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June 1987
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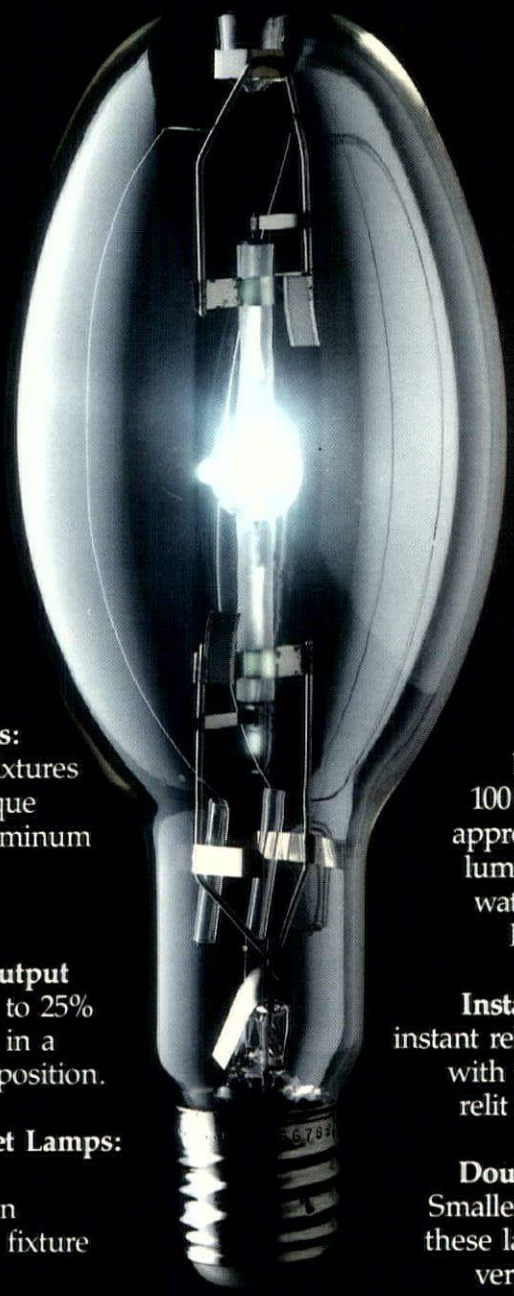

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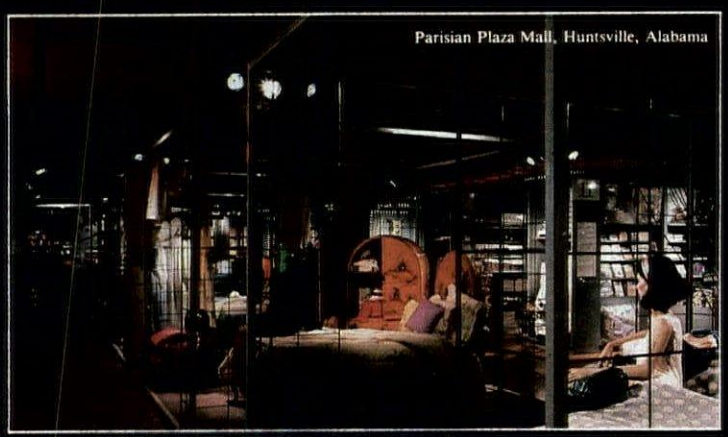
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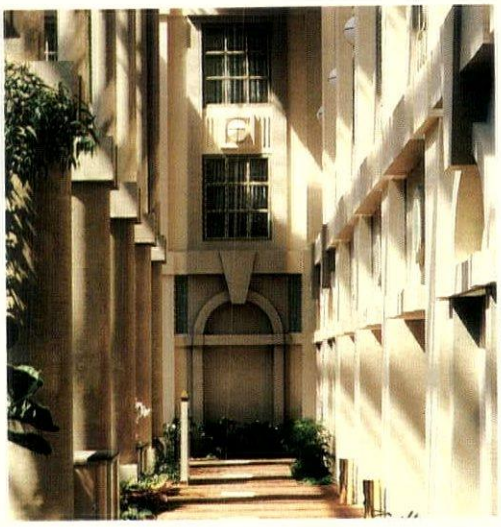
ARCHITECTURAL LIGHTING

June 1987
Volume 1, Number 6



COVER PHOTO: JOCK POTTLE

From the Editor

After viewing manufacturers' exhibits at Lighting World 5 last month, I can confidently report a fact that may sometimes escape a reader's notice within these pages. Concern for energy conservation is not dead, despite the fact that for most of us the cost of electricity is rising more slowly than it did in the 1970s.

How can I tell? By looking at new products. In many ways new products are a remarkable indicator of where the hearts of designers are. Manufacturers conduct market research to find out what designers want. What did they come up with for this year's Lighting World? Tons of luminaires for the new compact fluorescent lamps and the newer miniature metal halide lamps.

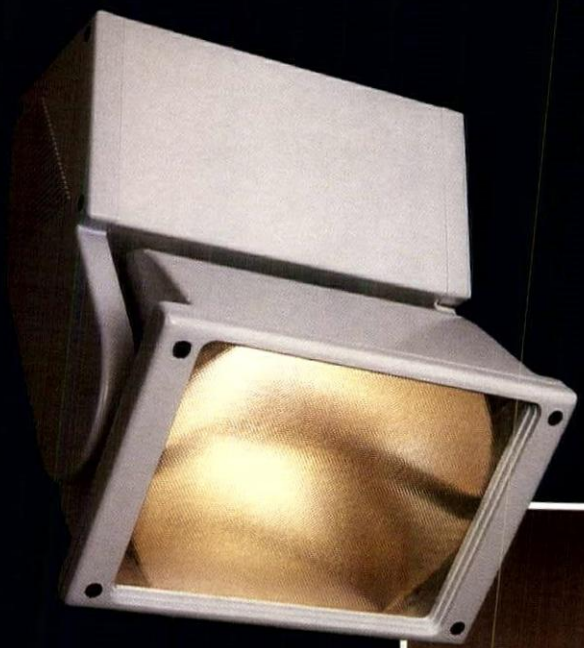
In case you don't already know why these lamps are better: they make more wattage into light and less into heat than incandescent lamps, so they're much more energy efficient. The new lamps last longer and require less maintenance. Their color rendering has been improved immensely. And recently they have become available in wattages and envelope shapes that make them practical for use where once we would have automatically specified an incandescent lamp.

Manufacturers have responded quickly to the market's hunger for luminaires to accommodate these new lamps. Designers simply can't incorporate energy efficient lamp technology into buildings without the fixtures to put them in, and designers seem to need a lot of choices! But now that manufacturers have responded to this challenge, it's up to designers to finish up the job — to become informed about these energy efficient products, and to use them when possible.

I wouldn't suggest that the new lamps and luminaires will make incandescent lamps obsolete in the near future. Incandescent is still the right source for many jobs. And I'm sure that our current energy crisis reprieve, coupled with the higher initial costs of these new lamps and hardware, will continue to discourage some people from using them for a while. In the meantime, we designers should take it upon ourselves to become informed about this technology — whether we know it or not, we're likely to be using it once this reprieve is over.

Sadly, I noted few exhibitors of products related to daylighting at Lighting World 5. Nor was there a daylighting lecture of any kind in the show program. Isn't it ironic that folks don't seem to think Lighting World ought to include the light of day?

Charles Linn, AIA



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Circle 8

Letters

Questionable savings

The Parts Department's [April 1987] general comments comparing the light output, efficacy, and life of the 40-watt CW (argon-filled) lamp system with the 34-watt LW (krypton-filled) energy "saving" system are questionable. Initial light output: 40-watt (3150 lumens times 95 percent ballast factor) is 2993 lumens; 34-watt (2925 lumens times 87 percent ballast factor) is 2545 lumens. The 40-watt lamp's output is about 18 percent greater. I think this is significant. Efficacy: although the 34-watt lamp's efficacy is about 6 percent greater, the lamps operate at a higher current; this increases the ballast losses. The result is that the system efficacy for both lamps is about the same. Life: I am not aware of any data that substantiates that krypton-filled lamps have a longer life than argon-filled lamps. In fact, the higher starting voltage for the 34-watt lamps suggests that their life should be somewhat shorter. The above facts, coupled with the 34-watt LW lamp's higher cost and lower CRI (55 compared to 63) [suggest that the 34-watt LW lamps] may not be a designer's most cost-effective device.

As a retrofit for overilluminated spaces, the 34-watt energy-saving lamps have filled a need. However, for renovation and new construction, blindly selecting the krypton-filled energy "saving" lamps without considering the argon-filled lamps may not be the cost-effective solution.

R.R. Verderber
Staff Scientist
Lawrence Berkeley Laboratory
Berkeley, California

The columnist responds

I appreciate your reading the column and picking up that error. Your letter is correct. Actually, I stopped recommending the use of 34-watt lamps for replacements with existing ballasts because of poor compatibility. We will be going into this in greater detail in the July column.

Sid Pankin

This is your forum

Architectural Lighting is your forum for lighting issues of all kinds. We invite your letters on subjects of interest to our readers.

Address your letters to Charles Linn, AIA, Editor, *Architectural Lighting*, 859 Willamette Street, P.O. Box 10460, Eugene, OR 97440.

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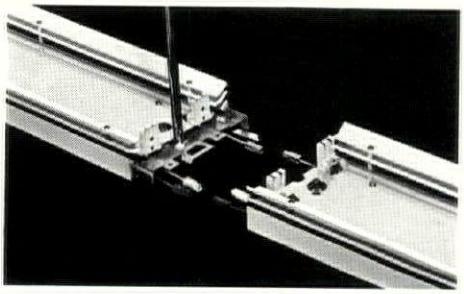
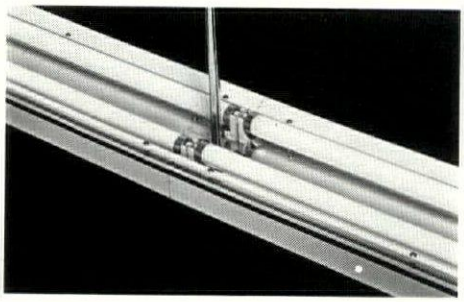
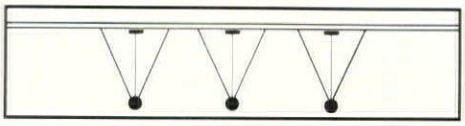


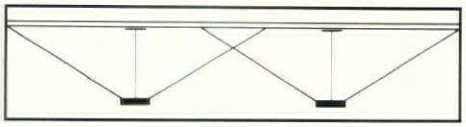


HOW IS IT DIFFERENT?

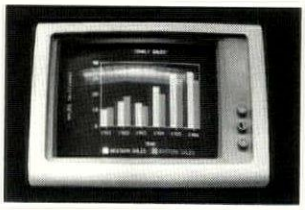
Conventional indirect systems do not distribute light evenly enough to avoid hot spots. Uneven ceiling brightness leads to uneven surface brightness.



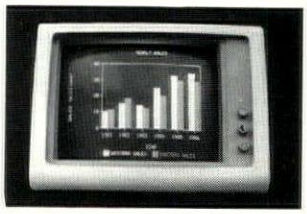
Lytespread, on the other hand, gives off a wide spread of overlapping light that creates a soft, even brightness throughout. With no shadowy areas.



WHAT ABOUT COMPUTER SCREEN GLARE?



Lytespread prevents it by indirectly diffusing the light evenly over the ceiling. As a result, brightness contrast between the light and the surface is reduced—eliminating veiling reflections from both printed material and computer screens.



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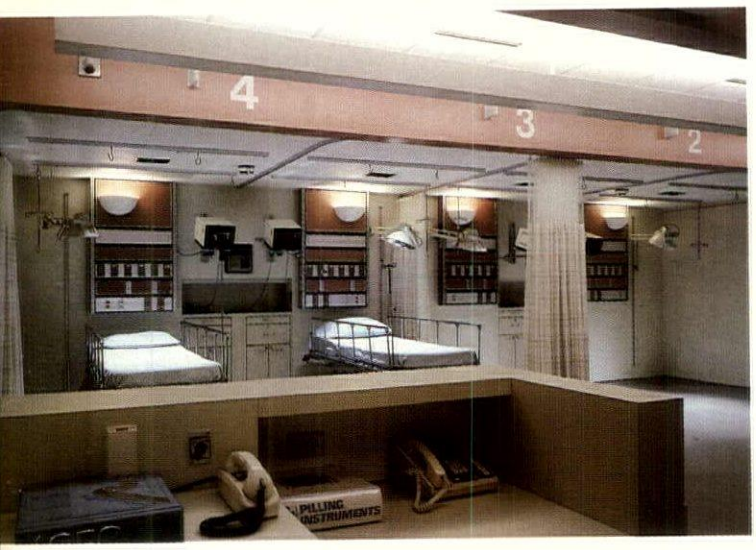
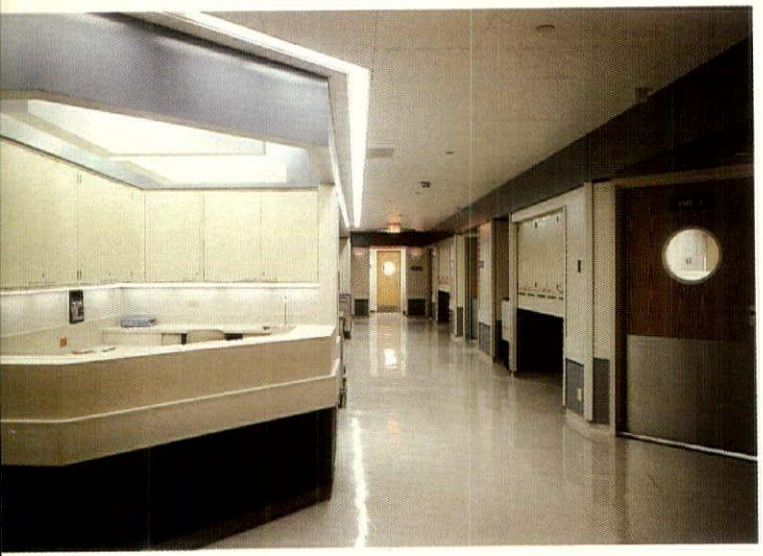
Circle 11

Nurses, doctors help plan surgery unit lighting





Project: Department of Surgery, Condell Memorial Hospital
Location: Libertyville, Illinois
Architects: O'Donnell Wicklund Pigozzi Architects, Inc.
Project Architect: Dan Cinelli
Project Designer: David Kuffner
Photos: Howard N. Kaplan, HNK Architectural Photography, Inc.

When Condell Memorial Hospital needed a new surgery unit, the administrators turned to O'Donnell Wicklund Pigozzi Architects, and the architects turned to the hospital staff. "We approached the project as a team effort," says Dan Cinelli, project architect and associate designer. He told staff members, "You know what's wrong with what you have now; let's work it out together."

The architects met about 25 times with the operating room supervisor, who was especially involved in the design process. She often returned to her staff with drawings, pinned them up in the nurses' lounge, and got feedback. "She would call me back and say, 'My assistant has a problem with what we're doing here,' and we'd explain it and talk it out," Cinelli recalls. Other supervisors worked with the architects as they designed the recovery and central sterilization areas. The team spent an entire day in the doctors' lounge explaining the plan and taking comments.

Lighting was considered an integral aspect of the project from the start. Some surgical tasks demand intense, specialized lighting. Anesthesiologists, for example, conferred with the architects on the importance of color rendering for accurate evaluation of skin color.

The team also used lighting to provide touches of warmth and comfort in a sterile area. Perimeter lighting in corridors doesn't glare into the eyes of a patient being wheeled on a gurney to surgery. Wall sconces — which Cinelli demonstrated for the staff before specifying — have glass covers so that all exposed surfaces can be wiped down.

In the recovery room, drowsy patients coming out of surgery need a calming environment. But in that same space, a patient may suddenly need emergency treatment. Staff members now control lighting that allows flexible use of the space.

An incandescent wall sconce in each gurney bay provides a comforting, familiar light. For critical medical evaluation and emergency procedures, a recessed halogen luminaire fitted with barn doors floods the surface of a single gurney with color-corrected light. A task light on a flexible arm swings out, and an undercounter light is fitted into recessed cabinetry to illuminate a pull-out shelf that can hold a patient's chart.

Cinelli credits the hospital administration with the foresight that enabled the successful team approach, saying, "I think hospital administrators are realizing that because their staffs were not asked to be a part of the process in the past, they've had to work around mistakes." ■

For product information, see the Manufacturer Credits section on page 70.

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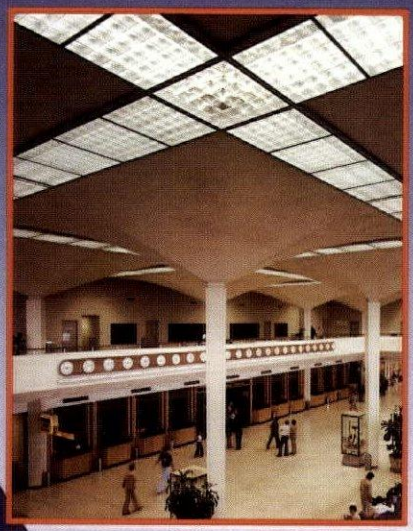

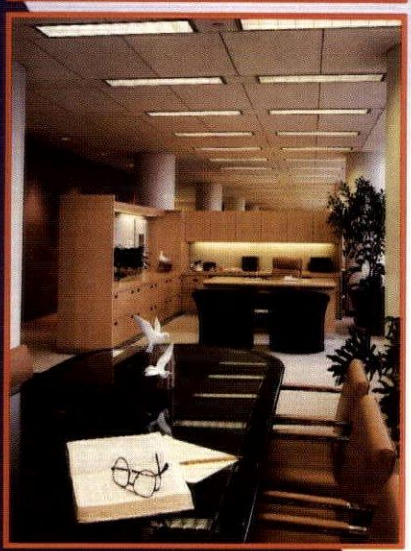

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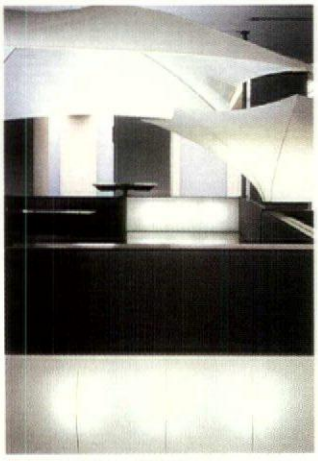
Circle 12

Prototype demonstrates possibilities for modular work stations



Project: Tensil Lighting Environment
Client: SunarHauserman Inc.
Lighting Designer: Peter Barna, Light and Space Associates
Architect: Nicholas Goldsmith, AIA, FTL Associates
Photos: H. Durston Saylor

After Peter Barna and Nicholas Goldsmith covered the entire interior of a Chicago building with illuminated fabric, they decided to bring the concept down to a smaller scale. Goldsmith thought that tensile structures could relieve the severity of modular furniture systems. "You feel you're in boxes; you don't have the escape you have in the natural world where things appear to be farther away," he says.

"Using fabric as a diffusing element for office lighting systems makes a lot of sense," says Barna. "In offices, you generally have mild ambient lighting and bright task lighting. As soon as you swivel in your chair away from your work area, your light level drops quickly." Fabric, however, can diffuse the light of multiple sources to evenly illuminate a whole work station.

Barna and Goldsmith decided that the Race modular furniture system from SunarHauserman would support the lighted fabric structures they had in mind. The manufacturer agreed to cooperate in building a prototype — the Tensil Lighting Environment.

The designers tested more than 100 fabrics for the project. They wanted one that would transmit light efficiently, yet appear to hold it within a volume instead of presenting a flat, shining surface. Eventually they chose a single flame-resistant, machine-washable, calendered nylon fabric for the canopy, wing, and panel elements.

Uplighted roof canopies enclose and define the work stations. Barna and Goldsmith designed the double-reflector uplights with the assistance of SunarHauserman engineers, and the company's shop custom manufactured them. Each elliptical reflector directs the light of a 13-watt compact fluorescent lamp in a 140-degree beam.

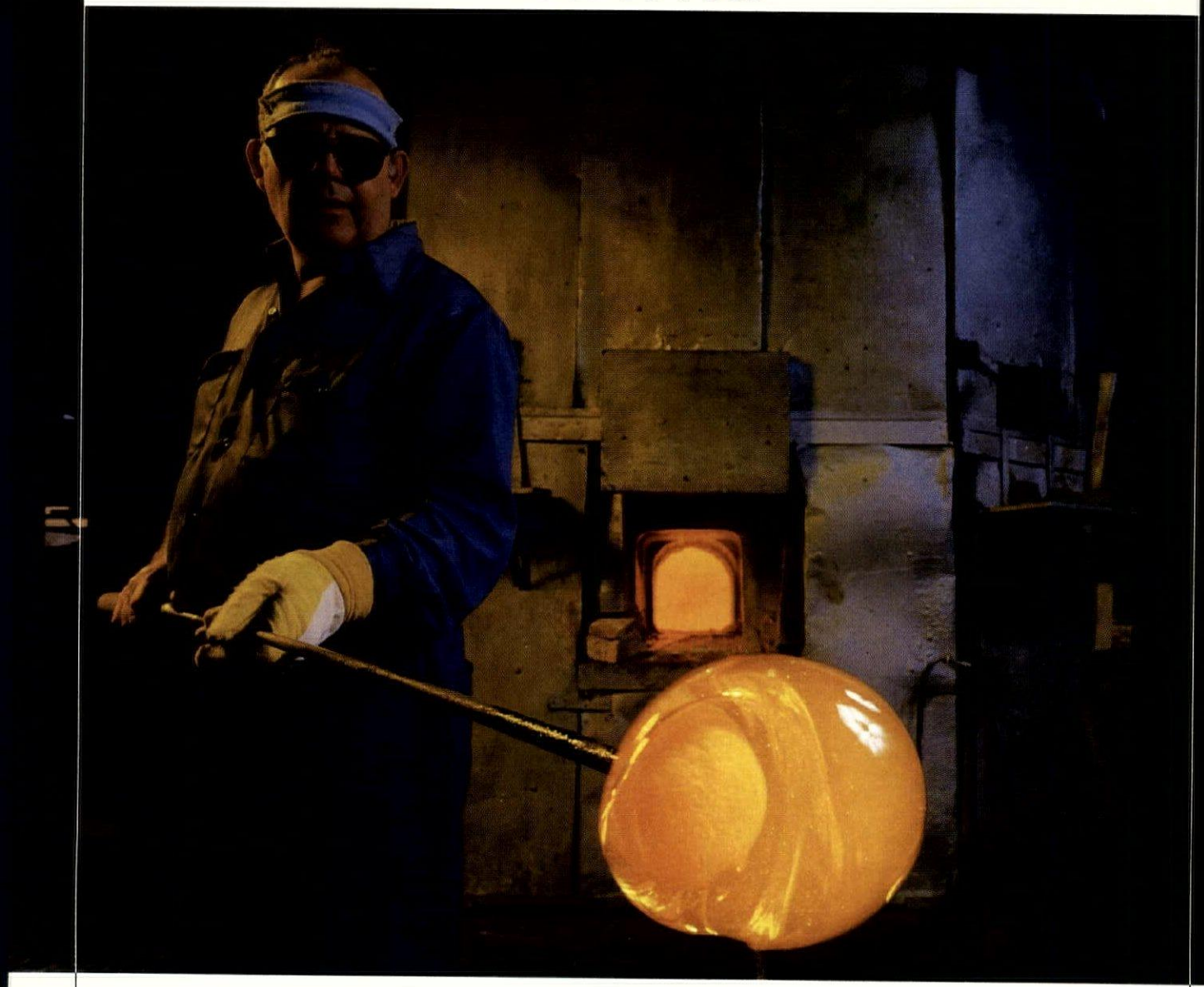
Fabric wings, designed to partially enclose work stations arranged along a central spine, flare out from the top of system panels. The same custom fixture — without reflectors — mounts on poles within the wing. Zippers allow access for re-lamping. An optional opaque cover for the wing structure reflects light downward, brightening the visible fabric.

Single- and double-sided luminous panels are interchangeable with the furniture system's standard opaque panels. Ballasts and lamp holders are concealed in an aluminum channel that fits neatly into the sytem with a screw or clip attachment. The luminous panel fronts have structural ribs that bow the fabric out slightly in front of each 5-watt compact fluorescent lamp. Users can remove and replace panel fronts without tools.

The manufacturer exhibited the prototype at several shows, but has not developed the project further. It remains a conceptual piece that demonstrates the potential of tensile structures for office lighting. ■

For product information, see the Manufacturer Credits section on page 70.

WHAT WE DO WITH IT NEXT IS UP TO YOU.



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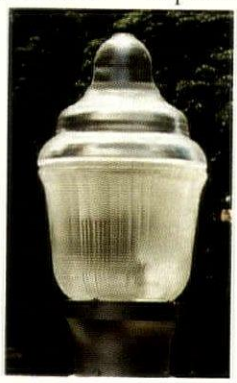

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Circle 14

Lighting reveals tones of cool bronze, warm copper

Project: Atlas sculpture and International Building lobby, Rockefeller Center
Location: New York City
Lighting Designer: Abe Feder, Lighting by Feder
Sculptor: Lee Lawrie
Photos: Bart Barlow

The 45-foot-high, 7-ton bronze figure faces east, looking across New York City's Fifth Avenue. Three walls enclose Lee Lawrie's representation of Atlas, the mythological Titan, within a 60-foot-square courtyard. Glazing in the facade behind the statue reveals a 44-foot-high lobby ornamented with copper leaf panels on walls and ceiling.

Lighting designer Abe Feder recently illuminated the sculpture of Atlas that has stood since 1937 on a granite pedestal in the forecourt of Rockefeller Center's International Building. Over the years, the sculpture had occasionally been lit from above at night. Feder was the first to create a lighting design to reveal the full dimensional quality of Atlas.

As he planned the lighting, Feder visited the sculpture night and day, walking around it, observing it, getting a sense of it as a work of art. His lighting design included not only Atlas, but also the lobby whose facade serves as a backdrop to the sculpture. "The brilliance of that lobby was the key to lighting Atlas," he says.

The golden light reflected from the copper panels in the lobby contrasts with the cool tones of the sculpture's surface, accentuating color and dimension. Thirty-four 400-watt high pressure sodium luminaires flood the lobby's 60- by 90-foot ceiling, columns, and facade, supplementing the golden color.

Feder lit the sculpture itself with 400-watt PAR 64 metal halide luminaires. Twelve are hidden in a 4-foot-high wooden structure that encircles the base of the granite pedestal. The beams, aimed through slots in the concealing structure, emphasize the figure's three-dimensional contours. Ten luminaires mounted six to eight stories high on the rooftops shine down at approximately 30-degree angles.

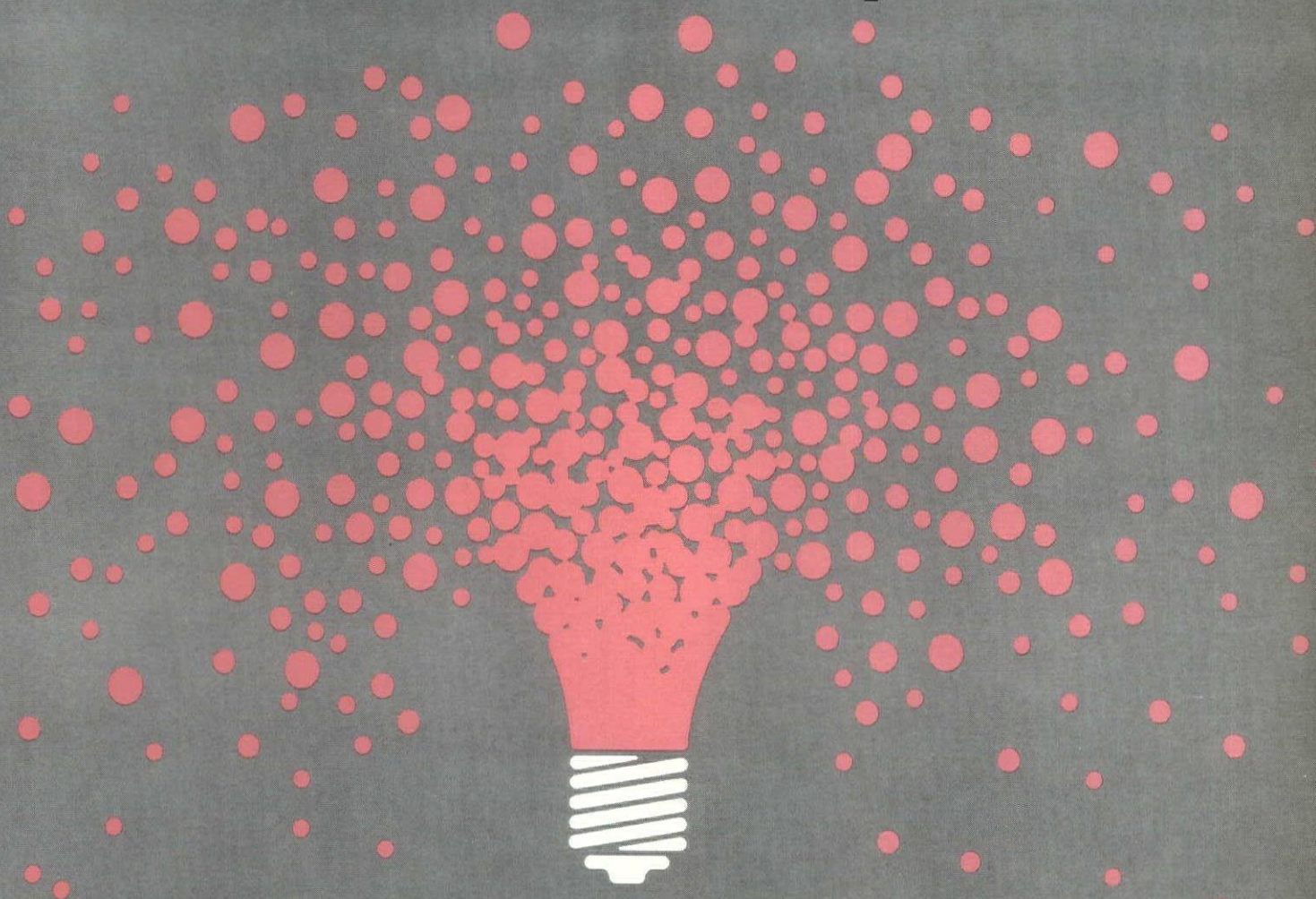
To position and aim the lights, Feder worked on both the roof and ground, checking and adjusting the target angle of each luminaire, using walkie-talkies to communicate with his crew. He took special care to highlight Atlas's face — "It's the face that counts," he says — bringing sparkle to the beads on Atlas's head and a bright gleam to his eyes.

Feder was especially sensitive to color rendering. After testing the lighting with 1000-watt PAR 64 quartz lamps, Feder decided their cast was too warm, and he changed to 3700K multivapor lamps. He wanted the look of the bronze patina at night to resemble its cool appearance in the daytime.

The on-site work lasted about two weeks. The result is a fine-tuned system that lights the entire courtyard, enveloping Atlas within a circumference of light without glare. ■

For product information, see the Manufacturer Credits section on page 70.

Concourse at Showplace Square



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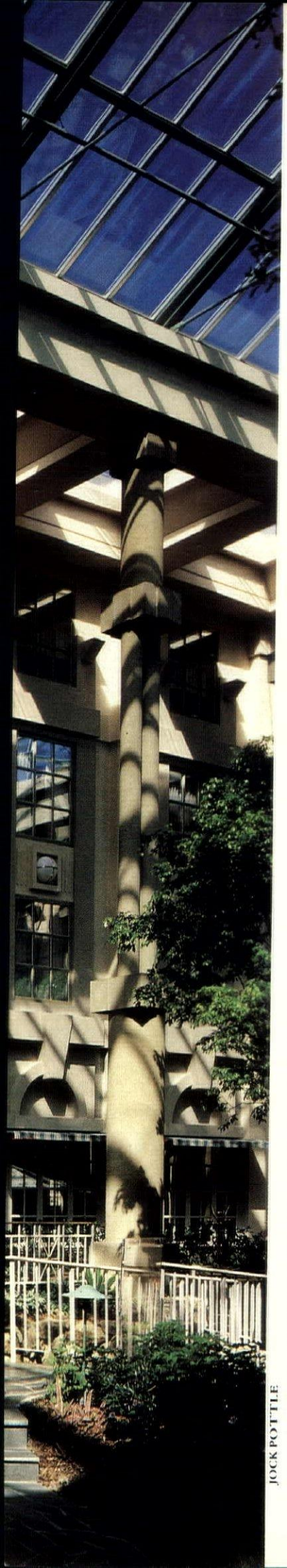
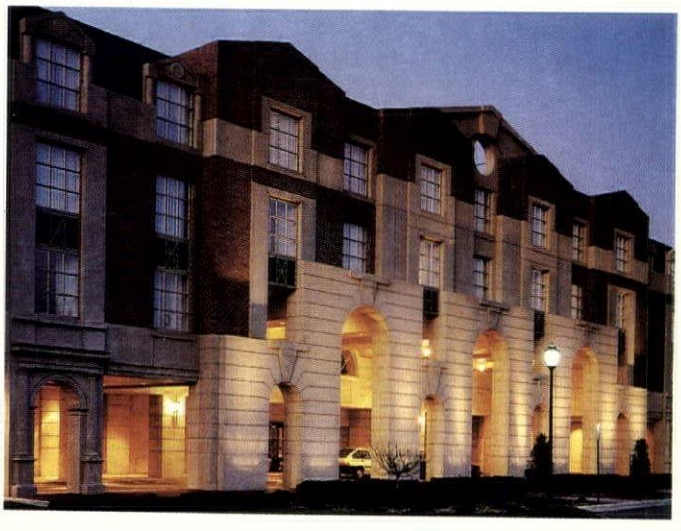


JOCK POTTLE

Daylighting analysis critical for successful atrium design

ARTICLE BY
CHARLES LINN, AIA



JOCK POTTLE

The atrium for the new Hyatt Regency at Greenwich, Connecticut, was inspired by the conservatory at Longwood Gardens, says Arthur May of Kohn Pedersen Fox Associates. Part of the old DuPont Estates located outside of Wilmington, Delaware, the conservatory has a handsome set of gardens, several of which are large atria — large columned rooms with clear glass skylights. "We looked at the conservatory, liked the feeling it gave, and designed something similar," May says.

"To carry off this concept," says landscape architect Peter Wells, "we knew we had to create a lush, rather temperate-looking garden within the atrium space. Rather than using the tropical-looking plants you see in shopping malls or other atria, we had to use plant species that have a 'New England' look about them.

"But, in choosing species that will give this kind of look, you've also got to be able to guarantee that an awful lot of light will be coming into that atrium — a lot more light than you need for the typical plants used in most atria," says Wells. "Still, some of these plants need more shade than others. We needed to know how the sunlight would be distributed in the atrium at different times during the day, and during different days of the year, in order to know the best locations for particular species."

Some of the species had never before been used in commercial interiors, like the black olive trees, the lemon-scented eucalyptus trees, the carrotwood trees, and the California pepper trees. Wells said it was also one of the first interior installations of sod in the country.

Kohn Pedersen Fox had many factors to consider when designing the fenestration and walls of this atrium space. The amount of skylight glazing, its transmittance value, shading coefficient, and orientation would all affect the amount of light reaching plants. The color,

Project: Hyatt Regency, Greenwich, Connecticut
Architect: Kohn Pedersen Fox Associates, PC
Partner-in-Charge: Sheldon Fox, FAIA
Partner-in-Charge of Design: Arthur May, AIA
Senior Designer: Geraldine Pontius
Atrium Landscape Architect: Peter Wells, ASLA, Berkshire Design Group
Daylighting Design Consultant: Mojtaba Navvab, Architecture and Planning Research Laboratory, University of Michigan
Sky Simulator: Windows and Daylighting Group, Lawrence Berkeley Laboratory

JOCK POTTLE

size, and orientation of the side walls and the percentage glazed affect the amount of light reflected into the atrium as well as the amount of heat absorbed by the walls and the amount of glare users of the atrium would experience. Every option had some bearing on the final cost of construction and future energy consumption.

To help them make these design decisions appropriately, Kohn Pedersen Fox worked with Mojtaba Navvab, assistant professor at the Architecture and Planning Research Laboratory, University of Michigan. Navvab conducted studies using several combinations of modeling techniques to quickly and economically simulate the effects of hundreds of different design options on the atrium's daylighting performance.

Using measurements and data generated by the studies, the architects could work with confidence that the atrium they designed would provide enough light to support the plants selected by the landscape architects. Similarly, the landscape architects were able to finalize planting plans based on predictions of the amount of light entering the atrium and the shading patterns for every hour of the calendar year.

Kohn Pedersen Fox began the process of collaborating with Navvab by first determin-

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ing the size, basic height, and shape characteristics of the atrium. "We started out knowing what the atrium was going to be like basically, and we started out knowing the things we could change and the things we could not change," says Navvab.

"In the initial discussions, certain options were discarded, certain options were finalized, and certain options were left open. We had to establish some things right up front so that we didn't waste any time testing options that could never conceivably happen.

"In this case, we had determined up front that the orientation could vary only a few degrees and what the atrium's size and shape would be. That left open the final surface properties, the configuration of the skylights, the final landscaping plan. Having determined everything else, we could begin building a scale model to test the options left open.

"Ultimately, the tests are for the purpose of predicting what will happen when the structure is built. They don't give you absolute values, but they are invaluable when trying to ensure that special landscaping and plants will flourish inside a space. To ensure that, maybe you've got to cost-justify something like a more expensive fenestration system, as we did here. These predictions are extremely important in cases like this," Navvab says.

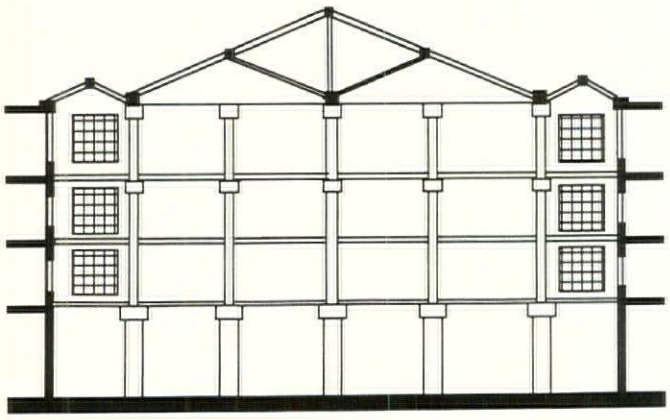
Using Scale and Computer Models

"There is no single daylight modeling tool available today that will give you a complete analysis of everything," says Navvab. "Both scale models and computer models have their own limitations. For example, you can measure illuminance inside a scale model placed outdoors much more accurately than you can predict it. But the outdoor sky is constantly changing, and there is a limit to the number of points you can look at each time. It would take a long time to test the model for every possible condition.

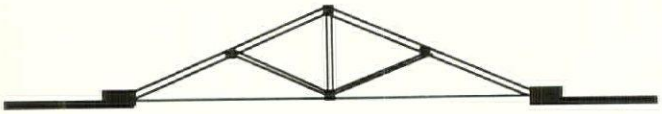
"You can put a model in the sky simulator, and test many conditions in a short period of time; but our model was so large we could test only part of it at a time," Navvab says. "In the simulator we can simulate the sky luminance distribution for clear and overcast sky conditions. We measure the illuminance level inside the scale model as well as outside of the scale model. These two measurements provide us with the daylight factor. Although these measurements are good for some comparisons, we can't use them to predict the average daylighting performance over an entire year." For that they turned to a computer model.

"The computer models have other limitations," Navvab continues. "DOE 2.1B is a computer model that you can give the solar radiation data for a given location based on measured hour-by-hour, day-by-day sky conditions for an entire year. It's primarily used as a thermal analysis program, which limits it as a daylighting analysis tool. It does many other things very well, but it allows you to predict the footcandles at only two points inside the space per run. Each run of the DOE 2.1B program is expensive and time consuming, given that the program makes a complex series of calculations for every hour daylight is available during the entire year."

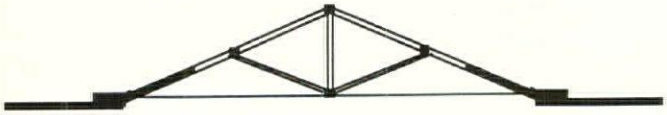
To measure the footcandles at many points, and at the same time account for the contribution of light bouncing off the walls into the space, it is possible to use Superlite 1.0. "Although this program will very



Design option 1: 100 percent of roof glazed, with perimeter skylights.

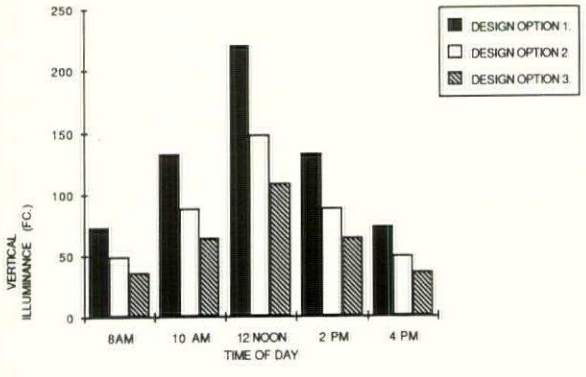


Design option 2: 100 percent of roof glazed, with no perimeter skylights.

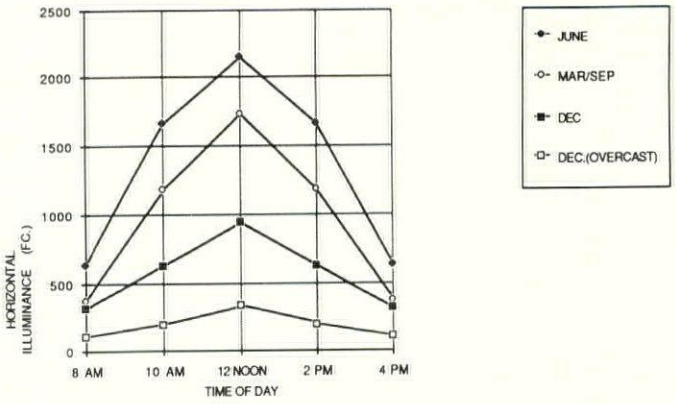


Design option 3: 75 percent of roof glazed, with no perimeter skylights.

Various skylight fenestration options tested (above), and computer printout of predicted daylighting performance for each option (below).

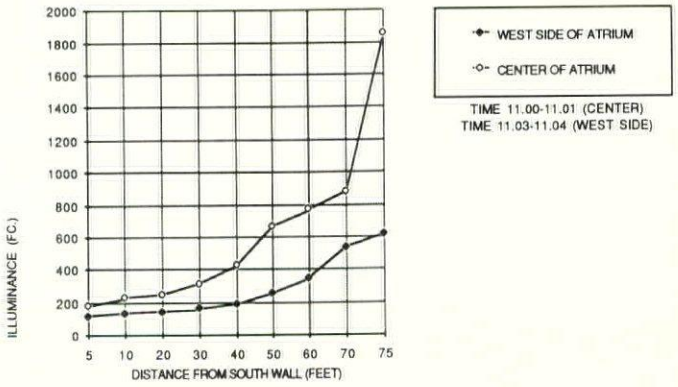


VERTICAL ILLUMINANCE AT THE CENTER ON THE NORTH WALL OF THE ATRIUM FOR THE MONTH OF DECEMBER (OVERCAST)



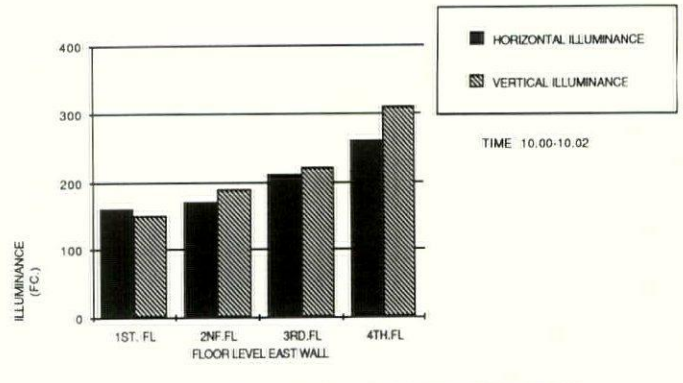
HORIZONTAL ILLUMINANCE AT THE CENTER OF THE ATRIUM FLOOR AT 4 FEET HEIGHT AS A FUNCTION OF TIME OF DAY AND MONTH
GREENWICH-CONNECTICUT

Computer printout of DOE 2.1B–generated daylighting performance predictions.



MEASURED HORIZONTAL ILLUMINANCE AT THE SITE ON OCTOBER 30 1986
4 FEET ABOVE THE GROUND FLOOR

Computer printout of measurements taken with hand-held photometer in completed building (above and below).



MEASURED HORIZONTAL AND VERTICAL ILLUMINANCE AT THE SITE ON OCTOBER 30 AS A FUNCTION OF FLOOR HEIGHT (2 FEET AWAY FROM WALL AT 5 FEET HEIGHT).

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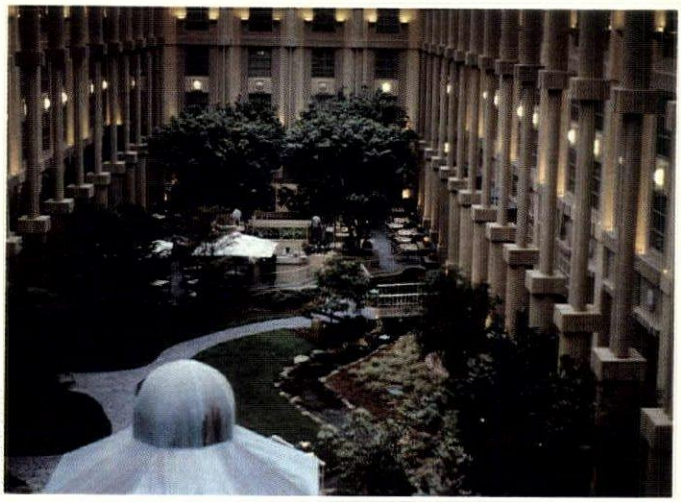
1/4-inch scale model of the atrium used for daylighting studies. Photometers are visible on model atrium floor.



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The completed atrium from a perspective similar to that shown for scale models.

precisely calculate the result of the interreflections in the space for diffuse surfaces, it cannot be used for specular surfaces, like glass," says Navvab. "For this we have to go back to the scale model."

Both of these computer models can simulate very complicated geometries, says Navvab, but they have their limitations. "They cannot simulate something like the 50 skylights we had here, or predict how much light is going to be reflected into or out of the atrium by the steel kingpost truss system. Again, for these you must go back to the scale model."

In the case of the Hyatt Regency in Greenwich, Navvab and his colleagues used all of these tools together. "We used measurements from the scale models to provide very accurate input for the computer models. We fine-tuned the scale model and took measurements that validated the predictions made by the computer models. Eventually, we were able to make conclusions that were input directly into the design of the atrium and its landscaping."

Scale Modeling

A 1/4-inch scale model was constructed and used for making illuminance measurements. Photometers were placed at points chosen by the landscape architect and also where readings would be required to provide data for later computer model validation studies.

An automated data acquisition system took the measurements; it read and recorded the amount of daylight measured by each photometer during tests outdoors and inside the sky simulator at Lawrence Berkeley Laboratory. The scale model was tested for a number of options, including various orientations, wall reflectances, and fenestration plans.

Outdoor illuminance measurements taken inside a scale model produce readings that closely correspond to the actual light levels likely to occur in the built space. There is no need to scale down measurements because daylight behaves the same way at any scale.

One of the most useful aspects of making these measurements is the ease of establishing the daylight factors of the space, a measurement of how well light is distributed in a building. The daylight factor — expressed as a percentage — is a ratio of the interior illuminance at a given point to the exterior illuminance under an unobstructed sky. Measuring illuminance levels and calculating daylight factors for the many different scale model options tested allowed Navvab to establish numbers that could readily be applied to the computer modeling studies.

To test for the effects of different colors on interior reflectance, Navvab measured the reflectance ratios of some 15 different paint samples submitted by Kohn Pedersen Fox. He found that only five had significant differences. Having established these reflectance ratios, he was able to reproduce them for the scale model using stock matteboard. "I have every kind of matteboard you can imagine, and their reflectance ratios are already calculated," he says. "All I have to know is the reflectance ratio of the selected paint, and I can pick matteboard that will duplicate it." Walls were built using these different matteboards and interchanged when the model was tested.

Models of three roof fenestration systems were placed on these different walls and tested to see if it was necessary to choose the more expensive options, which included more glass and skylights, in order to achieve the footcandle levels required by the plants.

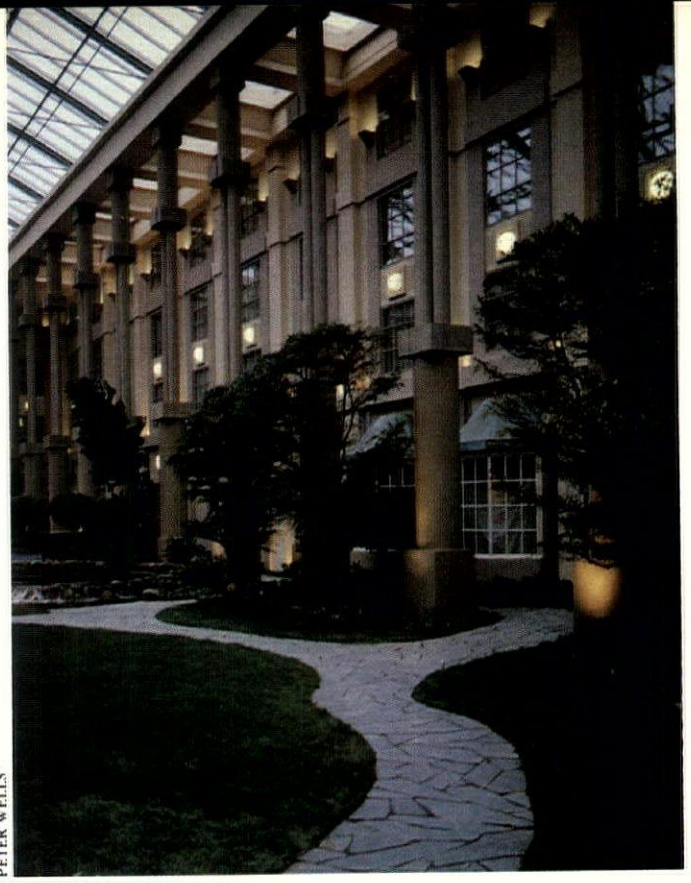
The first option, which was preferred by the architects, used a glass atrium roof with a row of small skylights around the perimeter of the atrium. This option could have been eliminated because of the additional cost of the skylights. The second option had the same glass roof, but no perimeter skylights, and the third option was a glass atrium roof that was partially covered on two sides.

Computer Modeling

After the interior illuminance measurements had been made and daylight factors were calculated, extensive computer analyses began. Navvab began with the computer program DOE 2.1B because of its unique weather tape feature. The weather tape allows the user to supply the computer program with the amount of solar radiation available for a given geographic location, based on historical hour-by-hour sky conditions recorded there.

Using the daylight availability data for the location and the measured daylight factors, Navvab predicted how much illuminance would result from each tested orientation, wall reflection, and fenestration option for each hour of the day, each day of the year for three critical locations: outside the atrium, at the glazing, and inside the atrium. After the illuminance at all of these points was calculated, they could easily be tabulated into a number of output forms for comparison.

The DOE 2.1B calculations



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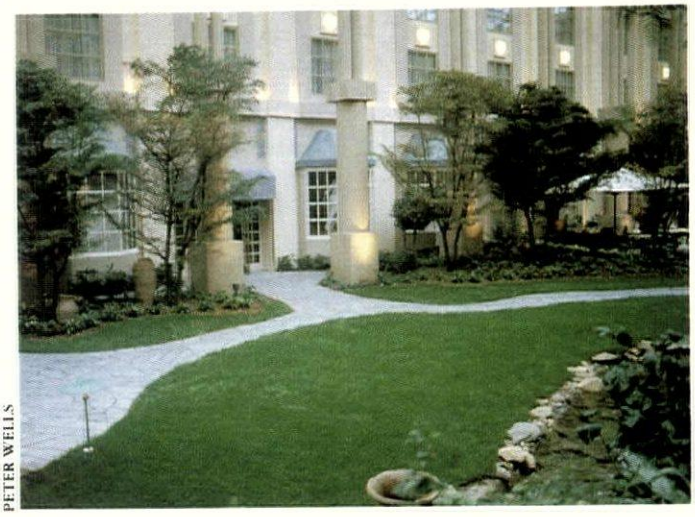

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of illuminance levels at these three locations for every hour daylight was available during the year were helpful for comparing the various options under consideration. They did not, however, give the illuminance distribution over many points needed by the landscape architect for plant locations. For these, Navvab used Superlite 1.0.

Superlite 1.0 predicts luminance and illuminance distribution inside a space. The predictions are based on exterior sun and sky conditions, the skylighting and fenestration system, and other characteristics of the room geometry. They also take into account the reflectance properties of the interior walls and other variables. One advantage of this program, in addition to its ability to predict the illuminance at many points, is that it predicts how much light reflectance and interreflectance will contribute to those points. This was important in the case of the atrium because so many different colors were being considered.

One disadvantage of Superlite 1.0 is that these interreflectance calculations are based upon the assumption that all of the reflecting surfaces are diffuse. This is not the case in the atrium, where a good percentage of these surfaces are glass and, therefore, specular reflectors. "This can cause problems with glare. So to examine this case, we have to go back to the model," says Navvab. "You have to account for the glare from the glass. The designer doesn't want glare from the glass to make the walls too bright. But if they're painted too dark, you lose the footcandles and change the light distribution in the space.

"It's a back-and-forth process. First we use the scale model, then we make parametric studies with the computer models. Then we go back to the scale models and refine them and test them to validate what we learned from the computer. Then we make more calculations to see if our sensitivity analyses with the model are effective and still work. This is what I mean when I say there is no design tool available yet that will analyze everything!" Navvab says.

Conclusive Studies

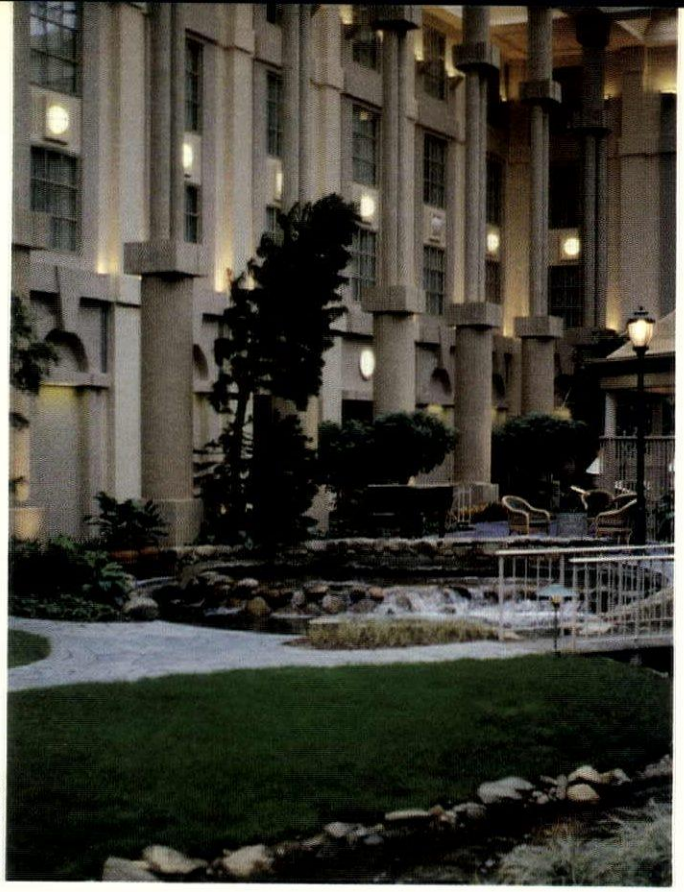
Once Navvab finished these studies, he met with the architects and landscape architects to review the findings. The studies showed conclusively that the more costly skylight fenestration system that included the smaller skylights around the perimeter of the large skylight would, in fact, be necessary to sustain the growth of the plant species chosen.

Landscape architect Peter Wells says, "It was a tremendous tool. Basically, we were able to find out how many footcandles we were going to have to design around. Beyond that we could see what spaces were shaded out during certain times of the day, and were able to design our seating areas and pathways around that.

"It also proved a helpful tool in the bidding process," adds Wells, "because the plant specifications went out to competitive bidders. When they saw we had done such an elaborate study, they were sure the footcandles would be exactly what we said they would be, rather than just predictions coming out of a computer program. Our bids were lower because the replacement costs they figured in were much lower than usual. The contractors knew the plant survival rate would be much better than average. And, in fact, the actual installation is doing extremely well."

Checking with Reality

In early November of 1986, after the atrium had been completed, Navvab made a site visit to take actual illumination measurements with a handheld photometer. "Naturally, it is important to do this. If you don't take those readings, all the calculations you've made really don't mean a thing,"



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Navvab says. He was surprised on several counts. First, the illumination levels were remarkably close to what he had predicted. "There were some slight differences," he says, "but that's to be expected — after all, no modeling technique is perfect.

"What's truly remarkable is this: you work on a scale model for a long time, and you've spent many hours looking at how the light comes inside, and the patterns of light and dark that occur. Even though you've got all these quantities and methodologies for examining them, you wonder if it will be the same when you visit the space or if it will be completely different. Then one day, you walk inside the real thing, and it really scales up — it really looks the way you see it in the model. And if the measurements are working out well, not only does the design work, but you know that other people can use this methodology to analyze other projects in the future."

Summing up this complex modeling process, Navvab says, "There are times when intuition is very valuable as a design tool. But there are times when you do not want to take a chance on intuition to make all these design decisions, because in the long term if you make a mistake, it does not pay. If you have more unknown than known variables, it is best to try to model it and see how it performs, before it's committed to concrete, steel, and glass." ■

For product information, see the Manufacturer Credits section on page 70.

Selecting luminaires for hazardous locations

Robert Zeller

Robert Zeller is research manager with the Holophane division of Manville Sales Corporation, Newark, Ohio.

Selecting the luminaires to illuminate a hazardous location requires special consideration because the nature of this industrial setting is radically different from a conventional industrial site. Hazardous locations are areas with a potential for explosion and fire because of the presence of flammable gases, vapors, or combustible dusts in the atmosphere or because of the presence of ignitable fibers or flyings.

Hazardous locations may result from the normal processing of certain volatile chemicals, gases, grains, or the like, or they may result from the accidental failure of storage systems for such materials. It is also possible that a hazardous location may be created when volatile solvents or fluids used in a normal maintenance routine vaporize to form an explosive atmosphere.

In each instance, it is essential that every precaution be taken to guard against ignition of the atmosphere. Because luminaires generate heat, they can be a source of ignition. If the surface of a fixture reaches a temperature that exceeds the ignition temperature of the particular

gas, vapor, or dust in the atmosphere, this hot surface could trigger an explosion or fire.

Not all hazardous locations are the same, and luminaires for each must have particular features to suit the operating conditions peculiar to each location. Therefore, it is essential to identify the different hazardous locations and to highlight important characteristics of the luminaire type best suited to the location in question.

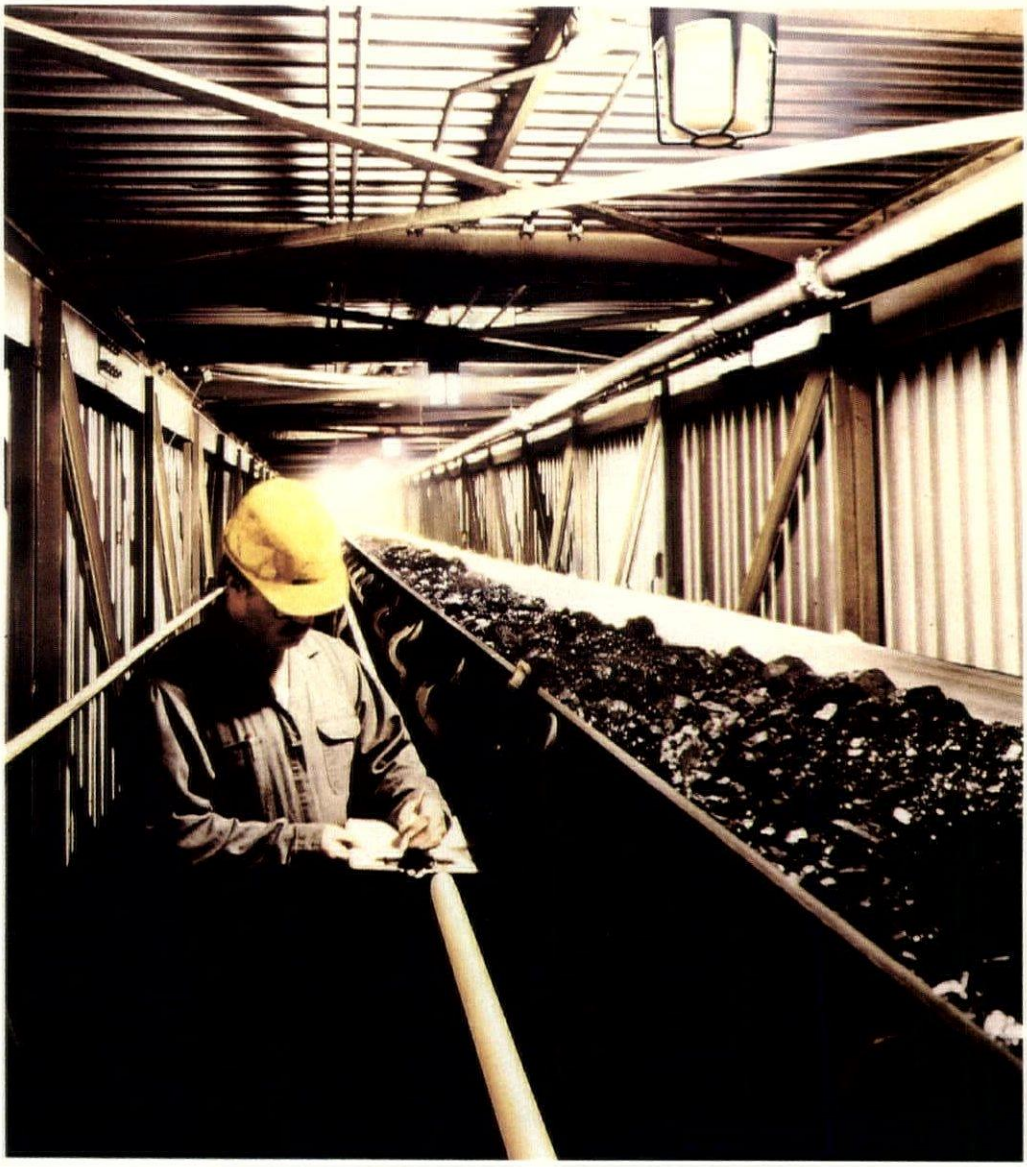
Class I Hazardous Locations

Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. Some examples of Class I locations are shown in the accompanying table. Class I has two divisions.

Division 1. As defined by the National Electric Code 1987 (NFPA 70-1987), a Class I, Division 1 location is an area "in which ignitable concentrations of flammable gases or vapors exist under normal operating conditions." The definition also includes situations in which gas or vapor may exist because of repair or maintenance operations, leakage, or breakdown or faulty operation of equipment or processes.

This classification usually includes interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable liquids or liquefied flammable gases are transferred from one container to another or where volatile flammable solvents are used; areas where open tanks or vats of volatile flammable liquids are stored; drying rooms or compartments for the evaporation of flammable solvents; locations containing fat and oil extraction equipment using volatile flammable solvents; portions of cleaning and dyeing plants where flammable liquids are used; gas generator rooms and other portions of gas manufacturing plants where flammable gas may escape; pump rooms for flammable gas or for volatile flammable liquids; and interiors of refrigerators and freezers in which volatile flammable materials are stored in open, lightly stoppered, or easily ruptured containers.

A critical aspect of luminaire applications in Class I, Division 1 locations is the temperature on the outside surface of the luminaire: the surface tem-



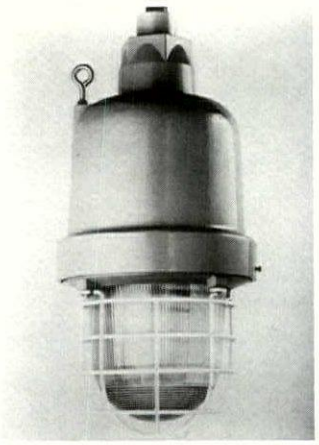
Class I locations
Petroleum refining facilities
Dip tanks containing flammable or combustible liquids
Dry cleaning plants
Petrochemical plants
Plants manufacturing organic coatings
Spray finishing areas (residue must be considered)
Petroleum dispensing areas
Solvent extraction plants
Plants manufacturing or using pyroxylin (nitrocellulose) type and other plastics (Class II also)
Locations where inhalation anesthetics are used
Utility gas plants, operations involving storage and handling of liquefied petroleum and natural gas
Aircraft hangars and fuel servicing areas

perature may not exceed the ignition temperature of the ever-present gas or vapor. Furthermore, should explosion or combustion of the gas-air mixture take place inside the luminaire, it must be contained within the unit. Such containment is likely to extinguish the lamp, but that would have no effect on the atmosphere. The containment feature must cool any gases generated so that, should gases escape into the gas- or vapor-laden atmosphere, they will not cause ignition.

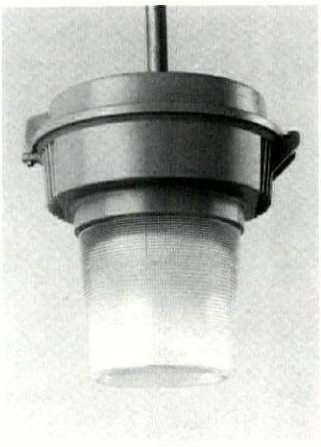
Because a primary function of this luminaire is to withstand an explosion, all of its components must have sufficient strength and size to accomplish this task. Its preponderant size and the complexity of the containment features make this type of fixture relatively expensive.

Division 2. A Class I, Division 2 location is an area where "volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems . . . or where concentrations of gases or vapors are normally prevented by positive mechanical ventilation, but become hazardous through failure or abnormal operation of the ventilating equipment."

This classification usually includes locations which, in the judgment of the authority having jurisdiction — normally the insurance underwriter — would become hazardous only in case of an accident or of some unusual operating condition. Factors that help determine the classification include the quantity of flammable material that might escape in case of an accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires.



Representative sample of a UL-listed luminaire for use as an explosion-proof unit in certain Class I, Division 1 hazardous locations.



Typical UL-listed luminaire for use in almost all hazardous locations — except Class I, Division 1.

Since the gases or vapors in this type of application will be in the atmosphere only if an accident occurs, it is vital to know the ignition temperature of the particular gas or vapor and to choose a luminaire on which this temperature is not exceeded. In most instances, the fixture does not have to be as substantial as in Class I, Division 1 applications. The designer can select smaller units with more efficient optical assemblies. Efficiency is the watchword. It pays to look for electrical and optical efficiencies as well as installation and maintenance efficiencies.

Because a high percentage of applications in this category are in outdoor environments, fixtures must be corrosion-resistant.

Class II Hazardous Locations

Class II locations are those in which combustible dust is present. The table lists typical applications. Class II is also divided into two divisions.

Division 1. Class II, Division 1 covers locations in which combustible dust is constantly present in the atmosphere. As defined by the National Electric Code 1987, a Class II, Division 1 location is one where "combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures . . . where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes . . . in which combustible dusts of an electrically conductive nature may be present in hazardous quantities."

Some products that produce electrically nonconductive dusts in their handling and processing are grain and grain products, pulverized sugar and cocoa, dried egg and milk powders, pulverized spices, starch and pastes, potato and wood flour, oil meal from beans and seeds, dried hay, and other organic materials. The risk is that such dusts may become combustible during processing or handling.

Dusts containing magnesium or aluminum are also very hazardous, and extreme caution is necessary with these materials to avoid ignition and explosion. Electrically conductive dusts are those with a resistivity less than 10^5 ohms per centimeter.

The luminaire used in dust applications must satisfy two stringent operating requirements. Its surface temperature must be controlled, and it must meet a no-dust intrusion specification. For example, in metal dust installations, the surface temperature of the luminaire, while coated with a heavy layer of dust, must not exceed 200 degrees Celsius. In grain dust conditions, the surface temperature limit is 165 degrees Celsius.

In order to minimize heat build-up, the fixture is restricted in terms of lamp wattages. It is vital that the luminaire provide long-term integrity in keeping dust from penetrating the interior. This

Class II locations

Grain elevators and bulk handling facilities
Magnesium manufacture and storage
Starch manufacture and storage
Fireworks manufacture and storage
Flour and feed mills
Pulverized sugar and cocoa packaging and handling areas
Magnesium and aluminum powder manufacturing facilities
Some coal preparation plants and coal handling facilities
Spice grinding plants
Confectionary manufacturing plants

Class III locations
Woodworking plants
Textile mills
Cotton gins and cotton seed mills
Flax producing plants

means that the enclosed and gasketed fixture must provide a tight seal that performs consistently over a long service life.

Division 2. Class II, Division 2 locations involve areas where "combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but combustible dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment . . . and dust accumulations resulting therefrom . . . may be ignitable by abnormal operation or failure of electrical equipment."

Although dust is not present all the time, but only as a result of an accident or malfunction, the luminaires used for this category are nevertheless similar to those recommended for Class II, Division 1 applications.

Class III Locations

Class III locations are deemed hazardous because of the presence of easily ignitable substances in the atmosphere — in this instance, fibers or flyings. The distinction, however, is that the fibers and flyings are unlikely to be in suspension in the air in quantities sufficient to produce ignitable mixtures. Examples of Class III hazardous locations are listed in the table. Class III locations are subdivided into two divisions.

Division 1. Class III, Division 1 includes locations "in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used."

Division 2. Class III, Division 2 incorporates areas where "easily ignitable fibers are stored or handled." Easily ignitable fibers and flyings include rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior, sawdust, wood chips, and other materials of similar nature.

Although the risk is less pronounced in Class III locations, the luminaires used must meet the requirements specified for some Class II locations. Surface temperatures must not exceed 165 degrees Celsius, and the fixture must be designed to totally exclude fibers or flyings from the inside of the enclosure.

Other Considerations

Ambient temperature is another important factor to consider in selecting lighting fixtures for hazardous applications. The main concern is the maximum temperature developed under normal operating conditions. To comply with temperature requirements established by the National Electrical Code, Underwriters Laboratories requires all hazardous indoor lighting fixtures to be tested and listed for use at 40 degrees Celsius ambient temperature. But all industrial applications are not necessarily in the under 40 degrees Celsius ambient range.

Consequently, many luminaire manufacturers list their fixtures for use at the highest ambient temperature possible. Therefore, if a particular operation has an ambient temperature of 60 degrees Celsius, it would be possible to select a lower wattage fixture if the maximum operating temperature as listed at this higher ambient temperature does not exceed the ignition temperature of that atmosphere.

These broad guidelines are intended as only an introduction, of course. Designers who are faced with a hazardous location lighting problem may need to work with a consultant. ■

Programmed lighting important ingredient in restaurant

Barbara Hillier

Barbara Hillier is managing principal of Hillier Interiors, a studio of The Hillier Group architects, Princeton, New Jersey.

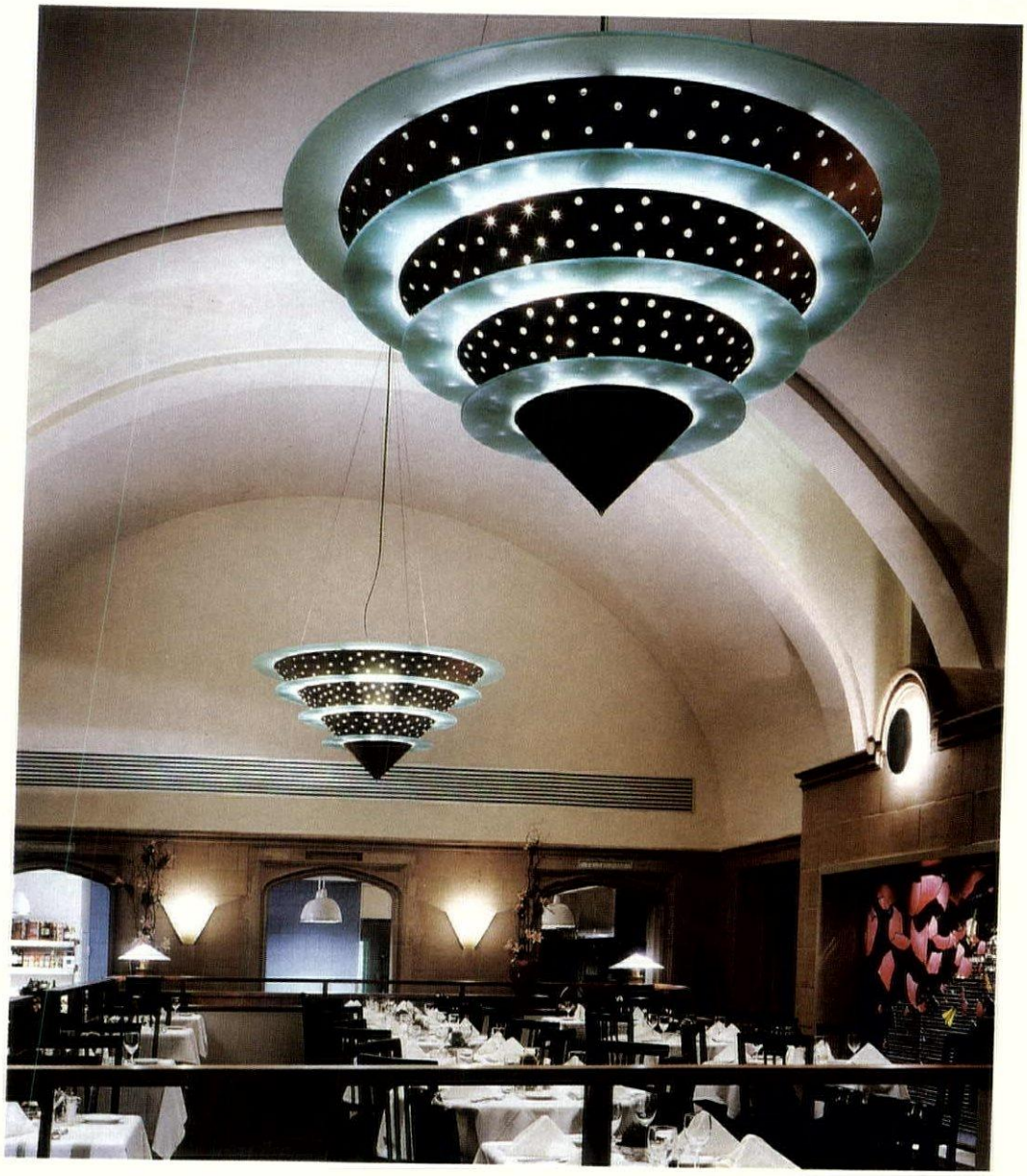
Historical railroad stations are popular renovation projects. In recent decades, the time between train whistles has stretched from minutes to hours to days, and many beautiful old train stations have been converted to other uses — to restaurants, shopping malls, and even a lighting showroom.

Passengers still meet trains at the historic station in Jenkintown, Pennsylvania, but most of the building has been transformed into a full-service restaurant. It may, in fact, be the only full-service restaurant operating in a functioning U.S. railroad station.

The station was designed by Philadelphia architect Horace Traumbauer and, when it was built in 1931, had a large waiting area, a ticket office, and a baggage handling area. Now, the waiting room is a restaurant; the old ticket area has a new stairway, lobby, and space for a headwaiter's desk; and the former baggage area houses an open kitchen. A 3000-square-foot addition under the train platform canopy has a glass and wood exterior; it houses a bar and a gourmet take-out service — The Market at Greenwood Grille.

Restaurant Lighting

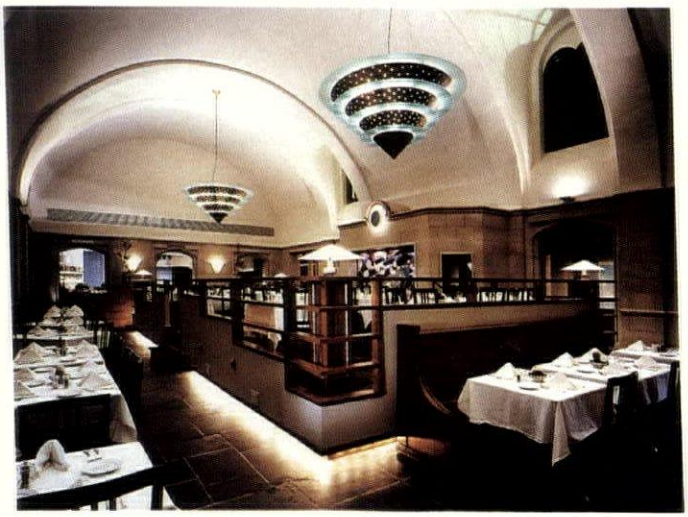
Lighting is the most important ingredient in restaurant design; it sets the stage for the menu and the dining mode for patrons. Well-designed restaurant lighting is flexible, appropriate



Two massive chandeliers in the dining room provide diffused fluorescent lighting and contribute to the room's indirect lighting.

Project: Greenwood Grille
Location: Jenkintown, Pennsylvania
Client: Skip DiMarco
Interior Designer: The Hillier Group Interiors
Lighting Consultant: Grenald Associates, Philadelphia
Consulting Engineer: Dawson Engineering, Inc., Fairless Hills, Pennsylvania
Photos: Mark Ross Photography

Wall washers heighten the texture of the stone wall behind the bar.



Small, low-voltage tube lights are routed into the underside of the mahogany rails in the main dining room.

for both daytime and nighttime dining. It takes into consideration not merely illumination levels but also the colors, materials, textures, and scale of the space illuminated.

Illuminating a restaurant in a historic structure involves multiple challenges. It is essential that the designer comprehend and appreciate the architecture's original function while restoring the building's vitality. The designer must seek balance — between new and old, hard and soft, cool and warm.

The challenge at Greenwood Grille was to strengthen and reinforce the lighting already at work in the space. One way to do that was to recreate at night a glow similar to that provided by four dormer windows, which throw rich daylight onto the ceiling.

Another goal was social lighting, to shed a warm glow on people's faces. Achieving the lighting goals for this project required using a variety of lighting techniques that take into consideration the variety of hard surfaces in the building — stone walls, a high barrel vault ceiling, and a slate floor.

Main Dining Room

Two massive chandeliers, designed and built by Ray King, dominate the decorative lighting visible in the dining room. The four rings of frosted green glass are separated by sheet metal, in which 1-inch holes have been plugged with glass. In addition to providing diffused fluorescent light through its glass, the chandelier contributes to the room's indirect lighting.

Four 500-watt quartz fixtures are built into the top part of each chandelier. They are aimed down into the luminaire to reflect off its white finish inside. Both the fluorescent sources and the quartz fixtures are controlled from the central dimming system.

Indirect lighting in the main dining room is augmented by four dormer-mounted quartz lights, which have shallow reflectors that can throw light 10 to 12 feet. Simple sconces accent stone and wooden wall surfaces, their shape subtly echoing the massive cones of the chandeliers. Mahogany railings surround the raised seating area in the main dining room. Small, low-voltage tube lights, routed into the underside of each railing, enhance the luster and texture of the railings below.

A colorful feature of the space is a stained glass window between the main dining room and the entry lobby. The semi-

opaque artwork is backlit by four low-voltage adjustable downlights. Each 12-volt lamp uses a 75-watt MR16 lamp. The window lighting gives arriving patrons a glimpse of the busy dining room behind the glass; but diners can enjoy their meals undisturbed by onlookers.

Accenting the wall above that window, where the train station clock once stood, is a weathered-copper–colored disk backlit by two incandescent lamps.

Bar and Market

In the 3000-square-foot addition to the building, an existing stone wall forms the back wall of the bar; it was washed with light to heighten its texture and add warmth. A single row of low-voltage adjustable downlights in the dropped ceiling uses 12-volt, 50-watt quartz lamps controlled from the central dimmer system. These downlights were chosen to create sparkle on the black granite bar surface. Lamps at either end of the bar are primarily decorative, but also provide social lighting.

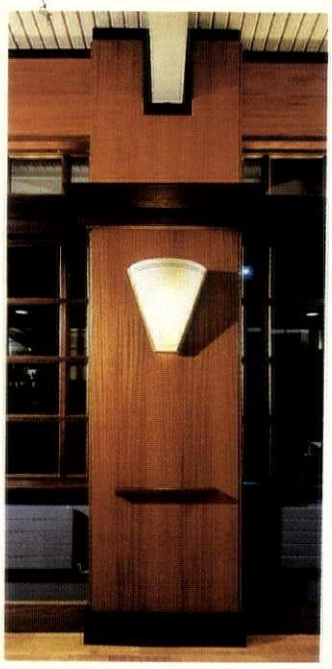
A two-track system was designed for The Market at Greenwood Grille to highlight each display area in the room. Incandescent fixtures mounted on movable tracks provide the versatility and flexibility needed for accent and shelf lighting in this space. Area lights are a combination of pendants and track lighting.

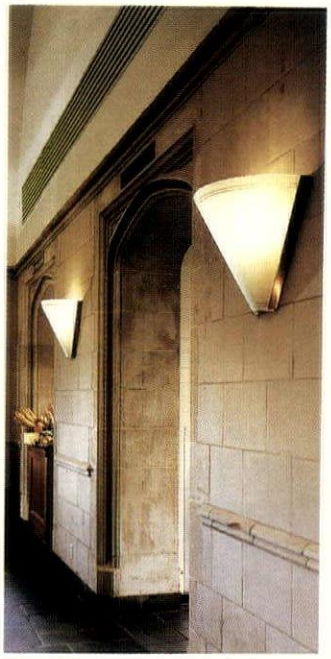
Exterior Lighting

The Jenkintown station is below street level, so approaching passersby may see only its highly articulated roof. In order to use that roof as a beacon and create awareness of the restaurant's presence, high pressure sodium lamps were placed at the gable ends and crotches. The result is a strong geometric pattern of textured gray triangles in sharp contrast to areas of darkness.

Main dining room.

The Market at Greenwood Grille, a gourmet take-out.





Simple sconces accent stone and wooden wall surfaces.

Exterior lighting also emphasizes the station sign. Like the interior lighting, the exterior system can be controlled from the central dimming system.

Dimmer System

For central control of all lighting in the restaurant, a programmable architectural lighting dimmer system was chosen. It allows the user to control the lighting from one master station. The restaurant is divided into four areas, each of which has a number of preset lighting scenes.

The largest control area includes the lobby, bar, kitchen, main dining room, and small dining rooms. At a preset-only station, the headwaiter can choose from eight preset lighting scenes. A ninth scene, controlled from the master station only, provides localized walk-through switching.

The manager of The Market specialty take-out area can choose from four preset scenes at a local control station that has a manual override. From the master station, there is a choice of eight programmable preset scenes and localized walk-through switching.

The only local control in the third area, the private dining room downstairs, is a manual override station. The master station controls eight preset scenes for this area, and the ninth scene is for walk-through. Control of the building's exterior lighting is possible only from the master station, where nine programmable preset scenes are available.

Scene changes for all areas can be fully automated by using the seven-day programmable time clock, which can also be used to set fade rates. The master station can lock out any local station. When manual override is permitted, it can be used to select a preset scene without disrupting the time-clock programming. The dimmer system also has two additional lighting scenes built in: a master clean-up and a master blackout, both with adjustable fade rates.

The Jenkintown station exemplifies a building renovation that respects and enhances the original architecture while making use of the latest technology to put the building to a new use. ■

For product information, see the Manufacturer Credits section on page 70.

Light without heat gain — glazing with a difference

Bradley J. Davids, PE

Bradley Davids is director of marketing with Southwall Technologies Inc., Palo Alto, California.

The use of daylighting for building illumination is experiencing a renaissance in architectural design. Last fall's International Daylighting Conference in Long Beach, California, attracted more than 300 architects, engineers, and researchers. The benefits of daylighting have been well documented and include lower energy costs (from reduced electric lighting and the resulting air conditioning savings), improved worker satisfaction and productivity, and enhanced aesthetics.

Unfortunately, the most common material for window openings — glass — has intrinsically poor energy performance. Although it fulfills the basic requirement of good light transmission, ordinary clear glass is highly transparent to solar heat. To prevent excessive heat gain in a building, architects often turn to dark tinted or reflective glass. The use of tinted or reflective glass for daylighting applications is self-defeating, however; it blocks useful daylight along with heat.

An ideal glazing material would be highly transparent to *light*, the part of the sun's energy to which the human eye is sensitive. At the same time, that ideal material would block the rest of the solar spectrum, the components of solar energy with no lighting value. In addition, the glazing would have insulation performance sufficient to minimize drafts and discomfort near windows during cold weather and to control heat loss or gain caused by differences between inside and outside temperatures.

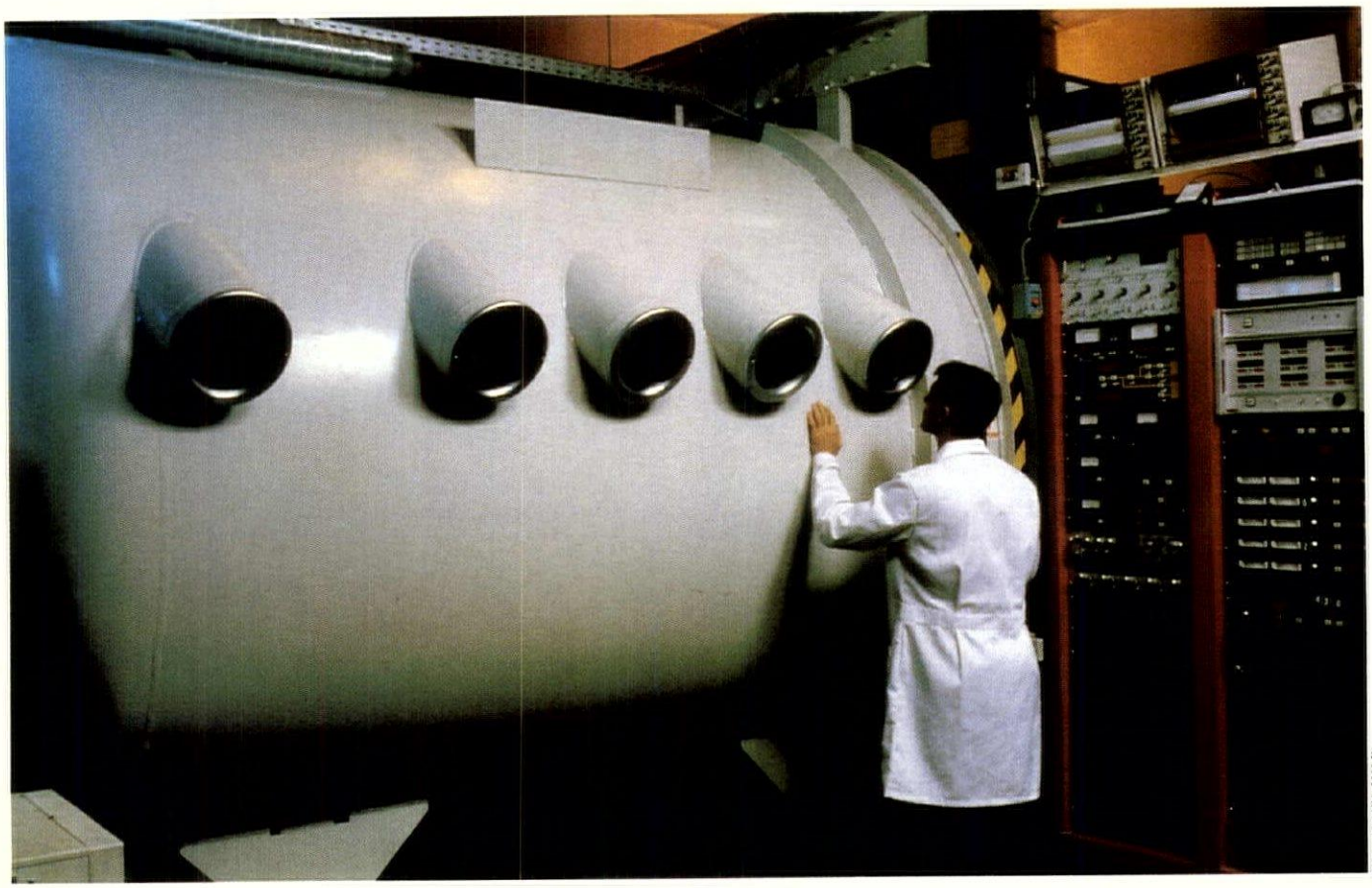
A new generation of glazing products has been designed with these objectives in mind. It incorporates the latest technology in vacuum-deposited thin-film coatings.

Clear Solar Shading

A major breakthrough in improved glazing performance occurred in 1981, when the first low-emissivity coating was used in an insulating glass system. This type of coating, often called *low-e*, consists of very thin layers of metals and/or oxides designed to transmit light while reflecting radiant heat.

The first low-e coating used in windows in the United States was deposited on a thin, clear polyester film and suspended tightly between the panes of a double-pane window. By 1983, most major U.S. glass manufacturers were offering similar low-emissivity coatings, deposited directly onto the glass.

These first-generation low-e coatings were designed to



PAUL FAIRCHILD

A vacuum coating chamber used in the manufacture of low-emissivity glass.

improve the insulation performance of double-pane windows, and they reduced heat loss through double-pane glass by 30 percent to 50 percent. They were not intended to block solar heat gain, however, and that is desirable in most commercial daylighting applications. As a result, the improved double-pane glass was used primarily in northern residential buildings, where winter solar heat gain is often a benefit, and air-conditioning costs are little problem.

A new type of low-e glazing was recently introduced. The new glazing is specifically designed for commercial applications where high daylight transmittance, low solar heat transmittance, and high insulation value are all important. It takes advantage of the fact that more than half of the sun's total energy is invisible, near-infrared and ultraviolet radiation.

These *selectively transmitting* glazings can transmit more than 50 percent of the sun's light while blocking more than 90 percent of the sun's invisible heat, providing *clear shading*. For the first time, a glazing product can provide high levels of daylight without excessive solar heat gain. By using these new glazings, daylighting designers can achieve ample solar control without needing to resort to dark tinted or reflective glass.

Comparing Glazing Options

When evaluating the daylighting performance of various glazing types, designers should look at two critical performance indicators: the daylight transmittance (Tv) and the shading coefficient (SC). Quite simply, the daylight transmittance figure measures light admitted through the glazing; the shading coefficient measures total solar heat transmitted.

Recently, a third performance indicator has been suggested: the ratio of these two values, called the luminous efficacy constant, or Ke (Ke = Tv ÷ SC). This light-to-heat ratio is an effective one-number measure that can be used to compare the energy performance of glazings in daylighting applications.

The performance of several popular glazing options is shown in the accompanying table, which displays the three indicators discussed above; the insulation rating, using the familiar R-value scale, is also shown. For most daylighting applications without skylights, the daylight transmittance should be above 50 percent. Below this level, building occupants tend to be aware of the tint, and the electric lighting reduction potential is significantly reduced.

Glazing selection factors

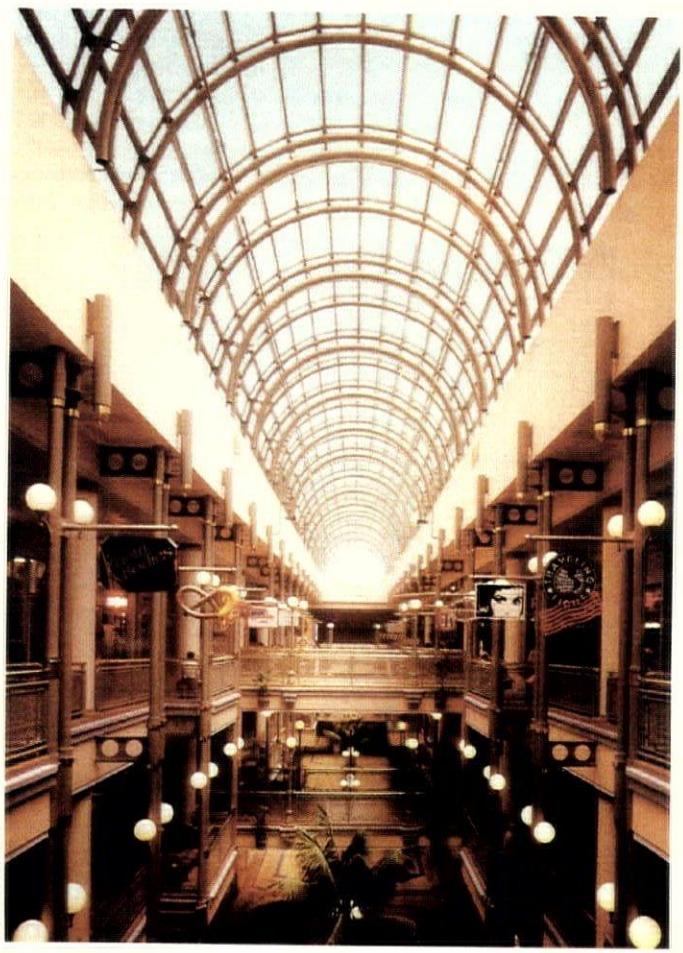
Glass Type	% Daylight Transmittance (Tv)	Shading Coefficient (SC)	Luminous Efficacy Constant (Ke)	R-Value
Clear single-pane	89	0.95	0.94	0.9
Clear double-pane	80	0.82	0.98	2.0
Black single-pane	14	0.65	0.22	0.9
Bronze double-pane	47	0.57	0.82	2.0
Reflective double-pane	19	0.34	0.56	2.0
Selective clear low-e	54	0.48	1.13	4.5

Selecting Glazing

The final glazing selection must take into account many factors, including window orientation, climate, building interactions (overhangs and wingwalls, for example), and aesthetics from both inside and outside the building. If daylighting is a major objective, the luminous efficacy constant for the glazing selected should be as high as possible, balancing the benefits of high light transmission with the liabilities of solar heat gain.

The proposed American national standard for energy-efficient design of new commercial buildings (ANSI/ASHRAE/IES 90.1P) will grant "extra credit" for daylighting designs that use glazings with a daylight transmittance greater than their shading coefficient, that is, a Ke greater than 1. By specifying such glazings as part of a daylighting design, designers can increase window areas above the proposed allowable limits in the standard.

Although these new glazing options may increase the first cost of the windows, reduced costs for heating, ventilating, and air conditioning equipment



IMAGINATION

Westside Pavilion shopping mall, Los Angeles.

often result in overall first-cost savings for the total building design. Studies recently completed by Lawrence Berkeley Laboratory's windows and daylighting group show that going from a glazing with Ke = 0.5 to one of Ke = 1.5 could cut the required size for a building's air conditioning chiller system by as much as 40 percent.

A complete analysis of glazing options for a daylighting application should consider all four of the parameters discussed earlier (Tv, SC, Ke, and R-value) and their combined effect on the energy consumption pattern of the building. In cold climates especially, the insulation performance of the glass (R-value) and its effect on heating costs, thermal comfort, and interior glass surface condensation deserve attention.

Case Studies

In January 1987, Bristol-Meyers Company opened a new research headquarters building in Wallingford, Connecticut, that has 23,000 square feet of selectively transmitting low-emissivity glazing. The glazing product used for the building — clear double-pane glass with a selectively transmitting film suspended between the panes — has a daylight transmittance of 46 percent, a shading coefficient of 0.40 (Ke = 1.15), and an R-value of 4.5. This outstanding combination of performance parameters made it possible for the architects, the Stubbins Associates, to use much more glass than would otherwise be practical. Therefore, Bristol-Meyers scientists and technicians have the opportunity to conduct pharmaceutical research in laboratories and offices illuminated by daylight.

Across the continent, the dramatic Westside Pavilion shopping mall in Los Angeles is topped by a 550-foot-long barrel-vault skylight containing 24,000 square feet of selectively transmitting low-emissivity insulating glass. Open since mid-1985, the project combined gray-tinted glass with the same selectively transmitting suspended film as was used in the Bristol-Meyers project. The pavilion architects, the Jerde Partnership, chose the new glazing for the skylight because it provides the same solar control as common reflective glass, but transmits more than twice as much light.

Looking Ahead

Although the number of glazing options available to the building designers has increased dramatically over the past five years, even more innovations in glazing materials are emerging from the laboratory. The most exciting of these may be electrochromic, or *switchable* glazings, which could be changed from clear to dark by applying a voltage across a special coating on the glass. With this system, windows could even be connected to the building's thermostat and lighting circuits and could be computer-controlled for optimal energy and lighting efficiency. Although these glazing products probably will not be available for buildings before the early 1990s, Nissan Motors has already incorporated an electrochromic sunroof into a prototype car that could be released by 1989.

Together, the glazing materials now available and those under development for the future mean that windows will no longer be seen as energy liabilities, but as active components of an integrated building envelope. These new materials for window openings let daylighting designers increase their focus on design, and deemphasize the focus on energy concerns. ■

Lighting World 5 product introductions

"The Latest in Lighting Today," a 90-minute session at Lighting World 5, featured a selection of 26 new products exhibited at the show. A panel representing the International Association of Lighting Designers, the Illuminating Engineering Society of North America, and the New York Section Illuminating Engineering Society selected the lamps, fixtures, and controls from a group of about 70 submissions. Jeffrey A. Milham, recipient of the New York Designers Lighting Forum's Honor Award, chaired the presentation and slide show.

Alanod USA Inc. (Dallas, Texas) presented a new reflector sheet material designed to reduce iridescence. The Cross Blade configuration also offers performance characteristics similar to those of parabolic louvers.

Alkco (Franklin Park, Illinois) introduced Recessed-Trak, an accent track lighting system in which both track and fixtures are totally recessed above the ceiling. Its MR16 track lamp holders can be adjusted from 0 to 40 degrees from vertical and can be rotated 380 degrees.

The HID 1600 emergency lighting system from the Bodine Company (Collierville, Tennessee) allows high intensity discharge lamps to be used for both normal and emergency illumination. Power to lamps is present continuously, so emergency operation can begin without transfer time.

BWF Offermann, Zeiler, Schmid & Co. KG (Offingen, West Germany) manufactures fluted acrylic rods with clear holes throughout the length of the rod. This material can be used in conjunction with low-voltage lamps to create luminous products such as handrails.

CPI Concrete Products (Memphis, Tennessee) has developed a concrete color-impregnation system for prestressed concrete poles. Seven solid and seven exposed aggregate colors are standard choices.

CSL Lighting, Inc. (Los Angeles) presented the FP400, a framing projector that custom frames objects regardless of shape. The projector uses an MR11 lamp and is compatible with most track systems.

The Magic Wand 3 from Edison Price, Inc. (New York City) is a compact low-voltage track luminaire that adjusts a full 360 degrees vertically and horizontally.

Electronic Ballast Technology, Inc. (Torrance, California) displayed a miniature solid-state, high-frequency fluorescent ballast. The ballast is available for one- and two-lamp configurations of T8, T12, and T4/T5 lamps from 25 to 45 watts.

Harry Gitlin, Inc. (New York City) has introduced No-Trans, a method of low-voltage series wiring that allows a circuit to remain functioning when a lamp fails. The other lamps burn at reduced intensity, which alerts the user and protects the remaining bulbs with reduced voltage.

GTE Products Corp. (Danvers, Massachusetts) demonstrated the Designer 16, a new tungsten halogen reflector lamp with a precisely molded ceramic reflector. The 55- and 75-watt lamps are available with narrow spot and narrow flood beam patterns.

The MODE system from Kesser Electronics International, Inc. (Troy, Michigan) uses a personal computer to operate a surveillance and security system. Functions include light usage and occupancy monitoring, equipment and personnel tracking, and detection of traffic patterns and intrusion.

Lighting Technologies (Boulder, Colorado) demonstrated LumenMicro, a lighting analysis software package for personal computers. The color option generates perspective images of rooms, showing the effects of lighting equipment within a space.

The Super Beamer from Lightolier, Inc. (Secaucus, New Jersey) uses its own built-in reflector and a 75-watt miniature tungsten halogen lamp to generate a well-defined beam of light. Users can adjust beam patterns from 6 to 18 degrees by turning a knob on the fixture.

Litecontrol (Hansen, Massachusetts) showed its LCI indirect lighting luminaire, which can be used with ceilings as low as 8 1/2 feet. When pendant-mounted with the bottom of a fixture 12 inches from the ceiling, the luminaire provides a wide lateral spread while minimizing output directly above.

Trucool from Lucifer Lighting Company (Miami, Florida) is an air-cooled low-voltage halogen showcase reflector that can achieve a 6-degree difference between case interior and exterior ambient temperatures.

Orgatec Lighting, Inc. (San Jose, California) can incorporate a wireless switching control device into its Orgalite and Platypus indirect high intensity discharge luminaires. The movable fixtures can then be remote controlled, individually or in groups, without secondary wiring.

Osram Corporation (Newburgh, New York) presented the HQI-T family of single-ended, bipin metal halide lamps. The compact, universal burning sources have a color temperature of 3000K and a color rendering index of 81. The three lamps in the series are 35, 70, and 150 watts.

Mighty Arc II from Phoebus Manufacturing (San Francisco, California) is a narrow beam, high-output follow spot designed for concert and stage lighting. It has a telephoto configuration and an automatic zoom system.

Prescolite Controls (Carrollton, Texas) introduced Horizon, a complete line of thin-profile wall-box dimmers that allow full range dimming and power control of the same load from up to five different stations.

Sentry-Lite (Rockville Centre, New York) announced the Sentry-Cycle diagnostic system, which provides continuous automatic monitoring and display of critical emergency lighting functions. The company is incorporating the feature into all new fixture models.

Siltron Illumination Inc. (Cucamonga, California) showed decorative emergency lighting sconces equipped with both high power factor ballasts and emergency battery packs.

Starfire Lighting Inc. (Jersey City, New Jersey) demonstrated Techtrack MR11, a miniature aluminum housing that holds adjustable MR11 lamps. It is available in a variety of lengths with universal corner connectors. A printed circuit board in each track reduces internal wiring.

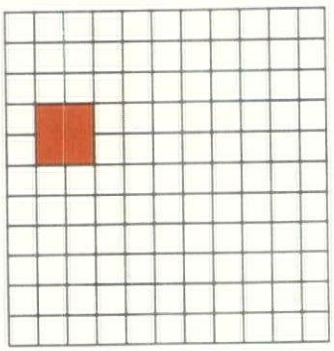
Arcstream from Thorn Lighting Limited (Enfield, Middlesex, England) is a compact metal halide light source for display lighting. The single-ended iodide lamp has a highly compact arc for precision optical control. It is available in 35-, 70-, and 150-watt models.

Thunderbolt Electronics Company, Inc. (Bound Brook, New Jersey) showed the Saver electronic ballast, an air-circulating electronic fluorescent ballast using all unpotted components. The ballast and two F40 T12 lamps consume less than 60 watts.

Union Metal Corp. (Canton, Ohio) demonstrated the Abacus system, a hinge-based assembly that uses a hydraulic system to raise and lower light poles for maintenance.

Venture Lighting International (Cleveland, Ohio) presented an instant restart metal halide lamp that relights instantaneously with the use of a switchable fixture and power supply. It is particularly applicable in sports lighting and industrial situations. ■

The Daylighting Department



Norbert M. Lechner

Norbert Lechner is an associate professor in Auburn University's School of Architecture, Auburn, Alabama. The daylighting column is adapted from his forthcoming book, Heating, Cooling, and Lighting: The Architectural Approach, *to be published by John Wiley & Sons.*

To understand window daylighting strategies, it is worthwhile first to examine the effect of a plain window. The illumination — as shown in last month's column — is greatest just inside the window and rapidly drops off to unacceptable levels. The view of the sky is often a source of direct glare, and direct sunlight entering the window creates both excessive brightness ratios and summertime overheating.

To overcome the negative characteristics of ordinary windows, designers should keep in mind several strategies — which are the subject of this month's column. Place windows high on the wall, widely distributed and of optimum area. Reflect daylight off the ceiling for deeper and more uniform light distribution. Place windows on more than one wall when possible. Use sill and overhead reflectors to project light deep into rooms. Place windows adjacent to interior walls. Shade direct sun; but do not shade daylight, filter it. Use movable shades. And, splay walls to reduce the contrast between windows and walls.

Various design strategies can overcome the negative characteristics of ordinary windows.

Widely Distributed Windows

Windows should be high on the wall, widely distributed, and of optimum area. Daylight penetrates farther into a space in proportion to the mounting height of the window. Whenever possible, ceiling heights should be raised so that windows can be mounted higher on the wall.

Daylight is more uniformly distributed in a space when it comes from more than one window. Le Corbusier, and other architects, often used ribbon windows for this reason.

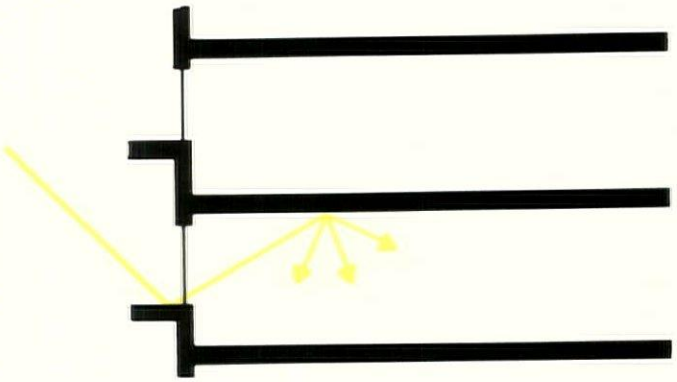
Window areas should rarely exceed 20 percent of the floor area. Above that percentage, an excess of light contributes to summer overheating — and to excessive year-round heat gains and losses — due to conduction through the glazing. Reflectors and diffusers permit small window areas to collect large amounts of daylight.

Reflecting Daylight

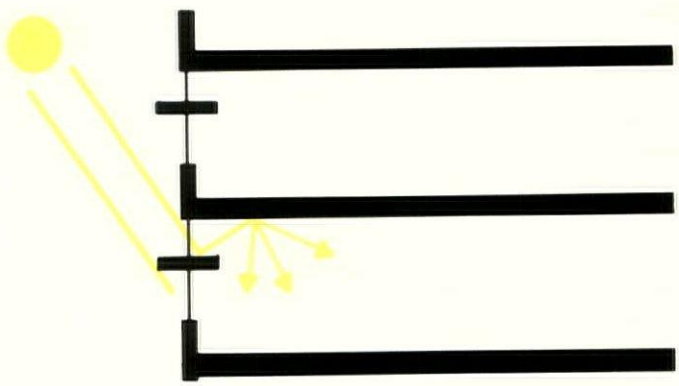
Reflect daylight off the ceiling for deeper, more uniform light distribution. There are various ways to project light onto the ceiling. In one-story buildings, light-colored patios, walkways, or roads can reflect a significant amount of light to the ceiling. In multistory buildings, parts of the structure can be used to reflect light indoors.

Wide window sills or light shelves can be quite effective. Light shelves are most often placed above eye level to avoid glare off their top surfaces. Any glazing used below the light shelf will be mainly for view. The light shelf acts as an overhang for this lower glazing to prevent direct sunlight from entering and creating puddles of sunlight; the overhang also reduces glare by blocking the view of the bright sky. Glare from the upper window can be controlled by louvers.

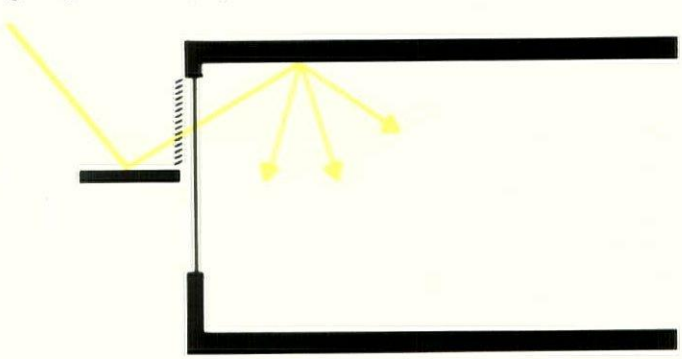
One of the most effective strategies for reflecting light onto the ceiling is an indoor



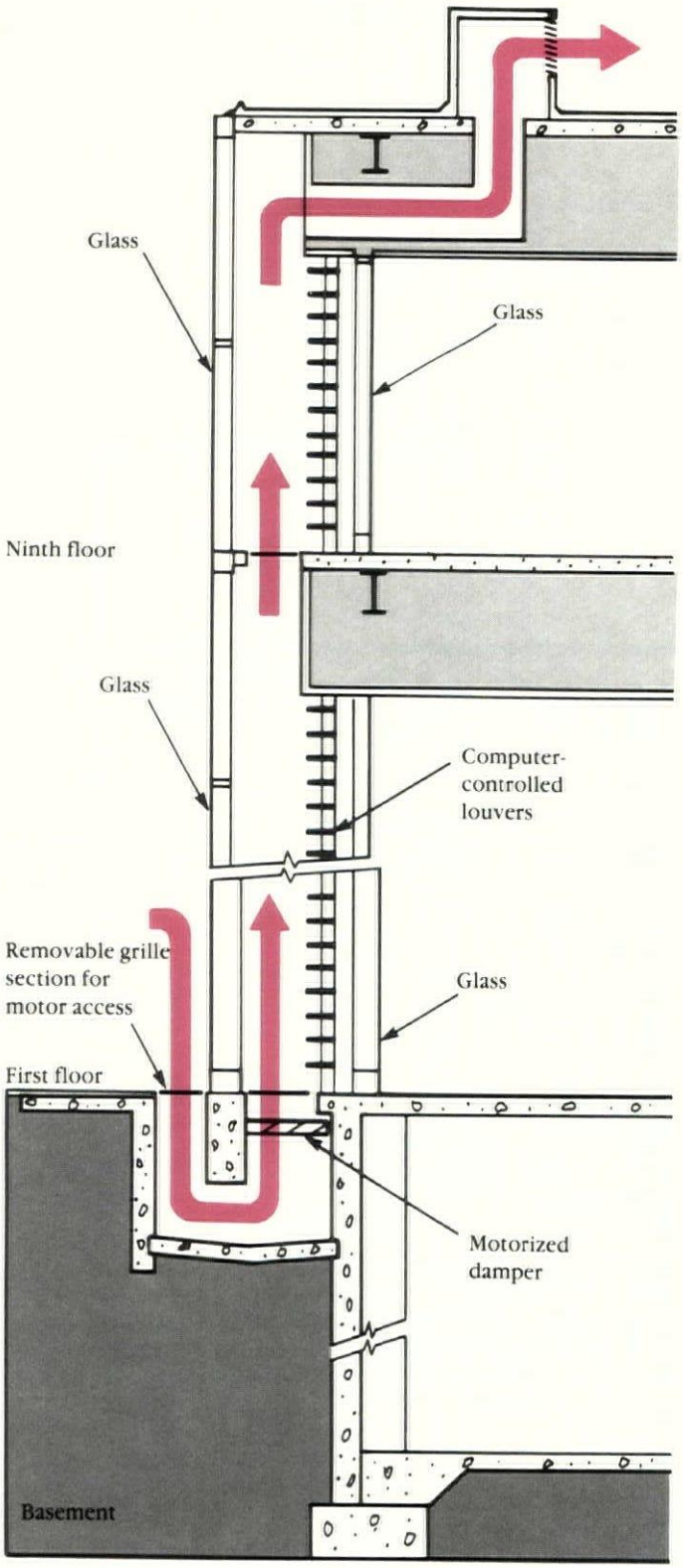
Wide window sills can be used as light shelves to reflect light deep into a building interior.



Light shelves are usually placed above eye level to prevent glare from the top of the shelf.

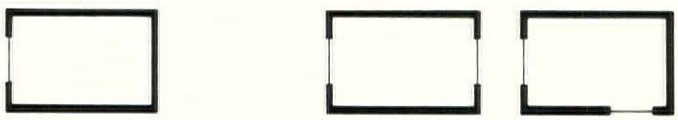


Light shelves act as overhangs for the view windows beneath; louvers can be used to avoid glare caused by the glazing above the light shelf.



The Hooker Office Building, Niagara Falls, New York, uses computer-controlled louvers to regulate the light and heat entering the building.

Both concave and convex specular reflectors can be used to distribute daylight over a wide area of the ceiling.



Bilateral lighting is usually preferable to unilateral lighting.

venetian blind or a similar outdoor louver system. Dirt accumulation is the venetian blind's main drawback; that drawback can be largely overcome by sandwiching the blind between two layers of glass. Miniature slats can reduce the annoying figure/background confusion that occurs when a view is interrupted by venetian blinds. Dynamic systems, such as venetian blinds, are much more effective than static systems because they can better respond to varying conditions of daylight and sunlight.

The Hooker Office Building in Niagara Falls, New York (1981), is covered by two glass skins that create a 4-foot air space in which horizontal louvers have been placed. These white louvers are automatically rotated to control the daylight entering the building. Direct sunlight is always intercepted and reflected to the ceiling. For insulation, the louvers rotate into a closed position at night.

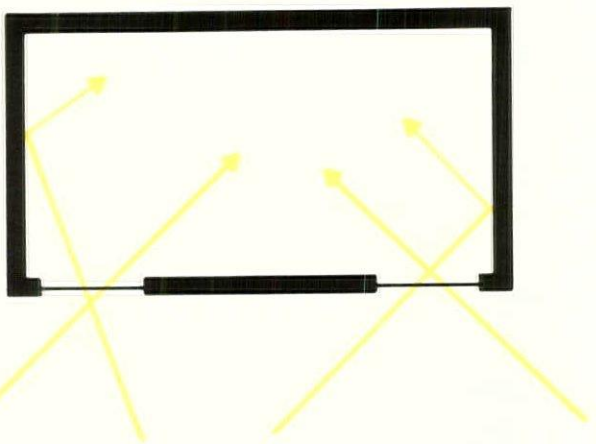
The ceiling should always be a diffuse reflector, but any device that reflects light onto the ceiling could have a specular finish to maximize the depth of sunlight penetration. The light shelf figures were drawn as if the reflectors were specular in nature. This was done partly out of convenience, because multiple diffuse reflections are very hard to represent graphically. Unless a drawing is specifically labeled, it cannot be assumed that the reflector is specular.

Specular reflectors often cast excessively bright patches of sunlight on the ceiling.

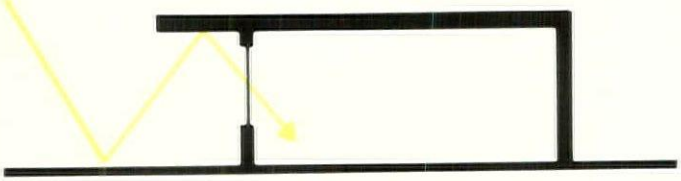
A disadvantage of specular reflectors is that they often cast excessively bright patches of sunlight on the ceiling. Curved specular reflectors minimize that problem by spreading sunlight over a large part of the ceiling. Matte reflectors, on the other hand, create very even light distribution; sometimes they also provide sufficient penetration into the space. Model studies are a good way to determine whether to use specular or diffuse reflectors.

Placement and Projection

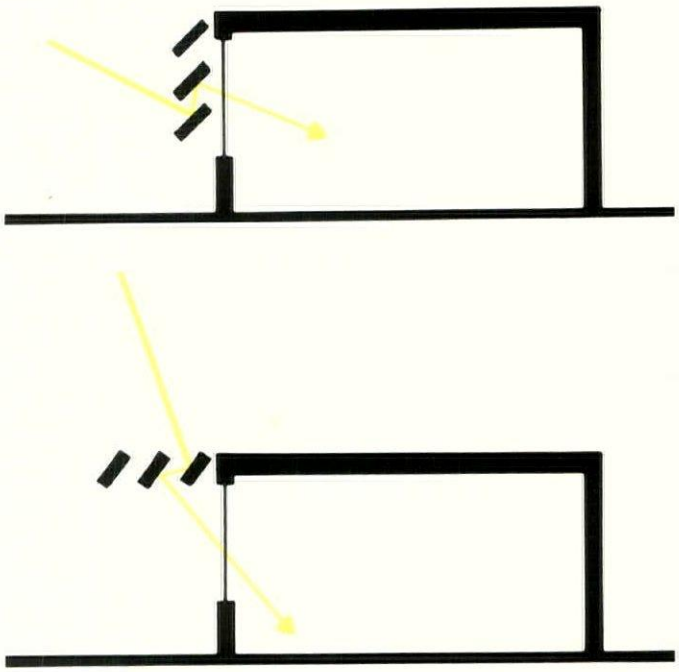
Whenever possible, avoid unilateral lighting (windows on only one wall). Instead, use bilateral lighting (windows on two walls) for much better light distribution and reduced glare. Windows on adjacent walls are particularly effective in reducing glare. The windows in each wall illuminate the adjacent



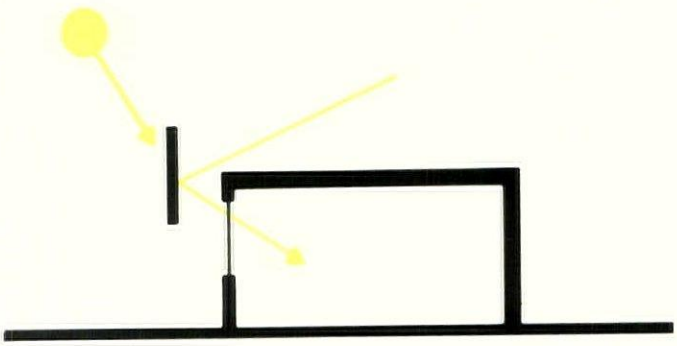
Light distribution and quality are improved by reflections off side walls.



Large horizontal overhangs block too much light unless both the ground and the underside of the overhang have high reflectance values.



Horizontal louvers block direct sunlight but allow some diffused light to enter the windows.



A vertical panel can block direct sunlight while reflecting diffuse skylight.

wall and thus reduce the contrast between each window and its surrounding wall.

Project light deep into rooms by using sill and overhead reflectors. Gunnar Birkerts' design for the IBM Regional Office in Southfield, Michigan, uses a specular metal reflector at the sill to project light to a semigloss reflector above the window. This solution allowed Birkerts to use a rather small window area to give seated workers a view while projecting daylight into the interior of the building. Although the curved reflectors were designed to maximize the light distribution, flat surfaces would also work.

Place windows adjacent to interior walls. The interior walls adjacent to windows act as low-brightness reflectors, which reduces the overly strong directionality of daylight. Glare from the window is also reduced because of the reduced contrast between the window and the bright side wall and slightly brighter front wall, which receives light reflected from the side walls.

Shading and Filtering

Shade direct sun but not daylight. Unless direct sunlight can be diffused by reflecting it up to the ceiling, it should be kept out of the building. If a large solid horizontal overhang is used, its underside should be painted white to reflect ground light.

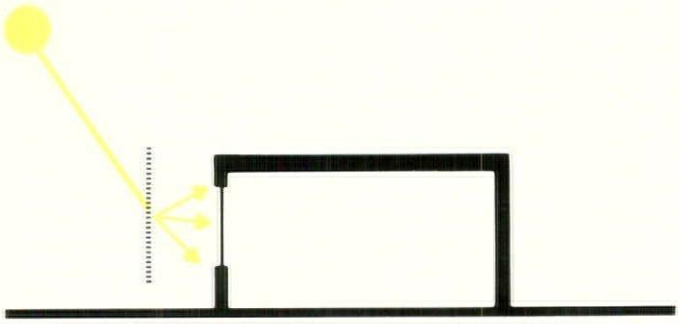
Shade direct sun but not daylight.

Vertical or horizontal louvers painted white are a good choice; they block direct sunlight, yet reflect diffused sunlight. On a clear sunny day, however, these louvers can become uncomfortably bright. A vertical panel in front of the window can block direct sunlight while reflecting diffuse sky light into the window.

Physical models can be used to determine how well various devices admit high-quality daylight while shading direct sunlight. In some spaces where visual tasks are not critical — such as lobbies, lounges, and living rooms — some direct sunlight may be welcome for its visual and psychological benefits, especially in winter.

Sunlight can be filtered and softened by trees or by such devices as trellises and screens. Translucent glazing, however, or very light drapes or shades, can make a direct glare problem much worse. Although they diffuse direct sunlight, they often become, in the process, excessively bright sources of light.

A dynamic environment calls for a dynamic response; use



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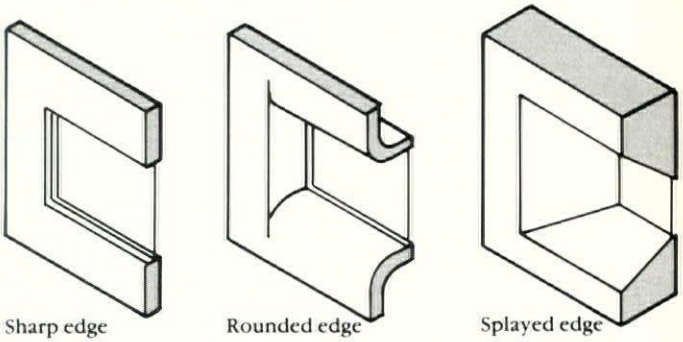


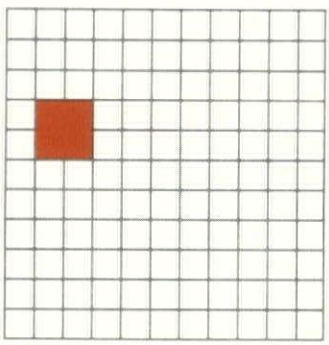
Excessive contrast between a window and a wall can be minimized by splaying or rounding the inside edges.

movable shades. Variations in daylighting are especially pronounced on east and west exposures, which receive diffused light for half the day and direct sunshine the other half. Movable shades or curtains can respond to these extreme conditions.

To reduce heat gain, the shade or curtain should be highly reflecting, and shading is much more effective if placed outside the glazing. The Bateson Office Building in Sacramento, California, makes very effective use of exterior fabric shades.

Splay walls to reduce contrast between windows and walls. Windows create less glare when the adjacent walls are not dark in comparison to the window. Splayed or rounded edges create a transition of brightness that is more comfortable to the eye. ■

The Parts Department



Sidney M. Pankin

Sid Pankin, the principal of Pankin & Associates, Inc., is a lighting applications engineer who specializes in lighting design, energy conservation, and the design and fabrication of lighting retrofit components.

The ballast is that vital component of a fluorescent fixture that starts and operates the lamp. It has three functions: it heats the lamp's electrodes with a controlled amount of electrical current, it provides the voltage necessary to start the arc between the electrodes, and it acts as an impedance that limits the current to the values set by the lamp manufacturer. The ballast provides a much greater charge than normal current to start the arc. Once the arc is established, the impedance (resistance) of the lamp is very low, and the ballast must reduce the flow of energy to the lamp to prevent its destruction.

Ballasts are designed to meet the operating requirements of a specific lamp type. For the optimum performance of both components, compatibility of ballast and lamp helps ensure expected light output and longevity. The three basic types of ballasts for fluorescent fixtures are core-and-coil, electronic, and reactance.

Ballast and lamp compatibility helps ensure expected light output and longevity.

Core-and-Coil Ballasts

The *core-and-coil* line-frequency ballast is the most frequently used. It has a core of laminated-steel transformer plates and a coil of insulated copper windings. Windings are coupled together to transform voltage and to limit current. In some ballasts, capacitors regulate line current, providing power factor correction. A resetting thermal device disconnects the ballast if it overheats, as specified by the Class P requirement of the National Electrical Code.

The assembly of components is impregnated with a nonconducting material for electrical insulation and heat dissipation. With wire leads attached, it is placed in a steel case, which is then filled with a potting material such as hot asphalt. The potting material completely surrounds the assembly, reducing noise and vibration caused by the case.

The *energy-saver* ballast is a more efficient version of the standard core-and-coil ballast. Better core materials, more copper windings, and improved design reduce internal losses of wasted energy, which produces no light. The energy saver uses less energy to operate lamps, and its cooler operating temperatures provide greater longevity.

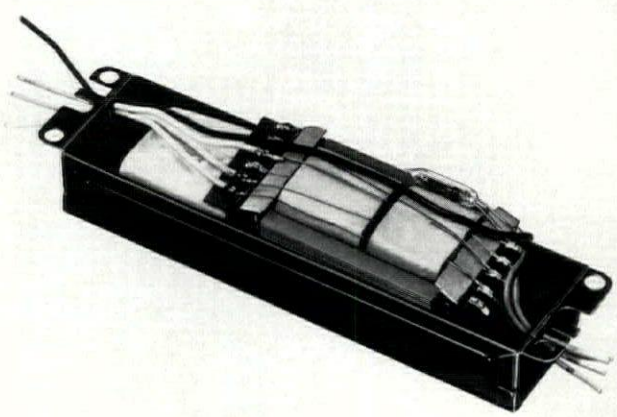
Electronic Ballasts

The high-frequency *electronic* ballast uses electronic circuitry to convert 60-hertz line current to a high-frequency current, 20 kilohertz or higher. At that frequency, fluorescent lamps operate more efficiently. The electronic ballast uses small inductive coils and/or capacitors to start and limit lamp current. Although the American National Standards Institute (ANSI) has not established standards for this family of ballasts, they are under study by the C78 and C82 subcommittees.

The electronic circuitry generates electromagnetic radiation at radio frequencies, which radiates from the ballast and the lamps and may also be picked up in AC line output. The Federal Communications Commission (FCC) requires that each electronic ballast must have an FCC-certified radio-frequency interference (RFI) device to ensure that the switching circuitry generates minimum interference. A new regulation stipulates that the ballast label must display the FCC identification number.

Electronic ballasts are much more susceptible to line transients than standard (core-and-coil) ballasts. The line transient can be caused by something as simple as a short circuit or as dramatic as a bolt of lightning that affects the distribution system. Ballast design should incorporate an adequate form of resistance to prevent failure from surges or spikes in line voltage.

Several brands of electronic ballast are available. Most of them have track records based on a good number of installations. But to be sure that the specific ballast selected performs efficiently in a specific project or facility, it is important to consider light levels, input wattage, and radio-frequency interference. The last is especially critical in hospitals, in computer rooms, and near communications systems. Nearly all electronic ballast manufacturers warrant ballasts for three years with an allowance for the cost of labor.



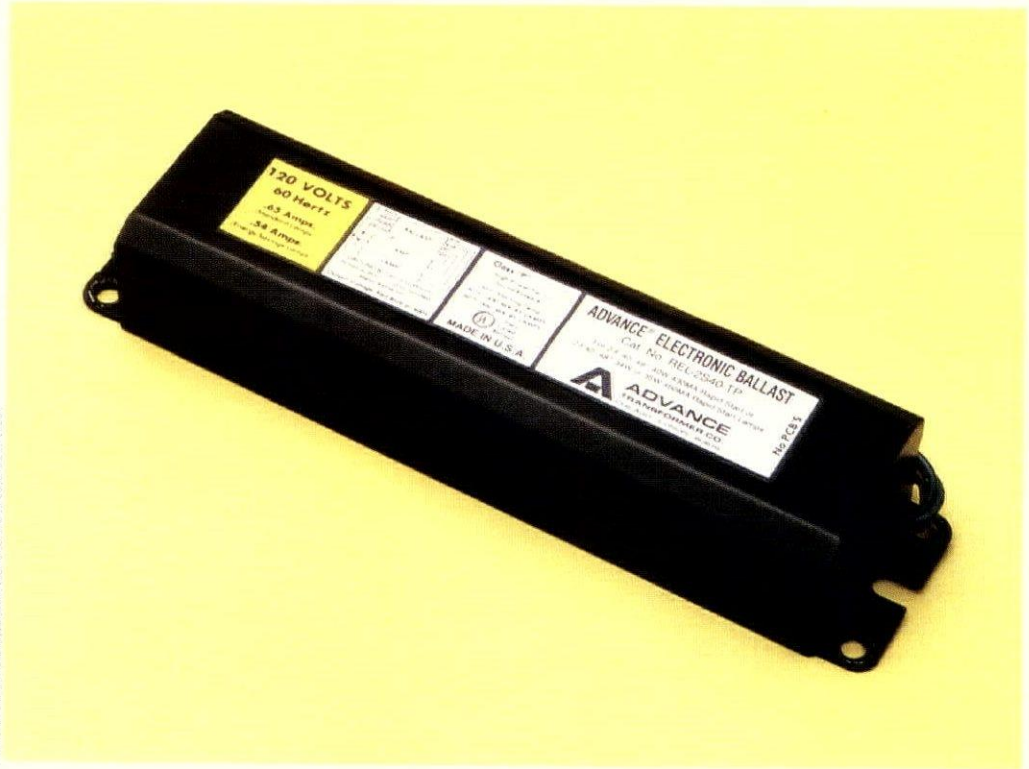
COURTESY OF ADVANCE TRANSFORMER CO.

Demonstration model of a core-and-coil ballast shows inner components. A small, glass-enclosed thermal protective device rests atop the core-and-coil assembly. The capacitor at left, fastened to the assembly beneath lead wires, provides power factor correction. In a usable ballast, potting compound surrounds the components, completely filling the case.

Reactance Ballasts

The *reactance* line-frequency ballast is a lesser-known but effective approach to lighting energy conservation. Its manufacturer has developed a 60-hertz line-current system that optimizes the energy transfer from the power line to the fluorescent lamp. According to the manufacturer, a special nonlinear inductor provides the optimum power factor for the lamp. Further, the placement of the inductor between the power line and the lamp makes it an effective RFI filtering system for the power line.

The reactance ballast is neither core-and-coil nor electronic; it uses magnetics to improve efficiency. Its specifications call for an operating temperature of 36.5 degrees Celsius (98 degrees Fahrenheit) with a 277-volt, two-lamp unit.



COURTESY OF ADVANCE TRANSFORMER CO.

The label of this electronic ballast lists electrical specifications, compatible lamps, thermal protection (Class P) and sound ratings, and minimum starting temperatures. The second panel from the left shows a wiring diagram and details installation requirements.

Extending Ballast Life

Ballast life is limited. A good-quality ballast has a median life expectancy of approximately 12 to 15 years. This is based on an average ballast case temperature of 90 degrees Celsius (194 degrees Fahrenheit) at the hottest spot on the case. An increase of 10 degrees Celsius over this temperature may cut ballast life by 50 percent, and a decrease of 10 degrees Celsius may increase ballast life by 100 percent.

Poor compatibility with lamps can cause ballast overheating. This may happen, for example, if energy-saver lamps are used with ballasts manufactured before 1978. The higher starting energy of the energy-saver lamp accelerates lamp aging, which significantly increases ballast operating temperature.

Immediately replace instant start (slimline) or preheat lamp burnouts on two-lamp ballasts. While one lamp of this type operates, the ballast may be trying to start the burned-out lamp and may burn itself out prematurely.

All lamps increase ballast heat as they near the end of their life cycle. To maximize ballast life, when one lamp on a two-lamp ballast burns out, replace both lamps so that they draw the same energy load.

A ballast that is not properly matched with supply voltage may burn out early. Ballasts operate within a range from 7½ percent below to 5 percent above their rated voltage. As a rule of thumb, a 1 percent increase in line voltage increases operating temperature 1.2 degrees Celsius. Ballast heat is also affected by fixture mounting methods, ceiling materials, and the temperature of the air in the ceiling plenum.

Achieving optimum lighting results is a matter of careful management of ballasts and lamps. Designers who do so can maintain both components and realize maximum light output and component longevity at the lowest energy cost.

Cutting Wattage

A frequently asked question about electronic ballasts is, "How can the input wattage for two 40-watt lamps and a ballast be less than 80 watts?" The answer is somewhat complicated. Simply stated, heat is a byproduct of electrical lighting. Lower ballast operating temperatures reduce ballast heat losses, and therefore wattage losses, and reduce lamp wall operating temperatures, which also reduces wattage.

A typical ballast loss for an electronic ballast, as determined by ANSI test procedures, is 8 watts with two F40 lamps operating at 56 watts — a total of 64 input watts. The energy-saver core-and-coil ballast with two F40 lamps has a total input wattage of 90½ (ballast, 10½ watts; lamps, 80 watts). The manufacturer of the reactance ballast claims that under the same conditions, the ballast has a total input wattage of 68 (ballast, 5 watts; lamps, 63 watts).

An electronic ballast can operate two F40 lamps with a total input wattage of 64 watts.

The economics of energy-saving ballasts can be attractive. However, the compromise in light levels, if any, must be considered. Light output is directly proportional to line current at a given temperature.

Lamp efficiency (lumens per watt) with the electronic and reactance ballasts may be greater than that with core-and-coil ballasts. But claims of "full light output" or "near full light" should be subject to field testing.

Claims of "full light output" should be subject to field testing.

There is a continuous flow of new product in the lighting world. Much of that product may be cost-effective and energy-effective if properly applied. This makes it all the more important to do on-site testing so the results can be seen and measured firsthand.

Evaluating Ballasts On Site

Group relamping and reballasting is a sound economic idea, especially if the existing ballasts are 12 to 15 years old and lamps have been replaced only when they burn out. If ballasts date back before 1968 and are not thermally protected, replacement may be a necessity because of heat and the personal liability risks associated with PCBs — oily substances used in ballasts before the EPA banned them in 1978.

If a group reballast is planned, do some serious investigation before making any commitment. Buy only after carefully evaluating test areas.

The following field test procedure may help you to compare ballast and lamp combinations. The test evaluates performance by answering the following questions: Does it work? Will it reduce energy costs? Are there any objections from the people who work in the test area — or do they like it? Do I like what I see visually?

Establish the test objectives in writing. Then select an appropriate test area. This can be a fully enclosed space such as an office or a computer room, or it can be in a corner of a large office space. The size of the test area will relate to your objectives. However, you can start small and — if successful — expand to a larger test site for additional verification.

You will need a footcandle meter and a watt meter. The test data include footcandle readings and the input wattage readings taken on the ballasts. Using the results, you will be able to compare the performance of the existing system as is, of the existing system after cleaning, and of as many new lamp and ballast combinations as you wish.

Draw a reflected ceiling plan of the space. This diagram of the lighting plan, showing specific fixture locations, will be used to record light readings. Determine the specific points where light readings will be taken, and mark the physical location so that readings are taken at the same points for each test.

Take light readings of the existing system as is; record them on the reflected ceiling plan. Take input wattage readings on more than one ballast. If more than one brand is installed, read more than one ballast of each different brand. List the manufacturer and the order number.

Clean fixtures, lamps, and light shields and take light readings. Then change lamps, using the lamp type you are considering for replacement with the ballast. Take light readings and determine input wattage, which may change with each lamp change.

Install the replacement ballasts, let them operate for a day, and then test again, taking light readings and input wattage readings. Repeat this step with other lamp types and/or test other ballasts, first with the same lamp type you first used for replacement.

This procedure will give you comparative data that will help you make a decision — or, at least, results to review with the component manufacturers, consultants, or anyone else who may be involved in the decision-making process. Tests do cost time and money, but a test is inexpensive insurance. The results will reinforce the idea, indicate a need to modify or expand it, or convince you to look elsewhere for another approach to lighting energy conservation.

Tests cost time and money, but they are inexpensive insurance.

The Ballast Label

Information on the ballast label is critical to the proper application of lamps and ballasts; it indicates voltage and line current, and it shows a wiring diagram. The following information may also appear on the label.

The *UL label* indicates that Underwriters Laboratories has evaluated and approved certain safety aspects of the ballast. UL implements the Class P requirement.

Class P of the National Electrical Code requires that fluorescent fixtures used indoors have ballasts fitted with a resetting thermal protective device that disconnects the ballast from the power line if it overheats.

"No PCBs" is an absolute indicator that the ballast contains no PCBs.

Lamp types that can be used with a ballast are specified on the label. Only the listed lamps should be used to ensure proper lamp and ballast performance.

High power factor (HPF) means that the power factor of the ballast is greater than 0.9. Power factor is the ratio of input watts delivered at the ballast to the volt-amperes supplied. HPF ballasts use capacitors to synchronize current and voltage cycles. This *power factor correction* determines how much of the energy supplied (volt-amperes) will be converted to actual watts.

A high power factor allows the ballast to use a lower level of line current. Low-power-factor ballasts may require twice the line current of HPF

Continued on page 50

Symbols of quality

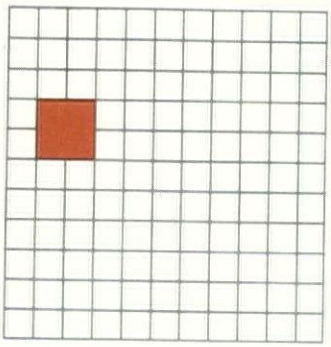
UL. Underwriters Laboratories Inc. is an independent not-for-profit organization that tests devices and materials in the interest of public safety.

ANSI. American National Standards Institute is the U.S. national coordinator of standards and is made up of about 200 trade associations, professional organizations, consumer groups, and manufacturers.

CBM. Certified Ballast Manufacturers produce ballasts to conform with ANSI specifications C82.1, C82.2, and C82.3, which are primarily concerned with the core-and-coil ballast. Their trade association is the Certified Ballast Manufacturers Association.

ETL. ETL Testing Laboratories, Inc., is a private, independent testing organization that is a recognized authority in the measurement of lighting equipment. CBM retains ETL to test member ballasts to ensure that they conform to performance specifications set by ANSI.

The Computer Department



David Lord

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

This is the first of a series of columns on the use of computers in the design of lighting systems. Reviews and comments on recent developments in microcomputer products will be based upon hands-on testing of current software available to lighting designers.

Two major issues in lighting design are quality and quantity, and the microcomputer is useful in solving problems in each of these areas. The lighting design concept must be illustrated and accompanied by calculations, both of which help turn it into reality.

Designers need to determine the amount of illumination received at the work plane and the wattage of a lighting installation. Designers and clients want to know ahead of time the economic and aesthetic effects of using alternate light sources or sources from different manufacturers. Architects and interior designers need to know how the space will appear when lighted as designed, so they can make timely and economical changes if necessary. They will appreciate any tool that brings increased accuracy, ease of computation, and clear graphic representation to this process. The microcomputer offers this potential to every lighting designer.

A new generation of lighting programs for microcomputers is available.

Mainframe computer programs for lighting calculations have been around for many years. These leviathans were useful to the largest lighting and design organizations, but they were expensive, required specialized skills to run, and were available to only a few lighting designers. In the past two or three years, a new generation of lighting programs for microcomputers has become available, some of them based on the earlier mainframe versions.

Expanding Capabilities

Standardized microcomputer hardware, notably the introduction of a virtual IBM standard, played an important part in making the new programs practical. Lighting manufacturers also spurred the development of software by agreeing to an IES standard, computer-readable format for luminaire photometric data. Many manufacturers now make this photometric data available to designers on floppy diskettes.

The range of capabilities of microcomputer hardware and current software packages is quite broad and is expanding at a rapid pace. The IES computer committee compiles, and IES publishes, a list of available computer software programs. Something is there for everyone in almost every price range.

Some lighting analysis software programs are in the public domain, and freely available, but have limited applicability; others are inexpensive, but of limited reliability. Some of the full-blown, user-friendly, comprehensive, and robust microcomputer programs can cost more than $2500.

Each type of software satisfies a need in the world of lighting design. Some of the less expensive programs used for educational purposes can give beginning designers a rough idea of the consequence of some lighting decisions. The more expensive, sophisticated packages are usually reserved for front-line professionals who demand the best possible results.

Although they are free of charge, there is a price to be paid for the public domain programs. Documentation is often poor or unavailable; usually there is no one to call on with questions about the operation of the program. In all cases, ultimate responsibility for the accuracy of the results obtained with any program rests with the designer or the lighting consultant; the software vendor has little or no control over data entry or the many ways it is possible to use the programs.

For instance, very often programs are written for generic room shapes, locations, and window and luminaire sizes. The design of unusual shapes, such as curved walls or arched windows, requires that approximations be made during keyboard entry. The subsequent output, then, is only an approximation of expected conditions.

Those still deciding on hardware will find it worthwhile to know that most lighting programs now available are written for the IBM PC/XT, AT, or look-alike computers. This family of computers seems to be chosen most often by people in the scientific and engineering communities.

Meanwhile, many designers are drawn to the Apple Macintosh, partly for its user-friendly operating system, partly for its attractive high-resolution screen display. It is curious that, in many cases, there seems to be no functional reason to prevent writing lighting analysis programs for the Macintosh. A few energy-related programs are available for the Macintosh, and the list will probably grow.

In addition to a microcomputer and monitor, a dot matrix printer is needed to print out results. The cost for all these components — enough for a lighting designer to get started using simple, dedicated microcomputer programs — can total less than $1000. A small office can keep the same microcomputer system occupied with other tasks, such as word processing and record keeping.

Top of the Line

It is also possible to spend several thousand dollars more and get increased computing capacity, higher speed, and sophisticated output. If saving time is important, then purchasing a math coprocessor chip can speed up computer calculations. These chips sell for about $150 and can be easily installed in your present IBM PC/XT or clone. Unlike many other microcomputer components, however, they have not decreased in price much in the past three years.

A standard 20-megabyte-capacity hard disk is now available for about $350 to $450. A hard disk provides far greater convenience and time savings than the older, double floppy disk system; but most available lighting analysis programs will run on the simpler dual floppy drive computers.

The nature of peripheral equipment, such as printers and plotters, determines the presentation quality of reports. It is possible to begin printing with the simplest dot matrix printers, which cost around $250. The Epson series produces graphics output with

resolution of about 200 dots per inch. Laser printers, costing 10 times that price, produce full-page graphic output with 300-dots-per-inch resolution.

More programs now can take advantage of advanced graphics displays, such as the IBM color graphics adapter or the enhanced graphics adapter card and monitor. Many manufacturers make compatible monitors and cards that can be used for color and graphics displays. As always, it is wise to get advice from both hardware and software vendors and determine compatibility before purchasing a new card for your computer.

Life Cycle Costing

Although the purchase price for some of the most capable lighting software may at first seem high, the time spent learning to use the program can quickly become the overriding cost consideration. There is a lesson in life cycle costing here: saving money on first cost may later lead to paying more in increased operation and maintenance costs — increases that can more than offset any original savings.

Saving money on first cost may lead to paying more for operation and maintenance.

In addition to being more user-friendly, the better lighting analysis programs come from companies with a commitment to support services for their users. Such companies also are committed to responding to user needs by updating their software, developing new modules, and improving their hardware interfaces.

Once a hardware system is put together and a software package is purchased, don't count on using it for the first time to meet an imminent project deadline, no matter how simple the instructions make it appear. A commitment to using microcomputers and sophisticated software may require major reassignment of responsibilities in the design office until staff members gain experience and work the kinks out of the operation. With confidence developed in both the hardware and software, realistic production schedules can be established and maintained.

The many software packages currently available range over a wide spectrum — from those

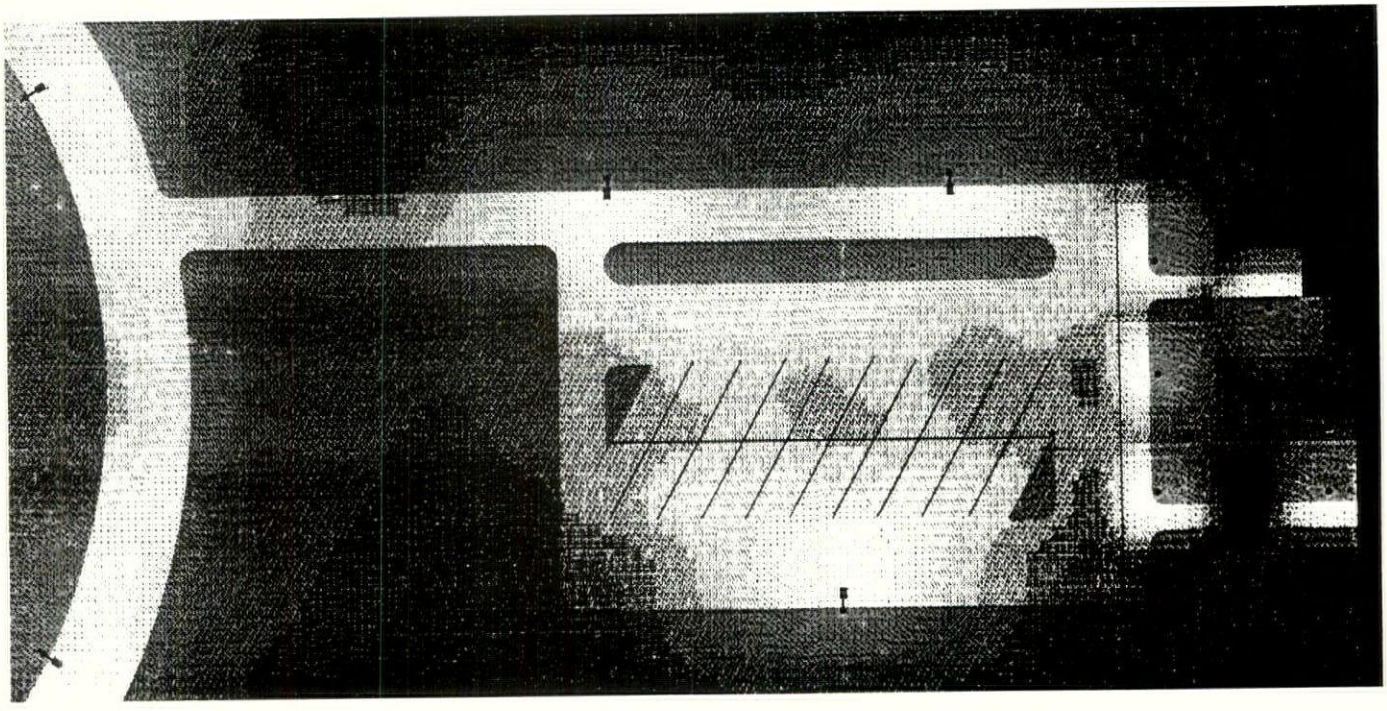
Featured program

Lumen-Point, $995
Line drawing module, $195
Lumen-Point demo package, $60
Lumen-Point CAD (not reviewed), $995

Runs on an IBM PC, PC/XT, AT, or any fully compatible hardware with an 8087 math coprocessor

Requires:
2 diskette drives (or 1 diskette drive and a hard disk)
Expanded memory (256K with DOS 2.1, 320K with DOS 3.0)
80-column monitor
Epson dot matrix printer (or look-alike)

Lighting Technologies
3060 Walnut Street
Boulder, CO 80301
(303) 449-5791



Computer-generated graphic shading and masking, used in conjunction with site plan overlays, provide a clear illustration of outdoor lighting effects, as demonstrated here for a parking lot and its driveway.

Grid Number 1: parking area

Quantity Calculated: HORIZONTAL ILLUMINANCE IN FOOTCANDLES
Scale: 1 INCH = 40.0 FEET Grid Height: .0 ft

Grid Statistics:

Average:	1.94	Max/Min:	8.40
Maximum:	3.87	Max/Ave:	2.00
Minimum:	.46	Ave/Min:	4.21
Mean Deviation:	.72		
Number of Points:	113		

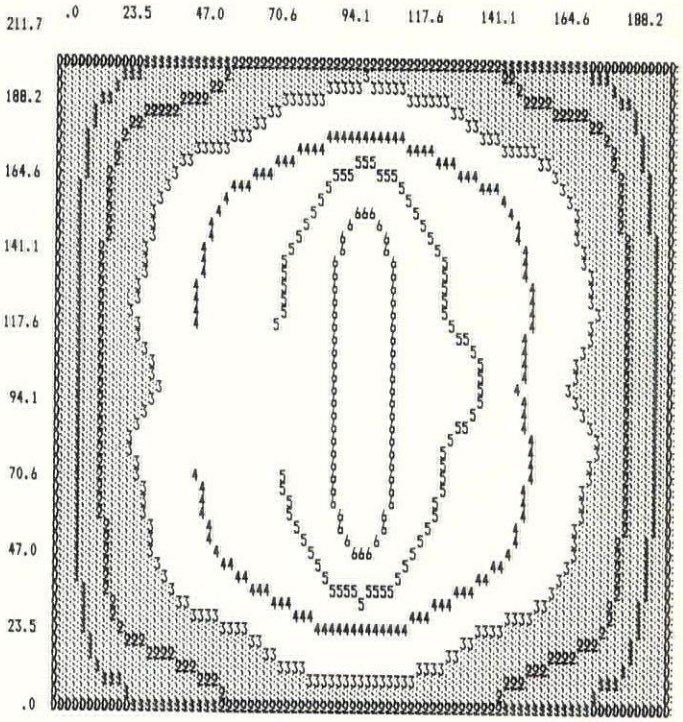
Axes Labeled in Global Coordinates

Y-Axis											
200.0	+	+	+	+	+	+	+	+	+	+	+
	.46	.90	1.15	1.59	1.80	1.92	1.80	1.59	1.15	.90	.46
180.0	+	+	+	+	+	+	+	+	+	+	+
	.62	1.47	1.78	1.97	2.34	2.48	2.34	1.97	1.78	1.47	.62
160.0	+	+	+	+	+	+	+	+	+	+	+
	.79	1.69	2.14	2.58	2.86	3.40	2.86	2.58	2.14	1.69	.79
140.0	+	+	+	+	+	+	+	+	+	+	+
	.86	1.76	2.33	2.83	3.08	3.79	3.08	2.83	2.33	1.76	.86
120.0	+	+	+		+	+	+	+	+	+	+
	.82	1.89	2.41		3.12	3.87	3.12	2.85	2.41	1.89	.82
100.0	+	+				+	+	+	+	+	+
	.88	1.74				3.63	3.37	3.00	2.20	1.74	.88
80.0	+	+				+	+	+	+	+	+
	.82	1.89				3.87	3.12	2.85	2.41	1.89	.82
60.0	+	+	+		+	+	+	+	+	+	+
	.86	1.76	2.33		3.08	3.79	3.08	2.83	2.33	1.76	.86
40.0	+	+	+	+	+	+	+	+	+	+	+
	.79	1.69	2.14	2.58	2.86	3.40	2.86	2.58	2.14	1.69	.79
20.0	+	+	+	+	+	+	+	+	+	+	+
	.62	1.47	1.78	1.97	2.34	2.48	2.34	1.97	1.78	1.47	.62
.0	+	+	+	+	+	+	+	+	+	+	+
	.46	.90	1.15	1.59	1.80	1.92	1.80	1.59	1.15	.90	.46

	.0		40.0		80.0		120.0		160.0		200.0
		20.0		60.0		100.0		140.0		180.0	

X-Axis

AXES LABELED IN GLOBAL COORDINATES



Dot matrix printout from a Lumen-Point calculation for a 200-foot by 200-foot parking lot. Left: horizontal illuminance in footcandles, printed to scale with various grid statistics. Right: horizontal lumens per unit area; criteria: less than 3, shaded; greater than 3, clear.

that provide early assistance in understanding simple daylighting and electrical lighting concepts to those that provide accurate calculations and highly specific images of the final lighting design. One outdoor lighting analysis program is Lumen-Point, from Lighting Technologies in Boulder, Colorado. Lumen-Point is one of three major programs that company has developed, and it is used to predict the performance of roadway, parking lot, or sports lighting. With it, it is also possible to make visual and technical comparisons of floodlighting or general area lighting systems.

Using Lumen-Point

One of the values of Lumen-Point is the hours of time savings its user-friendly data entry system offers. An on-line help system is useful for those who have not studied the manual and for very inexperienced or first-time users. I found it fairly easy to understand the way the program works by knowing only the specialized use of the function keys. I kept a copy of the function key layout at the side of the keyboard for the first few hours.

In a concentrated three-hour period, I was able to start from the beginning and work through the comprehensive example in the manual. I then generated a picture of the lighting results on an Epson RX 80 dot matrix printer, using the program's line drawing module, which is a separate enhancement. Obtaining these results assumes that the user is already familiar with lighting fundamentals and with the IBM PC disk operating system.

Lumen-Point begins by building a worksheet that can be saved and used again, so that the same information need be input only once. This is what makes the program interesting to me. Because repetitive keyboard entries are reduced, the computer does what it's supposed to do: it eliminates the tedium.

It is possible to compare several lighting alternatives in relatively short order. Lumen-Point is capable of considerable sophistication, and the user will probably continue to find new ways to apply its power. For instance, the lamps selected for the calculation may be tilted, rotated, and positioned to find the optimal combination for the best lighting solution. This is achieved during data entry, with a separate run necessary for each configuration.

Vertical illuminance at any point in the design can be determined, as well as "TV illuminance," which is the illumination on any plane perpendicular to the line-of-sight of a television camera. The position of the TV camera is specified in XYZ coordinates.

The software comes on three diskettes with the optional line drawing module on a fourth. The program is copy protected by means of a specially encoded first diskette, which must be kept in the A drive at all times. Should anything happen to this diskette, it is possible to make a

second, emergency, diskette using the accompanying instructions. The damaged diskette must be sent to Lighting Technologies for a replacement.

Inadvertently, while working through one of the examples provided, I made an incorrect data entry without detecting it. A few moments later, during the calculation routine, the program demonstrated its power. An error message flashed on the screen; the mistake was quickly identified and easily corrected. Error trapping is a significant feature of this program; all errors are listed and saved in a separate file if desired.

The graphic output possible from a dot matrix printer offers the real excitement of the program. The printout makes use of several overlaying dot densities, creating a shaded isocontour aerial map of the site lighting scheme. The contour plot contains symbols printed along lines of equal illuminance; each symbol corresponds to a particular illuminance value. These values are either entered by the user or determined by the program. If no values are input by the user, the program selects 15 evenly spaced contour values to use in constructing the plot. If the plot is wider than a single width of paper, it is divided automatically into sections, which may then be pieced together for a complete plot.

As with most programs to be reviewed here, Lumen-Point's merits will be appreciated most by those who have derived the same results from several hours of hand calculation. I can't help but wonder if only the older generation will fully understand and value this new technology. Recent college graduates have grown up with digital electronics and, having done so, may take its performance for granted.

Future issues will contain reviews of other software modules from Lighting Technologies — including Lumen$, which projects lighting costs, and Lumen-Micro, a comprehensive interior lighting analysis program with three-dimensional perspective graphics. Other programs already received for review are: Micro-Lite and Solar5, which are inexpensive public domain lighting and energy analysis programs; a recent release of Daylite (version 2.0) and Sunpas (version 4.02) from Solarsoft; and DynaPerspective, a 3-D solid modeling, design, and presentation package on three diskettes, from Dynaware. Also being tested is the Simplified Calculation Method, with its daylighting calculation module, from the California Energy Commission.

I would like to hear from readers who have experience with or know of useful programs or who have written their own programs and would like to share them with others. ■

Continued from page 46

ballasts; they require a heavier wire and allow fewer fixtures to be installed on a circuit. Some utilities charge a penalty when the power factor of a building drops below 0.9 because of the increased current required.

Sound ratings are assigned by manufacturers. Indoor ballasts are typically sound rated from A to D. Usually, the larger the ballast, the higher (further along in the alphabet) the sound rating. A typical ballast for F40 lamps is rated A, a ballast for 800-milliampere lamps is rated B or C, one for slimlines is rated B or C, and one for 1500-milliampere lamps is rated D.

All ballasts hum because of the vibration caused by expansion and contraction of the magnetic field in the laminated core. The basic electrical cycle hum of a 60-hertz supply, a 120-hertz humming vibration, may also be audible, but the potting compound that fills the case of core-and-coil ballasts often muffles the hum to some degree. In aging ballasts, where heat has softened the potting compound, vibration of the laminated core occasionally causes a loud buzz.

Fixture noise is usually a greater problem than ballast hum. In a two-by-four fixture, the ballast is mounted to the fixture housing, which may amplify the case vibration like a radio speaker.

RFI and PCBs

Radio-frequency interference (RFI) is seldom a problem with 60-hertz line-frequency ballasts. Although poor lamp contact or some other form of discharge can cause static, the ballast will suppress the conduction of radio frequency into the power system. In hospitals and in computer and communications rooms, it may be advisable to anticipate problems by specifying radio interference suppression filters for fluorescent fixtures. High-frequency ballasts, in which the problem of RFI is accentuated, have RFI filters built in.

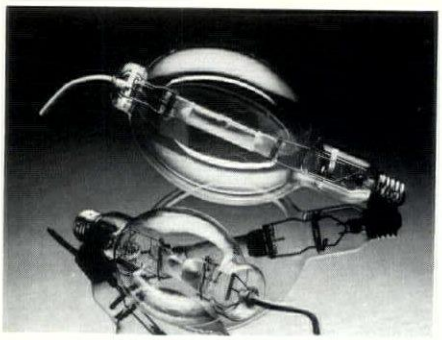
PCBs (polychlorinated biphenyls) belong to a chemical family known as chlorinated hydrocarbons. One or more chlorine atoms are combined with a biphenyl molecule to produce a substance with a consistency ranging from a heavy, oily liquid to a waxy solid.

Because of their cooling properties and because they do not easily burn or conduct electricity, PCBs have been used in electrical equipment, including transformers and capacitors. This includes the capacitor in ballasts found in fluorescent fixtures. The EPA banned the manufacture of PCBs in 1978 because of the strong possibility that they are carcinogenic.

When a ballast ages or fails, it generates excessive heat that may cause the capacitor to break open and allow 1 to 1 1/2 ounces of PCB oil to drip out. Exposure to much less than this amount is extremely dangerous to human health.

Any ballast that lacks the Class P mark lacks thermal protection, was probably manufactured before 1968, and therefore may contain PCBs. These ballasts should be replaced to ensure better lamp performance and reduce the risk of personal injury liability. Recently manufactured ballasts that contain no PCBs state "No PCBs" on the ballast label. ■

Product Showcase

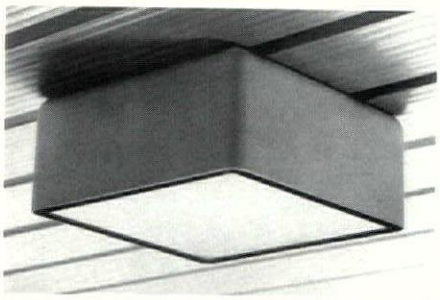


■ Instant restart metal halides

With the use of a suitable fixture and power supply, Venture's new line of metal halide lamps can be instantaneously relit. The light output after reignition is determined by the amount of time that the lamps have been off, but if they are relit within 15 seconds, the light level is 90 percent of the full output, according to the manufacturer. By contrast, standard metal halide lamps require 10 to 15 minutes to restart after power interruptions.

The lamps have a standard mogul base and an external wire lead at the dome end to allow for a high voltage restrike capability. An optional termination at the dome end is also available. Lamps of 175, 250, 400, and 1000 wattages are available in two burn positions: universal or base-up plus or minus 15 degrees. The 1500-watt lamp has a base-up burn position of plus or minus 75 degrees. These lamps are suitable for sports and industrial lighting applications. Venture Lighting International, Cleveland, OH.

Circle 60



■ Canopy light

A canopy light from Ruud Lighting features a die-cast aluminum housing with curved corners and a recessed die-cast aluminum doorframe that fits within the housing for improved sealing, vandal resistance, and appearance. The canopy light comes with preinstalled capacitor, igniter (for high pressure sodium), and multitap high power factor ballast.

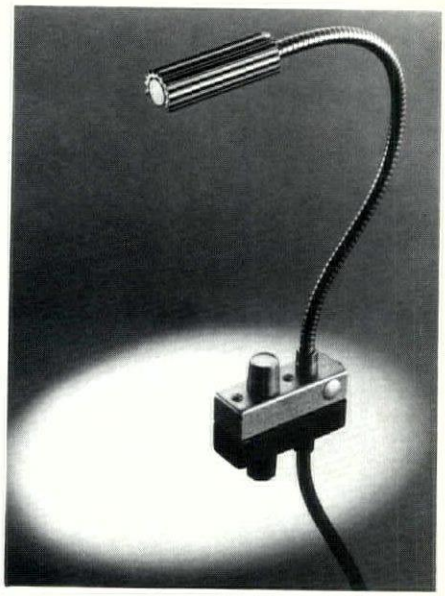
UL listed for wet locations, the luminaire has a standard finish of durable white paint. It is available in a variety of wattages for high pressure sodium, metal halide, and mercury vapor lamps. A 480-volt high power factor ballast is also available. The manufacturer notes that the luminaire's 1 to 1.5 ratio of spacing to mounting height makes it suitable for service stations, gymnasiums, indoor swimming pools, multipurpose rooms, overhangs, and drive-up tellers. Ruud Lighting, Inc., Racine, WI.

Circle 61

■ Outdoor luminaires

A new line of outdoor luminaires from the Snoc division of Manville Canada is made of cast aluminum with a choice of black, blue, or green finishes. The line's versatility is demonstrated by the fact that the twin-post top (bottom right) is actually two wall brackets (upper left) installed back-to-back. The diffusers are available in standard opal white acrylic or optional opal white polycarbonate. A socket for a 9-watt compact fluorescent lamp is available. Division Snoc, Manville Canada Inc., St. Hyacinthe, Quebec, Canada.

Circle 62

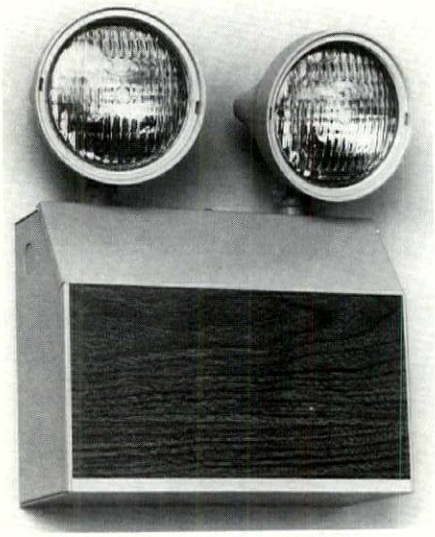


■ High-intensity gooseneck lamps

CAE offers the Littlite high-intensity gooseneck lamp, originally designed for professional sound and lighting consoles. The lamp has a black matte finish and a flexible neck in a choice of 6-, 12-, and 18-inch lengths. Pictured here is the L-3 featuring a permanently attached gooseneck with a high-intensity tungsten-halogen lamp in a finned-style hood. Another model has a detachable gooseneck with a swivel connector at the base and storage clips for the gooseneck. Incandescent versions of both models are also available.

All models come complete with tungsten-halogen lamp, mounting base, fully adjustable dimmer, 6-foot cord, a two-piece snap mount, screws for permanent mounting, and a wall plug-in transformer for 120-volt operation. A version without the transformer can be powered by any 12-volt supply. The Littlites are suitable for home or office applications as desk or table lamps. Various accessories are also available. CAE, Inc., Hamburg, MI.

Circle 63



■ Emergency light

Holophane has introduced 12-volt automatic emergency lights that accommodate up to three lamp heads and can operate for 90 minutes. The emergency lights feature sealed and rechargeable 6-volt, lead acid batteries that require no water. They are automatically kept at optimum charge levels by an integrated circuit charger. Assembled battery leads have a quick disconnect feature for easy maintenance.

Available in a variety of wattages and lighting distributions, the PAR 36 sealed-beam lamps mount in polycarbonate housings that are fully adjustable both vertically and horizontally. Lamp heads, which are factory mounted to the 18-gauge steel housing, aid on-site installation.

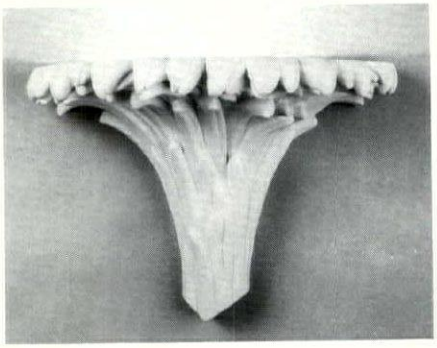
The fixture's controls include a light emitting diode that indicates whether the unit is operational and a test switch to simulate a power failure. The emergency light will operate for at least 90 minutes, as required by UL924, NEC, NFPA 101 Life Safety Code, and OSHA. Available in two models, the EI-10 with 72-watt capacity and the EI-12 with 36-watt capacity, the emergency lights are recommended for industrial corridors, stairwells, exits, and large open areas. Holophane, Newark, OH.

Circle 64

■ Commercial interior lighting

RWL Corporation has added the MA series, a collection of chandeliers for commercial applications, to its Odyssey Illumination line of contemporary interior lighting. The new fixtures are manufactured of aluminum in diameters of 20, 30, and 40 inches. Both rod supports and chain mountings are available. One-piece lenses of molded white acrylic diffuse the light of incandescent or high intensity discharge lamps. The manufacturer provides samples of finishes on request. RWL Corporation, New Haven, CT.

Circle 65



■ Wall sconce

The G6001 wall sconce is part of the Baroque Collection from Gross Chandelier. Made of fiber glass–reinforced resin, the UL-listed sconce measures 16 inches wide and 10 1/2 inches high with a 9-inch extension. It accommodates one 100-watt incandescent lamp. Also available is a 24-inch-wide version of the same design. Gross Chandelier Company, St. Louis, MO.

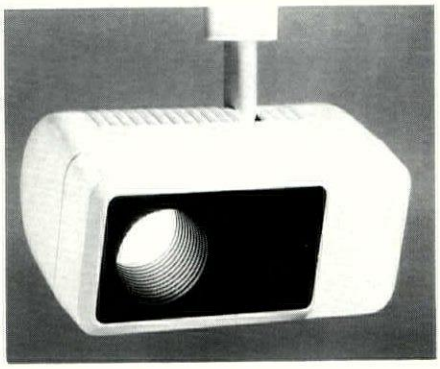
Circle 66

■ Lanterns

The Carriageway series from Lightway Industries features die-cast aluminum lanterns in two sizes. The post-top lantern measures 22 5/8 inches tall and 12 inches wide. It accommodates a 13- or 26-watt fluorescent lamp or a high pressure sodium lamp of 35, 50, or 70 watts. The miniature wall-mount lantern measures 16 1/8 inches high and 7 inches wide from wall to outside edge. It is available for 5-, 7-, or 9-watt fluorescent lamps.

Both lanterns come with a standard black finish and acrylic diffusers. The post-top model has a diffuser in a clear Flemish design. The miniature wall-mount lantern has a clear prismatic diffuser. Custom finishes and diffuser colors are options for both models. Lightway Industries, Valencia, CA.

Circle 67



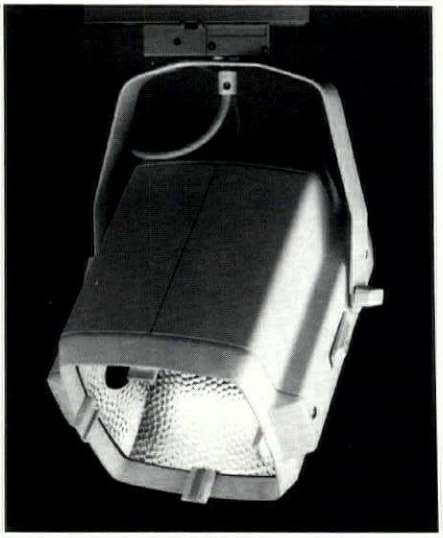
■ Low-voltage track lamp holder

The L1770 micro lamp holder from Halo Lighting incorporates a deeply recessed

75-watt MR16 lamp. Created with an integral 75-watt transformer, the lamp holder works with a variety of 12-volt MR16 lamps, ranging from 42 watts to 75 watts. The unit measures 4 1/8 inches long by 2 7/8 inches high and snaps easily into any standard Halo Power-Trac.

The L1770 accommodates color filters and accepts a choice of spread and soft focus lenses, which permit greater flexibility in lighting applications. Engineered to rotate 358 degrees and to adjust up to 90 degrees from horizontal, the lamp holder's deeply recessed design ensures freedom from glare and maximum visual cutoff. The fixture comes in white or black with MR16 lamps in a variety of available beam spreads. Halo Lighting, Elk Grove Village, IL.

Circle 68

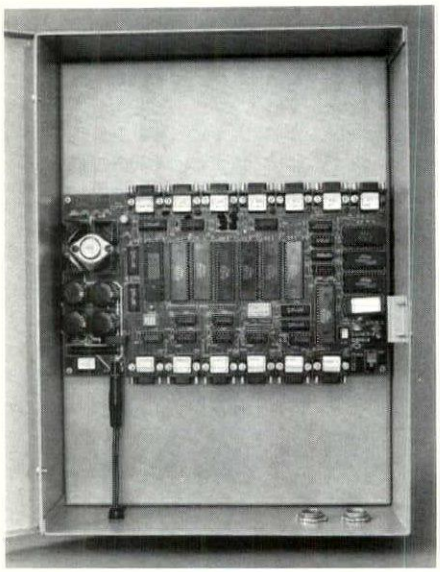


■ Metal halide display lighting

Amerlux offers a display lighting system for 70- and 150-watt double-ended metal halide lamps. The fixture has a focusing reflector of anodized specular aluminum that adjusts for flood- or spotlighting. Housing components are of die-cast and extruded aluminum. All fixtures are equipped with ultraviolet inhibiting coated glass.

One model has an adapter for mounting to one- or three-circuit tracks. A surface-mount version has a canopy for installation on ceilings or walls. Both models have stirrups for swivel adjustment. The fixtures are available in matte black and matte white finishes. Amerlux, West Caldwell, NJ.

Circle 69



■ Building control system component

PowerLine Communications has introduced the PCT 64, which allows existing building control systems to use the company's carrier control technology. The PCT 64 takes digital inputs from an existing control system and transmits the data over a building's electrical wiring to the company's PRS receiver switch. The product makes it possible to add additional lighting and HVAC control points to an existing energy management or building control system.

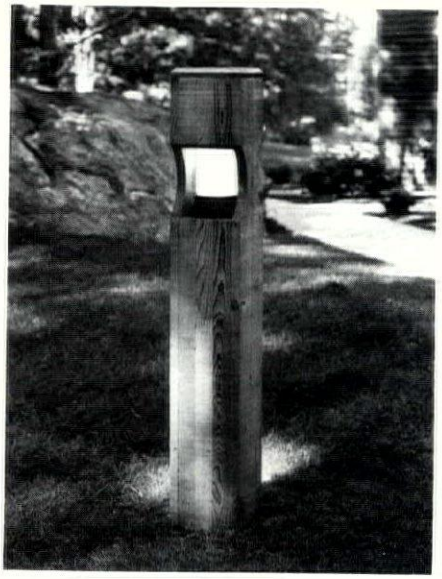
The PCT 64 needs no external contactor to control more than 1000 loads with a switching capability of up to 20 amperes, according to the manufacturer. A heavy-duty 30-ampere receiver switch is also available. PowerLine Communications Inc., Williston, VT.

Circle 70

■ Harsh environment fluorescent

Electro Elf's expanded product line includes a waterproof fluorescent fixture for harsh environments. Its all-polycarbonate construction resists corrosion, making it suitable for applications where insecticides, pesticides, disinfectants, or other chemicals are sprayed. The fixture is available with a lamp thread base and a ½-inch NPT or PVC Condulet mounting. The fixture can accommodate 7- or 9-watt fluorescent lamps. The manufacturer recommends it for applications such as poultry and egg production areas, plant and flower production areas, dairy barns, and equine foaling areas. Electro Elf, Temple City, CA.

Circle 71



■ Cedar bollard

The Pondcliff lighted bollard is a cost-effective alternative to Ryther-Purdy's other bollards, according to the company. Made of kiln-dried, laminated Western red cedar, which contains natural preservative oils, the bollard has a clear, natural finish that weathers to silver-gray. It has a standard mounting height of 42 inches above grade and is available for direct burial-post mounting or optional pedestal mounting. Other heights and finishes are available. The bollard is recommended for paths and walkways, patios, and other low-level lighting applications. It accommodates 60-watt and lower incandescent sources and 9-watt fluorescent sources. Ryther-Purdy Lumber Company, Inc., Old Saybrook, CT.

Circle 72

■ Cast-iron lamppost

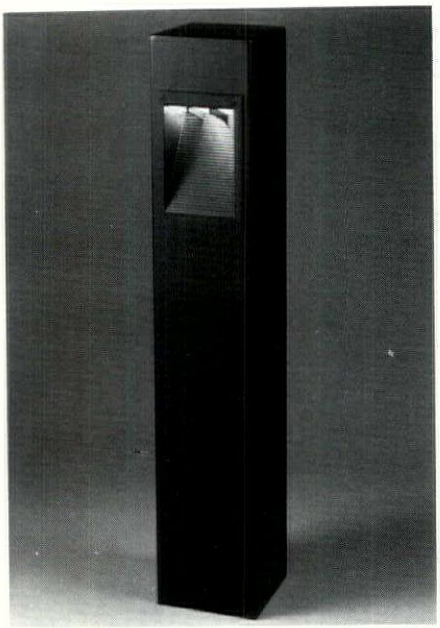
Spring City Electrical Manufacturing produces historically accurate cast-iron lampposts. Included in the collection is the Independence post, which is 7 feet 3 inches high and has a 5 1/2-inch octagonal base. Custom colors are available. Spring City Electrical Manufacturing Company, Spring City, PA.

Circle 73

■ Metal halide ballast

The new 71A5880 ballast for 250-watt double-ended metal halide lamps is the latest addition to Advance Transformer's line of ballasts for Osram HQI and Venture Pro-Arc lamps. Like other ballasts in the same line, the new ballast features a 120/277 dual-voltage input and incorporates high-reactance, high power factor circuits. Ballast components include a long-life igniter for lamp start-up. Where high power factor operation is required, a capacitor is also available. Advance Transformer Co., Chicago, IL.

Circle 74



■ Directional beam bollard

The Castellan illuminated bollard series from Guth Lighting includes square directional beam bollards for locations where spill light is undesirable. The directional beam bollards feature directional downlight louvers and reflectors for precise illumination control in three orientations: single lamp, 90-degree double lamp, and 180-degree double lamp.

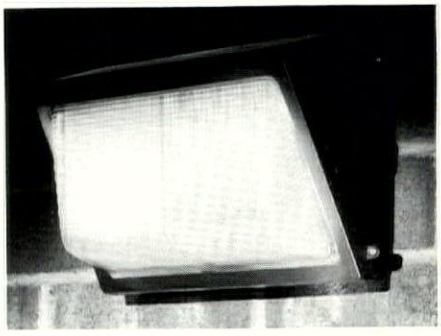
The single-piece cast aluminum housing has a double-baked acrylic enamel finish that resists fading, abrasion, and corrosion. All electrical and optical systems are mounted on a lift-out tray for easy relamping and maintenance. Available in bronze, black, and custom colors, the directional beam bollards come in heights from 36 to 48 inches. They accommodate high pressure sodium, metal halide, and mercury vapor lamps in wattages from 35 to 100. Guth Lighting, St. Louis, MO.

Circle 75

■ Reflective aluminum sheet

Alcoa has introduced Everbrite, a bright dipped and anodized aluminum sheet for use in retrofitting fluorescent luminaires with specular reflectors. The highly reflective aluminum sheet has an image clarity exceeding 90 percent, as demonstrated by the reflection of the crystal bell in the photograph. The aluminum sheet resists burning and corrosion, according to the manufacturer. Everbrite is available with or without a protective film, in coils or sheets, in widths up to 48 inches, and in thicknesses of .020, .025, and .032 inch. Alcoa, Davenport, IA.

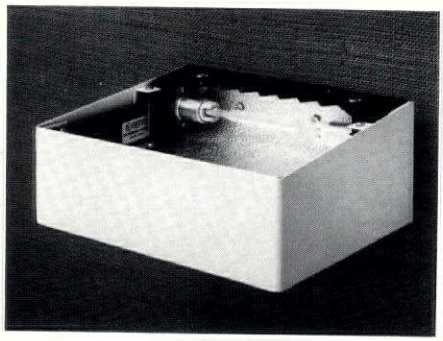
Circle 76



■ Wall washer

WPC wall washers are the latest additions to the Deluxe Wall-Lite I collection from Regent Lighting. The new luminaires feature polycarbonate lenses and side-hinged doors, which makes them suitable for demanding industrial and commercial applications. They are available with either 120-volt or 277-volt ballasts for medium-base high pressure sodium lamps in 70-, 100-, and 150-watt sizes. Regent Lighting Corporation, Burlington, NC.

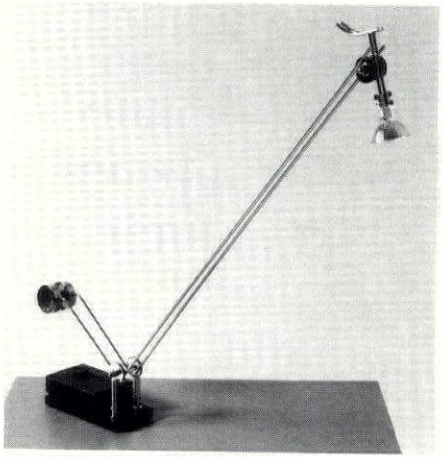
Circle 77



■ Compact indirect luminaire

A compact tungsten-halogen indirect luminaire from Lighting Techniques features an adjustable reflector system that allows users to align projected light cutoff with architectural details such as moldings and intersections of ceilings and walls. A sliding baffle above the lamp minimizes hot spots on the wall. The luminaire accommodates 300- and 500-watt tungsten-halogen lamps. Lighting Techniques, Paramus, NJ.

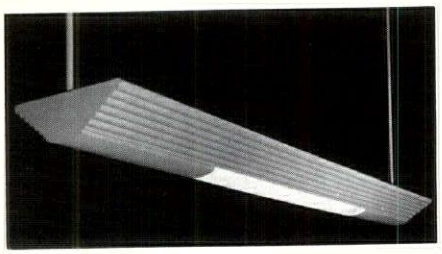
Circle 78



■ Designer desk, table lamp

Gallet di Vivie received the 1986 Silver Lamp award from French Artistic Création for his Italique desk and table lamp, which is distributed in the United States by Performance International. The lamp has a black pedestal with a built-in dimmer switch. Its 23½-inch-long chrome arm supports a 50-watt MR16 lamp. Performance International, Inc., Fort Lauderdale, FL.

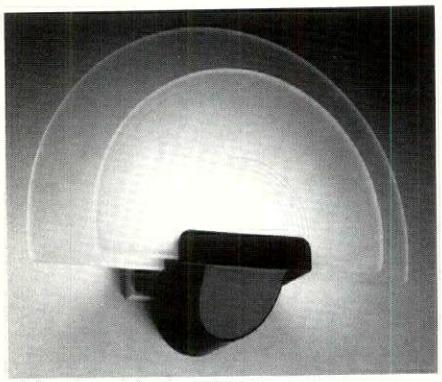
Circle 79



■ Direct, indirect lighting

Architectural Lighting Systems' luminaire, designed by Robert Sonneman, offers both lensed downlighting and ambient uplighting. Two basic configurations provide for either indirect illumination or a combination of direct and indirect illumination. The fixture is available in a wide range of colors with custom color matching as an option. Architectural Lighting Systems Inc., Tauton, MA.

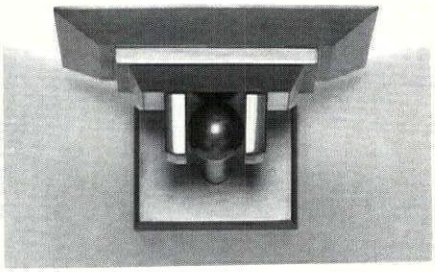
Circle 80



■ Wall sconce

Italian architect Ezio Didone designed the Diva wall sconce for Atelier International Lighting. Two semicircular glass diffusers attach to the luminaire's cast aluminum body. Available in white or rose, the front panel of frosted, patterned glass measures 9 3/8 inches in diameter. The white textured rear glass panel measures 12 1/2 inches in diameter. A textured white enamel backplate reflects light to the rear. Diffused light passes through the front and around the two frosted glass panels. The UL-listed wall sconce uses a single 100-watt incandescent lamp. Atelier International Lighting, Long Island City, NY.

Circle 81



■ Wall bracket

Boyd Lighting has introduced the Prometheus wall bracket, designed by architect Eric Stanton Chan. Sand-cast in brass or bronze with sharp, beveled definition, the wall bracket is hand-finished in polished brass, polished bronze, or sand-etched bronze. Its asymmetrical reflector and heat-resistant glass shield direct the light of a 300-watt tungsten halogen lamp. The wall bracket measures 5 1/8 inches high and 10 7/8 inches wide and projects 10 inches from the wall. Its outlet box mounting is fastener-free. Boyd Lighting Company, San Francisco, CA.

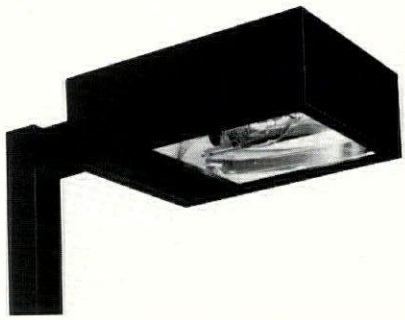
Circle 82

■ Edge-lit exit signs

The DEE Series AC edge-lit exit signs from York-Lite feature a polished-edge 3/16-inch-thick Plexiglas panel with engraved letters and directional arrow and a beveled, brushed stainless steel faceplate. In accordance with UL and NFPA-101 life safety standards, the panel has 6-inch-high letters and 3/4-inch letter spacing. The sign's welded 20-gauge recessed back box has a white enamel finish and an end knockout.

Red lettering on a white background is standard; other choices are red, green, and clear backgrounds and green or white lettering. The sign may be single- or double-faced; arrow directions are right, left, or double. Power options are 120- or 277-volt input and DC. York-Lite Electronics, Inc., Austin, TX.

Circle 83



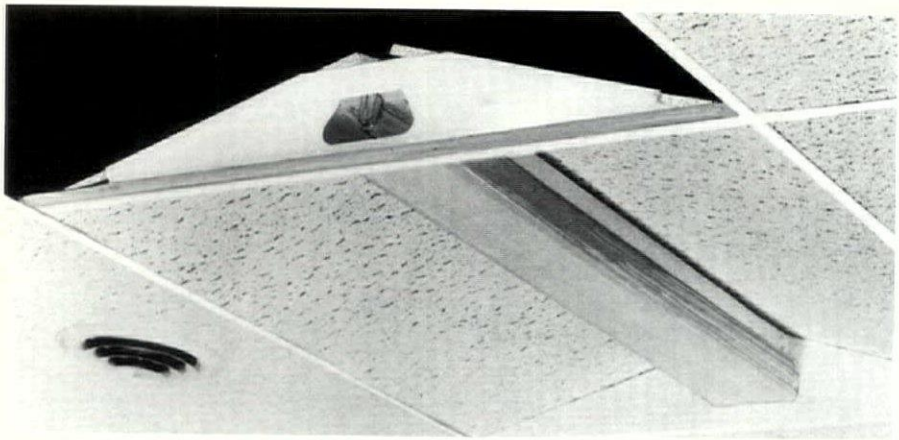
■ Outdoor luminaires

LSI's Citation outdoor luminaires with a one-piece aluminum housing have welded corners for increased strength, sharp appearance, and weather-tight construction. Designed for high pressure sodium, super metal halide, metal halide, or deluxe mercury vapor lamps, the unit features a baked-on powder coating, a porcelain lamp socket with spring-reinforced contacts, and a high power factor ballast for operation down to minus 20 degrees Fahrenheit. Two reflector styles are available: a standard Type III for medium light distribution and an optional forward throw for perimeter lighting.

The Citation series is available in three sizes. The smallest model accommodates lamps ranging from 50 to 175 watts and features a clear flat tempered glass lens. The medium model accommodates 250- and 400-watt lamps and has three lens options — clear flat tempered glass, clear sag tempered glass, and clear dropped acrylic. The largest model is for 1000-watt lamps and comes with either the clear flat or the clear sag tempered glass lens.

UL-listed for wet locations, the luminaires have square poles of steel or aluminum in 4-, 5-, and 6-inch diameters and four bracket mounting configurations. Pole heights range from 8 to 39 feet for steel and 8 to 30 feet for aluminum. Lighting Systems Inc., Cincinnati, OH.

Circle 84

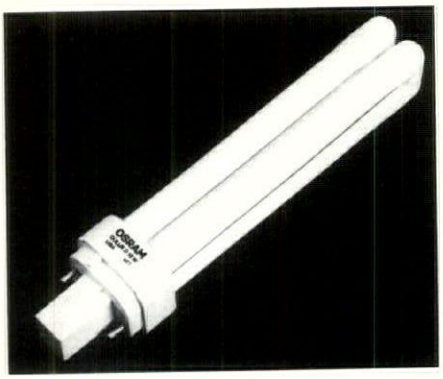


■ Vaulted ceiling fluorescent

The series VS4 vaulted fluorescent ceiling unit from H.E. Williams allows designers to create a coffered ceiling effect. The 4-foot-square unit is designed for use with a NEMA type G ceiling system that has maximum cross-T dimensions of 1 inch wide by 1 1/2 inches high. Installers can remove the cross-T between two standard 2-foot by 4-foot ceiling tiles and insert the recessed fixture without cutting any tiles. End supports of cold-rolled steel hold the luminaire and ceiling tiles in place at a depth of 6 1/4 inches so that the unit mounts cleanly into existing ceiling systems.

The unit features a white baked-enamel finish and an extruded clear acrylic lens with a prismatic pattern on sides and bottom. The unit accommodates one to four fluorescent lamps. A factory-ordered air-return option is available; it elevates tiles 5/16 inch to create a negative static pressure plenum for HVAC systems. The vaulted ceiling unit is suitable for institutions or schools and meets state specifications for schools in Florida and other southern states. H.E. Williams, Inc., Carthage, MO.

Circle 85



■ Compact fluorescent lamp

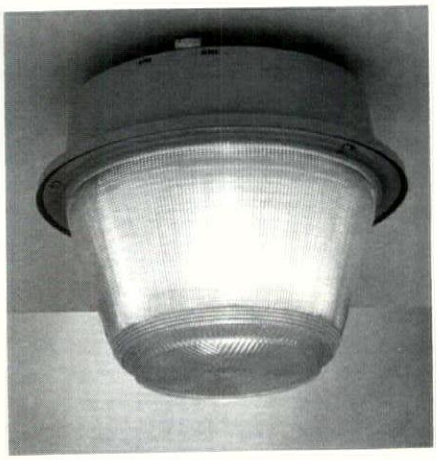
The Dulux D is part of Osram's line of double twin-tube compact fluorescent lamps. Its curved-tube design radiates light evenly in all directions. The lamp has a rated life of up to 10,000 hours and a color temperature of 2700K to emit incandescent-like light, according to the manufacturer. In its base, the Dulux D has a built-in starter and a capacitor that suppresses radio-frequency interference. Available in 10-, 13-, 18-, and 26-watt versions, the lamp is recommended for recessed downlights, track lights, table lamps, and pendant and wall lamps. Osram Corporation, Newburgh, NY.

Circle 86

■ Directional lamp

The Primo 5200 high-beam 12-volt halogen fixture from Norbert Belfer lights areas that require large pools or tight beams of illumination. Available in matte black and matte white finishes, the fixture adapts to a variety of mounting arrangements, including the company's model 2500 raceway. The unit comes supplied with an Osram PAR 36 metal reflector halogen lamp and requires a remote 12-volt transformer. Norbert Belfer Lighting, Ocean, NJ.

Circle 87



■ Shallow HID luminaire

The Ultralight Series 4100 high intensity discharge luminaire from Globe Illumination is designed for medium or low bay mounting heights. The shallow luminaire has a gray aluminum housing, white aluminum reflector, galvanized or zinc-plated steel hardware, a medium-base porcelain lamp socket, and closed-cell type gaskets.

The refractor features a miniprism optical system of acrylic polymer or impact-resistant, ultraviolet-stabilized polycarbonate. Installation requires no disassembly because the fixture is factory-lamped and prewired. The luminaire's design permits quick mounting and wiring on 4-inch-square or octagonal outlet boxes. Pendant mounting is possible if an outlet box is installed on the conduit.

The Ultralite Series 4100 luminaire measures 11½ inches high and 14¼ inches in diameter. It is available for 70-, 100-, and 150-watt high pressure sodium lamps and in voltages of 120 or 277. UL listed for damp locations, the luminaire is suitable for indoor and semiexposed areas, such as parking garages, loading docks, warehouses, and stairwells. Globe Illumination Company, Gardena, CA.

Circle 88

■ Wooden ceiling louvers

The NWL wood louver ceiling system from Norton Industries is available in a variety of hardwoods, including red oak, walnut, cherry, and mahogany. Louver modules range in size from 2 feet square to 4 feet square, with cells in sizes up to 6 inches square. The company offers a choice of standard T-bar suspension or a new nonmodular system. Norton Industries, Cleveland, OH.

Circle 89

■ Status monitor

Sentry-Lite's emergency-light status monitor senses low batteries, disconnected batteries, lamp failures, and transfer failures in such critical lighting units as emergency exit signs. Every 15 seconds, the Sentry-Cycle's integrated circuits automatically monitor all critical functions and display the results. Sentry-Lite, Rockville Centre, NY.

Circle 90

■ Low-voltage lighting

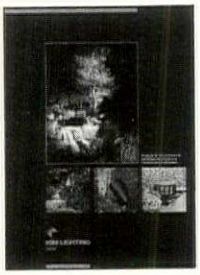
The Ray System from Light Solutions is a low-voltage system that features a fixture with interchangeable barrels. With the various barrels, the fixture can function as a spotlight, floodlight, projector, wall washer, or fiber-optic illuminator.

The body of the fixture has three components — a front barrel, a midbody, and a swivel mount — each of which is available in several interchangeable designs. The fixture accommodates a 20-watt, 12-volt MR11 tungsten halogen lamp with a double contact base in spot, medium, or flood beam patterns.

Compatible with most track systems, the Ray System can also be mounted on T-bar ceilings, canopies, or ledges. The fixture is made from hardened solid aluminum bars and has a clear anodized outer finish. Custom finishes are available on request. Other components include transformers, a power strip, a color filter pack, and a dimmer. The Ray System is suitable for a variety of applications, including theaters, restaurants, museums, stores, and residences. Light Solutions, Inc., Los Angeles, CA. ■

Circle 91

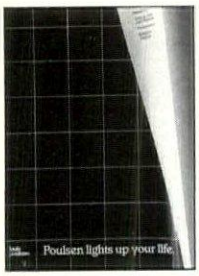
Product Literature



■ Landscape lighting

Kim's 26-page landscape lighting catalog features spread lights, path or border lights, accent lights, and minifloods. Color photographs and photometric charts accompany descriptions and specifications for each fixture. Kim Lighting, City of Industry, CA.

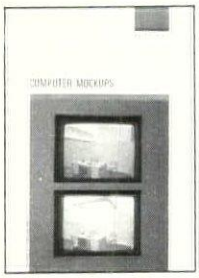
Circle 120



■ Designer lighting

An 84-page catalog features Poulsen's line of indoor and outdoor luminaires. For each fixture, the catalog includes the designer's name, technical data, and color photographs of representative applications. Poulsen Lighting Inc., Miami, FL.

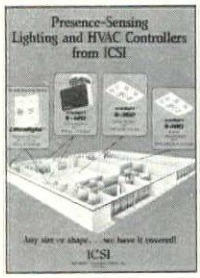
Circle 121



■ Computer mock-ups

The Peerless Lighting Prediction Program offers designers computer mock-ups of lighting system options. A brochure features color photographs of typical mock-ups, an explanation of the process, and a request form. Peerless Lighting Corporation, Berkeley, CA.

Circle 122



■ Lighting, HVAC controls

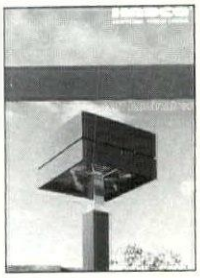
A brochure from ICSI profiles four presence-sensing lighting and HVAC controllers. The brochure shows typical coverage patterns, lists specifications, and explains motion-sensitivity adjustments. International Conservation Systems, Inc., Austin, TX.

Circle 123

■ Energy-efficient floodlights

Philips offers a brochure on low pressure sodium, high pressure sodium, and quartz halogen floodlights. It includes tables on footcandle selections, lighting levels, and cost savings. North American Philips Lighting Corporation, Hightstown, NJ.

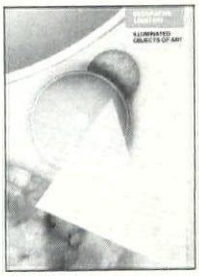
Circle 124



■ Sharp-cutoff luminaires

Polyquad sharp-cutoff luminaires offer symmetrical, asymmetrical, and wide flood distribution patterns. A 12-page brochure details the luminaires and provides ordering information. Hadco, Littlestown, PA.

Circle 125



■ Alabaster, glass fixtures

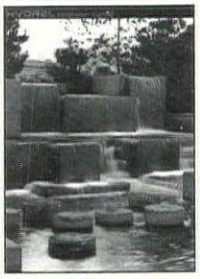
A brochure from Lightolier introduces three new lines of decorative fixtures. The new lines feature alabaster, etched glass, and cased opal glass diffusers, all accented with brass. Lightolier, Secaucus, NJ.

Circle 126

■ Downlight cylinder

A data sheet highlights the Miro-T variable-beam metal halide downlight cylinder. The sheet includes information on the downlight's design, standard features, dimensions, beam patterns, mounting applications, and options. Miroflector, Inwood, NY.

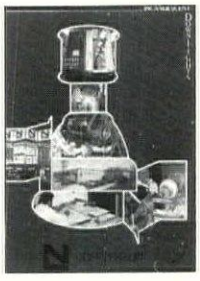
Circle 127



■ Underwater lighting

A 20-page catalog features photos, specifications, and dimensions for Hydrel's underwater lighting products. Fixtures, parts, and accessories for fountain and swimming pool illumination are included. Hydrel, Sylmar, CA.

Circle 128



■ Incandescent downlights

A brochure details NL Corporation's line of incandescent downlights, including adjustable fixtures, low-brightness cones and baffles, A lamp downlights, and wall washers. The brochure shows a cutaway sketch of each model. NL Corporation, Cleveland, OH.

Circle 129

READER SERVICE CARD

JUNE 1987
THIS CARD EXPIRES SEPTEMBER 1987

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Do you now receive? Yes ☐ No ☐

Name _____
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Company _____
Business Address _____ AFFIX ADDRESS LABEL HERE
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PHONE NO. _____ Date _____
Signature _____

This card must be completed and SIGNED in order to be processed.

A. What is your company/business type? (Check one only)
☐ 1. Architecture
☐ 2. Landscape architecture
☐ 3. Engineering
☐ 4. Design
☐ 5. Contracting/building
☐ 6. Independent consulting
☐ 7. University/school
☐ 8. Government
☐ 9. Library
☐ 10. Other _____ (please specify)

B. What is your profession? (Check one only)
☐ 1. Architect
☐ 2. Landscape architect
☐ 3. Engineer
☐ 4. Lighting designer
☐ 5. Architect/engineer
☐ 6. Electrical engineer
☐ 7. Interior designer
☐ 8. Contractor/builder
☐ 9. Other _____ (please specify)

C. What are your **major** project types? (Check all that apply)
☐ 1. Commercial
☐ 2. Industrial
☐ 3. Institutional
☐ 4. Other _____ (please specify)

D. What is your **primary** market? (Check one only)
☐ 1. New construction
☐ 2. Retrofitting of existing structures
☐ 3. Equal emphasis

E. Do you have the authority to specify products used in daylighting and electrical lighting?
☐ 1. Yes
☐ 2. No

F. Do you have the authority to purchase products used in daylighting and electrical lighting?
☐ 1. Yes
☐ 2. No

G. Do you have any lighting projects that may be suitable for publication in Architectural Lighting?
☐ 1. Yes
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Intensity of need:
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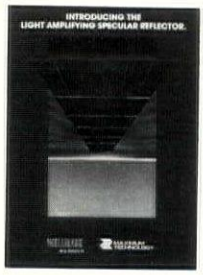


■ Retrofit reflector

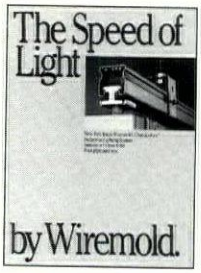
A folder explains the Light Amplifying Specular Reflector (LASR) from Maximum Technology and Wellmade Metal Products. The reflector allows users to reduce the number of lamps in a fixture. Maximum Technology and Wellmade Metal Products, Brisbane, CA.

Circle 130

■ Linear slide dimmer

Lutron's 1000-watt Skylark linear slide dimmer for incandescent lighting is compatible with other controls in the Skylark series. A data sheet describes available options and installation procedures. Lutron Electronics Co., Inc., Coopersburg, PA.

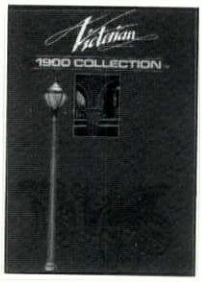
Circle 131



■ Industrial track lighting

Wiremold's Chan-L-Wire industrial track lighting system offers an alternative to standard pipe and box lighting systems. A brochure illustrates applications, describes installation, and lists specifications and system components. The Wiremold Company, West Hartford, CT.

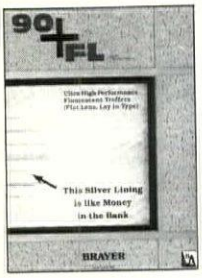
Circle 132



■ Lighting standards

The Victorian 1900 collection is a line of centrifugally cast, prestressed concrete reproductions of designs from the past. A brochure shows luminaires, poles, and available finishes in color. Centrecon Inc., Everett, WA.

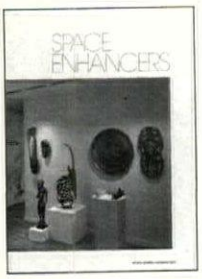
Circle 133



■ Retrofit reflector

Brayer Lighting has introduced the 90 Plus/FL, a faceted retrofit reflector for fluorescent troffers. A brochure describing the reflector includes dimensions, mounting options, photometric charts, and general specifications. Brayer Lighting Inc., San Rafael, CA.

Circle 134



■ Indoor lighting

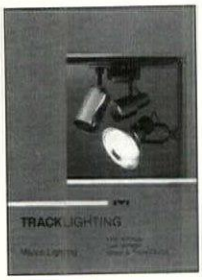
Alkco's new 22-page condensed catalog displays a variety of lighting systems, including a new recessed track lighting system. The catalog contains application photos, photometric data, and a list of accessories. Alkco, Franklin Park, IL.

Circle 135

■ Rope lights

Comet-lites are extendable, 1/2-inch-diameter chasing rope lights that are available in 16- and 24-foot lengths with six lamp color options. A data sheet describes specifications and accessories. National Lamp & Lantern Company, Dallas, TX.

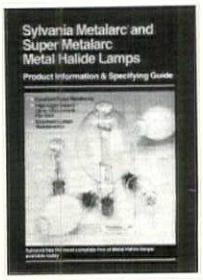
Circle 136



■ Track lighting

Marco's 36-page track lighting catalog presents a complete line of incandescent, MR16, and low-voltage luminaires, single and triple circuit tracks, and accessories. It includes seven pages of photometric charts for lamps. Marco Lighting, Los Angeles, CA.

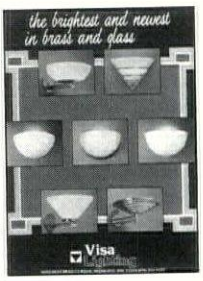
Circle 137



■ Metal halide lamps

A 16-page guide from GTE/Sylvania provides product information and specifications for Metalarc and Super Metalarc metal halide lamps. Charts outline physical, electrical, and photometric characteristics of the lamps. GTE/Sylvania, Danvers, MA.

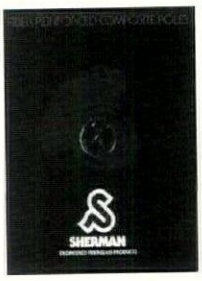
Circle 138



■ Wall sconces

A brochure from Visa Lighting features brass and glass wall sconces in seven styles. The brochure includes information about dimensions, lamping requirements, and standard finishes. Visa Lighting, Milwaukee, WI.

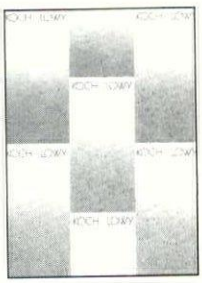
Circle 139



■ Poles

A brochure describes the production process and the advantages of Sherman's centrifugally cast fiber-reinforced composite poles. They are available in a variety of colors and in lengths up to 45 feet. Sherman Engineered Fiberglass Products, Birmingham, AL.

Circle 140



■ Lighting collection

Koch + Lowy's collection of new products includes floor lamps, desk or table lamps, pendants, and wall sconces. A color catalog features photographs of each fixture, names of designers, and lamping requirements. Koch + Lowy, Long Island City, NY.

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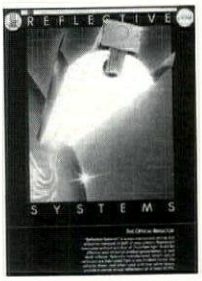

■ Optical reflector

Optical reflectors from JK Reflective Systems allow users to reduce the number of lamps in a space and maintain current lighting levels, according to a data sheet. JK Reflective Systems, division of Al Kramp Specialties, Stockton,CA.

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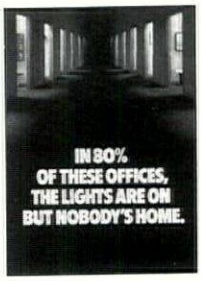

■ Motion sensors

H-MOSS motion switching systems control lighting with an infrared sensor. A brochure contains a chart of estimated cost savings and information on system placement, selection, operation, installation, and options. Hubbell Incorporated, Wiring Device Division, Bridgeport, CT. ■

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Calendar

June 15–19, 1987

Fundamentals I, short course, General Electric Lighting Institute, Cleveland. The course covers basic aspects of indoor commercial and industrial lighting. Repeats September 14–18, October 26–30, and November 30–December 4. Early registration is recommended. Contact: Janet Allen, Registrar, GE Lighting Institute, Nela Park, Cleveland, OH 44112, (216) 266-2614.

June 17, 1987

Battery Park City: A walking tour, Designers Lighting Forum event, New York City. Lighting designer Robert Prouse of Jules Fisher/Paul Marantz, Inc., will lead the tour. Contact: Louis Baldinger & Sons, Inc., 19-02 Steinway Street, Astoria, NY 11105, (718) 204-5700.

June 19–22, 1987

Architecture '87: Fact, Future + Fantasy, AIA national convention and design exposition, Orlando, FL. Contact: Ketchie Brassel, American Institute of Architects, 1735 New York Avenue, N.W., Washington, DC 20006, (202) 626-7396.

June 22–24, 1987

Electrical contractors lighting conference, General Electric Lighting Institute, Cleveland. The conference is for owners, managers, engineers, lighting specialists, and sales personnel in electrical contracting businesses, both experienced and newcomers. Repeats December 7–9, 1987. Contact: Janet Allen, Registrar, GE Lighting Institute, Nela Park, Cleveland, OH 44112, (216) 266-2614.

June 23–24, 1987

Central Texas Lighting Expo '87, Stouffer Austin Hotel, Austin, TX. Sponsored by the local IES of Austin and the Lower Colorado River Authority, the exposition will feature lighting products from more than 100 exhibitors. The free two-day event for architects, engineers, interior designers, and others interested in the field is open to the public. Contact: Judy James, (512) 473-3570.

June 29–July 1, 1987

Lighting workshop for college and university professors, General Electric Lighting Institute, Cleveland. Professors and instructors who teach lighting applications, architecture, engineering, or interior design are invited to enroll free of charge. Contact: Janet Allen, Registrar, GE Lighting Institute, Nela Park, Cleveland, OH 44112, (216) 266-2614.

July 12–16, 1987

Solar '87, conference and exhibition, Portland, OR. The annual meeting of the American Solar Energy Society will be held in conjunction with the society's 12th annual passive solar energy conference and exhibition. Local organizations will give workshops on July 17. Contact: Susie Burley, ASES, 2030 17th Street, Boulder, CO 80302, (303) 443-3130.

July 22–25, 1987

Pursuit of Perfection, American Society of Interior Designers national conference and international exposition, Toronto, Canada. Contact: ASID Conference, c/o Congress Canada, 111 Richmond Street West, Suite 808, Toronto, Ontario, Canada M5H 2G4, (416) 860-1772.

July 27–29, 1987

Basics of Lighting Institute, short course, Independent Testing Laboratories, Boulder. The institute is designed to introduce beginners to the technical side of lighting. Contact: Independent Testing Laboratories, Inc., 3386 Longhorn Road, Boulder, CO 80302, (303) 442-1255.

August 2–6, 1987

IES annual conference, Marriott Camelback Inn, Scottsdale, AZ. Contact: Cindi Altieri, Illuminating Engineering Society of North America, 345 East 47th Street, New York, NY 10017, (212) 705-7269.

August 6, 1987

IES daylighting workshop, Marriott Camelback Inn, Scottsdale, AZ. The one-day workshop will cover prediction and calculation of daylighting. Contact: Cindi Altieri, (212) 705-7269. ■

Manufacturer Credits

Nurses, doctors help plan surgery unit lighting (Department of Surgery, Condell Memorial Hospital, Libertyville, Illinois). Uplight sconce with glass lens: **Visa.** Tungsten halogen downlight: **Kurt Versen.** Examination light: **Hospital Systems Inc.** Undercounter light: **Alkco.** Nursing station uplight: **Alkco.** Corridor lighting: **Lam Inc.** Surgery corridor lighting: **Litecontrol.**

Prototype demonstrates possibilities for modular work stations (Tensil Lighting Environment). Custom luminaires: **SunarHauserman Inc.** Strip for compact fluorescent ballast and sockets: **Norbert Belfer.** Wing and canopy elements: **Eureka! division of Johnson Camping Inc.** Flameproof calendered nylon fabric: **Blank Textiles.**

Lighting reveals tones of cool bronze, warm copper (Atlas sculpture and International Building lobby, Rockefeller Center, New York City). Custom metal halide fixtures: **Sterner Lighting Systems.** Custom high pressure sodium fixtures: **Kliegl Brothers Lighting.** Lamps: **General Electric.** Luminaire design: **Lighting by Feder.**

Daylighting analysis critical for successful atrium design (Hyatt Regency, Greenwich, Connecticut). Main skylight: **Fisher Skylight.** Perimeter skylights: **Wasco.**

DOE 2.1B: For information, write to Kathy Ellington, Building Energy Systems Program, Building 90, Room 3147, Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720.

Superlite 1.00: For information, write to Michael Wilde, Windows and Daylighting Group, Building 90, Room 3111, Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720.

Programmed lighting important ingredient in restaurant (Greenwood Grille, Jenkintown, Pennsylvania). Custom chandelier, sconces, disk light, bar lamps: **Ray King.** Asymmetric reflector fixtures: **Rambusch.** 6-inch aperture downlights: **Kurt Versen.** Low-voltage adjustable downlights: **Omega.** Recessed adjustable downlights: **Capri.** Track lighting: **Capri.** Recessed wall washers: **Omega.** Pendant-mount single-lamp fixtures: **Atelier.** Receptacle strip: **Wiremold.** Stained glass window: **Ray King.** Desk task lamp: **Artemide.**

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