ARCHITECT
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CEIL WITH THERMOFORMED TILES AND PANELS

A NEW VOCABULARY FOR OVERHEAD DESIGN

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LEARNING OBJECTIVES

By the end of this educational unit, you will be able to:

1. Recognize design challenges for which thermoformed ceilings are an attractive solution.
2. Utilize drop-out ceilings to reduce the cost and impact of installing fire sprinklers.
3. Integrate LED lighting with new approaches to luminous ceilings.
4. Improve indoor air quality by eliminating ceiling problems associated with mold, airborne fibers, and VOC-emissions.

CONTINUING EDUCATION

CREDIT: 1 LU / HSW

COURSE NUMBER: ARsept2015.1

Use the learning objectives to focus your study as you read this article.

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EXPIRED

There is a thermoformed ceiling pattern for every architectural style or taste. When the Chintz Room in Columbus, OH was remodeled, M+A Architects envisioned a theme that was completely contemporary yet respectful of the restaurant's heritage as a lunch destination in the historic Lazarus department store. The traditional elegance of coffered panels is made fresh by combining deep and low relief panels and by creating a suspended cloud instead of a wall-to-wall expanse. *Design: M+A Architects / Photo: Danis Building Construction Company*

By Michael Chusid, RA FCSI CCS

It is time to revive a word that has fallen from favor. "Ceil" is a verb for the act of applying a finish to an overhead surface; "ceiling", a noun, is the gerund form. Some etymologists say ceil derives from the Latin *celare* which means "to hide or cover up"; others from the Old French *ciel* meaning sky, derived in turn from Latin's *caelum* — the sky or the vault of heaven (*cf.* celestial). Adding a word to one's vocabulary can give a person a new means of expression. The same can be said for adding a building product to one's palette of material choices. A wider choice of products can satisfy a designer's quest for aesthetic exploration, help a project manager meet a budget, or the specifier to address challenging performance requirements.

Quality. Cost. Performance. Is it possible that restoring thermoformed ceilings (TFC) to the architectural vocabulary can meet all three of an architect's needs?

The Manufacturers Trust Company Building is a striking example of a luminous, thermoformed ceiling. The New York City Landmarks Preservation Commission says, "Corrugated paper-thin vinyl sheeting, hung from T- shaped metal channels, gave the ceilings an uncluttered directional character. With none of the lighting fixtures visible, it could easily be seen from both streets and reads as a floating, illuminated grid." The building was designed by Skidmore, Owings & Merrill and completed in 1954. *Design: SOM / Photo: © Ezra Stoller/Esto*

THE REAL MID-CENTURY MODERN CEILING

Contemporary thermoformed ceilings derive from building products developed in the late 1940s. Like many other Mid-Century Modern classics, the new ceiling elements were modular and made from polymeric materials that were just finding applications in construction. The ceiling panels and tiles were embossed with the decorative motifs of the era.

Available in translucent materials, they were used in tandem with ascendent fluorescent lighting technology to create luminous ceilings. And, in an era that witnessed increased use of automatic fire sprinklers, the "drop-out" ceiling concept made it possible to install thermoformed panels beneath sprinklers.

Tastes changed, however, and thermoformed ceilings went underground — literally. For several decades, the most common use of thermoformed ceilings was for basement remodeling projects where ease of installation and resistance to humid conditions made them popular among the DIY set.

Yet tastes (and building requirements) continue to change and architects have found new reasons to ceil with thermoformed panels and tiles. For example:

- *Visual:* Designers are, again, embracing the decorative arts and thermoformed ceilings are available in new styles and an expanded range of colors and faux finishes.
- *Confidence:* Some thermoformed ceilings are now approved by ICC-ES, IAPMO-UES, FM, UL, and other code and product evaluation agencies.
- *Acoustic:* The noise reduction performance of the products has nearly doubled due to new research and testing.
- *Green:* Reformulated materials have improved the environmental footprint of products that already offer exceptional life-cycle performance.
- *LED-Ready:* Several levels of translucency and transparency provide new options for luminous ceilings.
- *Resilience:* Increased concern about floods and storms has focused attention on the immunity of thermoformed materials to water or moisture exposure.

To be sure, thermoformed ceilings do not offer any singularly unique characteristic. For example, there are other ceiling systems that are lightweight or light transmitting, cleanable or recyclable, decorative or sound absorptive. But there is no other ceiling system that offers all the properties of thermoformed ceilings. This makes them a versatile alternative that can solve many architectural challenges that are problematic for other types of ceilings.

Faux finishes have expanded the aesthetic range of thermoformed ceilings. The wood-look (top) is used in 2 x 4 foot panels with staggered joints to suit a casual workroom. The metal-look (bottom) is neatly framed within a ceiling tray (soffit). It is difficult to distinguish the facsimiles from the original materials when seen at normal viewing distances. Their relative economy, ease of handling, and light weight, however, will be immediately apparent to installers. *Design: Emma Davis / Photo: Ceilume*

While thermoformed ceilings can be made with various types of plastic and in myriad configurations, this article discusses ceiling panels and tiles made from rigid vinyl or polyethylene terephthalate (PET) sheets 0.013 or 0.03 in. (0.33 or 0.76 mm) thick. Flat sheets are thermoformed under heat and pressure to create decorative surfaces. Tiles that can be installed with adhesives are typically made

from the thicker material to avoid telegraphing irregularities in the substrate. Panels can be installed in conventional ceiling suspension grids and can be either material thickness due to the stiffening effect of thermoforming. (Definitions of “tile” and “panel” are based on ASTM E1264.)

APPEARANCE

Another suspected source for “ceil” is Latin’s *cælãre*, to carve, engrave in relief. This applies to thermoformed ceilings since they are available in dozens of styles, ranging from historic stamped tin patterns and classic coffers to contemporary geometric and multifaceted panels, and from shallow textures to profiles extending as much as 3 in. (76 mm) above or below the ceiling grid.

Additionally, digital fabrication techniques have lowered the cost of making molds for custom patterns. Some styles can even be installed upside-down; inverted panels change the relationship of shadow and highlight to engage the viewer. This makes TFCs an antidote to the plain plane imposed by mineral fiber, gypsum board, and other ceiling products.

Decorative moldings around the ceiling perimeter add to the relief. When a style with high relief is used, it is customary to use low relief panels as a border. Alternatively, adventurous designers can achieve interesting effects by expressing the panel or tile profile at the ceiling perimeter.

Other design options include white, solid colors, faux metallic finishes, and faux wood grain finishes. While they can also be painted or given other decorative surface treatments, TFC manufacturers have not tested these applied finishes for surface burning characteristics or use in drop-out ceilings.

LIGHTING

Available in several levels of optical transmissivity, thermoformed ceiling panels facilitate creative approaches to lighting. In a hotel lobby, for example, opaque panels can be used with uplighting at seating areas, translucent panels to create a luminous ceiling above the registration desk, and transparent panels below spotlights creating visual excitement above the lounge dance floor.

Translucent panels (top left) create the most even light distribution. Frosted panels (top right) hint at what is above the ceiling. Transparent panels fully disclose what is above the ceiling whether above-ceiling lamps are on (bottom left) or off (bottom right). Each ceiling style will scatter light differently; some display patterns of highlights and shadows or sparkling refractions that become animated as one moves through a room. *Photo: Ceilume*

Daylighting, as an energy conservation strategy, also suggests applications for translucent and transparent panels beneath skylights and for opaque or translucent panels as light shelves to direct light more deeply into buildings.

Opaque: Opaque white panels have a bright light reflectance value (LRV) of approximately 83, per ASTM E1477. This takes on special significance with directional light sources that cast shadows on the molded relief of panels and tiles.

Colored light, emanating from the “Kill Bar,” demonstrates how highlights and shadows can be used to dramatic effect in themed attractions such as the Times Scare haunted house in New York City. *Design: Egan Productions / Photo: Farouk Cherchali*

Translucent: Translucent plastic is used for backlit luminous ceilings. The amount of light transmitted varies depending on the thickness of the plastic and whether the plastic is a translucent white material or an unpigmented clear plastic with a ‘frosted’ surface.

This cloudscape was created with two styles of billowing translucent panels. The relief projects downward on one style and upward on the other to enhance the interplay of shadows and highlights. LEDs above the ceiling can be dimmed to adjust from high noon to the warmer tones of late afternoon. The drop-out panels are installed beneath fire sprinklers. *Design: Emma Davis / Photo: Ceilume*

Translucent panels are often used with a clear or frosted acoustical backer panel that sits above the ceiling panel. The backer can reduce

shadows caused by detritus that would otherwise accumulate directly atop ceiling panels. Frosted backers, moreover, help to diffuse above-ceiling light sources.

Ceiling panels with classic detailing complement the theme of the moving screening room in a Noir Lounge in San Francisco. The thermoformed translucent material "creates a gentle glow and avoids glare on the screen," according to Gi Paoletti of G. Paoletti Design Lab. She adds that dimmable LED lamps above the luminous ceiling avoid the need for pendant light fixtures that would block patrons' view. *Design: G. Paoletti Design Lab / Photo: Stuart Locklear*

While translucent ceilings reduce light transmittance, the loss in efficiency may be recouped by cutting glare to improve lighting effectiveness. Costs can also be reduced by using simple, inexpensive fixtures such as strip fluorescent lamps above the ceiling.

Increasingly, however, translucent ceilings are being paired with light-emitting diode (LED) lamps to create glowing illumination that can be programmed to change colors.

Transparent: Transparent panels allow light fixtures to be placed above a ceiling while maintaining the continuity of the surface's plane and pattern. For example, a light fixture with a directional beam can be placed above ceiling — and out of sight — yet still focused on a piece of artwork or other visual feature.

ACOUSTICS

Acoustics is now recognized as an important part of building sustainability — improving occupant satisfaction and productivity. TFCs can be used to quiet a room, meet HIPAA and speech privacy criteria, modulate reverberation, and reinforce sound.

Suspended TFC panels are diaphragms that transmit acoustical vibrations. In many instances, public address speakers and white noise generators can be effectively installed above panels to maintain an uncluttered ceiling.

Noise reduction as high as 0.85 NRC is available with perforated thermoformed ceiling panels in combination with a thermal-bonded, polyester fiber, non-woven batt. Panels and batts are Class A rated for surface burning characteristics and panels are Greenguard Gold certified for low VOC emissions. The faux wood finish shown here provides verisimilitude when viewed at normal ceiling heights. *Photo: Ceilume*

Noise Reduction: This acoustical transparency also allows room noise to pass into the above-ceiling cavity where the noise is damp-ened. Depending on panel style and thickness, NRC = 0.25 can be obtained per ASTM C423.

Noise reduction can be increased in three ways:

1. Acoustical backer panels create an additional air cavity, typically 3 in. (76 mm) deep, that further dampens sound and produce 0.30 NRC. Some thermoformed backers are approved for use in drop-out ceiling systems.
2. Acoustical insulation can be placed above panels to produce 0.50 NRC. Instead of glass or mineral fiber insulation, consideration should be given to special polyester fiber batts, typically 1.5 in. (38 mm) thick, as their light weight and stiffness does not cause thermoformed panels to sag. Polyester fibers do not irritate skin and, because they are less brittle than glass or mineral fibers, are less likely to release fibers into a room environment. Fibrous insulation, regardless of type, is not approved with drop-out ceilings.

The brick walls and hard surface floors of this meeting hall required a ceiling with good sound absorbing properties. For remodeling projects, thermoformed ceilings are also light weight to minimize loads on existing structures and can be installed beneath existing sprinklers. *Photo: Ceilume*

3. Recent testing has determined small perforations through the face of thermoformed panels, in combination with polyester fiber batts, can boost noise reduction to an outstanding 0.85 NRC, suitable for use in classrooms, offices, healthcare, and other occupancies with stringent noise control requirements. Sensitive placement of the perforations can enhance the dimensional appearance of panel styles.

Reflection: Thermoformed tiles can be adhered to a hard substrate such as gypsum board or concrete where acoustical reflection is necessary.

FIRE SAFETY

Surface Burning Characteristics: Thin plastic has such little mass that it provides insignificant fuel load relative to the other combustible materials in a building. Surface burning characteristics, however, are more relevant to life safety; there are now thermoformed ceilings with Class A Surface Burning Characteristics with flame spread ≤ 25 and smoke developed ≤ 450 when tested according to ASTM E84; these products can be specified for all but the most critical occupancies.

The International Building Code definition of a Class A interior finish also states, “Any element thereof when so tested shall not continue to propagate fire.” TFCs should, therefore, be made from plastic rated V0 under Underwriters Laboratories (UL) 94, Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances Testing. Such materials are self-extinguishing — flaming combustion stops within 10 seconds after removal of heat source, glowing combustion stops within 30 seconds, and materials do not drip flaming particles that could ignite cotton. This is an important distinction as there are similar-looking ceilings made, for example, from expanded polystyrene that melt and burn vigorously when exposed to flame.

TFCs can be used beneath fire-rated floor-ceiling assemblies, but do not contribute to fire separation between floors.

Drop-Out Ceilings: Unlike most types of ceilings, some thermoformed assemblies can be installed above or beneath fire sprinklers without interfering with sprinkler function when used in accordance with listings and approvals. When exposed to heat from a fire, panels soften, deform, and drop out of suspension grids at temperatures well below the activation point of commonly used sprinklers.

Referred to as ‘drop-out ceilings,’ thermoplastic ceiling panels can simplify sprinkler installation and significantly reduce construction costs by being installed beneath them. Sprinklers are not visible from below, making ceilings less cluttered and more attractive, while also protecting sprinklers against accidental impact or tampering and the water damage that results from sprinkler activation. Drop-out ceilings can be especially useful for suspended ceiling ‘clouds’ that could otherwise require sprinklers to be located both above and below the cloud.

These translucent, drop-out ceiling panels were installed beneath existing strip lights and fire sprinklers to reduce remodeling expenses. *Photo: Ceilume*

Installed with or without sprinklers, drop-out panels regain stiffness when they fall to the relatively cooler floor. Since they are thin and lightweight, they do not significantly impede egress or access by firefighters. Some authorities having jurisdiction (AHJs), however, may not permit drop-out ceilings to be used in exits or stairs.

Where sprinklers are required to penetrate ceiling panels, holes in panels must be at least 1/4 inch (6.3 mm) greater in diameter than the sprinkler head, trim rings, or escutcheons.

Luminous, back-lit ceiling panels create uniform illumination without the hot-spot of troffers or downlights. Sprinklers can be concealed above ceiling panels to avoid shadows that would be cast by penetrating sprinklers. The Storm Team 8 Newsroom, Grand Rapids, MI was designed by FX Design Group. *Photo: WOOD-TV*

MOISTURE, MOLD, AND HYGIENE

Vinyl and PET ceilings are not affected by moisture and can be used in wet or humid locations such as natatoria, shower and bathing rooms, spas, laundries, kitchens, and washdown areas. Even in normally dry spaces, moisture remains a concern due to ever-present risks of roof leaks, plumbing breaks, condensate from sweating pipes, and spills.

Moisture resistance is closely associated with mold resistance. Thermoformed ceilings neither hold the moisture required for fungal growth nor provide a source of nutrition. Thermoformed ceiling elements can be cleaned with a damp cloth and, if necessary, mild

detergent or compatible cleaning agents.

Hygiene: This is important in areas requiring good sanitation, including culinary and food-manufacturing areas where Food and Drug Administration (FDA) and US Department of Agriculture (USDA) regulations apply, healthcare, pharmaceutical compounding areas, and laboratories. TFCs smooth, durable, and non-absorbent surfaces comply with most requirements when patterns with low surface-relief patterns are used.

The ceiling is like a frosted confectionery on top of this cupcake bakery. Thermoformed ceilings can be installed above food handling and culinary areas because their smooth and impervious surfaces give no harbor to contaminants, can be easily washed, and meet FDA requirements. *Photo: Ceilume*

To minimize surfaces on which contaminants might collect, lighting fixtures can be located above luminous ceilings and sprinklers above drop-out panels.

Conference attendees borrowed thermoformed ceiling panels from a trade show display to use as umbrellas. The panels were put back on display after the downpour. *Photo: Ceilume*

Floods and Storms: Thermoformed ceiling panels meet Federal Emergency Management Agency (FEMA) Class 4 requirements for materials that:

> *"can survive wetting and drying and may be successfully cleaned after a flood to render them free of most harmful pollutants. Materials in this class may be exposed to and/or submerged in floodwaters in interior spaces and do not require special waterproofing protection."*

Stain-Resistance: While standardized stain-resistance tests have not been conducted on thermoformed ceilings, their long record of use demonstrates plastic's resistance to the grime and stains that typically disfigure ceilings. For example, the proprietor of a cigar lounge has reported that thermoformed ceilings in his establishment do not absorb odors from tobacco smoke and stains can be removed by washing.

INSTALLATION

Installation of thermoformed ceiling panels and tiles is similar to other materials. Lay-in panels can be used with standard suspension systems with 15/16-in. or 9/16-in. (24-mm or 14-mm) wide tees. Fiberglass, plastic, or aluminum suspension grids should be considered in wet areas. Direct-mounted tiles install easily with construction grade adhesives. Panels are available for both 2 x 2-ft and 2 x 4-ft (609 x 609-mm and 609 x 1218-mm) grids.

The lightweight panels and tiles are less likely to cause injury due to lifting or dropping. The material can be easily cut with scissors or aviation snips and, unlike metal panels, do not have sharp edges and corners.

Ceiling products made from mineral fiber or gypsum board come with labels warning against crystalline silica inhalation, dust, skin and eye irritation, and other occupational safety hazards. Thermoformed ceilings do not have these risks.

Lightweight and easy to install, thermoformed panels and tiles can be trimmed with scissors or aviation snips. Although the products are made with thin material, panels and tiles are robust, do not release fibers, and are not frangible. *Photo: Ceilume*

SUSTAINABILITY

Many of the already-discussed characteristics of thermoformed ceilings contribute to building sustainability, such as:

- lighting efficiency;
- acoustics;
- cleanability; and
- fungal resistance.

In terms of material choices, some advocate against vinyl, also known as polyvinyl chloride (PVC), since it is made from petrochemicals, may have problematic precursor products and additives, and may release toxic products of combustions if burned. Other authorities remind us that vinyl's long service life and low maintenance requirements mitigate some of these concerns.

Thermoformed ceilings are made with rigid vinyl, also known as unplasticized PVC (uPVC), that does not contain the questionable additives used in some vinyls. Reputable manufacturers source materials produced through modern, cleaner technologies. Additionally, the combustion risks are reduced by fire safety considerations previously mentioned, and vinyl is recyclable as a Type 3 plastic.

Environmental Building News suggests, "... our recommendation is not to avoid vinyl altogether, but to seek out better, safer, and more environmentally responsible alternatives." Reasoning like this has led to an increased use of recycled PET (rPET) for ceilings with as much as 40 percent post-consumer recycled content.

This circle within a circle motif was proposed for a children's playroom. More than a visual delight, the thermoformed panels are Greenguard Gold certified for low VOC emissions and do not release airborne fibers. *Photo: Ceilume*

While PET has a greener environmental rap sheet, the raw material costs more than vinyl, is more difficult to fabricate in certain ceiling styles, and is not yet approved for use below sprinklers. While vinyl has demonstrated longevity in building applications, PET service life has yet to be determined. PET is recyclable as Type 1 plastic.

Both vinyl and PET are available with Greenguard Gold Certification of compliance with California's Department of Public Health Services Standard Practice for Specification Section 01350 for low chemical emissions from building products used in schools, healthcare, and other critical environments. Indoor air quality (IAQ) is also protected because the plastics are fiber-free and hygienic.

While sufficiently rigid to maintain visual flatness once installed, both vinyl and PET are:

- resilient enough to flex during installation and maintenance;
- not frangible;
- able to resist moderate abuse without breakage;
- produced with ultraviolet (UV) inhibitors; and
- cleanable.

Finally, product selection must be made in comparison to other available products.

Thermoformed ceilings weigh as little as 0.10 psf (0.49 kg/m^2) — approximately 80 percent less than mineral fiber and gypsum board ceilings. This represents a significant reduction of manufacturing resource requirements. Additionally, transportation impacts are reduced because panels and tiles are lightweight, thin, and nest for compact packing. Five times as many panels can fit on a truck compared to 3/4-in. (19-mm) thick mineral fiber panels.

Plastic, moreover, does not contain fibers and crystalline silica that can compromise indoor air quality and pose occupational health and waste disposal hazards.

WHERE TO USE

While it's tempting to say that thermoformed ceilings should be used in any room in every type of building, their unique constellation of performance benefits is especially suited to the following occupancies:

Assembly: In large halls, pattern and relief can help create scale and visual interest, especially when several patterns of TFCs are combined. Noise reduction is also important in many areas. Consider for concourses, break-out areas, and lobbies, especially in themed facilities.

With draped walls, cascades of sparkling beads, slip covered chairs, and checkerboard carpet, it is hard to imagine this banquet hall without a decorative ceiling. Marie Pacitto Consulting designed the space for the Le Mont Blanc Conference and Reception Centre in Laval, Quebec. *Photo: Groupe Madison*

Education: Improved indoor air quality, including VOC emissions and airborne fibers, is expected in schools, especially facilities for younger children. Noise reduction contributes to improved learning outcomes in the classroom and aural comfort in noisy areas like corridors, multi-purpose rooms, and cafeteria. Washability is important for food service areas, labs, and art rooms. Luminous ceilings can be useful in libraries and elsewhere. Drop-out ceilings help reduce tampering with fire sprinklers.

Religious: While religious buildings share many of the characteristics of other building types, light is frequently used to express the mysteries of spirit; a renewed exploration of luminous ceilings may be in order.

Recreation: TFCs are ideal for wet or humid activities, such as swimming pools, locker rooms, and covered outdoor pavilions. Their decorative qualities can contribute to the playful atmosphere desired in many recreational facilities, especially when mated with colored LED lighting. Noise reduction is also an important criteria for many venues. Consider for bowling alleys, skating rinks, zoos, and fitness centers as well as lobby and concession areas.

Housing: Create a distinctive look in an entrance foyer, living room, or dining room. Personalize a den or home office. Create a playful mood in a child's bedroom and a romantic retreat in the master bedroom. Luminous ceilings were once popular in kitchens for uniform overall lighting and colored LEDs make them good candidates in all rooms used for entertaining. TFCs are often used in basements, garages, laundry rooms, and bathrooms where damp conditions are a consideration.

Consider, too, for the common areas of multi-family housing and the elevator lobbies of apartment buildings.

Retail: With dozens of patterns and other design options, there is a TFC to fit almost any merchandising concept, and custom patterns can be created for unique branding schemes. TFCs meets FDA requirements in pharmacy and food areas. Consider, especially, installation in existing ceiling grids as a relatively inexpensive and quick way to give a store a facelift.

Health Care: Hygiene is at a premium in exam, treatment, and storage areas and in patient rooms. Decorative ceilings can be calming to patients lying on their backs — either in their room or in treatment areas. Throughout a facility, TFCs can help create a less institutional looking interior and contribute to a more reassuring atmosphere. Panels can help control noise and comply with HIPPA regulations for aural privacy. Moisture resistance is important in hydrotherapy and bathing rooms, kitchens, laundries, and other humid areas.

Hospitality: Consider for decorative and branding purposes, noise control, and lighting options. Because TFCs can be used over food preparation areas, the design theme in dining areas can be extended to exposed-to-view culinary areas.

Lodging: Use in lobbies and corridors, and to create special decorative themes for guest rooms. They can also be used in guest bathrooms where moisture would preclude other types of ceiling panels.

Laboratories: Labs require hygienic conditions that are cleanable and free from airborne fibers. Consider locating sprinklers and lighting above luminous, drop-out ceilings to optimize cleanliness.

Industrial: Use TFCs in wet processing areas and rooms that require wash down. FDA and USDA-compliant for food packaging and pharmaceutical areas. Panels contribute to noise reduction, are resistant to common chemicals and stains, and are robust enough to handle an occasional knock without breaking. Consider, too, in lunch rooms and administrative areas to provide a contrast to conditions in the shop.

Summertime, and the living may be easy but the humidity's high. Daddy doesn't have to be rich for the porch to be good looking. Because thermoformed ceilings don't have to stay dry. (With apologies to George Gershwin.) *Photo: Ceilume*

Lobbies—both the front and elevator types—at the Plaza Hotel & Casino blend several styles of thermoformed panels to capture the spirit of the Strip. *Design: Innovativo Design Inc. / Photo: Ceilume*

The factory's luminous ceiling provided even illumination and reduced noise. It also cut energy consumption because only the work area is heated or cooled, not the high-bay area above. *Photo: Ceilume*

Data Centers: Luminous drop-out ceilings are widely used for cold aisle containment between banks of computer servers.

Transportation: Consider in passenger waiting lounges, concourses, ticketing, customs, immigration, retail, and hospitality areas.

Thermoformed ceilings are at home in the board room and at work in the home office. *Photos: Top: Ceilume / Bottom: Sherilyn Cockroft Hopkins, LEED-AP*

Office: In offices, perhaps more than in most building types, the ceiling is the most visible surface and can be used to express the personality of the firm. In large open offices, pattern and relief provide scale and visual interest. In loft-type workplaces with exposed structure in lieu of a drop ceiling, consider TFC clouds to infuse a creative atmosphere into collaborative work areas. TFCs can also be used to create an acoustical environment conducive to worker productivity and well-being.

There is a high "churn" rate in many offices due to shifting workplace needs or new tenants. Mineral fiber ceilings must often be replaced during remodeling due to breakage or discoloration. Thermoformed panels, however, resist breakage and can be washed and reinstalled in new locations. As in all sprinklered occupancies, drop-out TFCs can be considered as a cost-saving solution.

DESIGN VOCABULARY

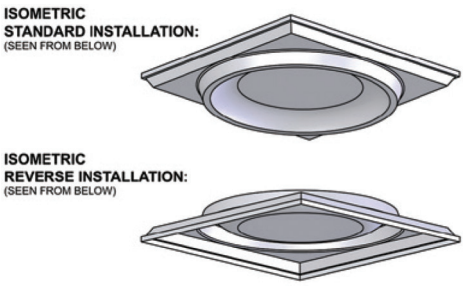
While thermoformed ceiling panels and tiles share many characteristics with ordinary products, understanding their grammar will enhance the range of effects that can be created.

One manufacturer offers 40 styles and keeps 14 finish options in inventory. It also has 5-axis milling equipment to simplify mold making for custom styles. *Photo: Ceilume*

The dark thermoformed ceiling of the Charlevoix Tourist Information center in Baie-Saint-Paul, Quebec directs the visitor's attention to the beautiful countryside just beyond the windows. A petal-like pattern suggests the region's summer flora and winter snowflakes. Border tiles and panels with downlights have a diamond-plate pattern with oblong embossments that complement the petal motif. *Design: Karine St-Gelais - KDesign / Photo: Tourisme Charlevoix*

High-relief ceiling elements can be bordered with low-relief elements to simplify perimeter conditions. Crown moldings can complement the ceiling style and embellish the wall-ceiling intersection. Decorative strips can be used to cover suspension grid tees or the butt joints between tiles. *Photo: Ceilume*

The range of opportunities inspires many designers to combine styles and colors. *Photo: Ceilume*



Many styles can be installed in inverted positions to switch the orientation of concave and convex surfaces and create subtle changes in appearance. *Photo: Ceilume*

It should be noted that not all combinations of styles, colors, and features are compatible for every application; consultation with a manufacturer is encouraged when specifying a project with atypical requirements.

COST SAVINGS

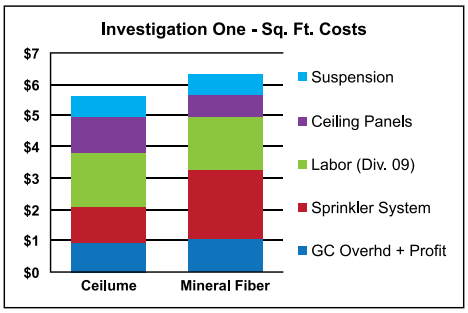
When drop-out ceiling panels were proposed for an 110,000 sq.ft. office building in Oklahoma City in 2014, Bill Kneeland, PE, a professional construction manager and cost estimator, prepared a detailed study comparing thermoformed and mineral-fiber ceiling panels.

He examined two scenarios and found that the thermoformed ceiling approach generated savings ranging from $3.29 to $0.72 per sq.ft.

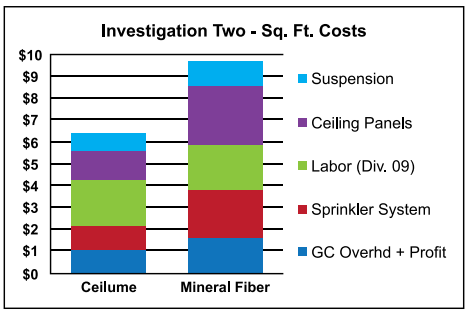
Other findings:

- Thermoplastic panels are more affordable than tegular and decorative mineral fiber panels and competitively priced with ordinary mineral fiber products.
- While labor to install panels is similar regardless of material, cutting individual thermoformed panels for perimeter units may cost slightly more than scoring and breaking square-edged mineral fiber tiles and about the same as trimming tegular panels. Thermoformed panels, however, nest compactly and several panels can be cut simultaneously with aviation snips.

Sprinklers may be required both above and below soffits and ceiling clouds (see arrows). With drop-out ceiling panels, however, one set of sprinklers above the ceiling may be sufficient. *Photo: Ceilume*



Investigation One: Thermoformed ceiling panels installed beneath fire sprinklers are compared to 5/8-inch thick, square-edged, fissured, mineral fiber ceiling panels with recessed sprinklers; panels are 24 x 48 inches. *Courtesy Bill Kneeland, PE.*



Investigation Two: Thermoformed ceiling panels installed beneath fire sprinklers are compared to 3/4-inch thick, tegular, fine textured, mineral fiber ceiling panel with recessed sprinklers; panels are 24 x 24 inches. *Courtesy Bill Kneeland, PE.*

The best looking fire sprinkler, in the opinion of many designers, is the one that isn't there. Sprinklers can be installed above approved thermoformed ceilings (top) or no more than 1 inch (24 mm) beneath surface (bottom). Holes for penetrating sprinklers must be slightly oversized to allow panels to drop-out without draping over sprinklers in the event of a fire. *Photo: Ceilume*

- Concealing sprinklers above ceilings reduces cost of sprinklers. For example, drop-out ceilings eliminate the need to extend pipes from sprinkler mains (usually located just under floor or roof structure) to ceiling elevation, and the piping used to position sprinklers at panel centers. This enables layout of sprinklers to be optimized and eliminates need for installation drawings to coordinate sprinklers with ceiling installers. Ceiling installers do not have to cut holes for sprinklers, and sprinkler installers do not have to return to the project to adjust sprinkler locations after ceiling installation.
- Lower-cost, non-appearance grade sprinklers can be used and finishing rings and escutcheons can be eliminated.
- The estimate is based on open-shop wages and savings are likely to be even greater in areas with prevailing wage rates.

DROP-OUT CEILINGS AND BUILDING CODES

Occupancy: Design of a drop-out ceiling system generally begins with identification of building occupancy. Listings from some agencies recognize drop-out panels in both Light Hazard and Ordinary Hazard Group 1 occupancies. Factory Mutual (FM), however, only recognizes drop-out panels in light hazard occupancies—where combustibility or quantity of contents is low and fires with relatively low heat release are expected. Examples of light hazard occupancies are:

- animal shelters;
- churches;
- libraries (except large-stack);
- museums;
- offices;
- ice rinks and recreational facilities;
- restaurant seating areas; and
- theaters (except stages).

Ordinary Hazard Group 1 occupancies are where combustibility of contents is low, the quantity of combustibles is moderate, stockpiles do not exceed 8 ft. (2.4 m), and fires with moderate rates of heat release are expected. Examples include: auto showrooms, food manufacturing and processing, electronic plants and similar light manufacturing facilities, and laundries.

While typical food-processing facilities are appropriate for drop-out ceiling panels, this would not pertain where significant quantities of cardboard packaging are stored.

Ordinary Hazard Group 2 occupancies are not recommended for drop-out ceiling panels. These include manufacturing occupancies used for plastic fabrication, wood working, and machining, and mercantile occupancies used for display and sale of merchandise. However, the AHJ may have latitude to accept drop-out ceilings if stockpiles of combustibles are limited, consist of materials with low rates of heat release, and have low probability of rapidly developing fires. A pottery store with these characteristics might be appropriate for drop-out ceilings and acceptable to the AHJ despite being a mercantile occupancy due to incombustibility of the merchandise.

In residential occupancies, drop-out ceilings can be used in combination with either standard-response, 165-F (74-C) or higher sprinklers or quick-response, 155-F (68-C) or higher sprinklers. Residential-type sprinklers have not been tested with drop-out ceiling panels.

When remodeling an existing building, the fire sprinkler riser should be located and its hydraulic nameplate data for occupancy classification checked. This information may help the AHJ determine whether a drop-out ceiling is appropriate.

Sprinkler Types: Next is selection of sprinkler types. All drop-out panels currently available have been evaluated for use with standard-response sprinklers that have a thermal element with an Response Time Index (RTI)—a measure of thermal sensitivity—of more than 50 (meter-seconds)$^{1/2}$. One brand of drop-out panels has been recently listed for use with quick-response sprinklers (see IAPMO-

To test drop-out ceiling panels, a fire (lower left) is ignited in a corner of a room. Thermoformed panels soften when exposed to heat, deform, and drop-out of the ceiling grid before the fire grows hot enough to activate sprinklers. In this test, panels above fire have dropped-out before wood crib is fully engulfed in flame, and falling panels have not melted or ignited. The fire sprinkler, seen above falling panel, can be installed at optimal location without coordination with ceiling layout. *Lab: Southwest Research Institute, San Antonio, TX / Photo: Ceilume*

UES Evaluation Report 0310). This is significant as quick-response sprinklers have been required in light hazard occupancies since the 1996 edition of NFPA 13. Quick-response sprinklers have an RTI of 50 (meter-seconds)$^{1/2}$ or less. At this time no drop-out panels have been approved with extended coverage, residential, dry-pipe, or other types of sprinkler systems.

Sprinklers must be installed in compliance with NFPA requirements, including avoidance of obstructions by structural elements, HVAC ducts, and other above-ceiling elements. Evaluation reports specify allowable sprinkler heights above ceiling panels and require identification of report on packaging. Examples based on a listed vinyl drop-out

panel include:

- standard-response sprinklers rated 165-F (74-C) or higher can be installed from 1 to 60 in. (25 to 1524 mm) above ceiling panels; and
- quick-response sprinklers rated 155-F (68-C) or higher require sprinklers installed 1 in. (25 mm) or less from top of standard T-bar ceiling grid. (One must verify the proposed ceiling panel can be installed within this clearance.)

Inappropriate applications: Conditions that may preclude drop-out ceilings include:

- use in exits such as corridors, stairways, horizontal exits, pressurized enclosures, and exit passageways;
- sprinklers installed both above and below panels;
- insulation between ceiling panels and sprinklers (insulating backer panels in specific listings are exceptions);
- panels exceed required surface burning characteristics;
- ceiling required to protect sprinkler piping such as soft-soldered copper pipe or combustible plastic pipe (drop-out ceiling will not provide concealment as it drops-out early in fire);
- ceiling part of fire-resistance rated assembly (drop-out ceilings can be installed below rated assembly but cannot be part of assembly);
- space above ceiling is air-circulation plenum;
- ceiling is non-horizontal;
- structure is floating or waterborne;
- ceiling suspension system does not comply with listing;
- clips prevent downward movement of panels (uplift prevention clips are permitted but not required); and
- drop-out ceiling panels are used as diffusers within light fixtures.

Maintenance: The building owner must maintain sprinkler and ceiling systems. Drop-out panels beneath sprinklers cannot be painted. If it becomes necessary to replace drop-out panels, the new ones should be of the same type as originally installed or another type approved for installation beneath sprinklers.

Some drop-out ceiling panel manufacturers offer signage reminding building users to replace panels in kind; signage can be posted at sprinkler alarm valve (next to hydraulic nameplate) or another conspicuous location.

A plaque should be installed in a prominent location with instructions about maintaining the integrity of drop-out ceilings. *Photo: Ceilume*

OVER ALL

It is crucial to verify the test data of proposed products because not all thermoformed ceiling products rise to the same standards. While thermoformed panels and tiles are widely used in simple do-it-yourself applications, design professionals may want assistance from a reputable manufacturer to identify suitable products for projects with more-demanding requirements.

Through thermoformed ceiling elements can be used for any one of their several beneficial characteristics, they provide especially good value when used to meet several requirements simultaneously. Data centers are a case in point. Thermoformed ceilings enclose the aisles between racks of computer servers and allow the aisles to be used as plenums to exhaust heated air. Light transmitting drop-out panels are used to allow both light fixtures and sprinklers to be located above the aisles and out of the way of technicians servicing the equipment. Both economical and practical, thermoformed ceilings are a good “over all” solution.

Growing acceptance of thermoformed ceilings is evidenced by addition of a new MasterFormat number and title, 09 54 29 – Suspended Plastic Ceilings, effective January 2016.

Ceilers, take note! ■