

On The Verge of a Revolution: Current Trends in Library Lighting

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HISTORICALLY, TOO LITTLE REGARD has been given to lighting in the design of many buildings. This results in part from the attitude among facility planners who see lighting as something to be engineered but not designed. Two forces, however, that have begun favorably to change this attitude are energy consciousness and the belief that better design brings lasting added value to architecture.

Consequently, lighting technology has made rapid progress in response to energy efficiency and has improved the quality of the interior environment, promising to revolutionize the common perception of lighting in buildings.

The architectural aspects of effective library lighting present a somewhat unique problem when compared to other building types. Diversified functions, with very distinct needs for quantity and quality of light, have precluded a uniform application of one type of lighting from being totally effective in typical library design applications. Only recently has available technology been coherently incorporated into building design. It is the intention of this article to further advance the integration of technology and functional requirements by assisting in library planning with respect to lighting.

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In an attempt to give the reader an overview of some of the available tools in lighting design, this article begins by touching very briefly upon the technical aspects of light and light sources currently being utilized. The article also investigates the options available in utilizing these lighting tools through a survey of library buildings that have successfully integrated recent technology with function in one or more applications. Finally, the article concludes with specific recommendations for the various functional requirements of a library. With the advent of technologies that enhance the dissemination of information—as well as the distribution of light—there is every reason to believe that through conscious planning, an environment can be designed to accommodate specific tasks with optimum quantities and qualities of light while enhancing the architectural expression of that environment.

The Physics of Light

The fundamental elements of physics that allow an individual to experience light—that is, to see—are too complex to comprehensively delineate in this limited space. So, for the purposes of this discussion, only those aspects critical to facility planning will be emphasized. Foremost of these fundamental aspects is light *intensity*, or quantity. A byproduct of intensity is visual *contrast* which is enhanced by the *brightness* of a given object. One of the most annoying byproducts of light is *glare*. These four items should be understood before effective planning and design can commence.

Intensity

While the most commonly known measurement of light quantity is the footcandle, it is only a two-dimensional criteria and needs to be viewed in relation to other issues. The lumen is the unit that is the true fundamental standard for measuring light energy.¹ In physical terms the lumen is defined as the amount of luminous energy radiating from one square foot of surface area of an imaginary sphere, two feet in diameter, surrounding the light source. In essence the lumen measures light at the source. A footcandle is a measurement of luminous energy at the surface upon which it falls and is defined as one lumen of light energy incident upon one square foot of surface area.² Hence, a footcandle measures the density of light, and since light is a radiant form of energy, the further light travels the more area it covers and the less density it has.

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Brightness

In terms of performing general tasks, such as reading and writing, the brightness or luminance of the subject surface is obviously affected by light intensity. It is generally considered that the higher luminance an object has the greater the visual performance is enhanced.³ It is this philosophy that in the past has led to an inappropriate response of virtually showering reading areas with large quantities of light with the

at hand.) While in many instances quantity of glare may be directly related to quantity of light, location (viewing angle) and size of the light source have obvious contributions to the amount of glare one perceives.

An index for calculating total glare source contributions is known as Visual Comfort Probability (VCP).⁸ Somewhat an inverse to the sum of glare quantity, the VCP rating of a lighted environment, ranging from zero to one hundred, is based on the number of people finding that environment comfortable. A VCP of seventy is considered good, meaning seventy of one hundred normal viewers would find the given visual environment comfortable. The criterion for calculating the VCP of various sources has been established by the Illuminating Engineers Society (IES) and contains a list of conditions too extensive to include here. It is important to note, however, that the IES criterion is somewhat limited in that it tends to take into account a certain degree of uniformity and presumption, and so tabulated VCP values tend to reflect the worst case in an environment.

Another gauge of lighting quantity developed by the IES is a criterion known as Equivalent Sphere Illumination (ESI).⁹ Virtually replacing the raw footcandle as the standard measurement of light at the task surface, ESI footcandle values compare contrast rendition based on optimum, laboratory test-condition light. This optimal lighting is based on a theoretical illuminated sphere that surrounds the task from which emanates a uniformly distributed light similar to light of the semispherical sky dome during daytime. Like VCP values, calculated ESI values have limitations since they are based upon a set of constant assumptions, and they are therefore inclined toward the worst condition in a given situation.

Light Sources

With this abbreviated overview of the fundamentals of light, attention will be turned to light sources commonly utilized in building design. The primary characteristics that differentiate one light source from another are basically threefold: initial cost, operational efficiency, and color rendition. Since long-term operational costs far outweigh first-cost of any type of light fixture, consideration will be given to efficiency (quantity per unit of energy) and color characteristics (quality related to the full spectrum of light energy) of these light sources.

In order to measure the efficiency of a light source, the amount of lumens produced by each watt of electricity is determined and is called lumens per watt. Artificial light sources have varying lumens per watt average ratios ranging from 7 to over 180.¹⁰

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The types of light sources utilized today can be categorized in several different ways, but for the purposes of this discussion they will be divided into groups of traditional and nontraditional types as follows:

<i>Traditional</i>	<i>Nontraditional</i>
Daylight	Metal Halide
Incandescent	Mercury Vapor
Fluorescent	Pressurized Sodium

One of the aspects reinforcing this division is the performance characteristics of each of these two categories. The nontraditional sources are also known as High-Intensity Discharge (HID) sources and will be discussed in more detail later.

Daylight

Daylight is the baseline against which the quality of all other light sources is judged. It is accepted that the color rendition of daylight is as accurate as is physically possible, though dusk and dawn daylight tend to appear more orange. It is also generally accepted that the price of daylight is free, but in a comprehensive energy analysis, heat losses and gains through glass and air infiltration around window frames generate some energy costs that may begin to offset the savings of using natural light to augment artificial light.¹¹

By nature, daylight is generally an indirect type of light in that it is usually reflected off or through many surfaces by the time it reaches a task surface. This characteristic, coupled with the quality of color rendition, is what makes natural light so attractive. However, there are problems that daylight presents as well. Certainly daylight is not as readily controllable as an artificial light source. And because the sun itself, even when filtered through thousands of miles and many layers of atmosphere, is such an intense source of light, brightness caused by even diffuse sunlight greatly exceeds that produced by artificial sources. This differential is commonly controlled by window blinds or by the location of the window aperture, but it must be addressed if successful application of daylight is to be achieved.

Incandescent

The working concept of the incandescent light bulb has not changed significantly since the days of Edison. Incandescent light is produced by sending electrical current through a filament element in order to heat it to temperatures high enough to make it glow. The color rendition of incandescent light is close to that of daylight yielding a yellow to white light on neutral surfaces. But while the initial cost of a

traditional light bulb is relatively low, the energy costs of operating an incandescent light are high, thereby making it the least efficient light source on the market outside of candle power. Only 10 percent of power input into incandescent bulbs is converted into visible radiation or light.¹²

The most efficient type of incandescent light is the tungsten-halogen lamp. A tungsten filament is regenerated by halogen gas inside a small tube, which enhances efficiency. Projector and reflector lamps are other types of incandescents that focus light into a beam (much like an automobile headlight) with the use of a reflective directional surface built into the lamp itself.

Fluorescent

The introduction of fluorescent lighting fixtures to modern architecture occurred about twenty-five years ago. Much more efficient than incandescent light, the fluorescent fixture utilizes an electric ballast to energize gas within a tube to produce light. Although early fluorescent tubes did not match incandescent light in terms of color rendition, recent developments have virtually color corrected fluorescent lighting, albeit at a cost of some reduced efficiency. In general, 22 percent of total energy input into fluorescent fixtures is converted to light.¹³

High-Intensity Discharge

Like fluorescent light, HID sources are ballasted energized gases within a tube. Unlike fluorescent light, these HID tubes tend to be much smaller in size while producing larger quantities of light in higher intensities—hence the term high-intensity discharge. A drawback of HID lighting is a prolonged warm-up time. Unlike incandescent and fluorescent luminaires which reach full capacity luminance almost instantaneously after switching them on, HID lamps can take several minutes before reaching full intensity. The significant differences between the various HID sources are their gaseous medium and their performance characteristics. Because of their intensity, HID light sources tend to be much more efficient but also may require different types of applications from traditional sources.

Mercury Vapor

The least efficient of the HID sources, mercury vapor lamps, tend to be less efficient than the most energy efficient fluorescents, converting only about 15 percent of input power into visible light. Clear mercury vapor lamps yield a predominantly blue-green light. However, color

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corrected lamps in mercury vapor have been developed by coating the inside of the lamp like fluorescents. These lamps result in lower operational outputs. Warm-up times for mercury vapor lamps span five to seven minutes.¹⁴

Metal Halide

Highly efficient and good color rendition, metal halide lamps convert almost 25 percent of input power into visible radiation. While metal halide lamps take only five minutes to warm up, they are extremely sensitive to burning position and must be installed correctly to achieve their full potential.¹⁵

Pressurized Sodium

Even more efficient than metal halide, these lamps can be categorized as two types: high-pressure and low-pressure sodium. High-pressure sodium lamps tend to give off a golden-white light rendering red objects orange and blue and green objects gray. Warm-up time for these lamps is about four minutes, while they yield almost 30 percent visible light energy. Low-pressure sodium lamps have the highest efficiency, converting over 35 percent of power input into light. However, these lamps emit a monochromatic yellow light and are generally only suited for exterior applications. Like metal halides, low-pressure sodium lamps are also very sensitive to burning position. Starting time to full lamp brightness can range from seven to fifteen minutes.¹⁶ Table I provides a summarized comparison of these various light sources and cites the efficiency and life expectancy of various types of lamps.

Lighting Applications

Having reviewed the characteristics of light and the various sources available for use, attention can now be turned to the choices in application. There are two extremes of lighting application—direct lighting and indirect lighting—with various combinations in between. While these describe the direction of light itself, consideration must also be given to the mounting of the light fixture. These possibilities include recessed, surface mounted, pendant mounted, track lighting, and free-standing luminaires. Mountings can be on ceilings, walls, floors, and even integrated into furniture, with varying possibilities of the quality and amount of direct and indirect light produced. In general, a fixture includes a lamp and its housing and may include some type of a reflector

TABLE 1
COMPARISON OF LIGHT SOURCES

<i>Source</i>	<i>Watts</i>	<i>Initial Lumens</i>	<i>Lumens per Watt</i>	<i>Life in Hours</i>
Incandescent				
general-service lamps	60	870	14.5	1,000
	300	6,360	21.2	750
projector lamps	75	765	10.2	2,000
	500	7,650	15.3	4,000
tungsten-halogen lamps	75	1,600	21.0	2,000
	500	10,700	21.4	2,000
reflector lamps	30	210	7.0	2,000
	500	6,500	13.0	2,000
Fluorescent				
rapid start tubes	40	3,150	78.8	20,000
slimline tubes	75	6,400	85.3	12,000
high output tubes	60	4,300	71.7	12,000
	110	9,200	83.6	12,000
very high output tubes	110	7,450	67.7	12,000
	215	16,000	74.4	12,000
Mercury Vapor				
clear, vertical mount lamps	75	2,700	36.0	16,000
color improved, vertical	1000	55,000	55.0	24,000
clear, vertical	1000	57,000	57.0	24,000
Metal Halide				
clear, vertical mount lamps	175	14,000	80.0	7,500
	400	34,000	85.0	15,000
	1500	155,000	104.0	3,000
High-Pressure Sodium				
clear lamps	70	5,800	82.9	24,000
	1000	140,000	140.0	24,000
Low-Pressure Sodium				
monochromatic yellow lamps	35	4,650	132.8	18,000
	180	33,000	183.3	18,000

Source: Sorcar, Prafulla C. *Energy Saving Lighting Systems*. New York: Van Nostrand Reinhold Company, Inc., 1982.

and a lens to control light distribution. Light distribution characteristics depend not only on the fixture itself, but also on the color and texture of the surfaces surrounding the fixture.

Direct Lighting

For years the primary application of incandescent and fluorescent light in libraries has been in direct lighting. Usually achieved by fix-

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tures mounted at the ceiling, these applications often serve as general lighting as well as task lighting by supplying enough light intensity to the work surface to accommodate most any task. As energy consumption has become more scrutinized in facility planning, this strategy of lighting, or by integrated or luminous ceilings, has given way to more direct lighting at the work surface itself. The ability to switch these types of remote lights on and off as use dictates results in potential energy savings.

Indirect Lighting

Possibly because of uncertainties of either how to measure quantities or of its behavioral characteristics, indirect light has not been widely utilized until recently. By its very nature, indirect light is diffused as it is reflected off surrounding surfaces and therefore tends to reduce glare and brightness contrasts. Almost by default, direct lighting produces indirect light as it bounces around an environment. Indirect lighting is the intentional application of light that is to be controlled by reflecting it off surfaces whose color and texture are also controlled. As stated earlier, almost any functional utilization of daylight is in an indirect fashion because direct sunlight can have uncomfortable or even damaging side effects. Indirect lighting, especially when using artificial sources, is often referred to as ambient lighting.

The pleasant characteristic of indirect light is that it is reflected off surfaces and actually comes from many directions. This multidirectional aspect, also known as diffusion, tends to reduce shadowing. Diffuse light can come from direct light sources too, providing a louver or lens covers the light source and diffracts the light into many directions. Most fluorescent fixtures currently in use have some sort of diffusing lens that aids in reducing direct and reflected glare and severe shadowing. The following considerations should be addressed in the planning of any facility:

1. Different quantities of light are appropriate for different types of tasks.
2. The quality of light, more than the intensity, has a direct bearing on the functionality of that light.
3. Quality is affected by many conditions including:
 - a. Brightness ratios between the task surface and immediate surroundings as well as background surroundings.
 - b. Direct glare caused by direct light quantity, brightness, and viewing angle.

- c. Reflected glare caused by the angle, color, and texture of the task surface.
- d. The directional characteristics of the light, being either singular in origin or diffuse and multidirectional.

Libraries with Successful Lighting

Quality of light is as much a concern, if not more so, than quantity. Planning quality lighting of a library takes time, and it is a part of the design process that has often been neglected or eliminated altogether. There have been many successful attempts to integrate quality lighting design with the diverse functional requirements of a typical library. A brief examination of a few significant library projects will yield a clearer concept of successful lighting applications in recent library design. The manner in which each achieves satisfactory results may differ—a testimony to the technology available and to the ingenuity and conviction of their architects, lighting designers, and clients.

Daylight plays a significant role in most of these libraries. When it is combined with other artificial lighting types in mutually complementary ways, the result is often a memorable and functional interior space. The range of applications spans from decorative custom task lighting, to highly specialized stack lighting, and finally to general ambient daylighting of the primary public spaces.

The San Juan Capistrano Regional Branch Library

The San Juan Capistrano Regional Library in California¹⁷ employs both daylight and incandescent light sources in subtle ways. The incandescent fixtures, custom designed by architect Michael Graves, solve a variety of functional needs. These include general room illumination from suspended pendants and decorative wall sconces, in addition to task/reading lighting from table lamps. Daylight is introduced into the interior spaces primarily from above via light monitors and clerestory windows. These monitors are a major design element in that they create distinctive pyramidal ceiling coffers that give a soft, diffused illumination from both the artificial and natural light sources (see fig. 1). The handling of light recalls the Mediterranean tradition of introducing light to interior spaces indirectly and sparingly.

Opened in December of 1983, the San Juan Branch consists of 14,000 square feet on one level. The library was designed by architect Michael Graves who won the commission through a design competition.

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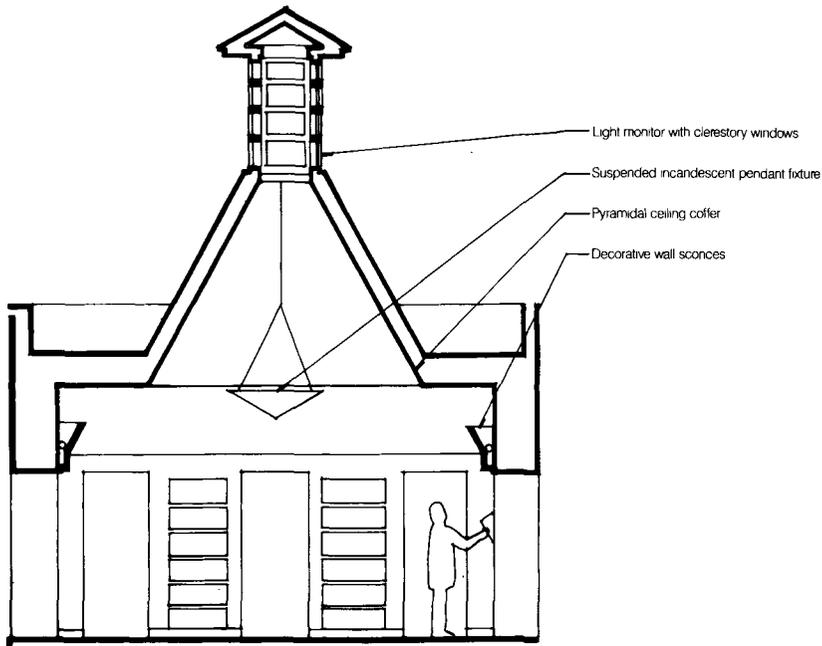


Figure 1. Reading Room Cross-Section, San Jaun Capistrano Regional Branch Library

The Seeley G. Mudd Library

Another project which uses light sparingly—this time artificial light—is the Seeley G. Mudd Library at Yale University.¹⁸ Daylight is confined only to a small number of perimeter study carrels which are separated from the larger reading rooms by near ceiling-height shelf partitions. These shelf units are lit by unique fluorescent fixtures with parabolic lenses which extend from the top of each unit on two metal arms. Light is distributed evenly over all the shelves, from top to bottom, as the fixtures are designed and located so as not to cast a shadow from anyone selecting a book.

The reading tables and study carrels in the Mudd Library also provide a unique solution to the requirements for task and general lighting. Both light sources are located in the same fluorescent fixture suspended eighteen inches above the center point of each table (see fig. 2). The task light shines down onto the tabletop while the ambient room

light shines from the top, casting a soft warm glow on the exposed concrete ceiling above (there are no light fixtures mounted on the ceiling). The effect is a very sophisticated reading environment with only the shelves and tabletops brightly lit and the remainder of the space being subtly rendered as a neutral background.

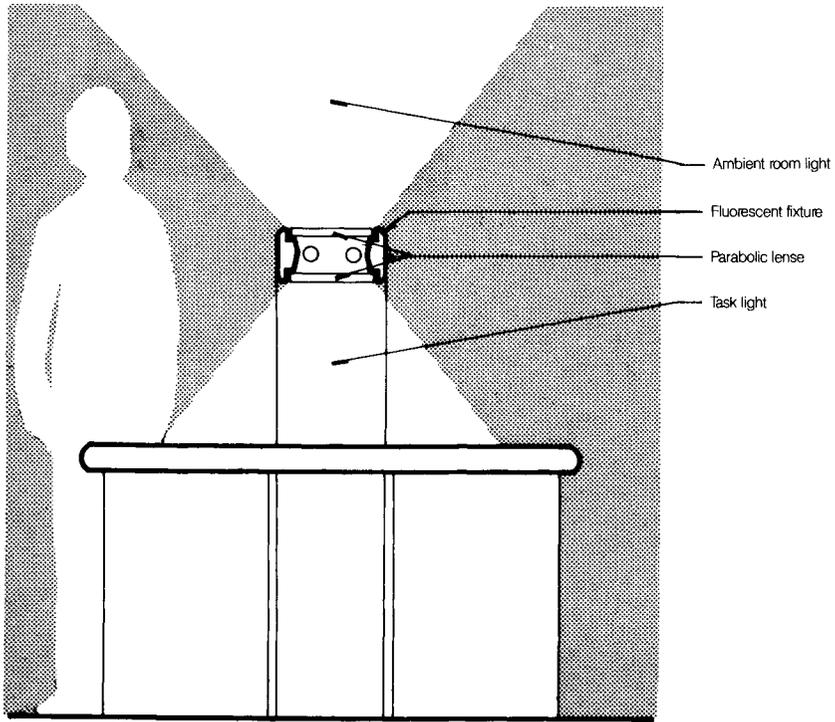


Figure 2. Reading Table Cross-Section, Seeley G. Mudd Library

The Mudd Library was designed for Yale by the firm of Ross and Moore Architects. Housing 1.6 million volumes on four levels, the 75,000 square foot library was open for operation in 1983.

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The Conrad Sulzer Regional Library

By contrast to the preceding projects, the Conrad Sulzer Regional Library in Chicago¹⁹ is an exuberant expression of light, from the oval entry lobby to the double-story reading room—both lit from above by a continuous skylight. The reading room also boasts a perimeter wall that is so evenly distributed with windows as to dispense with the need for artificial lighting on most days (see fig. 3). Suspended HID metal halide uplights and task lights at the reading tables provide lighting at night. The interior color scheme of lightly accented ceilings, walls, low partitions, and furnishings greatly reinforce the character of the interior

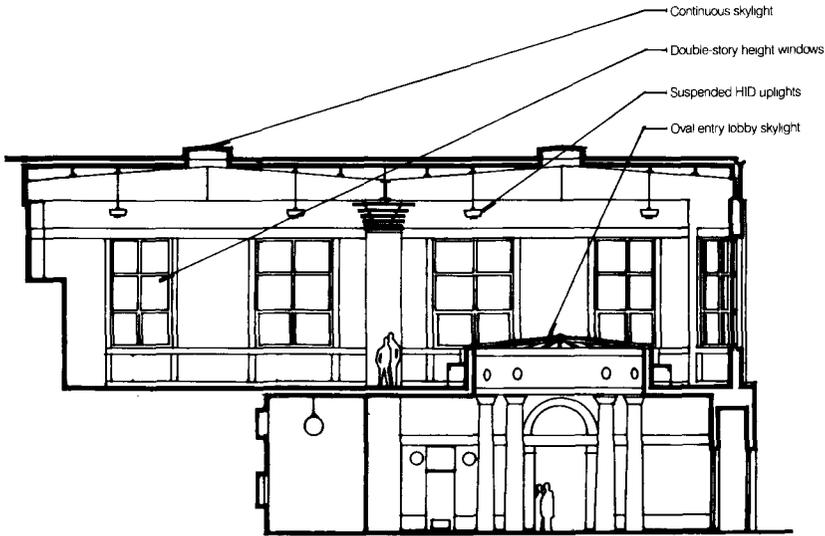


Figure 3. Building Cross-Section, Conrad Sulzer Regional Library

spaces by reflecting this indirect light throughout the space. And, despite the open airy feeling of the interior, only 24 percent of the exterior wall is given over to windows—a relatively low percentage.

Located in Chicago, the Conrad Sulzer Library includes 65,000 square feet on three floors and a mezzanine. Architects for the project were Joseph W. Casserly, city architect, and Hammond Beeby and Babka, Inc., consulting architects.

The Frances Howard Goldwyn Hollywood Regional Library

The Goldwyn Hollywood Library,²⁰ located in Hollywood, California, opened for operation in June of 1986. Designed by Frank O. Gehry & Associates, the library contains slightly over 19,000 square feet of space on two levels.

Similar to the Sulzer Library, the most striking aspect of lighting application in the Goldwyn Library is the abundance of natural light. An extensive number of exterior windows, particularly in the second floor reading rooms, creates a pleasant, spacious environment. Most of the window area, outfitted with tinted glass, is located at the front of the building. The double-story reading rooms, and the clerestory windows integrated there, allow for the light to be reflected off the white walls and ceilings, penetrating into the stack area toward the rear of the building (see fig. 4). The overall effect is of an abundance of diffuse sunlight, negating the need for task lighting during daytime hours.

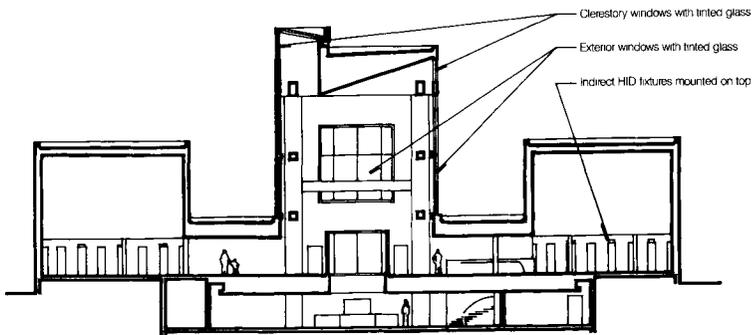


Figure 4. Building Cross-Section, Frances Howard Goldwyn Hollywood Regional Library

Another successful characteristic of the Goldwyn Library's lighting design is the provision for stack lighting. Since these areas only partially benefit from the extensive daylight found in the reading rooms, they are lit with indirect HID metal halide fixtures mounted on top of the shelves, reflecting light off the white ceiling down between the shelves below. The effect here is again a good diffuse light, certainly ample for a stack area. These fixtures are staggered on top of the shelves

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in a checkerboard-like pattern to facilitate even distribution of light throughout the area without shadows being cast by the stacks. And because they are mounted on the stacks themselves, when the stack moves the light moves thereby facilitating the flexible spacing of shelving.

One aspect of the Goldwyn Library that is particularly disappointing, however, is the apparent lack of consideration given to the function and location of the microfilm readers in the library. Located in an opening between the reading room and stack area, the reader screens are washed with sunlight, creating glare on the screen. The inability to control the light shining upon the screen *v.* the brightness of the screen itself, as well as the light on task surfaces around the reader, create a problematic work area lacking the functional and aesthetic quality of the majority of the other spaces in the Goldwyn Library.

University of Michigan Law Library Addition

A similar attitude toward abundant daylighting in library interiors is shared by architect Gunnar Birkerts in his 77,000 square foot addition to the Legal Research Building at the University of Michigan, completed in 1981.²¹ The addition is underground and the major source of daylight is a V-shaped moat that stretches along two sides of the older existing building. Light rebounds from limestone panels on one side of the moat through reflective glass on the other side and into the new library. Short-term study carrels are located continuously along this glass perimeter. The remainder of each open floor consists of ceiling-mounted fluorescent fixtures over reading tables and stacks. The significance of this project lies in the successful introduction of daylight into an underground building—a design challenge which could easily have resulted in an oppressive sense of burial for the building users.

The Folger Shakespeare Library Additions

The Folger has long been the site of one of the most extensive rare document collections in the world.²² Located on Capitol Hill in Washington, D.C., the Folger began an architectural expansion program in 1975 culminating in the opening of a second reading room in January of 1983. The additions, in two phases, added over 22,000 square feet to the renovated 68,000 square feet of the original building. The firm of Hartman-Cox Architects served as the designers of the additions which are comprised of two floors below ground and two floors above.

In contrast to the Sulzer and Goldwyn libraries, the daylight sources in the second reading room, the primary space of the Folger

additions, are mostly obscured from view. This strategy stems from both practical and artistic concerns in that the fragile nature of the documents and art utilized in the space must be protected from direct sunlight. Therefore, the long walls and the barrel vault that stops short of spanning between these walls are bathed in light from tinted glass clerestory windows and skylights located behind and above the vault respectively (see fig. 5). This light is augmented by incandescent lamps mounted between wall and vault and by task lamps at the reading tables. The effect is probably the most dramatic use of diffuse light cited in these case studies, a drama certainly appropriate to this Shakespearean setting.

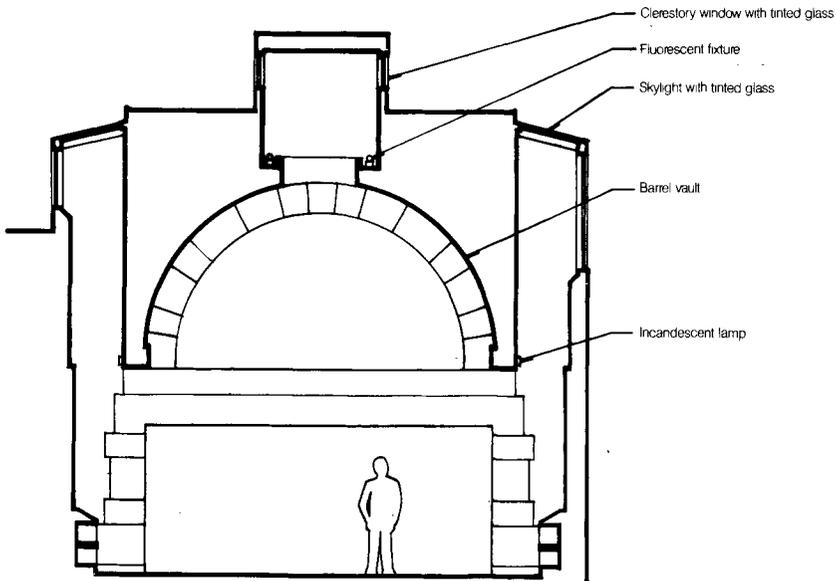


Figure 5. Reading Room Cross-Section, Folger Shakespeare Library Addition

Daylight as a Resource

In summary, the characteristics exhibited by this group of facilities can be distilled into three general categories. First, each library was chosen to be represented here because of the quality of light demonstrated in one or more applications in the facility. Second, most were

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relatively small in size, averaging 12,000 square feet of area per floor. Third, this size factor enabled each to use daylight to some degree of effectiveness—if not extensively—because of the ability of that light to penetrate the building. Daylight contributes to the perceived quality of most any working environment. It is granted that larger, centralized, urban libraries may not enjoy the opportunity to deploy typical floors of 10,000 square feet, but the opportunity always exists to employ daylight, a strategy that is apparently as cost effective as it is pleasing.

For these reasons, the authors highly recommend the use of daylight to the largest extent possible in any facility design and not solely for reasons of quality, but because utilizing natural light can reduce the number of fixtures required in lighting a building while dramatically impacting operating costs. Studies have shown that, when properly introduced, daylight can save over 50 percent of the energy required to light a building with standard lighting techniques.²³ This savings results not only from a reduction in energy used directly for lighting, but also in the reduced heat load experienced with the utilization of fewer luminaires.

Specific recommendations for the incorporation of natural light into a building have architectural implications that involve aspects such as building configuration, exterior window placement and shading, and climate and solar orientation—items not exclusively related to lighting the interior. Related issues that should be addressed when planning to utilize daylight in a facility are:

1. Multiple, smaller openings are desirable over few, larger apertures.
2. Light should be introduced high on the exterior wall or at the ceiling.
3. Direct sunlight beams should be avoided by using building elements to diffuse the light, preferably prior to entering the interior.
4. The color and texture of all surfaces in the interior should be coordinated to balance reflectance, contrast, and aesthetic considerations.

When properly planned, daylight can provide task lighting as well as ambient light, but in any case it should be utilized whenever and wherever possible.

Planning Light

With concern for natural or artificial lighting, the authors recommend that the planning strategy for the deployment of light should be to utilize low levels for general, ambient lighting while directing higher

levels to task-specific areas. Again, energy savings of over 15 percent can be realized by directing light to where it is needed rather than relying on general lighting systems to provide levels sufficient for task performance as well. The key to this strategy is giving the user and the librarian more control over the switching of light fixtures. This, coupled with flexibility of light placement, can reduce the number of lamps and the duration of their use.

Flexibility is also key in the planning of most any new facility constructed today or in the future. The need to change interior configuration to meet expanding technology and related user sophistication is critical in long-range planning of library systems as well as individual buildings. Hence, it is paramount to maximize building lifetime through planned flexibility.

With respect to lighting, fixtures that are movable are obviously more flexible, but since furnishings and displays are also movable, we would tend to recommend luminaires that are both task related and ambient in quality and that are incorporated into furniture. This type of consolidation has obvious benefits but also implies the unlimited placement of power cabling within the facility, a requirement that must be carefully considered. Current technology of trench ducts, energized floors, or under-carpet flatwire certainly makes this power connection possible, however at a cost presently higher than conventional power distribution. In the overall process of facility planning, these considerations must be weighed with appropriate value for the given situation.

In a holistic approach to lighting, all of the issues raised in this article, as well as numerous other technical and aesthetic considerations, bear upon final decisions on how to light a given space. However, cost and function tend to take on the largest order of magnitude in the majority of facility planning scenarios. Since HID lamps prove most efficient, and metal halide renders the best color, this combination seems a logical choice to utilize for general lighting purposes. Furthermore, since indirect light yields a more diffuse light with lesser associated problems of glare, indirect applications should be deployed wherever possible. Additionally, since luminaires that can be directed toward specific needs enable a reduction in the quantity of fixtures and the energy to light and to cool, flexible, adaptable lighting is both functional and cost effective. So, for reasons of energy efficiency, quality of light, and flexibility, we make the following recommendations for artificial lighting of specific functional areas of a library.

Book Stacks. Metal halide lamps in HID indirect uplights reflected off a light colored ceiling at least two feet above the fixture can

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provide a good diffuse light distributed evenly throughout the stack area. Books on top shelves are not subjected to direct light that might discolor or damage them. Also, if the fixtures are mounted on top of the shelves, spacing of the shelves is not predicated on the spacing of light fixtures, rather vice versa.

Office or Work Areas. With the advent of modular, open office systems furnishings has come a problem with fixed location lighting at the ceiling. Utilizing luminaires mounted on movable partitions that incorporate both a downward task light, as well as an upward ambient light, can free the ceiling of inflexible light distribution while providing light where it is needed. This combination task/ambient lighting application has proven effective from a flexibility standpoint, as well as for energy savings, by taking advantage of the characteristic of light projecting radially in all directions. However, since most partitions are equal to or below eye-level, a diffusing louver is recommended for the upward opening in the fixture in order to eliminate direct and indirect glare.²⁴

*Microfilm Readers and VDTs.*²⁵ Similar to generic workstations, VDT stations require specific task lighting and can utilize a task/ambient fixture. Because these areas require a greater control of contrast of surroundings, however, a second fixture should be introduced to wash the vertical surface behind the terminal (see fig. 6). This lighting application yields good task light along with a general lighting level that relies upon diffuse indirect light, virtually eliminating the possibility of glare upon the screen. A secondary consideration to glare concerns the VDT screen itself. Although various add-on devices have been manufactured to eliminate glare, the most effective procedure is to utilize what is known as a positive presentation screen. This produces dark characters on a light background—similar to standard book text—rather than the more common negative presentation of light on dark. Positive presentation reflects less direct glare by eliminating the contrast between the reflection and the dark background. It also relieves the strain associated with the eye fluctuating between light and dark backgrounds of hard copy and screen.

Study Carrels. Virtually identical to office cubicles in terms of lighting needs, care should be taken in selecting the color and texture of the finishes on study carrels. Light colors with matte finishes can provide a surface with good diffusing qualities for task/ambient lighting.²⁶

Reading Areas. If ceiling heights in these areas are so high as to preclude the effective use of combination task and ambient fixtures,

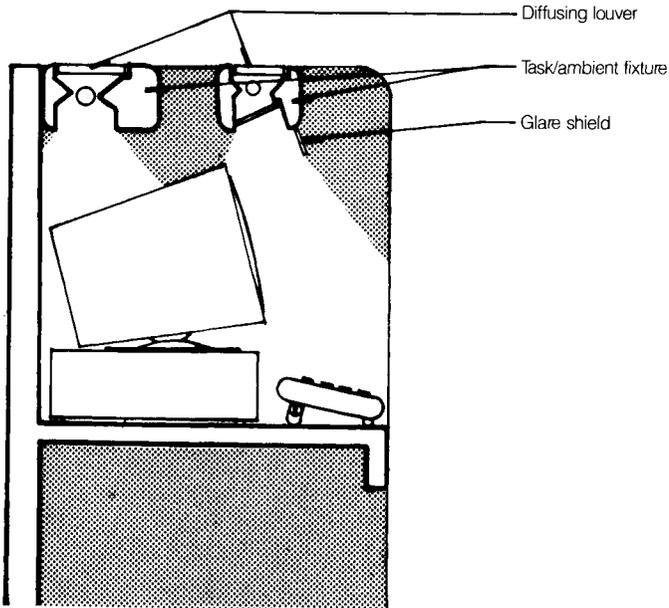
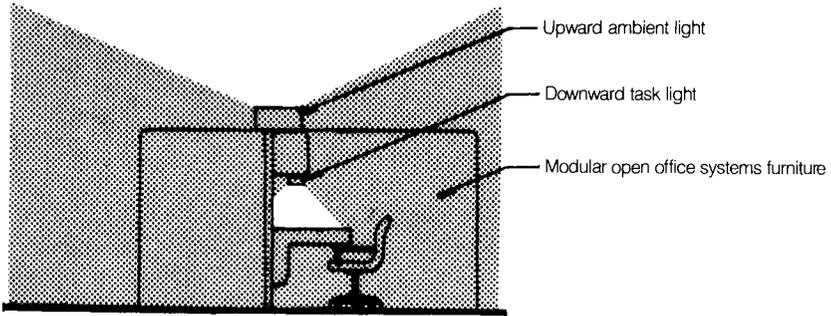


Figure 6. Task / Ambient Lighting at Video Display Terminals on Open Office Work Stations

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small desk lamps are recommended. Current availability of low-wattage, highly directable, compact incandescent lamps offer the user maximum control of the task light in a more efficient manner than traditional incandescent lamps while maintaining optimum color rendition.

Circulation Desk. If ceiling heights of a minimum of ten feet are achievable over the circulation desk, then HID indirect uplights are recommended. Lower ceilings do not allow the efficient reflection of HID light off the ceiling surface. Therefore, standard four foot fluorescent fixtures with parabolic louvers to diffuse the light are recommended since specific task lighting can conflict with staff interaction with users at the desk work surface.

Exhibits, Displays, and Art. For purposes of color rendition, incandescent light is the best artificial source to utilize in display lighting.²⁷ Adjustable track lights using high-intensity, low-wattage tungsten halogen lamps can be highly flexible and effective as directional spotlights. These fixtures have been developed as quite compact (some fitting in the palm of one's hand) so their use in limited or inconspicuous space is enhanced.²⁸

Storage Areas. Spaces affording the ability to switch off lights when not in use should utilize incandescent fixtures for limited application or fluorescent fixtures for larger areas. Warm-up time for HID fixtures precludes them from frequent switching. For fluorescent applications, parabolic louvers are recommended when affordable as they emit a pleasant, diffuse light with minimal glare.

Emergency Lighting. To enhance life safety, emergency lighting should be incorporated throughout the facility but most importantly in areas utilizing HID general lighting.

The Future of Lighting

Only the surface of the available physical and technical knowledge of lighting has been touched by this article. Before this publication goes to press, new advances will have been made in the field of optics and lighting that can only be chronicled through constant survey of technical and trade publications. Already, reconciliation of energy efficiency and color rendition of most lamps is being achieved and constantly improved.²⁹ Lamp sizes are becoming more compact. Low-wattage HID lamps are being introduced.³⁰ And computerized controls that allow automatic integration of artificial light in direct inverse proportion

with daylight or that switch lights on and off as people enter and leave a room are available at increasingly affordable prices.³¹ Even psychological research has spurred the development of lighting schemes that provide functional illumination while reinforcing positive environmental response with a sparkle effect.³²

Given all the technology in the world, however, it is still up to those persons responsible for planning a library to implement this technology and implement it wisely. Time must be budgeted into the planning and design processes to adequately integrate the design of the lighting with the design of the architecture. Input and participation needs to come from not only the architect, but from the librarian, the user, as well as the facility maintenance manager. Possibly most important, the early involvement of a lighting designer is critical as project goals are set and spatial concepts are developed. Through this involvement and interaction, the optimum use of ideas and technology can be incorporated into any facility to make it the best it can be.

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