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Let There Be Lighting

How to illuminate the world inside and outside your facility

By Kyle Ryan

Its most devout followers believe there isn't a question in life that isn't answered in the Bible. Installing a lighting system for your soccer field? Go no further than the Bible's opening passages:

In the beginning, when God created the heavens and the earth, earth was a formless wasteland, and darkness covered the abyss, while a mighty wind swept over the waters. Then God said, "Let there be light," and there was light. God saw how good the light was.

Endorsements don't come any bigger than that, but when it comes to the specifics of lighting installations, be they indoor or outdoor, the Good Book doesn't really have anything specific to offer. And it's not a simple subject.

"There's a lot of factors that go into this," says Mark McKinnon, general manager of the Homewood-Flossmoor Racquet & Fitness Club in Homewood, Ill. "engineering of lighting, it seems simple, but it can become very complex."

So listen thee, brethren, and learn from these examples.

GENESIS

In a report to recreation facilities on lighting systems, the Australian Ministry of Sport and Recreation listed some basic steps to follow. First, you need to define the need and, second, what level of lighting is required for it.

When it comes to sports, lighting needs increase with the level of competition. For example, a softball field behind an elementary school doesn't have the same lighting system as, say, Safeco Field in Seattle. The former might have 50 foot candle's worth of light in the infield (see sidebar on page 29), and the latter might have 200, according to Bill Whitman, a lighting designer for DMD & Associates, an electrical-engineering firm with offices in Seattle. Lighting standards are set by the Illuminating Engineering Society of North America (IESNA).

"They establish a class of play, and the class of play is based on the age of the player and the speed of the ball and the number of spectators," Whitman says. "The more spectators you have, the more lights you need because the more spectators, the further removed they are from the action."

Whitman summarizes it this way: Lighting needs increase as the speed of the ball increases and its size decreases. Lighting also has to be consistent, especially if it's outdoors.

"The reason uniformity is important for players is, as the ball moves through light and dark areas, the way the human eye perceives that is it appears the ball changes speed," Whitman says. "Both the trajectory and speed may be involved in terms of perception."

Some sports organizations have their own standards that supercede IESNA standards, according to Whitman, like Little League Baseball, which requires more light than the IESNA recommends. When television gets involved, all the standards change no matter what.

"TV has to be treated as a separate issue," Whitman says. "It's not the kind of thing a typical designer can do."

Once lighting needs have been evaluated, it's time to match those needs with what the budget allows. In some cases, installations may have to be built in phases, as the Schaumburg (Ill.) Park District did with its new Olympic Park. The park district is in the process of lighting the five baseball/softball fields and nine soccer fields at the park.

"If we don't have the money, we wait until we do," says Dan Otto, assistant director of the Schaumburg Park District. "Olympic Park, we didn't build it all in one year. We did it in phases."

That meant building the softball fields, then soccer fields, then eventually installing lights.

"We always did have a master plan, and we were always going to light all the fields," Otto says. "We just took our time little by little."

With the budget figured out, it's time to enlist the help of a consultant. Even if your staff has a general understanding of facility needs, it often pays to bring in someone with expertise, both with the design and dealing with vendors. The Homewood-Flossmoor Park District in Illinois quickly hired a consultant when it decided to upgrade the lighting system for the tennis courts at its racquet and fitness club.

"Your vendors will always give you some help because they want to sell you the product," McKinnon says. "Which is fine—you just have to temper that with knowing they're trying to sell you the product."

In Schaumburg, the park district did most of the planning itself.

"We have the expertise to do a lot of that work," Otto says. "Civil engineering drawings, obviously, we go outside. The lighting stuff we go outside. We basically came up with the plan ourselves. If you don't have that expertise, you hire somebody."

Lighting vendors can suggest engineering firms, and information is of course available online, but everyone suggests asking around.

"Ask the guys that have already done it," Otto suggests. "Did you have a problem? Were they responsive? Did they deliver what they said they would deliver? If you're getting good answers and you feel comfortable, then you're ready to go."

Once bids start coming, McKinnon warns against the low ones. Like the old saying goes, if something sounds too good to be true, it probably is.

"A low bid doesn't necessarily mean the most qualified bidder, and you've got to make sure they're qualified to do the job," he says.

Even if you find the most qualified, experienced contractor out there, delays are inevitable. McKinnon's sales representative for the light-fixture company he used tragically died in a car accident, which caused setbacks. Then there are weather and material delays.

"Those are just delays that are part of doing business," Otto says.

(INDOOR) WISDOM

The Australian Ministry of Sport and Recreation noted that indoor lighting has some advantages when compared to outdoor areas. Consistent lighting is more easily achieved because walls and ceilings control and reflect light, which helps reduce shadows. Weathering isn't a factor, so the lights require less cleaning. But indoor light must also be flexible, especially if the area hosts different activities.

Built in the 1970s, the Homewood-Flossmoor Racquet & Fitness Club has 10 indoor tennis courts in two banks of five courts and a fitness center. Large iron bar joists, which support the pitched ceilings, tended to prevent light from the 228 indirect fixtures from reflecting well.

When the park board decided to upgrade, it made a contradictory-sounding request to the engineer it hired: more light, fewer fixtures. It also protected its investment before the project even began.

"We actually fixed our roof first so it didn't leak, and then we did the ceiling and lighting installation second," McKinnon says. "The order is important. If you have any roof issues, address those first before you put in a ceiling and lighting systems because if you have a really leaky roof, you're just

going to damage your insulation that you're putting in."

Once the lighting project got under way, contractors worked on one bank of courts at a time during the slower summer months at the club. Once completed, the tennis area went from 228 light fixtures to 96, with an 50 percent increase in lighting—saving the district up to $25,000 a year in electrical costs.

How? First, designers brought the roof in a couple of feet to create a smooth surface, not one interrupted by intermittent iron joists.

"The combination of the ceiling reflection and insulation helped the reflection bounce the light back to the court better and allowed us to use less fixtures and increase lighting capacity," McKinnon says.

The new indirect system uses 1,000-watt metal halide lights, which Whitman estimates are used in 99 percent of outdoor sports lighting. Although fluorescent lights are common indoors (they're affected too much by temperature to be outside) because they're cheap, require no start-up time and generally light well, they have to be located in close proximity to the area being illuminated. In a tennis court with pitched ceilings they wouldn't work.

Metal halides have no such restrictions. Part of the high-intensity discharge family of lights, they offer excellent color rendition and last up to 10,000 hours but can be pricey and require a few minutes to start up. On the tennis courts in Homewood-Flossmoor, each one is protected from errant balls by a grid.

Unlike the light bulbs people use at home, HID lights don't burn out—they fade. Whitman recommends changing them when they reach 80 percent of their foot candle output level. In Homewood, where McKinnon estimates the courts are lit up to 20 hours a day, new lamps burn at 80 foot candles (roughly semi-pro by IESNA standards) but drop to about 50 by the time the staff changes them.

"So what we've done is every two years we change out all the light bulbs," he says. "That way it can guarantee even distribution of lighting throughout the building."

Metal halide lamps contain mercury, so staff members cannot just throw them in the garbage. Many types of high-intensity lights contain toxic chemicals, which is why the Schaumburg Park District has a special bulb-disposing machine. Bulbs are crushed then deposited in a 55-gallon drum that's sealed when it reaches capacity. A waste-management company handles the rest.

Sometimes the bulbs are fine, but the ballasts are not. The ballasts regulate the electricity in lamps and are typically located right next to the lamp. When they malfunction, they make an annoying buzzing sound but can be difficult to repair if located on the ceiling. In Homewood, designers moved the ballasts to floor level behind a curtain, which makes them easier to repair and muffles any buzzing noises.

What about the other areas of the Homewood-Flossmoor Sport & Racquet Club? Well, the fitness area at the club is only a few years old and currently uses metal halide lights that work well. The foot candle requirements are significantly lower in fitness areas, so the lights use 250-watt direct fixtures. On the courts, though, it's all indirect.

"You're looking up for the ball up in the air sometimes, so you don't want a light shining down on your face," McKinnon says. "In a sport like hockey or soccer, you might be able to get away with direct lighting."

And they do. The Homewood-Flossmoor Park District operates an ice arena that uses direct lighting with metal halide bulbs. With hockey, when players' focus is on the floor (with a reflective surface, no less), lighting is a bit easier, though imperfect.

"You can actually see the light spot on the rink sometimes depending on what the organization is," McKinnon says. "So it isn't as even as it is with indirect."

LIGHTING SPEAK

BALLAST: The device that regulates electricity in fluorescent and discharge lamps

BULB: The protective glass sphere of a lamp. The light source is located within the lamp's bulb.

FIXTURE: A luminaire. A complete lighting unit consisting of a lamp together with other parts such as the socket, reflector and lens designed to locate, orient and control electrically and optically a light-producing device

FOOT CANDLE (FC): The total intensity of light that falls upon one square foot surface placed one foot away from a source of light that equals one candle power. In the metric system, it's called lux.

GLARE: Any luminous source that is in sharp contrast to the area around it

HID: Short for "high intensity discharge," the most common type of sports lighting. High-pressure sodium and metal halide are its most popular types.

ILLUMINANCE: The density of light uniformly incident upon a surface. Measured and calculated in foot-candles (fc) or lux

LAMP: A generic term for a man-made source of light, including the light source, bulb and base, specified by ANSI codes. Characteristics of a lamp that a designer must consider include efficacy, bulb type, maximum overall length, light center length, base type, operating position, lumen maintenance, lumen output, anticipated life, color rendering index, color temperature, restrike time, spectral distribution, mortality, etc.

LIGHT SOURCE: A source of visible electromagnetic radiation. Typical light sources used in sports lighting include high intensity discharge sources (metal halide, high-pressure sodium) and sometimes incandescent or fluorescent. Other light sources include mercury vapor and light emitting diodes.

LIGHT SPILL: Illuminance falling beyond the boundary of the playing field

LUMEN: A measuring unit for the flow of light

LUMINANCE (ALSO KNOWN AS PHOTOMETRIC BRIGHTNESS): The concentration of light reflected in a given direction per unit area. Measured and calculated in cd/m^2

SKY GLOW: Light that's cast upward that obscures the view of the nighttime sky

Some definitions provided by Bill Whitman, a lighting designer for DMD & Associates in Seattle.

EXODUS

Even or uneven, Schaumburg's Olympic Park had no lighting system in place. A relatively new construction, the park was built in phases as funding became available. Light controls are being housed in a concession stand that's under construction.

"We decided that we have such a demand for a lighted athletic fields that by utilizing the lights, we'd get some extra time," Otto says. "Basically what you end up doing when you have a big tournament, your last game is over by 8 o'clock. We can extended those hours to 11...That gives us three additional hours per field if you're in a tournament. That's three additional games per field, so that's pretty substantial."

Otto says light levels on the softball fields tend to be around 50 fc in the infield and 30 in the outfield, which is about a recreational level. Because the soccer is different (bigger ball, eyes more focused on the ground), Otto says they keep light levels on the soccer fields to about 30 fc.

The more light needed for outdoor areas, the more issues come up with light pollution, especially

when there are nearby residential areas.

Pollution generally comes in three forms: sky glow, trespass and glare. Sky glow happens when light aimed upward (or reflected off the field surface) creates a low-level glow. Any resident of a major city knows the result: few visible stars.

Whitman has encountered readings on field surfaces showing that as much as 10 percent of the light gets reflected off the field. With sports (especially baseball or softball), a certain amount of sky glow is necessary so players can track balls in the air. Otherwise the balls disappear in the dark and become visible only a second before impact. Sky glow can be controlled by special visors that restrict light traveling above the fixture.

Light spill occurs when light travels into areas outside the boundaries of the field.

Schaumburg's strict lighting regulations dictate no more than one foot candle's worth of light can strike a park's property line. Luckily for Olympic Park, its 72 acres aren't near a residential area, but Otto and company remained cautious and purchased fixtures with special shields to eliminate spill. The shields restrain the light beams to certain areas and can be set to contain light within specified space.

While Whitman describes light spill as easily calculated and reduced, he admits that glare isn't as easily subdued. Glare is light that's in sharp contrast to the area surrounding it.

Glare and light spill aren't even measured the same way. Spill light is measured by illuminance, light falling on a surface. Glare is measured by the intensity of the luminance, that is, the concentration of light in a certain area.

"Typically residents object mostly to glare issues," Whitman says. "But the bad thing is since people are all different, different people are affected in various manners by the same amount of glare... There's not a really easy way to measure glare, what actually bothers people. It's a very subjective thing."

Glare isn't invincible, though. Whitman's firm set a glare standard that proved so effective the city of Seattle adopted it: The luminous intensity of a fixture is calculated, then engineers limit it through mathematical calculations.

"Most people don't do these kinds of calculations when they do a sports field, and that's why there are so many terrible sports fields," Whitman says. Those are the kinds of fields people remember, and those memories spark opposition to park lighting.

"Typically a big problem with sports fields is the amount of glare coming from the field is not limited, and people can see it for miles around," Whitman says. "Properly designed fields, they're very unobtrusive. It's not that they don't have some glare impact, but they're very unobtrusive."

One of the "obtrusive" aspects of outdoor recreational sports facilities are light poles. Standing above the trees, they are gawky necessities. Nearby residents, when they grudgingly allow lights to be installed often insist the poles be short so not to harm the area's aesthetics.

Such a setup creates greater light-control issues, according to Whitman and the International Dark-Sky Association, a advocacy group that monitors light-pollution issues. Lower mounting heights require a higher angle for aiming the lights, which sends more light off-site. Taller poles for mounting lights reduce the angle of the light's aim, keeping the beam focused on the ground.

"That's a little bit counterintuitive because most people are familiar with, in terms of area lighting, parking lots and streets," Whitman says, adding such lights become less obtrusive as you lower them. The beams go straight down, and as the lights get closer to the ground, there's less spill light. So why can't sports fields be the same way?

Sports lights are high-intensity fixtures that require precision focusing to be effective. To center the highest intensity point of the beam on a certain point on the field, the light poles have to be higher—otherwise the light beam isn't focused, thus creating light spill.

The design of the poles themselves can make them obtrusive. For a more natural look, some parks

opt for wooden poles, a grave mistake according to Whitman.

"Wood poles are not acceptable in our opinion at all," he says. For one thing, it takes time to aim lights precisely. Wooden poles warp and bend with age, meaning lights will have to be adjusted regularly. Second, Whitman says the poles tend to be chemically treated, so when it comes time to replace that warped pole, it's considered hazardous waste. Finally, and most unnerving, wooden poles rot on the inside, and it's undetectable. Is that pole sturdy or just a brisk breeze away from collapsing? You can't tell from the outside.

The most common type of pole Whitman deals with is galvanized steel, which is either mounted to a concrete foundation (sturdier, but more expensive, longer to build) or buried in the ground (cheaper, unobtrusive visually, but susceptible to decay). Aluminum and concrete poles are a little more costly. Although concrete has a low-maintenance finish, Whitman says concrete poles are limited in height because of shipping—a truck can only carry so much.

LIGHT LEVELS

ACTIVITY	CLASS I	CLASS II	CLASS II	CLASS II
Baseball	150/100 FC	100/70 FC	50/30 FC	30/20 FC
Basketball			30 FC	20 FC
Golf Driving Range			20 FC	20 FC
Horizontal (at grade)			10 FC	10 FC
Vertical (at 200 yards)				
Football	100 FC	50 FC	30 FC	20 FC
Golf Course Tees (at grade)				5 FC
Fairways (at grade)				3 FC
Greens (at grade)				5 FC
Horse Racing				
Horizontal (at track)	30/100 FC			
Vertical (at 5 feet)	70 FC			
Ice Hockey		50 FC	30 FC	20 FC
Rodeo		50 FC	30 FC	
Roller Hockey (at grade)		50 FC	30 FC	20 FC
Soccer (outdoor)		50 FC	30 FC	20 FC
Softball	150/100 FC	100/70 FC	50/30 FC	30/20 FC
Swimming Pool				
(at water level)		30 FC	30 FC	10 FC
Deck (at water level)		20 FC	10 FC	10 FC
Tennis	125 FC	75 FC	50 FC	30 FC
Track & Field		50 FC	30 FC	20 FC
Track (at grade)			20 FC	20 FC
Volleyball		30 FC	30 FC	20 FC

DATA COURTESY OF LITHONIA LIGHTING

REVELATION

It wasn't a problem for Schaumburg's Olympic Park, which uses direct-burial concrete poles. Although pricier, Otto says it was all part of the plan to make Olympic Park stand out among similar facilities in the area.

"We wanted to provide so that people would come there and say, 'This is a good place to play at night,'" Otto says. "We want to make that impression, so we were willing to spend the extra money."

It's money Otto believes the park easily recoups.

"In our community, we have a lot of people playing athletics, not only youth but adults," he says. "We have tournaments that bring in additional revenue to the community through hotels and through restaurants, so these things are important. We have a number of tournaments all year long; they bring in millions of dollars to the community."

That long view makes footing the bill for an expensive lighting system a little bit easier.

"The initial cost of putting it up is expensive," Otto says. "You also have to consider the long-range maintenance costs… That's why when you initially buy a fixture, you're looking at those type of things so that you'll have a fixture that will last for years and years and years, not something you have to replace in five years."

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