T**ransmission **C**lass (STC)



Sound through a ceiling plenum =
Ceiling **A**ttenuation **C**lass (CAC)

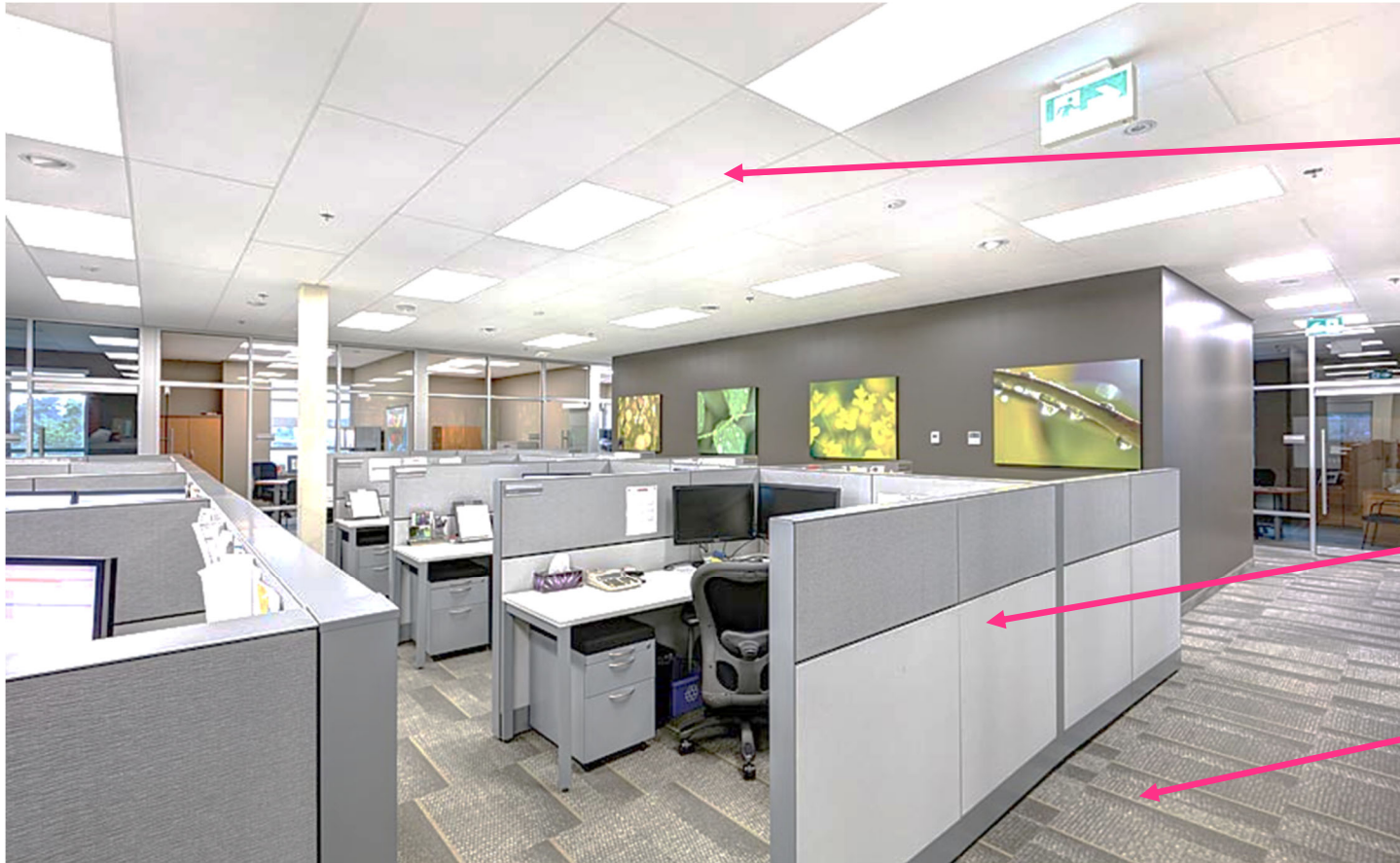


Reflected ceiling noise = **N**oise **R**eduction
Coefficient (NRC) or ISO Class (A-E)



Classical Design Approach – Open Office

- Classical Design Approaches Managed Light & Sound Separately



Ceiling: Typically most of the area is covered with Acoustic Ceiling Tiles (ACT)

Partitions: Some sound is absorbed at the work area

Carpet Floors: $NRC = 0.20$
Some sound is absorbed

Noise reduction capability is provided by non-lighting components

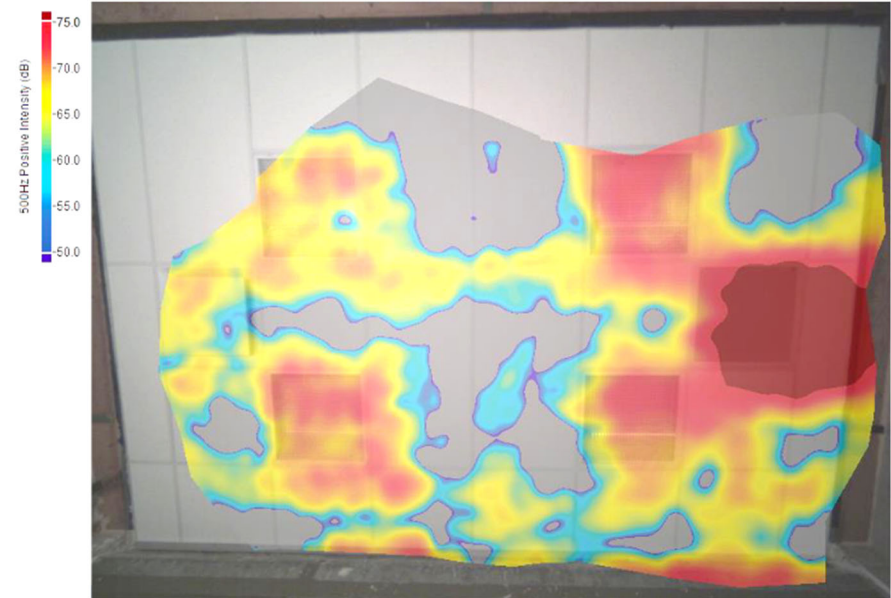


Lights & Acoustics -

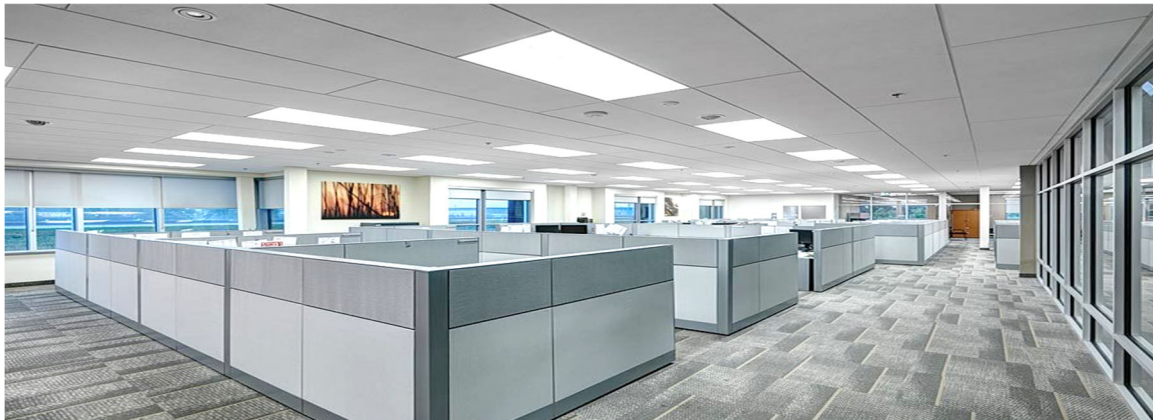
- Traditional Lights have no noise reduction capability



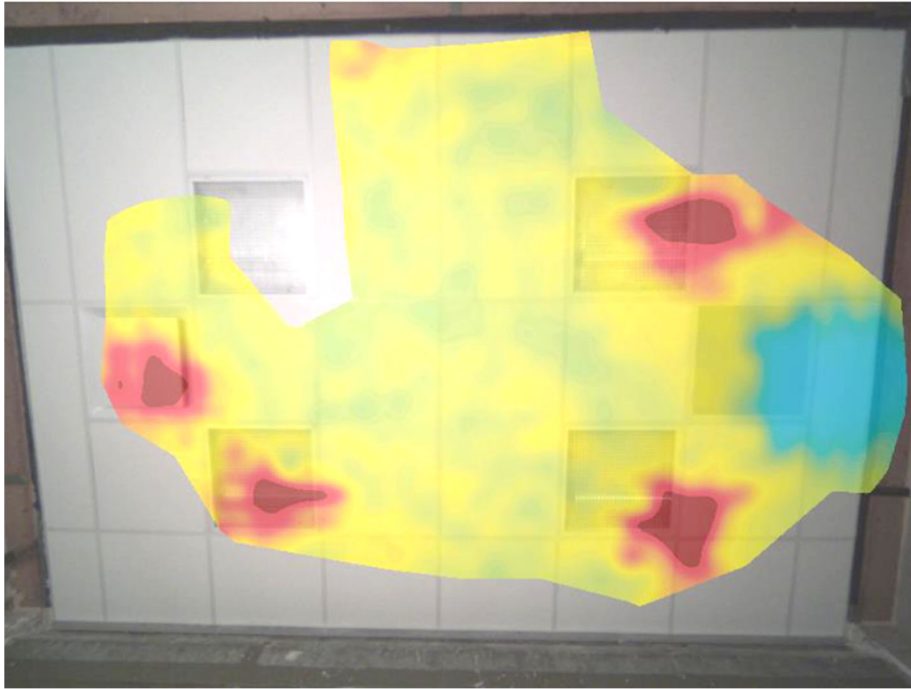
Typical ceiling system configuration used throughout the testing with various acoustic ceiling panels suspended in a metal grid and with light fixtures



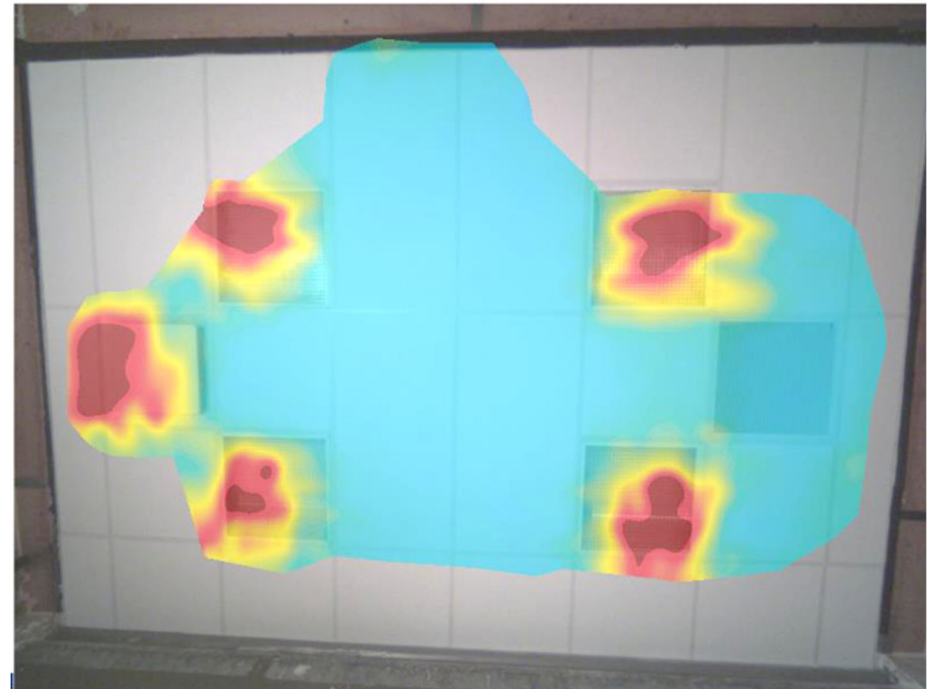
A color map showing sound transmission through the ceiling



Lights & Acoustics – Cont'd



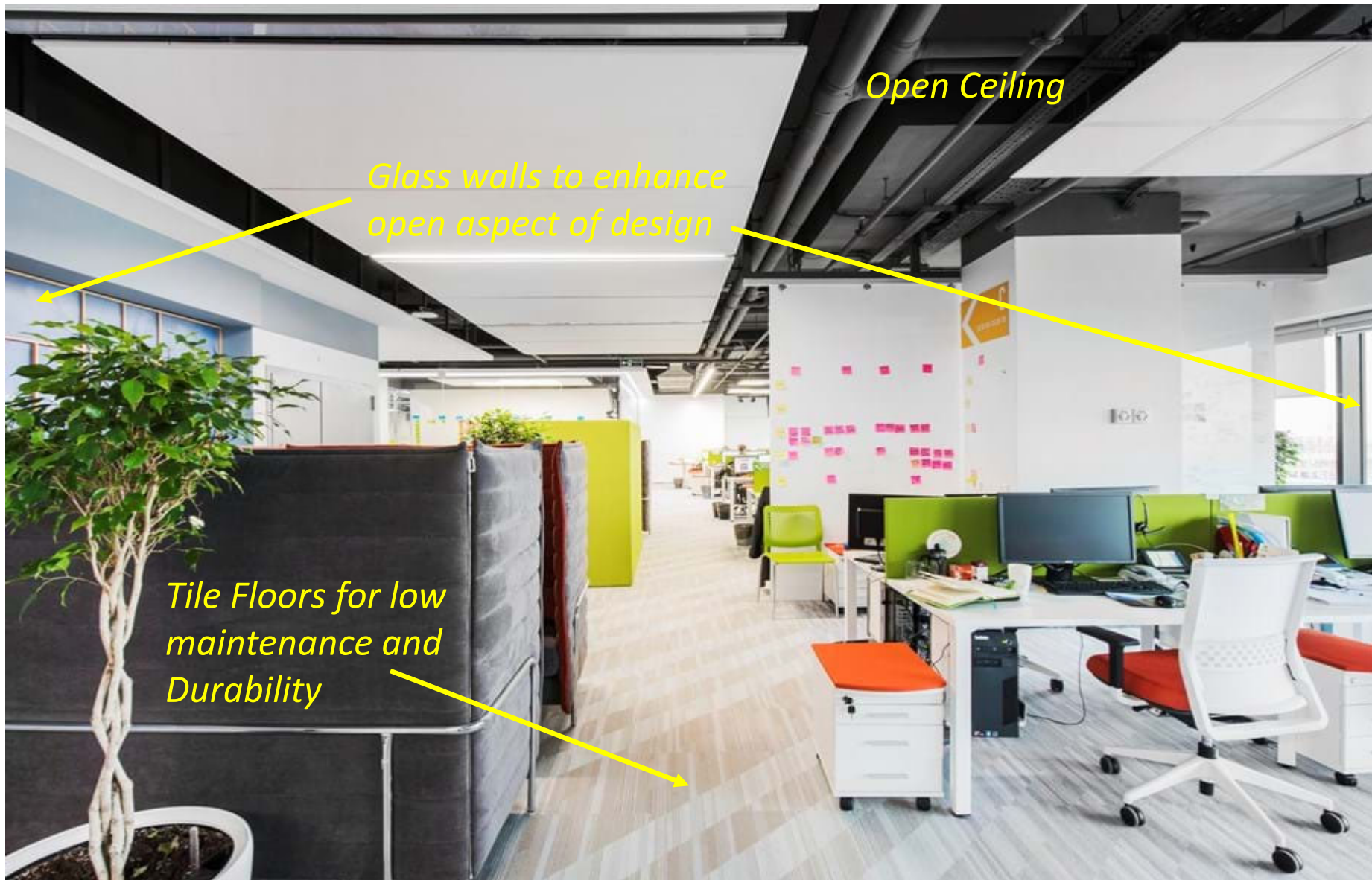
A color map showing sound reflecting off a mineral-fiber panel acoustic ceiling with a NRC rating of 0.60 (yellow)



A color map showing sound being absorbed by a stone wool panel acoustic ceiling with a NRC rating of 0.95 (blue)



But the World Wants “Open Concept” Spaces

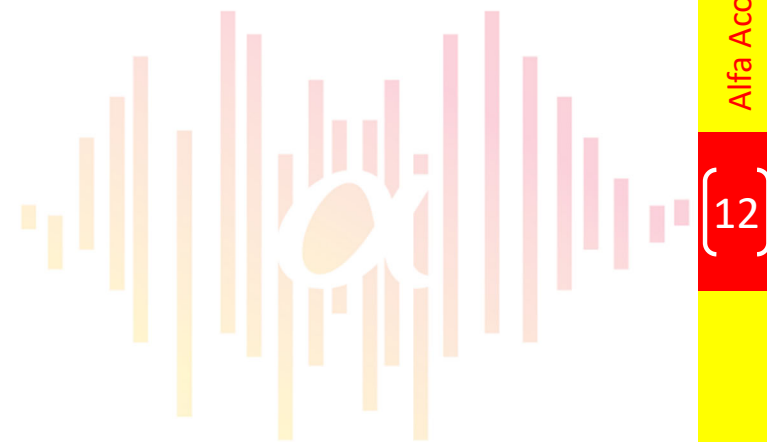


Sound is almost reflected back in Open Spaces

Why Acoustic Lighting Fixtures?

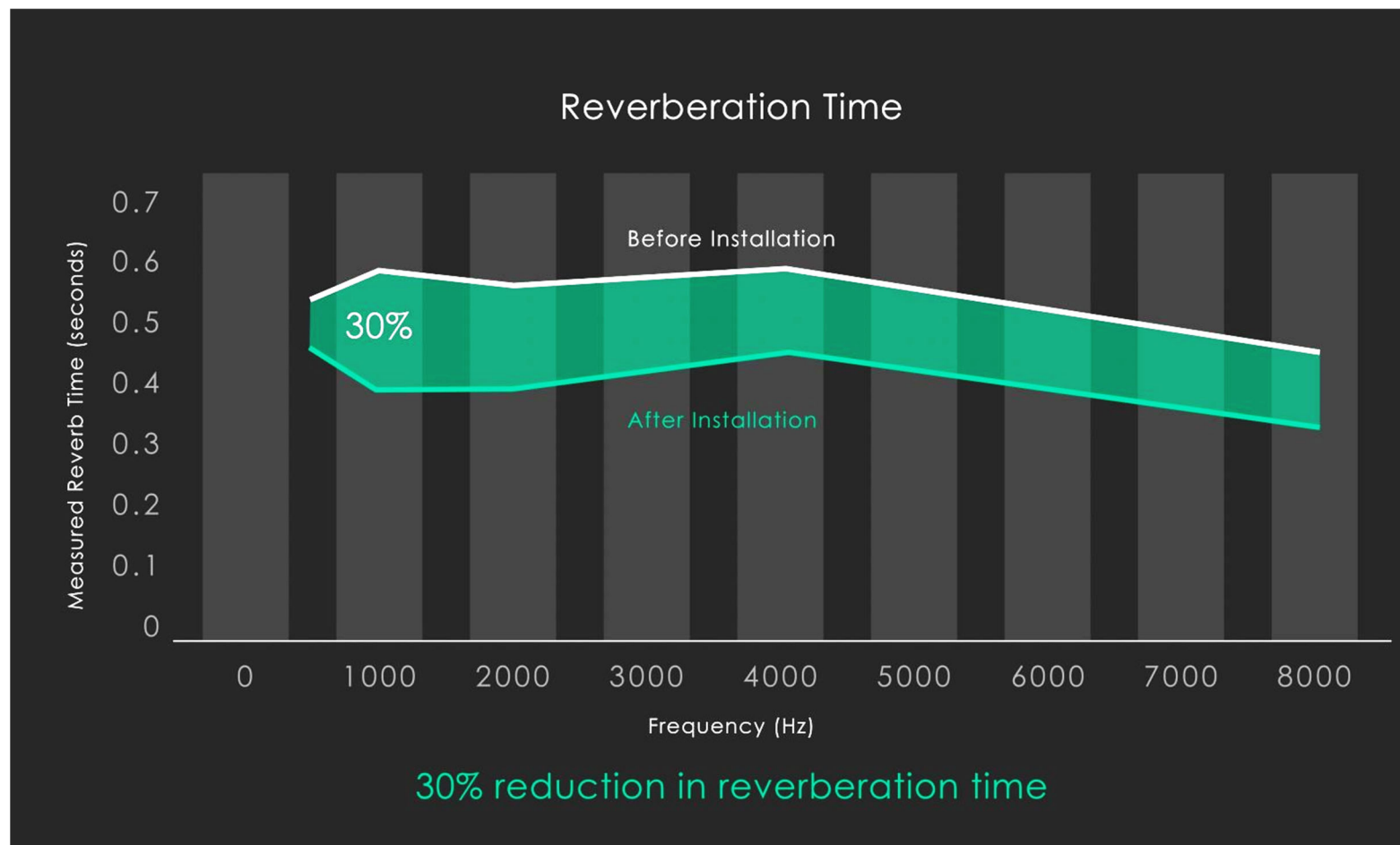


- Out of visual field
- Possible to have similar sound absorbing surface area compared to partitions
- Close to the ceiling
- Traps sound between reflective ceiling and sound absorb materials
- Decorative elements
- Fabric materials

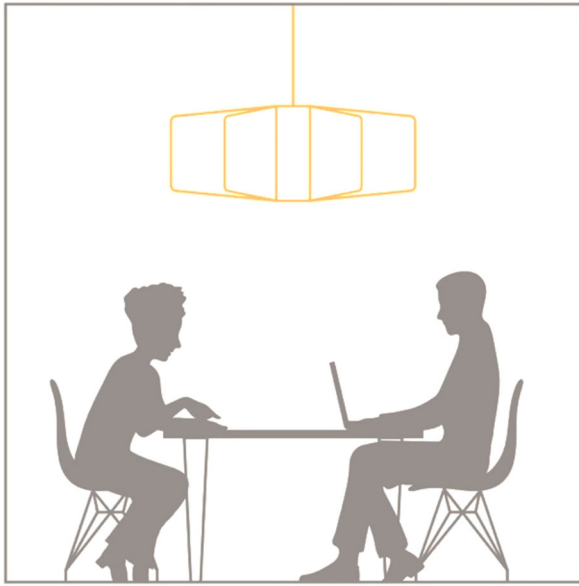


Acoustic Lighting -

- Acoustic Lights reduce up to **30% of mid-frequency/ conversational** noise and up to **45% of high/ background frequency** noise in the surrounding environment.



Sound Illuminated -



The open office plan: ideal for collaboration and creativity but noise and a lack of privacy can inhibit productivity.



Many times, supplemental acoustic treatments are placed on walls and ceilings to absorb sound and curb the issue.



Now there is an acoustic and lighting solution that seamlessly blends in any space.



Acoustic Lighting Helps Solve the Reflected Ceiling Noise Problem-

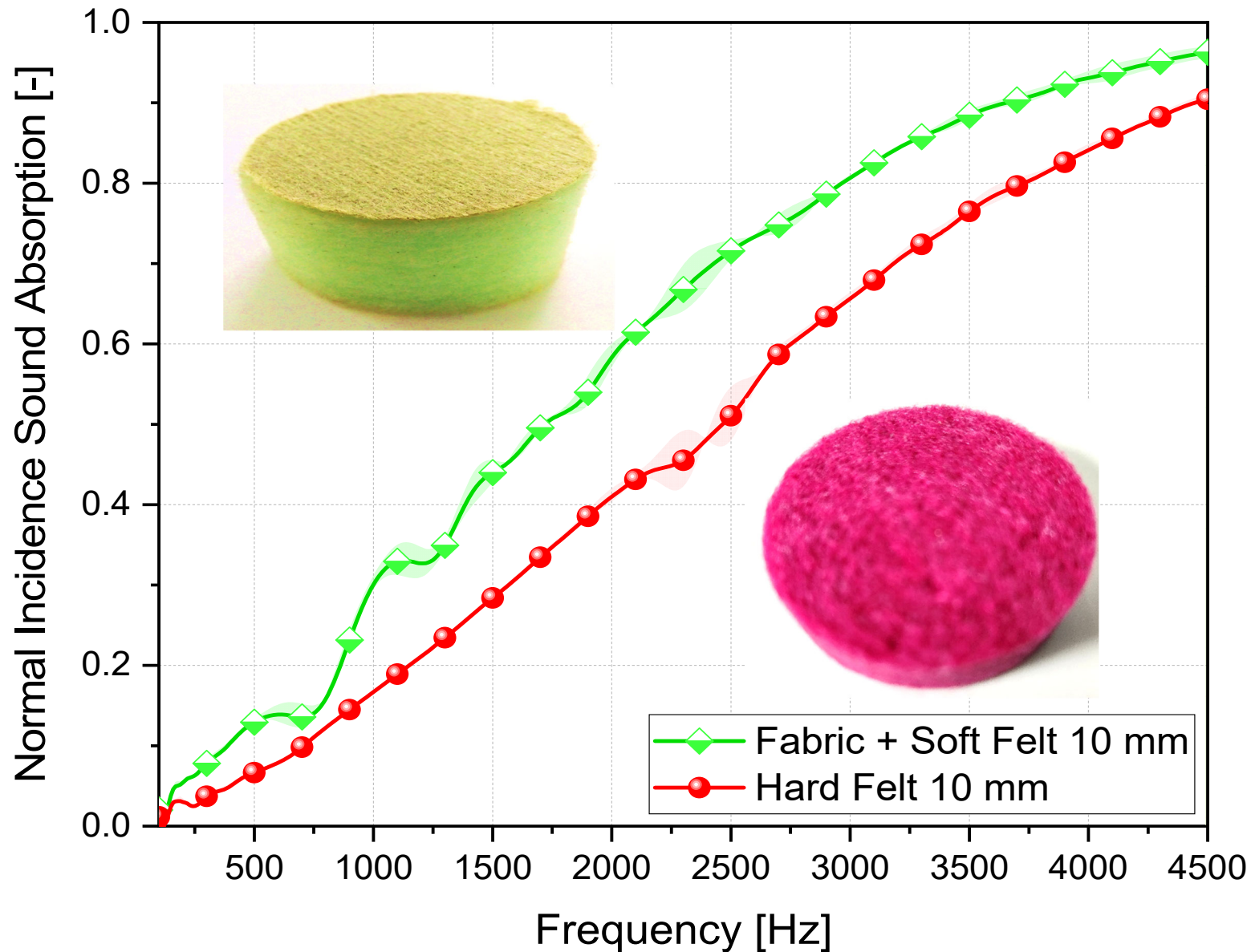


Sound Absorbing Light Design -

- Lighting first
 - *Performance / spacing*
- Material for sound absorbing
 - *PET Recycled “Felt”*
 - *Fabric over perf metal*
 - *Foam*
 - *Wood & pulp*
- Surface area
- 3D Designs
 - *Multi-layer & Hollow*
 - *Sound trapping*



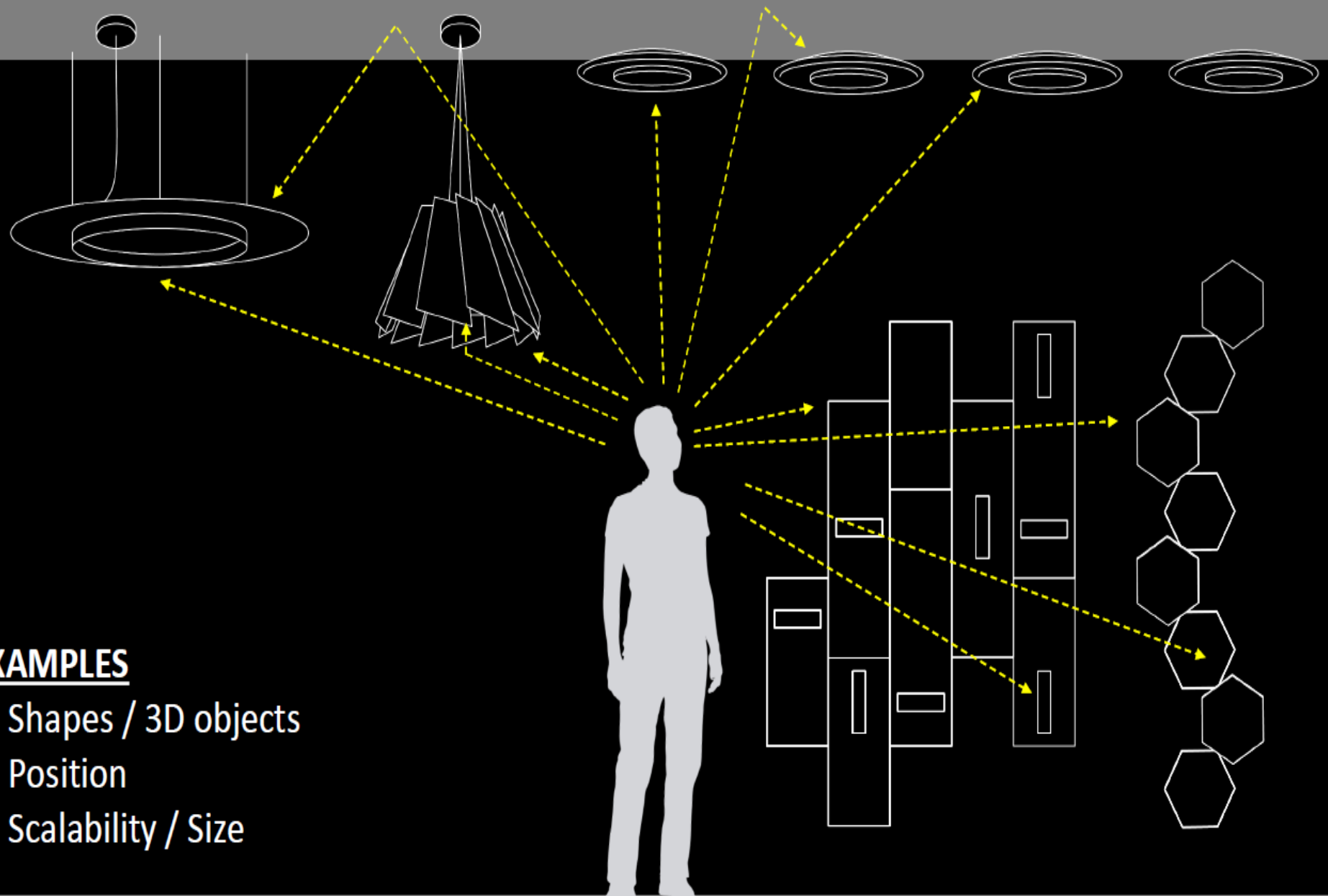
Effect of Material Type on Sound Absorption Coefficient -



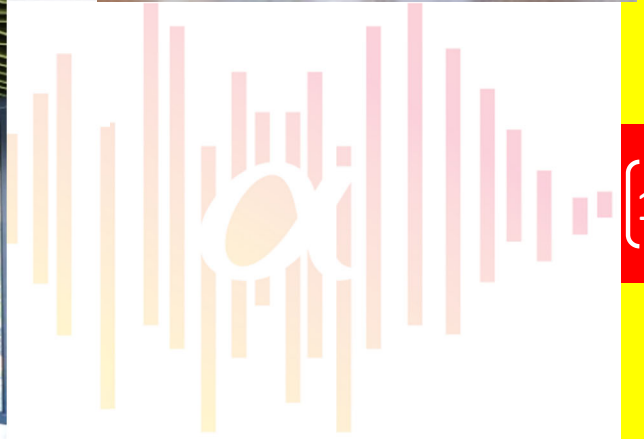
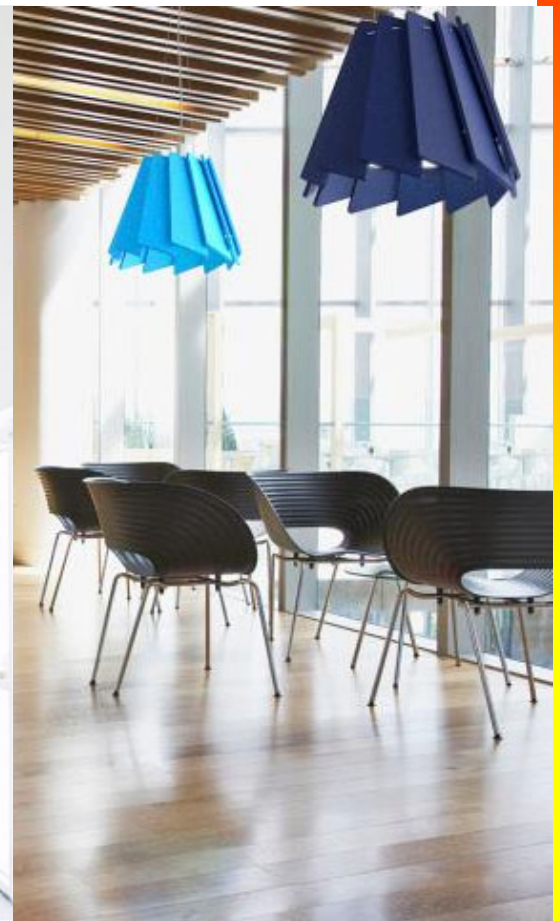
Sound Absorbing Light Design -

EXAMPLES

- Shapes / 3D objects
- Position
- Scalability / Size



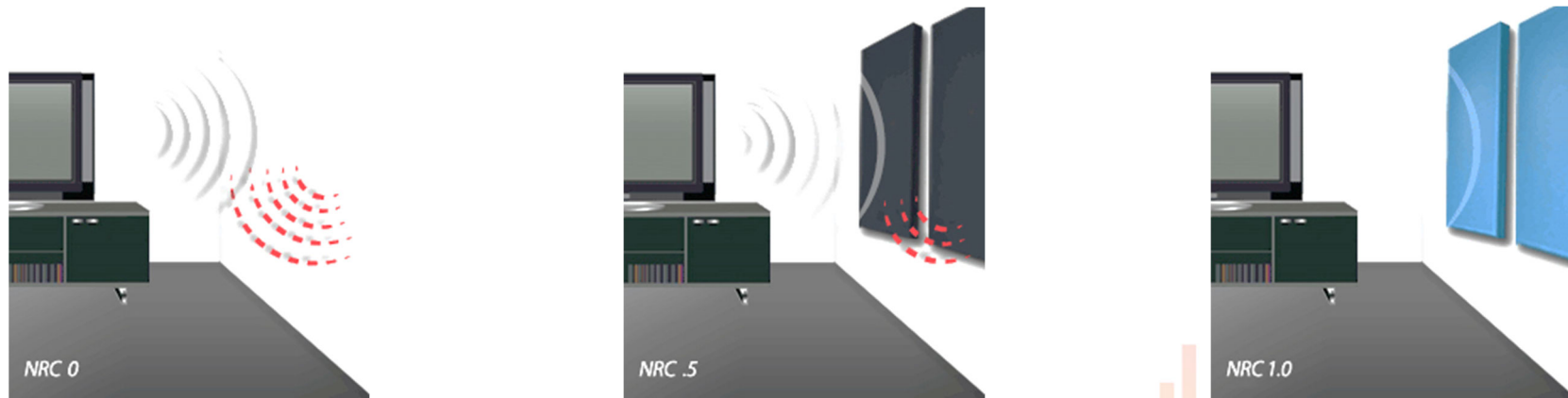
Sound Absorbing Light Design -



Noise Reduction Coefficient (NRC) -

- The **Noise Reduction Coefficient (NRC)** is a single number rating starting from 0.0 - 1.0.
- It describes the average sound absorption performance of a material.

$$NRC = \frac{\alpha_{250} + \alpha_{500} + \alpha_{1000} + \alpha_{2000}}{4} \quad [-]$$



NRC is being replaced by the **Sound Absorption Average (SAA)**, which is described in the standard version 1999 and later versions of the ASTM C423 standard

Sound Absorption Average (SAA) -

- The SAA is a single-number rating of sound absorption properties of a material identical to NRC.

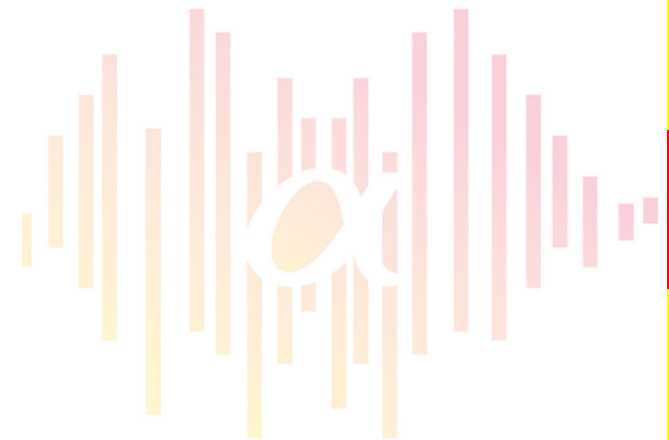
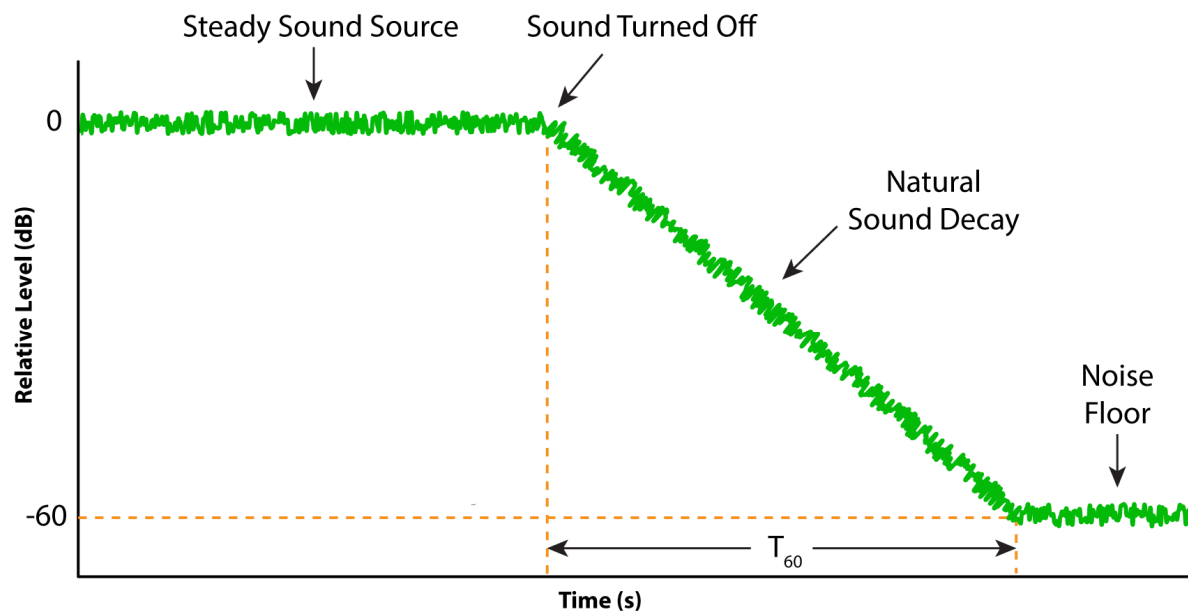
$$SAA = \frac{\alpha_{200} + \alpha_{250} + \alpha_{315} + \alpha_{400} + \alpha_{500} + \alpha_{630} + \alpha_{800} + \alpha_{1000} + \alpha_{1250} + \alpha_{1600} + \alpha_{2000} + \alpha_{2500}}{12} \quad [-]$$

- SAA averages more points over a slightly larger range, the SAA can be a better indicator of low frequency sound absorption performance.
- It is calculated as per ASTM C423

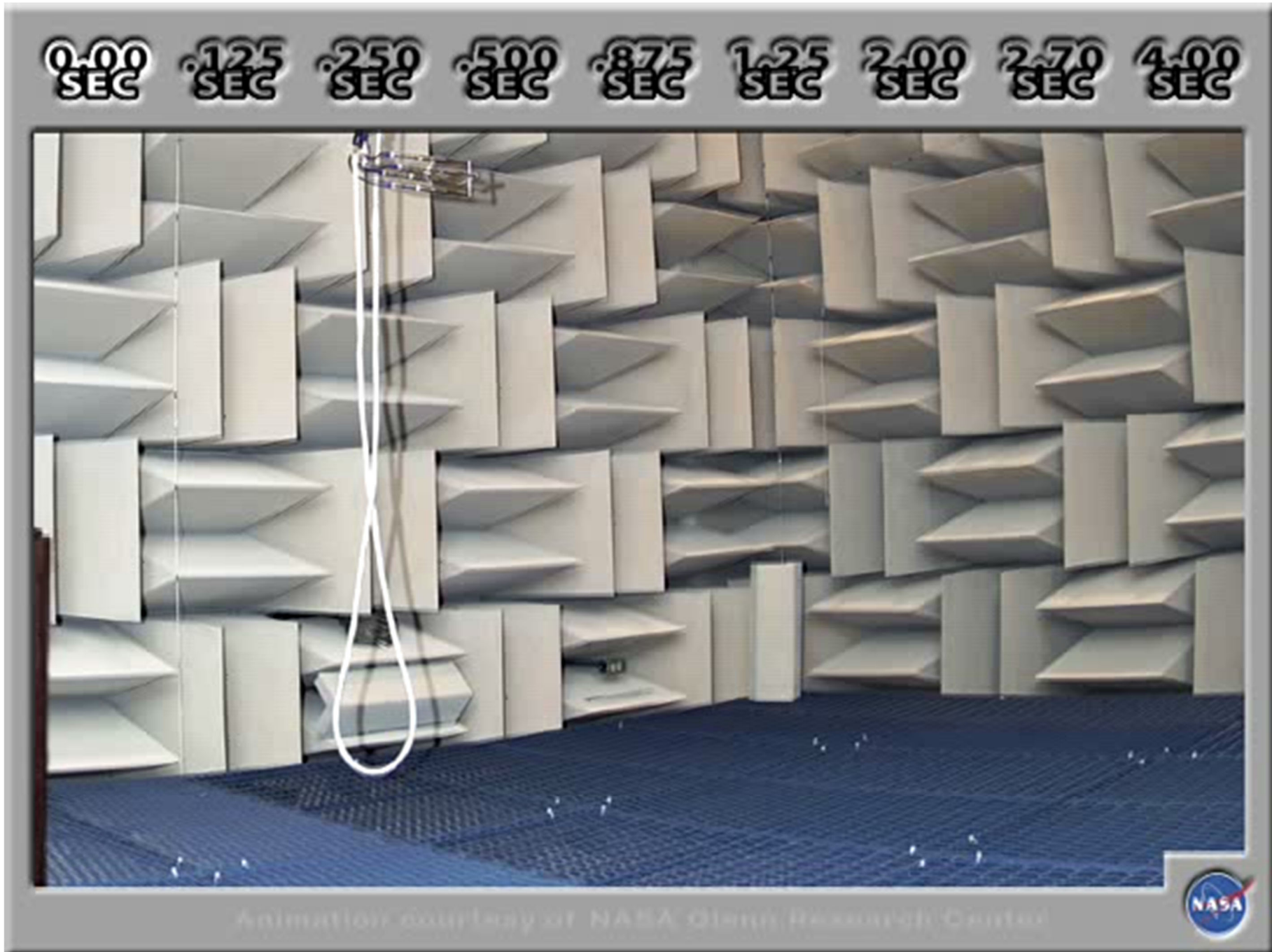
ASTM C423-17 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

Reverberation Time -

- It is a measure of the time required for the sound to "fade away" in an enclosed area after the source of the sound has stopped.
- The reverberation time is the time the sound pressure level takes to decrease by 60 dB, after a sound source is abruptly switched off. Commonly-used abbreviation for reverberation time are T or RT60.
- Reverberation time is frequency dependent and is stated as a single value if measured as a wideband signal (20Hz to 20kHz).

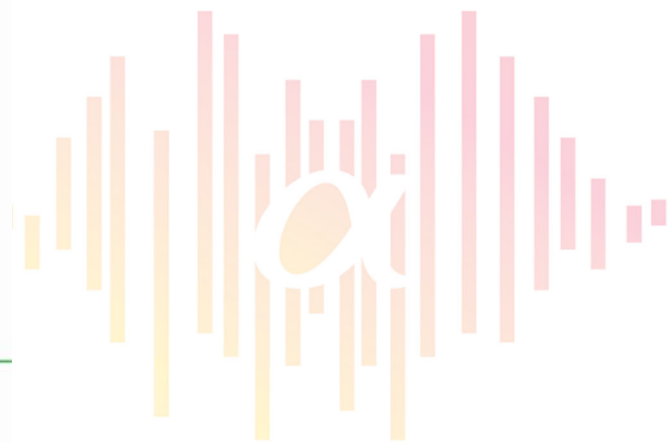
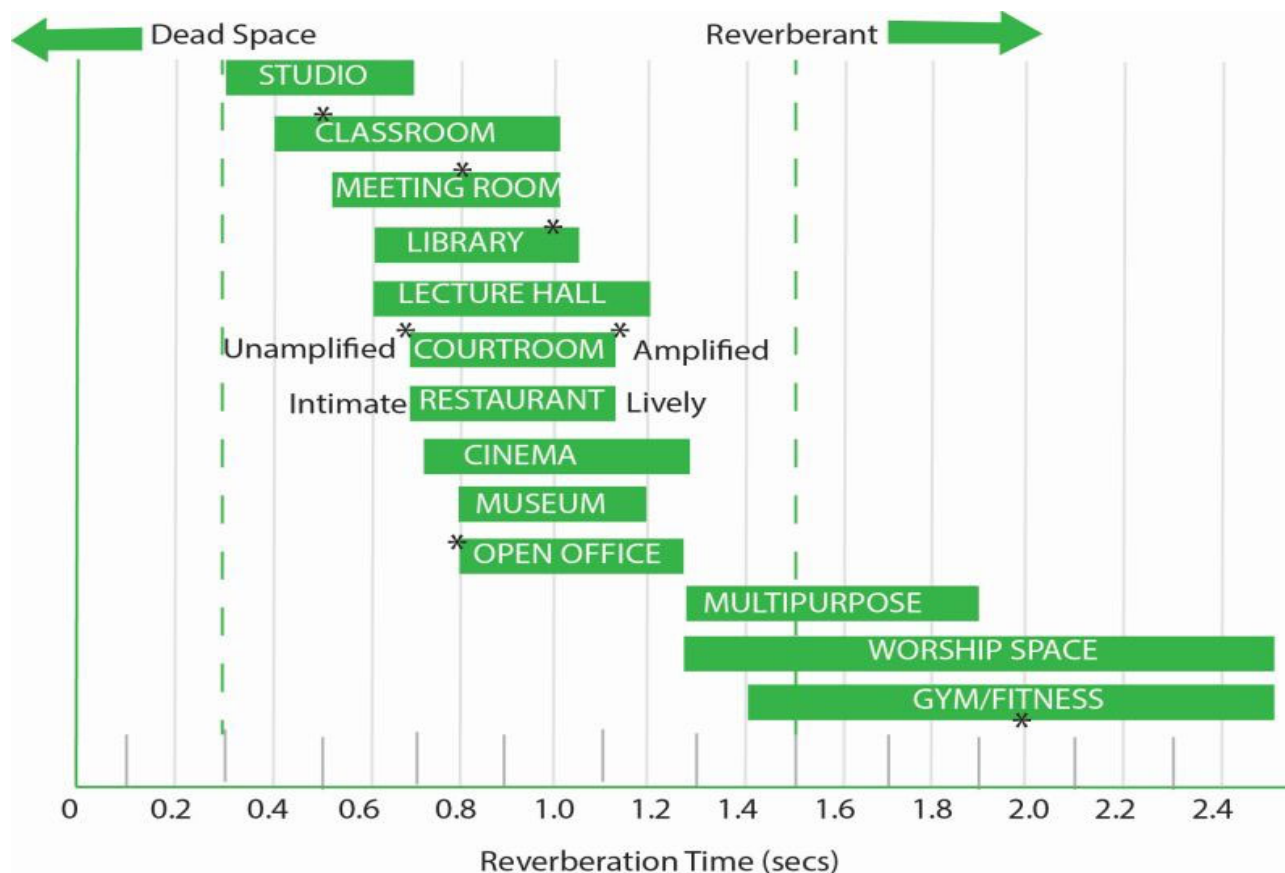


Effect of NRC – Reverberation Time



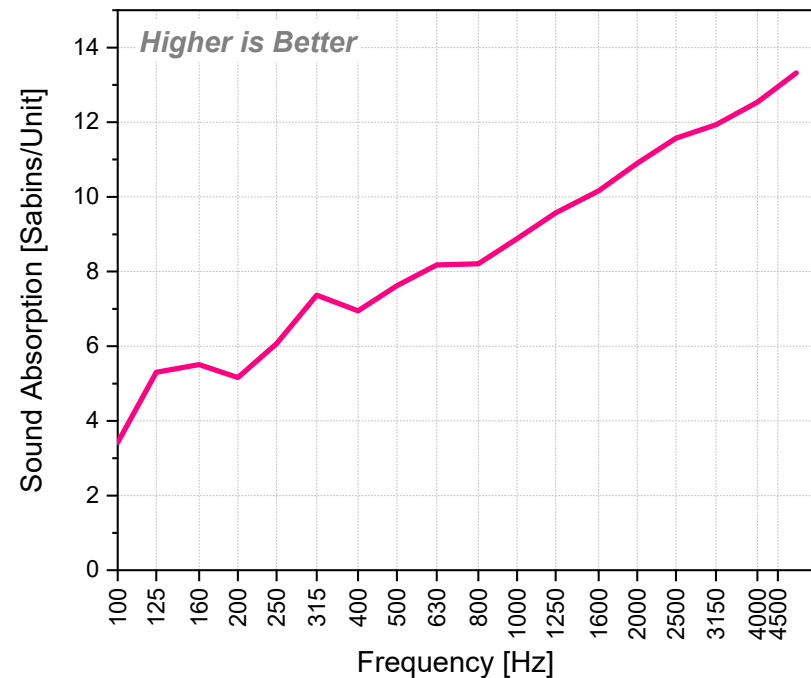
Reverberation Time (RT 60) :

- Reverberation Time = Time required to decay sound by 60 dB
- Reverberation Time depends upon
 - Volume of the Room
 - Surfaces of the Room
 - Furniture in the Room

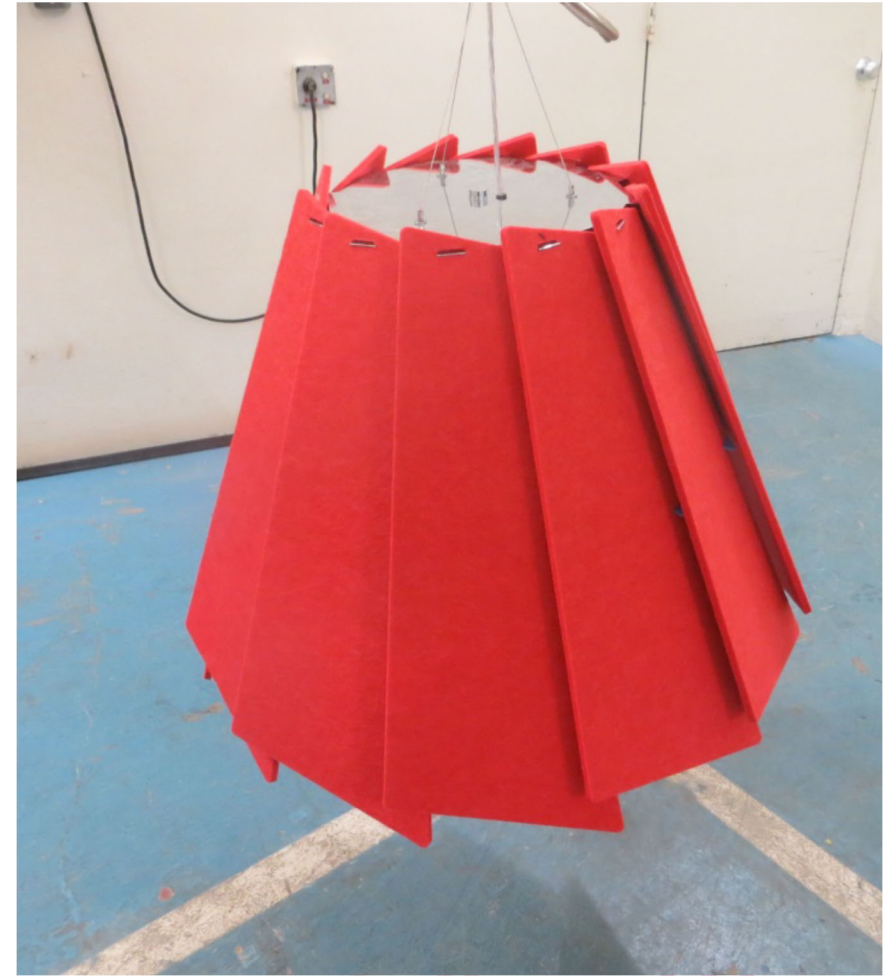
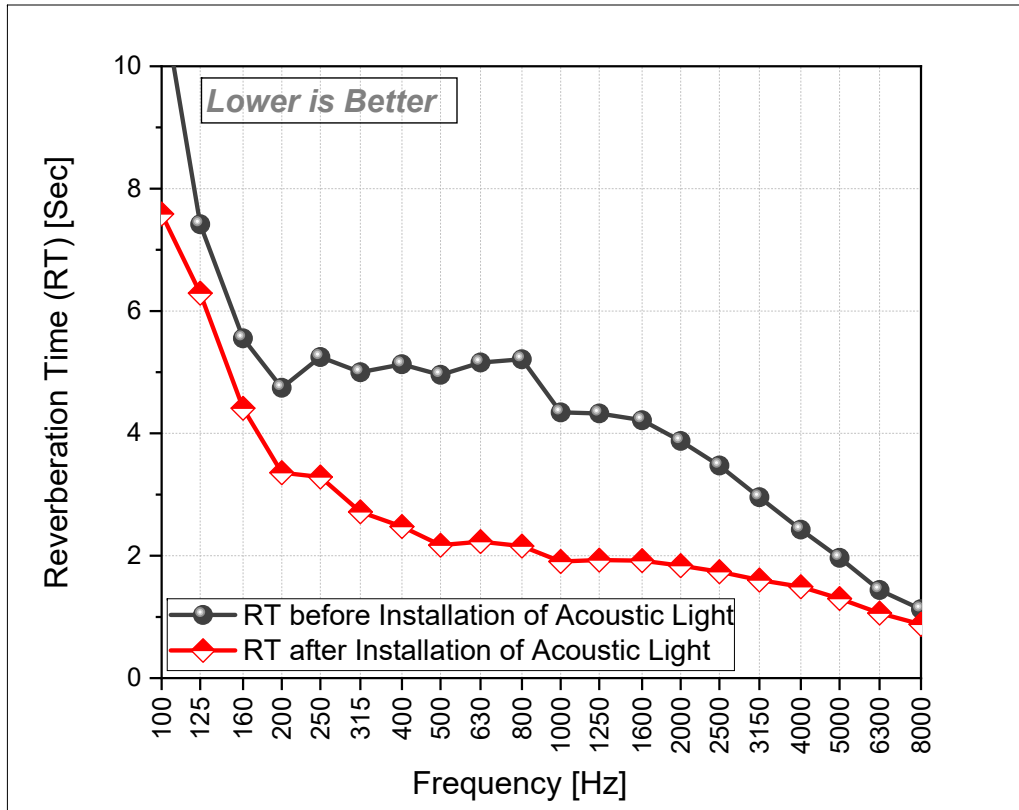


How Acoustic Light Works -

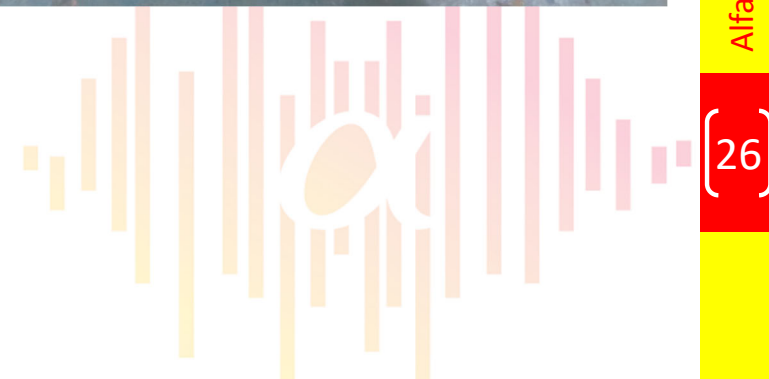
- Each sound absorbing unit had an approximate absorptive area (all exposed surfaces) of 3.14 m^2 .
- The specimen is an array of spaced sound absorbing baffles suspended from a cable above the horizontal test surface as per Type J Mounting mentioned in ASTM C423.



How Acoustic Light Works – Reverberation Time (RT)



Reverberation Time	RT
In Empty Room	
With Acoustic Lights	



Acoustic Lights –Size Matters

- Acoustic engineers use a metric called a “sabin” to quantify sound absorption. A higher sabin value means more sound absorption... equals less noise.

$$\text{Sabin} = \text{Absorption} \times \text{Area}$$

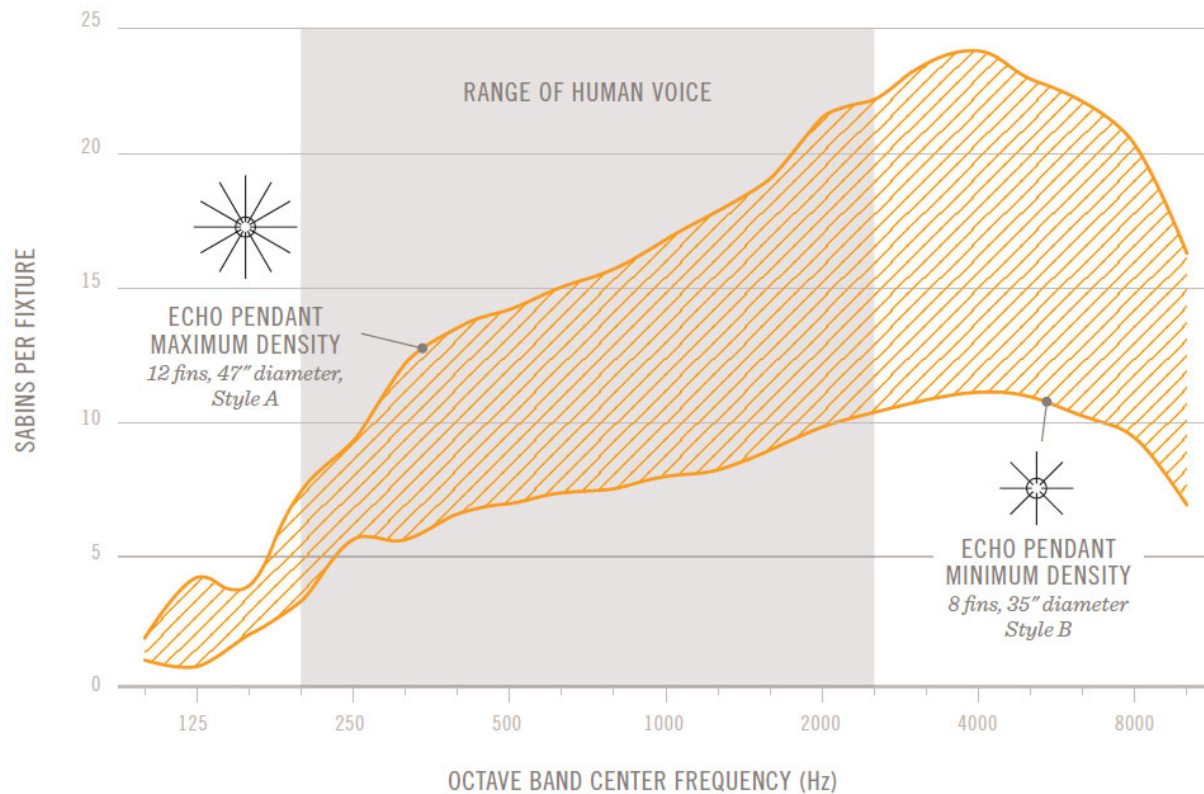
- The noise reduction capability of a luminaire is dependent on TWO equally important characteristics:
 - ❖ Absorption (approximated by NRC)
 - ❖ Light (fixture) Size

Linear Pendant	Large Area Light
	
Sound Absorbing Area = 0.72 m ²	Sound Absorbing Area = 4.46 m ²
NRC= 1.0	NRC= 0.75
Sabin = 0.7	Sabin = 3.35
Equivalent to 1 Acoustic tile	Equivalent to 4.5 Acoustic tile

Noise reduction requires high sound absorption and large scale

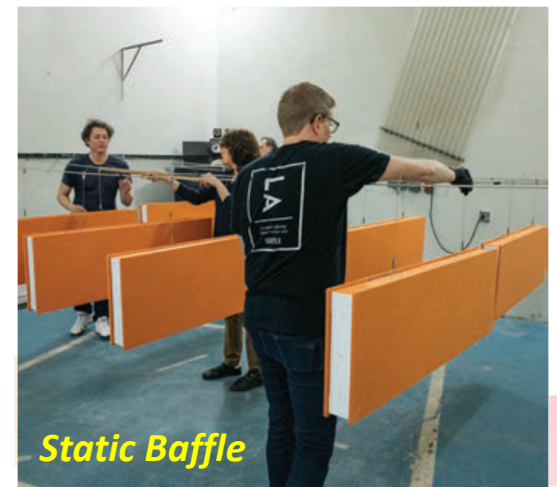
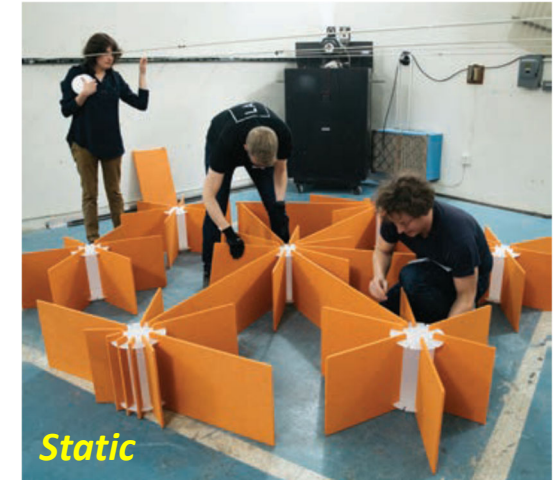
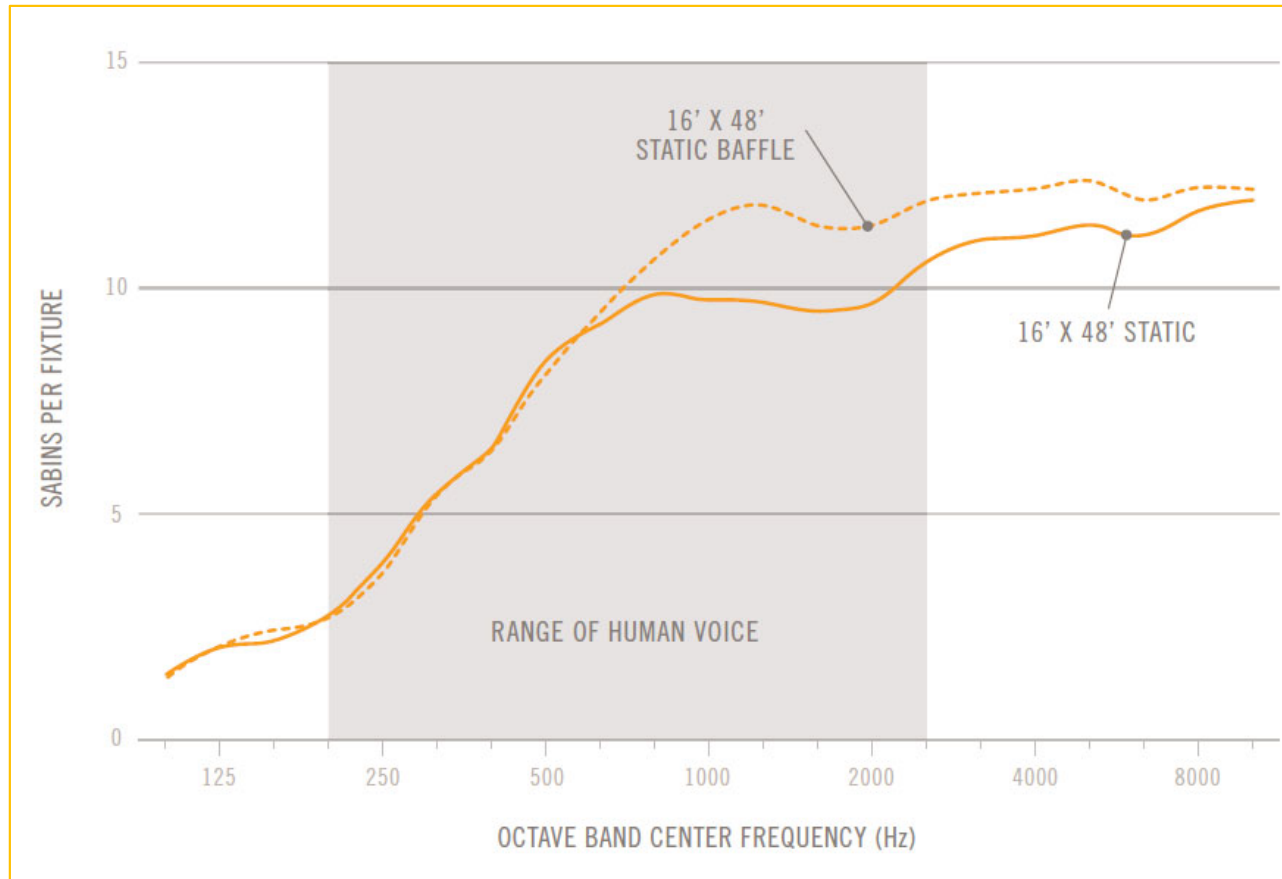
Effect of Density -

- NRC: 0.80–1.00 Absorption per fixture:
7.59–15.50 sabins



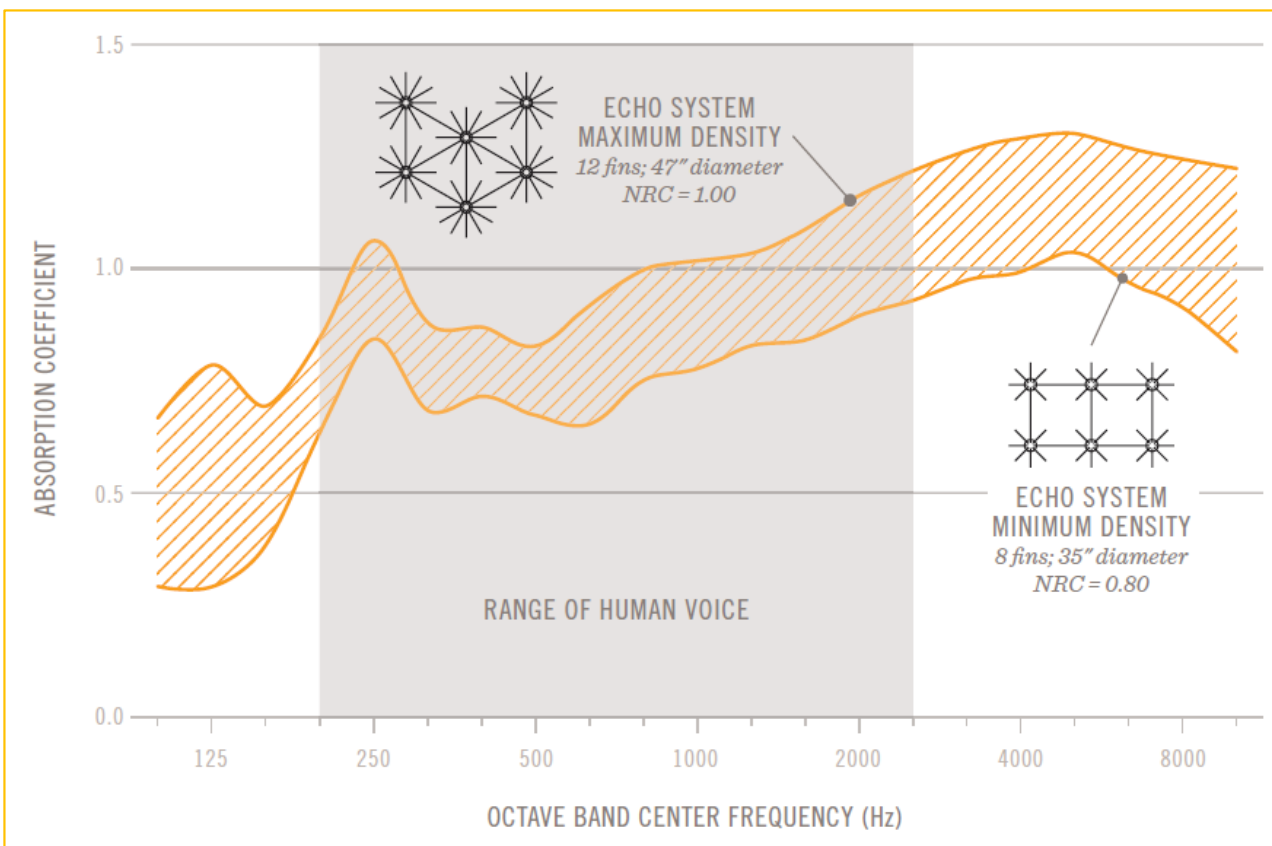
Effect of Acoustic Materials-

- Static Baffle with lighting components replaced with sound-absorbing felt.



Effect of Shape -

- This light shape is a pendant that can be connected as a system to cover large surface areas. The chart on the below shows the range of acoustic absorption possible with light shape, from NRC 0.80–1.00, depending on the fin shape, pendant size, and pendant arrangement.



Acoustic Lighting -



How much Absorption is needed?

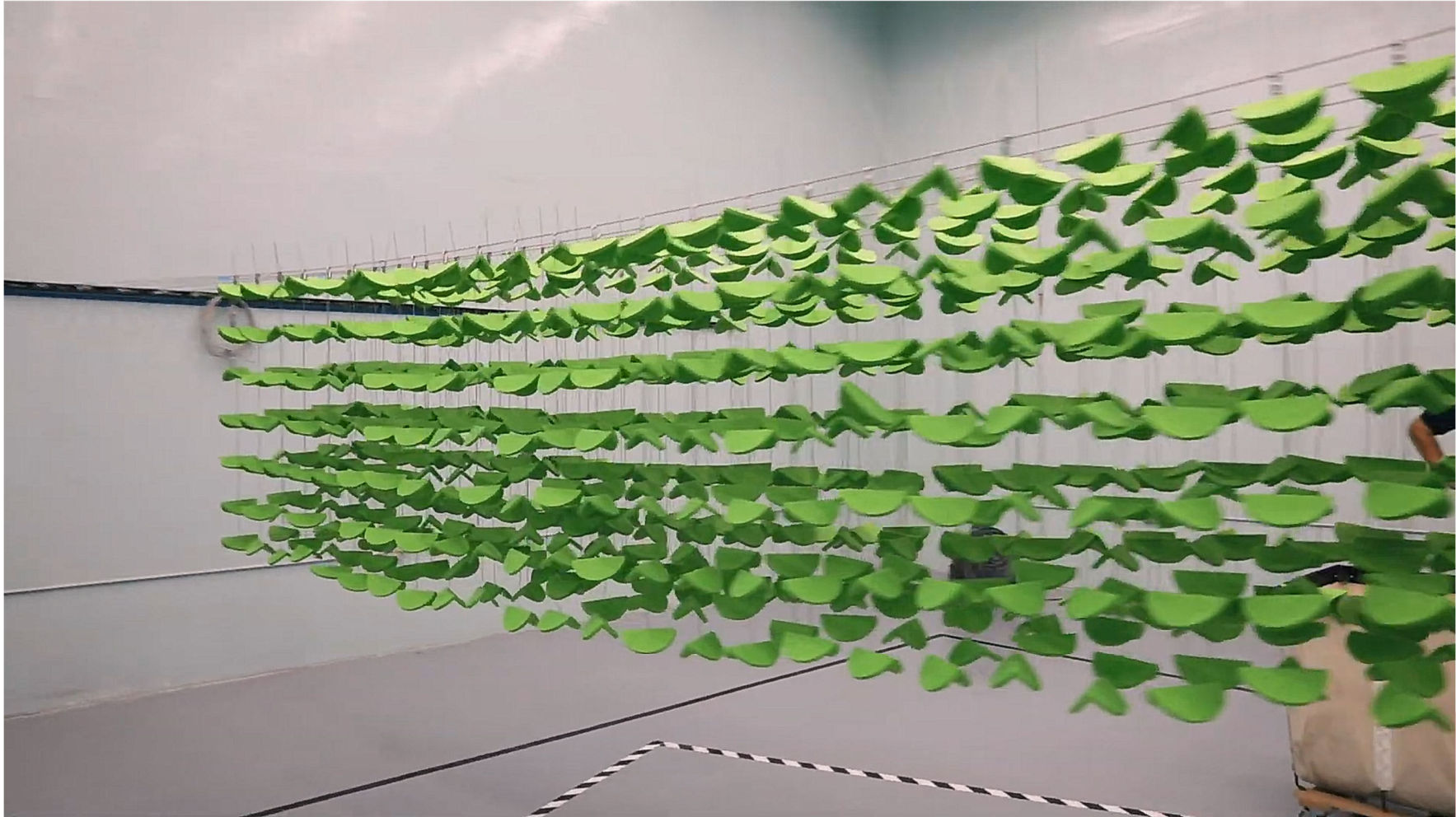


Sound Absorption Measurement – Reverberation Room

- ASTM C423 — Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- ISO 354 — Measurement of sound absorption in a reverberation room



Acoustic Light Testing-



Acoustic Light Case Study - Café



ZACKERY BELANGER
Arcgeometer Detroit, MI

Acoustic Light Case Study - Bar

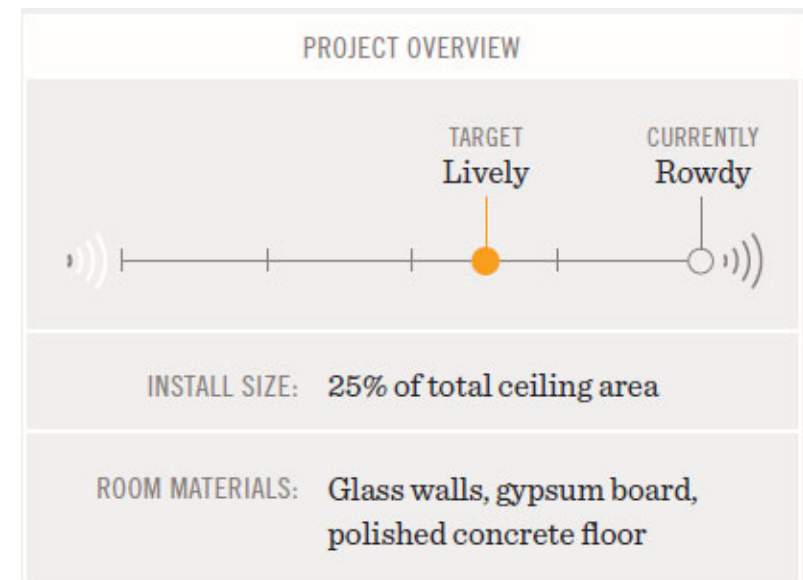
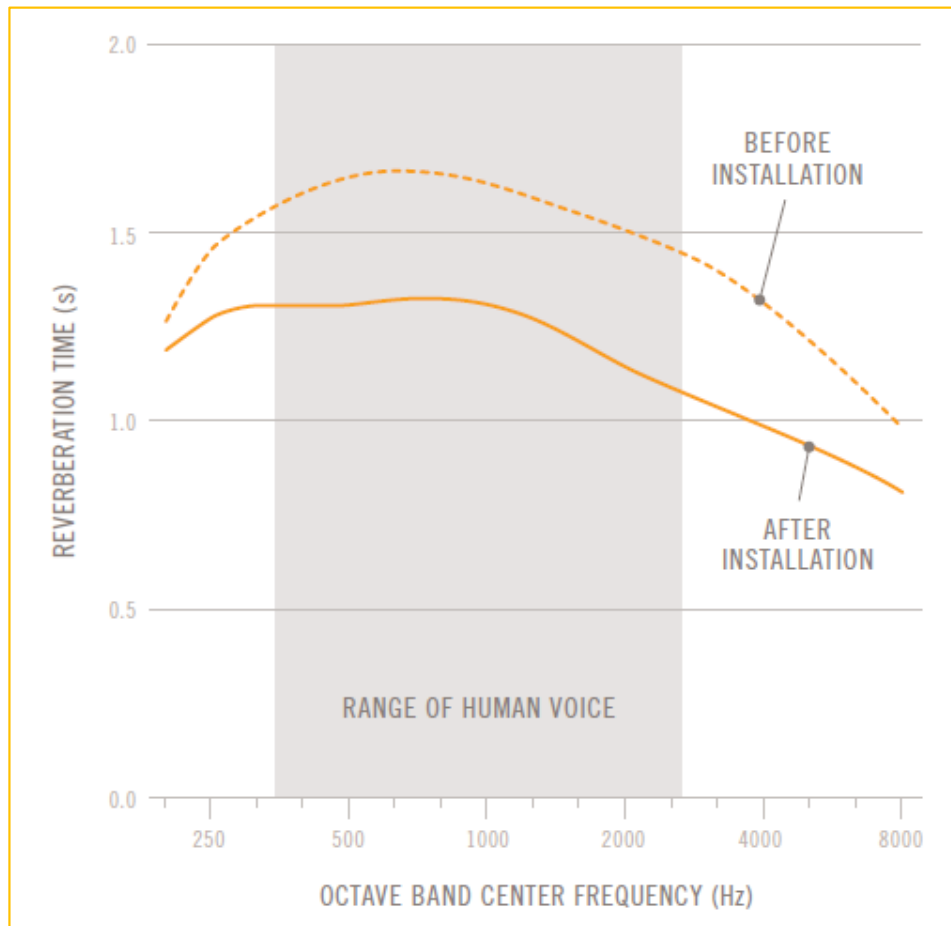


Acoustic Light Case Study – Conference Room

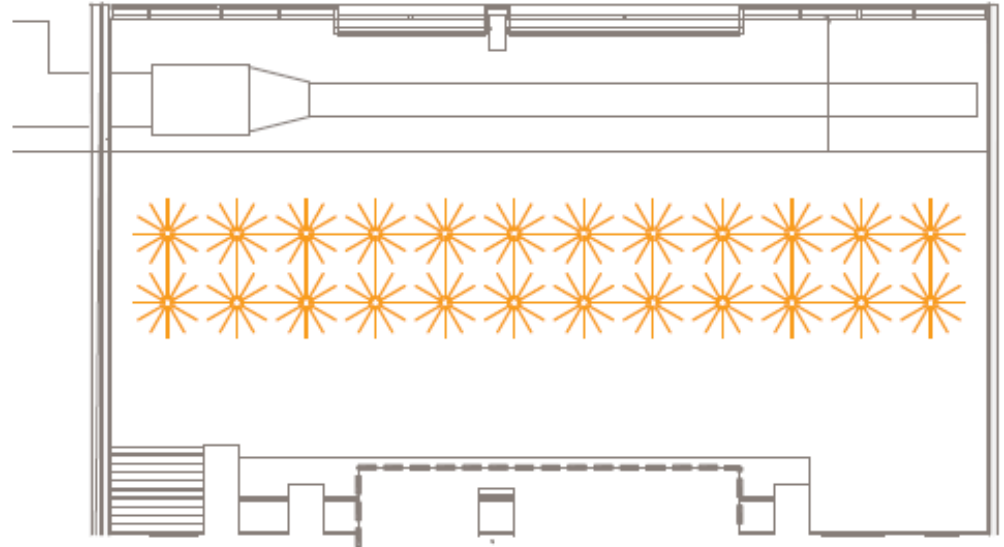


Acoustic Lighting – Café Case Study

- The latest outpost of this Seattle-based chain is in a newly-constructed building with beautiful high ceilings and sliding garage doors that make up the south-facing wall. An open kitchen adds to the acoustical complications of the space. While allowing light in year-round, and open-air dining in the summer, the doors limited the potential for acoustical wall solutions. A grid of 24 sculptural fixtures was just what the café needed.



Acoustic Lighting – Café Case Study

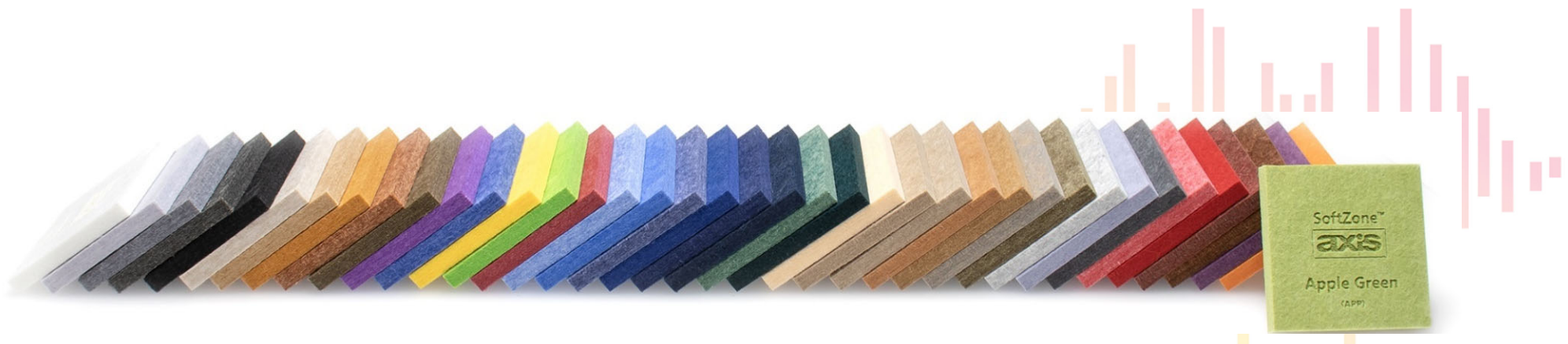
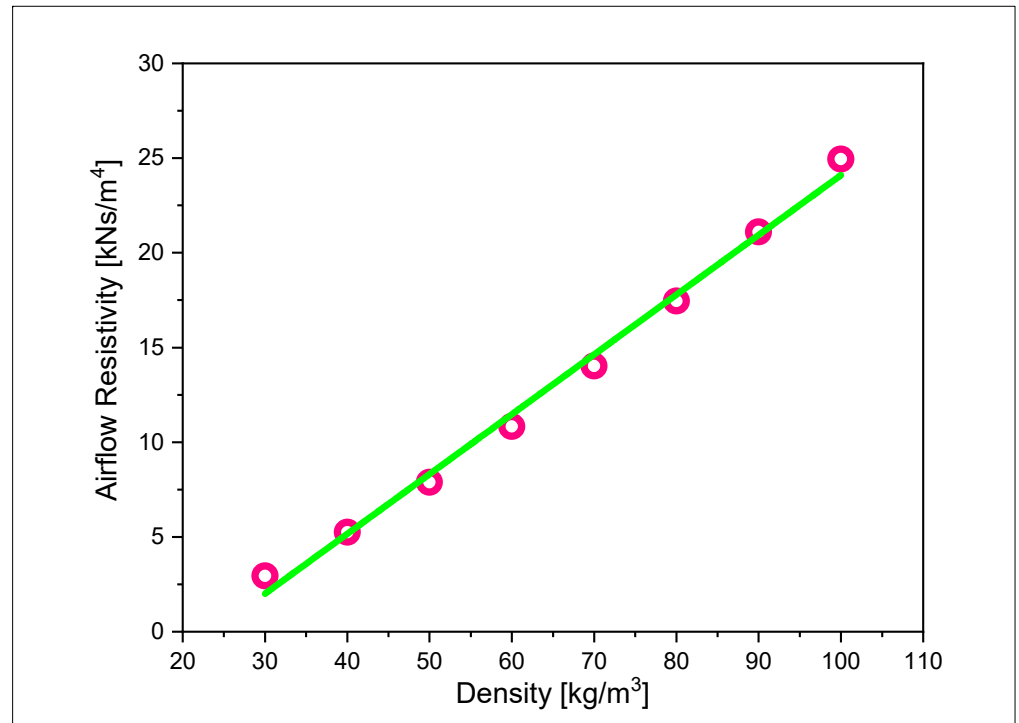


The Echo installation resulted in a 20% reduction of the reverberation time at the café. The room remains lively yet comfortable for patron communication.

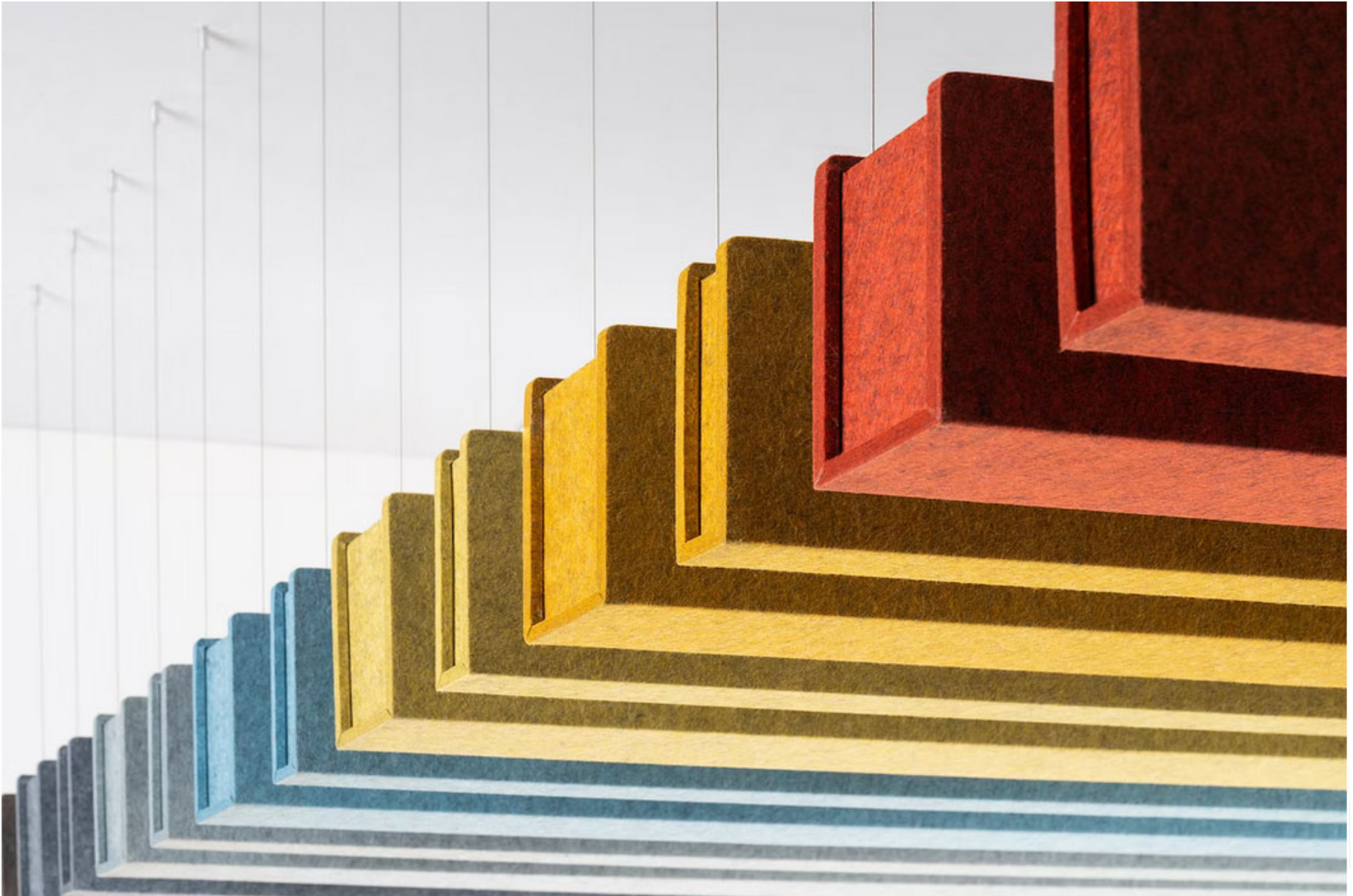


Acoustic parameters which play important role -

- Airflow Resistivity
- Sound Absorption



Acoustic Light Baffles -



NO Acoustic Lighting >> Reverberation Time = 1.3 sec



Acoustic Lighting Luminaires >> Reverberation Time = 0.8 sec



Acoustic Lighting + Acoustic Panels >> Reverberation Time = 0.6 sec



Thank you for being with us.



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