Customizable Acoustical Solutions for Open Plenum Design

Presented By:

CertainTeed SAINT-GOBAIN ARCHITECTURAL


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LEARNING OBJECTIVES

1. Examine the importance of acoustical design for open spaces and how free-hanging and direct-mounted ceiling systems provide acoustic control.
2. Identify how to transform a space using customizable metal ceiling systems for open plenums.
3. Assess how to enhance open plenums with wood ceiling systems.
4. Describe how to design with innovative fiberglass ceiling systems, including oversized panels, clouds, and baffles, to achieve dramatic, sculptural design.
5. Explore how to use felt ceiling systems to maximize acoustics and aesthetics.

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ACOUSTICAL DESIGN FOR OPEN SPACES

Modern open spaces create a unique set of challenges when it comes to acoustics. For the past several decades, historic factories, warehouses, and other buildings with open floor plans have been converted into offices, studios, retail, or living spaces. The adaptive reuse of these buildings is a trend that is not going away, and it can pose challenges when the purpose of a building is fundamentally changed to meet different occupant needs. Noise control was not part of the design when most of these buildings were constructed, and now that they're being used for offices and living spaces that require varying degrees of privacy and quiet, optimizing acoustics is paramount.[1]

New buildings are also being designed with open plans and open plenums. These tactics provide industrial flair to a space, but often lead to an uncomfortable acoustic environment. The use of glass, wood, metal, polished stone, concrete, and other acoustically reflective materials can further exacerbate this problem. In addition, the numerous benefits of daylighting buildings have been studied extensively, which has led to more open floor plans where daylight can spill across the entire space, or soaring atriums that flood lobbies and other public spaces with natural light.

Fortunately, there are innovative open plenum ceiling systems on the market that can help to overcome these challenges while adding incredible aesthetics to the space. Wall-to-wall suspended ceilings were typically used in the past for acoustic control and to hide unsightly HVAC ductwork, plumbing, and fire protection systems that are typically located in the ceiling plenum. But wall-to-wall suspended ceilings are often not aesthetically desirable or practical. Creative freedom and acoustic control can be achieved simultaneously, without the need for a suspended ceiling. With the strategic use of ceiling treatments, you can achieve the right acoustic performance in each space without compromising visual impact or the budget.

Acoustic alternatives to suspended ceiling tiles include clouds, pods, beams and

baffles, and wall panels, which are available in a variety of materials like metal, wood, fiberglass, and felt. These systems can significantly improve acoustics and, when properly configured, can achieve sound absorption comparable to that of a traditional wall-to-wall acoustic ceiling tile system, but with a much more exciting aesthetic.

FUNDAMENTALS OF ACOUSTICS

Choosing the right acoustical products for an open plenum space requires a basic understanding of the acoustic principles these products are designed to address.

Reverberation Time (RT)

A primary acoustic concern in open spaces is reverberation time (RT), which is the time it takes for the sound to die off after the source has stopped. RT is directly impacted by the exposed surface area of sound-absorbing materials in the space.[2] For example, a completely empty, unfurnished 1,000 ft^2 space with 12′ high ceilings (12,000 ft^3) and standard drywall surfaces has an RT of 3.2 sec. Acoustic surfaces anywhere within the space like upholstered furniture, carpet, and curtains will shorten RT. Room volume is also a driver. Larger spaces have larger volumes and require more sound absorption to achieve an acceptable RT. The reverse is true for smaller volume spaces.

The right reverberation time for a space depends on the purpose of the space. If the goal is to maximize speech intelligibility, which is important for office environments, the RT should be less than 1 second. Some areas require a livelier, more energetic sound environment. Restaurants and other social spaces are most comfortable with an RT between 1.4 and 2 seconds, but even energetic spaces require some sound absorption to strike the balance between comfortably lively and just plain loud.[3]

Noise Reduction Coefficient (NRC)[4]

Noise Reduction Coefficient (NRC) is another measurement that is often used with building products, such as acoustic panels. NRC is a test measurement of sound absorption. To appreciate how NRC is calculated, you must first understand frequency, which is the measurement of how often a wave passes a fixed point in one second. Measured in hertz (Hz), frequency dictates the pitch of the sound and its audibility to the human ear. High frequency sounds are high pitched. Low frequency sounds are low pitched. The human voice has a general range between 80 Hz to 240 Hz for men and 140 Hz to 500 Hz for women. For comparison, a piano produces sounds between 27.5 Hz and 4186 Hz. The human ear can distinguish sounds between 20 Hz and 20,000 Hz. The NRC of a product is determined by averaging how much sound it absorbs at four frequencies: 250, 500, 1000, and 2000 Hz. This average is represented as a decimal between 0.00 (no absorption at all) and 1.00 (complete absorption), rounded to the nearest .05.[5] For example, fiberglass is one highly sound-absorbent option for ceiling panels, with an NRC that typically ranges from 0.90 to 1.00.

Sabins[6]

Another key to understanding the sound absorbing capabilities of an acoustical product is the Sabin, which can be helpful when designing open plenum spaces. Every exposed surface has sound absorption and offers a quantity of Sabins when calculating RT. Sabins are the measurement of the quantity of sound absorption provided by anything inside of a space. This measurement can take the form of Sabins per square foot of an exposed surface (wall, floor, ceiling) or it can be the absorption from a three-dimensional element in the space like furniture, baffles, or clouds. This is important to our discussion as a wall-to-wall acoustic ceiling absorbs sound through a single, exposed face, whereas the products we will discuss in this course, such as baffles and clouds, are absorbing sound from all exposed surfaces.

There is a direct relationship between the reduction in sound level in a room and the amount of sound absorption added to the room. A high NRC material (like fiberglass) will typically translate to products having a high level of Sabins, but ultimately the total amount of sound absorption is determined by either the square footage of the material in the space or the number of panels, clouds, or baffles in the space. In order to compare Sabins to NRC, take the NRC provided for the product and multiply it by the total square footage for that product; that will give you the number of Sabins that it is bringing to the space. This will apply to products that are installed as a full wall-to-

GLOSSARY

Baffle—An architectural device used to prevent the spread of sound or light in a particular direction

Beam—A horizontal ceiling element that creates visual interest, separation, and depth

Cloud—Free hanging ceiling element that is exposed for sound absorption on all sides

Frequency—The measurement, in hertz (Hz), of how often a sound wave passes a fixed point in one second; frequency dictates the pitch of the sound and its audibility to the human ear

No-Added Urea Formaldehyde (NAUF)—Urea-Formaldehyde is a type of resin that is used as a bonding agent in some types of plywood and composite wood panels; NAUF products are specifically manufactured by the wood industry to remove urea formaldehyde from the bonding process, eliminating the harmful effects of VOCs, like eye and throat irritation

Noise Reduction Coefficient (NRC)—Measure of sound absorbed by a material; the single number designation represents the average of the sound absorption coefficients of a material at 250 Hz, 500 Hz, 1000 Hz, and 2000 Hz rounded to the nearest 0.05 when tested in accordance with ASTM C 423

Open Plenum—The space provided for HVAC, plumbing, lighting, and other systems that is typically located between the structural ceiling and a drop-down ceiling; an open plenum results in an exposed structural ceiling

Reverberation Time (RT)—The time it takes for the sound to die off after the source has stopped; RT is directly impacted by the exposed surface area of sound-absorbing materials in the space

Sabins—A unit of sound absorption necessary for Reverberation Time calculations

Wall-to-wall suspended ceiling—Typically a metal grid that supports ceiling tiles that are used for acoustic control and to hide unsightly HVAC ductwork, plumbing, and fire protection systems located in the ceiling plenum

wall ceiling, or to things like floor coverings and wall coverings, such as gypsum board or glass.

Free hanging elements like clouds and baffles, since they are exposed for sound absorption on all sides, behave somewhat differently than a traditional lay-in ceiling. As such, a good rule of thumb is that, typically, 50–60% coverage of the ceiling will perform similarly to a full wall-to-wall ceiling constructed of high-quality fiberglass ceiling panels. The panels being exposed on all sides allow for more than just the panel face to absorb sound, hence fewer panels are needed to perform like a wall-to-wall ceiling.

In short, 100 ft^2 of wall-to-wall fiberglass ceiling offers 100 ft^2 of 0.90 NRC or approximately 90 Sabins. However, 100 ft^2 of fiberglass hanging baffles actually have 200 ft^2 of exposed surface and can offer approximately double what is offered by the suspended ceiling. Of course, acoustic evaluation isn't quite that simple, but this conceptual description should provide a better understanding. Typically, acoustic elements are tested to provide a useful acoustic descriptor, Sabins per unit. This enables a calculation of how the introduction of this unit (or several units) will affect the RT of the space.

OPEN PLENUM SOLUTIONS AND WHY FORM AND MATERIAL MATTER

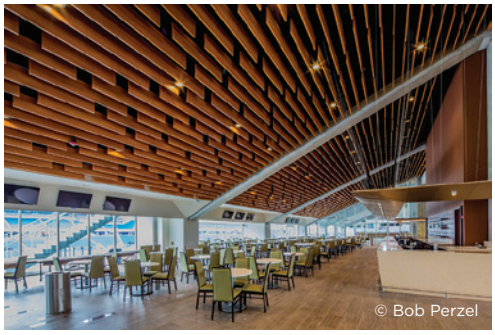
There are many types of open plenum solutions available to achieve the acoustics we've discussed, including baffles, beams, and clouds. The materials used in these products matter greatly. Some materials, like fiberglass and felt, are inherently sound absorbent while others, like wood and metal, are not. But, they can be combined with sound absorbent materials to create solutions that have the desired combination of aesthetics and acoustic traits. Now let's delve more deeply into each of these open plenum solutions.

With the strategic use of ceiling treatments, you can achieve the right acoustic performance in each space without compromising visual impact or the budget.

Beams and baffles help to disperse noise in a space, even when made from material that is not inherently sound absorbent. For better acoustical performance, metal beams and baffles are also available with a combination of perforations and acoustical infill that allow the sound to pass into the beam and be absorbed inside rather than reflect off its surface.

METAL CEILING SOLUTIONS FOR OPEN PLENUM SPACES[7]

The metal ceiling systems we will discuss in this course include beams and baffles constructed of lightweight extruded aluminum. As mentioned earlier, metal is not sound absorbent, but metal beam and baffle products are available with a combination of perforations and sound absorbent infill that allows the sound to pass into the beam and be absorbed inside rather than reflect off its surface. Such systems can be specified for acoustic performance, as they can achieve NRC values of 0.70 and higher.



Designers are able to create topography and rhythm at interior ceiling planes by combining metal beams and baffles of multiple heights and reveals.

Designing with Metal Ceiling Systems

Metal beams and baffles allow for easy plenum accessibility and a variety of installation options. There is an extensive portfolio of lengths, widths, and heights to choose from along with canted, tiered, and diverging options to create unique designs. Designers are able to create topography and rhythm at interior ceiling planes by combining beams and baffles of multiple heights and reveals. They can be precision-cut with straight and curved elements to create peaks, valleys, angles, walls, and screens. Twist clips can also be used to create a sense of motion.

Metal ceiling systems can be clad in both real wood veneer or decorative wood-look options.

A wide choice of colors, wood looks, and finishes are possible, with manufacturers often offering custom color matching upon request. Light color finishes such as white can increase daylighting, as they have higher light reflective values. To prevent glare, designers should specify a low-gloss finish. Metal ceiling systems can also be clad in both real wood veneer or decorative wood-look options. While real wood veneer is only suitable for interior applications, decorative powder-coated, wood-look options can be specified for both interiors and exteriors. In addition, designers can incorporate lighted backgrounds into some metal ceiling systems to create illumination and depth.

From a practical standpoint, a key feature of beam and baffle systems is its integration with a standard heavy-duty 15/16" T-grid system that allows for easy installation—the same type of system used for traditional suspended ceilings. Beams mount via hidden scissor clips to enable single-beam access to the plenum as well as freedom from fixed modular assemblies.

WOOD CEILING SYSTEMS

Designing with wood brings the beauty of nature indoors, creating a sense of warmth as well as depth, separation, and visual interest in ceiling designs. Architectural wood ceiling systems range from familiar forms with options for customization, to fully engineered custom acoustic solutions, making it easy to elevate the style of any space on any budget. Like metal, non-sound-absorbent wood systems can be used for visual impact as part of a larger design plan that includes acoustic products. Some wood products can be specified with micro-perforations or grooving patterns along with a sound absorbing fiberglass core infill to provide acoustic performance. Acoustical absorption characteristics can also be modified by changing the thickness of the baffles as well as the spacing between installed baffles.

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A subsidiary of Saint-Gobain, CertainTeed has shaped the building products industry for more than 110 years. From acoustical ceiling panels and suspension systems to custom-engineered showpieces, the CertainTeed Architectural portfolio includes solutions for every space and budget—backed by collaborative support to help you unleash the creative potential of every project.

QUIZ

1. Which of the following measures the time it takes for sound to die off after the source has stopped?
   a. Reverberation Time (RT) b. Noise Reduction Coefficient (NRC)
   c. Sabins d. Decibel

2. _____ measure the quantity of sound absorption provided by anything inside of a space (i.e. furniture and ceiling treatments).
   a. Reverberation times b. Noise Reduction Coefficients
   c. Sabins d. Decibels

3. A good rule of thumb is that typically _____ percent coverage of a ceiling with free-hanging elements, such as clouds and baffles that absorb sound from both sides, will perform similarly to a full wall-to-wall ceiling constructed of high-quality fiberglass ceiling panels.
   a. 30 to 40 b. 40 to 50
   c. 50 to 60 d. 60 to 70

4. Which of the following materials are inherently sound absorbent? Choose all that apply.
   a. Metal b. Wood
   c. Fiberglass d. Felt

5. Metal beam and baffle products specified for acoustic performance can achieve NRC values of _____ and higher.
   a. 0.55 b. 0.60
   c. 0.65 d. 0.70

6. Some _____ products can be specified with micro-perforations or grooving patterns along with a sound absorbing fiberglass core infill to provide acoustic performance.
   a. Metal b. Wood
   c. Fiberglass d. Felt
   e. Both A and B

7. When using wood products in design, which of the following should architects prioritize to ensure environmental responsibility and occupant safety?
   a. Forest Stewardship Council certification
   b. High recycled content
   c. No-Added Urea Formaldehyde
   d. Class A Fire Rating for veneers and Class C for solid wood
   e. All of the above

8. Fiberglass clouds should be spaced at least _____ inches apart to ensure optimum sound absorption.
   a. 5 b. 10
   c. 12 d. 18

9. The square footage of fiberglass baffles and clouds should equal _____ percent of the wall-to-wall ceiling area to ensure adequate sound absorption.
   a. 10 to 30 b. 30 to 60
   c. 40 to 80 d. 60 to 90

10. Some felt products offer a high acoustical performance of NRC _____ or higher.
    a. 0.50 b. 0.60
    c. 0.70 d. 0.80

Designing with Wood Ceiling Systems

Wood ceiling systems can be created in standard product forms such as open cell, beams, baffles, and canopies, or designers can traverse more adventurous territory with customized framing and architectural forms. Designers can also customize their installations with custom toning, sheening, and color-matching, among other wood finishes.

Prefabricated wood beams and baffles can be constructed of solid wood or clad in veneers such as cherry, red oak, walnut, and bamboo. The base material of wood beams and baffles is often composed of

METAL CASE STUDY

Healing a Ceiling in an Aging Sports Arena

Nassau Veterans Memorial Coliseum, Uniondale, New York

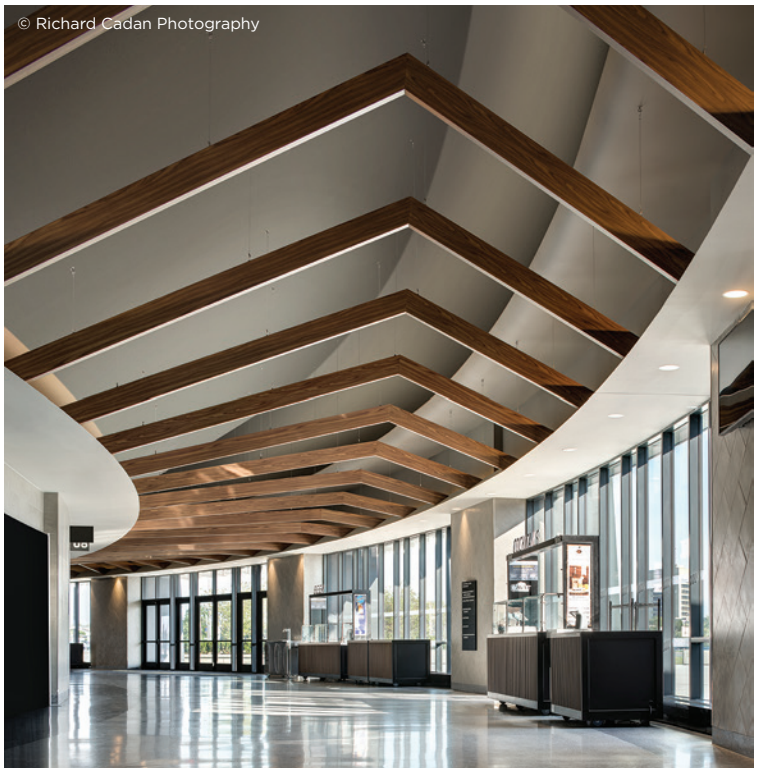
The Nassau Veterans Memorial Coliseum, home of the Long Island Nets and New York Islanders, was built in 1972 and has hosted many concerts and other professional sporting events. From 2013 to 2017, it was redesigned and retrofitted to meet the technological and aesthetic demands of a modern entertainment and sports venue. One of the most visually striking elements of its new look is a one-of-a-kind, design-forward ceiling combining clean lines, modern aesthetics, and subtle wayfinding cues. San Francisco design firm Gensler sought to create an iconic new look that first started with the concourse that encircles the stadium. One of the key features of the concourse is a custom ceiling that adds a lively sense of motion and energy overhead.

Intended to simulate rafters, lightweight extruded aluminum beams powder coated with a wood-grain finish follow the ridge line around the space and guide visitors where to walk. The wood-like finish adds an element of warmth, which is complemented by soft recessed accent lighting in the soffits. The coliseum's old stucco ceiling is still visible above the new ceiling's rafters and serves as the plenum from which the new rafters are suspended.

The large scale of the ceiling, compounded by the complications of working within the confines of the existing structure, presented significant engineering challenges, as did the intricacy of its design. The ceiling comprises approximately 6,000 feet of custom-engineered elements: 200 rafters set 6 feet apart at 24 unique angles, mounted with 1,200 brackets. Each rafter is created from two beams of varying sizes. The longer of the two ranges in size from approximately 12½ to 15½ feet, while the shorter falls between 4 and 9½ feet. They meet at angles ranging from 132 to 157 degrees.

Suspending the beams from the existing plenum and soffits forced the engineering team to reckon with complicated angles. The biggest challenges involved the engineering of the angles, lengths of beams, and weight that was attached to the ceiling or resting on the bulkhead. 20 to 30 angles mean 40 to 50 unique cuts are required. To mitigate this, the project team selected a product made of extruded aluminum, a highly durable material allowing for precise angle cuts.

With so many variables involved in the ceiling's design, it was essential for components to be fabricated with precision, schematics to be drawn with detail, and installation to be carried out with accuracy. The manufacturer worked with designers at Gensler to develop detailed CAD models and to test specific beams and suspension assemblies for fit and coordination to achieve the seamless effect the design firm visualized before moving on to the installation. While the rafters' sizes and angles varied widely, the same basic process could be applied to cut and align each one. By reducing the number of angles and beams, making precision cuts, giving diagrams on how to seam the beams together properly with the brackets, and identifying placement of hanger points, the engineering team supplied the installers with everything they needed to simplify an otherwise complicated installation job. Due to the in-depth planning, efficient engineering, and detailed guidelines, the installation phase went quickly and smoothly.



One of the most visually striking elements of the coliseum's new look is a one-of-a-kind, design-forward ceiling combining clean lines, modern aesthetics, and subtle wayfinding cues.

By following the ceiling around the curving concourse and tracing the gently undulating ridge line above, one will eventually arrive at a stairwell and escalator. Above the stairwell hangs one of the signature elements of the space: a decorative shelf wall, or 'vertical ceiling,' which continues the beam's visual lines from one level of the concourse to another. Hanging at a 15-degree angle, the shelf wall is constructed of the same wood-finished aluminum beams that comprise the rest of the ceiling. Each beam is connected to visible black steel rods providing structural support. The 12 steel brackets on which the shelf wall is mounted (six on the bottom and six on the top) had to be custom designed and engineered and are each ½ inch thick. The result is a striking visual anchor piece greeting and guiding event attendees as they descend the stairs or escalator.

The success of the redesign transformed a familiar but outdated venue into a destination able to deliver first-class programming for guests and artists alike. What end users see is a new design paying homage to the coliseum's history by preserving the interior architecture while injecting a new sense of energy and bringing a beloved old building back to life.

fire-retardant MDF, fire-retardant particle board, or solid wood, and typically has a clear topcoat to protect the surface.

Note that the dimensions of wood beams and baffles will vary based on the wood species and whether they are solid wood versus veneer. Mounting options are another consideration. Beams can be directly mounted to a ceiling structure or attached to a channel strut. Smaller beams or baffles can often be free-hanging or independently suspended units. Wood baffles can have two open ends, one open and one closed end, or two closed ends. Mounting options for wood baffles include:

- Direct or strut-mounted with adjustable mounting
- Direct or strut-mounted with fixed mounting (Solid Wood)
- Adjustable mounting or strut-to-strut (Solid Wood)
- Independently suspended or free-hanging

When using wood products in design, the sourcing, sustainability, and fire rating of the wood are always important considerations to ensure environmental responsibility and occupant safety are prioritized. Designers should specify wood products: are certified by the Forest Stewardship Council as responsibly sourced, have high recycled content if applicable, are No-Added Urea Formaldehyde (NAUF) products, and are Fire-Rated Class A for veneers and Class C for solid wood.

INTRODUCTION TO ACOUSTICAL FIBERGLASS

Acoustical fiberglass is available in sound-absorbing clouds, baffles, and custom 3D architectural forms in a multitude of shapes, sizes, colors, and configurations that elevate designs while also maintaining outstanding acoustic control. Applications for both products include open-plan offices, auditoriums, classrooms, lobbies, hallways, restaurants, and healthcare. Fiberglass clouds and baffles may be GREENGUARD Gold Certified, can be constructed using a no-added-formaldehyde core, and those with high post-consumer recycled content can help to achieve several green credits under LEED v4. In addition, some fiberglass products are inherently resistant to the growth of mold and mildew, while some offer cleanability.

WOOD CASE STUDY

Better Together: A Global Gateway to Acoustical Design

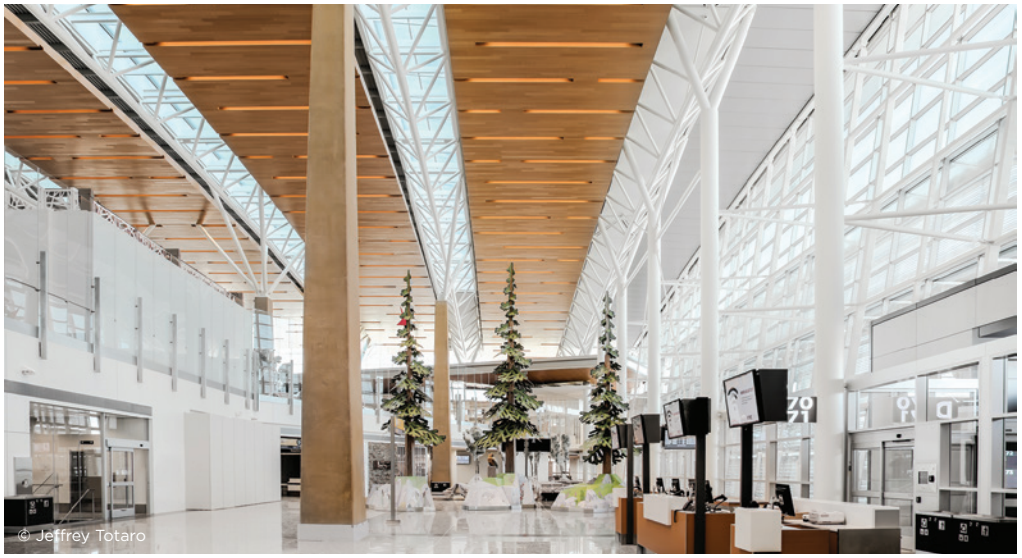
Calgary International Airport, Calgary, Alberta

When YYC opened this fall, it not only became a reimagined gateway to one of Canada's largest and most economically significant cities, it took on the role as the country's most iconic airport. Designers from around Canada worked for several years to cultivate a design that blended aesthetic beauty with functionality and sustainability. The space needed to say "Calgary" without being too literal. Combining natural materials in unique and unexpected ways for an airport environment allowed them to play with colors, finishes, and shapes, while still providing the necessary durability required for a bustling, growing facility. A key aspect of the design process was to specify and install a unique, modular ceiling system that would assist with wayfinding, help manage acoustics, and mitigate noise, leading to a stress-free and anxiety-reducing travel experience for the airport's 15.7 million annual passengers.

Acoustic wood panel ceilings were specified throughout the airport, as they offered the design team an aesthetically pleasing wood product that was easy to install and offered full accessibility after the installation. The suspension systems used to support the wood panels gives the illusion that the wood ceiling panels are floating in air—tying in well with the overall design theme of the airport that features open and airy spaces with natural materials. In addition to 200,000 sq. ft. of acoustic wood panels, perforated metal ceiling panels were incorporated throughout the space as a design juxtaposition.

Offering the facility a product with an extraordinarily long lifecycle, along with unmatched durability, the bright metal finish of the panels combines perfectly with the matte finish of the wood. Mineral fiber ceiling panels and fiberglass ceiling panels were also installed throughout the terminal, as they offer a product that is economical with positive acoustic principles. The panels provide differing acoustic performance with a consistent visual. This allowed the design team to mix and match products based on specific design needs and specifications for each space within the terminal. Rob Adamson, lead architect and partner at Dialog Design, noted "The multiple ceiling and gypsum solutions worked in conjunction with the other design features seamlessly. There were no particular design challenges, as the ceilings were modular and quite easy to deal with."

After a massive design, manufacturing, and installation process, the ceiling products occupy a unique and important position at YYC/Calgary International Airport. An international gateway to an increasingly international city, the finished product is a reminder that critical, billion-dollar infrastructure upgrades require out-of-the-box thinking and innovative, design conscious, and functional solutions.



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Lightweight, frameless fiberglass clouds provide two-sided sound absorption.

FIBERGLASS CLOUDS[8]

Lightweight fiberglass clouds provide two-sided sound absorption. Clouds are typically constructed from a fiberglass core with a drywall-like finish that can be color-matched to meet a project's aesthetic. Designers can specify fiberglass clouds in a variety of shapes, including circles, rectangles, triangles, trapezoids, hexagons, or custom abstract shapes. Curved (convex or concave) and flat shapes are available in standard sizes, or they can be manufactured to meet project-specific designs and requirements. They can also be specified in a variety of colors or custom color-matched to specific paint chips. Fiberglass clouds are also available in fabric-wrapped panels, can incorporate geometric patterns, or even metallic finishes. Or, designers can choose a simple white finish that is easy to clean and diffuses light.

Individual clouds can be suspended from the ceiling, wall-mounted for added dimension, or angled, which can add a sense of movement to the ceiling design. Multiple clouds are often combined to create a sculptural point of interest that doubles as sound absorption. When acoustic fiberglass clouds are suspended at various heights and angles, a uniform appearance is presented regardless of the viewing point. The acoustical clouds and shapes can be installed individually to identify a space or grouped together to create unique configurations. Fiberglass clouds can also be hung in layered tiers, which adds depth, texture, and enhanced acoustic control by increasing the number of elements.

Designing with Free-Hanging Fiberglass Clouds[9]

As you can see, acoustic clouds are an incredibly versatile design tool when you consider the potential of positioning, angling, and layering. Placement is key to acoustic performance. The closer to the origin of the sound, the better. In spaces where speech is the primary sound source, installing clouds toward the middle of the space rather than close to the ceiling is more efficient, as it allows them to absorb sound from the source as well as sound reflected from the deck above. How much more efficient? For example, a 16 square foot absorber installed 40 inches from the structure absorbs 15 percent more sound than one installed 8 inches from the same structural deck. Spacing units such as these at least 18 inches apart also ensures better sound absorption. Positioning elements too close to each other or to the structure can inhibit their acoustical performance. Adding lowered clouds directly above tables or desks dramatically reduces the overall noise level and sound propagation in open plenum restaurants or offices.

From this simple principle, creativity can take over, allowing designers to create anything from minimalist acoustic control to dramatic sculptural installations. Enhance the drama of projects with customizable options such as 3D architectural forms (fiberglass panels constructed with a hollow core), edges with design returns that visually add depth, and interesting combinations of colors and materials. Lighting components can even be integrated into fiberglass clouds and baffles, with several installation options available to achieve the desired design intent. LED lighting can be custom-sized and custom-configured to attain the desired lumen output and temperature, as well as deliver the ability to control dimming settings.

FIBERGLASS BAFFLES[10]

Fiberglass baffles are distinct from clouds in that they are installed vertically; like clouds, unframed baffles provide excellent sound absorption and design flexibility. In spaces with standard proportions and average ceiling heights, baffles can create a uniquely modern linear visual, providing excellent sound absorption with a relatively shallow system depth. In large atriums and clerestory spaces, suspended baffles are an even better option than clouds, as they visually maintain the magnitude of the space without disrupting sight lines to the top of the building.

As with fiberglass clouds, customization options are virtually unlimited, including abstract shapes and creative combinations of colors, finishes, and materials.

Baffles perform best acoustically when they are positioned to allow sound to move between and bounce off them.

Fiberglass acoustic baffles are customizable to a wide range of unique shapes and various thicknesses with the option of cutting shapes out of the material for visual impact. Some of the shapes available include straight rectangles, waves, and zig zag edges. Oversized shapes are also available as fabric-wrapped free hanging screens. Demountable baffles can be hung from a distance, directly from a structure to enable versatility, or from a wall. Designers can create movement with angular or wave-like expressions by stacking or staggering baffles in unique patterns. Additional design options include integrated LED lighting, digitally printed and textured textiles (for fabric-wrapped baffles), and a range of brilliant finishes and colors (or custom-color matching to a paint chip). As with fiberglass clouds, customization options are virtually unlimited, including abstract shapes and creative combinations of colors, finishes, and materials.

Whatever the configuration, fiberglass free-hanging solutions enable two-side sound absorption, reducing reverberation and excess noise to help create a more productive environment in open spaces such as offices and lobbies.

Designing with Fiberglass Baffles[11]

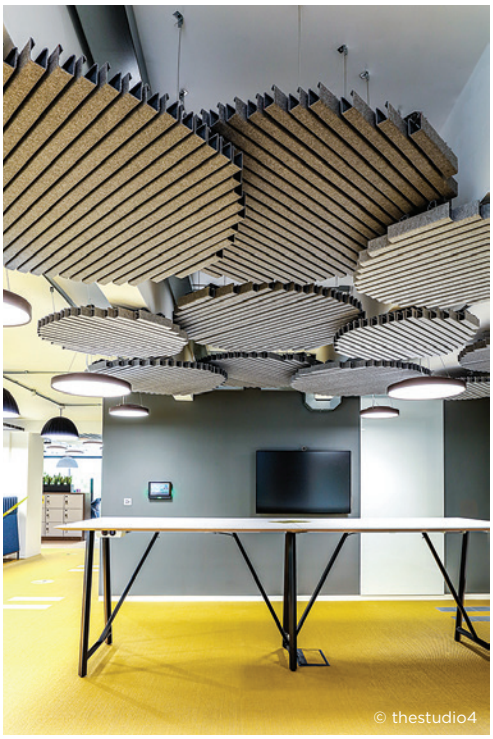
Fiberglass baffles can open up a world of possibilities to architects, but there are a few basic guidelines designers need to keep in mind to get the desired sound benefits from these high-impact sculptural designs.

Like clouds, the square footage of fiberglass baffles should equal 30 to 60 percent of the wall-to-wall ceiling area to ensure adequate sound absorption. Baffles also perform best when they are positioned to allow sound to move between and bounce off them. Therefore, baffles must be carefully spaced at distances dependent on the application and noise mitigation goals. Typically, sound absorption is optimized when rows or checkerboard patterns are spaced a minimum of 24 inches apart.

ECO-FRIENDLY ACOUSTICAL FELT[12, 13]

Felt is an age-old material that is believed to be one of the first textiles humans ever created. It has been long admired for its warmth, absorption, and tactile nature. Today's felt is a sophisticated material with far-reaching applications and often prized for its aesthetic merit. Felt's water-resistance, cutability, insulative quality, and high sound absorption make it a natural fit for the built environment.

The architecture and interior design industries are taking notice and getting a better feel for what felt products have to offer in design. As a result, the growth of felt design is now yielding products for use in unexpected applications: ceilings and walls. Felt ceiling products can help to create soft and relaxing spaces with unlimited design possibilities. They provide a warm aesthetic and optimize acoustic performance. From linear, multi-layer, and large-format panels to baffles and open cell formats, designers have limitless design flexibility to transform



The wide variety of felt ceiling products can solve aesthetic and acoustical challenges with equal ease, and turn any space into a warm, inviting, and visually stunning architectural feature.

FIBERGLASS CASE STUDY

Free-Hanging Clouds Save the Schedule, the Budget, and the Day in Innovative Office Project

EMD Performance Materials Headquarters, Philadelphia, PA

Philadelphia's Navy Yard, a 1,200-acre waterfront campus on the Delaware River, is a collision of storied past and dynamic present. It served as the birthplace of the U.S. Navy in the 1770s and is a magnet for cutting-edge businesses today. One of the newest additions to this campus' mix of historic brick structures and glass office towers is a cleverly designed LEED Gold certified building constructed in 2016 at 1200 Intrepid Avenue. As the first Philadelphia building designed by famed international firm Bjarke Ingels Group, the four-story structure is designed with a mesmerizing mix of angles and curves in a gesture resembling the bows of the massive decommissioned warships in the docks surrounding the Navy Yard. It's a design-forward aesthetic that provides the perfect new home for EMD Performance Materials, which moved into the first and third floors in late 2017.

As the North American high-tech materials business of Merck KGaA, Darmstadt, Germany, EMD Performance Materials offers a robust portfolio of applications in fields such as consumer electronics, semiconductors, lighting, coatings, printing technology, plastics, and cosmetics. The work EMD employees undertake day in and day out demands a flexible, high-performance environment that can accommodate everything from lab research to business strategizing to accounting and also must facilitate the need for solo work, small group collaboration, and large meetings. "We were looking for a space that was innovative, inspiring, and promotes advancing technology," EMD communications manager Alisha Davis says of the group's search for its new home.

Inside, the third-floor office is an airy, open floor plan with an abundance of collaborative, free-form spaces. Enormous, 10-foot vertical windows dominate the perimeter, leaning outward with the building's curved east-facing facade; rows of desks are occasionally interrupted by collaborative work areas; a small handful of glass-walled offices line select sides of the floor plan; and a tiered ceiling sprawls above it all. "We wanted unobstructed views and floating ceilings," says architect Gary Musciano, "and getting the ceilings as high as possible."

The largely open floor plan indeed feels inspiring. But the design and building materials used to construct it had to function so that small groups collaborating at a table area would not disrupt the workflow of individuals working at desks nearby. That meant one of the biggest design challenges was controlling acoustics. And one of the most effective ways to achieve an acoustically sound office environment is through ceiling products specifically designed to absorb and block sound. "The ceilings were the single contributor to acoustic attenuation because we didn't have many partitions, and the partitions we do have are glass," Musciano says. "So, the ceilings do all the work acoustically."

The design team created a specially designed ceiling in varying sections. Over the main portion of the office, the ceiling consists of a grid of unconventional 1′ x 8′ narrow-reveal panels from which tiers of strategically placed frameless 4′ x 4′ clouds hang freely to absorb ambient noise. Smaller sections of ceilings called for 4′ x 4′ clouds to be suspended from beams at gradually increasing angles that ascend up the walls into the ceiling in a beautiful wave-like effect that captures resonant sound vibrations.

One of the most effective ways to achieve an acoustically sound office environment is through ceiling products specifically designed to absorb and block sound, such as the free-hanging clouds used at the EMD Performance Materials Headquarters.

The element of acoustic control, coupled with how the product would function aesthetically in a three-dimensional space, added a level of complexity that demanded more than a standard panel and grid ceiling solution—this installation needed a product that would control sound but also look attractive from any and all angles.

The unconventional angling of the free-hanging clouds meant that both sides of many of them would be in full view and had to be finished on the back. Free-hanging clouds finished on both faces provide acoustic performance and elegant visual appeal. Regardless of their free-hanging orientation, these clouds and baffles show a clean, finished surface when viewed from any angle, and their ease of installation is an added attraction for contractors.

EMD's research and development labs occupy a portion of the third floor and additional space on the first floor. In the labs, controlling sound is one issue, as is cleanliness, because performance materials research can get loud and messy. A durable, easy-to clean suspended ceiling was specified in this area. The ceiling specification met Herbst Musciano's architectural and aesthetic goals while staying within budget. The result is a ceiling structure that feels lofty and sculptural, juxtaposed with acoustic control that belies the vastness of the space.

otherwise ordinary areas into spaces that are calm and inviting, but also visually inspiring.

Because it is particularly excellent at absorbing high frequency sounds such as speech and office noise, felt is not only soft to the touch, but soft on the ears as well. Most felt products on the market offer a high acoustical performance of NRC 0.80 or higher. It's ideal for education applications, offices, restaurants, and retail spaces, or anywhere you're wanting to achieve a creative design while maintaining sound absorption properties.

Designing with Felt Ceiling Systems

In open plenum spaces, baffles, clouds, and open cell ceiling and wall designs are often specified in felt. The wide variety of products can solve aesthetic and acoustical challenges with equal ease, and turn any space into a warm, inviting, and visually stunning architectural feature.

Felt baffles and clouds merge the soft visuals of felt with an eye-catching sculptural aesthetic. Baffles come in a broad range of formats. Clouds can be stacked or angled and suspended by hanger wire for an even more creative look that contrasts the softness of the material.

Baffle systems offer high acoustical performance and are typically available in heights between 6" and 24" and lengths between 1' and 8'. When using adjustable, budget friendly suspension options like hanger wire, installation is fast and efficient.

Color is a major appeal of felt ceilings. Vibrant, saturated hues can create energetic, playful environments, while timeless neutrals create subtle sophistication in natural, biophilic spaces. Some manufacturers offer easy customization of felt colors that can match and help emphasize brand identity, which is ideal for spaces in high schools, universities, sports facilities, and corporate headquarters.

In addition to color options, shapes and sizes are entirely customizable as well.

Felt baffles and clouds merge the soft visuals of felt with an eye-catching sculptural aesthetic.

Because felt is flexible and easily cuttable without the risk of fraying, ceiling and wall products can be easily manipulated and cut onsite to create billowing curves, sharp angles, and more.

CONCLUSION

We hope you now have a better understanding of the importance of acoustic control in buildings with open floor plans and open plenums, and how customizable acoustic ceiling systems, available in a wide variety of formats, materials, and configurations, can provide infinite solutions for open plenum design. From clouds, baffles, and beams to metal, wood, fiberglass, and felt, acoustic ceiling systems can significantly improve acoustics while providing designers the creative freedom to transform commercial spaces into works of art. ■

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