LIGHTING AND ACOUSTICS IN UNION:
Enhancing environments through integration

Introduction

Lighting and acoustics each impact the experience of a space—the comfort of occupants, their ability to perform tasks, and how they engage the space or connect with others within it. Optimizing these impacts by merging lighting and acoustic design is becoming more refined as the approach matures in the built environment.

Incorporating acoustic ceiling elements with lighting as well as an increasing number of integrated acoustic luminaire styles provides a dynamic range of design concepts not seen in the past.

As expected with any innovative trend, however, there are challenges to understanding and then balancing the strengths and drawbacks among the options.

The following information provides benchmarks and definitions for acoustics as well as design considerations for integrated acoustic luminaires. A case study with four different lighting and acoustic design concepts is also included to illustrate the impacts of different approaches. The options showcase where each approach provides biophilic enhancement, aesthetic augmentation, lighting improvement, acoustic improvement, and cost consideration.

Acoustic benchmarks

The best way to understand the intersection of acoustic design with lighting design is to recognize that in all rooms both disciplines deal with reflectance. Acoustic reflectance is called “reverberation time” (RT, or RT60), one well-accepted metric that measures how fast room reflection dies out, often in tenths of a second. Reverberation time is critical in maintaining speech clarity and supporting acoustic comfort. A typical range for reverb time is selected early in design, often between 0.50 seconds and 1.5 seconds for small- to medium-sized speech rooms, conference rooms, or collaboration spaces. A classroom is typically 0.60 to 0.70 seconds, and a larger auditorium is about 1.2 seconds, for drama and speech. For music, reflection may increase further, but vocals would begin to suffer with a longer RT. It is important to understand that speech clarity is a key driver for acoustic success, and longer reflection times compromise speech effectiveness quickly.

The selection of this key acoustic goal begins a calculation and then translates to enough surface area. The reverberation time governs type, thickness, and locations for surface areas including the new lighting luminaire’s acoustic contribution by surface area. This means luminaires with acoustic treatment are

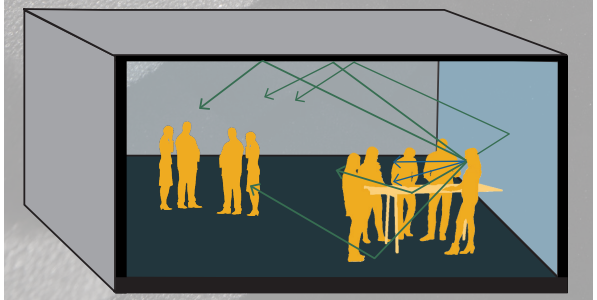
Acoustics Definitions

Noise criteria (NC) is a target noise level for listening, learning and acoustic comfort. NC is a curve that defines a collection of upper annoyance limits by octave bands.

Sabin is a unit of sound absorption. One sabin is equal to one square foot of perfect absorption, like a fully open window.

NRC (Noise Reduction Class) is a value ranging from 0.0 to 1.0 that describes the average sound absorption performance of a material.

Room reverberation, also referred to as RT or RT60, is the time after the sound source ceases and until the sound is reduced by 60 decibels. This is a very short time (in seconds) in which a single fast impulse within a room dies off.



combined with other treatments to maintain a minimum surface area for absorption as determined by calculation and governed by the reverberation time for the room. A variation in surface area for acoustic treatment can vary higher or lower than the optimum by choice and design effort, but it should be appropriate in both reverberation time, surface area, and frequency to be effective.

The acoustics designer may also use the term "NRC" (Noise Reduction Class) to gauge the total absorption needed in the room that is offered by products. This metric will also control the room reverberation time. As the NRC goes up the reverberation time can go down. For example, a classroom using LEED goals would use an NRC 0.70 for acoustic ceiling tile, add that to the NRC of the lighting fixtures, and add the NRC of other surfaces to arrive at the room's total reverberation time. The credible maximum time still falls in a range of 0.5 to 0.70 seconds to support teaching and speech clarity.

Reverberation metrics that provide under one second of reverberation time (RT60) and HVAC noise that is quiet are typical of LEED acoustics for most any standard classroom or assembly space, and can even add LEED points for acoustic comfort to a project.

Integrated acoustic luminaires

Today's integrated acoustic luminaires bring the relationship between performance and lighting even closer and create visually impactful design elements in the aesthetic toolbox. The flexible nature of the material also allows for the creation of dynamic and biomorphic forms supporting many biophilic constructs. Moreover, the visual texture of the felt material often utilized for acoustic luminaires engenders an almost tactile connection—when we see it, we experience a visual softness and can easily imagine how it feels to the touch. Additionally, the readily available color selection of the acoustic materials can add visual interest. How far a designer takes this new color field is limited only by their imagination.

Integrated acoustic luminaires are applied in numerous ways and support a variety of design goals. These may include but are not limited to improving acoustic properties in the space, supporting biophilic or other wellness goals, or aesthetic factors.

Designers focusing on supporting acoustic goals may choose to utilize luminaire styles which have a higher yield of acoustic material,

or which may be applied in greater density such as linear acoustic integrated pendants or center surface acoustic integrated pendants. These or standard luminaires also may be applied in conjunction with non-illuminated coordinating acoustic baffles, pendants, or other treatments or form factors. The lighting designer should be cognizant of location, quantity, and materials needed to impactfully support acoustic goals.

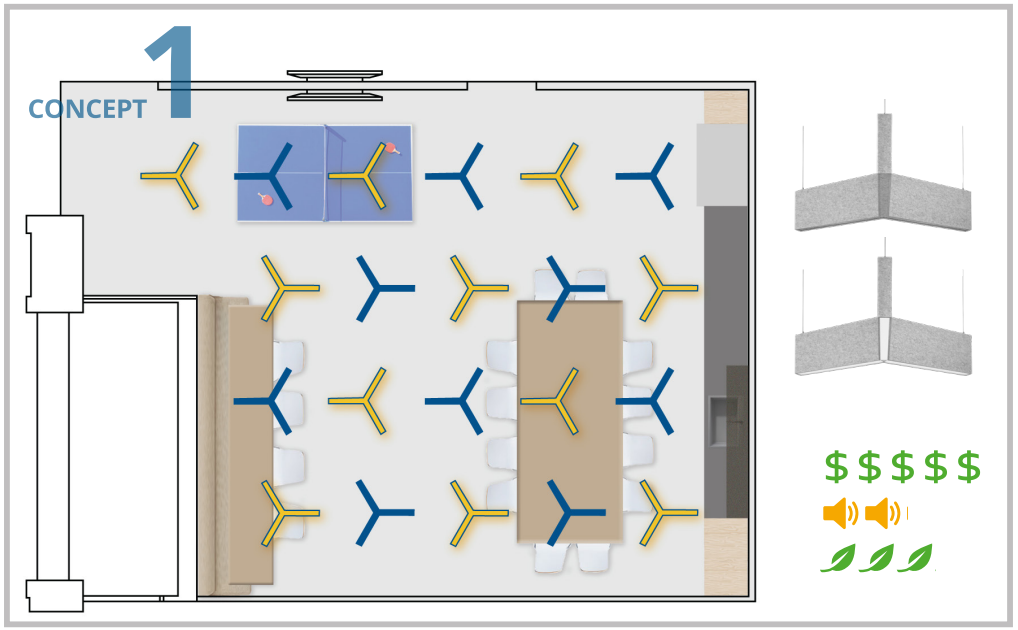
Designers with the goal of breaking the traditional luminaire form factor or adding more playful visual interest may choose to create their space with one of the many decorative integrated acoustic luminaires available on the market today. These come in an assortment of form factors that support a variety of aesthetic goals.

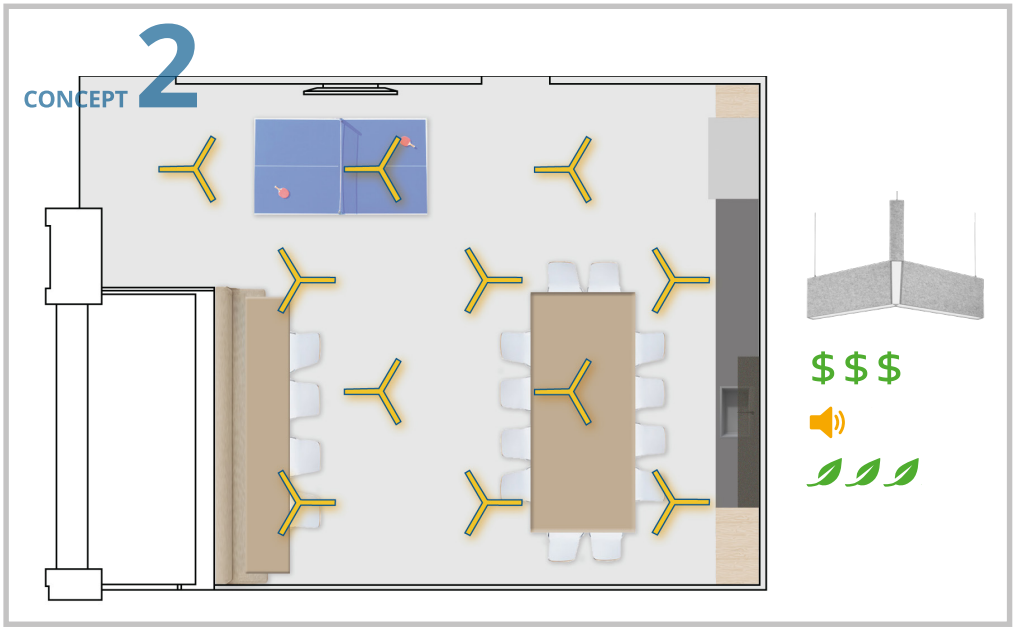
They may have a softer form and curvilinear lines, or they may be more facetted to create a fractal pattern. Each of these support biophilic goals. Additionally, the plethora of available color selections may add an extra aesthetic punch to an interiors concept. Just be cognizant of color selection as these could easily become dated.

Numerous styles and form factors can be found across this expanding market sector. The example case study on the following pages provides a sampling of the breadth and variety of integrated acoustic luminaires available today.

The diagrams at right and on page 5 illustrate the design concepts examined in the case study on pages 5-7. The dollar, acoustics, and biophilic icons show the levels of each characteristic relative to its counterpart in the other concepts.

$ Relative cost Relative acoustic quality Relative biophilic elements





Luminaire images courtesy of Focal Point.

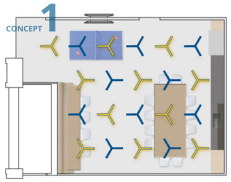
CASE STUDY:
Lighting and acoustics options

During IMEG's recent design of its own Chicago office, the team considered four different lighting and acoustics options, shown on page 4 and at left and explained on pages 6-7. Each of these has benefits and drawbacks such as lighting and acoustic qualities, biophilic design elements, and cost. Depending on the programmatic goals of your next project, one of these approaches may be just the right choice. (These options also are the basis of a joint study by IMEG and PNNL; read more .)

The concepts provide just a few variations of the numerous design possibilities and solutions available when seeking to integrate lighting and acoustics design. Each new or renovated space has its own characteristics, needs, goals, and budget, and the options presented here certainly will not align with every project for which integrated lighting and acoustics is desired.

Regardless of the criteria of an individual project, however, integrating lighting with acoustics can universally help optimize the experience of a space for those within it. Hearing well and seeing well are particularly supportive of and critical for accomplishing goals and tasks within high-performance, collaborative spaces.

The best results are achieved when the lighting and acoustics consultants you choose are brought on early, during the concept stage, and have a history of collaboration or are integrated themselves. Keep in mind, too, that a successful lighting and acoustics integration is about the design, not the products.



Concept 1: Illuminated and non-illuminated acoustic suspended trios

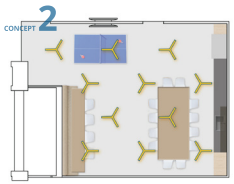
This option includes both illuminated and non-illuminated tripod-shaped suspended acoustic luminaires in a hard ceiling environment with acoustic treatment secured by adhesive. Non-illuminated luminaires flow into the illuminated and each row counterbalances the other's direction. The acoustic finish selected could vary depending on aesthetic preference but should maintain as much surface area as possible and be as thick as possible.

The materiality and shape of the luminaires create visual softness, movement, and balance—a haptic-like experience, akin to looking across a prairie and seeing the blades of grass blowing in the wind. This aligns with biophilic design concepts to create a pleasant and warm environment.

This scenario offers a high density of luminaires with a significant surface area for acoustic materials while maintaining an open concept with either hard or exposed ceilings. Although the density of the luminaires is high, half of these are non-illuminated, so the illuminance levels remain appropriate. Additionally, the noise control design is within a range of recommendations for common assembly and collaboration at an RT of 0.7 to 0.8 seconds.

Compared to the following options, the cost of this concept is higher on the luminaire side but lower on the exposed ceiling portion. Should luminaire cost reduction be required, more acoustic material must be added to maintain the minimum required treatment area and design intent.

$ $ $ $ $



Concept 2: Illuminated acoustic suspended trios

This is a scaled-back, more cost-effective option in which non-illuminated pendants have been eliminated. This concept includes illuminated, tripod-shaped suspended integrated acoustic luminaires in a hard ceiling environment. The layout allows rows to flow into each other for visual balance but reduces acoustic treatment in a predictable fashion. (See photo on page 3.)

The materiality and shape of the luminaires still creates visual softness and interest. With the reduction in luminaires the space feels more open and larger in scale, which may be a preferred aesthetic for certain spaces. Visually it also still aligns with biophilic design concepts but is less effective for acoustics. For less critical spaces this may be a balanced aesthetic and budgetary option, as long as acoustics and noise calculations verify boundaries for design intent.

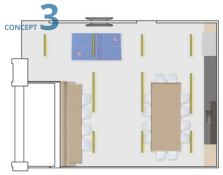
This option has a longer RT of 0.8 seconds and requires more attention to lower HVAC ambient noise control, with lower noise criteria (NC) metrics used from the mechanical designer. This can lead to a higher cost for the project to keep the balance between light, acoustics, noise, and mechanical design.

The relative cost for this concept is less than Concept 1 but still higher on the luminaire side. The cost of the ceiling materiality portion remains low and is the same as Concept 1.

$ $ $

KEY

- $ Relative cost
- Relative acoustic quality
- Relative biophilic elements



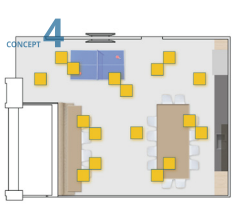
Concept 3: Linear slots in a drop acoustic grid ceiling

This is a flush lensed product , the cleanest concept from an aesthetic standpoint and one frequently seen in many spaces in the last decade. This option could be enhanced with a pop down or regressed lens, providing a continuous form factor, or a pendant mounting depending on ceiling height, aesthetic preference, and programmatic goals.

This scenario is a straightforward lighting solution with even illuminance and good acoustic treatment. However, it doesn't speak to the visual biophilic enhancements as do the other options. Here, noise abatement and speech clarity are driving design priority. This option has a low RT of 0.5 seconds, making it appropriate for a space with a hard floor area that needs more attention to speech clarity or presentations for a group or collaboration space.

While the ceiling grid and tile does add some cost, of the four concepts this has the lowest total luminaire and acoustic product cost.

$ $ | | |



Concept 4: Illuminated architectural regressed lensed troffers

This option features illuminated architectural regressed lensed troffers with asymmetric appearance and a rich field of integrated acoustic diffusion product that can be manipulated and arranged. The layout offers luminaires in clusters to create a visually dynamic experience. The angularly cut and dropped acoustic panels can vary in angles, rotation, depth, and color and offer a large amount of acoustic performance that can be predicted in advance. This room becomes an upgrade for conferencing with improved listening, faster learning, more clarity, less distraction, and even better translation of a foreign dialect.

The shape of the luminaires creates visual interest, movement, and an asymmetric balance. Adding acoustic drop-down panels adds softness and more interest. The dynamic between the regressed luminaires and protruding luminaires provides a rich detail that draws the eye in and across the space. It also creates a sense of mystery, like an architectural take on stalactites and stalagmites in a rich pattern, which correlates well to a biophilic design program.

This scenario offers high density acoustic materials to create a high intelligibility sharing space with good connection and engagement. The lighting provides a low glare, dynamically lit space with appropriate illuminance. The asymmetric layout and dynamic balance create pockets or a range of greater or lesser illuminance to reduce uniformity, and the acoustic panels can be arranged across a field or concentrated, relative to occupancy, talkers, and listener positions. This option has the lowest RT rating, less than 0.5 seconds, making it ideal for both transition and executive spaces where effective communication is critical. If it were an executive space the lighting uniformity may be further improved through a more advanced lighting control system. The color selection of the acoustic panels and the impact to lighting should be considered. The darker and more saturated the color—which will create a lower reflectance value—will require more energy to provide the same level of illumination.

The relative cost of this option is lower on the luminaire side but higher on the acoustic panel portion. But for feature spaces with good performance, this arrangement is strong and justified.

$ $ $ $ $ | | |

LEARN MORE

To learn more about integrating lighting and acoustics on your next project, contact Shanna Olson, IMEG Architectural Lighting Team Leader, at Shanna.L.Olson@imegcorp.com, or David Wright, Senior Acoustics Technical Specialist, at M.D.Wright@imegcorp.com.

Shanna Olson

David Wright

Architectural and Theatrical Lighting Services

As a versatile design team, IMEG'S architectural lighting designers understand the art, science, and technologies involved, as well as the complexity, challenges, and uniqueness, of each project. Creating a luminous environment that is visually curated, technically versed, and enriches the architect's design is the pinnacle of our work.

Our services and expertise includes:

- 3D computer renderings and visualizations
- Interior architectural lighting design
- Theatrical lighting design
- Exterior and facade lighting design
- Illuminance and EML calculations
- WELL- and LEED-compliant design
- Circadian support design
- Custom luminaire design
- LED lamp and retrofit consulting
- Lighting and controls commissioning

Acoustics & Noise Abatement Services

IMEG's in-house acoustics specialists combine experience and creativity to provide innovative solutions for noise control, speech intelligibility, room acoustics, and vibration control. We predict the results before the room is built. We can coordinate with other disciplines, allowing acoustics and vibration goals to be economically integrated throughout the design of the various building systems.

Our services and expertise includes:

- Noise control
- Speech intelligibility
- Room acoustics
- Vibration control
- Privacy and masking
- LEED certification