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CASTING LIGHT ON COST CUTTING

Tubular daylighting offers natural illumination, saves energy

BY MICHAEL SATHER

A tubular daylighting device (TDD) is a relatively simple concept — a dome at the roof level captures sunlight, a reflective tube channels it through the attic and a diffuser lens at the ceiling spreads the light evenly throughout the interior. Prior to the turn of the century, TDDs were only used in residential applications. In fact, they have grown so popular residentially that TDDs are now more common in homes than traditional skylights. With the advent of advanced optical TDD technologies, this same trend is also occurring in commercial buildings.

The arrival of commercial daylighting

In 2000, the first TDD specifically designed for commercial buildings appeared on the market. With a 21-inch diameter

tube and an internal reflector in the dome to capture low-angle sunlight, the new product surpassed the light output from two standard 2- by 4-foot fluorescent troffers in a typical office space (assuming three T8 lamps per troffer). This revolutionary “daylight fixture” offered a transition box system to take it from a round tube into a square diffuser, fitting securely into a typical acoustical ceiling grid, replacing a 2- by 2-foot ceiling tile. The product also offered an “open ceiling” version that could be used in any space with an exposed deck, like a warehouse or manufacturing environment.

Thirteen years later, TDDs are commonplace in all types of commercial buildings, with manufacturers offering a

range of sizes from compact 10-inch diameter tubes for smaller spaces to whopping 29-inch diameter tubes for large high bay applications.

Energy saving seems the obvious reason to daylight a space. If you can reduce the need for electric lighting by using daylight, you can save money. The more advanced TDDs on the market can deliver the visible spectrum of daylight with minimal heat gain, and produce less heat than the equivalent electric lights, often reducing the cooling load of the building. However, energy saving is really just the icing on the cake.

Furthering that analogy, the cake itself would be represented by the human performance benefits associated with

daylighting. It's no secret that people prefer a well-lit environment over one relying solely on artificial light sources. There are countless studies citing the benefits of daylighting in terms of increased productivity, reduced absenteeism, enhanced employee retention, and improved test scores in students.

Environment dictates behavior, and people are happier and more excited about coming to work in a space that offers comfortable and reliable natural light. This makes sense, since research on seasonal affective disorder indicates that our brain chemistry is directly influenced by the amount of daylight we receive.

When considering the impact of daylighting from a financial perspective, you may spend US\$1 per square foot in a typical office for annual electric lighting costs, but in that same office, you may well spend US\$200 per square foot on employee salaries. Thus, even a small improvement on the human side can dwarf the electrical energy savings. The good news is that a space properly designed with TDDs and lighting controls will produce both human performance and energy benefits.

Visible sustainability

In today's business climate, companies of all sizes are spending serious money to promote corporate sustainability and project an environmentally conscious image to their employees, investors and customers. There are many things that can be done to reduce the carbon footprint of a building or improve sustainability metrics. If you want to have a direct impact on building occupants, it's important to first consider the anticipated visibility of any planned sustainable feature. How many people who visit or work in the building will recognize that there is recycled content in the carpet or a state-of-the-art HVAC system? When a building is properly daylit with TDDs, the results are clearly visible and can be immediately experienced by everyone who enters the space.

Our brain chemistry is directly influenced by the amount of daylight we receive.



DPR Construction's Phoenix regional office, a net-zero energy and LEED®-NC Platinum certified building, has tubular daylighting devices installed throughout.





Daylighting at Allegheny College – Richard J. Cook Center for Environmental Science (Meadville, Pa., USA)

Human performance benefits, energy savings and technology available on the market today make TDDs a very realistic option for new construction, renovation and retrofit projects.

Consistent lighting

Another benefit of TDDs is their ability to offer consistent light output regardless of building orientation. Windows and other sidelighting strategies (like translucent wall systems) are orientation specific. The results achieved with sidelighting, in terms of light and heat gain, are highly dependent on which direction the building is facing. Sidelighting strategies are also only effective for the perimeter areas of the building — those close to an exterior wall. When working with TDDs, building orientation is not a concern for performance, provided there is no shadowing of the domes at the roof level. TDDs will also allow daylight deep inside the building, without dependence on proximity to exterior walls. In new construction or major renovation projects, designing chases in the walls to allow the

tubing to be channeled to interior areas on lower floors is becoming more common.

Traditional skylights are another toplighting strategy that is independent of the building orientation. However, unlike advanced TDDs, skylights don't typically offer dome optics to more effectively collect low-angle sunlight or control high-angle sunlight, so they have much greater daily and seasonal variation. When there is a ceiling in place, most traditional skylights require constructing a shaft to connect the roof opening to the ceiling. This can be problematic, as the skylight shaft does not allow for angles, and it can take up a fair amount of plenum space and could create significant reflection losses.

Due to the larger diameter opening of traditional skylights, they can potentially bring

excess heat and glare to the interior space and create shifting patterns of light throughout the day and year in response to the sun's position in the sky. Shifting light patterns can be very distracting in a task-oriented work environment, sometimes causing visual and thermal discomfort and the need to adjust the work station to compensate.

Specular superiority

Today's advanced TDDs can transfer daylight into a space using a highly reflective tubing system that is spectrally selective. This allows for superior transfer efficiency of the visible spectrum of light while filtering out the majority of the infrared spectrum, which is the main culprit of heat gain. Specular reflectance is the main indicator of light transfer efficiency, and some advanced TDDs offer tubing with a specular

reflectance as high as 99.7 percent. Color temperature maintenance — how well a system can deliver the reflected light to the interior without a color shift — is also an important factor in a TDD's tubing. When natural daylight is transferred through a tubing system with no color shift, the result is perfect color rendition of interior surfaces.

Flexible control

The tubing can also offer angular capabilities to accommodate multiple 90-degree turns, allowing easy navigation around plenum obstructions so that roof and ceiling locations can be truly independent of one another. The smaller diameter of TDDs also means that structural modifications to the roof deck are often not required. Advanced TDDs will typically offer several lens or diffuser options for the interior, whether for an open or drop ceiling, to allow for predictable light distribution patterns regardless of sun position.

If control is a concern, such as in training or conference rooms, most TDD manufacturers offer a dimmer option to give occupants total control over the amount of daylight coming through the TDD. For best results, look for a dimmer system with a "butterfly baffle" design to keep distribution patterns consistent at any degree of dimming.

LEED and net zero contributions

If you are planning a LEED project, TDDs can contribute a number of points and credits for all LEED rating systems. In fact, under LEED 2009 for new construction, TDDs can potentially contribute up to 27 points in the following prerequisites and credit areas: light pollution reduction (SS), minimum energy performance (EA), optimize energy performance (EA), controllability of systems (IEQ), daylight and views (IEQ) and innovation in design (ID). There are very few products that can contribute this significantly to the overall effectiveness of a project. Using TDDs extensively in a project could mean the

Since their debut in 2000, commercial TDDs have been installed in every type of building imaginable.

difference between a LEED Silver and LEED Platinum certification in some cases. In net zero projects, TDDs may be even more of a factor, as they can be easily situated between solar panels on the roof. TDDs can allow for almost total displacement of electric lighting during a building's occupied hours, allowing the electricity generated by solar panels to be used elsewhere.

Since their debut in 2000, commercial TDDs have been installed in every type of building imaginable. Currently, the most popular types of spaces being daylighted with TDDs include offices, classrooms, manufacturing, warehouse/distribution centers, retail facilities and community buildings. Human performance benefits, energy savings and technology available on the market today make TDDs a very realistic option for new construction, renovation and retrofit projects.

Selecting the right TDD

With dozens of TDD manufacturers on the market today, how do you select the right one?

- **Research the manufacturers.** Browse the website of each manufacturer and you will notice some big differences. Some manufacturers specialize in TDDs as their main business, whereas other manufacturers just offer TDDs as a small part of their overall product line. Make sure the manufacturer has a solid reputation for its TDDs and can offer the right product for your particular application. A reputable TDD manufacturer will offer a wide variety of product models and components that

can be assembled to fit the daylighting strategy for your particular space.

- **Request photometric data.** Some TDD manufacturers can offer credible third-party photometric data that can be used by architects, engineers or lighting designers in simulation programs to model the daylighting design in a given space. TDD manufacturers may even have a network of commercial distributors or installers who are trained in photometry and can offer light studies to help support the proper design of the project and carry it from inception to final installation.
- **Check references.** Get an unbiased third-party opinion, ask for references of past customers and see if the vendor can arrange a tour of an installed project in your area. With TDDs, seeing truly is believing.

Everybody deserves daylight, and with today's advanced TDDs, there is every possibility of bringing daylight into any interior space and displacing the need for electric lighting. **FMJ**

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