ARCHITECTURAL

LIGHTING

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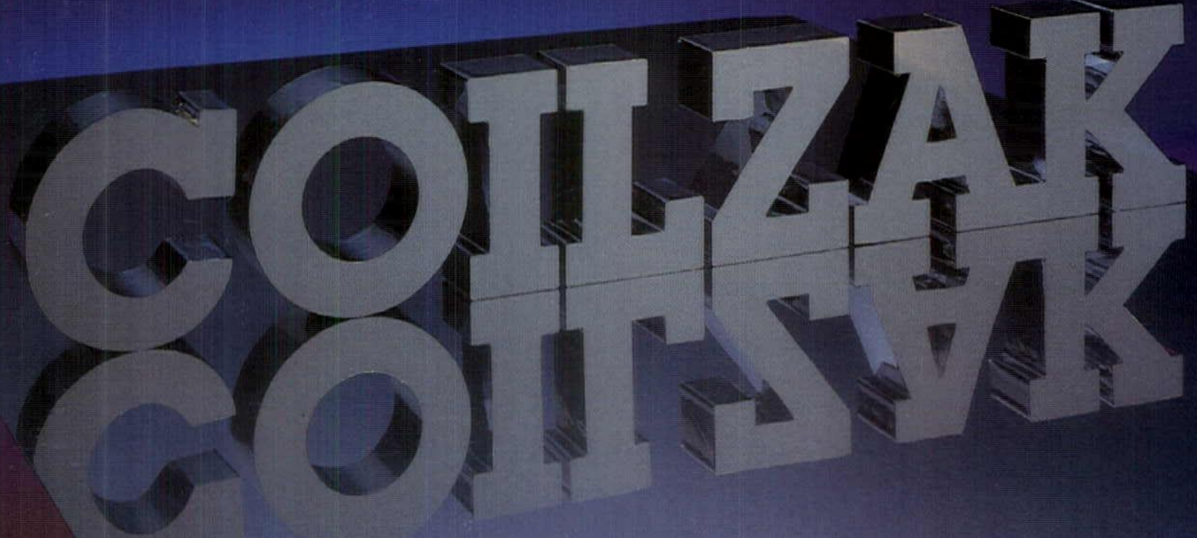

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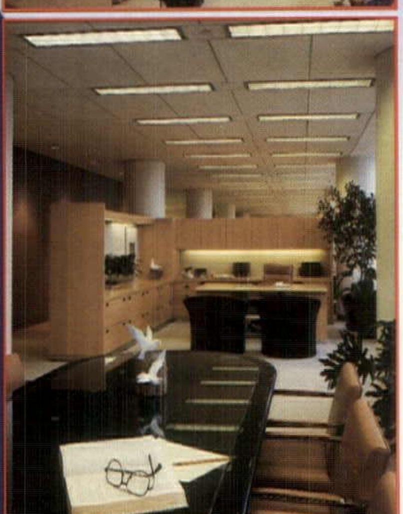

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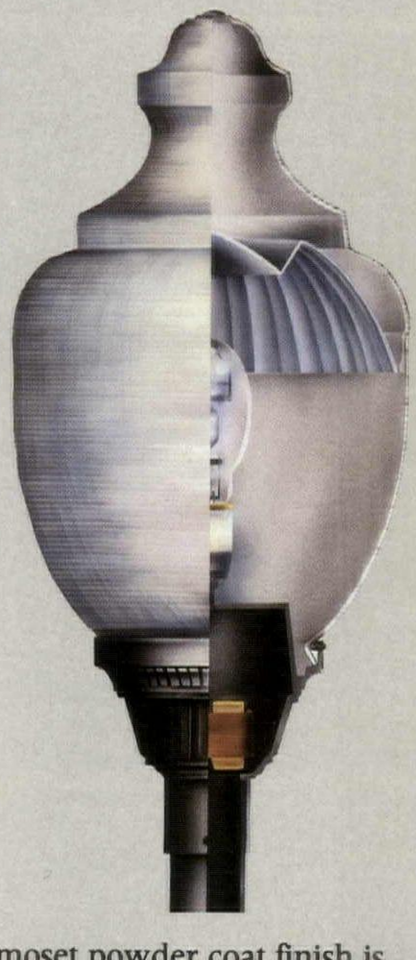

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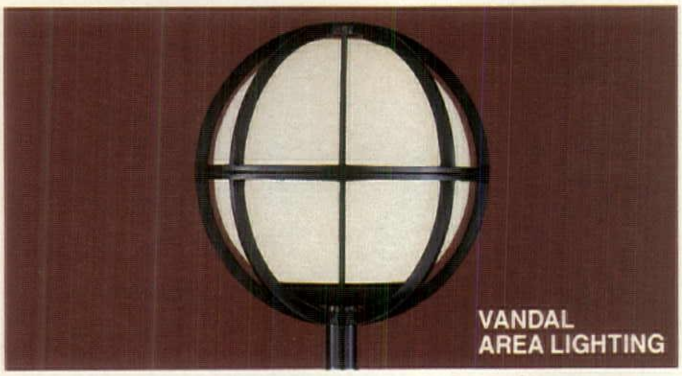

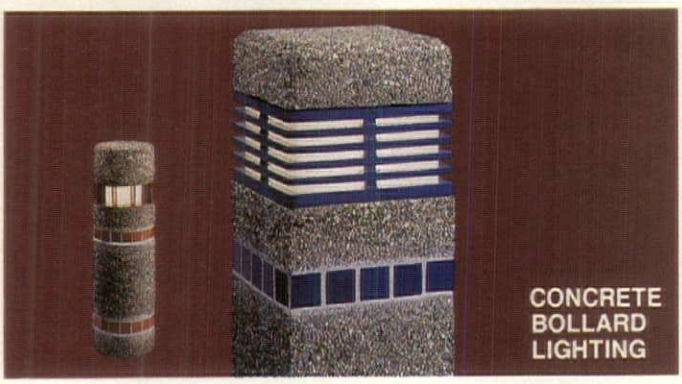

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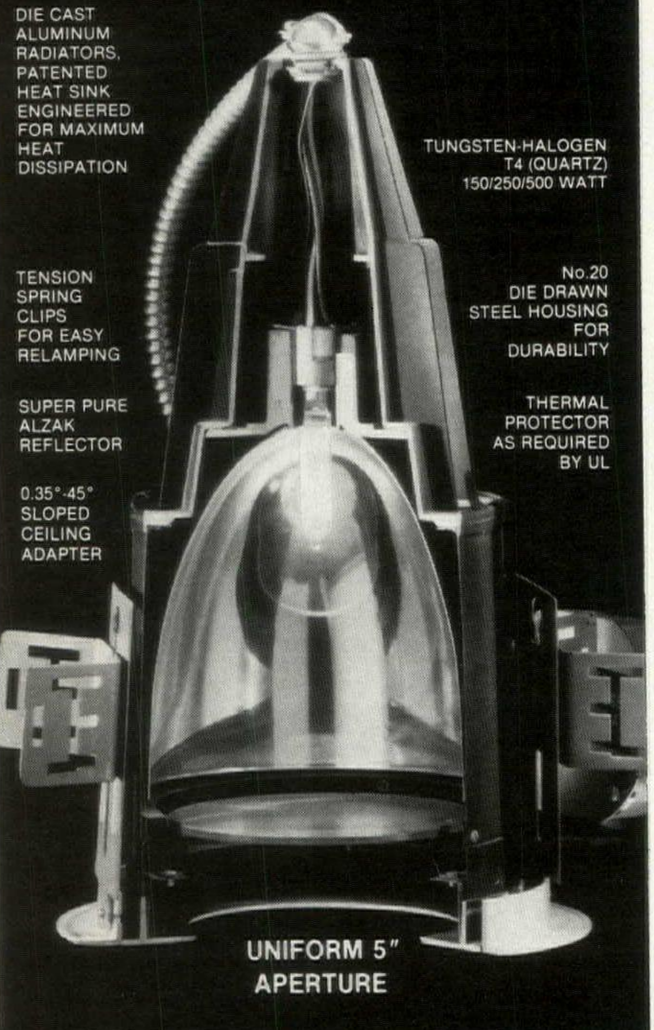

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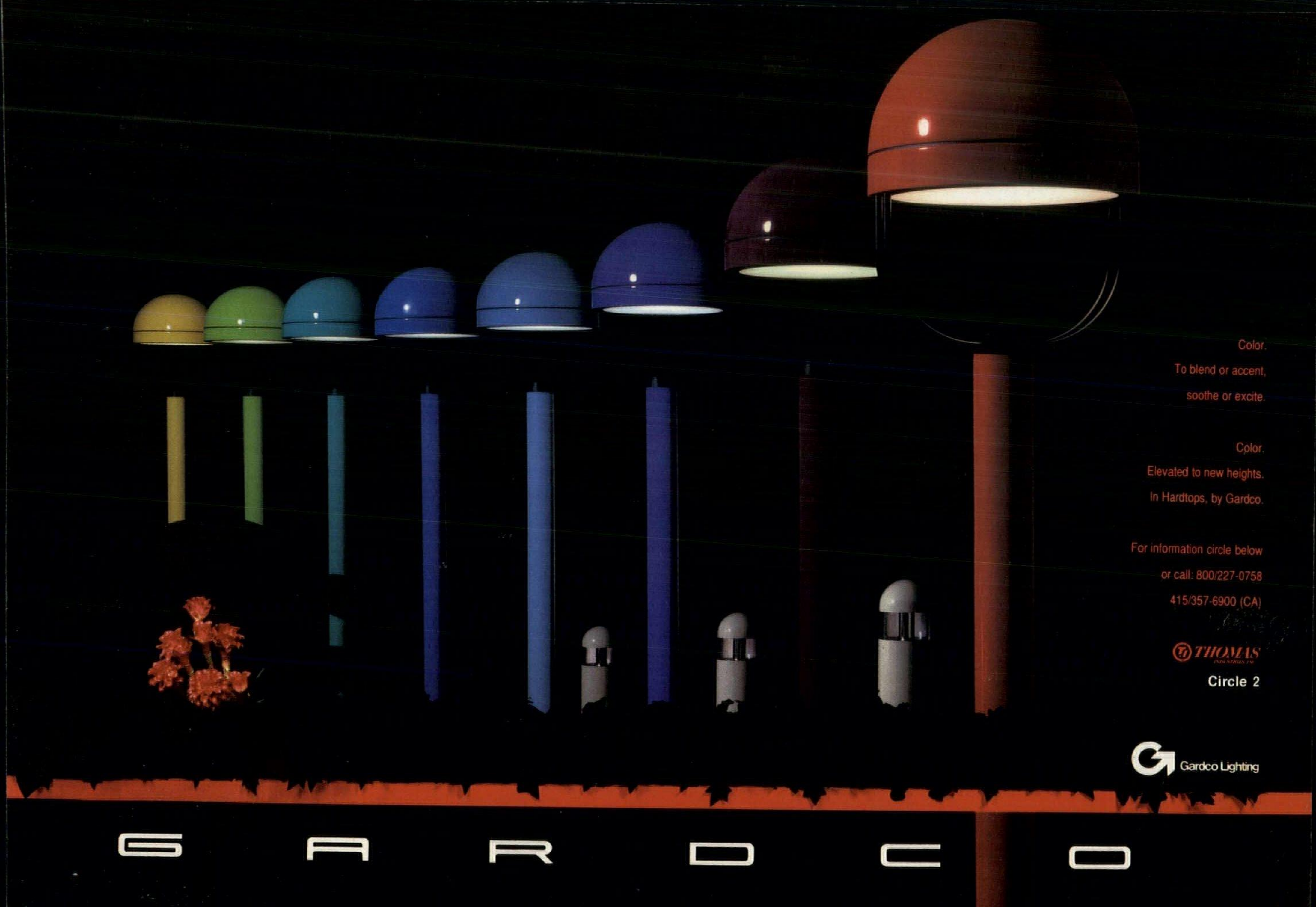
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Charles Linn, AIA

Charles Linn is the editor of Architectural Lighting.

Interior designer Dennis St. John and lighting designer Gary Steffy used a number of architecturally integrated lighting details to help provide a sense of comfort and intimacy at United Airlines' Red Carpet Club in Denver, a space so large it could have overwhelmed its users.

The 22,000-square-foot club is United's largest and was built in conjunction with the replacement of the B Concourse at Stapleton International Airport. The club provides its members with lounge areas, conference rooms, a business center complete with copiers and personal computers, and coffee and liquor service. Here, businesspeople may relax or conduct business between flights in a quiet atmosphere, away from the bustling terminal.

"The room can seat about 500 people at a time," says United's project architect, Bob Koch, "and that doesn't count people standing up. On the average, about 1600 people per day use the space, and we operate from 5:00 a.m. to 10:00 p.m., seven days a week."

"The problem was breaking up this huge space," says St. John. "One of our prime concerns was that we had a two-story entry area, itself small in terms of square footage. The balance of this very large space was all on the second floor. We were looking for a way to make the small entry open and inviting, and to keep the huge second story organized, but broken into areas, so guests wouldn't feel they were sitting in the middle of a football field."

"We wanted to create a sense of intimacy, to make people feel that they were in a nice clubby environment," says Steffy. "To do that, we wanted to lower ceiling elements, but in doing

The main reception area (above and right) is highlighted with artificial skylight elements. To balance brightnesses, a continuous wall wash is used around the core wall. Highlighting is focused on a piece of art depicting a Rocky Mountain scene.

Project Architect: Bob Koch, United Airlines
Interior Designer: Dennis St. John, project designer; Hague-Richards Associates Ltd.
Lighting Designer: Gary Steffy; Jeff Brown, project manager; Gary Steffy Lighting Design
Photos: Ron Johnson, Imageworks

We'd like to see your best lighting project: How to send it

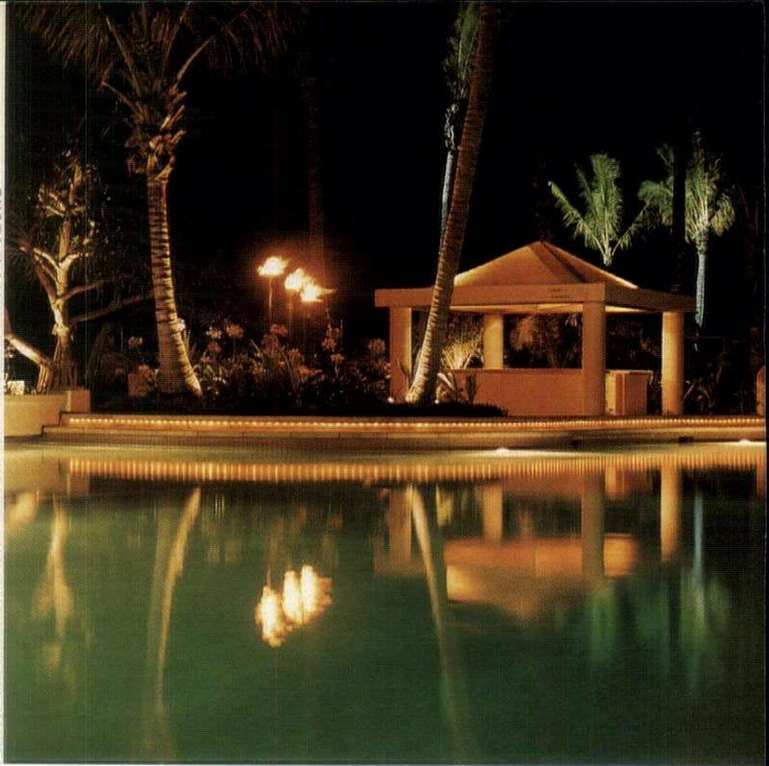


PHOTO: RIK HAMILTON. LIGHTING DESIGN: NORMAN DISNEY & YOUNG

It's easy to have your project considered for publication. You don't have to be a writer, but you do need to send enough information to let us "visit" the lighting project.

We want to see creative solutions to indoor and outdoor lighting problems, everywhere and anywhere a lighting problem has been solved with creativity, practicality, and innovation. We're interested in both electrical lighting and daylighting.

To make a preliminary evaluation, we need photographs and a brief written description.

Photographs

Sharp color transparencies focused on the lighting achievement are the next best thing to giving the editorial reviewers a tour of your project. Our first choice is 4×5 color transparencies, but we also accept 2¼×2¼ transparencies and 35mm slides. We prefer to review original slides or transparencies; we cannot review color negatives.

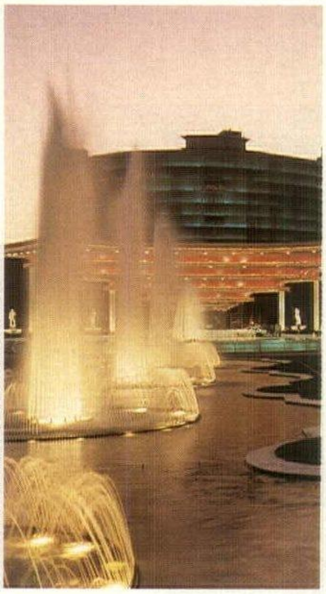
If your professional photos were originally shot as color negatives, please send full-frame prints. We prefer the following enlargements: 4×5 contact prints; 4×4 prints from 2¼×2¼ film; and 5×7 prints from 35mm film.

Be sure to provide the photographer's name and phone number, and indicate who owns publication rights. We return all photos promptly after review or publication.

Written description

Our editorial reviewers focus on information, not presentation; factual details are much more important than writing style. The best write-ups briefly describe the lighting design problem and the way it was solved, explaining the story behind what we see in the photos.

Objectives and scope. A brief statement about the effect the designer was after helps us evaluate whether and how well the objectives were fulfilled.


LIGHTING DESIGN: JOHN RENTON YOUNG

Philosophy. What broader, basic beliefs about what lighting should accomplish for the end user influenced your design objectives? Was the lighting solution chosen primarily for aesthetic effect? User comfort? Energy efficiency? Or for other reasons?

Calculations and planning. What did you do that might help our readers to approach their own work in some new and productive ways? Have you created or discovered a way to predict lighting results?

Light sources and luminaires. Why did you choose the particular lamps, luminaires, and/or glazing used in the project? What custom design or architectural detailing was involved?

Drawings

Drawings are optional. Include sections or details that illustrate the lighting achievement and any special luminaires, installations, or other notable features. If you send a reflected ceiling plan, please send an elevation with it.

The Review Process

Upon reaching our offices, your project submission enters our editorial review process. We send you an acknowledgment letter and circulate your submission among our reviewers. Usually, you can expect to hear from us within four weeks.

When a project is selected for publication, we usually request more information about the design team and your selection of light sources and luminaires. We may arrange a brief telephone interview to discuss design issues.

Finally, we offer contributors an opportunity to review article manuscripts so that we can correct any factual errors before publication.

Time to Publication

If the materials you submit for review are complete, and if the review and development processes are completed without any difficulties or delays, it is possible to rush a project into print in about 10 weeks. Typically, the time to publication — that is, from the time a designer submits materials for review until the published article is mailed to readers — is four to five months. If projects are complex, require additional art or photography, or are chosen to be cover stories, the total time to publication may be six to nine months.

To talk about your project or get more information, telephone our editorial offices at **(503) 343-1200.**

Send project submission materials to
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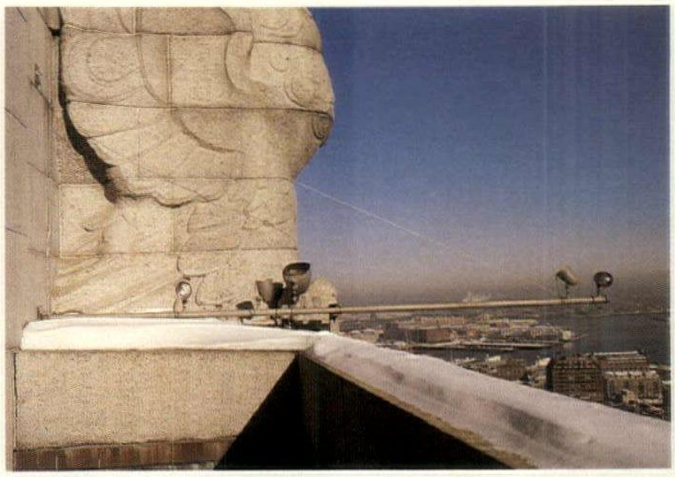
ARCHITECTURAL LIGHTING

The author with an improvised boom during the mock-up of the east facade. The mock-up demonstrated lighting concepts to the client and helped fine tune the design.



Targets of PAR fixtures, in order of mounting from end of boom to wall: cornice with rosettes, eagle breast, clockface, clock facade, and opposite eagle.

Some of our lighting tasks were so precise that we were playing with differences in lamp technology between manufacturers. It was difficult, for example, to get an ellipse of light washing across the clockface exactly as we wanted it. We eventually selected 6-volt PAR 64 very narrow spot lamps to do it. That was probably the hardest beam target on the whole job, because we were shooting at a diagonal angle to crosslight a round face with oval beam spreads.

The rooftop pinnacle was another tough target. Again, we used the same 6-volt lamps to hit a tiny brushed stainless steel pinnacle. A cornice line just below the pinnacle obstructed the beam, so we worked with the contractor to get the source mounted as far out as we could on the stone ornament.

Blending In

Although the illumination dramatically changes the appearance of the Custom House at night, the Landmarks Commission required that our fixtures themselves be unobtrusive. Most of the housings are skillfully painted to match the granite. They blend in so well that you can't tell them from pieces of granite — except when it rains. Wet stone turns black while the fixtures stay gray.

To light the large columns on the first floor, we designed a fixture housing that concealed the source. The original design used a standard medium-base PAR 38 lamp in a 12-inch-tall box. The commission thought the box was too high, so we redesigned it for a lamp with a side-prong base, and got it down to about 8 inches.

Mineral-insulated cable was another choice for minimal impact on the building. This thin, soft-roll copper cable can span a long way without attachment. We used it for surface-mounted exterior wiring on the 16th floor and observation deck.

A complete mock-up of the east facade, from street to peak, was part of the review process. For a one-night work session, we scrounged up dozens of extension cords and improvised booms with 2-by-4s. It wasn't a perfectly symmetrical or precisely aimed mock-up, but it demonstrated our design concepts to Boston Edison and the Landmarks Commission. It also helped us fine tune the design. We'd inspected the building, and we figured aiming angles based on sepias of the original building documents, but the mock-up told us more about fixture positions, aiming, and wattage.

We worked until two o'clock in the morning on the mock-up. That was average for us in the home stretch, because we had to do our tune-up work at night. Boston Edison decided to restart the clock and unveil the first-ever lighting of the tower at a public ceremony. So, we spent two weeks working with the electrical contractor from 10 p.m. until 2 a.m. to install and aim fixtures. Using two-way radios, our ground crew relayed aiming instructions to a crew working with the installers. After these work sessions, we would often go to our favorite Chinatown restaurant, the Lucky Dragon, and discuss our progress over a late dinner!

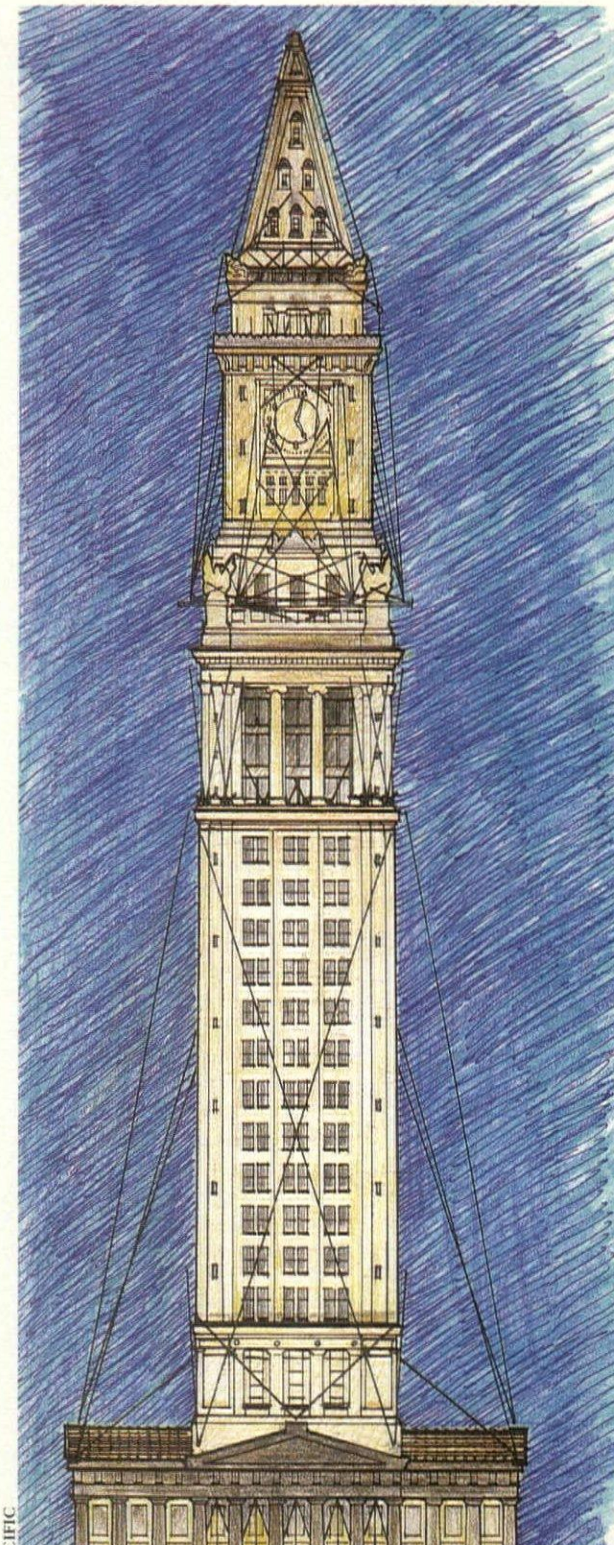
We had another unusual field condition to contend with. A state-protected pair of peregrine falcons live in the roof of the building. They're beautiful birds, but very territorial. During the mock-up, we were lucky: there were no falcons in sight. But when the contractor actually started installing the fixtures, the falcons came swooping out, very unhappy. The workers had to restrict their hours to times when the falcons were out of the building.

The lighting debuted on October 29, 1987, with a spectacular laser light and sound show. The illuminated Custom House tower has added drama to Boston's nightscape and generated enthusiasm throughout the community. Local preservationists are now encouraging the lighting of other historic buildings. As a utility, Boston Edison has shown customers that it is possible to aesthetically and efficiently light their own buildings. We hope our story helps other people who want to light landmarks and monuments. The teamwork really made this project a success for us, for the client, and for Boston. ■

For product information, turn to page 70 and see Manufacturers.

Custom House lamp and fixture requirements			
Fixture	**Lamp**	**Lamp Wattage**	**Number of Fixtures**
First floor			
Column uplights	PAR 38/3 SP*	150	29
Portico downlights	PAR 38 SP	150	5
Third floor (roof)			
Shaft lights	QT6CL VNSP	1000	12
Shaft lights	PAR 64 VNSP	500	4
16th floor (ledge)			
Column uplights	PAR 38 SP	150	32
20th floor (booms by eagles)			
Clock facade uplights	QPAR 38 SP	250	8
Clockface spotlights	PAR 64 VNSP	120**	8
Crosslights on eagles	QPAR 38 SP	250	4
Outside eagle wing	PAR 38 FL	150	4
Eagle breast	PAR 38 FL	75	4
Crosslights below eagles	PAR 38 FL	75	8
22nd floor			
Highlight door headers	A23/99	150	8
23rd floor (clockfaces)			
Number backlights	LPS	35***	48
Blue minute markers	Blue C.F.	7***	192
White minute markers	White C.F.	5***	48
24th floor (poles between dentils)			
Clockface downlights	PAR 38 FL	150	8
25th floor (observation deck)			
Column uplights	PAR 38 SP	75	16
Cornice uplights	PAR 38 SP	150	16
Ornament accent	PAR 38 FL	150	8
Roof			
Roof wash	PAR 38 SP	150	16
Roof ridge accent	QPAR 38 SP	250	4
Pinnacle accent	PAR 64 VNSP	120**	4

**Side-prong lamp for low-profile housing.*
***Lamp wattage on 6-volt transformer.*
****Lamp wattage only (not including ballast).*



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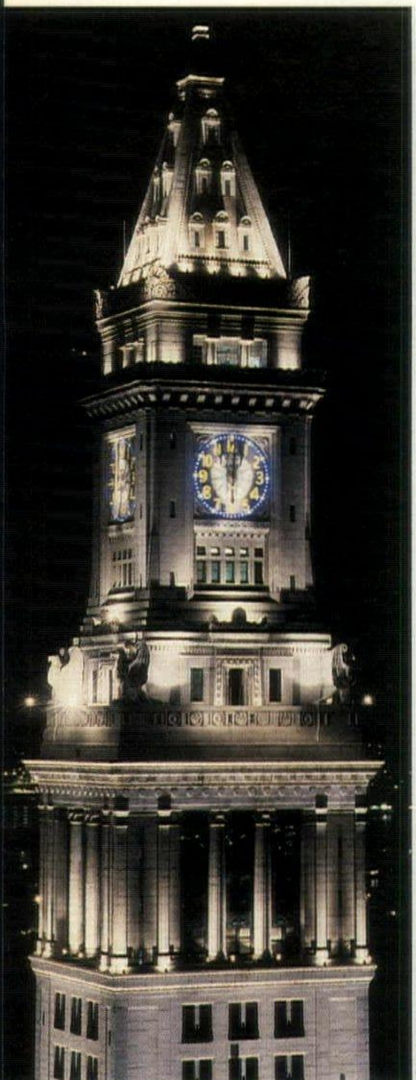


FAYFOTO

to wash the area around the base of the clock with 250-watt quartz PARs. This works well enough when the hands are horizontal, but the uplights reflect off too little surface when the hands are vertical. So we added downlights mounted on pipes that project above the clock.

The downlighting works very well for observers on the ground within a three-block radius and from the expressway. About 10 blocks away, you lose the angle of reflection and the hands don't read as well. If I could redo the job, which is historically impermissible, I would redesign the clockface to get more contrast.

Tower Lighting

Most designers would expect to use HID lamps on a project of this magnitude. But lighting the building from itself, and targeting specific features, required precise beam spreads available only with incandescent sources. We also wanted to render the building as accurately as possible, and incandescent afforded the best color for our purpose.

Given our selective lighting concept, we concluded that incandescent was actually the most energy-efficient source for the job. HID is more efficient in a zonal cavity situation, calculating lumens per watt when the source dumps light into a space. In this case, HID not only would throw far more lumens at a slender column or rosette than we needed, but also would dump half of the light into the sky. A 75-watt incandescent PAR spot on that feature instead can fully light it to the appropriate level. The compact, concentrated incandescent source is far more efficient in this situation than a higher-wattage HID source.

We used the lowest wattage possible, squeezing every possible bit of juice out of our light fixtures. Nine giant buck-and-boost transformers reduce the power supply to the entire system by 10 percent to 108 volts, thus conserving energy and extending lamp life. To fine tune the light output from the 12 low-voltage lamps in the system, we put them on a separate 2000-watt dimmer instead of the transformers.

Hardware

We used very simple hardware — in most cases just outdoor boxes with adjustable sockets and bare lamps. For critical locations, we designed custom stainless steel housings to surround those assemblies. Housings on the ledges have angled backs that redirect the spill light to provide infill on the lower portion of the target feature.

The housings also hide the hardware and protect the lamps. We could imagine a window washer putting a foot into a fixture, so durability was an important requirement. The stainless steel housings are very, very strong.

Mounting Measures

Although the building is not perfectly symmetrical on both axes, we wanted the lighting to be symmetrical. The eagle level (20th floor) was especially tricky. We designed pivoting booms to hold fixtures aimed at the eagles, rosettes, and clock. The $18^{1}/_{2}$-foot-long galvanized poles are pinned to the wall and stabilized with airplane cable. Quite a few feet out, just shy of the ledge, a heavy-duty rubber wheel rolls the pole back within reach. The booms are very easy to operate; in fact, we put a lot of mileage on them as we adjusted the fixtures to get the aim just right.

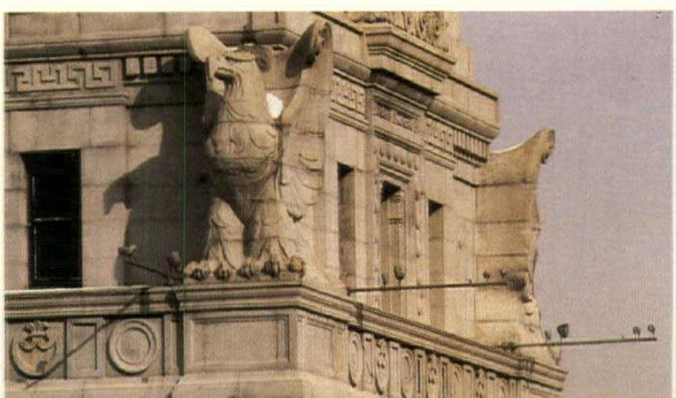
Balconies on the east and west sides allow easy access to the ledges, but those on the north and south sides are much shallower. On the east and west, we had a much easier time of it; those much larger balconies allowed us to climb up on the ledges and work with the fixtures directly. On the short sides, it was much tougher; safety belts were recommended to allow the workers to aim the fixtures properly.

For the clockface downlights, we cut into the granite and welded pipe sleeves perpendicular to the building — two above each face, tucked between granite dentils in the 24th floor cornice. Fixtures are mounted at the ends of longer, narrower pipes that rest inside the sleeves. For access, a worker pulls the narrow pipe from inside the building until the fixture is close enough to reach through a window.

Lamps

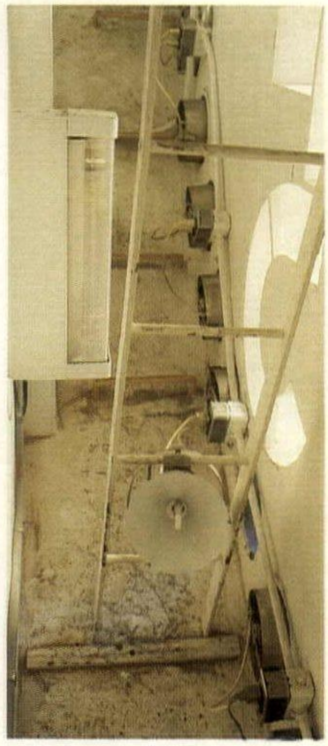
We were very concerned about maintenance and providing the easiest system for changing and adjusting lamps. The contractor helped us to modify the design and assured us the final result was workable.

Of the 195 incandescent lamps on the job, 175 are PARs in various sizes, wattages, and beam spreads. Readily available PAR 38s do most of the work. The accompanying table gives a detailed breakdown of lamps and fixtures for the tower.



Galvanized pipe booms on the 20th floor hold precisely focused PAR fixtures to light the clockfaces and decorative stone features.

New lighting illuminates the Custom House from street to peak with the same amount of power previously used to light only the clock. Precisely focused PAR lamps light tower exterior.



Clock backlighting was retrofitted with low pressure sodium for the numerals and compact fluorescent for the minute markers. One of the light-reflecting funnel units is shown pulled out of its cast concrete aperture. A white or blue compact fluorescent lamp fits inside each funnel.

The unusual clockface design is not very legible, even with the hands newly gilded to catch light. Lam Associates aimed uplights and downlights at the face.

standard lamps have low output in the blue range.

Clock Lighting

Surface lighting on the clockface was probably the toughest part of the job, and the one that drew the most criticism. The unusual face design is extremely difficult to light. After all, it was not originally designed for nighttime visibility.

Classic clocks on old buildings are readable because of sharp contrast: they have either dark hands on a luminous background or vice versa. The contrast makes the hands read against the numbers. The Custom House clockfaces, however, have an unusual color combination: a creamy white surface with a dark green starburst painted in the center. Unfortunately, the numbers are in a dark bronze band — and when a hand goes between numbers, your eye loses the dark hand on a dark band.

Someone had previously installed lamp holders all over the clock, trying to catch the moving hands. We went through some hoops to try to solve the problem more effectively.

We knew Boston Edison planned to replace the original 14-foot wooden minute hands — they overloaded the clock mechanism, continually breaking it down. A local company was making the new hands out of plastic composite. I drove over and carried one back on top of my car so we could experiment with it in our office. We mocked it up with various surface finishes (including diffraction tape and the glass beads used for white roadway lines), then hung it out a hatch on the west clockface to test lighting schemes.

Ultimately, we suggested goldleaf for the minute and hour hands to catch sunlight, and rounded off edges so we'd have a tangent to catch with our uplights. We intended to target the hands with 6-volt spots and

Lighting a historic 500-foot clock tower with PAR lamps

Solely by changing the types of lamps for the existing clock lighting, William Lam Associates saved enough energy to light the entire exterior of Boston's Custom House on the same power budget. We did it partly with a programmable controller: the clock lighting operates nightly from dusk to dawn, while the base and tower surfaces are lit just from dusk to midnight (2:00 a.m. on weekends). And, we did it partly with PAR lamps — a surprising choice for energy efficiency.

We never wanted to create an Empire State Building in Boston. Instead of making the tower stand out like a glowing beacon, our intent was to highlight the building's distinctive architectural features. For example, during the day, sunlight tends to wash out its decorative rosettes and 12-foot-high stone eagles; at night, lighting can bring out these elements without overpowering them. The selective lighting concept led us to choose incandescent lamps for the exterior. In the process, we had to cope with mounting locations above sheer dropoffs, a clockface design that resisted our best efforts to make it readable, and a pair of angry falcons.

Paul Zaferiou

Paul Zaferiou is a lighting designer with William Lam Associates, Cambridge, Massachusetts.

Lighting a Landmark

For nearly 150 years, Boston's most distinctive building spent the night in darkness. Its only exterior lighting (added sometime this century) was limited to a four-sided clock that often showed four different times. Finally, last year, Boston Edison funded a project to light the Custom House tower and repair its broken clock as a gift to the people of Boston. The landmark project also promotes exterior lighting and demonstrates energy efficiency.

The 147-year-old building is an architectural oddity. Originally, it was a four-story Greek Revival building topped with a dome. In 1915, the federal government built a 25-story Italian renaissance tower on top. The architect retained the dome, which is still visible inside the building. The 500-foot tower became Boston's first skyscraper because, as a federal building, it was exempt from the city code that limited building heights to 125 feet. At the time, its 22-foot-diameter clock dials were the largest in the country.

The clockfaces are 8-inch-thick precast concrete walls, perforated by 4-foot-high cast numbers. When we came to the job, the single-digit numbers were each backlit with four 40-watt gold fluorescent lamps, the double-digit numbers each had six of the gold lamps, and the minute markers each had a 60-watt incandescent lamp. The Boston Landmarks Commission, which had right of review on the project, decided to keep blue and gold filters that had been added in 1976 for the Bicentennial. In fact, retaining the gold filters allowed us to use low pressure sodium to backlight the numbers — a rare opportunity. A 35-watt source goes a long way in this application.

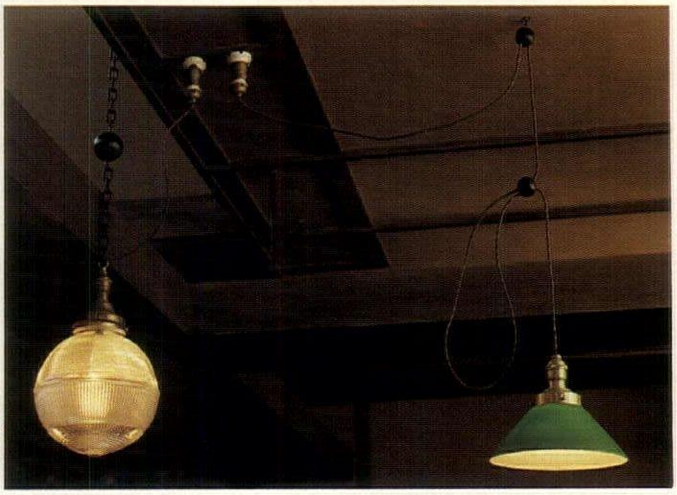
Behind the minute markers, compact fluorescent socket adapters were installed in the incandescent sockets, and copper funnels were fabricated to fit over the lamps. The funnels, painted gloss white inside, deliver virtually all the lumens directly to the minute markers. For blue markers, we had to use a special blue compact fluorescent to "punch up" the color because

Project: Custom House
Location: Boston
Client: Boston Edison
Lighting Designer: William Lam Associates
Contractor: Norton Electric
Building Manager: John Mavillio

An architectural oddity: a Greek Revival base for an Italian Renaissance tower.

JON MILLER, HEDRICH BLESSING

Originally, the drafting room had just one band of clerestory windows. To get more light, Wright raised the roof and added the second band. Anchor points for the balcony's hand-forged "chain harness" suspension system also support prismatic pendants.



DON KALEC

Wright's adjustable task/ambient lighting system. Prismatic globes efficiently distributed the weak light of early electric lamps; green glass shades could be pulled down close to a drawing. Under these lights, Wright and his draftsmen created documents for at least 136 executed designs.

home and studio, 32 were missing and had to be made anew. Almost all the rest had to be restored; their zinc cames were severely corroded, and most of the original copper and brass plating was gone. The old art glass panels were carefully cut apart and rebuilt with new cames.

Only a few cracked or missing pieces of colored art glass had to be replaced. Luckily, old samples of glass were found to match the originals. New art glass doesn't always match old colors; many of the original formulas have been lost or their use prohibited by Environmental Protection Agency safety regulations.

The Drafting Room

The 1898 drafting room is the only room in the studio without a skylight. Wright never explained why. Originally, light from above, so favored by Wright for his workspaces, was provided by a continuous band of wide clerestory windows around the top of the octagonal second story. In 1904, Wright doubled the amount of overhead light by adding another band of clerestory windows atop the first. He painted the plaster ceiling metallic gold to help reflect light down through the balcony opening to the drafting room below.

The first floor is also daylit from the north and east walls; each wall has two large casement windows connected by a long, high window. The main focus, however, is vertical —up toward the greatest source of light and out to a view of sky and tree tops.

Wright used stock electrical fittings and lamps in novel ways to provide task and ambient lighting. On the underside of the balcony, he placed 16 porcelain and brass sockets — two pairs on each side of the square opening. He ran twisted cloth-covered wire from each socket to a lighting fixture: one task and one ambient fixture per pair of sockets.

Hardly a trace of the innovative system remained in the room when restoration began. Luckily, enough concealed porcelain and brass ceiling sockets were found in other parts of the studio to be cleaned and reused in the drafting room; they would

DON KALEC

Survivors of repeated renovation, these old sockets were moved from concealed locations to replace missing exposed ones in the drafting room. Other antique stock parts — once worth only pennies — had to be laboriously recreated by hand for the restoration.

have been difficult and expensive to reproduce.

For ambient lighting, brass-canopied fixtures hang on chains from the balcony. They hold prismatic glass globes that distribute electric light in specific ways, depending on the angle and placement of small prisms cast into the surface of the globe. The manufacturer of the original prismatic glass globes donated new ones, which are still on the market.

For task lighting over each of the eight drafting tables, the power cord loops through a ceiling hook and suspends a brass socket and a conical shade. The cord also loops through two holes in a $^{1}/_{2}$-inch wood ball, a spherical adjuster that allows the shaded light to be raised and lowered. The ceiling hooks can also be moved as the drafting tables are moved.

Wright might be embarrassed today at the painstaking recreation of his wiring and suspension apparatus. "Wiring for lights, as piping for plumbing and heating, should not show all over the house unless by special design," he wrote in 1954, "any more than you would have organs of your body on the outside of your skin." ■

For product information, turn to page 70 and see Manufacturers.

JON MILLER, HEDRICH BLESSING

JON MILLER, HEDRICH BLESSING

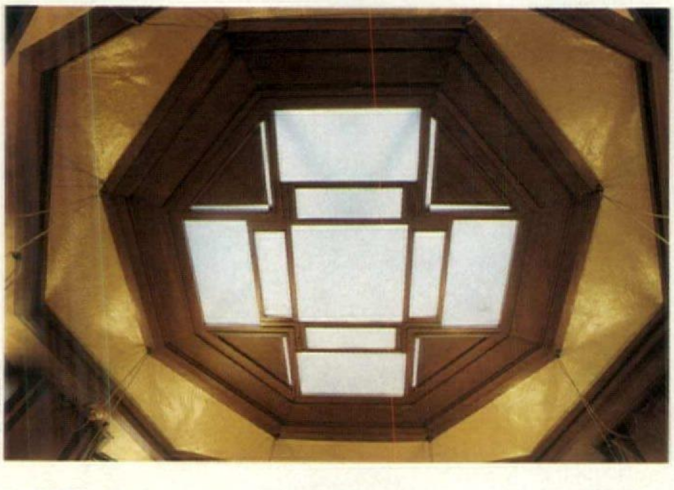
The octagonal library required a high light level for reading and presenting drawings to clients. In response to this need, Wright used a band of clerestory windows on seven of the eight sides, an 11-foot-diameter octagonal skylight that nearly covers the roof, and frosted glass panes set on a wooden framework. For relamping, the glass is simply pushed away.

frequently used in restoration projects to preserve a building under its new conditions — tourist traffic and higher electrical loads.

Art Glass

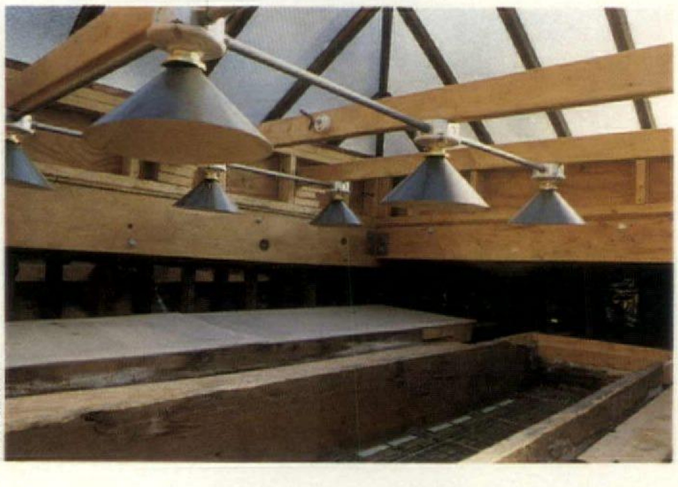
To provide a focus at the window plane without obscuring the view, Wright used rectilinear patterns of clear and colored glass in the casement sash. He used different width cames (the metal divisions between the glass) to make the designs more interesting and expressive.

Of the 110 art glass windows and laylight panels in Wright's



DON KALEC

In 1942, someone roofed over the leaking library skylight and painted the glass laylights to look like a plaster ceiling. Restoration saw the added roof torn off, the skylight replaced, and new sandblasted glass set in the original laylight frames.



DON KALEC

At night, electric lamps in the skylight wells replace daylight. These fixtures above the reception hall laylights are serviced via an access panel opening off the drafting room balcony. New thermal venting helps to disperse heat.

ing fixtures had to be substantially modified to meet code. For example, cloth-covered wiring was permitted for historic fixtures as long as it was new and UL approved. Energy use was not an issue; appearance and light quality were paramount, because the restoration was to be as accurate as possible.

Lighting God's Way

"The best way to light a house is God's way," Wright declared in 1954. "Day lighting can be beautifully managed by the architect if he has a feeling for the course of the sun as it goes from east to west and at the inevitable angle to the south. The sun is the great luminary of all life. It should serve as such in the building of any house."

Extra-large windows or bands of windows, wrapping around the corners of bays, fill Wright's interiors with light. Windows placed high on the wall, near the ceiling, throw light back into the depths of rooms.

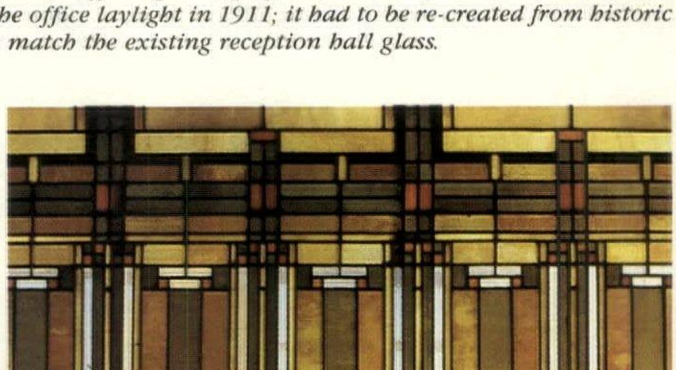
Although Wright relied mostly on windows to light residences, including his own home, he preferred lighting public spaces from above by placing most of the windows around the top of the room. He usually also put a large skylight in the center. He followed this scheme throughout his 1898 studio complex and in all the significant public buildings he designed.

JON MILLER, HEDRICH BLESSING

Most of the reception hall ceiling is made up of three art glass laylights deeply framed by wooden beams. The adjoining private office (photo, page 20) has a 4-foot by 7-foot laylight over the desk. Wright removed the office laylight in 1911; it had to be re-created from historic black-and-white photos. Colors match the existing reception hall glass.

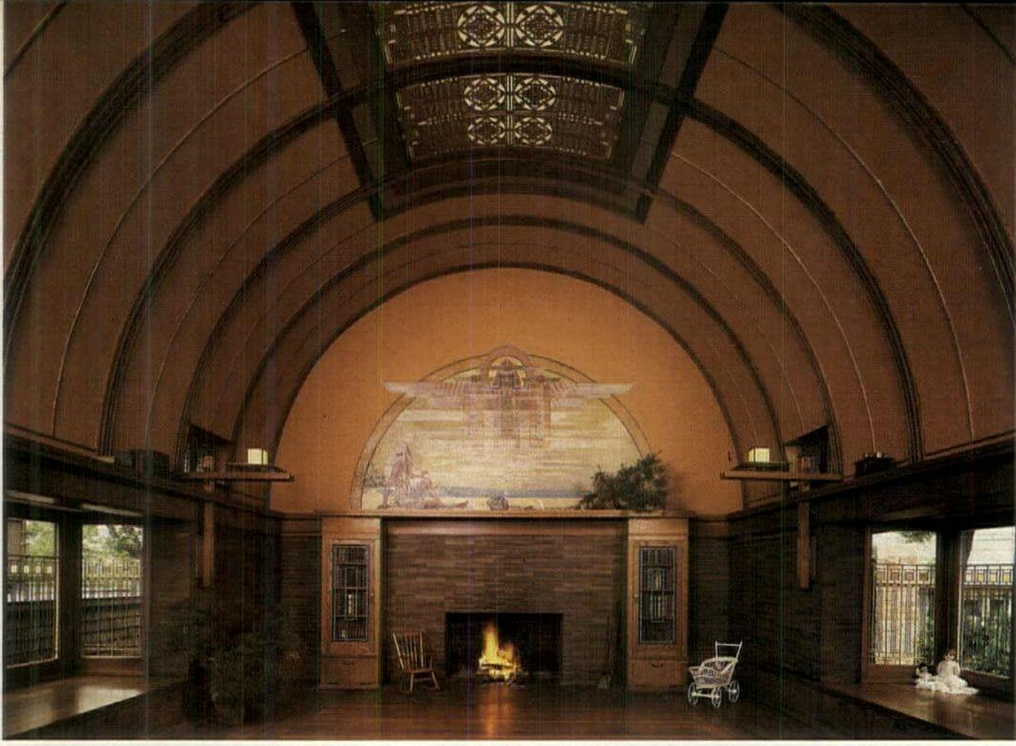
Below the studio's rooftop weather skylights, Wright used laylights — horizontal glass panels set in the ceiling to diffuse the light and hide skylight panes from view. In the skylight well, rudimentary electrical fixtures with porcelain sockets and conical sheet-metal shades provide general night illumination, "as nearly like the day as may be."

Unfortunately, the galvanized sheet-metal skylights in Wright's home and studio rusted out over the years. Copper replicas now faithfully duplicate the geometry of the deteriorated originals. To disperse heat, each skylight well now opens to an attic space with a mechanical vent controlled by a temperature switch. This kind of invisible update is



DON KALEC

Detail of reception hall laylight. Wright used solid brass cames and colored glass in a tapestry-like geometric pattern. These laylights were in place when restoration began; they needed only cleaning and minor repairs.



JON MILLER, HEDRICH BLESSING

So that light would seem to come from the structure itself, Wright covered the 1895 playroom's pyramidal skylight with a curving wooden grille. Electric wall sconces and fixtures in the skylight supplement firelight after dark.

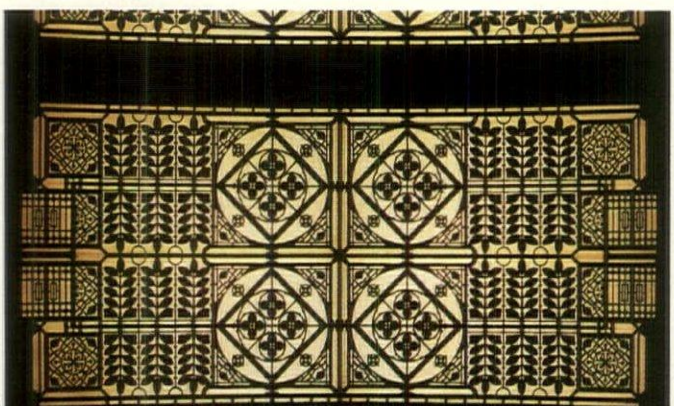
bare-lamp wall sconces for general lighting in his own quarters and in many of his midwestern Prairie houses (1902–1917) as typical fixtures for living rooms, halls, bathrooms, and bedrooms. During those early years, he reserved special electrical fixtures for special rooms.

Wright's own 1895 formal dining room features his first use of recessed electrical lighting, which was one of the first in the United States. The new electric light, unlike gas light, could be completely enclosed. To screen lamps from view, Wright designed a wood ceiling grille set flush with the plaster ceiling. The grille's decorative openings were hand cut with a fret saw in a thin oak veneer mounted on a light wood frame.

In 1974, only the plastered recessed cove — with added fluorescent lights — was still in place. Marks on the original cove casing showed where hinges had allowed the missing grille to swing down for relamping. The frame was found in pieces in the basement; the decorative veneer had long before disintegrated.

Using historic photographs as a guide, the associate restoration architect for the dining room, Robert A. Bell, drew the grille design full size. A print of the drawing fixed to a $^1/_4$-inch sheet of oak plywood served as a template for the millworker, who carefully cut out the openings with a saber saw fitted with a fine blade. Even with a power saw, the process took 30 days.

The plywood was mounted on a new wood frame and installed in the cove opening. Because of fire regulations, tan fiber glass simulates the original rice paper diffuser. Electrical boxes with porcelain sockets were simply flush-mounted in the recessed cove and connected together with exposed conduit.



DON KALEC

The playroom's diffusing grille design is a geometric abstraction of the seed pods, blossoms, and leaves of the prickly ash tree. Both the playroom and dining room grilles had to be painstakingly recreated from photos.

Skylit Playroom

Wright designed similar diffusing grilles for the barrel-vaulted playroom he added to his home in 1895. The ceiling opening below the room's skylight is divided into four sections by curved wooden trim — continuations of the wooden ribs that band the vault every 3 feet. Curved grilles keep the ceiling form unbroken.

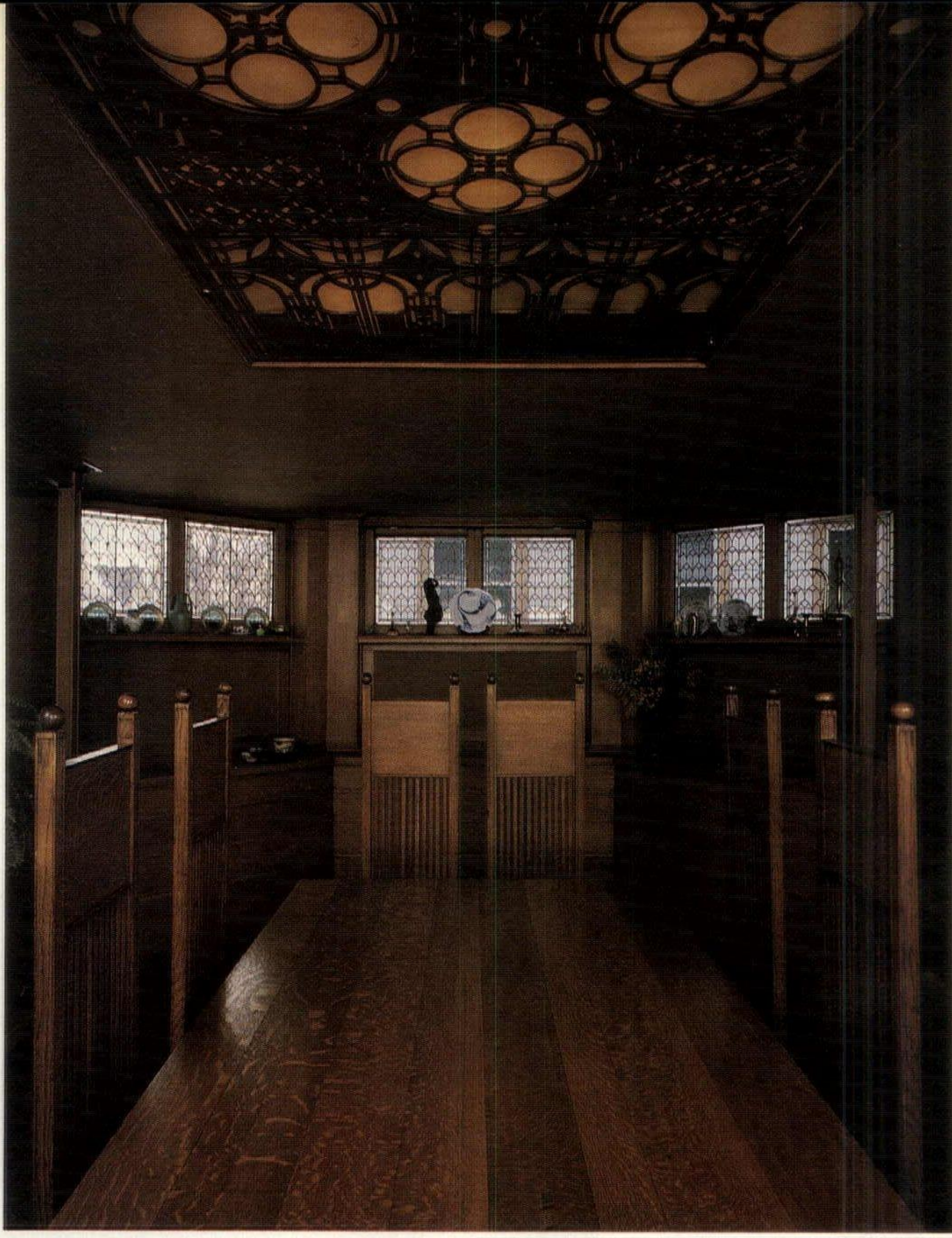
Only the grilles' removable wood frames remained when the Foundation acquired the property. Fortunately, an original grille had been photographed in the woodworker's shop right after it was made. The design was easily drawn from the photograph and transferred to $^3/_{16}$-inch oak plywood. Cabinetmaker Mark Duginske used hand and power tools — drills, chisels, gouges, a fret saw, and a saber saw — to reproduce the grilles. The plywood was easily bent to the gentle arc of the original wood frame, then glued and nailed to it.

Restoration Research

During restoration planning, selective probes into the ceiling and wall cavities revealed evidence of the structure, lighting, additions, alterations, colors, and materials. In some rooms, wall and ceiling light fixture locations were revealed when plaster was removed: cut-off ends of the original wiring marked the location of earlier fixtures. Some wires were still connected to porcelain light sockets, which had been unscrewed and pushed into a joist or stud space.

Light fixtures were reproduced for this project using photographs taken between 1890 and 1918; no fixture drawings or specifications survived. Restoration drawings had to be scaled from historic photos and existing original fixtures. Wright-designed fixtures that were installed after 1909 were removed and put in archival storage.

Because the Oak Park building code has provisions for historic buildings, none of the light-



The 1895 formal dining room features Wright's first art glass design and his first use of recessed electrical lighting.

Simple-looking wall sconces, found throughout the home and studio, are complex constructions of brass and oak. The original clear glass lamps radiated a soft, dim light — not bright enough to glare.

Wright's first lighting fixture design (1889). Four white glass globes illuminate the living room from its corners. The foliate plaster panels are quite unlike his later abstract geometric motifs.

The young architect's home grew rapidly as his family and his reputation expanded: a playroom, kitchen, and dining room addition in 1895, a studio complex in 1898. Wright constantly altered his residence and his workspace, too, experimenting with new architectural ideas. Then he left for Europe in 1909, ending his work and family life in Oak Park. The building changed drastically in 1911, when he moved to Wisconsin. He added new garages, sealed off the house as a rental unit, and completely remodeled the studio as a residence for his wife and children, who lived there until 1918.

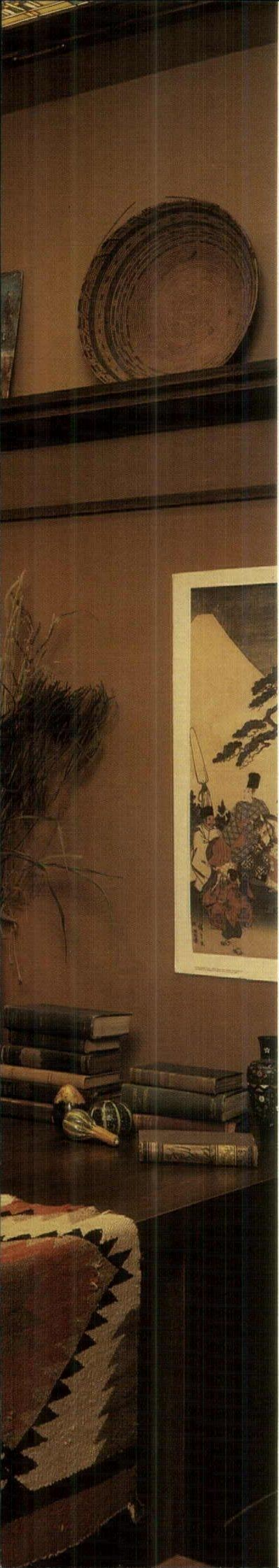
Wright lost the property to pay off a debt in 1925. Over the years, subsequent owners converted the building into a six-apartment complex. In 1974, a local group joined with the National Trust for Historic Preservation to buy the property and open the home and studio for public tours. The group also undertook a massive project to restore the building to its 1909 design, the last year Wright lived and worked there.

The lighting fixtures now in the home and studio are true to the 1909 date chosen for the restoration, except for the lamps. The originals gave a soft, but dim, orange light because of their low wattage (less than 7 watts). Such a low lighting level could create a safety problem for the 60,000 tourists who visit the building each year and would make some rooms too dark to see details. Today's higher wattage (30- to 60-watt) lamps provide a brighter light, but, like the originals, they have clear glass bulbs with glowing wire filaments.

Integrating Fixtures and Structure

Wright wrote in 1954 that electrical lighting "should be an integral part of the house — be as near daylighting as possible. In 1893, I began to get rid of the bare light-bulb and have ever since been concealing it on interior decks or placing it in recesses in such a way that it comes from the building itself; the effect should be that it comes from the same source as natural light."

Nonetheless, Wright used



CHESTER BRUMMEL

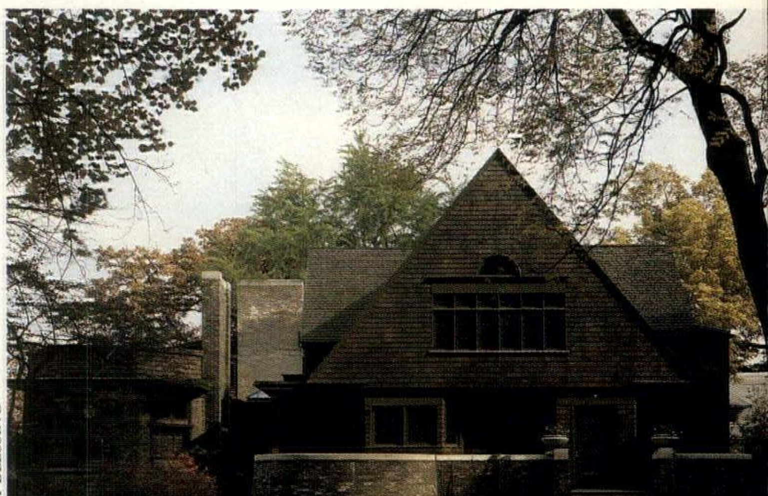
Restoring 1909 lighting in Frank Lloyd Wright's home and studio

ARTICLE BY
DONALD G. KALEC

No electricity was available in the Chicago suburb of Oak Park when Frank Lloyd Wright built his first home there in 1889 — but he knew it was only a matter of time. The newlywed Wright, who was only 22, worked as chief draftsman at the architectural office of Adler and Sullivan. The firm was just finishing the Auditorium Building, one of the first large structures in the United States to be completely electrified at the time of construction, so Wright had firsthand knowledge of electrical service in buildings. He wired his new house and waited for the power, which arrived in 1891.

Wright later wrote of the conventional architecture of the period: "Steam heat, plumbing, and electric light were the only redeeming features, and these new features were hard put to it to function in the circumstances. Bowels, circulation, and nerves were new in buildings. But they had come to stay and a building could no longer remain a mere shell in which life was somehow to make shift as it might."

Wright borrowed his first lighting fixture design — a white glass globe centered in an ornate plaster panel — from the Auditorium Building. Soon, he was creating his own custom fixtures for the house, then rearranging, replacing, and modifying them.

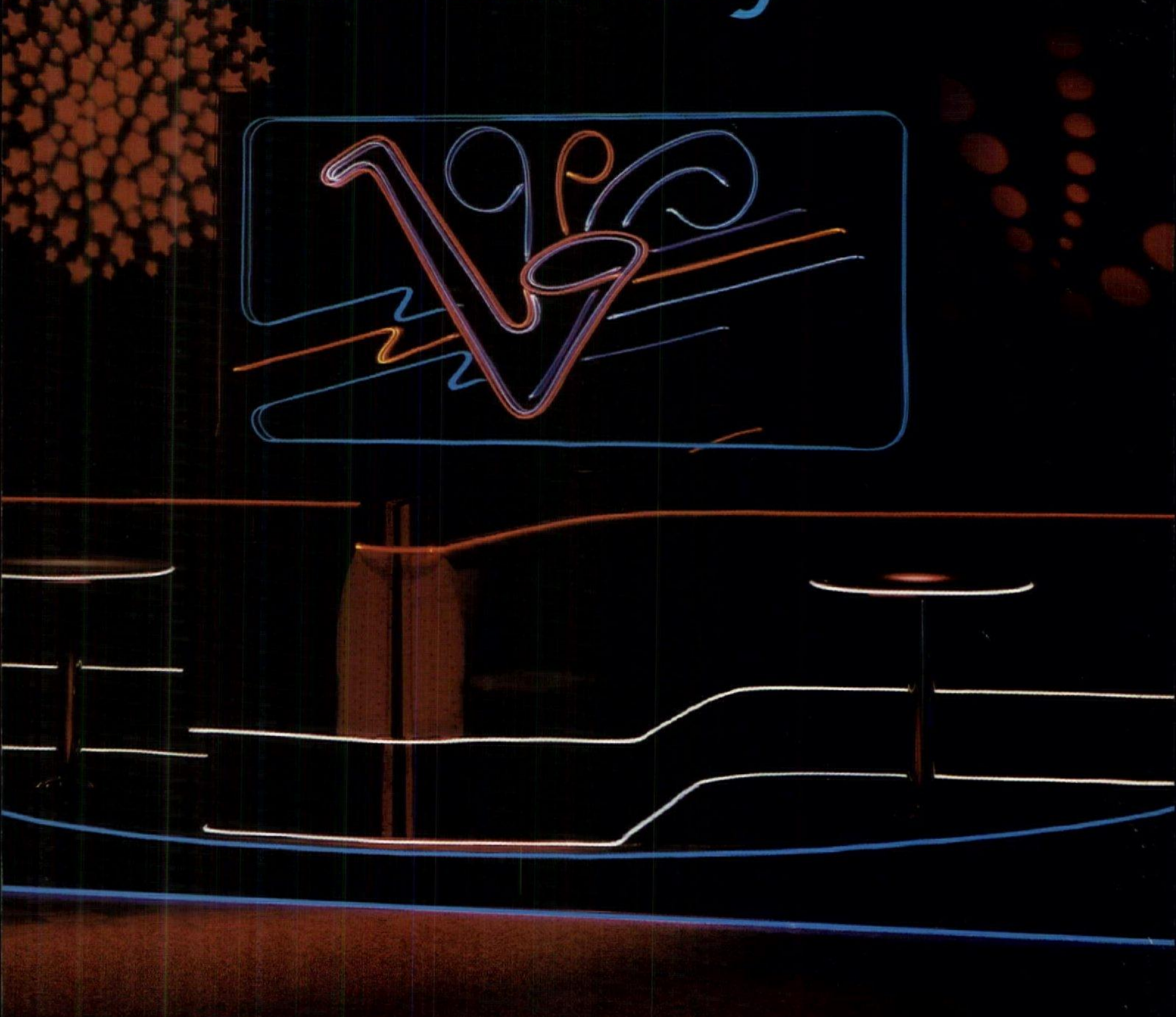


JON MILLER, HEDRICH BLESSING

Wright's home (above) and private office (left).

Project: Major restoration, The Frank Lloyd Wright Home and Studio
Location: Oak Park, Illinois
Owner: The National Trust for Historic Preservation; restored and administered by the Frank Lloyd Wright Home and Studio Foundation
Architects: The Restoration Committee of the Foundation; Donald G. Kalec, director of research and restoration; Ann K. Abernathy, project architect
Associated Architects: John Vinci and Robert A. Bell
Landscape Architects: The Natural Garden
Special Architectural Consultants: Lloyd Wright, David Wright, and Eric Lloyd Wright
Lighting Designer: Frank Lloyd Wright

the 21st Century



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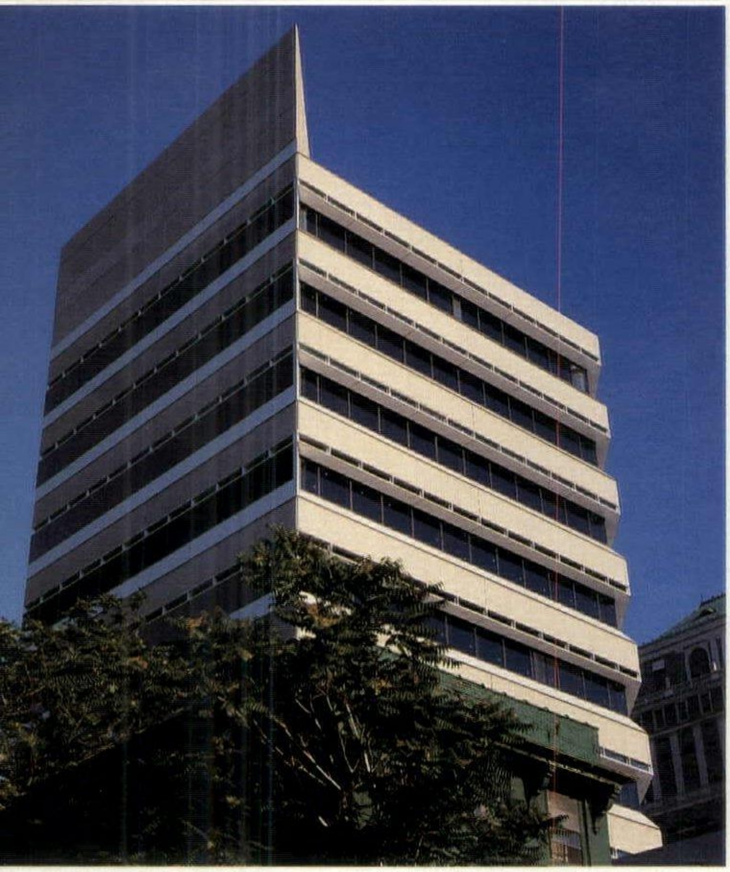
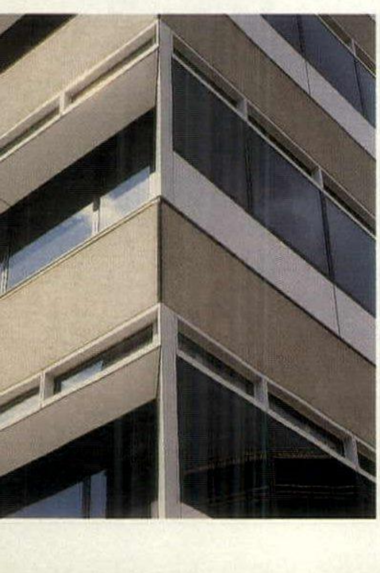
5-year energy analysis shows daylighting saves dollars





Project: Norstar Building
Location: Buffalo, New York
Architects/Engineers: Cannon
Architect Team: Mark Mendell, Edward Cannon, Hans Kullerkupp, Charles Gordon
Director of Engineering: Alan Sloan
Electrical Engineer: Ron Parsley
Interior Designer: Douglas Purcell
Landscape Architect: Gary Scott
Photos: Patricia Layman Bazelon

Too often, architects and engineers walk away from a completed building without ever turning to assess how well it works. But designers at Cannon tracked the actual performance of the Norstar Building in Buffalo, New York, which incorporates daylighting as a strategy to cut energy costs.

Norstar's footprint, orientation, and fenestration optimize the amount of daylight available within the building. Sunlight reaches 90 percent of the facade during the day. The northeast side has flush glazing; the southeast side has recessed glazing and light shelves. Daylight effectively lights office areas on all sides within 15 feet of the windows; only the narrow service core receives no daylight.

Electrical lighting has a daylighting control system on 11 of the 12 floors. Fixtures zoned in two bands are wired to fiber-optic photosensors that constantly monitor light levels and adjust lamp output to maintain 60 footcandles. The adjustment occurs without switching, stepping, or delay.

Cannon received a national energy conservation award for Norstar on the basis of its design projections. Rather than rest on their laurels, though, Cannon engineers installed a computerized energy monitoring system, then did a follow-up study after five years of operation at full occupancy. Electrical engineer Ron Parsley, who designed the building's electrical lighting systems, plotted energy-consumption during 1983–1987. He found that Norstar's average energy consumption is 16 kilowatt hours per square foot per year — 60 percent higher than originally projected.

Parsley went looking for answers. He discovered that the building is being operated differently than Cannon anticipated. "We found that a computer facility is operating 24 hours a day, the building operating hours are about 20 percent longer than expected, and the light shelf and lighting control system have been disabled in a few instances." Taking these factors into account, Parsley says, the building's performance is closely in line with the original projections.

Because the power consumption records are not broken out by load, some interpretation is needed to isolate the lighting component. Parsley evaluated daily energy-use plots from different seasons to observe how daylighting contributes to the total. "During the winter, less daylight is available because the sky is gray and days are shorter. This accounts for a long, flat plateau at the top of the curve," he explains. "The other seasons have longer days and clearer skies, thus accounting for a shorter plateau.

"From spring through fall, a dip occurs in the curve while the sun passes from one side of the building to the other. This reduction in energy use is partially caused by the lighting control system reacting to the sun angle." The results indicate that even with a few impairments in the system, daylighting really is saving energy at Norstar.

—Gareth Fenley

For product information, turn to page 70 and see Manufacturers.

Fiberstars™: Lighting for

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Fiberstars' new High Intensity "lateral-mode" fiber optic light tube is made of durable plastics *so, unlike glass, it won't break—and there's nothing to burn out in the light tube.* It always looks beautiful. It even cleans easily. There's only one bulb to change in the light box—and you can run the light tube 100 feet between light boxes.

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Low-voltage system lights offices dramatically

Project: Opus Southwest Corporation headquarters
Location: Phoenix, Arizona
Client: Opus Southwest Corporation, division of Opus Corporation
Architects: Gensler & Associates
Lighting Designer: Patrick B. Quigley & Associates
Electrical Engineer: Spectrum Electric
Interior Designer: Gensler & Associates
Photos: © 1986 Al Payne

Dramatic low-voltage halogen lighting is an unusual choice for an office environment. It was the most technically demanding of several schemes proposed. But the clients wanted their new offices to reflect Opus Southwest Corporation's image as an organization on the cutting edge of technology.

Lighting designer Patrick Quigley placed packs of recessed low-voltage fixtures in public areas, overlapping beam edges to soften the starkness of the MR16 light sources. In the reception area, for example, they highlight the central desk and nearby lounge seats. A decorative halogen task luminaire and fluorescent strips under the desk counter supplement and soften the low-voltage units aimed at the work surfaces and the receptionist.

A glass-block wall curves around the corner and separates the reception area from offices and conference rooms. The wall also serves as a backdrop for displays of projects, each highlighted by a ceiling-mounted low-voltage monopoint spotlight. Recessed adjustable fixtures, spaced 2 feet on center and aimed directly at the glass, backlight its entire length. Breaks in the walls behind the glass blocks called for this unusual solution, says Quigley.

Quigley eliminated reflected glare from adjustable low-voltage fixtures in the large conference room by centering a cluster over the highly polished table and placing other fixtures in line with its edge. "The units over the table are aimed straight down," he says, "so they act as fill light at the work surface. Adjustable fixtures along the sides were placed just beyond the right shoulders of those seated at the table and aimed at an angle to throw light on the surface in front of them. Reflected light is directed away from the eyes of those sitting on the opposite side."

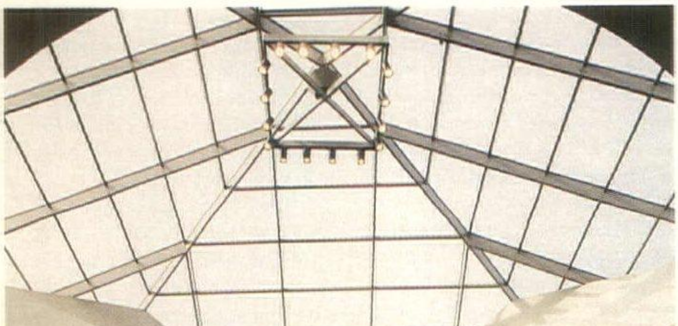
The low-voltage system and fluorescent fixtures in offices around the building's periphery allowed Quigley to reverse the standard scheme of fluorescent troffers and incandescent task lights. In the open-plan area, for example, custom halogen uplights wash ceilings with soft indirect light, and fluorescent task lights illuminate desk surfaces.

When the clients were considering their lighting options, Quigley warned them that the low-voltage design might require more frequent relamping and maintenance than a more conventional system. However, few lamps have failed during the first year, and the clients report that the low-voltage system has required no more attention than their previous standard one. Quigley purposely overengineered light levels to encourage dimming, which helps prolong low-voltage lamp life. Perhaps the best result of all is that the clients, who participated actively in the project, have deepened their own commitment to well-planned lighting in future projects.

—Susan Degen

For product information, turn to page 70 and see Manufacturers.

Industrial device solves lighting maintenance problem in atrium



Project: Hughes-Trigg Student Center, Southern Methodist University
Location: Dallas, Texas
Architect: Harwood K. Smith; George Richie, partner-in-charge; Cliff Horsak, designer; Craig Stockwell, project architect
Engineer: Arjo Engineers
Interior Designer: Lynn Perry
Photos: King Douglas

The casual ambience that makes atria so desirable can be offset by the difficulty of lighting them effectively. Daylight may be inadequate at ground level, and electrical lighting problems can include fixture access (for relamping or light adjustment) and concealment of wiring or other components. An atrium in the new student center at Southern Methodist University takes advantage of an industrial lowering device to help solve some of its lighting problems.

Daylighting is provided for SMU's 60-foot-wide, octagonal atrium by a geometrically designed, domed skylight. Its 40-foot height posed a night lighting design challenge for architects George Richie and Craig Stockwell and designer Cliff Horsak. Together, they designed a track lighting fixture that uses PAR 38 floodlights mounted on a 12-foot-square aluminum frame that is suspended from the dome's apex.

The access problem was solved by installing an electrical lowering device more commonly seen in industrial applications. The system allows maintenance people to mechanically detach the fixture from its mounting and lower it to ground level using a system of cables. The lighting circuit disconnects when the frame leaves its mount — an important safety feature.

"The lowering system is an absolute necessity because of the height of the lighting fixture," says Ed Williams, associate director of the SMU physical plant. "The only other way to relamp would be to set up some type of scaffolding, which wouldn't be practical or cost-effective." The device was recommended for use in the atrium by the building engineers who use the system in the university's Moody Coliseum sports facility.

Long-life, 2400-hour lamps on a photoelectric cell also cut costs by making the need for relamping infrequent — probably once a year, according to Williams. "We've been in this building since last October and we haven't had to relamp yet," he says.

Aesthetically, the fixture and lowering device work well together. The square fixture repeats and blends unobtrusively with the square design of the central portion of the dome. The cables for the lowering device run along the skylight's structural members, and the operating location is concealed in a ceiling plenum on the second level of the atrium.

The atrium has become a popular gathering place. Lunchtime events have included a jazz piano concert and a demonstration by a professional pool player. In the evening, students may gather in the atrium for a theatrical production or a College Bowl final. Although the problem of adjusting the lighting for different types of events has yet to be solved, the lowering device has made possible safe, economical and convenient ground level lighting fixture servicing.

HKS construction administrator Tom Hampton sums up: "It's an interesting application for something you wouldn't expect to find here."

—Joanne Wolfe

For product information, turn to page 70 and see Manufacturers.

Lighting improved, energy conserved, Apollonians happy

Project: Apollo Computers
Location: Chelmsford, Massachusetts
Electrical Engineer: Richard Hadley
Photos: George Riley

The primary goal when Apollo Computer relit 600,000 square feet of office space was saving energy. The icing on the cake has been an unforeseen enthusiasm for the new system among employees.

The incentive for an energy-conserving retrofit was two-pronged: problems with the old system and the promise of a rebate with the new. Senior electrical facility engineer Richard Hadley says, "We had a lamp failure rate of 28 percent and a ballast failure rate of 16 percent over three years with the old lights. When Massachusetts Electric offered an 80-cent rebate for every approved lamp installed, it helped us make our decision."

Apollo's managers replaced ballasts and lamps that dated to the company's start in 1980. The new ballasts, Hadley says, are the key to the energy savings. The old system's three-lamp fixtures consumed 0.138 kilowatts; its four-lamp fixtures used 0.181 kilowatts. The new ballasts drop those numbers down to 0.078 and 0.108, respectively, decreases of 43.5 and 40.3 percent. Also, because they run cooler, they're expected to knock $15,000 off the annual air conditioning bill. Altogether, Apollo projects annual electricity savings of $285,000!

Because the new ballasts, unlike the old, are electronic, Apollo managers worried about electromagnetic interference and radio frequency interference around their computers. They were relieved to find the fixtures' shielding sufficient to prevent that.

Sixty percent of Apollo's employees work at video display terminals. Both new and old systems featured parabolic lenses to reduce glare. Under the old system, workers frequently complained about uneven color rendition after lamp changes. The color shift had no direct effect on their work, "but people looked sicklier than they do now," Hadley says, "with the greens and blues prevailing disproportionately over the reds and yellows." Lamps in the new system have a color temperature of 3100K and a color rendering index (CRI) of 75. The CRI of the old lamps was 60.

"Cleaning up the diffusers with the new lamps has made for a more pleasant, relaxed work environment. People feel that the light levels have increased, but actually they've stayed the same," Hadley says. The company plans to install the same combination of lights and ballasts in its 300,000-square-foot research facility, scheduled for construction this winter.

—Mike Heffley

For product information, turn to page 70 and see Manufacturers.

Lighting Clinic

Scientific disagreement

The California Building department wants fluorescents to be used. Most people say fluorescent is bad for skin cancer. Is there an ultraviolet-free fluorescent lamp?
Reader
Santa Barbara, California

The only report in the medical literature that attempts to relate fluorescent lighting to human skin cancer has stimulated a great deal of scientific disagreement. Further studies are under way to determine its validity. At this time, the study's findings can be considered a speculative correlation and certainly not proven.

Whether fluorescent lamps are bad for the skin and whether they might cause skin cancer is not precisely known. The wavelengths of light emissions from fluorescent lamps differ with different types of lamps, the presence or absence of plastic covers over the lamps, the distance from lamps that people work, and the length of time people work under them.

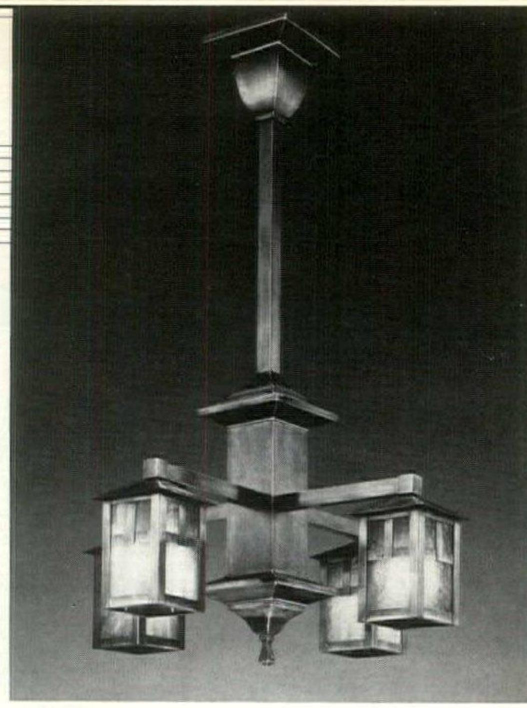
Ultraviolet (UV) light is carcinogenic, especially in the short wavelengths (sunburn spectrum, 280–320 nanometers). Longer wavelengths (320–400 nanometers) may also be a contributing factor in skin cancers. Some evidence suggests that the combination of both UV wavelengths induces skin cancers, especially when individuals with light, unpigmented, readily sunburned skin are exposed to sunlight over a lifetime. The skin "remembers" all UV light exposure over its owner's life; each time UV light hits the skin, it causes damage. After many years of continuous UV light "insults," the skin can reach a threshold that induces carcinogenesis.

Fluorescent lamps emit some UV light — with peaks at 298, 302, and 313 nanometers — but in very low doses, much lower erythema (sunburn) amounts than are found in terrestrial solar radiation. The specific wavelengths and intensities of UV light emitted vary with the type of lamp, its glass envelope and other covers (which may absorb UV light), and any defects in the tube (which may increase UV emissions). Further, the amount of UV light falling upon individuals varies depending upon, for example, the distance between the lamps and the work area and the position of indirect or overhead lighting.

Rare occurrences of skin reactions to fluorescent light have been reported in the medical literature, but these instances have involved individuals who are unusually sensitive to very small amounts of UV energy and have no known relationship to skin cancer. There is also evidence that fluorescent light causes mutations in cultures of mouse embryo cells, but this highly specialized research situation may have little relationship to human skin carcinogenesis.

It appears that although fluorescent lamps may emit small amounts of UV light, they are not likely to play a significant role in skin carcinogenesis, especially if the lamps are enclosed within glass and plastic covers.

Frank Parker, MD
Professor and Chairman
Department of Dermatology
The Oregon Health Sciences University
Portland, Oregon



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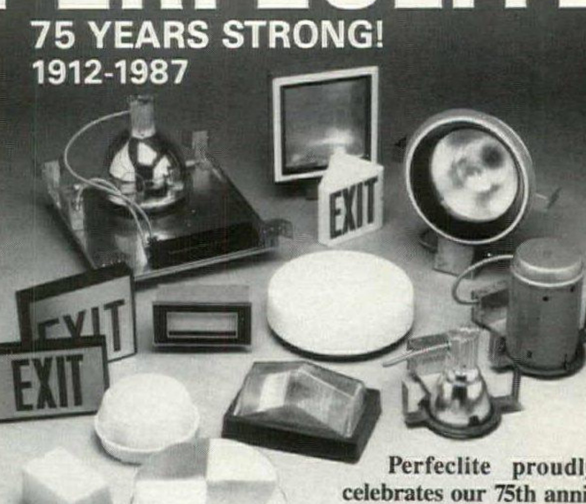

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Guest Editorial

Eight years ago this month the field of architectural lighting suffered a monumental loss with the untimely death of John E. Flynn. John was a Professor of Architectural Engineering at Penn State University and an architect and lighting consultant. He died of cancer at a hospital near his home on Monday, August 25, 1980. The annual conference of the Illumination Engineering Society of North America was in session in Dallas at the time and word of his death swept through the meeting rooms and corridors on a wave of disbelief and sadness. John was known and liked by all in attendance, having been a member since 1956 and the immediate past president. In spite of the seriousness of his illness, his death seemed, somehow, unimaginable and impossible. The loss of this unique individual during the prime of his life was individually tragic and professionally significant. Time has proven it to be even more significant than first thought.

I first met John in the summer of 1955. We were both starting our professional careers in lighting and architecture with the General Electric Company at its Nela Park Lighting Laboratories in Cleveland, Ohio. Our friendship developed quickly out of a common need as architects in a building top-heavy with engineers, many with degrees in a strange sounding science called illumination engineering. Our mutual interest in lighting, as distinguished from engineering, soon labeled us as accomplices and advocates of an untested proposition suggesting that, perhaps, footcandles were not the only significant measure of lighting design and performance.

In late 1958, I moved on to private practice; John stayed with GE to further his lighting education and to participate in projects like the lighting design for the 1964 New York World's Fair. This was also the time he developed his interests in the psychological and motivational influences of lighting. In 1962 we coauthored a book titled *Architectural Lighting Graphics*, devoting three grueling years to the effort — which predated word processing, press-type, and computer graphics. This was my introduction to John's unique command of the English language, with his easy-to-read style and clear technical and architectural expressiveness. In 1970 he published a second book titled *Architectural Interior Systems*.

In 1964, John left GE for private practice; in the ensuing years, he compiled an impressive list of professional accomplishments. He was on the faculties of Michigan, Columbia, Yale, Pennsylvania, Kent State, and Penn State Universities. In 1965, he was awarded the Arnold Brunner Scholarship Award from the New York Architectural League and the Technical Achievement Award from the Cleveland Engineering Council. He was made a Fellow of the Illuminating Engineering Society in 1973. His considerable contribution to the national and international lighting community during these years was dedicated and ongoing. He served in official capacities, worked on many committees and study groups, and published numerous technical papers and articles on lighting application and research.

He started his most important work, I believe, at Kent State University in 1967 and continued it at Penn State until his death. It involved research on the effects of lighting on human judgment, attitudes, and behavior and was funded by the Illuminating Engineering Research Council. It was important for many reasons, but primarily because it included input from environmental and behavioral scientists and employed a new research methodology not traditionally associated with lighting research.

The technical papers and articles published on this research should be required reading for all students and practitioners of lighting design. A published compilation of all his articles and papers would be a worthwhile and welcome addition to anyone's lighting library — if it were available. In 1973 John wrote an article titled "Concepts Beyond the IES Framework." In it he suggested that our long-range survival as professionals and as an industry depends upon a better sense of humanism in our lighting practices. He argued that there is considerable evidence that light makes an identifiable contribution to our quality of life, and that the value of this contribution should be considered along with other items in the accounting of desirable environmental factors and building budgets.

He identified active involvement in this work as currently being outside the IES framework, but he looked for and expected future IES leadership in this area. This expectation came true, but lasted only as long as his term in office as president. This is not a criticism of the IES but is offered to reinforce the uniqueness of his understanding of this fascinating area of research. His premature death has left an immeasurable gap in the field of environmental lighting research and education. Unfortunately, no one has taken on the challenge of continuing his work. His dream of finding usable answers to the puzzles of the psychological and motivational aspects of lighting now seems unobtainable — at least in the near future. Nevertheless, I believe it would be worthwhile for appropriate academic institutions and professional societies to begin a coordinated effort to encourage and support a continuation of this research.

For me, the most astonishing revelation of the last eight years is the almost total lack of recognition of his substantial accomplishments by the very institutions and organizations he served so well. Except for a small proprietary research fund and the naming of an illumination lab in his honor at Penn State University, recognition has been strangely and unexpectedly absent. At the very least, he should be considered a worthy and overdue candidate for the IES Gold Medal.

Sam Mills, AIA, IES

The John E. Flynn Memorial Illumination Research and Scholarship Fund at Penn State provides research and scholarship funds in architectural engineering to outstanding students studying illumination. It is funded by $5000 from an Illumination Engineering Research Institute grant awarded to John for education and research. Available funds are awarded from accumulated interest. Contributions can be made to the Office of University Development, Planned Giving, Two Old Main, The Pennsylvania State University, University Park, PA 16802.

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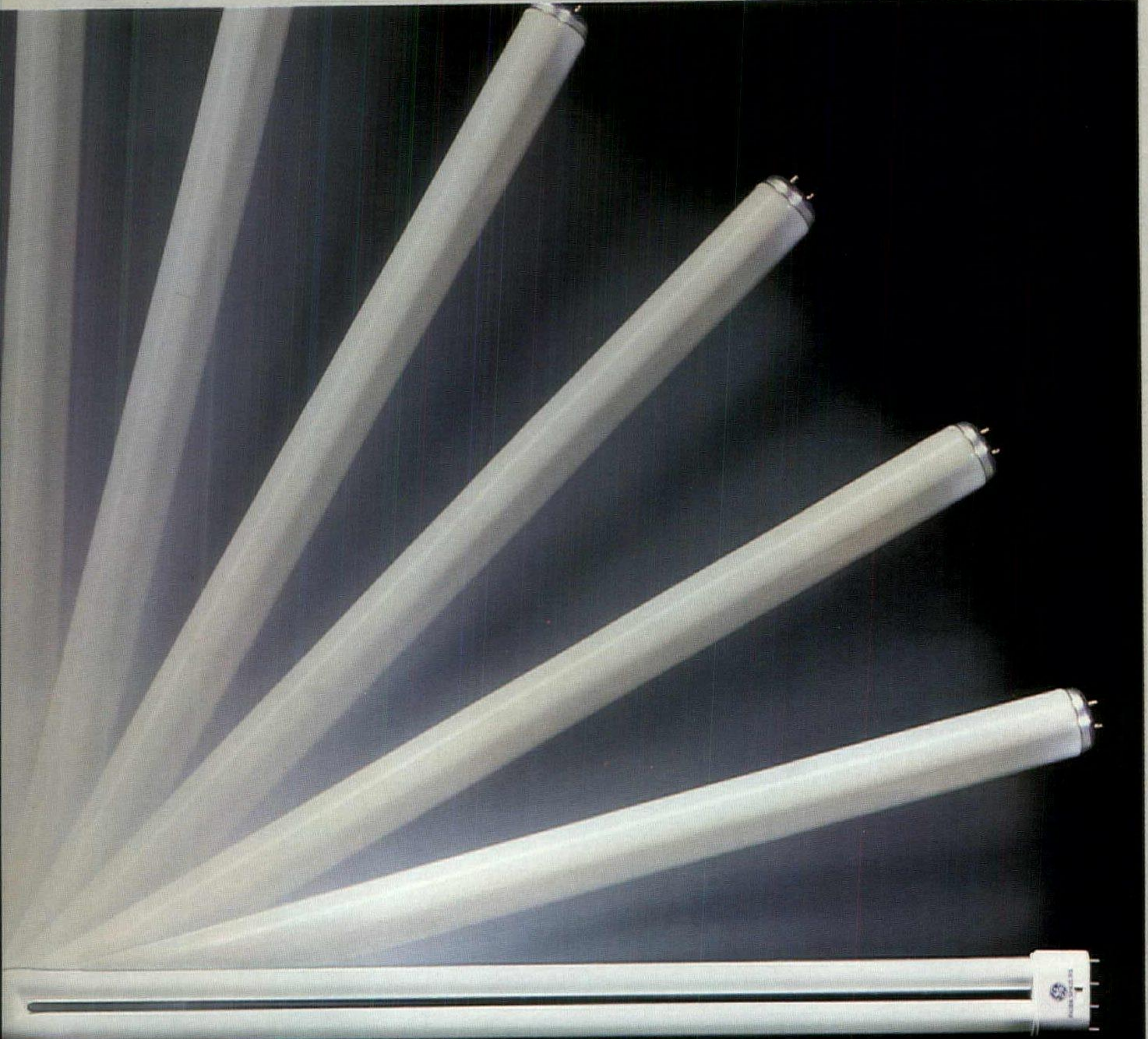

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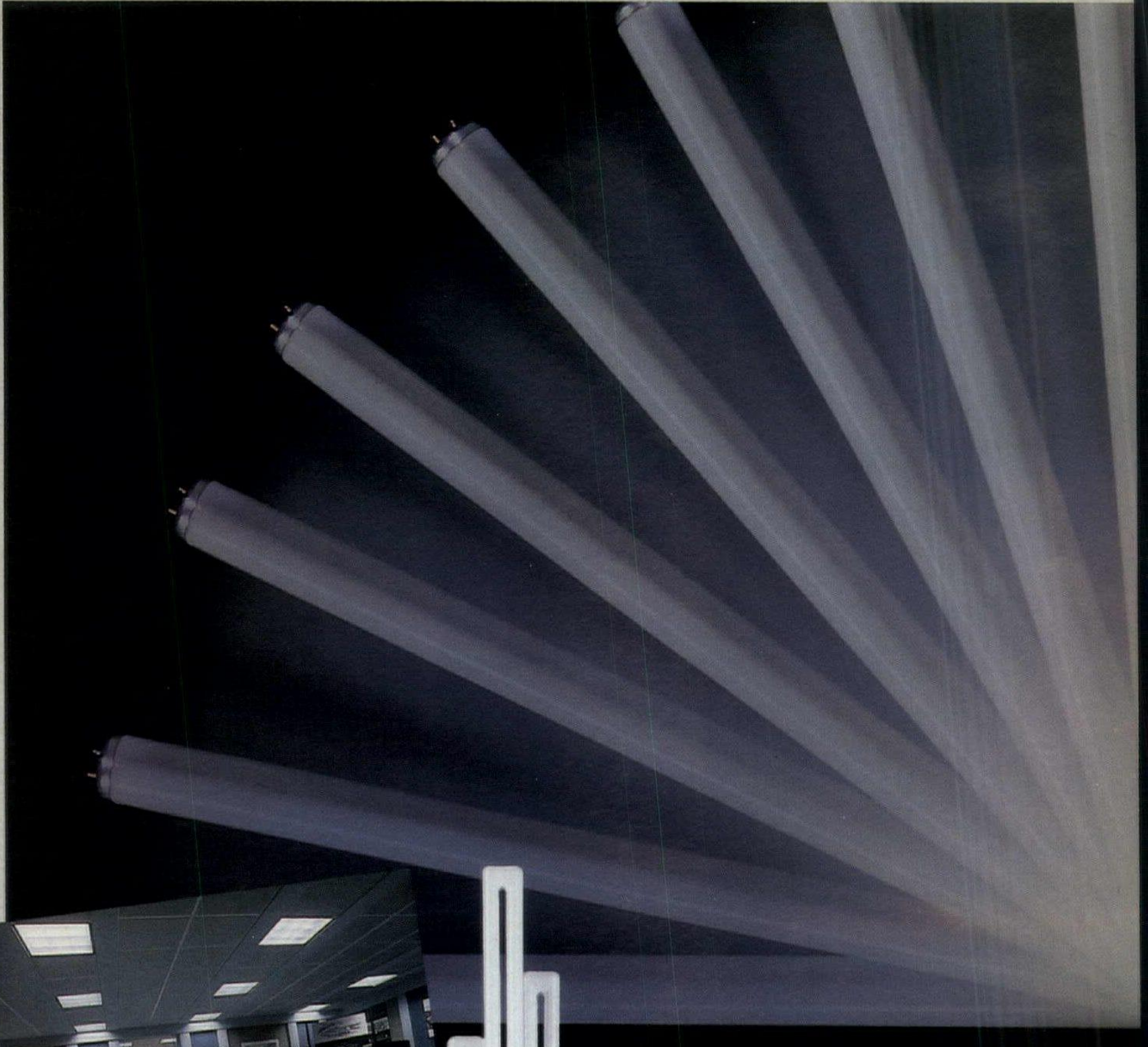

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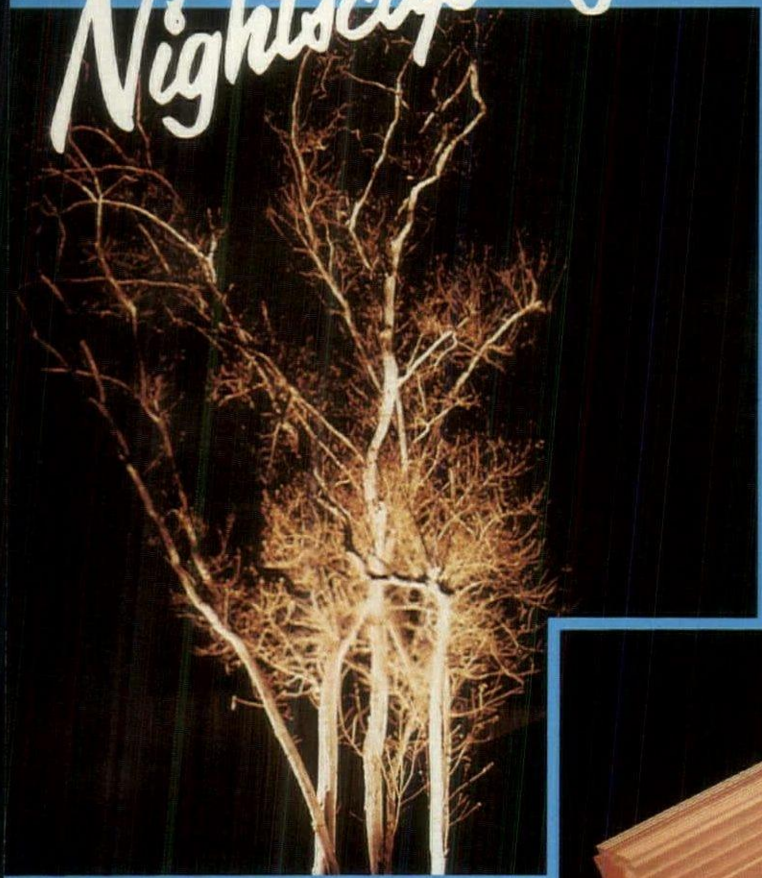

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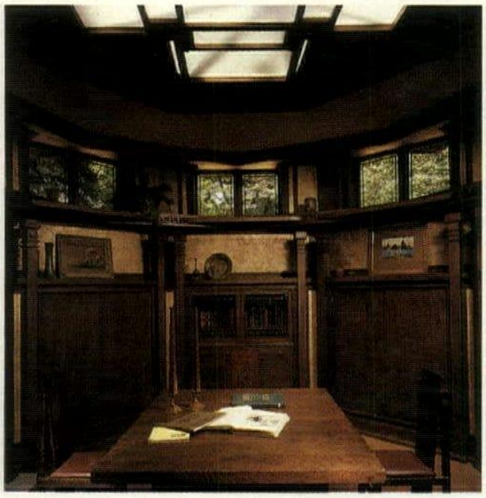

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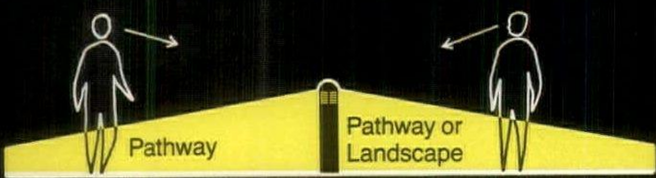

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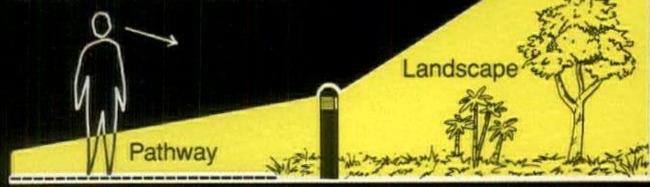

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Blue walls washed with 2800K neon flank the escalators that take guests from the security check-in desk to club reception area. 3000K triphosphor fluorescent lamps in indirect fixtures are hidden in the ceiling lattice.

so, not make people in the rooms feel claustrophobic."

Club members check in at a security desk, and take an escalator to the club level, past a pale blue wall illuminated with 2800K neon hidden in the beam and girder lattice. This slightly pink light source provides a lavender blue reflection from the wall that "looks like the sky's out there," says Steffy. "The feeling is one of openness, airiness, a feeling of light, without having lots of light and without having any glare. In order to do that, we began to light the surfaces instead of just directing light down on to people and the floor."

Overhead, indirect fluorescent luminaires, fitted with 3000K fluorescent lamps, are hidden in latticework suspended below the ceiling plane. "We were very careful to use luminaires that had reflectors that would give us a very wide light distribution without any streakiness. We have to be very careful about what we specify in order to maintain that nice uniform glow."

At the top of the escalator, the main reception area is highlighted with artificial skylight elements. "Originally, the design called for skylights," says Steffy, "but there was so much structural and mechanical stuff up there they couldn't get skylights to lay out nicely. So we asked, 'why not use a luminous ceiling that looks like skylights and avoid going through the entire plenum with a light well?' " White acrylic panels were fitted into pyramidal coffers and, above, fluorescent strip lamps were spaced to give a uniform wash of downlight.

"To help balance out the brightness created by the lighted ceilings and window walls," continues Steffy, "we ran a continuous wall wash around the perimeter walls, which gives you a nice layered look, as if the ceiling plane is floating. Of course, that doesn't really light artwork very well, so we came

In lounge areas, spaces are further defined by blue grids suspended between beams carrying indirect fluorescent uplights, similar to those in the entry space. Incandescent floor lamps for reading and writing provide a further personal touch.

Banquettes have been fitted with miniature built-in luminous ceilings. These are illuminated with fluorescent strips, backlit by white acrylic panels fitted with louvers. The panels block the fluorescent strips from view.

back with the incandescent accent lights on the artwork. We find that you really need this fluorescent wall wash layer to help balance out those brightnesses."

Lounge and Work Areas

In lounge areas of the club, spaces are further defined by other illuminated ceiling treatments. Blue large-cell louvers are suspended between beams that carry the indirect fluorescent uplights, similar to those in the entry space. "We lit through the grids with low-voltage framing projectors to go along with the skylightlike effect," says Steffy, "throwing the shadow of the grid on the floor and walls and creating sunlike shade patterns." Indirect lighting provides a soft glow without interfering with television viewing in the TV areas. Incandescent floor lamps for reading and writing provide a further personal touch.

Banquettes built into alcoves are illuminated with fluorescent strips. The fluorescent strips backlight white acrylic panels fitted with louvers to create luminous ceiling areas over the alcoves. Other individual workstations are illuminated by a double layer of fluorescent wall slots used to provide sufficient light and to highlight the perimeter walls. This highlighting eliminates the gloomy, depressing look of unlit walls. The heavy ribbed wall fabric eliminates highlighting tape joints and drywall faults, which often spoils the effect of wall-washing. The precise baffle spacing and alignment on long runs are a feature of the extruded aluminum blade baffles. "These extruded baffles work very well," says Steffy. "The runs are very straight, the spacing between the blades is precise, and they have nice, sharp corners, not to mention that maintenance people can treat them rather roughly without ruining them. The fluorescents are simply mounted in a drywall box.

"In the conference spaces," says Steffy, "the wall wash on fabric walls continues. Here, the light tends to help visually open the space, and provides brightness balancing between the task area, which is the table, and the background, which is the wall. A series of incandescent accent-luminaires is used in each conference space to allow for artwork highlighting. And incandescent downlights are used to provide task lighting at the table."

The bar is lit with flat acrylic panels backlit with 15-millimeter, 2800K neon; the panels provide a soft, very warm glow. Low-voltage downlights highlight the bar, and fluorescent slots in the back bar highlight glassware.

A Sense of Time

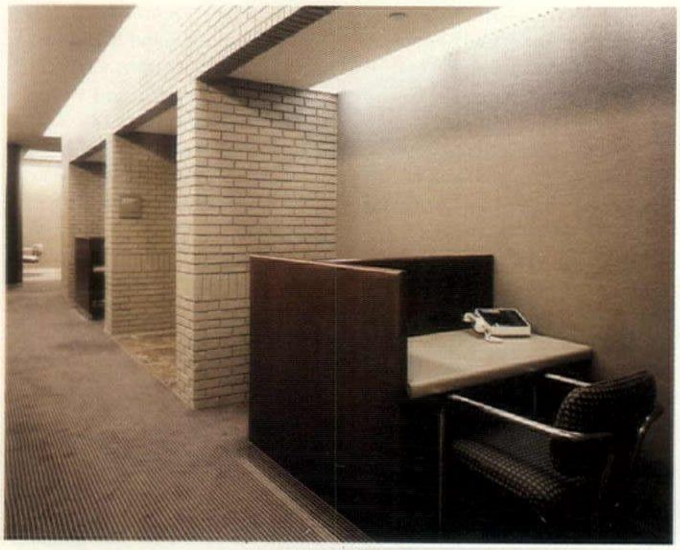
Because the club is in use from early morning until late at night, Steffy used a dimming computer to give club users a sense of the time of day. "Even though there is a reasonable amount of daylight available on the outside walls of the space, we wanted to help people who were in the interior zones of the club to understand what time of day it was. So we used a dimming computer to carefully modulate the incandescent lighting during the course of the day. The lighting is different at noon, different at 6:00 p.m., and different at 10:00 at night, but it dims so gradually that guests don't consciously notice that it changes at any specific time.

"What we've done here is to use brightnesses and contrasts effectively."

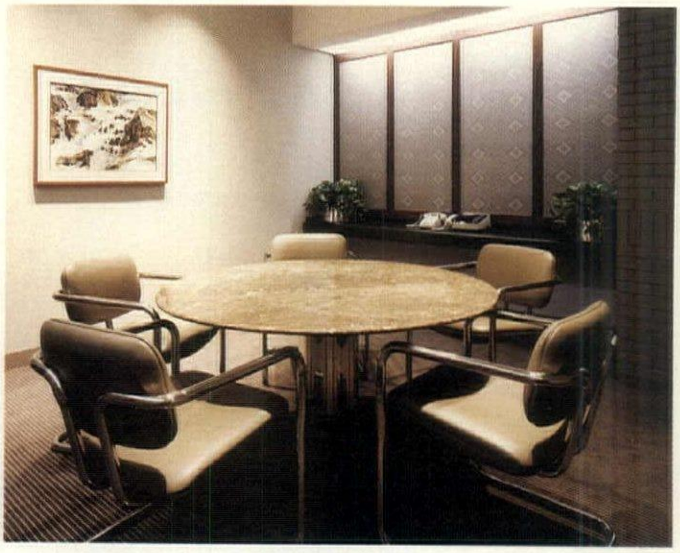
"And of course, we don't turn on all the lights at once — they sequence on. The bar doesn't open until noon, so lights there don't come on until that time. And by switching the fluorescent on different circuits, we can achieve a couple of different light levels."

Brightnesses and Contrasts

"What we've done here," concludes Steffy, "is to use brightnesses and contrasts effectively. We have an entry area that has a lot of brightnesses, which



Individual workstations are illuminated by a double layer of fluorescent wall slots used to provide sufficient light and to highlight the perimeter walls. Here, extruded aluminum baffles cover the fluorescent strips.



The fluorescent wall wash helps open the conference rooms visually. Incandescent accent luminaires are used to highlight artwork, and incandescent downlights provide task lighting at the table.

The bar is lit with flat acrylic panels backlit with 15-millimeter, 2800K neon that provide a soft, very warm glow. Low-voltage downlights highlight the bar, and fluorescent slots in the back bar highlight glassware.

tends to open it up visually. As you get back into the more intimate waiting and lounge areas, we tend to become a bit more contrasty with our brightnesses. We might still have uniformly lighted ceiling planes, but we come back in with accent lights on the louvered trellis work combined with the floor lamps. The whole point is that you and I don't see light levels —we see brightnesses and brightness relationships." ■

For product information, turn to page 70 and see Manufacturers.

Renovation creates coves, light ports for new fixtures

Frederick W. Gore, AIA

Frederick W. Gore is an architect with Greiner, Inc., Grand Rapids, Michigan.

The renovation of the Welsh Auditorium reversed a long trend of careless maintenance, undoing the "quick and dirty" alterations and additions that had introduced exposed wiring and gaudy, surface-mounted luminaires to the lobby. New and restored architectural detailing helped to integrate modern lighting technologies into the historic Art Deco building. Energy consumption was cut in half, and lamp life was increased by 10 to 30 times that of the original installation.

Built during the Great Depression, the facility was conceived to boost the local economy by relieving unemployment, encouraging new industry, and drawing thousands of visitors to the "Furniture Capital of the World" for major business, social, athletic, and labor events. Ironically, changes in society over the years left it virtually unused.

Before its renovation, the building failed to meet the needs of modern convention planners and show promoters. Its 50-year-old wiring, plumbing, and lighting systems fell short of code, and it was inaccessible to persons with disabilities. Heavy use of inefficient incandescent lighting kept electrical costs high — both for operating the lighting and for added air conditioning to cope with the undue heat gain.

Some people thought the facility should be demolished. But the citizens of Grand Rapids, presented with a proposal to raze the structure and build a modern new one, voted to revitalize the Welsh.

In 1983, Greiner, Inc. was allocated a $6 million budget to convert the auditorium to a multipurpose facility, part of a new convention and entertainment complex. "We had to adapt the building for conventions, trade shows, concerts, sporting events, and banquets — all without

Cove lighting, restored with the help of old photographs, emphasizes clean lines of main lobby ceiling, once cluttered with surface-mounted fixtures.

Project: George W. Welsh Civic Auditorium
Owner: City of Grand Rapids, Michigan
Architects and Engineers: Greiner, Inc.; Calvin D. Lane, AIA, project director; Frederick W. Gore, AIA, project architect
Electrical Contractor: Johnson Electric Company
Photos: David Banta

changing its basic character," explains project director Calvin D. Lane. "After discovering old photographs in remote closets of the building, we decided to restore the old lighting with better sources — for both task and decorative lighting — and to hide new task lighting wherever possible."

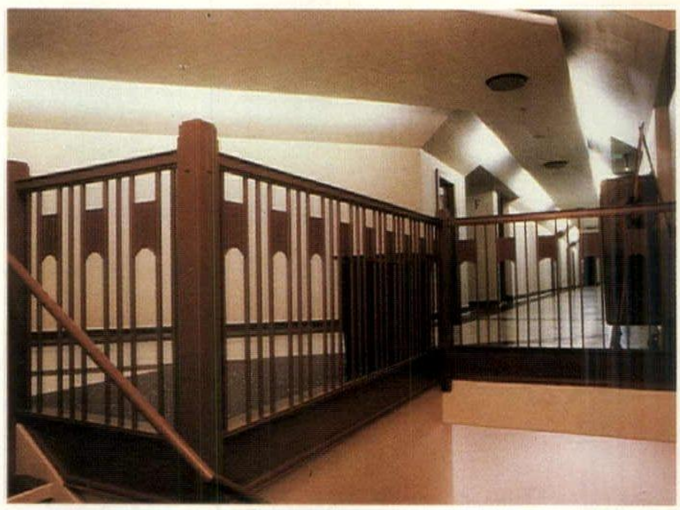
The design team removed the lobby's surface-mounted luminaires, then restored the original cove lighting, using efficient high-output fluorescent lamps. Discreet recessed metal halide downlights were added to achieve desired light levels on the refinished terrazzo flooring, mahogany woodwork, and brass railings and ornaments.

Before renovation, the upper circulation corridor around the auditorium balcony was seriously underlit. Dark colors and minimal lighting created a heavy, enclosed atmosphere. To brighten the space, fluorescent cove lighting was restored, and an existing "vertical cove" at the stair landings was reconstructed and relamped with fluorescent. Refurbished Italian crystal chandeliers from a converted portion of the building took new places in stair landings from the lower lobby.

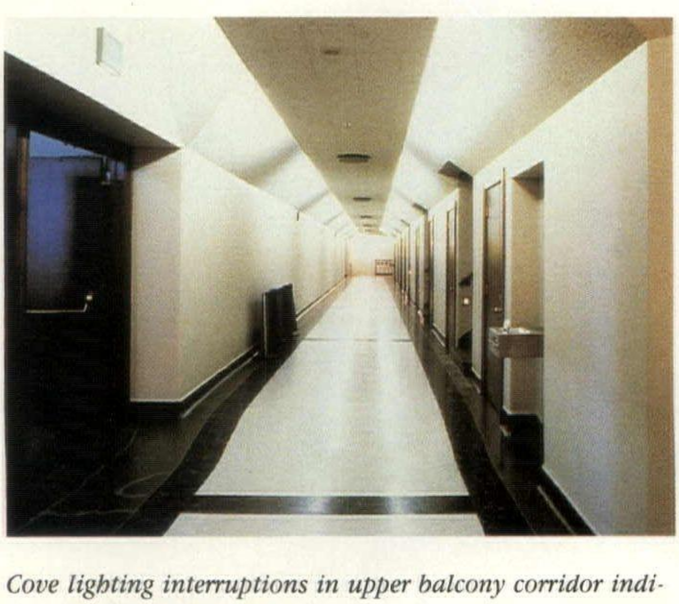
The architect introduced a linear panel of dropped ceiling tile immediately below the existing corridor ceiling. The panel creates coves for high-output fluorescent lighting, and it conceals new fire protection lines. Interruptions in the cove lighting draw attention to the vomitory entrances of the balcony and limit the amount of light entering the auditorium during darkened presentations. Existing semirecessed incandescent fixtures were reinstalled for an attractive touch.

Auditorium Lighting

The original lighting for the 30,000-square-foot auditorium



Vertical indirect luminaires flank west balcony exits.

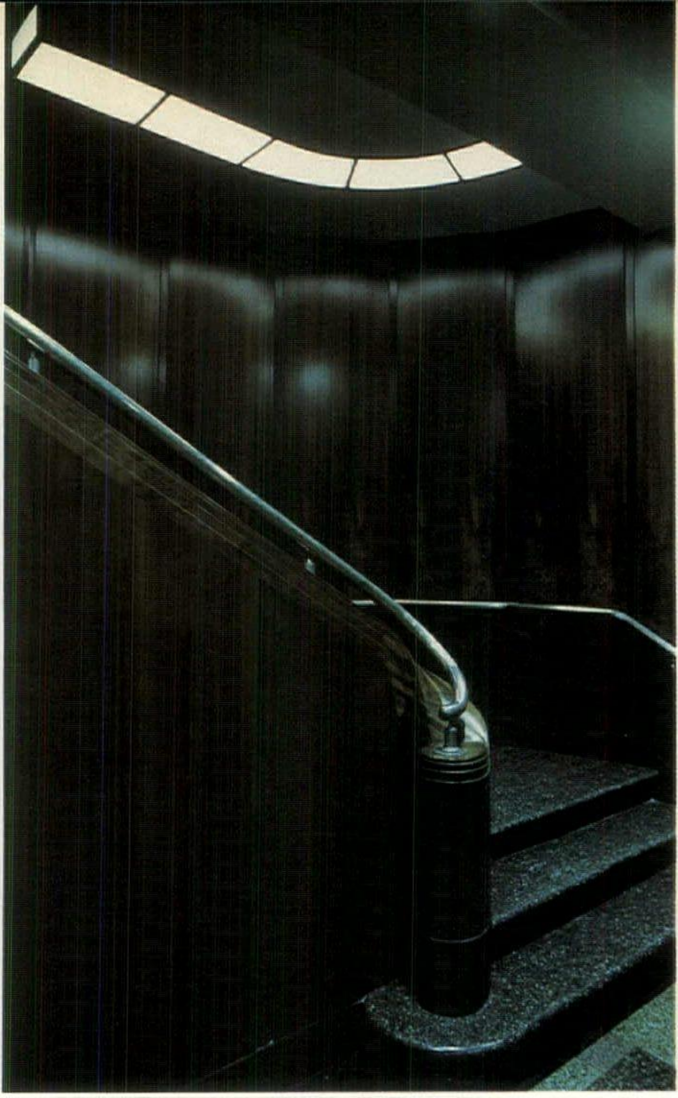


Cove lighting interruptions in upper balcony corridor indicate vomitory entrances.

Dropped ceiling panel accommodates new cove lighting in balcony stairwell and hall.

floor consisted of 300 incandescent downlight luminaires (300 watts each) above glass diffusers, plus 120 incandescent downlights (200 watts each) over the balcony area, more than 900 colored marquee lights (40 watts each) behind yellowed acrylic diffusers at the top of the walls, and miscellaneous decorative lighting. It all added up to 5.33 watts per square foot. The new lighting requires only 2.7 watts per square foot when all sources are at full output and 1.7 watts per square foot in normal operating mode.

New recessed light ports replaced the old glass diffusers. Each port contains five distinct fixtures designed to provide flexibility and efficiency for different public events. For low-level mood lighting, a 500-watt dimmable incandescent is used. For higher ambient levels, two high intensity discharge fixtures are used together to simulate incandescent color rendering: a 400-watt metal halide and a 250-watt high pressure sodium. The metal halide is used alone for maintenance lighting. Finally, each port holds two 750-watt theatrical follow-spots. Lighting under the balconies reuses the existing hobnail-style glass lenses with new 13-watt compact fluorescent lamps.



Refurbished linear fixture was converted from expensive incandescent to more economical fluorescent.

A single system monitors and controls all lighting for the auditorium floor and corridor lighting for the main level and balcony. Control stations can be located at an upper control booth, backstage, or in the center of the floor. The four source types in the light ports enable complete stage lighting functions. Selected luminaires are controlled by key for auditorium cleaning.

Thanks in part to efficient, versatile lighting technology, the auditorium once again hosts a full range of activities. Special attention to architectural detail preserved its historic integrity and revived its original purpose: to be a bustling civic and commercial center for Grand Rapids. ■

For product information, turn to page 70 and see Manufacturers.

Multipurpose light ports in auditorium ceiling each hold five different fixtures.

Lighting Graphics

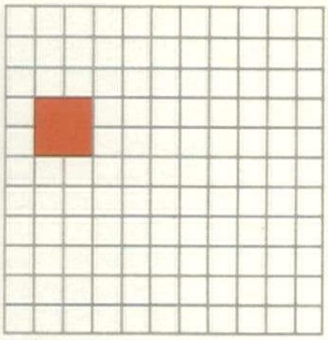
In the June 1988 Lighting Graphics column, I suggested that lighting design can be thought of as the creative composition of lighted architectural surfaces. A more complete description might be this: Lighting design is a process involving the visualization of three-dimensional space to establish overall ambience, brightness ratios, and visual patterns — all within the appropriate functional requirements of the space and accepted illumination engineering standards.

Research tells us that the visual image created by these lighted surfaces influences our interpretation of the luminous environment and modifies our emotional responses. An observer interprets the environment primarily through the brightness and color of the principal surfaces within the space with only secondary or prolonged influence as a result of the quantitative horizontal illumination.

Some quantity of light, from either the lighting equipment or interreflection, falls on all major surfaces. The area and relative intensity of the light reflected from these surfaces determines their visual significance in the architectural composition.

The illustrations in the June column (shown here at reduced size) demonstrate two simple brightness patterns. One represents a uniform luminous environment with a sense of spatial somberness and the other a nonuniform distribution that emphasizes the occupants and activities in the space. The larger illustrations show two additional brightness distributions. They are intended to demonstrate how the vertical surfaces of a room can be used to modify the visual image and use of space.

In the illustration of a nonuniform environment, one wall is lighted to a higher level than the others, creating a significant brightness contrast between the major architectural surfaces. This induces a visual response of attracting and directing attention to the brighter surface. (Actually, both lighting and surface reflectance contribute to this contrast.) This simple luminous pattern can be creatively used in a number of ways — for example, architectural and decorative emphasis, directional motivation, and occupant-oriented activities — as suggested in the illustration.

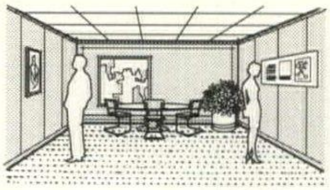


The distribution of brightness in architectural space: Part 2

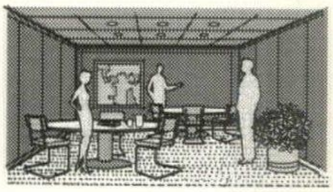
Sam Mills, AIA, IES

Sam Mills is an architect and lighting consultant with his own firm in Oklahoma City.

The selected distribution illustration reverses this brightness pattern with a dark end wall and highly reflective, brightly illuminated side walls. This distribution of brightness, which results in an increased sense of spaciousness, can be used to modify the visual proportions of space. A designer can, for example, expand the apparent width of a long narrow room as the more highly illuminated side walls visually recede.



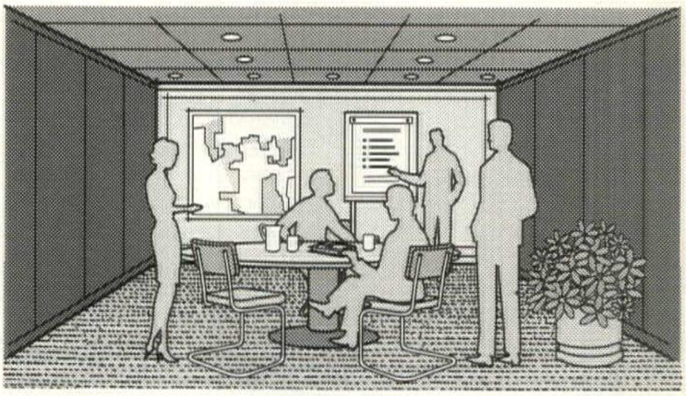
Uniform distribution, creating spatial somberness.



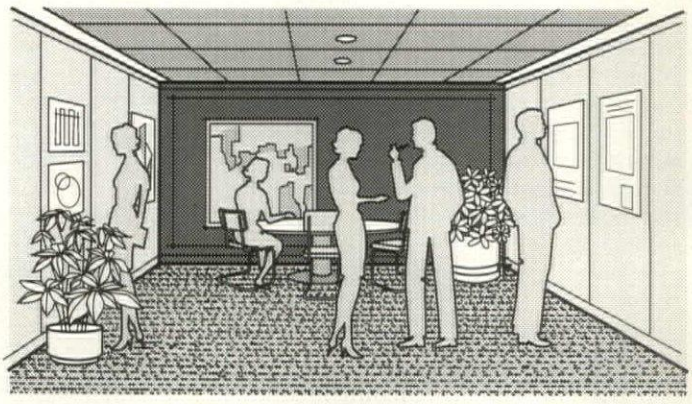
Nonuniform distribution for focus on occupant activities.

The design techniques presented here are generally of an intuitive nature and not entirely founded on research. However, we all seem to understand and use this information in similar ways. It is offered only as one practitioner's interpretation of the incomplete information available to us from lighting research and practical experience.

As lighting practitioners, we would all appreciate more information. Unfortunately, it appears that little, if any, significant research effort is taking place to fulfill this desire. In fact, the research community seems to have an established and longstanding lack of interest in the aesthetic and psychological influences in lighting design. It is difficult to understand why. ■



Nonuniform distribution of brightness for focused architectural emphasis.



Selected distribution of brightness for control of spatial proportions.

The Lighting Design Professional

The art of control, Part I: Architectural and residential dimming

James R. Benya, PE, IALD

James R. Benya is senior principal and CEO of Luminae Souter, San Francisco. He is on the faculty of California College of Arts and Crafts, is active in IES and Designers Lighting Forum of Northern California, and teaches lighting design classes for the ASID, IBD, and AHLI.

The means to turn electric lights on and off and to vary their intensity is part of nearly every lighting design. In choosing the right control technique, designers are faced with everything from wall switches to computerized multilocation systems.

The field of lighting and electrical controls was staggered at first by the energy crisis of the 1970s. Then, the formerly low-tech electrical construction industry began to wake up, and technology advanced rapidly. Reliable, affordable electronics dramatically changed the industry, presenting a whole new range of control choices.

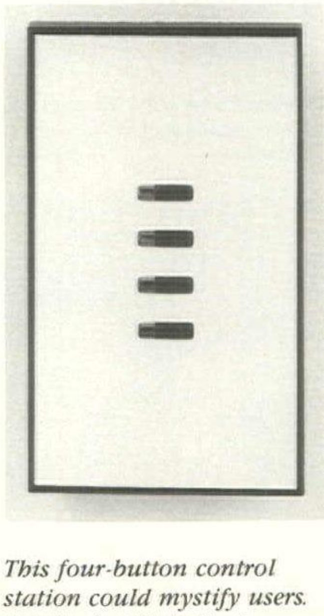
Two Control Categories

Today's controls generally fall into two major categories: architectural dimming and switching, and energy management and conservation. This column explores modern design concepts in residential and commercial architectural dimming. A future column will examine lighting controls for energy management.

Architectural dimming and switching controls are the functional, friendly controls used in familiar day-to-day architectural applications. Their primary goal is convenience; their primary purpose, human comfort and the creation of appropriate moods. Simple line-voltage switching and manual dimming are by far the most commonly applied techniques.

Energy management and conservation controls are primarily intended to minimize energy consumption. These controls enable practical overseeing of lighting energy usage. They require that facility managers make decisions about the genuine need for lighting—sometimes despite the user's choice!

Cost often makes the greatest difference between the two control categories. A good energy management device saves enough energy to pay for itself over time. But a good architectural dimming system is often costly enough that only the owner's satisfaction supports the expense.



COURTESY OF VANTAGE CONTROLS

This four-button control station could mystify users. Labels should indicate control functions.

Good Simple Controls

Keep three basic rules in mind when specifying architectural controls.

Keep controls simple and easy to use. Devices should be in familiar locations and should encourage easy use. Residential dimming systems can be somewhat gimmicky, depending on the owner, but commercial dimming systems should be easily understood and labeled by function. Sliders or dials have an obvious function, for example, whereas hold-to-dim pushbuttons may confuse an infrequent user.

Minimize the number of dimmers and switches. Though it is tempting to have a separate control for each light, this presents too many choices for most users. If many control channels are necessary, consider preset dimming systems.

Make sure the dimmers and switches match each other. In general, this means ganging together switches, dimmers, and possibly other electric devices. Most dimmer manufacturers make matching switches. This helps keep walls clean and free of clutter.

Simple Single-Point Dimming

A simple dimmer or switch near a door provides a convenient way to adjust the lights upon entering a room. Standard switch heights are 40, 44, and 54 inches; the lowest is easier to reach for wheelchair users and children.

Switches can be illuminated by *night lights,* which stay on when lights are off, or *pilot lights,* which stay on when lights are on. Night-light switches are excellent for residences; pilot lights are good for outdoor lights and other remote loads that can inadvertently be left on.

Use dimmers for permanently installed incandescent, low-voltage, neon, and cold cathode loads. Switch individually dimmed portable lighting, or dim split-duplex outlets; install unusual receptacles (NEMA 6-15R, for example) to indicate the dimmed circuits, and equip portable lights with matching unusual plugs. Whenever installing dimmers, be sure to use low-voltage–rated incandescent dimmers unless you're certain of the load. A standard dimmer could burn up the integral low-voltage transformer found in many of the new portable and permanent fixtures.

Multiple-Point Switching and Dimming

Conventional three-way and four-way switching can have one conventional dimmer in the switch leg, using special versions of standard dimmers that have a three-way switch. Two dimmers in series are not recommended (except with autotransformers, a specialized application discussed in the sidebar).

Multilocation dimmers and touch switches have been developed with modern electronics. Silicon control rectifiers (SCRs) are electronic devices specifically designed for dimming and power control; a TRIAC is a component that incorporates two SCRs in the same package.

True multilocation dimming generally involves a master dimmer and several slaves. The real dimming device (a TRIAC) is in the master, and the other locations send signals to it to make it change. Most multilocation devices use conventional three-way wiring techniques, avoiding specialized low-voltage wiring that can confuse electricians. Though much more expensive than single-point systems, these devices offer a tremendous advantage in small multiuse spaces, such as meeting and conference rooms.

The Sound of Lighting

Modern lighting controls use electronic thyristor (SCR TRIAC) dimming. This dimming technique is actually switching, turning lights on and off 120 times per second. The effect is like reducing voltage, but there are side effects.

Hum. A dimmer often worsens the familiar hum of a transformer or ballast. If humming occurs, try tightening or replacing the offending device. High-quality transformers and class A sound-rated ballasts should not hum.

Buzz. Buzzing is usually associated with power-handling solid-state devices. Buzzing dimmers are usually heavily loaded, inexpensive devices, and a higher quality dimmer usually cures the problem. Buzzing transformers are either defective or the result of dimmer interaction. Try replacing the offending transformer.

Sing. Long incandescent filaments, such as linear incandescent, emit a high-pitched whine when dimmed. So do focused incandescent lamps, especially PAR 36. The only known cures are debuzzing coils and autotransformers.

Debuzzing coils, also called chokes, are a classic way to cut down on all dimmer noise problems. They almost always eliminate hum and sing, and often cut down on buzz. Chokes soften the wave form by running power through wire wound around an iron core. They should usually go on the primary side of the transformer in series with the dimmer. If the dimmer has a neutral connection, the choke must be wired after the dimmer; the choke generally can go either before or after a 2-wire dimmer.

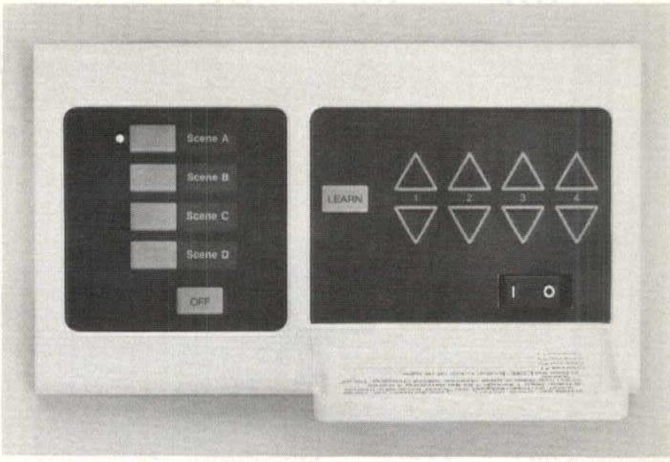
Chokes are optional on almost all architectural dimming systems. They can also be mounted on a J-box and wired into a circuit without a dimmer — for wall-box preset and autotransformer dimming, for example.

In addition, we have successfully placed very small debuzzing coils in the secondary (low-voltage) wiring of PAR 36 fixtures. We splice one donut-shaped toroidal coil, the size of a silver dollar, in series with the lamp. The coils eliminate sing; they may also reduce lamp operating voltage and drop color temperature very slightly.

Autotransformers are large, unwieldy, old-fashioned dimming devices that use a giant dial to change transformer voltage. They can be manually controlled or motorized. Because their output wave form is a perfect sine wave, absolutely free of electrical noise, they still find use in critical environments where dead quiet dimming is essential. We used them, for example, in the sound testing and listening rooms for Dolby Laboratories.

Help is on the way for low-voltage track dimming. Solid-state transformers are notoriously noisy when used with solid-state dimmers, but I have tested an early sample of a Lutron electronic transformer dimmer specifically engineered to eliminate the problem. It performed as promised in a demanding situation: my living room. I have a dozen track lights that buzzed with a conventional solid-state, low-voltage dimmer, even a high-quality one. When I put in the new dimmer, the noise completely disappeared.

—J.R.B.



COURTESY OF LIGHTOLIER

The control panel for this programmable preset dimming system fits in a standard wall box.

Preset Dimming Systems

Preset dimmers call up memorized dimmer settings — sometimes called *moods* or *scenes* — upon command. Single-scene preset dimmers turn on a previously adjusted setting at the touch of a button or switch. Multiscene preset dimming systems link several dimmers to push buttons that select preset combinations. Some systems store the combinations in a computerized digital memory; some use groups of conventional analog potentiometers (rheostats) switched in banks. Digital memories are less costly, but volatile; unless they have a battery, memory is wiped out when power is interrupted.

Until recently, most preset systems were expensive. Single-scene presets were easily made by switching a group of conventional wall box dimmers, but multiscene presets involved complete dimming systems with electronics in a remote dimmer cabinet and low-voltage push-button stations in the room. Now, a multichannel, four-scene system can control up to 6000 watts from a self-contained wall box dimming system for about one-fourth the cost of its predecessors. These exciting wall-box preset systems are available with infrared remote controls, allowing the complete interface of dimming to audiovisual functions on programmable master infrared remotes.

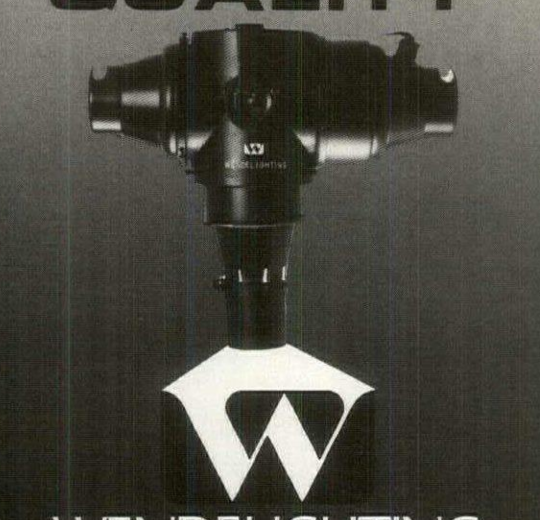
Power Line Carrier Systems

Power line carrier (PLC) systems transmit control signals over power wires by encoding digital information in an imposed radio frequency (RF) signal. Common codes allow each transmitter to signal every receiver with the same code. The most common system allows 16 "house codes" to isolate neighboring systems, and 16 channels per house code. Commercial systems can access all 16 house codes, giving a total of 256 channels.

A *channel* is simply a dimmed circuit that provides power to a group of lights. A dimming system can divide an incoming 20-amp household circuit, for example, into two or more outgoing channels, or it can dim the entire input as one channel.

PLC systems can switch or dim. They are incredibly easy to install. Receivers usually either plug into or replace receptacles and wall switches, and transmitters plug in anywhere

UNDENIED TECHNICAL QUALITY



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Circle 13

in the house. Combination time clock–transmitters allow automatic programming of on-off functions, and special transmitters hook up directly to personal computers for creative automatic control. PLC controls are used by most "smart home" control systems and by a range of commercial energy-saving applications.

PLC systems are inexpensive and powerful. Their effectiveness can be compromised, however, by noisy power lines and long signal-path distances. Because of these inherent weaknesses, PLC systems may not operate perfectly. Also, PLC dimmers are not low-voltage rated, so to control transformer loads you must forego remote dimming — unless you wire a local preset dimmer in series with a PLC switch.

Central Dimming Systems

Central dimming systems are the most expensive and powerful of all. Like theatrical dimming systems, they have one or more central dimmer cabinets. The dimmers are dumb, power-handling devices. The brains are in the electronic front-end controls, which can include computers and all forms of low-voltage manual and automatic controls.

Local single-room systems are the oldest form of central dimming system. They typically consist of modular dimmers and nondimming switches, and they usually handle large amounts of power and/or many control channels. The dimmed wattage is limited only by the number of modules a dimmer cabinet can hold — and additional cabinets are easily added. In addition, these systems are easily customized, offering conventional and unconventional combinations of manual, preset, assignment, and time clock control. They can incorporate occupancy sensing, photocell, and emergency power functions. Some systems even allow wireless remote control and standard audiovisual systems interface.

Assignment systems allow several single-room systems to be patched together by a flexible master control. Hotel ballrooms and convention center meeting rooms are the most common applications. By selecting the "master" control station and "assigning" it to the separate rooms, single-point control of any open space can be established, leaving additional spaces isolated with their own control stations.

Whole-house systems are the pinnacle of residential dimming. Using many small modular dimmers, a central computer, and small, finely detailed control stations, these systems offer virtually every feature needed for top-quality dimming. They can be programmed with adjustable fade rates and multiscene presets for any load. Whole-house presets (globals) can be used for emergency, burglar alarm, or just "welcome home" lighting; local preset capabilities are nearly limitless, allowing up to 12 dimmers per preset and as many presets per room as desired. These systems can operate anything electric, such as motorized curtains or Jacuzzi pumps, and they interface easily with burglar alarms, "smart home" systems, and other systems.

Whole-house systems are hardwired and have high-quality inductive load dimmers, making them somewhat superior to PLC systems while offering complete home control. These systems are more expensive, though, and their wiring technique makes them better suited for new installations than retrofits. ■

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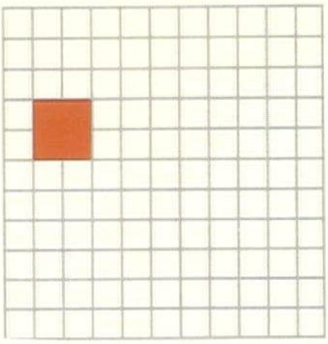
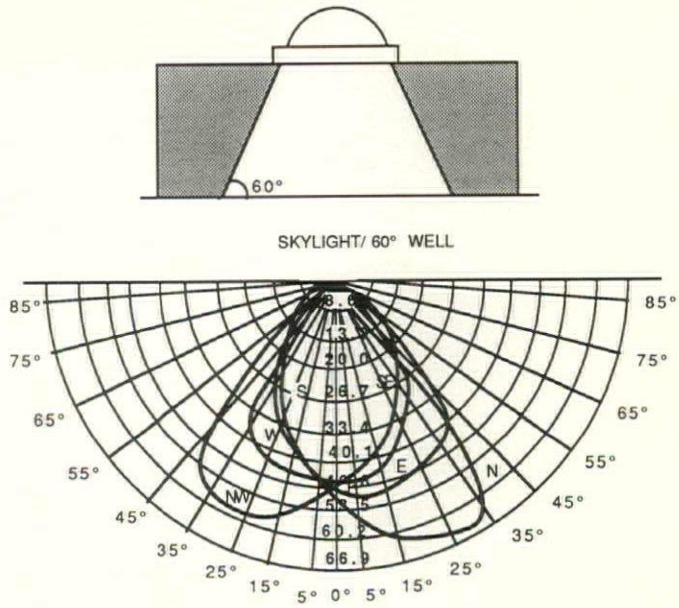
Daylighting Techniques



Skylights as a light source

Mojtaba Navvab

Mojtaba Navvab is an assistant professor of architecture in the College of Architecture and Urban Planning at the University of Michigan, Ann Arbor.



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PER 1000 EXTERIOR HORIZ. FC FOR A 6 IN. SQ. SKYLIGHT

Recent advances in skylight technology — such as major refinements in aluminum extrusions, high-performance sealers, and better glazing — have made improved and increasingly complex designs possible. Those improvements, in turn, have earned designers' appreciation of skylights as energy-saving light sources that yield high satisfaction among building users. Formerly, designers commonly perceived skylights as the cause of weatherproofing problems.

Among other things, skylights can be used to satisfy a building occupant's need for contact with the outside. They enhance the interior environment by admitting light and heat. Because skylight as a light source is dependent upon the sun, changes are expected in the intensity and distribution of light admitted during the course of a day. The sun's earth orbital cycle and atmospheric variables, such as clouds, create a more dynamic environment than does uniform interior lighting. People respond favorably to the variations in brightness and changes in color caused by bringing outdoor light indoors.

Depending upon its design, a skylight system can distribute daylight locally or over a large area.

Depending upon the design of the skylight system, daylight distribution can be localized or uniformly spread over a large task area. For many types of buildings, the skylight is an enhancement or complement to the interior appearance and electric lighting of the building. Besides being attractive and having a favorable impact on the senses of occupants, properly applied skylights can save energy while bringing the outdoors inside.

Increased use of skylights has forced designers to search for more detailed skylight information and data in order to make the best use of them in many building types. The skylight industry has responded by examining many of the current systems and techniques in order to assist architects and designers with skylight applications.

Architects and lighting designers have to factor the following functions into their designs: geographic location of the building, light well geometry, light distribution, thermal and visual comfort, reflections, color and texture of adjacent surfaces, cooling loads and costs, and heat loss. Skylight applications are addressed in various energy and design publications — including that of the American Architectural Manufacturers Association (AAMA) — which have become increasingly detailed over the past few years (see "Effective Aperture: Getting the Light of Day Indoors," *Architectural Lighting*, July–August 1987).

Skylight Zonal Cavity Method

In a paper presented at last year's IES conference, Marc Parent and Joseph Murdock of the University of New Hampshire discussed an interesting way to expand the zonal cavity method — a means of calculating average interior illuminance that normally is applied to electric lighting — to include skylighting. They gave particular attention to a number of characteristics of skylights: dome transmittance, diffusion, dome height-to-width ratio, well reflectance, well angle, well height-to-width ratio, and direct sun shielding.

At the heart of the paper were the scores of coefficients of utilization and skylight intensity curves for skylight and well geometry configurations. The curves were established under real sky conditions using 8:1 scale models of domed skylights. These data can be used in the same way that electric light intensity distribution curves are used in zonal cavity method calculations for electric lighting.

In another paper, presented at the Chartered Institute of Building Science Engineers (CIBSE) National Lighting Conference in Great Britain earlier this year, the researchers came to some interesting conclusions:

- Although 45-degree skylights take up much more ceiling area than 60-degree wells, they provide only a marginal improvement in daylight distribution.
- Deeper skylight domes gather more light at low and high sun positions because of the interreflection and high transmittance caused by dome thinning of the skylights at the top.
- Although domes made of prismatic plastic result in erratic light distribution patterns with

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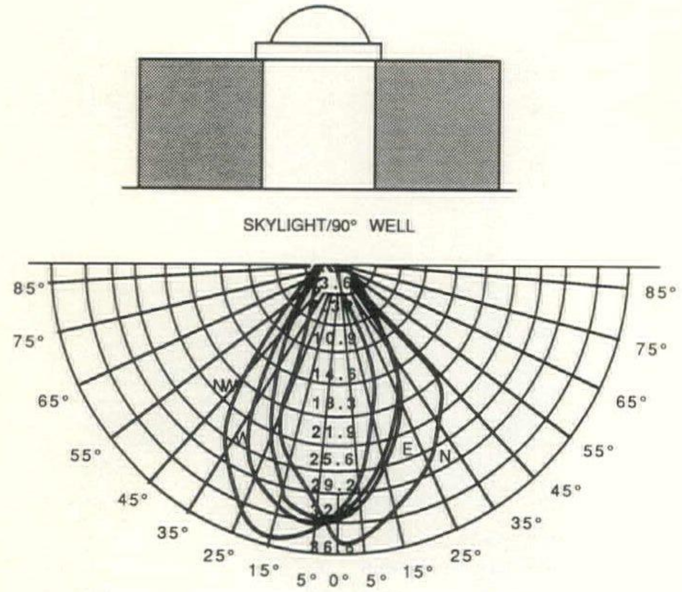

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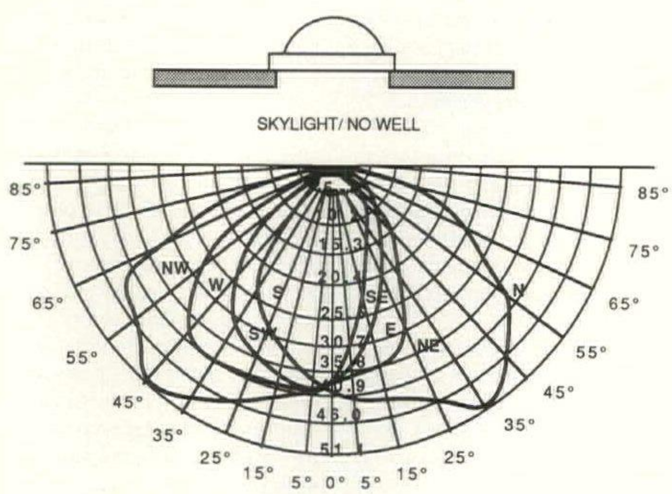
PER 1000 EXTERIOR HORIZ. FC FOR A 6 IN. SQ. SKYLIGHT

The skylight distribution curves are measured in different directional planes, using several different skylight materials and well configurations. These are typical of dozens produced by Parent and Murdock's study of applying the zonal cavity method to skylighting.



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PER 1000 EXTERIOR HORIZ. FC FOR A 6 IN. SQ. SKYLIGHT

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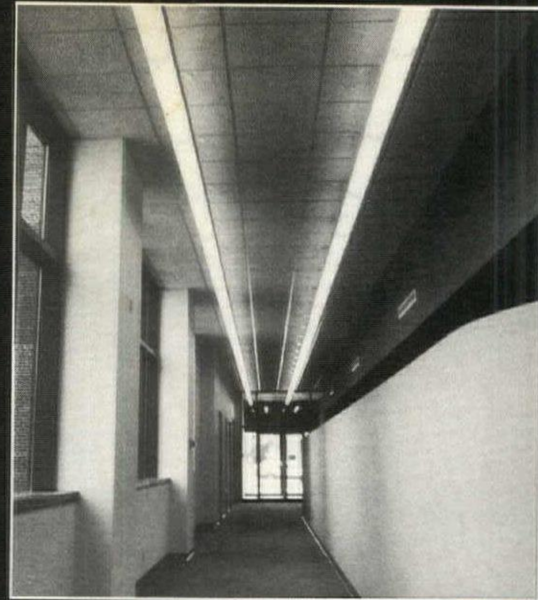

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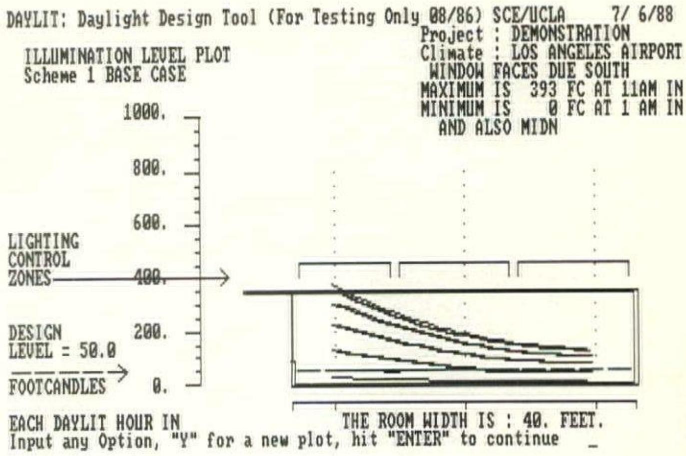
Software Reviews

Daylighting is more than an efficient strategy for building energy conservation: it can be a major architectural form determinant in many building types. Computer software for electric lighting is more plentiful than programs for calculating daylighting, so two recent daylighting programs and a program for energy analysis are all of interest. The daylighting programs are PC Superlite 1.0 and Daylit. The energy calculation program, which can analyze the effect of daylighting on building energy consumption, is ADM-2.

Daylighting and energy analysis programs

David Lord, PhD

David Lord is a professor of architecture at California Polytechnic State University, San Luis Obispo.



PC Superlite 1.0

PC Superlite 1.0, originally written to operate on a mainframe computer, now works on IBM PC microcomputers with few limitations. The microcomputer version, developed at Lawrence Berkeley Laboratories, can handle complex room and light source geometries with great accuracy. It is not for the faint-hearted computer novice. It is useful to researchers and to technically minded lighting designers who need detailed daylighting analysis — and who have the patience to interact with computers at a cybernetic level.

Superlite will model daylight coming through as many as five openings and being reflected from as many as 20 opaque surfaces oriented in any direction. This makes it possible to predict daylighting in L-shaped rooms with partitions or A-frame structures, but the user must break all complex surfaces into a set of flat elements. Superlite will also model exterior shading surfaces such as fins and overhangs and can take into account the shading effect of nearby buildings.

Superlite accepts any of four different sky conditions for your design simulation: clear sky with direct sun, clear sky without direct sun, overcast sky, or uniform sky. In addition to calculating daylighting levels from diffuse sources of outdoor illumination, Superlite can account for the effect of direct sunlight in the room.

Users can supply solar and weather data to the program by giving latitude and longitude, time and date, and stipulated sky conditions. They also have the option of designating specific solar location and radiation values.

Using the program requires three steps: creating an input file, processing the file, and interpreting the output. The input file is a series of numbers and cryptic phrases that describe the geometry of the room being studied and the weather data. The input file is usually based on example files included with the program and modified with a word processor. Instructions for the computer are embedded in the input file.

Next, the program processes the input file to calculate daylighting values; running time for this step is dependent upon the type of computer used. An IBM XT took 30 minutes to model the daylighting in a simple room with no obstructions.

When the calculations are complete, an output file is generated and saved on disk. Superlite is now finished, but if you want to read the results in a graphic format, your work has just begun. Looking at the output file with the DOS *type* command or with a word processing program reveals only tabular numeric values for the daylight factor or illuminance level.

I successfully modified the output file using Word Perfect, a word processing program with search-and-replace features, so that I could import the file into a Lotus 1-2-3 spreadsheet. Once the tabular figures are in the spreadsheet, it is easy to graph the daylighting values for visual interpretation. It can be tedious to go through each of these individual steps, but no other microcomputer program can achieve the precision of these results.

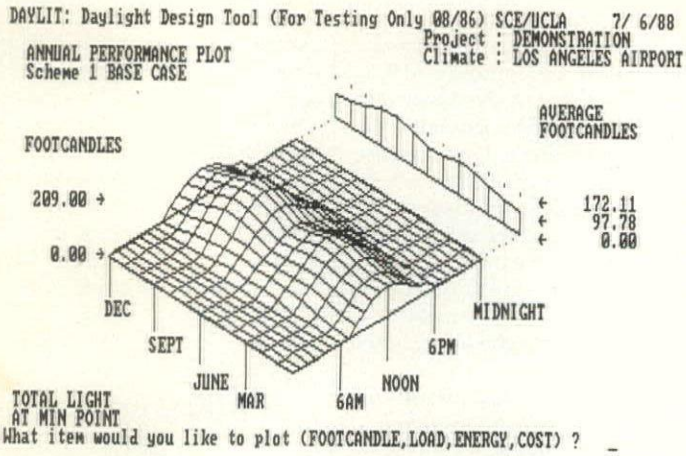
Superlite is an excellent initial value because it is available at very low cost. If you wish to read about it first, you can purchase the manual for the program. The greatest expense for professionals is the time that must be invested to learn how to use and manipulate the program.

Daylit

If PC Superlite does not sound like your cup of tea, then you may prefer Daylit. If any two programs are at opposite ends of the user-friendly spectrum, PC Superlite and Daylit are. PC Superlite is good for detailed analysis; Daylit is a schematic design tool. Architecture students at Cal Poly, San Luis Obispo, have found Daylit an easy-to-learn and valuable design aid for uncomplicated building configurations. After running Daylit a few times, most users gain an intuitive feel for daylighting.

Developed as a joint effort by Southern California Edison, the University of California at Los Angeles, and the University of Southern California, Daylit is geared to designers. Daylit is available only in a beta test version, however, and accuracy is not guaranteed. Although it gives a good indication of daylighting performance, I recommend verification of the final design by other means, such as by physical modeling. Preliminary validation of Daylit indicates a loss of accuracy for windows located high on a wall compared to that for windows located lower down.

Daylit can handle simple window, skylight, and room configurations. It delivers graphic information on integrated elec-



tric lighting and daylighting as well as on total building energy consumption. It is a self-prompting program that comes complete on two diskettes. The manual can be printed out from one of the diskettes.

Daylit operates in a fashion similar to Solar-5, which was reviewed in this column in December 1987. The two programs complement each other nicely; and if you know how to operate one, you will find the other easy to learn. As does Solar-5, Daylit creates a base-case design, against which users can compare variations. A design screen prompts the user for information about the building, such as the sizes of windows, transmissivity of glass, reflectivity of surfaces, and hours of occupancy. If you don't know the correct values — the transmissivity of the glass, for example — Daylit presents tables of typical values from which to select values.

After calculation of daylighting and energy performance, which typically takes less than a minute, a series of analysis screens appears. The screens present graphic and tabular displays of illumination level and annual performance plots, as well as many other useful values. Thermal energy and lighting characteristics are calculated, and the total effect of daylighting on energy consumption during heating and cooling seasons is modeled. You can view these analysis results in the order presented, or you can call for any one of them specifically by name.

If you wish to make a permanent record of the results, you can send the graphics screen to a dot matrix printer, using the DOS program GRAPHICS.COM and holding down the *caps* key and the *print screen* key simultaneously. We use a laser printer and the utility program Grafplus to print the graphics screens.

If you become lost at any point when using Daylit or forget the name of a command, all you have to do is type "help" or "options" and the help functions or all the possible commands will be listed on the screen. We encourage experimentation and trial and error as ways to learn the operation of the program. A reasonably experienced computer user should see useful results from Daylit in little more than an hour.

ADM-2

If you have ever contemplated using DOE2.1, the energy analysis program, but have hesitated because of its infamous complexity and quirkiness, there is an alternative. ADM-2 is based on the same methodology and algorithms used for DOE2.1, giving the program the same gen-

Continued on page 50

Featured Programs

PC Superlite 1.0

Requires IBM XT or AT with 8087 coprocessor and 600K memory. Program on diskette available from:

Michael Kroelinger
College of Architecture and Environmental Design
Arizona State University
Tempe, AZ 85287
(602) 965-5561

Superlite 1.0 Evaluation Manual, $12

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Daylit

Requires IBM PC/XT/AT with 256K RAM, 8087 coprocessor, DOS 3.xx, and graphics capability. For further information on program availability, contact:

Gregg D. Ander, AIA
Southern California Edison Co.
2244 Walnut Grove Avenue, Room 391
Rosemead, CA 91770
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Grafplus

Utility program for scaling and printing screen images. Supports all dot matrix, ink jet, and laser printers. Contact:

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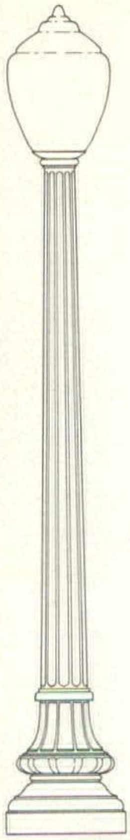

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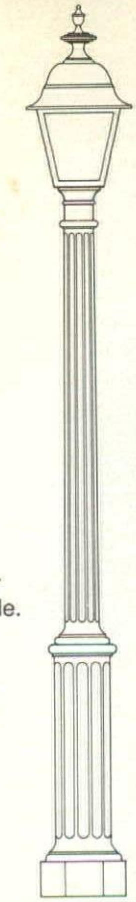

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Continued from page 49

eral accuracy, but with a far friendlier user interface. ADM-2 is approved by the Bonneville Power Administration and by the California Energy Commission for demonstrating compliance with Title 24 energy standards. Over the last three years, ADM-2 has been used by ADM Associates to calculate the energy performance of thousands of buildings throughout the United States.

ADM-2 is written for use on an IBM or compatible microcomputer, making it easily accessible for designers, architects, engineers, and utility analysts. I mention ADM-2 here particularly because of its ability to model a building's internal heat gains due to lighting.

Daylighting can be accommodated in the ADM-2 energy analysis by assigning a percentage of time that electric lighting is replaced by daylight. That assumption may in turn be derived from Daylit. Solar heat gain from skylights and windows — and from more than 100 other variables, such as HVAC operation and U values — are incorporated into the ADM-2 analysis.

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The software review columnist welcomes reader comments. Write to David Lord, Architecture Department, Cal Poly, San Luis Obispo, CA 93407.

Continued from page 47

excessive luminances, flat prismatic sheets contribute to better light distribution.

☐Skylight wells finished with higher reflectance material minimize the effect on illuminance variation during overcast days.

☐Direct sun penetration into the space can be controlled by using 90-degree north-facing skylight wells.

North-facing skylight wells can help provide good light distribution without sun penetration problems.

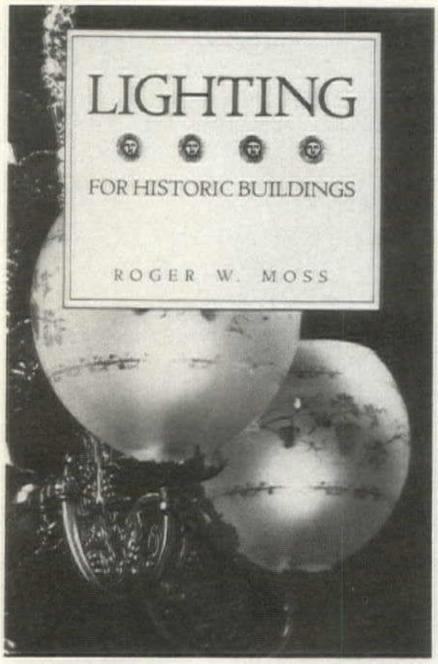
A final recommendation is to use skylight-well systems with sealed double-glazed skylights consisting of a dome over prismatic flat sheets mounted over a combination 90-degree–60-degree north-facing skylight well to provide a good illuminance distribution and avoid sun penetration problems.

The work of Parent and Murdock is most interesting because it explains how to apply to skylighting a universally known calculation method traditionally reserved for electric lighting. This is a significant step toward making skylighting calculation techniques accessible to a wide range of design professionals. ■

The daylighting columnist would like to hear from readers about unique daylighting applications. Write to Mojtaba Navvab, MIES, College of Architecture, University of Michigan, Ann Arbor, MI 48109.

Circle 17

Book Reviews



Moss's book lists nearly 100 companies that manufacture or supply historic reproduction lighting.

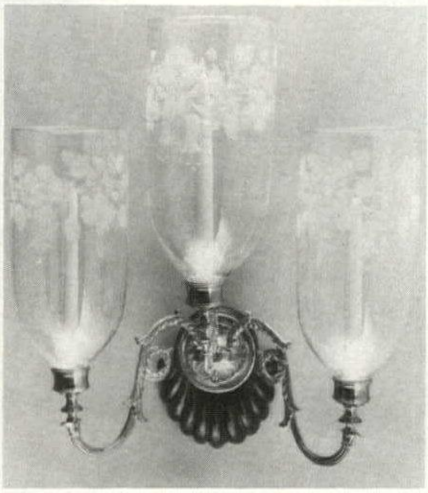
Lighting for Historic Buildings: A Guide to Selecting Reproductions, by Roger W. Moss. Washington, D.C.: National Trust for Historic Preservation, Preservation Press, 1988. 192 pages.

Try to light a historic building historically, and you face a vexing problem. Only a few generations ago, people were most active from dawn to dusk — when they could see. For nighttime tasks like reading and sewing, they hand-carried candles or small fuel-burning lamps. The advent of gaslight, then dim and erratically powered electric light, only slowly changed that pattern. Historian Roger Moss observes, "Because few 20th-century homeowners and curators would or could accept the daily limitations of life dependent on sunlight, most historic interiors will not be authentically illuminated."

In *Lighting for Historic Buildings,* Moss teaches the necessary art of compromise. The new guide shows how to select and install modern lighting that honors historic design intentions. Its hundreds of catalog listings also provide ready access to a selection of new electric fixtures that mimic antiques.

The guide covers commercially available reproductions of American lighting fixtures from 1620 to 1930, classified by original lighting technology: candles, kerosene, gas, or electricity. Moss includes a fifth category of fixtures for whale oil, lard oil, and "burning fluid" — common nineteenth-century fuels — although reproductions are currently unavailable. He tells how to determine which technology is most appropriate for any particular project.

The introduction and five lively essays for the main categories are laced with historic references and illustrations. Moss emphasizes the technical constraints of open-flame lighting. "The style of pre-electric lamps and lighting fixtures," he explains, "is incidental to the primary purpose of the object: to deliver the fuel to a more or less controlled flame. For this reason a Coca-Cola bottle fitted with a wick and burner is just as effective a kerosene lamp as the most handsome and collectible ruby-cut-to-clear product of the Boston and Sandwich Glass Company."



Designers who understand the historic origin of electrified reproductions will avoid common gaffes: gas fixtures suspended on chains ("More than one curator has blushed bright red when asked, 'How do you suppose the gas got to that fixture?' "), ceiling fixtures too high for a lamplighter to reach, and unshielded candle holders in drafty vestibules. Moss also discusses how the low light levels of early light sources affected interior design and suggests a few unobtrusive ways to introduce task, ambient, and emergency lighting.

The catalog entries present specific products appropriate for historic interiors. Within categories, entries are further organized by fixture type and manufacturer. Each includes a brief description and a specific name or number to use when ordering; some have photographs. Moss independently screened products for historic merit and interviewed manufacturers to discover design sources. With a historian's passion for detail, he provides much previously unpublished information in the listings, including bibliographic citations and the current location of original "document" fixtures.

Sections at the back of the book provide additional resources. A selection of specialty items and services directs the reader to custom manufacturers and suppliers of antiques, electrified candles, crystal prisms, and old-fashioned lamps, switches, posts, and shades. A street lighting section, though, is disappointingly incomplete. There are also a glossary, a bibliography, and a list of museums and other institutions to contact for information.

For practicing designers, the single most valuable section may be the appendix, which lists the complete name, address, and phone number of every manufacturer and supplier mentioned in the book. The first edition lists nearly 100 companies; the publisher plans to reissue the book periodically with additions and changes.

Moss told us that he invited "several hundred" known historic lighting manufacturers to submit product information. Many failed to respond; some others sent "things that wouldn't fool anyone from a mile off." *Lighting for Historic Buildings* presents the sources Moss judged most likely to help designers achieve the best combination of appropriate technology and historic authenticity.

—Gareth Fenley

Gareth Fenley is senior assistant editor of Architectural Lighting.

***Lighting for Historic Buildings,* $12.95 (paper)**

For mail orders, include $3 for shipping.

Mail Order
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1600 H Street, NW
Washington, DC 20006

Product Showcase

Chroma meter

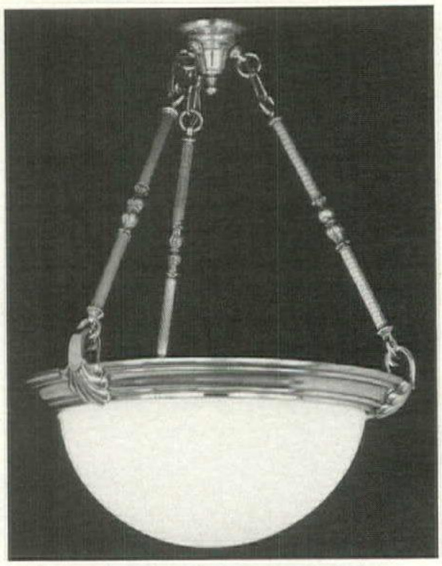
Minolta's hand-held CL-100 Chroma Meter is a compact, lightweight tristimulus color analyzer that determines lamp color temperatures, measures color differences between sources, and helps adjust source outputs to meet specified standards. Features include an integral microcomputer for precise readings of light sources, silicon photocells filtered to match CIE standard observer response, and a built-in memory for storing a reference color and a calibration standard. The meter has five modes for measuring chromaticity and color difference and can be operated by remote control or interfaced with the company's DP-100 data processor. Minolta Corporation, Industrial Meter Division, Ramsey, NJ.

Circle 60

Compact filter inductors

Amecon's compact inductors filter out noise currents from electronic and electrical power control circuits such as EMI-RFI filters, lighting dimmers, lighting filters, SCR controls, and other devices that require a noise-rejection system. The inductors come in sizes as small as ⅝ inch in diameter and operate from 1 to 100 amperes. Horizontal and vertical mounting configurations are available. Amecon, Inc., Anaheim, CA.

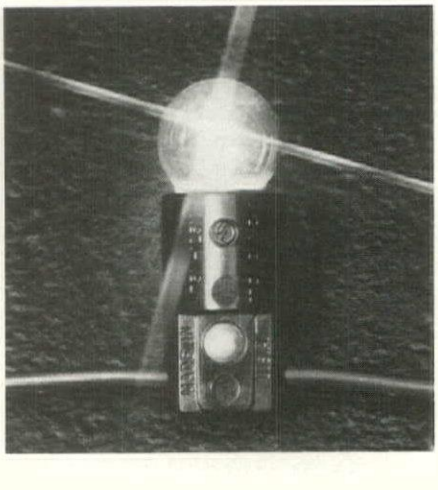
Circle 61



Decorative pendant

Art Directions offers the Calypso, a pendant luminaire with an opal white acrylic dome and a copper finial and rim. Three reeded brass tubes accented with copper-plated cast columns support the 24¼-inch-diameter pendant. A version with an art glass shade is available. Art Directions, St. Louis, MO.

Circle 62



Track fixtures

Lithonia Track surface fixtures from Lithonia Downlighting incorporate one- and two-circuit wiring in the same low-profile housing to combine economy, compact size, added capacity, and switching flexibility in a single system. A variety of cylinders, squares, spheres, bell spots, wall washers, and other fixtures, many with low-voltage versions, are available in several sizes, wattages, and finishes. Lithonia Downlighting, division of Lithonia Lighting, Conyers, GA.

Circle 63

Outdoor light strings

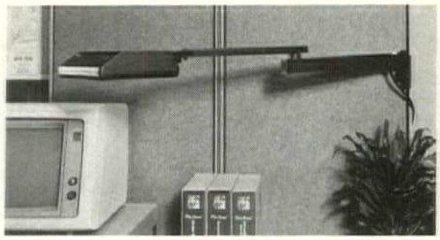
New Horizons Lighting offers Firefly Tree Lighting light strings. Pictured is a version for stationary or flashing 3-watt G6 lamps with 34 lamps in a 50-foot string. Versions for stationary T1¾ and T3¼ lamps are available. Life of the units is estimated at up to 93,000 hours, depending on the type of lamp used. New Horizons Lighting, Palm City, FL.

Circle 64

Synthesized candelight

Monarch Lighting's model 100009 Williamsburg is from a collection of chandeliers incorporating the electronic SynthaFlame system. The system makes incandescent lamps resemble individual flickering candles while maintaining a relatively constant fixture brightness. Controls for adjusting overall light output and for varying the depth of the flame effect can be used separately or together. Models are available with controls integrated into the fixture itself and with wall-mounted controls that provide variable and preset operating modes and scene control interface. Monarch Lighting Company, Tustin, CA.

Circle 65



Open-plan task light

Waldmann Lighting has introduced the PMS-209, a compact fluorescent task light specifically designed for open-plan office furniture systems. The five-axis, articulated, adjustable arm gives users individual position control, and the built-in parabolic louver reduces glare. The unit fits more than 40 panel systems from various manufacturers. Waldmann Lighting Company, Wheeling, IL.

Circle 66

One Touch Can Make Your Whole Day!

Vantage lighting control systems provide the ultimate in convenience and flexibility. Engineered specifically for luxury residential and custom commercial projects, Vantage's attractive and space-efficient control stations enhance any decor.

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Circle 18

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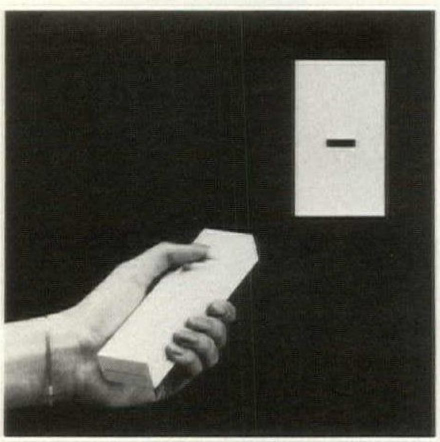
■ Gimbal ring lamp holders

Con-Tech's Gimbal Ring Series lamp holders accept a wide variety of lamps. The open style, with its high-tech look, allows excellent heat dissipation and full horizontal and vertical rotation. Con-Tech Lighting, Northbrook, IL.

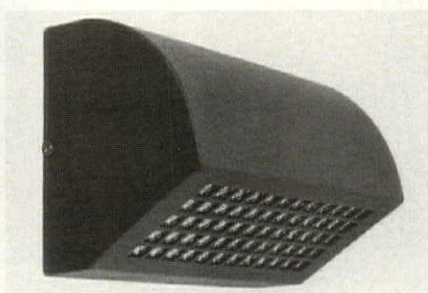
Circle 67



■ Wireless dimmer system

Lutron's RanaX control system provides wireless, continous linear slide dimming of standard and low-voltage incandescent lamps. System components include a hand-held wireless remote control, an intensity control receiver, a manually operated intensity control, and a master power module. The system can control combinations of up to five intensity control receivers and/or manual intensity controls. Master power modules are for loads of 2500 and 3600 watts. The system is expandable up to 18,000 watts per power phase. Lutron Electronics Co., Inc., Coopersburg, PA.

Circle 68



■ Glare-free fixture

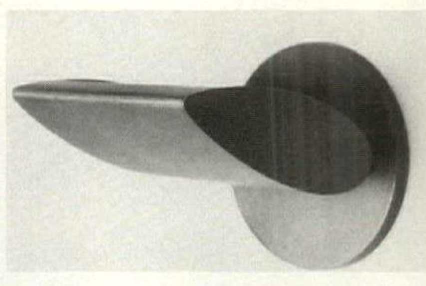
Bullnose glare-free lighting fixtures from Eclipse Lighting accommodate quad and twin-tube compact fluorescent lamps and come in three sizes for indoor and outdoor locations. They are suitable for low-level, surface-mounted lighting in walkways and doorways. A vandal-resistant clear prismatic polycarbonate lens with louvers is standard; white polycarbonate and an open-window space are optional. Eclipse Lighting, Morton Grove, IL.

Circle 69

■ Decorative pendant

Jerry van Deelen designed the Selene pendant luminaire from Les Prismatiques, which has a 1/2-inch-thick ring of frosted glass with a clear edge detail. The ring is set over a half round of frosted acrylic supporting the light source. Models come in three sizes for three or four candelabra-base incandescent lamps. Les Prismatiques, New York, NY.

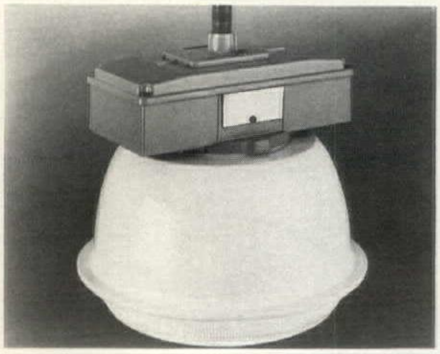
Circle 70



■ Wall-mounted luminaire

The Varial wall-mounted luminaire from Norbert Belfer Lighting has a cast aluminum housing and canopy, a specular anodized aluminum reflector, and a horizontal swivel mount that tilts 22 degrees. It accommodates a 150-watt halogen lamp. Norbert Belfer Lighting, Ocean, NJ.

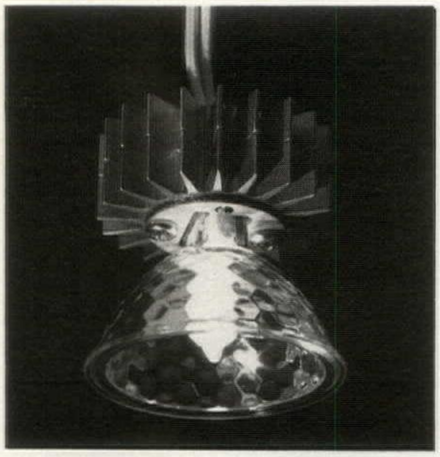
Circle 71



■ Industrial luminaire

The Enduralume industrial luminaire from Holophane fits applications with low mounting heights, controls glare, and has low surface brightness. Its optical assembly features a low-profile aluminum reflector and a spun-in prismatic borosilicate glass refractor for precisely controlled HID illumination in a wide, symmetrical light pattern. The refractor's dropped sidewall creates a soft, luminous appearance and furnishes some uplight. Holophane, Newark, OH.

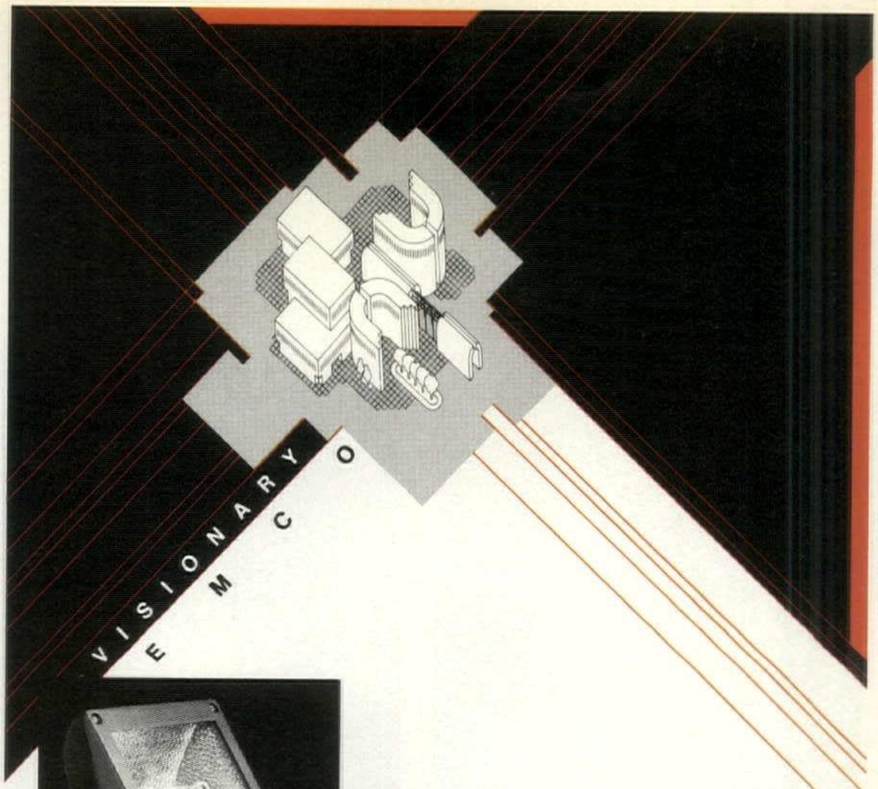
Circle 72



■ MR16 cooling socket

Lighting Technology's Ice Star cooling socket extends the life of MR16 lamps by cooling the seal and surrounding glass, according to the manufacturer. It can be easily installed to replace the ceramic electrical connectors in most low-voltage fixtures. The socket provides a reliable connector that is reported to extend the life of a 75-watt MR16 lamp to 3000 hours. Lighting Technology, Incorporated, Roanoke, TX.

Circle 73



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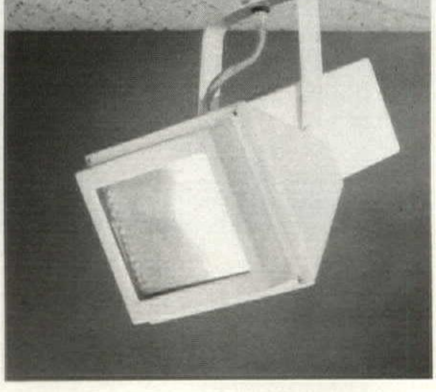
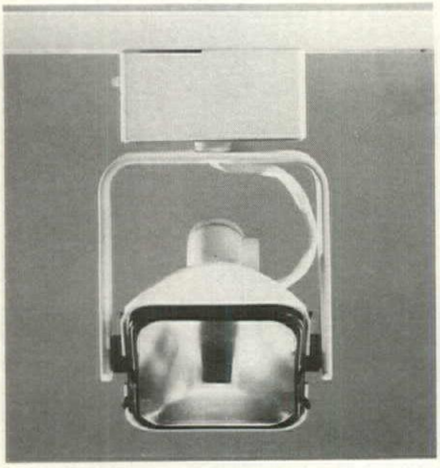


■ Metal halide track head

Gim Metal's model 3520 track head for a single- or double-ended 70-watt Osram HQI metal halide lamp can be used with most track adapters. Light output is equivalent to two 150-watt incandescent fixtures; color rendition and thermal protection are excellent, according to the manufacturer, who also cites lowered costs for lighting and related cooling. Lamps and ballasts are not included. Gim Metal Products, Carle Place, NY.

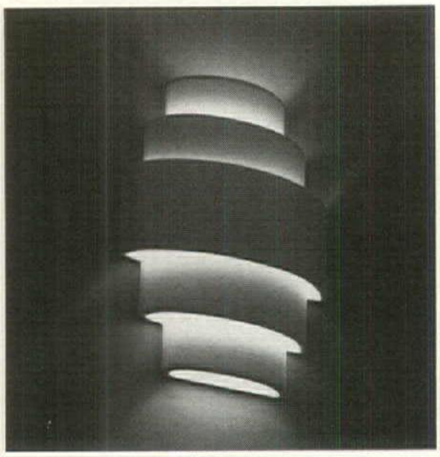
Circle 74



■ Adjustable fixture

The beam spread of Lightolier's Super Beamer low-voltage track fixture can be adjusted from 6 to 18 degrees without dimming the lamp. Optional spread lenses for wide or stretched beams are available. The 75-watt fixture has a built-in reflector for a T4 tubular halogen lamp. It can be dimmed with conventional dimmers. Lightolier, Secaucus, NJ.

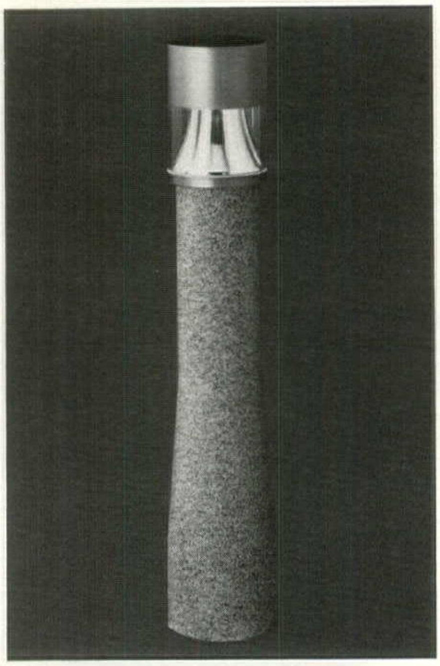
Circle 75



■ Ceramic sconce

Taos Clay Products produces the Ziggurat series of louvered wall sconces in high-fired ceramic. The 16-inch-high Double Spiral Ziggurat fixture illustrated here comes in 10 standard matte porcelain colors and uses two 60-watt incandescent lamps. Also available are custom colors, compact fluorescent lamping, and exterior use models. Taos Clay Products, Inc., Taos, NM.

Circle 76



■ Bollard

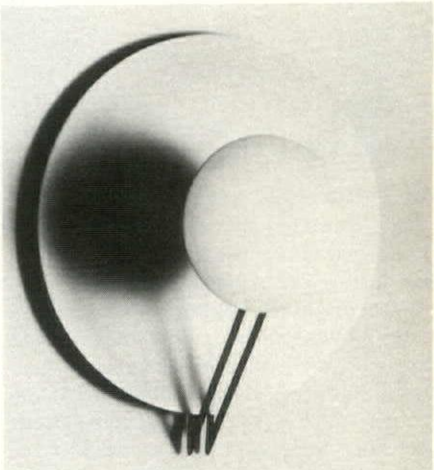
Bollards from Emco Environmental Lighting provide glare-free, low-level illumination and come in a wide selection of shapes and finishes. Optics and lamps meet most architectural specifications. Emco Environmental Lighting, Milan IL.

Circle 77

■ Mission-style chandelier

The four-arm Mission-style Wilshire chandelier from Rejuvenation Lamp & Fixture's Craftsman Collection is a faithful solid brass reproduction of an early 20th-century fixture. A matching two-arm model is available. Rejuvenation Lamp & Fixture Co., Portland, OR.

Circle 78



■ Indirect halogen lighting

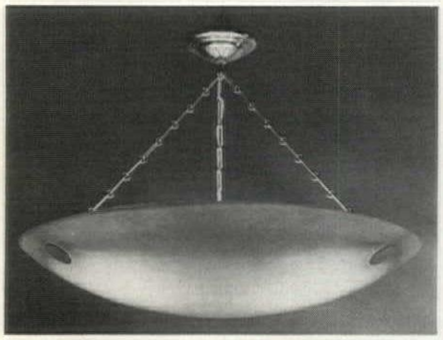
Lightning Bug distributes Tre Ci Luce's Vega series of fixtures for surface mounting on walls or ceilings. An aluminum arm finished in satin black connects two convex aluminum alloy disks. The small disk comes in two finishes and conceals an anodized aluminum inner reflector; the large satin-finished aluminum disk comes in three sizes. The fixtures take linear halogen lamps. Lightning Bug, Ltd., Hazel Crest, IL.

Circle 79

■ Self-luminous exit signs

Brandenhurst LuminExit Series B-100 self-luminous exit signs are simple to install, require no batteries or external power sources, and stay lit continuously for up to 20 years, according to the manufacturer. Light comes from tritium gas hermetically sealed inside glass tubes with phosphor-coated interior surfaces. The tubes are shock-mounted in a high-impact plastic case; a clear, high-impact plastic shield protects the sign's face. A vandal-resistant plastic frame is standard; an anodized aluminum frame is optional. SRB Technologies Inc., Danbury, CT.

Circle 80



■ Chandelier

An opal chandelier from Sirmos features a design popular in the 1920s that has been restyled and simplified for the 1980s. Its translucent bowl is of simulated alabaster with a solid brass trim. It comes in four sizes and custom finishes. Sirmos Inc., Long Island City, NY.

Circle 81

■ Ceiling luminaires

Murray Feiss offers a surface-mounted ceiling luminaire with a solid piece of acid-frosted glass inside a solid brass drum rim. It accommodates two 60-watt incandescent lamps and comes in 12- and 16-inch-diameter models. Murray Feiss Import Corp., Bronx, NY.

Circle 82

THE NEO-ART DECO LUMINAIRE.

This new luminaire declares its aesthetic heritage boldly in its emphatic contours and sculptured linearity. Created originally for the new Lower Canal multi-use development in downtown Indianapolis, Series SIC is not only visually striking by day, it is also rugged, vandal-resistant, and extremely energy-efficient at night. Available with mating posts for single or cluster mount. Write, call, or fax for details, price, and delivery. **See us in Sweet's and LAFile**

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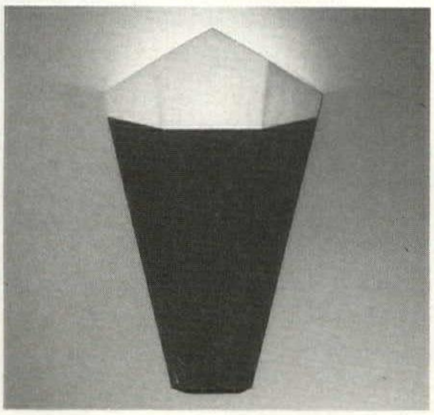
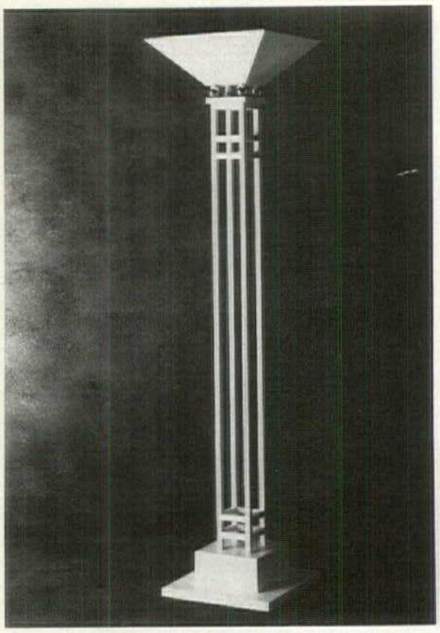


■ Wall sconce

The Torch marble wall sconce from Line Lites comes from a series of seven marble sconces made for mounting on a junction box. All are handmade and numbered. The sconce comes in gray and in two-color combinations of opaque and translucent marble and granite. It can also be fabricated from customer-supplied stone tiles to match an installation. Line Lites Inc., Atlanta, GA.

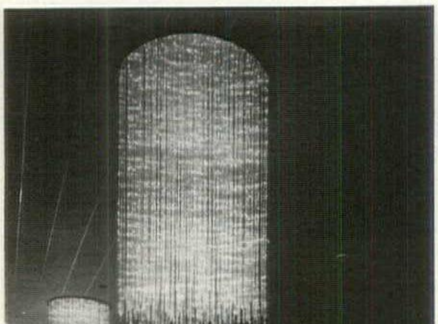
Circle 83



Decorative torchere

The Venus torchere from Visa Lighting has an inverted pyramid-shaped shade balanced on four solid brass spheres. The shade, structure, and base come in a choice of painted and metal finishes. The torchere accommodates an incandescent, halogen, fluorescent, or metal halide source. Visa Lighting Corporation, Milwaukee, WI.

Circle 84



Chandelier

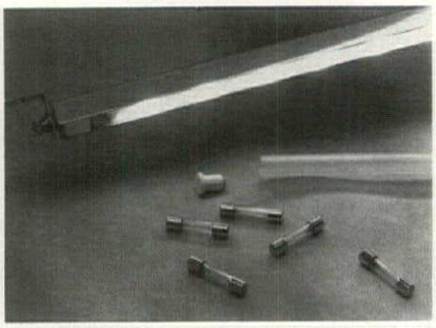
Lightworks offers the CHL series of chandeliers, made of strings of low-voltage UL-listed tube lights. The chandeliers come in a variety of sizes and configurations. Lightworks, Philadelphia, PA.

Circle 85

Nautical-style luminaire

Architectural Area Lighting offers a post-top luminaire in a nautical style. It has a solid copper hood, solid brass rods, and a Fresnel diffuser. Architectural Area Lighting, La Mirada, CA.

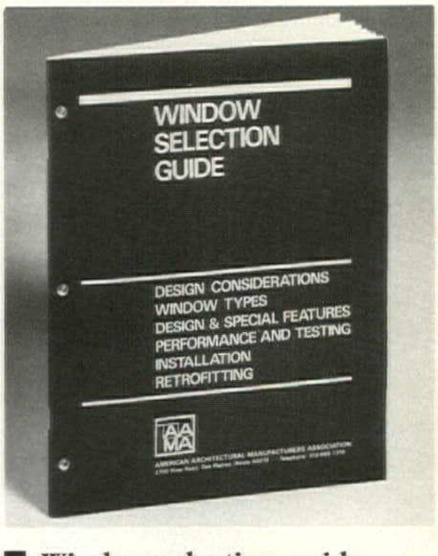
Circle 86



Cabinet light

Lite Cycle's LC2120 lamp is a narrow $1/2$-inch-square line-voltage linear fixture for display and under-cabinet lighting. Light comes from a series of long-life incandescent fuse lamps. The brass-finished fixture comes in two sizes and wattages, is easily installed with two screws, and swivels for precise adjustment. Lite Cycle, Lewisville, TX.

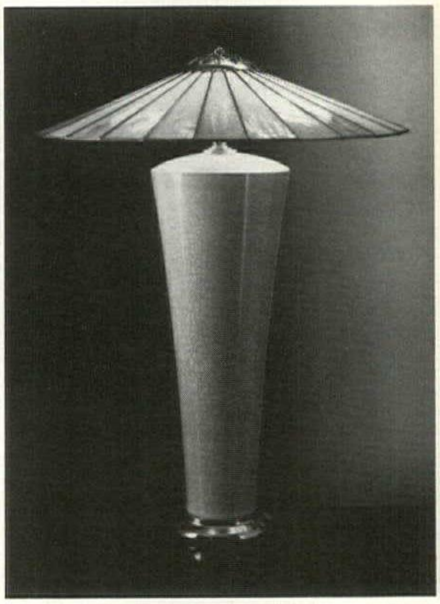
Circle 87



Window selection guide

The AAMA has published a 64-page manual that discusses 16 types of windows, related industry performance standards, installation, and retrofitting. American Architectural Manufacturers Association, Des Plaines, IL.

Circle 88



Decorative table lamp

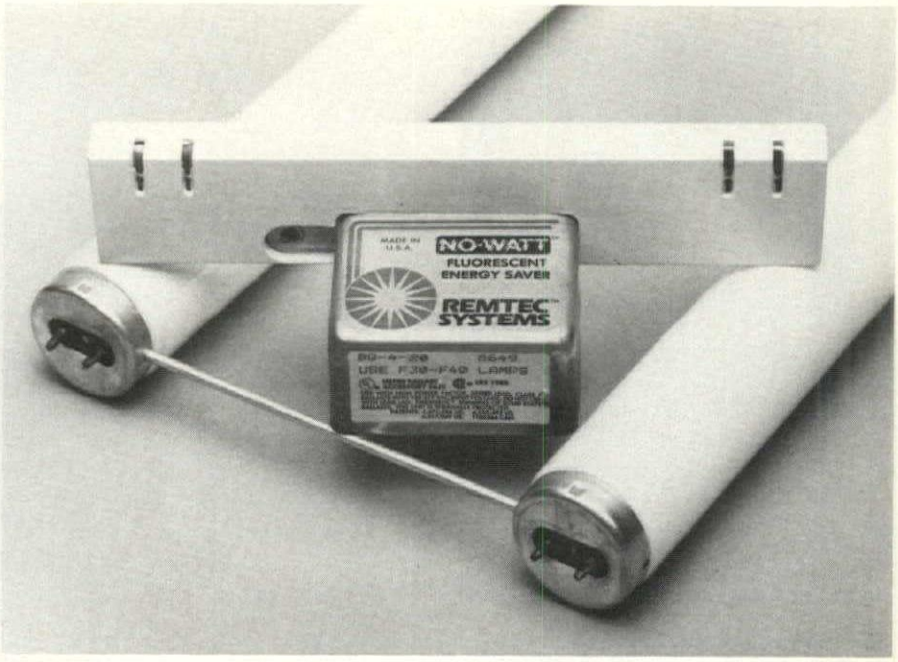
Gemma Studios' Delos table lamp has a 22-inch-diameter parasol shade handcrafted in the Tiffany copper foil technique from domestic or European opalescent glass. The lamp features solid brass fittings, a pull-chain switch, and a hand-poured, handfired porcelain base. Sandblasted shades for diffused lighting and versions with and without borders are available. Gemma Studios, Northampton, MA.

Circle 89

■ Low-voltage landscape light

Idaho Wood's S222 Stick Light is an energy-saving 12-volt landscape fixture that can be installed individually or in series. The 50,000-hour lamps that come with the fixture last 15 years in normal use, according to the manufacturer. Idaho Wood, Sandpoint, ID.

Circle 90



■ Current limiter

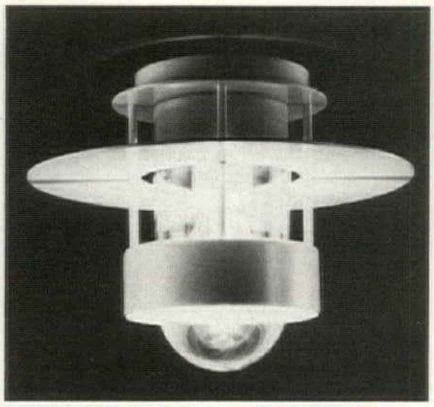
The model BU No-Watt energy-saving current limiter from Remtec Systems snaps into 2-foot-square fixtures for U-tube fluorescent lamps without hard wiring and can be removed for relocation. The device helps lower heat in a fixture to prolong lamp and ballast life and to reduce air conditioning requirements. Models for current reductions of 20, 30, and 50 percent are available, each with a five-year warranty. Remtec Systems, Duarte, CA.

Circle 92

■ Exit sign

High Lites offers nonemergency and fully self-powered emergency models of die-cast exit signs for 7-watt compact fluorescent lamps. An optional power pack for field installation is available. High Lites, Waterbury, CT.

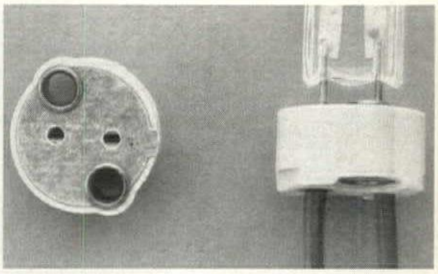
Circle 91



■ Ceiling luminaire

Jens Moller Jensen designed Poulsen Lighting's Saturn Ceiling luminaire, which is made of heavy-gauge galvanized steel. A flat reflecting ring and an antiglare shield surround the light source; a threaded glass envelope encloses the lamp compartment. Poulsen Lighting Inc., Miami, FL.

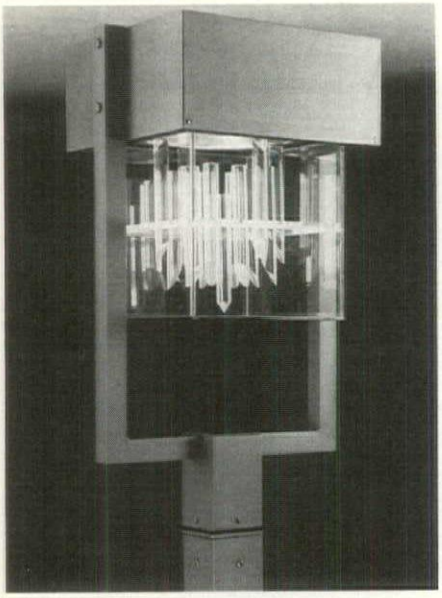
Circle 93



■ Halogen lamp sockets

Gilway Technical Lamp offers ceramic sockets designed to withstand the high temperatures of halogen lamps. Two mounting holes allow them to be mounted on most surfaces. Gilway Technical Lamp, Woburn, MA.

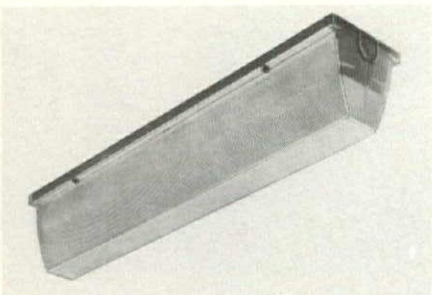
Circle 94



■ Cutoff luminaire

Devine Design's RAB 100 cutoff luminaire has a sealed optical system that uses acrylic cylinders to create the effect of an outdoor chandelier. It comes in yoke and canopy mountings, meets IES requirements for cutoff luminaires, and is CSA approved and UL listed for wet locations. Devine Design, Kansas City, MO.

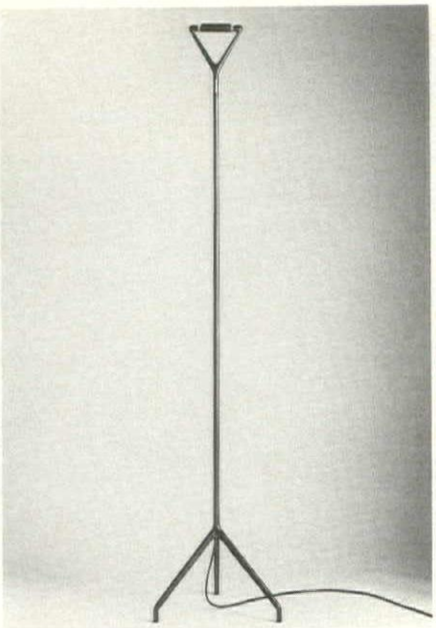
Circle 95



■ Wraparound fixture

Kenall Manufacturing's Shorty-Forties multipurpose injection-molded wraparound fixtures accommodate GE's 40-watt Biax fluorescent lamps. They have a high-strength refractor, a high-efficiency reflector, and a choice of lenses and laminated trims. The fixtures are suitable for use where space and materials funds are limited. They come in sizes for one, two, or four lamps. Kenall Manufacturing Company, Chicago, IL.

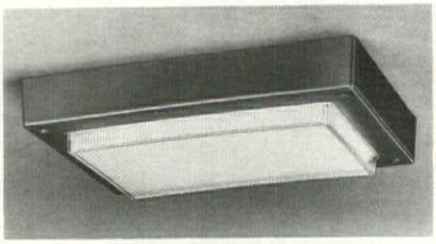
Circle 96



■ Floor lamp

Artemide offers Luce Plan's Lola floor lamp, part of a series of halogen luminaires in floor, wall stem, and wall versions. The version shown is made of polyurethane and thermoplastic polyester and accommodates one 300-watt double-ended halogen lamp. Features include a telescoping stem, a floor dimmer, and an adjustable lamp head. A wall-mounted model is also available. U.S. distributor: Artemide Inc., Long Island City, NY.

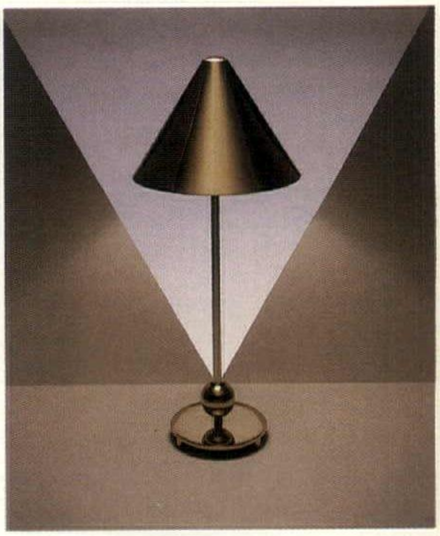
Circle 97



■ Vandal-resistant fixture

Fail-Safe's vandal-resistant light fixture accommodates up to three 13-watt compact fluorescent lamps. Its shallow $2^{1}/_{2}$-inch profile is ideal where space is limited. Options include housing colors, lens types, emergency battery pack, and high power factor capacitor. Fail-Safe Lighting Systems, Inc., Chicago, IL.

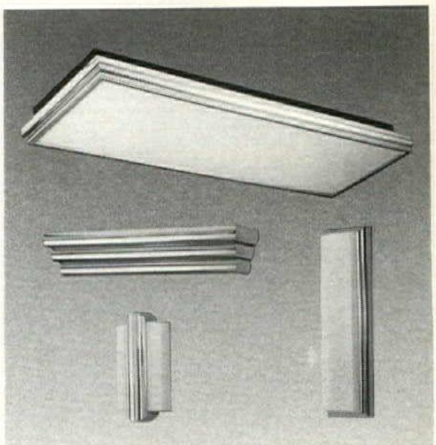
Circle 98



■ Table lamp

The Pendulum table lamp from Boyd Lighting has a spun brass shade and a sphere base accent. The lamp stands $21^{1}/_{2}$ inches high on a $5^{1}/_{2}$-inch-diameter base. An on-off cord switch is standard; a cord-line dimmer is optional. Boyd Lighting Company, San Francisco, CA.

Circle 99



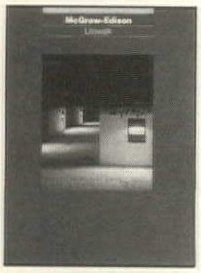
■ Decorative fluorescents

Lumax Industries Light*Forms are energy-saving decorative wall- and ceiling-mounted fluorescent luminaires with wood trims and metallic moldings. Models are available for standard and compact fluorescent lamps. Lens and louver combinations are optional. Lumax Industries, Inc., Altoona, PA. ■

Circle 100

Product Literature

Walkway lighting



The Litewalk low-profile cutoff luminaire for HID sources is designed for walkway illumination. A brochure illustrates applications, provides a detailed cutaway drawing, and lists features. McGraw-Edison, Vicksburg, MS.

Circle 101

Merchandise lighting

A 12-page color brochure from Lighting Services demonstrates the design and display possibilities of track, spot, and accent fixtures in a retail environment. Applications in nine retail sites are shown. Lighting Services Inc., Stony Point, NY.

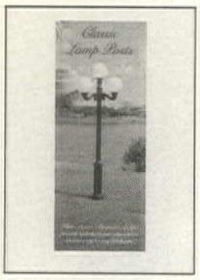
Circle 102

Light measurement

The Litemate/Spotmate System 500 combines a pocket-sized illuminance photometer and a spotmeter with a 1-degree acceptance angle. A brochure describes applications, specifications, and accessories. Photo Research, Chatsworth, CA.

Circle 103

Outdoor luminaires



A color brochure from Classic Lamp Posts describes and illustrates five luminaires and two posts molded of a steel-reinforced polyethylene and urethane laminate. Classic Lamp Post, Miami, FL.

Circle 104

Electronic ballasts

A brochure describes benefits of Ballastar high-frequency electronic ballasts and contains charts of electrical and physical characteristics for three versions. MagneTek Triad, Huntington, IN.

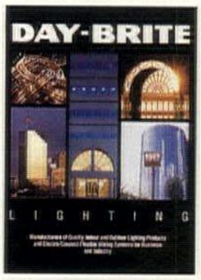
Circle 105

Large lamp catalog

GTE/Sylvania's revised 92-page Large Lamp Catalog provides ordering and general information on incandescent, fluorescent, and HID lamps for industrial and commercial installations. Discussions introduce each section. GTE/Sylvania, Danvers, MA.

Circle 106

Lighting, wiring products



Day-Brite's 164-page comprehensive condensed catalog covers indoor and outdoor lighting products and Electro-Connect flexible wiring systems; it contains 18 pages of applications information. Day-Brite Lighting Company, Tupelo, MS.

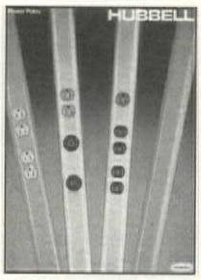
Circle 107

Fluorescent fixtures

A 20-page color catalog illustrates Brodwax Lighting's fluorescent luminaires, many with oak or walnut frames. Sizes are available for straight, circular, and U-shaped fluorescent lamps. Brodwax Lighting Corp., Island Park, NY.

Circle 108

Power poles



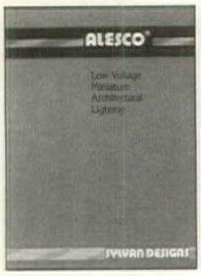
A six-page color brochure details aluminum and steel power poles, including standard specification-grade duplex receptacles and options for isolated ground, surge protection, and blank two-channel poles. Hubbell Incorporated, Wiring Device Division, Bridgeport, CT.

Circle 109

Ceiling fan, lights

A color brochure describes Meridien ceiling fans, which feature elements of rosewood, lead crystal, and metal, and shows a selection of blade styles, finishes, light fixtures, and shades. Casablanca Fan Company, Inc., Pasadena, CA.

Circle 110



Low-voltage accent lights

A 40-page illustrated catalog features more than 60 Alesco low-voltage fixtures in models for recessed, semirecessed, and surface mounting. Photos, line drawings, and complete specifications are included. Sylvan Designs, Inc., Northridge, CA.

Circle 111

Commercial luminaires

NL Corporation manufactures chandeliers, custom luminaires, track and channel fixtures, church luminaires, and architectural lighting fixtures. A brochure includes photos and describes the company's capabilities. NL Corporation, Cleveland, OH.

Circle 113

Light-transmitting panels

A color brochure details Kalwall's system for walls, window walls, and window replacements. Double panels of insulated fiber glass–reinforced sheets transmit and diffuse light. Kalwall Corporation, Manchester, NH.

Circle 112

Fiber-optic lighting

The Fiberstars perimeter lighting system consists of lengths of flexible tubing that encase fiber-optic strands connected to a light-emitting box. No electricity runs through the tubes, so they can safely be used near water. Fiberstars, Fremont, CA.

Circle 114

MINOLTA METERS THE MEASURE OF EXCELLENCE

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ENJOY SOME EXCELLENT LIGHT READING.

Minolta wrote the book on light reading capabilities with these superbly accurate Illuminance Meters.

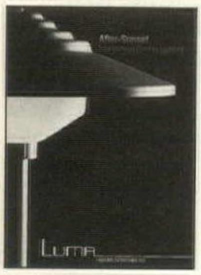
All three models are convenient because they're so light themselves, less than 8 oz. including one 9v battery. Consider, too, their remarkable ease of operation and you'll realize they're ideal for industrial, or a broad range of scientific applications. Just choose T-1 for most situations, T-1M for use in smaller areas or T-1H to measure very high illumination levels.

And these are just three of Minolta's full line of light and color measurement instruments. For more information, including our 21 page booklet "Precise Color Communications," please call (201) 825-4000 or write: Minolta Corporation Industrial Meter Division, 101 Williams Dr., Ramsey, New Jersey 07446.

Our brochure, as you'd imagine, provides even more excellent light reading. ***ONLY FROM THE MIND OF MINOLTA.***

MINOLTA

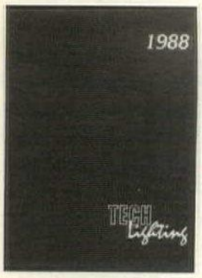
Circle 21



■ Garden lighting

The After-Sunset line of low-voltage garden lighting fixtures includes 25 styles in three colors for path, area, directional, and novelty lighting. Color photos of applications accompany descriptions of the fixtures. Luma Lighting Industries, Inc., Orange, CA.

Circle 115



■ Decorative collection

A color catalog details Tech Lighting's collection of decorative table, floor, wall, ceiling, and suspension luminaires. It contains descriptions and color photos of each luminaire, including several from the Foscarini line. Tech Lighting, Chicago, IL.

Circle 116

■ Product selection

A brochure contains a selection of lighting products in Hadco's Quik-Ship program. Traditional and contemporary bollards, posts, and fixtures for residential, performance, and low-level lighting are included. Hadco, Littlestown, PA.

Circle 117

■ Emergency, exit lighting

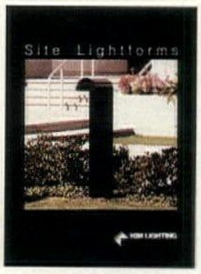
A 20-page catalog profiles Mule Emergency Lighting's line of emergency lighting systems and exit signs. Features, photos, and options are included for each product. Mule Emergency Lighting Co., Inc., Providence, RI.

Circle 118

■ Emergency DC system

Siltron's central DC systems, series AC/DC, eliminate the need for individual emergency power packs and provide DC emergency power in levels from 12 to 120 volts and 200 to 20,000 watts. Siltron Illumination, Inc., Cucamonga, CA.

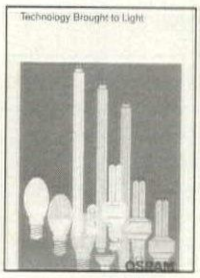
Circle 119



■ Site lighting

The Site Lightforms catalog from Kim Lighting depicts six luminaires that complement neoclassic and high-tech architectural designs and provide vandal-resistant cutoff lighting. Kim Lighting, City of Industry, CA.

Circle 120



■ Lamp collection

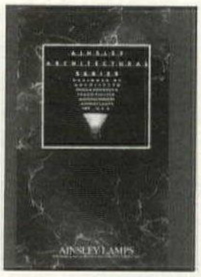
A 10-page catalog contains photos, descriptions, and technical data on Osram's compact and T8 fluorescent lamps, low- and line-voltage halogen lamps, high pressure sodium lamps, and metal halide lamps. Osram, Newburgh, NY.

Circle 121

■ Discharge lamps

A 16-page brochure lists specifications, dimensions, and wattages for Ushio's discharge lamps, including super high pressure mercury, xenon mercury, and two types of high pressure xenon lamps. Ushio America, Inc., Torrance, CA.

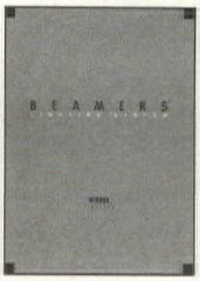
Circle 122



■ Decorative luminaires

Ainsley's Architectural Series of decorative luminaires was designed by architects Sheila Kennedy and Frano Violich. A 14-page color brochure depicts floor, table, ceiling, and wall lamps in five styles. Ainsley Lamps, Inc., Brooklyn, NY.

Circle 123



■ Indirect ceiling system

Beamers light squares create a nonlensed indirect reflecting lighting system that fits standard suspended ceiling grid systems. Light from lamps inside ceiling-mounted moldings shines up and is redirected down into the space. Winona Lighting, Winona, MN. ■

Circle 124

Calendar

August 20, 1988	**Lighting Living Spaces,** seminar, University of California Extension Center, San Francisco. Fran Kellogg Smith on lighting homes, hotels, and other intimate spaces with emphasis on mood, task, and focal lighting. Contact: UC Berkeley Extension, 2223 Fulton Street, Berkeley, CA 94720, (415) 642-4271.
August 25, 1988	**Calendar deadline** for October *Architectural Lighting*. Contact: Susan Degen, Assistant Editor, *Architectural Lighting,* P.O. Box 10460, Eugene, OR 97440, (503) 343-1200.
September 14–15, 1988	**Conpac 88 and Pan Pacific Lighting Expo,** Contract Design Center, San Francisco. Show and conference for office, hospitality, health care, and institutional furnishings. Lighting presentations by Sam Berman, Phillip Hughes, Ross de Alessi, and others. Cosponsors: Contract Design Center and local chapters of IBD, IFMA, ASID, HIA, and IES. Contact: Craig Winter, Executive Director, Conpac 88, 2 Henry Adams Street, San Francisco, CA 94103, (415) 864-1500.
September 15, 1988	**Entry deadline.** Ninth annual National Lighting Awards Program recognizes projects completed on or after January 1, 1986, that demonstrate the value of effective electric illumination. Contact: National Lighting Awards Program, c/o National Lighting Bureau, 2101 L Street, NW, Suite 300, Washington, DC 20037, (202) 457-8437.
September 15–16, 1988	**Innovations '88,** Houston. Contact: INNOVA, 20 Greenway Plaza, Houston, TX 77046, (800) 231-0617 or (713) 963-9955.
September 16, 1988	**Entry deadline** for IALD's sixth annual lighting design awards program, which recognizes permanent lighting installations completed after January 1, 1986. Contact: International Association of Lighting Designers, 18 East 16th Street, Suite 208, New York, NY 10003, (212) 206-1281.
October 6– December 11, 1988	**Neon design and techniques,** Museum of Neon Art, Los Angeles. Eight-week course includes history of neon and creating a work in neon. Contact: Museum of Neon Art, 704 Traction Drive, Los Angeles, CA 90013, (213) 617-1580.
October 17–19, 1988	**Architectural Lighting: Basics for Design and Application,** Penn State University, University Park, PA. Instructors: Craig Bernecker and Richard Mistrick. Contact: Donna Ricketts, 409 Keller Conference Center, Pennsylvania State University, University Park, PA 16802, (814) 863-1743.
October 23–26, 1988	**IFMA '88,** national conference and exhibition, Atlanta Market Center and Westin Peachtree Plaza, Atlanta. Contact: International Facility Management Association, 11 Greenway Plaza, Houston, TX 77046, (713) 623-IFMA.
October 24–25, 1988	**Southern Lights,** Atlanta Market Center. Lighting products exposition runs concurrently with IFMA '88. Contact: Susan Brashear, (404) 658-5672.
October 24–27, 1988	**Indoor lighting institute,** Boulder, CO. Course covers design issues and analysis techniques for indoor lighting. Contact: Independent Testing Laboratories, 3386 Longhorn Road, Boulder, CO 80302, (303) 442-1255.
November 3–4, 1988	**Lighting Management,** Boston. Course on basics of energy-efficient design and retrofit. Repeats December 8–9 in Orlando, FL. Contact: Association of Energy Engineers, 4025 Pleasantdale Rd., Suite 420, Atlanta, GA 30340, (404) 447-5083.
November 3–5, 1988	**IIDEX,** Metro Toronto Conference Center, Toronto, Canada. Contact: Association of Registered Interior Designers of Ontario, 168 Bedford Rd., Toronto M5R 2K9, (416) 921-2127.
November 5–9, 1988	**ASLA annual meeting and educational exhibit,** Seattle, WA. Contact: American Society of Landscape Architects, 1733 Connecticut Avenue, NW, Washington, DC, 20009, (202) 466-7730.
November 7–9, 1988	**China–North America Daylighting Conference,** Scientific Hall, Beijing, People's Republic of China. Cosponsors: IESNA, China IES, and Architectural Physics Academic Committee of the Architectural Society of China. Contact: IESNA, 345 East 47th Street, New York, NY 10017, (212) 705-7915. ■

Classified Directory

ACCENT AND DISPLAY LIGHTING (INTERIOR)

BEND-A-LITE (see ad this section)

MIROFLECTOR CO., 40 Bayview Ave., Inwood, Long Island, NY 11696 .... ***516/371-1111***
Full line of recessed accent lights, down lights & wall washers. Architectural cylinders for HQI, incandescent compact quad fluorescents and HID lamp sources.

NL CORP., 14901 Broadway, Cleveland, OH 44137 .... ***FAX 216/662-9069 or 216/662-2080***
Recessed HID and incandescent; decorative; custom; church; 20, 30, & 60 amp track; fluorescent lighting systems. Call for more information.

ACCESSORIES AND COMPONENTS

AMERICAN LOUVER CO., Skokie, IL, Louvers and Lenses .... ***800/323-4250 or 312/470-3300***

AMBIENT LIGHTING SYSTEMS (INTERIOR)

AREA LIGHTING (EXTERIOR)

AMERICAN ELECTRIC, 1555 Lynnfield Rd., Memphis, TN 38119 .... ***901/682-7766***
HID luminaires for area, facade, roadway, sports, and industrial lighting applications.

C.P.I. CONCRETE PRODUCTS, P.O. Box 13324, Memphis, TN 38113 ... ***FAX 901/775-9883 or 901/775-9880***
Concrete light poles & bollards. Fourteen decorative colors & exposed aggregate finishes such as dark bronze, black, & granite to match any setting. Square tapered design up to 65 ft.

ELA CO., 17891 Arenth Ave., City of Industry, CA 91748 .... ***818/965-0821 FAX 818/965-9494***
Mfgs. of decorative outdoor fixtures, poles and arms for the commercial and residential mkts. Custom designing and mfg. of decorative interior/exterior fixtures.

J.H. BAXTER & COMPANY, P.O. Box 10797, Eugene, Oregon 97440 .... ***503/689-3020***
Manufacturer of Timberwood Lighting Standards. A superior pressure-treated Douglas fir laminate for decorative outdoor lighting support. Contact Richard Baxter.

PEMCO CORP., Philadelphia, PA, Exterior HID & Custom Lighting & Poles ***215/236-9020***

STONCO, 2345 Vauxhall Rd., Union, NJ 07083. Contact Phil Henry at ***201/964-7000***
Outdoor lighting; fixtures and accessories for industrial, commercial and residential markets.

UNION METAL CORP., 1022 9th St. SW, Canton, OH 44707 .... ***216/456-7653***
Steel, aluminum and concrete poles for area, roadway and sports lighting. Hi-mast raise-lower systems. Ornamental nostalgia lighting poles and luminaires.

W.F. HARRIS LIGHTING, 4015 Airport Ext. Rd., Monroe, NC 28110 .... ***704/283-7477***
Indoor/outdoor decorative & vandal-resistant rustproof lighting for wall, ceiling, post & landscape applications. U.L. listed H.I.D., FL, INC & emergency fixtures.

CONTROLS

LEE COLORTRAN, 1015 Chestnut St., Burbank, CA 91506 .... ***FAX 818/954-8520 or 818/843-1200***
VIEWPOINT, a field-configurable system of off-the-shelf Architectural Dimming and Control Components from Lee Environmental Lighting—a division of Lee Colortran, Inc.

DAYLIGHTING PRODUCTS

DECORATIVE LUMINAIRES (INTERIOR)

DESIGN SOFTWARE & TESTING/MEASURING INSTRUMENTS

INTERNATIONAL LIGHT, Dexter Industrial Green, Newburypost, MA 01950 .... ***617/465-5923***
Radiometers, photometers, spectroradiometers, laser power meters for radiometry, photometry, UV curing, UVA/B phototherapy, germicidal radiometry & UV hazard use.

LAMPS

VENTURE LIGHTING INTL., 625 Golden Oak Pkwy., Cleveland, OH 44146 .... ***800/437-0111***
Metal Halide, High and Low Pressure Sodium, Mercury, MR-16 and MR-11 Display Lamps. Many new and unique products not available from other manufacturers.

LANDSCAPE LIGHTING

ABEC LIGHTING, 4084 Arnold Ave., #8, Naples, FL 33942 .... ***813/643-4242 or 813/643-3305***
Quality outdoor landscape & security lighting. PVC construction. Fluorescent/low voltage available—all styles. Custom color & design. Commercial, residential, marine.

IDAHO WOOD, Sandpoint, ID, Landscape Lighting (Wood) .... ***800/635-1100 or 208/263-9521***

LIGHTING DESIGNERS AND CONSULTANTS

FREDRICK RAMOND INC., 16121 S. Carmenita Rd., Cerritos, CA 90701 ..... ***FAX 926-1015 213/926-1361***

OEM MANUFACTURERS

GAYNOR CO., 200 Charles St., Stratford, CT 06497 .... ***203/378-5545 or FAX 203/381-9019***
For more information about fluorescent wiring devices, switches and lamp holders, call and ask for Jill Sapak.

OTHER LIGHTING SYSTEMS AND LUMINAIRES

CUSTOM NEON Mfg., Install interior neon. Portable & wall-mount art & signs. ***213/937-6366***

PARADISE DESIGN & MFG. INTL., 2633 E. 28th, #602, Signal Hill, CA 90806 .... ***213/427-5756***
Portable neon fixtures, custom cove lighting & neon art, stock figures for residential, commercial, & architectural applications. For information call Don Narbone.

OTHER SERVICES

REPS WANTED/REPS AVAILABLE

REPRESENTATIVES WANTED/Lighting wholesale exclusive high-end contemporary lighting.
Residential and commercial. Great opportunity with highly respected growing company. Send resume in strict confidence to: CAREER DEV. CENTER, P.O. Box 10460, Dept. AL-788, Eugene, OR 97440

THEATRICAL/STAGE LIGHTING

The Classified Directory is a monthly feature of ***Architectural Lighting,*** offering readers easy access to lighting products and services for commercial, industrial, and institutional applications. Listings in this reference section are sold on an annual basis at the rates outlined below. For full information and closing dates, contact Gordon Exe, (800) 822-6678 or (503) 343-1200.

FIRST LINE—$990/12 issues
BOLDFACE, ALL-CAP ITALIC LISTING or Boldface, Upper/Lower Case Italic.

ADDITIONAL LINES—$690/12 issues
REGULAR, ALL-CAP LISTING or Regular, Upper/Lower Case.

VISA MasterCard American Express ***accepted***

In This Issue

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Triad-Utrad: Electronic ballasts.

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Imperial Glass Structures: Atrium skylight.
Joslyn Corporation: Lowering device.
Reynolds Company: Luminaires.

Page 16. *Low-voltage system lights offices dramatically* (Opus Southwest Corporation headquarters, Phoenix, Arizona).
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Capri: Recessed, adjustable low-voltage accent light and wall washer.
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Page 17. *Five-year energy analysis shows daylighting saves dollars* (Norstar building, Buffalo, New York).
Conservolite: Fluorescent controls.
Gibson: 2-by-2, 9-cell, 4-inch-deep parabolic fluorescent fixtures.
Lutron: Incandescent controls.
Marco: High-hat downlights.

Page 20. *Restoring 1909 lighting in Frank Lloyd Wright's home and studio* (Oak Park, Illinois).
Bob Cooper, Cooper Art Glass: Art glass restoration and reproduction.
Holophane: Prismatic glass globes.
Charles Lotton: Blown glass globes for master bedroom.
Racine Sheet Metal: Weather skylights.
Albert Wagner and Sons, Inc.: Weather skylights.
Wilmer Snow & Co.: Restoration and reproduction of custom light fixtures.

Page 28. *Lighting a historic 500-foot clock tower with PAR lamps* (Custom House, Boston).
GE: Various lamps.
GTE/Sylvania: Shaft uplights; 6-volt PAR fixtures; various lamps.
Harry Richmond Co., Inc.: Custom housings and booms.
Hubbell: PAR 38 lamp holders.
Lightolier: Yoke for first-floor fixture.
Lutron: Dimmers for 6-volt lamps.
Osram: Blue compact fluorescent lamps.
Prescolite: Portico downlights.
Square D: Programmable logic controller.
Stonco: PAR 64 lamp holders; vaportight surface-mounted A lamp holders.
Tork: Programmable timer.

Page 34. *Lighting makes airport club, business center relaxing, inviting* (United Airlines Red Carpet Club, Denver, Colorado).
Alcan: Extruded aluminum baffles.
Boyd: Floor lamps.
Electro Controls: Dimming and time clock system.
Halo: Framing projectors.
Hydrel: Tree uplights.
Integrated Ceilings: Skylight and ceiling grid elements.
Lithonia: Fixed and adjustable downlights.
Lutron: Conference room dimmers.
McPhilben: Edge-lit exit signs.
Peerless: Fluorescent uplights.
Philips: Lamps.
Voltarc: Neon tubing.
Wiremold: Sign lamp strip.

Page 38. *Renovation creates coves, light ports for new fixtures* (George W. Welsh Civic Auditorium, Grand Rapids, Michigan).
Halo: Track lighting.
Lithonia: Asymmetric fluorescent cove lighting; light port luminaires in auditorium.
Omega: Recessed metal halide fixtures.
Strand: Lighting controls.
Union Metal Mfg.: Street luminaires.

Manufacturer credits reflect the products specified for the projects; it is possible that other products were installed during construction or maintenance.

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