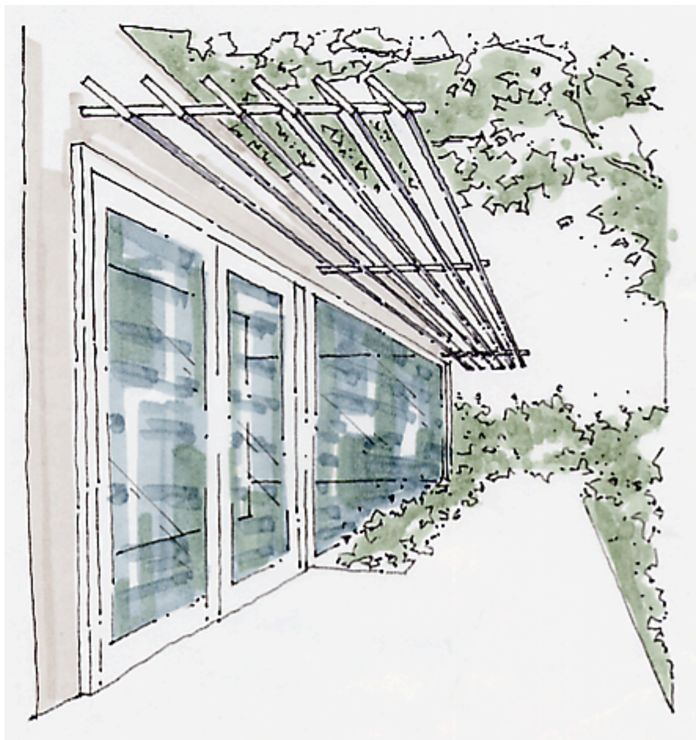
Daylighting Design in Libraries



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1. INTRODUCTION

The use of natural light, or *daylighting*, has traditionally been a desirable building feature and a hallmark of good design. When skillfully introduced, daylight creates an ambience of quiet contemplation and visual comfort, and links the modern library user psychologically with the pre-technological past. Memorable library spaces for centuries have been characterized by volumes and surfaces illuminated with natural light, providing glare-free light in reading spaces.

Daylighting design has recently taken on a new importance, beyond these esthetic and psychological aspects, with the advent of energy shortages and sustainability concerns. The alternative to daylighting, the use of electric power for library lighting, contributes to the strain on California's electric generation capacity as well as the inefficient use of non-renewable energy resources. Furthermore, the cost of lighting a library has become a major burden to communities and will continue to increase in the future. Daylight, which is free, provides the opportunity to greatly reduce these negative impacts created by the over-dependence on electric lighting sources.

Effective use of daylight in library design is both an art and a science. The intent of this article is to present the technical principles of daylighting design as a guide to library clients involved in a building design project, with some illustrations that suggest the esthetic possibilities within that framework.

2. DAYLIGHT BASICS

2.1 Background and Definitions

The light in a library must be adequate for the user to *see* a particular task, usually reading a book or the text on a computer screen. The first requirement is then for enough light energy, or *lumens*, distributed over the area of the page or the screen so that the information can be readable. That is, the light density or intensity on the reading surface must be a minimum amount; the unit of light density or *illumination* is the *foot-candle.* Professional organizations have set recommended standards for illumination levels in libraries (see Section 3.1 below); these include, for example, horizontal foot-candle level at tabletop height or vertical foot-candle level on the spine of a book in the stacks.

If this light energy is supplied by electric light fixtures, then there is a consumption of electric energy at a certain rate to supply a given level of light. The unit of electric power is the *watt*.

One measure of the efficiency of a light source is the ratio of the amount of light energy put out by the source for every watt of electric power consumed. This ratio, known as the *efficacy* of the source, provides a useful comparison of different sources of light.

Almost all of the light energy from an electric light fixture is converted to heat in the building, thus adding significantly to the cooling load. The *wattage* of a light fixture is therefore also a measure of the rate of heat injection into the space. The efficacy then can also be regarded as the ratio of the amount of light energy from a source to the *heat content* of that energy.

When sunlight enters the space through a window or skylight, it brings not only light energy (whether direct or indirect, but preferably indirect light in libraries), but also heat energy. This *solar heat gain* from daylight can be a burden on the building cooling system, and sunlight must be carefully controlled to avoid this. With good design, the daylight is not only a good source of light but also the most efficient. A calculation of the ratio of the amount of daylight typically available on a sunny day incident on one square foot of horizontal glass to the heat content of that incident sunlight gives an efficacy for daylight that is nearly twice as high as an efficient fluorescent lamp. (See Figure 1.)

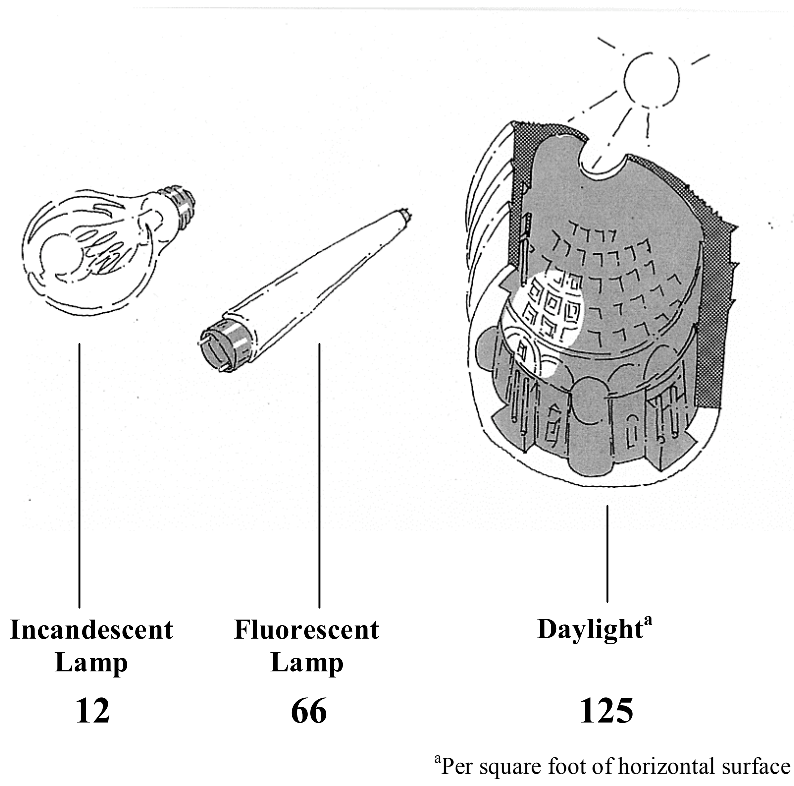


Figure 1. Relative Efficacy of Light Sources (Ratio of Number of Lumens of Light Energy per Watt of Power or Rate of Heat Energy Supplied).

These ratio numbers lead to the conclusion that if properly and carefully designed, daylighting techniques can both reduce electric energy demand for lighting as well as minimize loads on the cooling equipment due to lighting. Since sunlight is an intense source and has a substantial amount of heat content, daylighting design must be carried out with great care. Well-designed daylighting should be a design objective for any library project because of the obvious benefits.

2.2 Daylight and Electric Power

Daylight is superior to electric light sources in the measure of light source efficiency. Beyond the simple conclusion that well-designed daylighting can reduce electric energy use in libraries, there are two additional traits of daylighting that make its use compelling.

The first important fact is that the efficacy numbers are based on energy used *at the building*. If the total energy used to generate the electric power were accounted for, the electric light fixtures would have a dramatically lower efficacy. To create electric power at the electric generation plant, fuel is burned to drive turbines and about two-thirds of that energy is lost to the surrounding atmosphere in the form of heat. Only about one-third of that energy arrives at the building site in the form of electric energy, assuming the transmission losses are small.[1] (See Figure 2.)

Figure 2 also implies the second important fact about daylighting versus electric lighting, namely that daylighting energy is locally available at the site and it is *renewable*. New electric power (i.e., provided by new electric generation plants), on the other hand, is non-renewable.[2] Daylighting design is therefore an important component of sustainable (*green*) design of buildings.

[1] The California energy code is based on "source" energy for electric power, so this generation inefficiency is actually accounted for in the regulations.

[2] There is some hydropower in the California mix of source energy, but all new electric power in the state is typically of natural gas source. There is also some nuclear power in the mix of existing source energy. The key point here is that the construction of any new library is part of the creation of a growing demand for new electric power plants, with the associated cost to consumers, land use, river water impacts, air pollution, contribution to global warming, drilling of new oil and gas fields and the international politics of oil/gas. Daylighting mitigates of all these negative impacts, while failure to incorporate daylighting in a new building means that the building is contributing to these modern problems.

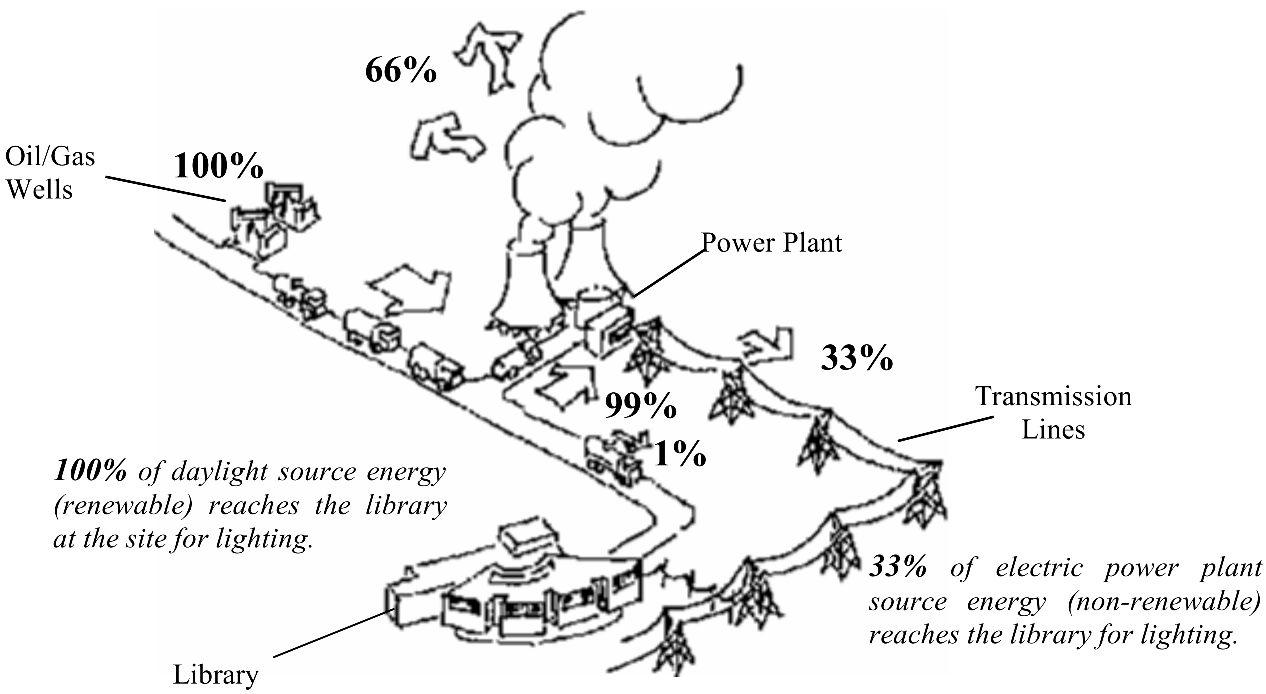


Figure 2. The built-in inefficiency of electric power generation for lighting buildings with non-renewable resources Two-thirds of the energy is lost during electrical generation at the power plant. 33% is transmitted to the building in the form of electricity and 1% as fuel for heating.

2.3 Physical Characteristics of Daylight

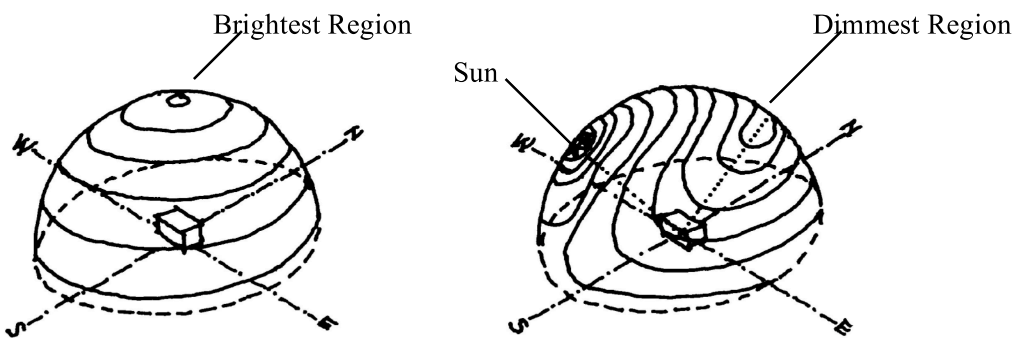
Daylighting design begins with an understanding of the physical characteristics of daylight. Controlling it and tailoring it for use in a library requires some knowledge of this energy media that is entering the building.

The fact that sunlight is so intense (at least at California latitudes) means that the sheer amount of daylight must be carefully limited and manipulated to avoid glare or heat gain problems. Design issues and methods pertaining to this daylight issue are discussed in Section 3 below.

As noted above, the first requirement for library lighting is to provide enough light to accomplish a visual task such as reading. For daylight, this means tuning the aperture designs to minimize solar heat gain while achieving the foot-candle levels required for visual acuity.

The second requirement is that the contrast brightness of other objects within the field of view must not be excessive, such that the library user can view the task comfortably and not become visually fatigued over time. In daylight design, glare conditions (i.e., when the brightness ratios of surfaces exceed visual comfort conditions) are avoided through aperture design, exterior sun control components and the placement of adjacent surfaces to balance the nearby surface brightness levels. A typical condition that can be observed in libraries with relatively poor daylighting design is that electric light fixtures are turned on during the day to overcome glare conditions created by windows or roof monitors and to balance the brightness distribution in the space. See Section 3 below for further discussion of this issue.

Another characteristic of daylight is its *variability*. The amount of daylight and its direction at the window or roof of a building vary during a typical day as the sun moves, and seasonally as the sun's predominant position in the sky changes. There is additional variation depending on sky conditions. Daylight direction on cloudy days is still variable, though the light is more diffuse than on a clear day. On overcast days, the daylight is uniform, though varying in absolute brightness somewhat from sunrise to sunset.[3] See Figure 3.



Overcast Day

Clear Day

Figure 3. Sky brightness distribution on overcast and clear days.

In general, people prefer variable light in the form of daylight and the connection it provides to the natural environment. However, it is important in libraries to maintain a relatively constant light level for visual tasks so that short term variability does not become distracting or inadequate. This is accomplished by using electric light fixtures for what they do well,

[3] Interestingly, the brightest area of the sky on a mildly cloudy day is actually in the north, opposite the position of the sun, due to the scattering effect of the clouds. In California, especially along the coast, this means that care should be taken to control glare in north-facing daylight apertures.

namely, provide a constant level of comfortable light, in coordination with the light available from daylight.

For roof apertures, the variability can actually be controlled fairly well through the shape of the openings, diffusing the incident light through multiple reflections off matte white surfaces so that the daylight becomes directionless from above. For wall apertures (primarily windows), the variability is an immutable condition, and to provide constant levels of light for visual tasks near windows, the electric light fixtures should be controlled using daylight-responsive control systems. See Section 3.2 below for some further discussion of the coordination of daylight with electric lighting systems.

Finally, it is worth commenting on the types of light in daylight compared to electric lamps, because of concerns about the effect of daylight on furniture and furnishings in a building. Like electric lamps, the daylight spectrum contains a percentage of energy in the ultra-violet (UV) range as well as the radiant heat component of infra-red energy. There is fundamentally no difference between the impacts of the two light sources on library interiors provided the daylight is designed to enter the space in measured and controlled quantities. If furnishings or artwork is sensitive to UV light, plastic UV-inhibiting sleeves are often placed on fluorescent lamps to intercept this type of light. In the case of daylight, normal glass removes most of the UV content of daylight, and applied UV films on the glass have the same effect as UV sleeves on electric lamps.

Fading of carpet and drying out of furniture occurred in the past when sunlight was allowed to enter the building directly, or too much daylight was admitted in an uncontrolled manner. These issues can be avoided with good daylighting design.

3. DAYLIGHTING DESIGN IN LIBRARIES

Daylighting design is part of the overall lighting design of a library. The professional lighting designer must work closely with the building architect and heating/cooling engineer to ensure an integrated approach to all considerations surrounding the lighting design—controlled to maximize daylight use and visual comfort for the library users. Lighting design in libraries is treated more thoroughly elsewhere,[4] but a short summary is provided in Section 3.1 for continuity of discussion.

[4] See *Lighting for Libraries* on the Libris Design website: *http://www.librisdesign.org/docs/index.html*. See also *Energy Management Strategies in Public Libraries*, a monograph available from the California State Library through the Libris Design website.

3.1 General Principles

The integrated building lighting system composed of both daylighting and electric sources must provide adequate levels of light that are distributed in a manner that is glare-free and comfortable.

3.1.1 Light Quantity

The Illuminating Engineering Society (IES) is an independent organization of professionals that sets light level guidelines which serve as the recognized standards for light in building spaces. The following table provides the illumination levels recommended for library spaces.

Table 1. IES Recommended Light Levels for Libraries[5] (Foot-candles)

Space	Recommended Illuminance (Foot-candle Level)
Active (occupied) Book Stacks	See table footnote *a* below
Inactive Book Stacks	**5[b]**
Book Repair and Binding	**30**
Cataloging	**30**
Circulation Desk and Reference Desk	**30[c]**
Computer Areas	**30**
Audiovisual Areas	**30**
Audio Listening Areas	**30**
Reading (normal size and contrast: newsprint, magazines, keyboard)	**30**
Reading (very small size and low contrast: fine detail items, small print)	**50[d]**

[a]For book stacks, use *vertical* foot-candle levels. See the discussion immediately below.

[b] At 30 inches above the finished floor level.

[c] Although this is the IES standard, lighting designers typically prefer 40-50 foot candles at these desks.

[d] This should not be used as an excuse to light the whole library to 50 foot candles, just because there are always some low contrast tasks interspersed throughout the library. The higher light level would apply only in specific areas, such as collections of phone books.

Book Stack Illumination

Book stacks must be lit evenly across the stack face so that titles and call numbers can be easily found and read. The lighting level should be a minimum of 6 foot-candles measured

[5] IESNA Handbook. 8th edition.

vertically on the face of the book spine at a height of 12 inches above the floor, and a maximum of 35 foot-candles at any height, so that no more than a 6:1 ratio results across the entire vertical face of the book stack. Daylight should be introduced above and behind the patron so that book titles are illuminated without glare. See Figure 4 for a diagram and Figure 18 for an example in a built project.

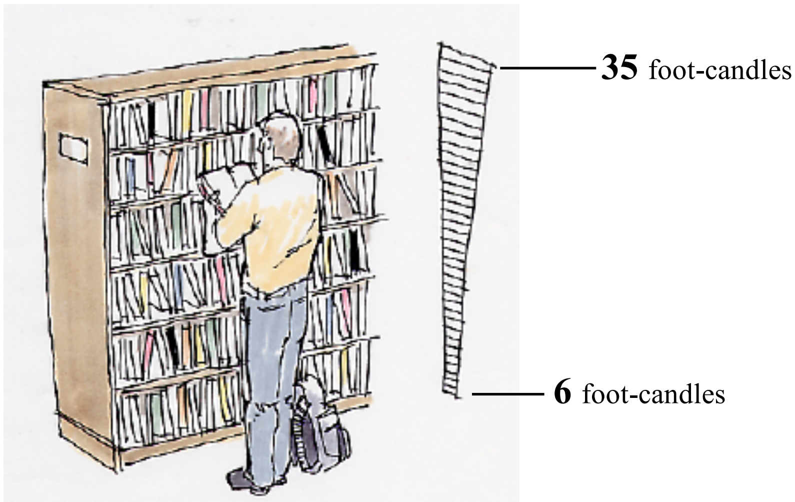


Figure 4. Ideal vertical foot-candle distribution at book stacks.

3.1.2 Light Distribution

For good daylighting design, low glare lighting is a principal objective in libraries. Ideal ratios of brightness levels within the field of view are often described at 10:3:1, for brightness of visual task to brightness of the immediate surround to brightness of the general surround. A library space that largely achieves these ratios can be considered to have a good level of visual comfort and no glare conditions.

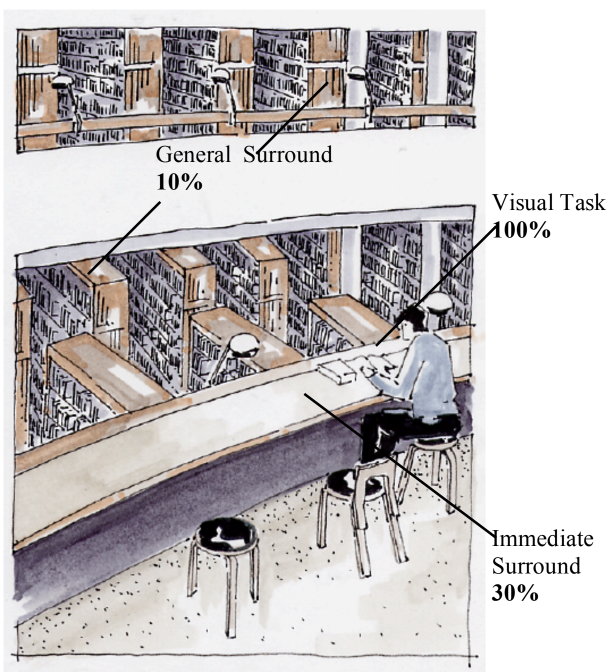


Figure 5: Recommended relative brightness of surfaces within the field of view for good visual comfort (lack of glare). If the brightness of the reading task is taken as 100%, then the brightness of the immediate surround should be 30% of that level, and the brightness of the general surround should be 10% of that level.

3.2 Design for the Daylight Component

As noted in the previous sections, the efficacy and heat content of daylight require careful control of the daylight aperture size, wherever it is located. The three fundamental design issues in daylight design are:

- Sun control, to mitigate any increase in the cooling load and to control direct glare.
- Glare control, to create and maintain comfortable brightness distribution, including no direct views of the bright sky in the normal direction of view.
- Variation control, to avoid any user perception of insufficient local light levels.

Daylight apertures in walls and roofs are essentially *in situ* light fixtures using renewable light energy from the sun. The building design team must not only address the three principal issues above for a variable, heat-laden source, but must configure the daylight apertures to reflect and diffuse the light effectively to serve the lighting tasks appropriately.

Daylighting solutions that address the above issues are most successfully executed when focused on providing general background lighting as opposed to specific task lighting, and when augmented by electric lighting in an intelligently controlled and seamless manner. When used as general lighting, the variability of daylight is more acceptable to users and easier to control. Smooth integration with electric lighting also helps mitigate the variability issue.

The following sections treat the three design issues in the context of the types of daylight apertures that are commonly used in libraries.

3.2.1 Daylight Apertures: Roof

Small and medium-sized libraries tend to be one or two stories with fairly large and open floor plans. Service and surveillance requirements dictate the open plan and the desire to avoid more remote unserviceable spaces such as building wings or long extensions. Special reading rooms can be an exception, although frequently these spaces are provided with a service point during open hours.

Normally, good surveillance and service point arrangements with minimum staff requirements work well on one floor, up to an area of about 30,000 square feet. Beyond that size, since extra service points would be required because of the distances involved, a second floor is usually added. Site coverage and land cost also become issues beyond this size.

Most libraries up to about 60,000 square feet are usually two stories in height with a fairly regular floor plan shape. Whereas designers can manipulate the building envelope configuration of office buildings, for example, to maximize access to daylight through windows for people sitting at desks all day, library space tends to be limited to more internal types of space, away from the 20-foot wide daylighting perimeter.

The design implication of these typical planning characteristics of libraries is to work with the roof component of the building envelope to provide the controlled use of the sun and daylight to offset much of the normally high internal lighting load. There are a variety of methods of introducing diffuse, low-glare daylight from the roof level, including skylights and *roof monitors*. An example of an array of roof apertures is shown in Figure 6.

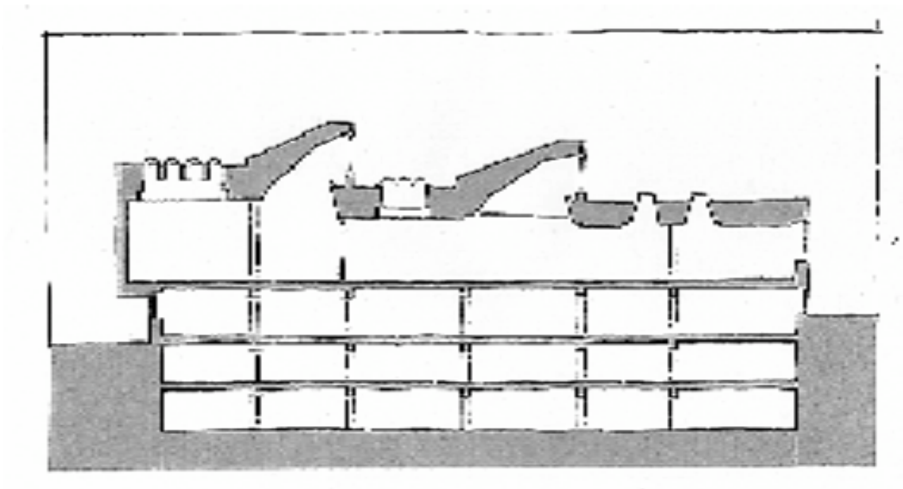


Figure 6. Section through a library showing extensive use of various types of roof apertures, including different types of roof monitors and skylights. (In this example, the upper level houses all primary library activities and the lower three levels are enclosed stack levels.)

Roof monitors are popped-up extensions of the roof, with vertical glass areas. Large roof monitors often appear to be forms of vertical extensions of the ceiling, and can provide dramatic high internal spaces in special areas. One advantage of roof monitors compared to skylights is that there is less risk of water leakage than with conventional skylights. Furthermore, roof monitors avoid the strong solar impact of the overhead sun and can be designed with exterior sun control devices as necessary to diffuse direct sunlight. See Figure 7.

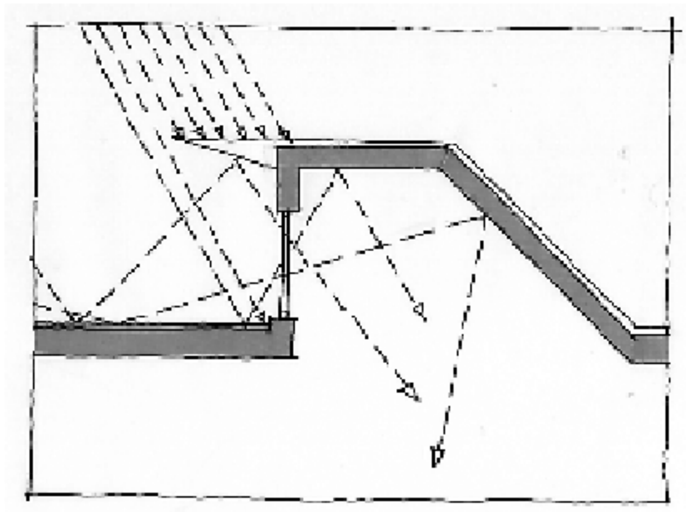


Figure 7. The sun-protected roof monitor is a basic design component of roof design for daylighting.

Libraries are ideal building types for extensive use of roof monitors because of the typical one- or two-story configuration of the floor plan, as noted above. Roof monitors can also provide daylight to the lower floor level in a two-story facility by carefully locating openings on the second floor below the roof aperture areas. Daylight easily penetrates the normal 25-30 feet from roof level to first floor level. See Figure 8.

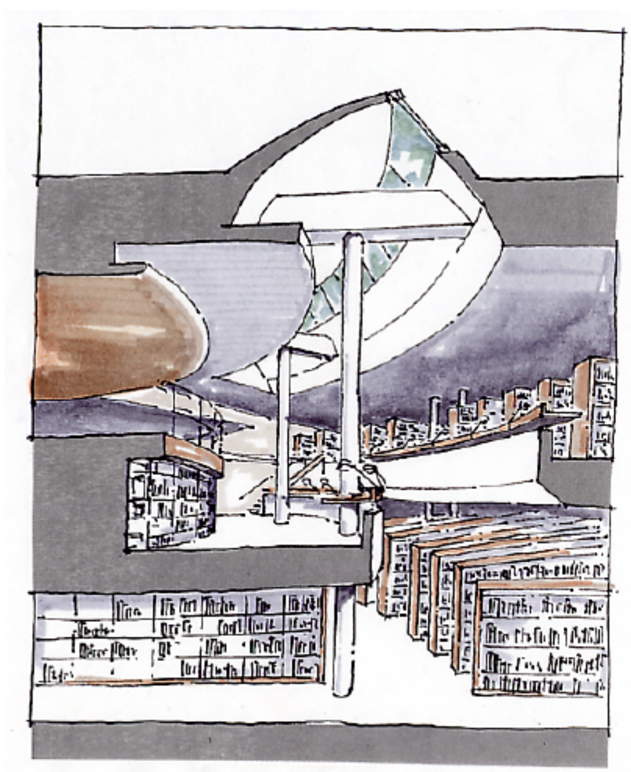


Figure 8. Example of a roof monitor in the middle of a two-story library, which introduces daylight at internal circulation and reading areas. Note how placement of the roof monitor above internal stairs and circulation zones allows daylight to penetrate to the lower floor level. (Library of Mount Angel Benedictine College, Mt. Angel, Oregon)

Skylights can be successful daylighting roof apertures provided the direct sun is prevented from coming within view by washing down walls or striking floor or table surfaces. In addition, because of the heat content of direct sunlight, the skylights should be relatively small in area and should be accompanied by large adjacent diffusing surfaces. A simple configuration of a skylight roof aperture that works well to meet these conditions is shown in Figure 9.

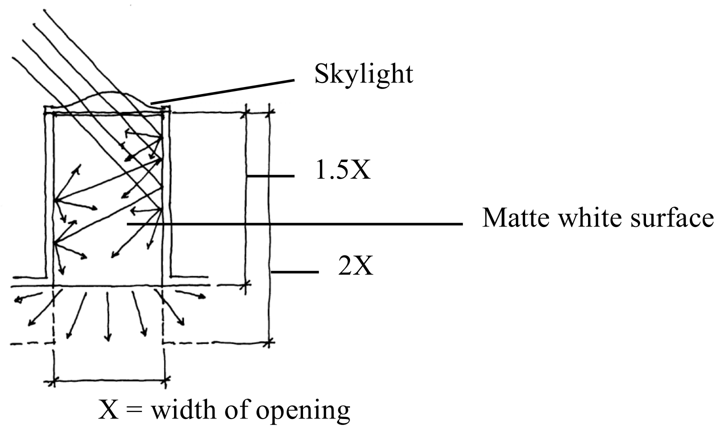


Figure 9. A skylight with deep adjacent diffusing surfaces is a simple technique of protecting from direct sunlight while providing non-directional, comfortable light to the space below. A 2:1 ratio of depth to width normally provides enough diffusing reflections for glare-free light.

If deep apertures are not possible in a design, an alternative is to equip the skylight with some type of sun control device, such as exterior louvers or movable translucent shades. Normally, to be effective, the sun control device should be operable and should respond to the position of the sun to reflect all direct sunlight otherwise incident on the glass. Figure 10 shows an example of such a design.

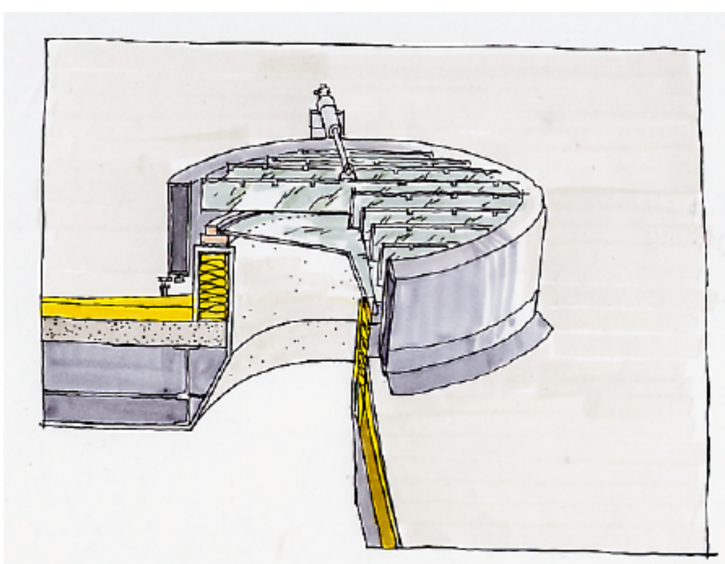


Figure 10. Cutaway view of a skylight with an exterior sun control device to prevent direct sunlight from entering the library space below through a shallow aperture. (Phoenix Central Library, Phoenix, Arizona)

Like roof monitors, skylights can also be creatively utilized to render dramatic space in a library. Figures 11 and 12 show examples of how the daylighting elements of the roof aperture completely replace the normal appearance of a ceiling containing electric light fixtures. The electric light fixtures, required for times of poor daylight availability, are visually hidden within the skylight apertures in both examples. In Figure 11, deep cylindrical plaster tubes above the ceiling plane are integral with the skylights at roof level; they are painted matte white on the inside surface to maximize light diffusion for a soft uniform light.

Figure 11. Example of a skylight roof aperture system for a special collections room. Note the architecturally interesting ceiling that results. (Pensions Institute, Special Collection, Helsinki, Finland)

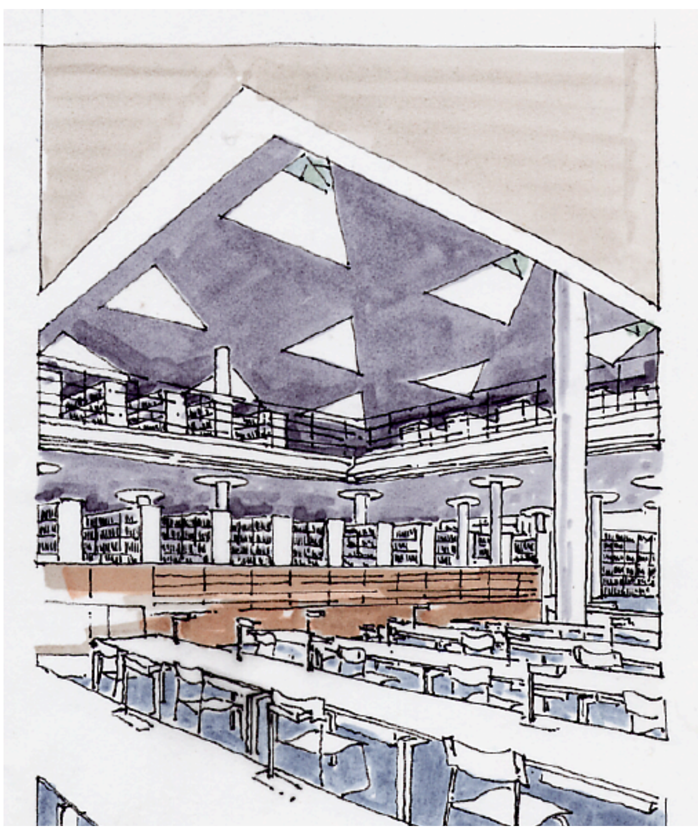


Figure 12. Triangular skylights over the library's main reading room. (German National Library, Frankfurt Am Main, Germany)

The creative skills of architects and lighting designers can allow these basic criteria for good daylighting design to be the basis of exciting architectural space. Figures 13 and 14 show examples of the combined use of roof monitors and skylight apertures to define architectural space in libraries.

Figure 13. Example of skylights and roof monitors combined. Note how the size of the roof monitor creates interesting high space in the room. (Periodical Room, Library of the Institute of Technology, Otaniemi, Finland)

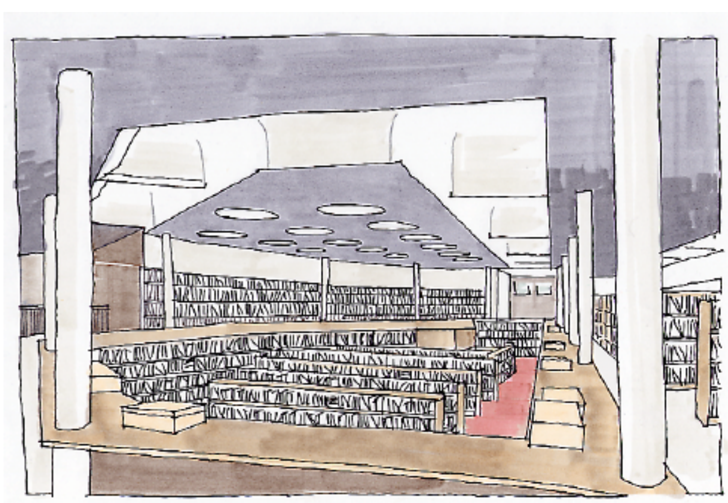


Figure 14. Example of skylights and roof monitors combined over a central "popular library" space. Note how the roof monitor slot outlines the shape of the lowered floor area below. (Wolfsburg Public Library, Wolfsburg, Germany)

3.2.2 Daylight Apertures: Wall

The perimeter spaces of the library can be effectively daylighted for approximately twenty feet from the exterior wall by using windows and *clerestories* (high windows). Generally, the taller or higher the window, the deeper will be the daylight penetration into the space.

Clear glass is preferred for daylighting, but this in turn requires carefully designed exterior sun control devices to provide adequate shading. Although internally mounted shades and blinds reduce the high intensity and heat content of direct sunlight, the most effective sun control device is the exterior sunshade. An internal shade, even a light-colored fabric or blind, reduces solar heat gain by about one-third to one-half of the incident solar energy. An exterior shade will create a reduction of 80% of the incident solar energy.

The south-facing window is easiest to protect since the sun is at relatively high angles in the sky for most of the day relative to this orientation. Horizontal sunshades located above eye level easily shade the south-facing window and create the least obstruction to view and daylight.

Highly sophisticated design of south-facing sunshades can be realized by making the sunshade as permeable to daylight as possible, while maintaining the full shading characteristics. A solid horizontal overhang will create full shade from direct sunlight, but the overhang can also be designed with enough depth of structure so that openings can be introduced in the otherwise solid element. The more open sunshade can still provide full shade at the window for the angles of incident light, while reflected daylight can pass through the openings to provide higher levels of light at the window face. See Figure 15.

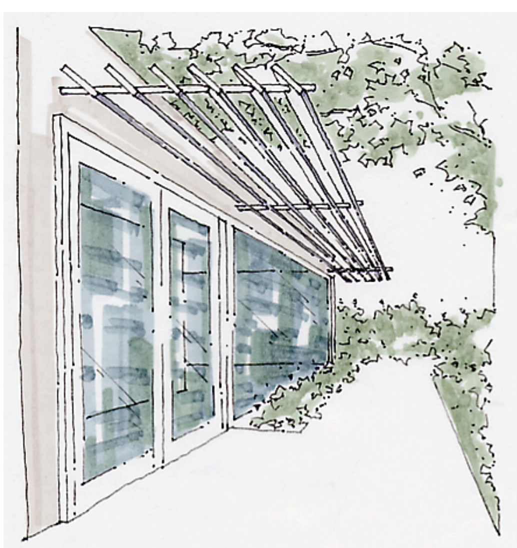


Figure 15. Horizontal sunshade for the south elevation of a library. Note structure that excludes all direct sunlight, but is open to allow diffuse daylight to pass through.

Sun control at north-facing windows should not be ignored in hot climates since late afternoon summer sun will penetrate the north-side spaces from May through July. Simple fixed vertical elements are adequate to control this type of direct glare. Many interesting architectural solutions are possible for this condition, as shown in Figure 16.

Figure 16. Exterior sunshade for a north-facing glass wall. The design protects against late afternoon mid-summer sun and reduces glare from bright surroundings. (Phoenix Central Library, Phoenix, Arizona)

East- and west-facing windows are more difficult to shade since the sun is low in the sky in the mornings and afternoons, and the angle of incident sunlight is almost perpendicular to the glass. For these windows, some kind of vertical device or operable shutter is generally needed. See Figure 17.

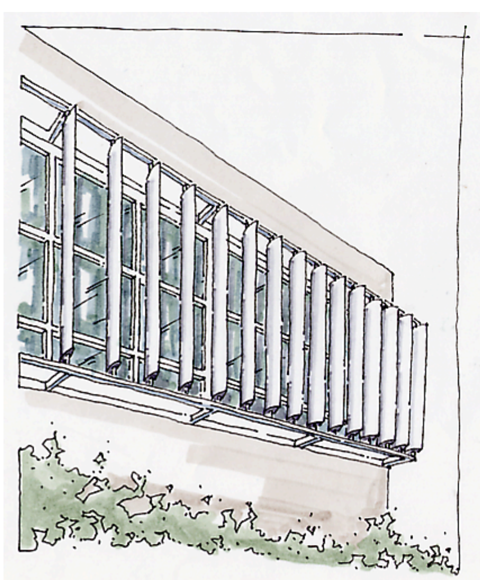


Figure 17. Vertical sunshade for the east or west elevation of a library. The open design allows view out and daylight penetration. This design should be augmented with internal shades for low perpendicular sun angles.

Daylight through east or west windows is always best when the sun is on the opposite side of the building. When it is not, there will be no daylight at window level since the sunshade must be fully employed to screen the perpendicular low angle sunlight. This problem can be solved to some extent through the use of *clerestories*, or window openings placed high in the wall above the normal window location, and shaping the ceiling as shown in Figure 18 or by adding a *light shelf* as shown in Figure 19.

Figure 18. Example of a high clerestory window in an exterior wall, with a back reflecting surface to provide light on the vertical surfaces of the stacks at the wall. (Wolfsburg Public Library, Wolfsburg, Germany)

The light shelf is a device located at the bottom of a clerestory that captures direct sunlight by reflecting it off the top of a plane that extends into the space, either a mirrored or diffuse surface. If the plane of the light shelf screens the clerestory window from direct view, there will be no direct glare and the low angle sunlight will be reflected from light shelf and ceiling, and will reach the task level deep in the space as diffuse light. The light shelf can be used on the south-facing walls as well, and the light shelf can be extended to the exterior to form a horizontal sunshade for the lower window.

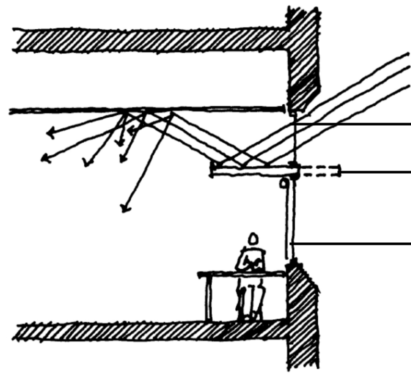


Figure 19. Diagram of the "Light Shelf" concept.

3.2.3 Daylight Controls and Integration with Electric Lighting

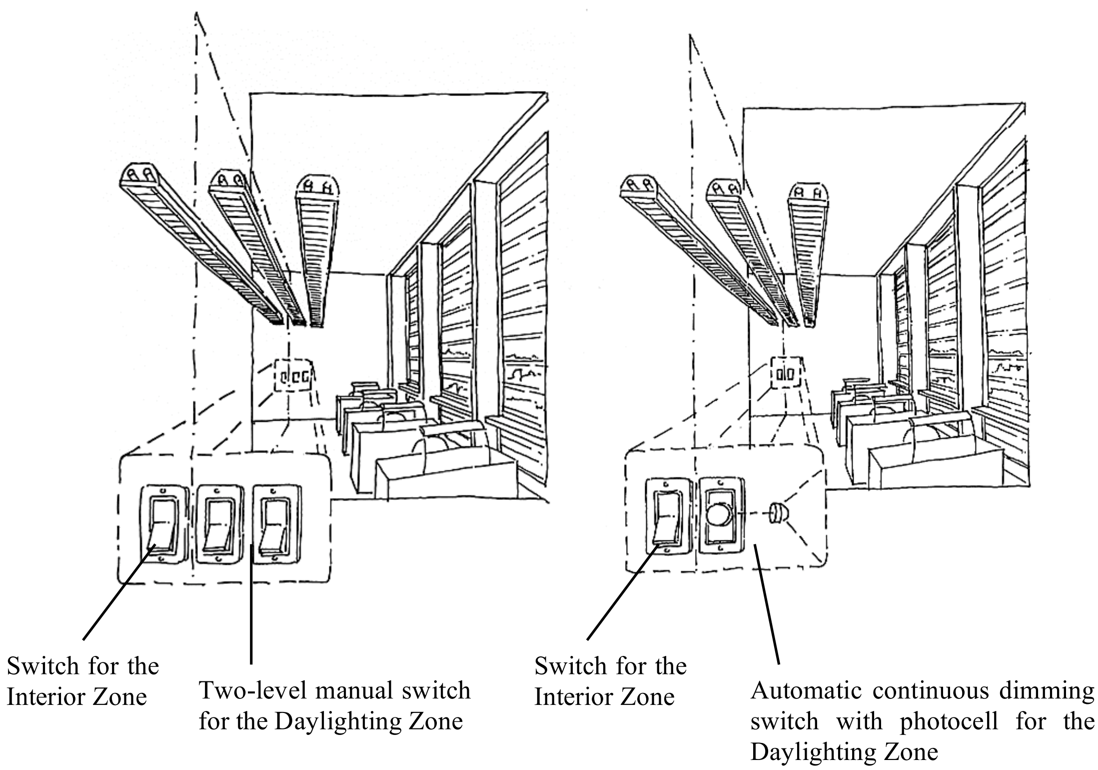
Effective daylighting design requires the smooth integration of daylight design features with electric lighting in order to control the inherent variability of daylight, which can be undesirable in certain types of library spaces, and to provide sufficient light when adequate daylight is not available.

This integration is achieved by wiring the electric light fixtures separately near daylight apertures and using the light control system to reduce the use of electric fixtures in these areas when they are not needed or only partially required.

Basic daylight controls are required near window areas by the California Energy Standards of Title 24. This code mandates that new buildings must use bi-level switching and separate control of light fixtures that are within 15'-0" of exterior windows. Separate control permits electric lighting to be reduced near the windows without affecting areas outside the daylighting zone. Electric light fixtures normally have more than one lamp, and bi-level switching allows individual lamp control so that a portion of the lamps are turned on or off in response to the amount of daylight available.

Beyond code requirements, the most sophisticated daylight controls are the *continuously dimming* type. Both fluorescent lamps and some types of halogen lamps can be continuously dimmed in response to available daylight, avoiding the noticeable change in light level when entire arrays of lamps are turned on or off with a bi-level switch. Continuous dimming is recommended for internal areas of daylighting, where roof monitors or skylights are located, since anything else would be particularly noticeable.

The bi-level switching can be done manually, where a staff person or a patron responds to available daylight by turning lamp arrays off or on at the switch. It would be more appropriate for libraries to use a photocell sensor, however, and continuous dimming, so that optimum savings are realized through automatic control and the highly responsive control is executed seamlessly in response to daylight availability. Figure 20 shows diagrams of both types of dimming systems for windows.



A. Bi-level Manual Switching

B. Automatic Continuous Dimming with Photocell

Figure 20. Methods of control of electric light fixtures near windows in response to daylight availability.

4. GLOSSARY OF DAYLIGHTING TERMINOLOGY

Bi-Level Switching Light Controls	Type of electric light fixture control that switches lamps in the fixture separately to allow full "on" or partial "on".
Brightness Ratios	Ratio of the brightness of the task to the brightness of the immediate surround to the brightness of the general surround.
Clerestory, Clerestory Window	Glazing or window above the normal location of a window in an exterior wall.
Continuous Dimming Light Controls	Type of electric light fixture control that dims lamps continuously in response to daylight availability.
Daylight Aperture	Shaped opening in the exterior surface of a building that is designed to admit daylight.
Efficacy	Ratio of the amount of light energy from a source to the heat content of that energy.
Horizontal Foot-candle Level	Amount of light energy incident on one square foot of horizontal surface in lumens per sq. ft.
Illuminating Engineering Society (IES)	Organization of lighting professionals involved in design of buildings and other spaces.
Light Shelf	A device located at the bottom of a clerestory that captures direct sunlight by reflecting it off the top of a plane that extends into the space.
Lumen	Unit of light energy.
Renewable Energy	Energy produced from natural resources that are not consumed in the process.
Roof Monitor	Daylight aperture on the roof of a building created by a popped-up extension of the roof and ceiling surfaces, with vertical glass areas.
Source Energy	Electric energy located at the source of its generation, rather than at the site of its use.
Vertical Foot-candle Level	Amount of light energy incident on one square foot of vertical surface in lumens per sq. ft.

5. FURTHER SOURCES OF INFORMATION

Societies, Organizations, Agencies

IES	Illuminating Engineering Society of North America	*www.iesna.org*
Libris Design	Informational website concerning library design	*www.librisdesign.org*
LBL	Lawrence Berkeley Laboratory, Windows and Daylighting Group	*http://windows.lbl.gov/daylighting/*
IALD	International Association of Lighting Designers	*www.iald.org*

Reference Books

Dean, Edward. Energy Management Strategies in Public Libraries. A Publication of the California State Library. Los Angeles: Balcony Press, 2002.

Guzowksi, Mary. Daylighting For Sustainable Design. New York: McGraw Hill Professional Book Group, 1999.

I.E.S. Lighting Handbook: The Standard Lighting Guide. 8th edition. New York: Illuminating Engineering Society.

For additional information and references, see *Lighting for Libraries* at www.librisdesign.org.

The Author

Edward Dean, AIA, is located in San Francisco. He has led project design teams on many academic and public library projects, including the U.C. Berkeley Main Library, the City of Mountain View, the City of Santa Maria, the University of San Francisco and the joint academic-public library, San Francisco State University / Sutro Library. He has led workshops and written extensively about library design, concerning in particular energy and "green" design. He also taught design in the Department of Architecture at U.C. Berkeley for ten years, before devoting himself full-time to professional practice.

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