Construction CANADA

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Selecting the Right Ceiling for an Office

By Chris Marshall

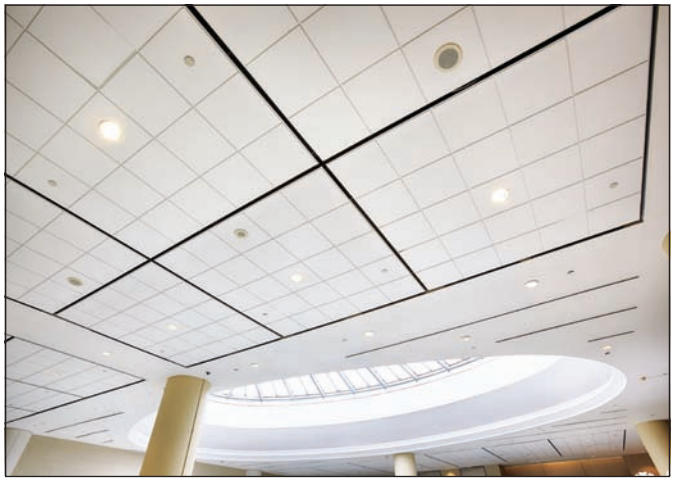
In the business world, how people work and interact is constantly changing, affecting how interior office spaces are designed and built. Ceilings play an essential role in providing a productive, creative environment. Architects, designers, and specifiers who follow workplace trends will have a greater understanding of how to select different ceiling systems to best meet the needs of both employers and employees.

In the early 20th century, Frank Lloyd Wright saw the spaciousness and flexibility of an open-plan area as a way of liberating office workers from the confines of walled boxes. He and his contemporaries designed uninterrupted spaces with long rows of desks. Cubicles were later introduced, breaking the rows into pods and islands. The most senior staff members were separated from the group into private offices lining the perimeter and enjoying the only available natural light.

Today's employees can work from anywhere, anytime, enabled by wireless devices, social networking, and video conferencing tools. On any given day, in any typical office space, many workers are offsite, leaving their workstations unoccupied. Consequently, the concept of 'hot-desking'—where multiple employees share the same workspace at different times throughout the day or week—has become the norm in many buildings. This has enabled companies to increase the number of people working in the office without having to set aside more space for workstations. Position and size of office no longer always equates to rank and seniority, increasing the learning opportunities between colleagues.

When employees are at an office, some are more productive and happier when they can interact freely with each other in a creative setting. An open-plan design can contribute to such an environment—the office itself can assist in achieving corporate goals, while protecting the positive elements of a corporation's culture.

The heightened interaction and flexibility of the 21st century workplace is reflected in the increased use of exterior and interior glass, expansive floor spaces, integrated lighting, and contiguous ceilings with a monolithic appearance. Designers are creating inspiring spaces that reflect the energy and openness of the organization. Some take the notion of 'openness'even further by showcasing formerly 'hidden' areas, such as production areas and meeting rooms, in aquarium-like fashion. In fact, many companies see their office space as a way of promoting their brand and values to visiting clients and prospective employees.



Suspension systems define the ceiling's visible grid. Coupled with stone wool ceiling panels, the grid can be accentuated with a wide face, minimized with a concealed grid, or recessed for a shadow effect.

Companies that embrace an open-plan office design are moving beyond traditional meeting rooms to include informal communal spaces, like coffee bars or lounges encouraging impromptu connections. Atriums and hallways are configured to promote chance encounters and casual interaction. High dividing walls are being replaced by lower partitions, or removed completely, encouraging employees to share ideas outside of scheduled meetings. Within the open-plan design scheme, some employers are designating quiet rooms when work requires greater reflection, confidentiality, and concentration.

Modern ceiling design

Since the 1950s, suspended or 'drop' ceiling assemblies have been the preference in office settings with functionality frequently dictating appearance. Suspended ceilings consist of a metal grid comprising cross-tees and main runners. The main runners are suspended by hanger wires from the structure above, and wall channels or angles provide a clean look around the perimeter. Panels, air diffusers, lights, and other components are placed within the modular system. These conceal the plenum—hiding the structure, suspension system, HVAC, and other equipment, while providing simple access for future maintenance or renovations.

Historically, suspended ceilings' appearance has been synonymous with the fibrous ceiling panels aged by their stains, broken corners, and visible, grey fissures. Today, acoustic ceiling panels are no longer limited to this dated appearance.

Smooth and lightly textured surface finishes are currently the design style of choice, giving an impression the ceiling is lighter in texture, weight, and colour. A bright, white finish also assists in addressing light reflectance in office buildings.

Stone wool ceiling panels are produced from basalt, the earth's most abundant bedrock. It is inherently anti-microbial and achieves Class A fire protection, along with offering humidity, mould, and sag resistance. They also may be specified for impact resistance, seismic design categories, wind loads, and other requirements. One of its most recognized attributes, stone wool panels' porous material provides high sound absorption without showing deep fissures like old acoustic tiles.[1]

Expanding modern ceiling design options, metal ceiling panels may be combined with stone wool panels or, in certain applications—such as in soffits—may be used alone. Usually, metal panels are fabricated from either aluminum or steel. They can be manufactured with square edges to lay-in to a grid, or they can have reveal edges for a more decorative look. Baked enamel and powder-coat paints can be selected in nearly any colour, including metallics and simulated wood grain patterns. Metal panels can be perforated and backed by fibrous stone wool for sound absorption or left nonperforated when sound reflection is required.

Acoustic comfort

Designers of office work environments have to design not only for the eyes, but also for the ears. The days of selecting an acoustic ceiling tile with moderate to high noise reduction co-efficient (NRC) and using it throughout all spaces no longer suffices from the perspective of people who spend their days in these environments. In a study of what employees found most dissatisfying about their work environment, sound privacy was the primary complaint for more than half of employees in open office plans, with dissatisfaction with noise levels making up another 25 per cent.[2]

Achieving acoustic comfort comes from categorizing work functions according to desired acoustic experiences and intentionally designing various spaces with the appropriate acoustical characteristics. On any given day, some people will need to concentrate for long periods without disturbances. Quiet rooms, like quiet cars on a train, are needed. These rooms for either small groups or individuals are acoustically isolated from other areas of the office with full-height walls and heavy doors with perimeter seals to keep noise from breaking concentration. The ceilings are intentionally kept low and made of highly sound-absorptive fibrous panels of NRC 0.85 or higher.

At the same time, other people may be hosting a client and want to keep the conversation lively and accessible to draw in passing coworkers. In this case, the ceiling is raised higher and perhaps there are changes to 'islands' containing a mixture of sound-absorbing fibrous panels and sound-reflecting metal panels. In other office designs, walls are selectively reduced in number and in height, or become acoustically translucent. This design approach intentionally allows some sound to permeate out to the immediate surrounding common areas.

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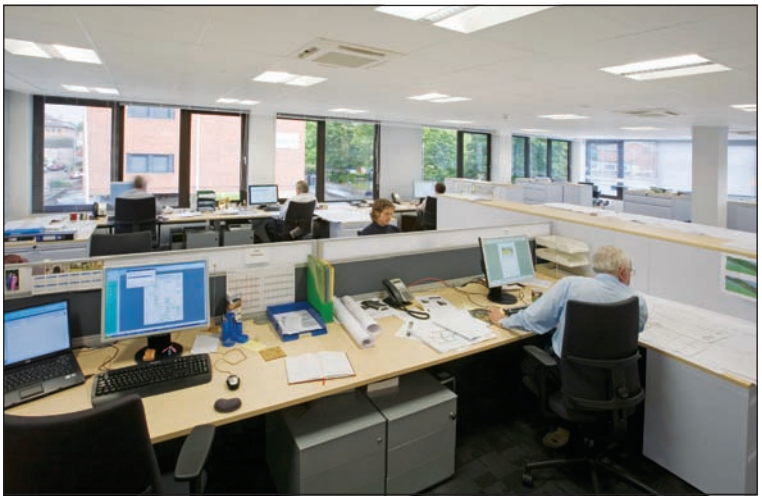


Smooth and lightly textured surface finishes are a current design trend. Stone wool ceiling panels' porous material provides high sound absorption without showing deep fissures like old acoustic tiles.

Photos courtesy Rockfon

Installed in the open-plan office, these stone wool ceiling panels provide a high level of acoustic control, along with easily cleaned surfaces, fire safety, humidity-resistant properties, and light reflectance.

Elsewhere in the office, a medium-sized group of people may be listening to a presentation. Here, speech intelligibility is the key acoustical criterion. The ceiling becomes more sound reflective to project the presenters voice out to the group. A common mistake made by designers is to place a highly sound-absorptive ceiling over an assembly space where speech intelligibility is required.

In large, open areas with numerous workstations, ceilings should maximize privacy and productivity by being low and comprised of highly sound absorptive fibrous ceiling panels of NRC 0.90 or higher. This physical component is often combined with electronic sound-masking to provide a normal speech privacy level despite the openness resulting from not having walls.

The key to acoustic success in contemporary office work environments is forethought about the numerous acoustic experiences needed by the occupants. Intentional acoustic design uses various materials to provide spaces appropriate for quietness and concentration, lively social interaction, and privacy and confidentiality.

There are two main architectural components when designing an acoustic experience in a given space: sound insulation and sound absorption. Some ceiling panels can be specified with both properties in one product. The front side absorbs sound from the source room, while the back blocks sound coming from the plenum.

Sound insulation

Sound-insulating techniques can reduce sound from transmitting from one space to another. Full-height walls—from floor to floor—are the most common because they are required by many standards and guidelines. They help maintain confidentiality and minimize disturbances from sound transfer between adjacent spaces. Another solution is to build the wall up to the suspended ceiling and use high sound-insulating ceilings. Ceilings also can be combined with sound barriers in the plenum installed directly above partition walls to further reduce sound transfer between enclosed spaces.

Sound absorption

Porous treatments on the surfaces within a space absorbs sounds from people and equipment. Absorption reduces reverberation time and noise levels, and increases speech intelligibility. This creates a double effect—when the noise level is low, people talk more quietly. As a result, less noise is transferred to the adjacent rooms.

The two main contributors to sound absorption are high-quality fibrous ceilings and wall absorbers.

Sound absorption also has an indirect impact on room-to-room sound insulation. Using a high-absorbing ceiling in the source room reduces the sound in that room, resulting in less sound being transferred into the adjacent room.

Energy efficiency

Heating and cooling are also primary considerations in managing the large amounts of natural light that define today's open plan office designs. Even in enclosed offices, workstations often have walls of complete or partial glass to allow in daylight. The less partitioned an open plan, the further daylight may travel into the building core. Ceiling panels may be specified for their light reflection to extend the sunlight more deeply into the workspace.

In a typical office building, more than half the total energy use is attributed to the lighting, heating, and

IAQ and Wellness

Forward-thinking building owners are seeking more than energy performance. An increasing number of architects, designers, and specifiers now examine the full environmental impact of a building throughout its entire lifecycle, and this includes the indoor environment.

UL Environment states indoor air can be two to five times more polluted than outdoor air.* Heightened awareness of the indoor air quality (IAQ) and environmental influence on productivity also inspire innovation in building materials. Stone wool ceiling panels may be specified with UL Environment's Greenguard Gold certification for low-emitting products.** Certification is only given to products compliant with the associated requirements, which among others include stringent limits on emissions of more than 360 volatile organic compounds (VOCs).

Similarly, metal ceiling panels contain no organic compounds to support mould or microbial growth. Some metal ceiling panels can be specified with up to 100 per cent recycled content and can be fully recycled at the end of their useful life.

Offices that take steps toward lower VOC emissions, higher IAQ, improved energy efficiency, and increased environmental responsibility have demonstrated benefits in employee productivity. Buildings certified through the Leadership in Energy and Environmental Design (LEED) rating system show promising improvements in employees' wellness.

A study from the School of Planning, Design, and Construction at Michigan State University discovered that in a LEED-certified office, the average number of hours per month that employees report being absent due to allergies and asthma can drop from 1.12 hours to 0.49 hours; further, employees' reports of being affected by allergies and asthma dropped from 16.28 hours to 6.32 hours—a drop of 60 per cent. † The study went on to show a decrease in absences due to depression and stress from 0.93 hours per month to 0.47, and a decrease in employees who reported the number of hours affected by depression and stress dropped from 20.21 hours to 14.06—a decrease of 30 per cent.

Geo Clausen is a leading international expert in the field of indoor air quality (IAQ) and an associate professor at the International Centre for Indoor Environment and Energy (ICIEE) at the Technical University of Denmark. He publishes comparative studies on discomfort caused by lighting, indoor air pollution, thermal conditions, and noise. Clausen cites the North American energy crisis in the 1970s as a benchmark: During this time, ventilation of office buildings was reduced by two-thirds. Soon after, employees started complaining about poor indoor environments and research has followed.

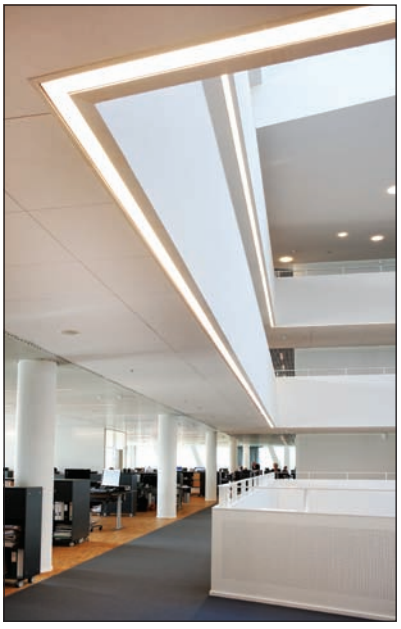
According to Clausen:

> There are three main families of effects. The first is perception: how does the person 'feel' about the environment; is it too hot, too cold, too bright, too dark, too noisy, too quiet, etc. Then there are real physical symptoms like dry eyes, runny noses, tiredness, or headaches. At the far end of the spectrum comes illness. … Employees expect more and more from the offices they work in. Our expectations of the cars we drive and the computers we use have changed, so why should it be any different for offices? People are less and less willing to tolerate a poor work environment, which is important to recognize if you want to hold on to good employees. No one would want to work for a company where employees got sick if they ate the lunch. So who would want to work in a building that makes them sick or tired? … When you compare this loss of productivity [*i.e.* five to 10 per cent in ICIEE studies] to what it costs to create a good indoor environment, you don't have to be a genius to figure out that you should do all you can to create a good indoor environment from the outset.

* Visit www.greenguard.org/en/indoorAirQuality.aspx.

** More information on the programcan be found online by visiting www.greenguard.org/en/index.aspx.

† To read the study, visit ajph.aphapublications.org/doi/abs/10.2105/AJPH.2009.180687.



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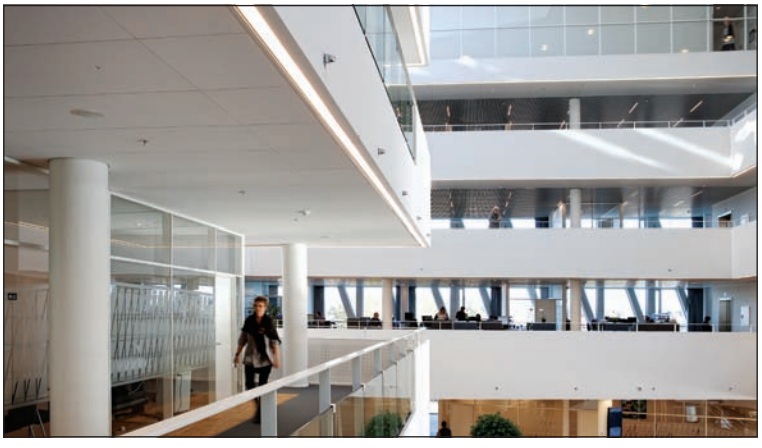


The heightened interaction and flexibility of the 21st century workplace is reflected in the increased use of exterior and interior glass, expansive floor spaces, integrated lighting and daylighting, and contiguous ceilings with a monolithic appearance.

Characterized by brightness, openness and flexibility, open-plan offices with stone wool acoustic ceilings provide an inviting workplace for employees.

cooling. Dimmers can be added to electrically powered lights to take advantage of particularly sunny days and reduce energy costs. On cloudy days and at night, reflective surfaces and ceiling panels assist the electric lighting in maximizing dispersal while minimizing resources and associated costs. Some offices also have reduced the number of light fixtures needed from every 3.7 m (12 ft) to every 6 m (20 ft).[3]

Light quality and acoustic considerations are too often overlooked in parking garages and transit stations. For many employees, this is the first and last space they see during their workdays. When properly specified and installed, ceilings in these areas mostly go unnoticed in their goal of conveying a safe, welcoming environment.

Design trends

Esthetically speaking, monolithic ceiling designs are standard in open-plan spaces. These designs combine the functionality of a ceiling suspension system with the creative potential offered by acoustic and metal panels in curves, clouds, mixed shapes and sizes, or flat, linear spans.

Suspension systems define the ceiling's visible grid. This can be accentuated with a wide face, minimized with a concealed grid, or recessed for a shadow effect using bolt-slot suspension with a centre regress. Material and finish selection contributes to the appearance. Suspension systems usually are fabricated from:

- aluminum, for most interior applications;
- stainless steel, for more heavy-duty applications; or
- steel with an aluminum cap option for those applications where environmental considerations are primary.

The suspension systems' exposed metal face can be finished to either match or contrast with the panels. White, silver, and black are frequently specified. Most manufacturers offer a broad choice of painted colours or anodize finishes. Some include metallic hues, laminates, and options mimicking wood grain. Choosing a single-source supplier for metal panels provides consistency in finish and colour selection.

Along with the finish, metal panels can be specified with or without perforations. The perforations not only contribute to acoustical performance, but also enhance interior designs. The diameter of the holes can range from imperceptibly small to more than 15 mm (0.6 in.). The holes can be round or square, and placed tightly together or far apart; they can have lineal, diagonal, or staggered patterns. Some manufacturers offered graduated designs where the

Stone wool ceiling panels may be specified for their light reflection to extend the sunlight more deeply into the workspace, which helps reduce the need for electrically powered lights (and the associated energy costs).

holes increase in dimension and decrease in spacing. Detailed, custom patterns also can be created for corporate logos, university mascots, and other pixelated graphic reproductions.

Compared with metal panels, acoustic stone wool ceiling panels are more limited in pattern and texture, but offer a broader selection of edge designs. Coupled with the range of suspension systems, the edge design can help to hide the grid with tightly fitted panels, shadow the grid with beveled recesses, obscure the grid with panels that seem to float under it, or emphasize the grid with square or angled tegular edges.

Current trends in acoustic ceiling panels call for lightly textured or smooth finishes in white. Other than a bright white, natural tones are the most popular. Acoustic panel manufacturers usually offer

Renovation Considerations

As part of supporting a healthy, happy office environment, the freedom to roam and collaborate within an open-plan office generates a greater need for flexible layouts. Organizations need to be able to adjust workspaces accordingly. Sometimes referred to as 'agile interiors,' these spaces can be reconfigured relatively quickly and easily. However, any change in floor plan requires a review of the ceiling plan to ensure the space's acoustic performance keeps pace with the changing needs of its occupants.

By refurbishing and improving their current office layouts, companies can also accommodate more staff comfortably without having to move into larger premises. This helps keep costs down, increase operational flexibility, and meet employee expectations. To maintain the competitiveness, building owners who invest in renovating their existing properties enjoy higher occupancy and rental rates with longer-term agreements and more satisfied tenants.

In addition to preferring more modern, better quality spaces, many tenants are sensitive to the operating costs of offices and to achieving greater efficiency. First, there is economic efficiency. In a typical office building, more than half the total energy use is attributed to lighting, heating, and cooling. Making an old building more energy-efficient will, therefore, reduce operating costs and offer a more comfortable climate—both of these factors can be important incentives for occupants.

Next, there is operational efficiency. Very often, older office spaces do not provide the level of HVAC, electrical, and IT services required today. Moreover, some office spaces were not designed to be offices in the first place. When updating an old industrial building that has been converted into office space, alterations may be needed to ensure it meets current acoustic, fire, safety, and air quality regulations.

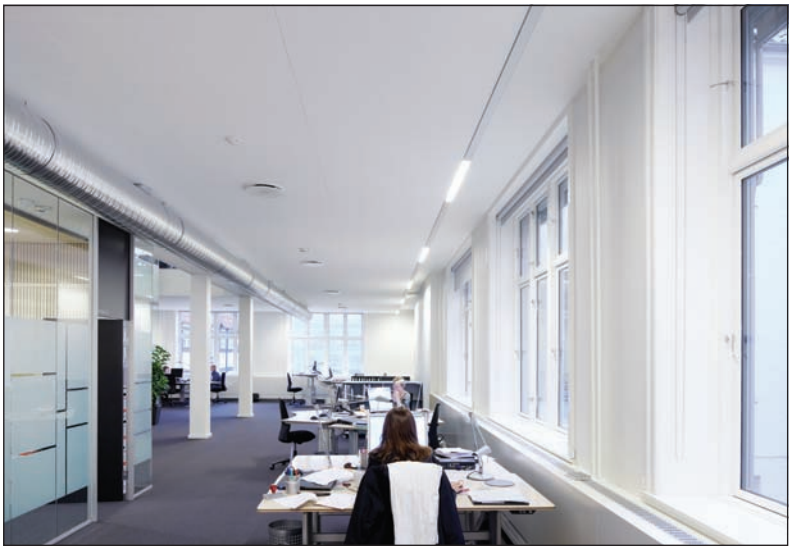
Finally, there is organizational efficiency. The way buildings are used evolves over time, and this is particularly true of office spaces. To improve the value of their assets, property developers are keen to upgrade existing, outdated, individual cellular office spaces to more commercially attractive open plans. Even in offices with open-plan landscapes, the layout may no longer match the organizational requirements.

One of the biggest and most frequent challenges in renovation projects is achieving acoustic comfort when the original room height is too low for a traditional suspended ceiling. Directly mounted ceilings can be a low installation height of just 31 mm (1.22 in.) when fixed directly to the soffit and can still achieve good sound absorption levels.

To preserve ceiling height in office spaces, the plenum above corridors often houses the majority of a building's HVAC, mechanical, electrical, and plumbing systems. However, concentrating these systems above the hallway leaves little room for traditional ceiling hangers and increases the noise level generated by services. Ceiling problems that can be suspended from the wall—even across large spans—help absorb hallway noise, reducing sound transfer from the plenum to adjacent rooms.

In historic buildings, acoustic ceiling panels, clouds, or baffles can be installed around architectural details such as high windows, structural beams, pillars, and other structural obstacles—maintaining these significant design elements, while improving acoustic performance.

Companies that embrace an open-plan office design are including informal communal spaces and hallway configurations to promote chance encounters and casual interaction. Intentional acoustic design provides spaces appropriate for lively social interaction, as well as for private concentration.

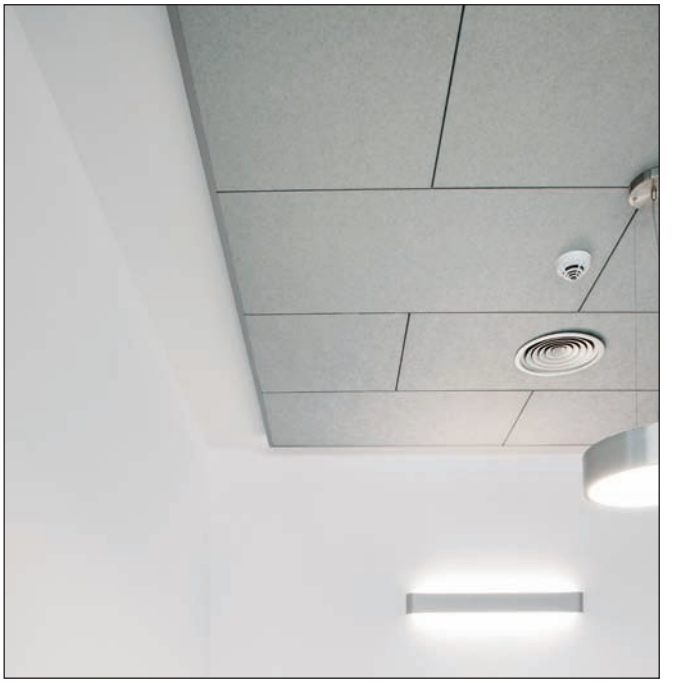


The line of a ceiling impacts the perception of a space and creates focal points that may show direction, outline an object, or divide a large space into more comfortable zones.

a special palette of bold, metallic, pastel, and other hues. Custom blends may be provided to match school colours, company décor, or specific applications such as black panels for a theater. Colour choice can have a strong influence on occupants' emotions, too. Brighter colours, whether white or sky blue, convey a sense of energy. Paler colours tend to have a calming effect. Yellow and green are associated with health and well-being. Used purposefully, colourful panels can complement signage, helping visitors find their way.

By combining different module sizes, even small rooms may seem larger and long corridors less distant. The line of a ceiling impacts the perception of a space and creates focal points that may show direction, outline an object, or divide a large space into more comfortable zones. Horizontal lines convey stability, grounding, and direction. Vertical lines also communicate stability, along with pillar-like attributes of strength and balance. Diagonal lines are perceived as dynamic and transformational with overtones of freedom, while curves are considered playful, organic, and soothing.

More office building designers are combining linear and curved lines, metal and acoustic panels, as well as mixing sizes, directions, and colours. Intricate floor designs can be reflected in the ceiling design. Brickwork wall patterns can be replicated with staggered ceiling panel sizes. The serpentine shape of a riverbed viewed through the window can inspire the ceiling's curvilinear undulations.



Creative office designers are combining linear and curved lines, metal and acoustic panels, or different panel sizes, directions, and colours to make small rooms seem larger or produce inventive patterns.

Conclusion

With the proper specification, installation, and maintenance, today's ceiling systems can last for decades, evolving with the open-plan office design to meet the trends and functional needs for future workplaces.

Notes

[1] For more on this type of product, see the April 2014 issue of *Construction Canada*, which featured the article, "Far From Conventional: Looking up at Metro Toronto Convention Centre's Ceiling Renovation," by Scott Debenham. To read it, visit www.constructioncanada.net.

[2] See the article, "Workspace Satisfaction: The Privacy-Communication Trade-off in Open-plan Offices," by Jungsoo Kim, and Richard de Dear in the *Journal of Environmental Psychology* (36, 2013). For more on NRC, and metrics such as ceiling attenuation class (CAC) and articulation class (AC), read the article named in note 1.

[3] Visit Facilitiesnet.com for the December 2010 article by Karen Kroll, "Study Links Green Buildings and Employee Productivity."

Chris Marshall is the director of architectural sales for Rockfon's stone wool acoustic ceiling assemblies. He has worked with specifiers, designers, installers, and manufacturers of stone wool products for more than a decade. Based in Toronto, Marshall earned a bachelor's degree from the University of Windsor (Ontario) and an MBA from Western Michigan University in Kalamazoo. He studied global supply chain management at Northwestern University's Kellogg School of Management (Evanston, Illinois), participated in the Ivey Leadership Program through the University of Western Ontario's Richard Ivey School of Business (London, Ont.), and was a student at Ontario's York University's Schulich School of Business in the executive program for sales leadership and management. Marshall can be reached at chris.marshall@rockfon.com.