LIGHT

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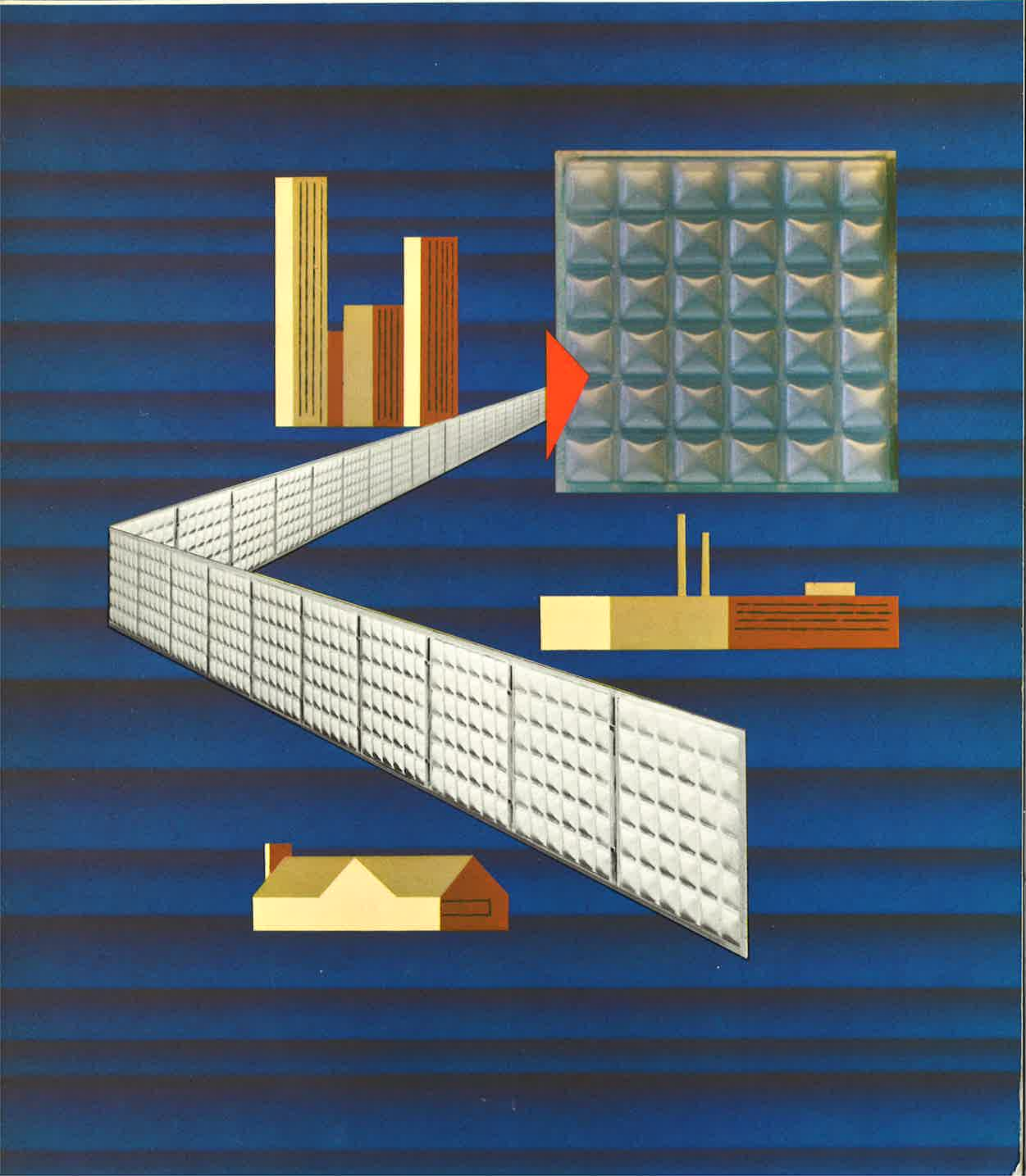

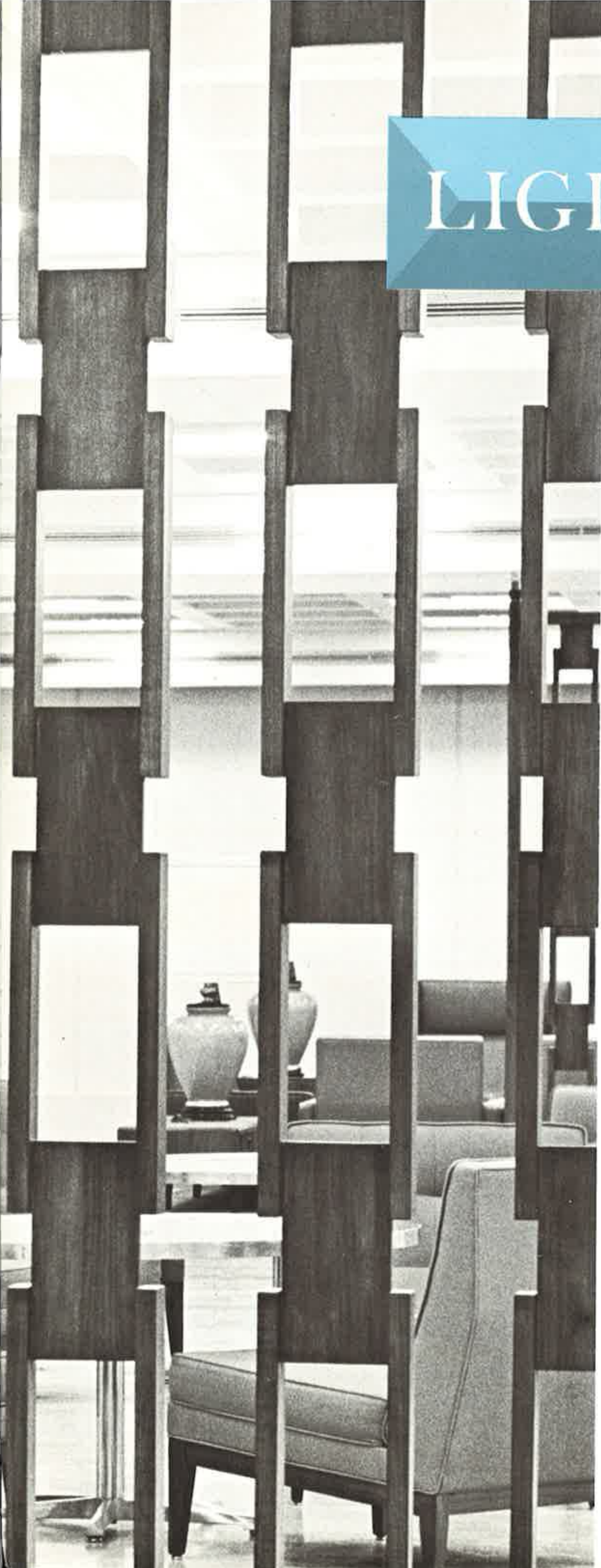

LIGHT

Published in the interest of the progress of sound Lighting Practices

CONTENTS

COVER

Selecting a cover subject was easy. How it should be treated was a different matter. Finally it was decided that both art and science should be represented. The wrap-around design was contributed by the Nela Park Art Section. The lamps were loaned by PP&A, and the product pictures were taken by Tom Knowles. The face on the back cover belongs to G.E.'s Lady of Light. More about her later.

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The Panel F . . . Why and Where

by **D. E. Siembieda**
Product Planning and Application, Nela Park

Now that the Panel fluorescent lamp is available in quantity, two questions asked by lighting designers have a greater air of urgency about them. "Why should we use Panel F when there are already many varieties of lamps to choose from?" "Where should these lamps be used . . . in what type of luminaire and for what effects?"

First of all, let's look at the size and shape of the lamp. It's just about a foot square and less than two inches thick (11-5/6 in. by 1½ in.). The average face brightness of the cool white is about 3200 footlamberts. At 600 milliamperes, this lamp produces 4400 initial lumens. However, there is also the Panel Deluxe, which delivers 4200 lumens – a small sacrifice in amount of light, but with the additional benefit of improved color rendering. Actually, less light is sacrificed for better color rendering than is the case with any tubular fluorescent lamp. This is the result of being able to use two types of phosphors in this lamp, because it is made of two molded sheets of glass sealed together on all sides. One phosphor on the back plate, another on the face plate, result in a color blend that is only slightly different from deluxe warm white. Thus, Panel Deluxe retains most of the efficiency of standard cool white, while providing warmer, more vibrant color rendering.

So, here's a fluorescent lamp that is small, compact (compressing a 62-inch arc stream into a 12-inch square because of its six loops in the back plate), strong, and decorative lighted or unlighted. These last two characteristics are the result of the 36 square "bubbles" on the face plate.

Economic Comparisons

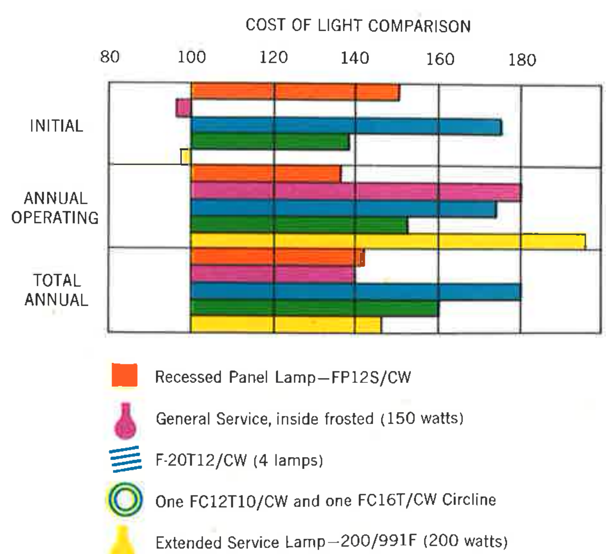
Because the Panel F is a fluorescent lamp, it has the light output versus electricity consumed that has traditionally put fluorescents at an economic advantage. This fact is apparent in the table of

costs. But, the lamp is compared, also, with other fluorescents. Based upon equal levels of illumination, the Panel F lamp in a suspended unit with plastic egg-crate louvers (the entire unit is the base for the table) is compared with the Panel F recessed — also with plastic egg-crate louvers for visual comfort; with the 150-watt A-line lamp in a unit having prismatic lens; with a unit using four 20-watt fluorescent lamps, recessed and with a white diffusing plastic cover; with a typical recessed louvered unit containing two circline fluorescent lamps; and with a 200-watt extended-service lamp in a prismatic — lensed, recessed unit.

These lamps, in the units described, were selected for cost-of-light comparison, because they are the ones most logically considered by designers for the same types of applications.

Because this is an area light source, and luminous top and bottom, with more brightness per square inch than tubular fluorescent sources, good use can be made of perforated-sided luminaires, of shielding, and of suspending the units from high-reflectance surfaces. In all cases, comfortable visual brightness is an important consideration in system design.

An acoustic ceiling consisting of sections two feet long, suspended on a T-bar system, provides ample space for a two-lamp Panel fluorescent lamp system oriented in relation to the design of the space and to proper brightness control. To do this with tubular lamps might require four 20-watt fluorescents having less light output, less efficiency.

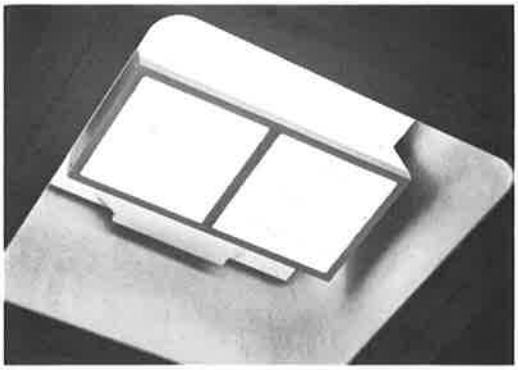


Vertical line is basis of comparison: suspended FP12S/CW, louvered=1.0 or 100%

In general, Panel lamp installations are usually more economical than incandescent downlights, some circline luminaires, and even 20-watt fluorescent lamps. On the basis of equal levels of illumination this is most obvious in the comparison with a 150-watt incandescent lamp system which has a lower initial cost, but an annual operating cost that is about 80 per cent higher. As a result, the incandescent lamp system has a 40 per cent higher total annual cost than does the suspended, plastic-louvered Panel F system.

Cost comparisons are based upon standard cool white. However, the Panel Deluxe lamp has 95 per cent as much lumen output as the standard cool white. Therefore, it shows an even greater economic advantage as compared to deluxe warm white in circline and 20-watt fluorescent lamps.

The poured concrete, "waffle" ceiling provides an obvious application for the Panel fluorescent lamp. Here, four Panel F lamps fit neatly into a recess. The luminaire is easy to install and service; has a plastic louver-grid that is supported by a ballast housing on each side of the unit.



The recess is deep enough to shield a single lamp from normal viewing angles; but with two or more lamps, additional shielding may be necessary. This unit has two lamps and the ballast housing.

These panel fluorescent lamps can be arranged symmetrically, in groups, or in clusters in large luminous elements, or in some custom-designed architectural element. Because they are quite small and lightweight, they are incorporated easily into the overall design. Because they have good light output per watt, they are efficient and functional, enabling the lighting designer to meet the I. E. S. minimum recommendations without difficulty.

The lamp operates efficiently in a vertical position. also. Here it's hung from the wall behind a luminous element; 9 inches from wall; 8½ inches from the luminous panel.

Suspended in a coffer-like, surface-mounted luminaire, a shielded Panel lamp can contribute a design element most welcome in an otherwise uninteresting space.

Behind a diffusing element, one Panel lamp can provide much the same brightness and light output as several tubular sources commonly associated with such a unit.

When it is necessary to install a luminaire that will blend with traditional decor, it is still possible to use the most modern light source. Panel Deluxe are tested, here.

Good color rendering and brightness control are especially important when the lamp is used in the home. Regardless of the style or mounting method used, these factors must be considered. The Panel Deluxe lamp is a logical choice for many areas because of its unusual design features.

Long, narrow, irregularly shaped interior spaces like corridors may require lamps that have long life and high light output. The Panel fluorescent lamp meets these objectives. If every other lamp can be controlled independently of its near neighbors, half of the system can serve for night lighting, also.

A large floating panel luminaire in the reception room diffuses light from 300-watt R-40 floodlamps mounted above it. Panel fluorescent lamps above the desk provide 100 fc of comfortable illumination. A subtle "path of light" leads from door to desk, and is provided by 150-watt PAR-38 lamps above the luminaire, which also conceals a fluorescent (Power Groove) wall washer to illuminate the wood-panelled walls. Outside the door, the decorative, free-standing metallic screen is edge-lighted by 150-watt PAR-38 spotlamps.

We Sell Lamps (Lighting)

by **B. F. Avery**
Large Lamp Sales District, New York

In a General Electric Lamp Division Sales District office you rarely find salesmen. They are out calling on customers. When you do find them in the New York Lamp Division headquarters they are apt to be showing their customers around the new facility or making arrangements for their guests to see and hear something new about lighting in our Progress of Light room. This is a deceptively small space equipped with displays for demonstrating lamps, lighting effects, color, the economics of lighting (all concealed behind hinged panels), lamp merchandisers, and, through color slide projection, installations throughout the country. Only a few months old, this room has averaged a formal meeting every other working day, and two informal meetings a day. As we anticipated, however, when people attend meetings in the Progress of Light room they are apt to look at our other facilities, too. On almost any day we find a designer, architect, or engineer looking thoughtfully at a lighting unit in use in an office. So we try to have most suitable, most up-to-date lighting elements in everyday work quarters, too.

What We Have — Generally

When we outgrew our quarters in the G-E building on Lexington Avenue, we found a space on East 42nd Street. It had unusually high ceilings (the building once housed REA's horse-drawn wagons), and was being completely refurbished. This gave us a real opportunity to employ many types of lighting systems at various ceiling heights. For example — in one low-ceiling area we use recessed, air-handling troffers and operate the lamps on 3000-cycle high frequency. This increases lamp and ballast efficiency and reduces heat loss at the fixtures. Air is removed from the room, moves past the lamps, and escapes into the plenum. Lighting heat does not get into occupied space, and size and cost of the air-handling system were reduced.

More Specifically

There are general and private offices; full partitions and semi-partitions; recessed and surface-mounted fluorescent fixtures; floating panel luminaires; recessed and suspended Panel fluorescent lamps; lighted wall brackets; ceiling-mounted incandescent lamp wall washers . . . even a luminous wall with colored fluorescent lamps on dimmers. We can demonstrate Cool-Beam lamps, dichroic-color lamps, the effects of spots and floods, multi-level switching . . . all kinds of comfortable illumination in what is, truly, one of the nation's best-lighted office facilities.

For example . . .

Floating panel luminaires and other large-area luminous elements permit a variety of lighting effects and assume their rightful position as an architectural element in a space. In offices shown here, different types of panels are used, different types of fluorescent lamps, and different methods of switching. Lighting levels are about the same.

wedge louvers, gold specular . . . 15% uplight . . . eight Power Groove lamps on one-foot centers . . . switched for two lighting levels . . . four 150-watt Cool-Beam and two 200-watt side-prong lamps aimed at draperies . . . two 25-watt, low-voltage PAR-46 lamps aimed at items on shelf . . .

grey louvers (½″ cell) . . . 15% uplight . . . 12 Power Groove lamps on one-foot centers . . . five side-prong 150-watt PAR spots aimed at draperies . . .

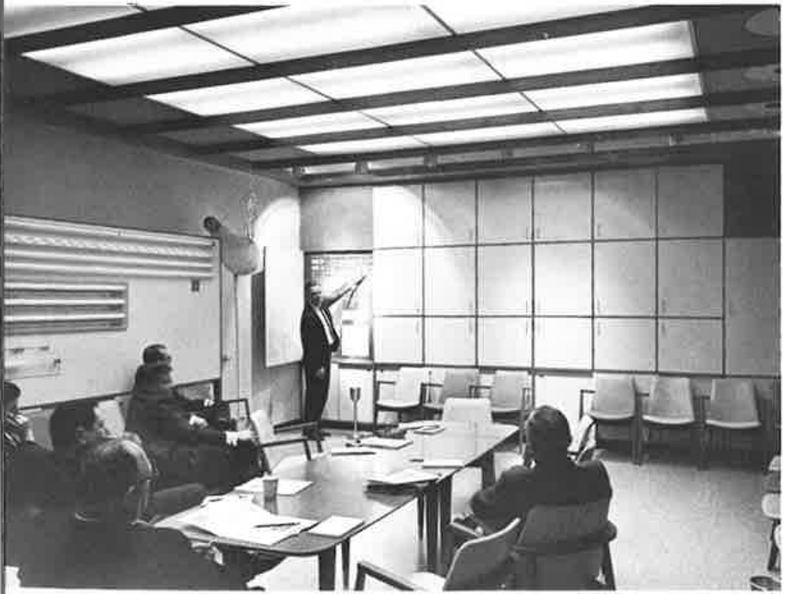
white plastic grid louvers (½″ cell) . . . 3000-cycle operation . . . recessed, air-handling unit . . .

wedge louvers . . . six Power Groove lamps on one-foot centers . . . switched for two lighting levels . . . behind plastic wall panels are F-40 fluorescent lamps —seven gold, six blue . . .

In the Miniature and Photo Lamp general office, the 4-lamp units are surface-mounted in continuous rows on 6-foot centers. These plastic-sided units meet scissors' curve.

This windowless, general office has rows of four-lamp, air-handling troffers. The 40-watt fluorescent lamps operate on 3000 cycles. Shielding consists of white metal grid (½" cells). Walls are lighted by two-lamp units (lamps overlapped). Cool-Beam lamps (300-watts) are above walkway.

Devices for increasing the apparent width of the space, and for controlling brightness are demonstrated here. Note the wood louvering, the under-cabinet lighting, and the recessed Panel fluorescent lamps above publication files.



The Progress of Light room is approximately 18 feet long. Its general lighting system consists of cool-white, warm-white, and Power Groove lamps — each set switched independently to provide different lighting levels, and to demonstrate color-rendering differences. Along the drapery wall are recessed floodlamps; along the cabinet wall, which contains many types of displays, are adjustable, ceiling-mounted spotlamps. The projection room is at the rear.

Take a Tour

by **G. M. Sauer, Jr.,** *Plant Engineering, Nela Park*
J. M. Smith, *Product Planning and Application, Nela Park*

Floodlighting is related to building design. Recessed in the peripheral overhang of the office building, at left, are 150-watt R-40 spot lamps—101 of them. The Monogram is mounted on the facade of the truck dock. This 10,000-square-foot surface is illuminated by nine 1500-watt Quartzline® lamps spaced 45 ft. on center, 30 ft. from the building.

Planning a large distribution center requires a knowledge of the product, of how it is stored and handled, of how the product is identified. The General Electric Lamp Division Central Distribution Center, Ravenna, Ohio was planned to incorporate the most up-to-date methods of storing and shipping lamps manufactured by ten G-E plants in northern Ohio and Illinois. The facility consists of a single-story warehouse with a floor area of 420,000 square feet and a clear height of 22 feet. The space can accommodate 55 million lamps of 5000 different types.

Adjoining the warehouse is an all-electric office building (10,400 square feet). On the front of the warehouse is an inside truck dock containing 58,600 square feet. (Enough room to handle seventeen 40-foot trailers at the same time.) A two-track railroad spur also serves the facility.

Recessed in the covered entrance walkway are 1600-watt quartz infrared lamps in 26 two-lamp units for snow melting.

Seeing Tasks and Lighting Systems

Obviously, a variety of seeing tasks are involved. These include close, difficult desk work and the operation of business machines in the office, and the operation of lift trucks and identification of packaged lamps in the warehouse. Although much of the warehouse work is automated, it is still under the control of people — who must see.

There are three types of lighting systems — one in the office; one in receiving, shipping and packaging areas in the warehouse; and another in the actual storage areas.

The Office Building

Here, 150 footcandles of comfortable illumination are provided. The lighting system has two-foot by four-foot troffers containing four 40-watt fluorescent lamps. These troffers have white aluminum louvers with 45° x 45° shielding.

The office building has provided an excellent opportunity to install and test, under operating conditions, Electrical Space Conditioning. Lighting heat is removed through the lighting units before it can enter the occupied space. The heat is either recirculated or exhausted depending upon building needs. Because the heat escapes through troffer slots, lamps are cooled, and operate at higher efficiency than they would in non-ventilated equipment. Electric baseboard heaters along

The all-electric office building includes a reception room, private and general offices, a conference room, and a lunch room. There are 150 fc in the general offices. Colors were carefully selected for their attractiveness and visual comfort and meet I.E.S. reflectance recommendations.

Heat exhaust troffers in the office building. Lighting heat is sufficient to maintain comfortable inside temperatures even when outside temperatures drop to 20 degrees.

Analysis of Electrical Space Conditioning is facilitated by a test console. Air flow, wattage consumption, and air temperature for various elements are shown.

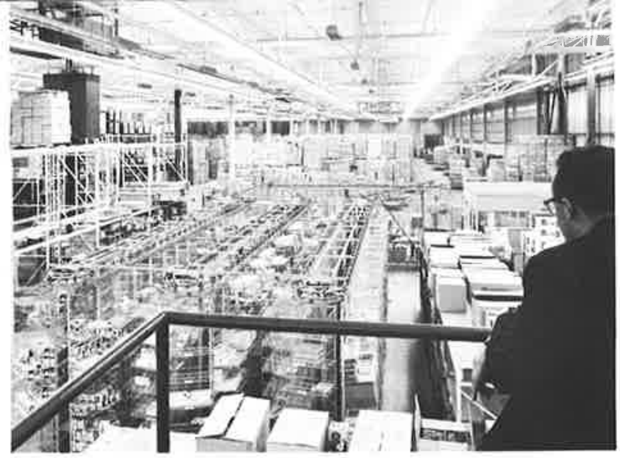
the perimeter walls compensate for wall heat losses. And electric heaters, located in the supply air ducts, provide additional heat during extremely cold weather. If, at night, the supplementary heating cannot maintain temperature, the general lighting system comes on automatically. Temperature variations outdoors were wide this past winter, but the system maintained a comfortable interior.

In the Warehouse

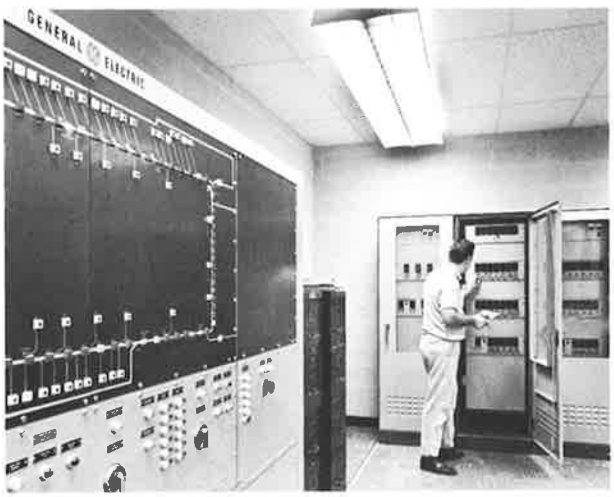
The receiving, shipping, and packaging areas are lighted by Power Groove® lamps. Each two-lamp industrial unit has 30-degree crosswise shielding and 25 per cent uplight. Lighting level is 100 fc.

In the storage areas, Power Groove lamps are installed above the aisles. Single-lamp channels are installed above aisles less than 10 feet wide. Aisles 10 feet wide or wider are lighted by Power Groove lamps — either in two-lamp channels or in two single-lamp channels. This selection was based on other considerations as well.

In the packaging and truck service areas, infrared lamps are used for people heating.

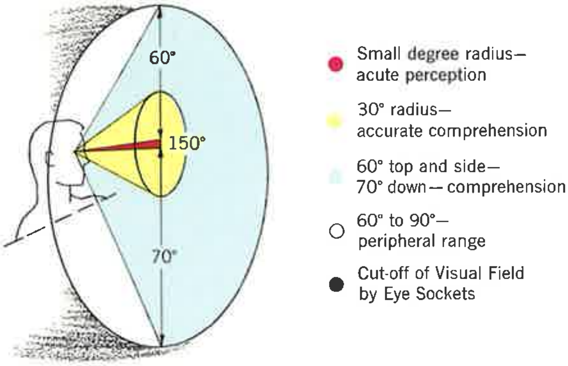


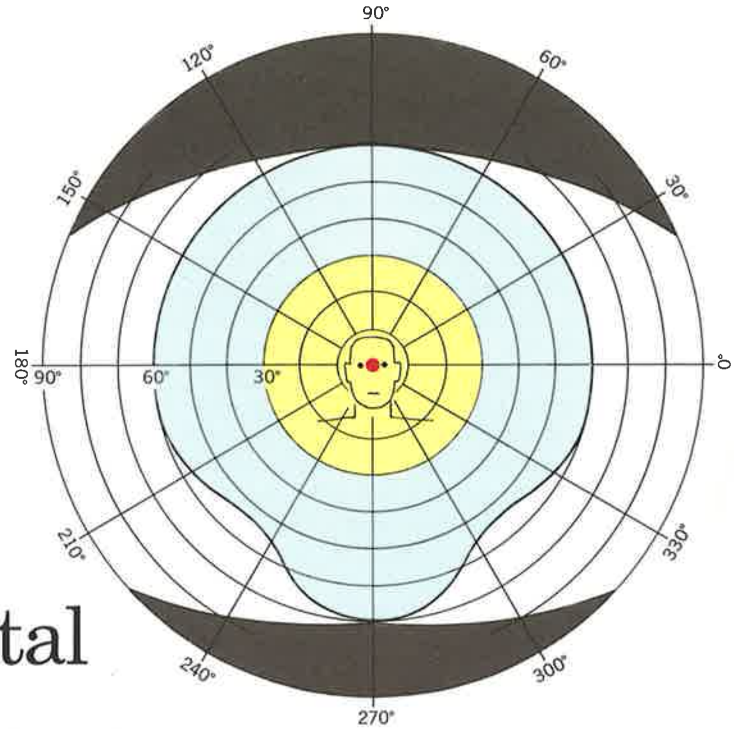
In the Broken and Special Packaging areas, and in Loading Areas the lighting level averages 100 fc. Rows of suspended, two-lamp, shielded luminaires containing Power Groove lamps are on 15-foot centers. The roof deck and trusses are painted white to take advantage of the uplight.



The materials-handling system, designed by the G.E. Industry Control Department, features a combination of mechanical and electrical automatic techniques. The mile-long, under-floor, drag-chain conveyor with its 77 switch-off spurs is shown diagramatically on the board. The system is called "Directomatic Control." Truck destinations are preset.

Supplementary heating is provided by quartz infrared lamps in both the Special Packaging and Truck Maintenance areas. Each unit contains two 2500-watt lamps. Units are on about 12-foot by 18-foot centers. Each area also has 100 fc. Lamps are Power Groove in shielded, uplight fixtures.





Brightness is Fundamental

by **Kaye Leighton**
Product Planning and Application, Nela Park

Simply stated — lighting is for people. Its purpose is to serve the sense of sight. Good lighting design gives equal consideration to the seeing task, "visibility," and the surroundings — visual environment. Why? It's because of the way human eyes perform under a variety of conditions.

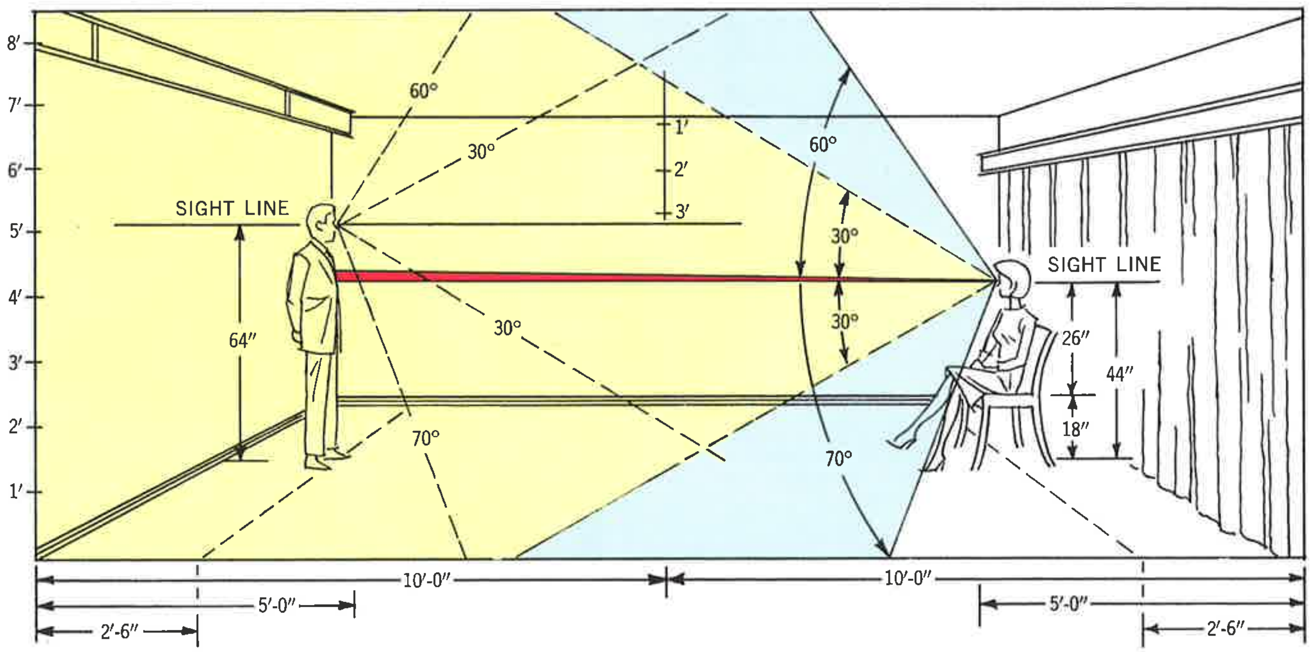
With normal binocular vision, the eyes, focusing upon some small detail, subtend a very small degree within which a distinct image and acute perception takes place. At 30° above and below the center and to the sides of the pupil line of sight, clear imagery and accurate comprehension take place. The range of comprehension then extends to 60° at top and sides and to 70° downward. A fourth range — between 60° to an approximate 90° — to either side of each eye constitutes the peripheral area of vision. Here the eyes register forms as indistinct masses, but there is also a quick awareness of any movement, and a high sensitivity to change in brightness. The combination of ranges encompassing 60° upward, approximately 180° sidewards and 70° downward is termed the Binocular Visual Field. Wherever a person moves through space, whatever posture he assumes — whether he turns his head or only shifts his eyes — the Visual Field is in operation. Eyes send messages through the connectors to the brain at a rate that would confuse a computer. The physical operation of the eyes, the mental impressions recorded, and the emotional responses invoked will be directly related to the projected brightness messages. Therefore, the prime objective of all lighting design is to create brightness patterns in the Visual Field that will permit the sense of sight — the function of the eyes — to operate at optimum value to the individual.

Brightness Control in Limited Area

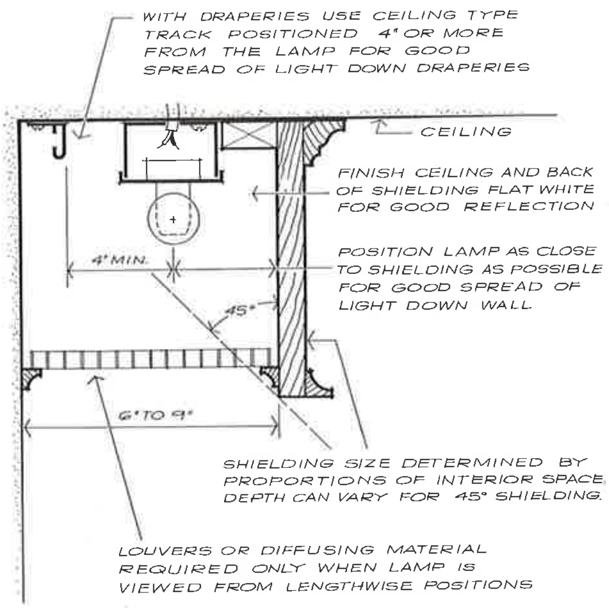
The correctly installed built-in study desk is a good example of a controlled brightness situation. Designing started with the physical considerations; height of desk (approximately 30 inches) height of chair (18 inches). Then it progressed to the distance of eyes from seeing plane (average 14 inches — maximum distance 17 inches). The position of the seeing plane is horizontal; therefore the body bends forward and the head tilts at the neck to bring the eyes into as near a parallel position to the plane as possible. When these factors are established and eye operation is understood, it becomes easy to project the range areas of the Visual Field (see cross section of desk).

The lighting objective is three fold — (1) to directly light the seeing plane, (2) to synchronize this brightness with the surrounding area, and (3) to avoid direct light reflection back into the eyes. Number one requires a diffused, low-brightness, high output light source. Number two — the control of brightness in the surrounding area — is related to task brightness by the selection of matte surfaces that will diffuse the light and that are semi-neutral (of light color) to have a reflectance within the percentage range of the task, and not so strong in color that they will induce a

SCHEMATIC OF CROSS SECTION OF VISUAL FIELD

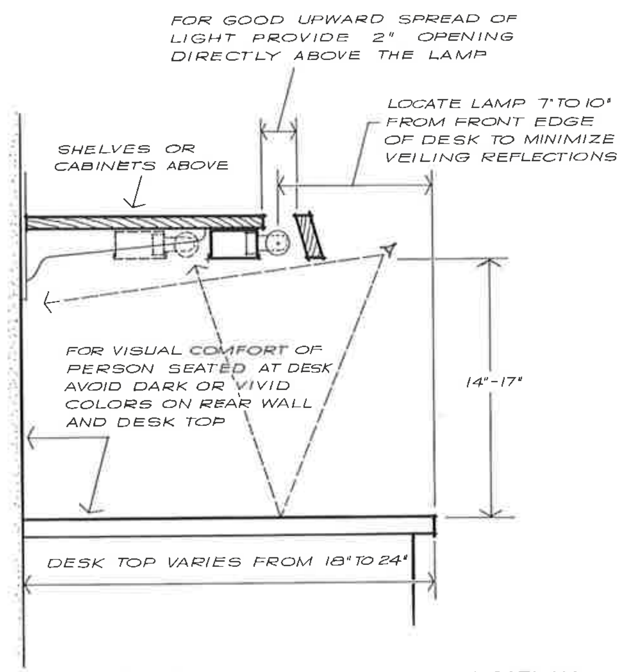


The entire vertical surface plane is within the central 60° radius range—from either the standing or seated position. Lighted cornices, valances, and wall brackets raise the brightness of vertical surfaces and thereby reduce sharp contrasts between locally lighted areas and the surroundings. These contrasts complicate and confuse seeing.



LIGHTED CORNICE - DESIGN CONSIDERATIONS

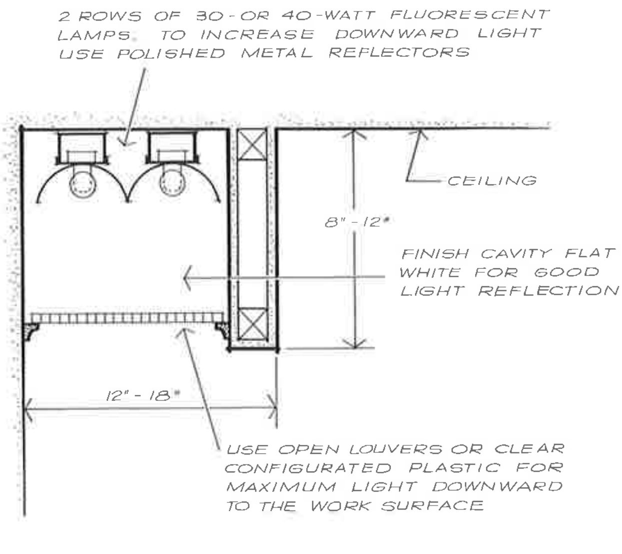
The dimensions shown in this drawing are adaptable to lighted cornices used on walls with and without draperies.



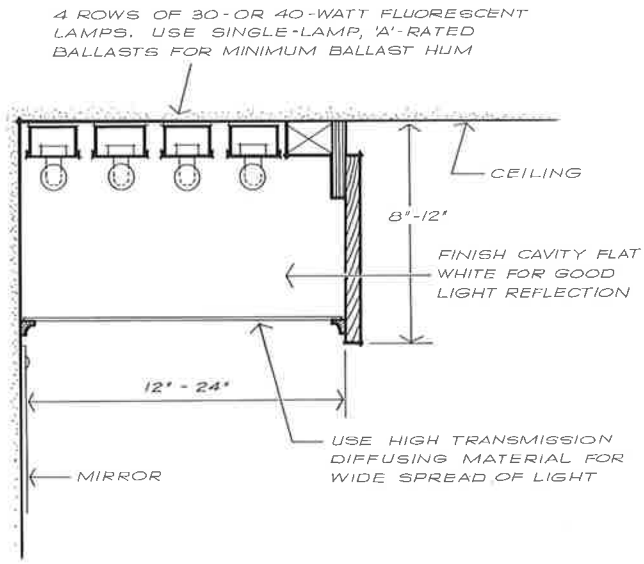
DESK LIGHT - DESIGN CONSIDERATIONS

Dimensions are related to such considerations as height of desk, height of chair, distance of eyes from seeing plane.

complementary color reaction in the eyes. Number three is concerned with control of the direction of light. If the source is placed too far back, the reflected rays from the seeing plane will bounce back directly into the eyes. As the source is moved forward, the reflected light angle toward the eyes is reduced; the bounce-back terminates at chest height. Glare that interferes with seeing comes from light that is reflected directly into the eyes, or from a high brightness or unshielded light source. The wood shield prevents the desk user from seeing the source, but because it is open at the top it allows light to spread upward, preventing sharp contrast between lighted and non-lighted surfaces in the Visual Field when the body posture is changed to a contemplative or rest position.



Lighted soffits over work surfaces are designed to provide a high level of illumination on the work, with a minimum spread of light in other directions. The reflectors help.



This is designed to provide light directly on a person's face and head. Vanity top should be of high-reflectance, neutral color to reflect light to under surfaces of face.

Soffits

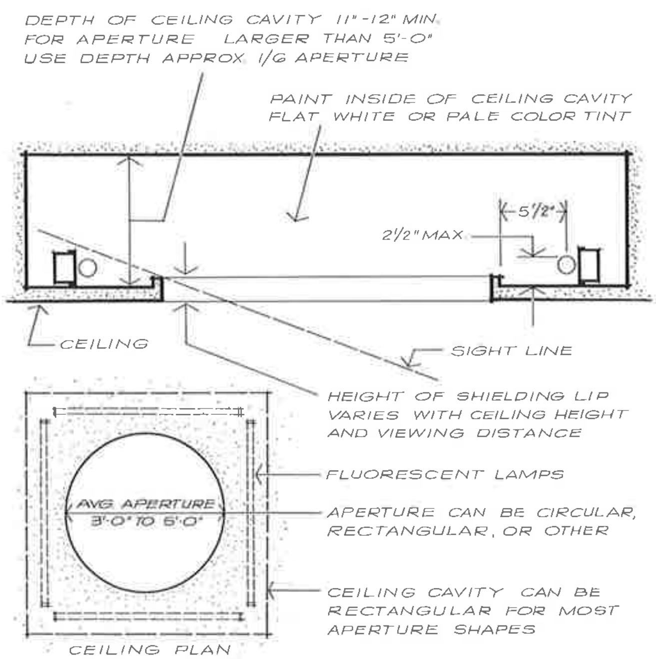
Lighted soffits place the lighting installation out of the range of the Visual Field (beyond the upward 60°) and also provide lighting that encompasses the entire Visual Field. For either horizontal or vertical seeing planes, they create the sensation that performance is visually free and easy.

Within a soffit cavity, it is possible to incorporate means for increasing lighting levels or variations for flexibility in use. For example, polished metal reflectors used with louver shielding will approximately double the concentration of downward light on a work surface. A minimum depth, 12 inches, in a vanity soffit is suitable for two rows of lamps. With an increase to 18 inches, three rows of lamps may be installed for approximately a 50-per cent increase in light level. For a real innovation, offering flexibility in color rendering, use four rows in a 24-inch cavity. Rows one and three, lamped with deluxe cool white (daytime lighting) on one switch; rows two and four, lamped with deluxe warm white (nighttime lighting) on another switch . . . . and my lady can have the ultimate confidence in both her daytime and nighttime appearance.

Coffer

Traditionally a coffer has been used to give a feeling of increased height and spaciousness. In modern interiors it provides the sky light appeal without water leaks. Scale and proportion to interior design are as important as ever, but the human factors must be taken into consideration carefully. How wide is the dining table? Where will the eye be located and also the projected boundaries of the Visual Field? Once these are known, it is easy to establish the size of the aperture. The most pleasing coffers establish the lip of the coffer out of the Visual Field range of the person seated directly opposite.

Understanding how the sense of sight serves the mind – what is its purpose and function – will give to custom designing a firmer basis for procedure. To the designer it offers the possibility for more confidence in the acceptability of the final lighting results.



The coffer provides a good example of the many factors that must be considered in the process of custom designing.

Toys Were Tools

by **A. Makulec**
Product Planning and Application, Nela Park

The pictures* in this article are of scale-model 1964 Cadillacs in a scale-model "showroom". The scale was approximately 3/8 inch to the foot. The "ceiling" of the showroom was removable so that various luminaire patterns, brightnesses and reflectances could be demonstrated together with the lighting effects they produced. In a full-scale showroom this would be impossible, of course, and with ordinary toys, exterior finishes and trim would not be sufficiently detailed nor of the right material to make such a project worthwhile.

What Makes an Auto Showroom Different

Unlike most stores, the items shown do not constitute all of the types and colors that are available. In fact, many of these are not even in stock. What's on display merely represents the "line".

Then, too, the automobile is vastly larger than the average retail item — so large that it cannot be appraised at a glance or even from one position.

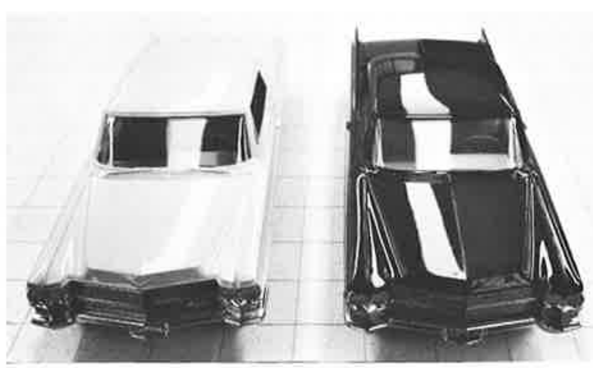
In a psychological sense the automobile is different. This is not only because of its higher cost, but because of the tendency of the purchaser to consider its social implications as well as its function and appearance.

Appearance, then, is of great importance, and the visual qualities that form the basis for appraisal are really much the same as for smaller goods. Gross details, such as form and exterior color; fine details such as quality of finish and of interior trim . . . . these, combined with surface polish and sparkle, establish the major things seen.

* *In general, the camera lens was higher than the observer's eye would be in a regular showroom so that lighting effects would be more apparent.*

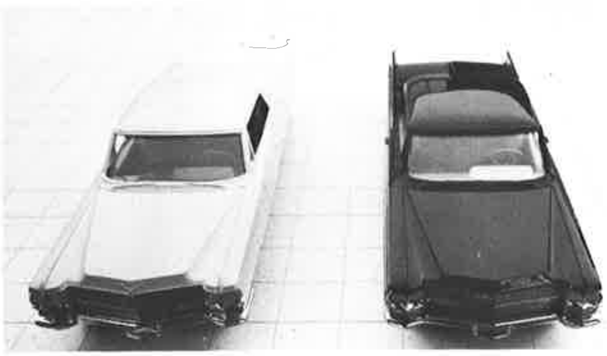
Only a box with a removable top and scale models of automobiles — but these permitted study of lighting effects on automobiles in full-size showrooms. In this demonstration set-up, "recessed troffers" provide 200 footcandles.

The illumination level on the hoods of the cars is the same as that above, but to achieve equal footcandles when a dark floor is used, fixture brightness had to be increased (or more lighting fixtures could have been used). With dark floors, less light is reflected to the ceiling, and the lower side panels of the cars are less visible.



Rows of luminaires parallel to the automobiles produce reflected highlights that follow principal styling lines. However, pigment in the dark car reflects so much less light diffusely than the white pigment that highlight streaks are more prominent — accenting styling lines and surface polish. Details of finish quality in light-colored cars are revealed because of high general reflected brightness.

Reflections in cars displayed at right angles to the lighting system cut across the principal lines of styling contour.



A completely diffuse luminous ceiling tends to mask the color of surface finish by covering the pigment reflection with a veil of reflected brightness. Because light comes from four times as much ceiling area as it would with troffers providing the same level of illumination, the ceiling and the reflections are only about ¼ as bright. Distinctive highlights are missing; everything looks a bit "flat".

Large, egg-crate-type louvers in a ceiling system are reflected in the windshield. To avoid distracting reflections of this type, the shielding elements should consist of small-scale louvers, or of diffuse or prismatic panels.

All of these emphasize characteristics of styling, size, and quality of manufacture that help the shopper to make the buying decision.

Principles Established

There are many factors that can be considered in lighting for selling, and they are covered in considerable detail in a G-E technical publication — TP-106. Some of the most obvious were clearly demonstrated in the study of scale models.

For close-up appraisal and show window effectiveness, the general illumination level should be about 200 footcandles provided by deluxe cool-white fluorescent lamps. The size and wattage of the lamps depend upon a number of local design considerations, but the lighting equipment should be as unobtrusive as possible — surface mounted or recessed. Small-scale louvers, prismatic panels, or diffusing shields should be used on luminaires to minimize excessive brightness overhead. The ceiling pattern formed by the lighting equipment should be as simple as possible. This might take the form of large-area elements or rows of luminaires aligned parallel to the principal direction in which cars are displayed on the floor.

Now, the same lighting level might not apply to the entire salesroom — especially where there are large, non-selling areas. However, the rear wall should have high reflectance. In addition to a light-colored surface, it might be lighted by a row of the general lighting fixtures parallel to it, or by a lighted cornice or wall bracket.

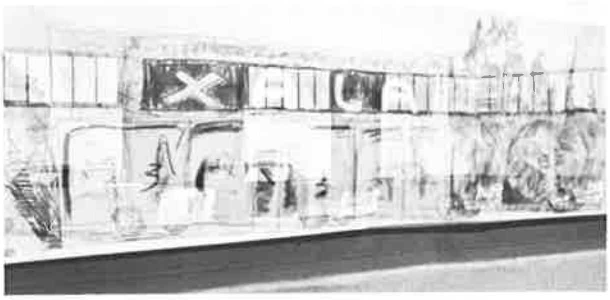
Display spotlighting — aimed to add sparkling highlights to body finishes and brightwork (trim) — should be located above and to the front of the cars on display. Wattage and size of spotlight equipment are determined by the geometry of the room. Highlight illumination should be from 300 to 1000 footcandles.

The Show Window

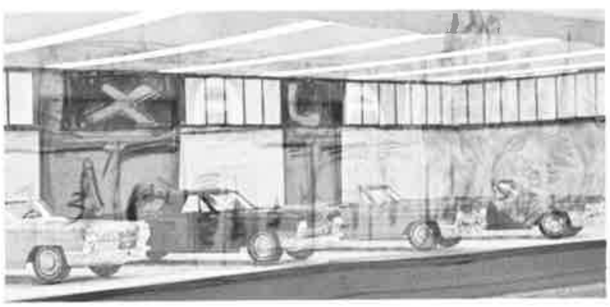
As in any "open-front" store, the window glass of the showroom creates all of the reflections and consequently all of the seeing problems involved in looking at merchandise from the exterior. Good interior lighting should, as part of the designer's purpose, contribute to the certainty of making merchandise visible through the glass.

When this is accomplished, the lighting has advertising value in addition to display value.

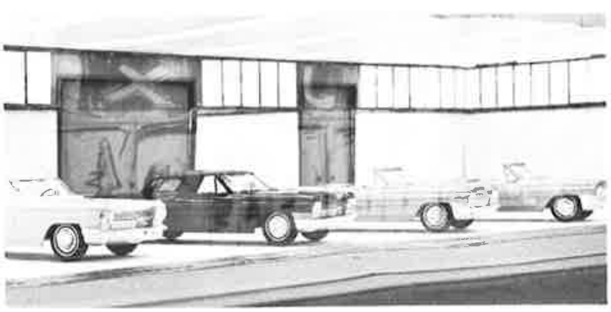
Incandescent downlights are much brighter for a given level of illumination. Therefore, surface reflections are more intense; look like points of sparkle. Shadows are more prominent. Less light gets into interiors. Incandescent spotlighting accents key features and brightwork.



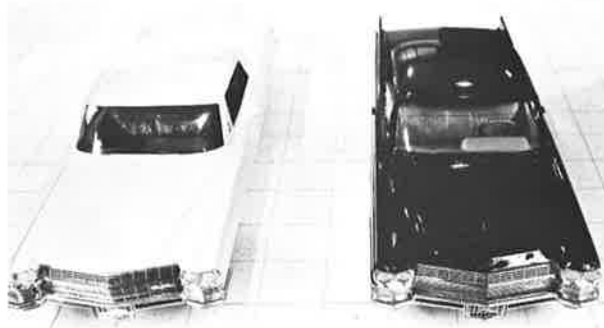
With the interior unlighted, the plastic "show window" inserted in the front of the box acts as a partial mirror. A simulated street scene and store front sketched on a luminous panel a few inches away are reflected in the window.

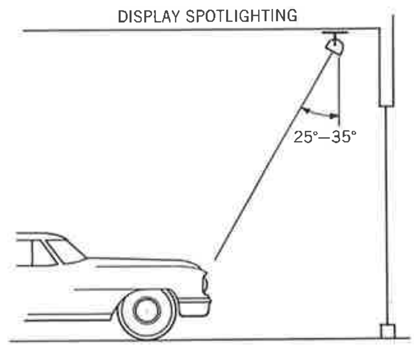


A moderate level of illumination (about 75 fc on the hoods) begins to reveal the cars in the showroom. They are not easily seen, but the lighting helps to make them visible.



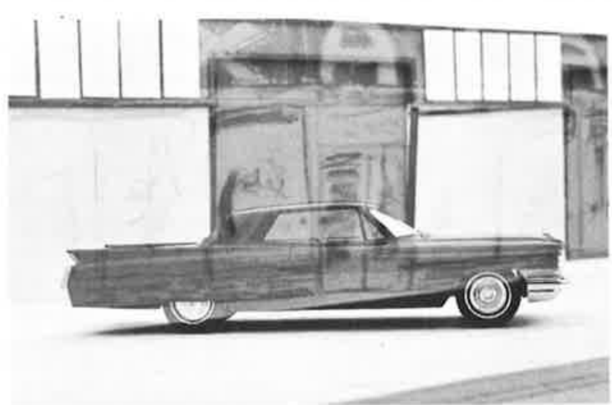
A general lighting level of about 200 fc really minimizes details of reflections and reveals the merchandise. It's impossible not to see inside — and that's the objective.





Spotlights should be aimed at the front-end brightwork to provide attention-getting glitter. Every time the display is changed, the lamps should be re-aimed to avoid glare and to be sure that the system is really effective.

It's the brightness of the lighted surface that overcomes window reflections. Only the models were changed — not the level of illumination. The reflections are less apparent on the white model and light-colored wall surfaces.



When You Can Measure . . .

by **Dr. S. K. Guth, Mgr.**
Radiant Energy Effects Laboratory, Nela Park

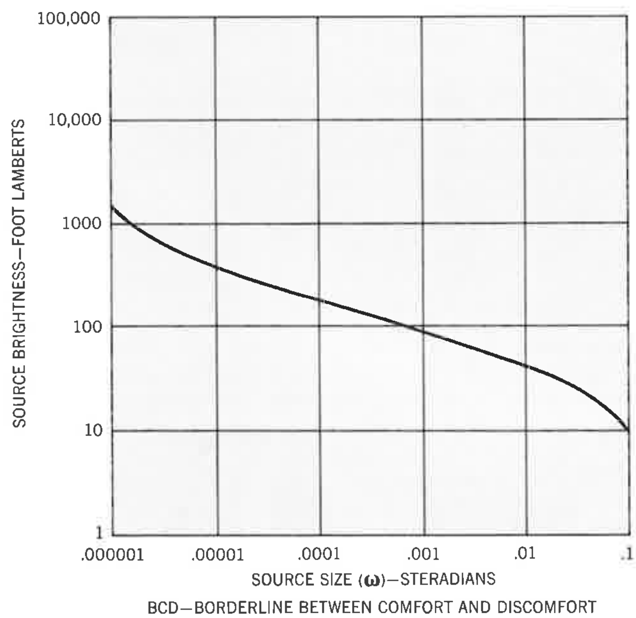
Discomfort glare used to be a relatively simple problem in the pre-fluorescent days. The usual solution was to enlarge the diameter of the enclosing globe as the lamp wattage was increased. Then, when the practical limit of size was reached, the use of indirect lighting solved the problem until the ceiling brightness became excessive. These lighting methods imposed a limit of attainable levels of illumination . . . with the light sources and equipment then available (not to mention other aspects of environmental conditions such as heat – ed.). Fluorescent lamps and improved equipment made it possible to provide the levels of illumination known to be needed for the wide range of difficult work-world tasks, and to do it economically, but they also reintroduced the problem of discomfort glare.

The simplest ways of providing more light are to increase wattage or number of lamps in each luminaire, or to increase the number of luminaires – even to the extent of having an almost totally luminous ceiling. But these can cause trouble.

Brightness ratios and other simplified procedures have provided some rule-of-thumb guidance to lighting designers, but any such approaches to lighting design cannot include all of the factors that are involved. The variety of lighting systems available increases every day, it seems, and the spaces to be lighted are not always simple, small, rectangular "boxes". What we have needed is a comprehensive procedure that can be used for evaluating or rating glare of small or large luminous elements in any type, size or shape of space.

Glare Rating

During the course of many years of research on this subject, we have obtained a great deal of



Luminaire brightness must be lowered as the relative area of the source is increased, if a high degree of visual comfort is to be maintained. Note that the curve dips as the size of the area is increased. This variable factor is represented by "Q" in the glare formula. If it is not included when the formula is used, the amount of glare produced by a luminaire may be over- or under-rated.

data for a large variety of experimental conditions — real, simulated, and abstract. From these data we have derived a formula which includes the basic factors of size, brightness, and location of a source and of the general field brightness.

This is the formula:

$$\text{Discomfort Glare Index} = \frac{BQ}{PF^{0.44}}$$

This formula tells us that glare increases with the brightness (B) of its area; and decreases according to a function (P) of its location, and a little less than the square root of the average brightness (F) of the field. The area function (Q) is important. For example — in a large room (approximately 100 x 200 feet) the apparent or projected area of individual luminaires or of luminous elements may range from 25 to 500 square inches. In calculating the discomfort glare we use solid angle ω because it includes the actual area (A), a foreshortening factor ($\cos \Theta$), and the distance (D) between the observer's eyes and the source: $\omega = A \cos \Theta / D^2$. In this example (of a large room) the range of solid angle is from 0.00002 to 0.093 steradian.

The position factor (P) is important, also, and similarly complex, because our sensitivity to discomfort glare depends upon where the luminaire is located. We are more sensitive to brightnesses located to the side of us than to those located above the line of sight.

An important part of this glare evaluation procedure is that all luminous areas are included in the determination of the field brightness — i.e. the brightnesses of walls, floor, ceiling, and luminaires. These are given weighting factors in accordance with how much of the field of view is occupied by each. It may seem contradictory to some people to include the luminaires in this, but experimental data show that they do contribute to the general field brightness as well as to producing visual discomfort.

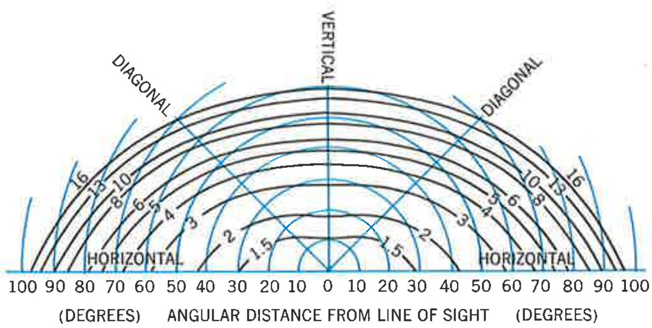
The big problem, after developing a formula for rating a single source (which many researchers have done), has been to find out how to apply it to lighting installations involving anywhere from two to several hundred luminaires. This hasn't been easy, but we think we have it.

A New . . . And Practical Formula

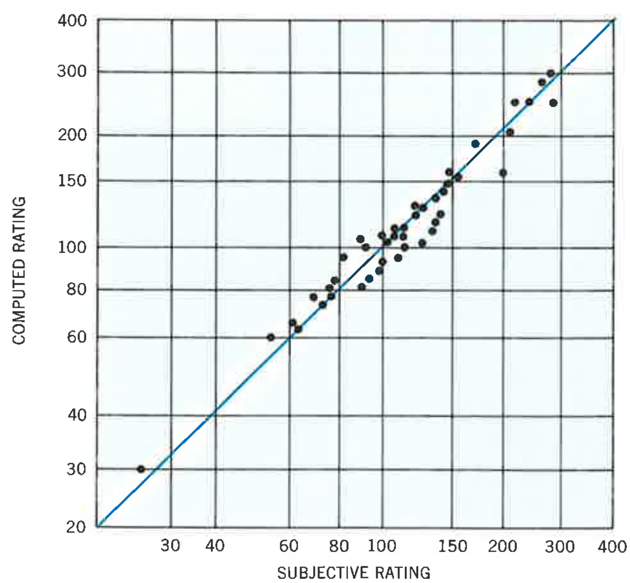
During the course of many investigations, we have obtained subjective evaluations of a wide variety of lighting systems — applying what we had learned in the development of the Discomfort Glare Index. An analysis of these data resulted in a unique variable exponent procedure for obtaining the over-all rating of a lighting installation. It amounts to adding up the individual ratings computed for each of the luminaires in the test and in applying to this sum our exponent that is a function of the number of luminaires involved in the system being evaluated.

The *Discomfort Glare Rating* formula is expressed as m_t^a. The exponent range is from 0.939 for two units to 0.616 for 200 units. It becomes progressively less for larger numbers of units. We were pleased, of course, to discover that the ratings given the systems by the observers, and the ratings determined by computation were very close.

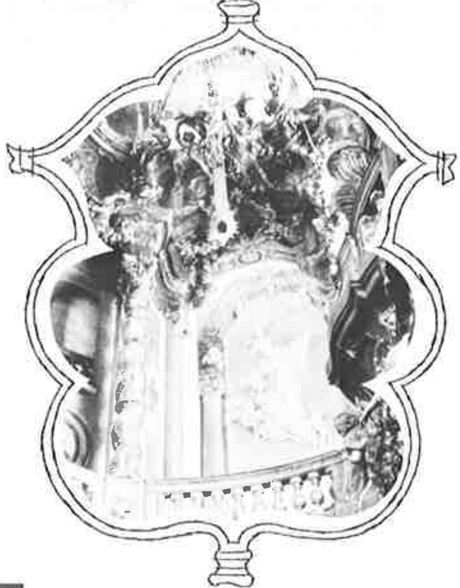
The development of this formula not only enabled us to attach real significance to computed ratings, but also revealed that subdivision (for computational convenience) of large areas, such as luminous ceilings was not a significant factor.



When a source is located 45 degrees above the line of sight, it can be seven times as bright as one viewed directly. However, when this same light source is located 45 degrees to one side of the line of sight, its brightness can only be doubled. This differential sensitivity (the "P" factor in the Discomfort Glare Index formula) must be included for proper appraisal of the contribution of the luminaires located anywhere in the field of view.



Computerized data are represented by the solid line. The white space on either side represents the accepted 10 per cent range of deviation. Almost all of the subjective ratings of a given condition of BCD fall within this range.



State of the Art

Time was when I could list the names of lighting designers and of architects really interested in electric lighting on the fingers of one hand. Lighting was considered the province of the engineer — a science . . . . and only a science. Yet, the pioneers in lighting design preached, almost from the beginning of the electric lamp, the beauty and art that could result from knowing the subject well.

Architect: Frank D. Winder
Lighting Consultant: Sylvan R. Shemitz

Change

Furthering the art *and* the science of lighting was the objective of the few. The many listened only to the words of science and engineering. It was necessary to listen, of course, because science provides the foundation for art created wisely and well. But a change is coming. It can be attributed to many things — a general awareness of what the term "luminous environment" means . . . . a more affluent society aware of and willing to invest in art in all its forms . . . . the lower cost of electricity . . . . new, readily available tools and equipment . . . . a new generation of leaders willing to adapt tested techniques to their ideas.

Ears and Attitudes

The new generation of leaders actually includes many men who have been trying to establish the art for years — but there are comparatively few of them. Some of the younger designers are beginning

Bertrand Goldberg, Associates

Hamel and Langer Lighting Consultants
New York World's Fair, **1964-1965**

to specialize — some in commercial interiors; some in landscape illumination; some in floodlighting monumental buildings; some in residential areas. Interior designers are beginning to visualize the luminous environment as one that can be manipulated to enhance their designs. Architects are rediscovering lighting as a design medium and as a determinant of architecture.

So . . . .

The lighting industry — at least many people in it — have said for years that properly designed and manipulated electric lighting can aid the architect and the designer in creating beauty. It required the specialized knowledge and training that these people could contribute to awaken a response in the lay public.

Lighting design is not quite such a hazardous occupation as it once was . . . . in terms of making a living. It has a long way to go, admittedly, but at least the trail has been blazed and the signposts are up. Even the road, in some places, is well trodden. When science and engineering are reinforced with the creativity and knowledge of other professions, we are really on our way.

W.D. Riddle A.I.A

Note: photographs from standing files were selected to illustrate different types of lighting effects and installations. They by no means represent all of the work of the many architects and designers active today—ed.

Architects: Curtis and Davis
Lighting Designer: Seymour Evans, Associates

John Watson
Landscape Illuminator

Architect: Minoru Yamasaki

Interior Designer: Alexander Girard
Lighting Designer: Richard Kelly

GENERAL ELECTRIC