GREENFIELD, CECELIA DOREEN. Designs for Lighting Selected Art Objects in the Interior of Chinqua-Penn Plantation in North Carolina. (1970) Directed by Dr. Clara Ridder. pp. 97

Many older homes and buildings containing objects of interest which have been opened to the public are inadequately lighted. This study was undertaken to determine the effects of accent lighting on displays and to provide a basis for further application of the lighting design methods in the field of restoration and preservation. The purpose of the study was threefold: (1) to identify types of lighting and lighting apparatus available that might be used to focus on areas of interest in an existing building, (2) to develop possible installations that will fit into the setting of existing structures and will not interfere with the architecture, and (3) to present solutions that would be applicable to older buildings for lighting various types of wall, floor and surface objects.

Chinqua-Penn Plantation House near Reidsville, North Carolina was used as the site for this experiment in lighting. Photographs and diagrams were used to illustrate the varying effects which were achieved from the lighting installation.

Lighting must be carefully applied to enhance the appearance of art objects and to create a focus of interest in a particular area. Violations of normal standards of good seeing and risk of injury to objects must be avoided. The light source, the viewer and the illuminated object form a triangular relationship which must be considered in all lighting design problems.

DESIGNS FOR LIGHTING SELECTED ART OBJECTS IN THE INTERIOR OF CHINQUA-PENN PLANTATION IN NORTH CAROLINA

by

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A Thesis Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Master of Science

Greensboro
May, 1970

Approved by

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APPROVAL SHEET

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ACKNOWLEDGMENTS

The writer wishes to express her sincere appreciation to Dr. Clara Ridder for her help as adviser and to Dr. Beatrice Kalka and Dr. Jean Gordon for their assistance as members of the thesis committee.

The writer is indebted to Mr. John Greenfield for the photography and to the rest of her family for their understanding and support throughout the writing of this thesis.

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CHAPTER I

INTRODUCTION, PURPOSE, AND DEFINITIONS

I. INTRODUCTION

Throughout the United States older homes of historic and artistic interest have been opened to the public for tours. Displayed in these homes are objects of particular interest which are often lighted with the houses' original residential lighting systems. These lighting systems, while adequate when the houses were used as residences, are no longer adequate for the study and examination of objects by members of tour groups. Rarely does the original lighting serve to permit critical examination of the interior. The problem is to light the areas of interest so that they may be seen more clearly. There are many factors involved in the lighting of interior areas. These include flexibility of all concentrating sources of light, the structural design of the room, the location of the windows, the location of objects to be lighted, wiring and outlets. A study of accent lighting in older buildings is a step toward the improvement of the visual experience for all viewers. This study is concerned with such accent lighting in a home filled with interesting art objects that now belongs to the University of North Carolina.

The University was given the home of the late Mr. and Mrs. Jefferson Penn. The home, Chinqua-Penn Plantation, was built in 1925 near Reidsville, North Carolina on a 935 acre estate. The University received the estate upon the death of Mrs. Penn with the stipulation "that it be perpetuated for the benefit of all who come here to enjoy its quiet charm."

> When the administrators gave the house to UNC-G, it was assigned to the Development Department under the direction of a committee consisting of the Chancellor, the Vice-Chancellor, the Dean of the Faculty, the Business Manager and the Director of Development. The committee arrived at three uses to make of the property: (4)
>
> 1. Correlating it with the University's teaching program. The School of Home Economics, the Art Department, the Biology and Botany Departments, the Physics Department (for photography) all expect to expand this program of utilization for academic purposes.
>
> 2. Offering the facilities as an entertainment center for officials and guests of the University for meetings, luncheons, and dinners.
>
> 3. Opening to the public with guided tours of the house.

The house is filled with art objects and antiques collected by the Penns from around the world. The collection attracts many visitors who come to the Plantation House annually to view the furnishings which are lighted in only a general way. The house is open to the public by means of conducted tours.

There are twenty rooms open for forty-five minute guided tours. For the most part, the visitor feels he has

only had time for a quick glance into a room because it contains so many interesting objects and furnishings. Few objects can be inspected closely, and there is not enough time to linger and look at objects of interest. The viewer must stand at the entrance of a room to view the interior since each room is roped off at the doorway. A general overall impression of the room is received in this manner, but many objects of particular interest may be missed.

The most interesting objects are not given prominent places in the rooms, nor are they isolated from the general surroundings; therefore they have to compete for attention.

In general, such situations are common to many older homes that have been opened to the public for tours.

FIGURE 1

THE EAST WING OF CHINQUA-PENN PLANTATION HOUSE

II. PURPOSE

With the idea that the lighting methods used in Chinqua-Penn Plantation House could have further application in the field of restoration and preservation programs, the writer undertook this study. The purpose was threefold:

1. To identify types of lighting and lighting apparatus available that might be used to focus on areas of interest in an existing building.
2. To develop possible installations that will fit into the setting of existing structures and will not interfere with the architecture.
3. To present solutions that would be applicable to older buildings for lighting various types of wall, floor, and surface objects.

Objects of particular interest should be brought into the visitor's view with impact, and accent lighting might be used to achieve this aim. The display of treasures needs to be lighted so that the objects become definite focal points in directing and holding the attention and interest of the viewer. Lighting that will emphasize the characteristics of objects and add interest to what might otherwise be an atmosphere of overall sameness is to be the subject of this study.

The responsibility of the lighting is to call attention to objects in accordance with good lighting principles as they apply to a lighting problem. Lighting can discriminate for the viewer those objects which are worthy of more than a passing glance. To be effective,

lighting must be designed for each separate object and for each specific effect.

III. DEFINITIONS

Listed below are definitions of terms used in this study and in the review of literature.

Absorption. The process by which incident flux is dissipated within a medium.

Adaptation. The process by which the retina becomes accustomed to more or less light than it was exposed to during an immediately preceding period. It results in a change in the sensitivity of the photoreceptors to light.

Cove Lighting. Comprises light sources shielded by a ledge and distributing light upward over the ceiling.

Degrees Kelvin. The measurement which specifies the degree of whiteness and the spectral energy composition of the light source.

Flood Lamp (R or PAR). Incandescent filament lamp providing a relatively wide beam pattern.

Footcandle (fc). A quantitative unit for measuring illumination: the illumination on a surface one foot square on which there is a uniformly distributed flux of one lumen.

Footlambert (fl). A quantitative unit for measuring luminance. The footcandles striking a diffuse reflecting surface, times the reflectance of that surface equals the luminance in footlamberts.

Lumen. The unit of luminous flux.

Luminous Flux. The descriptive term of the time rate of flow of light.

PAR Lamp. Parabolic aluminized reflector lamp, spot or flood distribution, made of hard glass for indoor or outdoor use.

Reflector Lamp (R). Incandescent filament lamp with reflector of silver or aluminum of inner surface.

Spot Lamp (R or PAR). Incandescent filament lamp providing a relatively narrow beam pattern.

Surface Mounted Unit. A luminaire mounted directly on the ceiling.

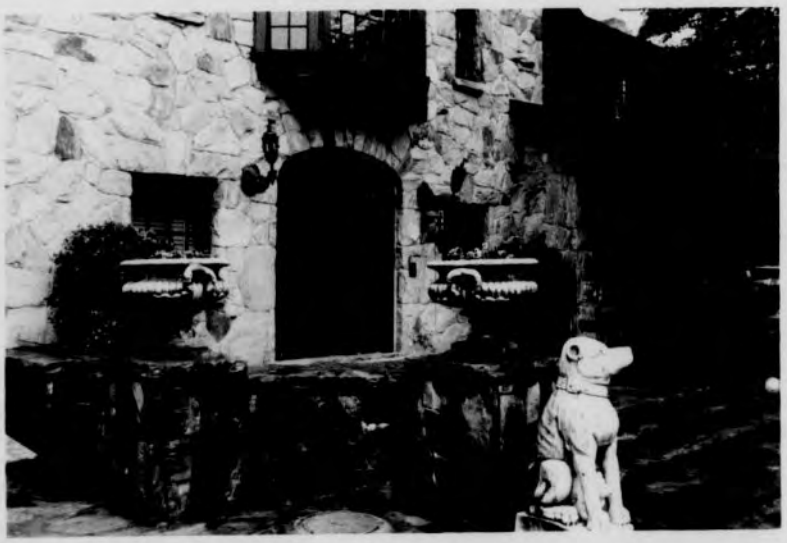
Troffer. A long recessed lighting unit, usually installed with the opening flush with the ceiling.

This chapter brought out the need for a study of lighting in older buildings that have tours, particularly to improve the visual experience for all the viewers.

The literature which pertains to the specific problem of accent lighting in interior areas will now be reviewed.

FIGURE 2

THE FRONT ENTRANCE TO CHINQUA-PENN PLANTATION HOUSE



CHAPTER II

REVIEW OF LITERATURE

Mr. Frank Horton, the Director of Restoration at Old Salem in Winston-Salem, North Carolina, wrote concerning the sparseness of literature on the lighting of interiors of historic houses: (22)

> There is little published material that will apply directly to the lighting problems in a setting such as Chinqua-Penn--room setting lighting or, as we call it, house-museum lighting. Most published material deals with lighting in museums which are built in modern times and thus have built-in aids such as high ceilings, false overheads, unlimited power, etc.

Mr. Horton was indeed correct in his analysis of the literature. However, it was important to be aware of how the problems of lighting design were solved in many various situations before undertaking the lighting design problem at Chinqua-Penn. In reviewing the literature concerning installations in existing buildings, it was desirable to note how the specifications for special artificial lighting environment were determined, what results were attained and what special equipment was used. In some cases structural changes were made. The literature was divided into three main categories. First, there were the notable installations for lighting design already in existence. Second, there were the research and testing in the field of lighting

design. Third, there were general and specific recommendations for lighting design made by experts in the field of lighting.

I. NOTABLE INSTALLATIONS FOR LIGHTING DESIGN

Museum of Modern Art's display of Renaissance Art. (13) A lighting design which was created in 1940 became the classic example for lighting three-dimensional art objects. The new fourth edition of the I.E.S. Lighting Handbook refers to this outstanding installation because of the excellent results obtained through careful scientific and esthetic consideration. In 1940 the Italian government sent a collection of Renaissance Art which was displayed at the Museum of Modern Art in New York City. The methods used to determine the specification for the special artificial luminous environment included a check of the reflection factors (via brightness readings with a Luckiesh-Taylor meter). The highest reading showed 90% as a maximum on the Della Robbia porcelain to 1.3% on the Donatello bronze. The Donatello would need 70 times more light (90/1.3). A base brightness of 25 fL was determined by first selecting a value of 25 fL from adaptation and visual acuity and then confirming it by the judgment of trained observers. With 25 used as a base brightness it was figured that the Donatello would need 1900 fc (100/1.3 x 25). Scientifically 1900 fc was the specification, but to the

visitor's eyes the brightness would have been entirely too intense for quick, comfortable adaptation. For physiological and esthetic reasons then, the scientific specification had to be modified.

Virginia Museum of Fine Arts. (7)

At the Virginia Museum of Fine Arts at Richmond the problem of space flexibility and light control was solved with the development of a new light called the "Lusklite," which is an optical spotlight similar in function to certain theatrical devices capable of controlling the shape of the light beam. It provides an economically efficient method of eliminating objectionable background light around paintings and statuary. The installation of the Lusklite was between the ceiling and roof cavity. The ceiling was specially constructed from squares of plywood, so that holes could be drilled out, and the light beam could shine through. The lighting could be moved by plugging up the holes and drilling new ones. This installation is an example of the versatility that is afforded when structural changes are a part of the lighting design.

Gallery of Modern Art. (15)

Abe Feder, lighting consultant, was responsible for the lighting design of Edward Durell Stone's Gallery of Modern Art. Mr. Feder felt the goals of the gallery were to permit paintings to be seen in the true perspective, dimension and color. His problem was to provide an even

wash of light over the entire painting within which certain features could be highlighted. The solution to the problem was a continuous troffer in the ceiling built to follow the contour of the curved walls. The even wash was provided by the powergroove fluorescent lamp in the troffer. To provide highlights a small intense lamp, two and one half by five inches, 650-w, 120-v, twenty-five hour DWY quartzline lamp was also used in the troffer. It could be adjusted both horizontally and vertically. Since both fluorescent and incandescent lighting were used simultaneously, a color balance was achieved. The fluorescent lamps provided violet, blue and green from the color spectrum, and the incandescent lamps provided yellow, orange and red; thereby providing the full range of the spectrum.

This article on the lighting for the Gallery of Modern Art gave the method for achieving both diffuse and concentrating light as well as achieving acceptable color rendition with a combination of fluorescent and incandescent lights. Structural changes in the ceiling were a necessary part in the design for lighting this gallery.

The Bergstrom Art Center and Museum. (9)

In Neenah, Wisconsin, the Bergstrom home was given to the town as an art center and museum. Mr. Frank Shattuck, architect for the project, wrote concerning the lighting design: (23)

> When the residence was remodeled into a museum, a new lighting system employing cove lights above the line of the window heads and shining on to the ceiling

> were installed in the entrance hall and the living room . . . In the former living room, a series of display boards were installed with spotlights in the ceiling trained on them.

By remodeling the Bergstrom home the lighting engineers had the opportunity to make the necessary architectural changes for cove and recessed lighting.

Old Salem, Inc.

In explaining the methods used in the Old Salem restoration program, Mr. Horton wrote: (22)

> We have found that the most effective way to light a room in one of the Old Salem houses is by simple floor stand with indirect light, this of a height to miss a tall person's eye level, and the whole fixture painted as the wall. This is a frank admission that lighting is modern and that we recognize the need to see the room in more detail than did our forebears.

This need to see the room and to see the objects within the room in more detail is the rationale for further study of the lighting problem. The examples of solutions to the problem of lighting various types of wall, floor and surface objects have ranged from complex scientific procedures to such simple methods as the use of the floor stand. In each installation there were separate sets of factors that contained their own peculiar difficulties. It is assumed that each solution was based on the examination of these factors, so that in the end the best solution was obtained.

II. RESEARCH AND TESTING IN THE FIELD OF LIGHTING DESIGN

The Metropolitan Museum of Art. In 1945 The Metropolitan Museum of Art set up two laboratories to test a series of lighting situations for galleries. Both laboratories had luminous ceilings especially designed with fluorescent strips which acted as diffuse background for overtones of incandescent concentration. A great concern for the color rendition of the light was expressed, and it was found that the fluorescent lamp of 4500° Kelvin gave the most neutral, balanced and accurate light for color response. The method of tapestry lighting was of great interest. In one lab, the ceiling contained bluish fluorescent lamps of 6500° Kelvin. With a tapestry in place, R-40 spots with red, green and amber filters were focused on the object, and the proper combination of tones was adjusted by dimmers, until the proper "balance" between the colors of the tapestry was secured. Since an initial concentration of "seeing" light was used first, a minimum wattage of color filtered incandescent light was needed. There was no need to rely on the inefficient building of primary colored lights to obtain white light. In the other lab the ceiling was constructed with polarizing plastic sheets between two layers of glass. Fluorescent strips were installed above the ceiling in housing finished in a

glossy paint. It was found that the light passing through this ceiling became polarized and glare was reduced. Another good feature of this ceiling was that the brightness was very low within a normal line of sight. (12)

The National Gallery of Art. Another concern in the literature is the occurrence of deterioration of objects due to illumination. The National Gallery of Art Research Project has studies which deal with the effects of this illumination on museum objects. Previously these studies emphasized the photochemical damage caused by lights. A recent study by Robert Feller of the Mellon Institute deals with the deteriorating effects caused by heat from incandescent lamps. Objects most sensitive to heat are wood, ivory, silk, parchment, leather and paper. They require the most attention. The damage is both physical and chemical as evidenced by drying out, shrinking, splitting and cracking. Heat also causes chemical changes in the molecules of textiles, thereby causing the textiles to deteriorate. The greatest portion of the radiant energy of incandescent lamps is in the infrared. It is the absorption of this invisible radiation and its conversion to heat that is the major factor to consider in the short term exposure of objects to strong illumination. Damage can be prevented by the use of infrared filters, forced air ventilation of objects and cooling of the air. (19)

Those institutions whose duty it is to protect, preserve and display objects of great value and/or interest

have realized the necessity for engaging in a program of research and testing in the field of lighting design.

III. RECOMMENDATIONS FOR LIGHTING DESIGN

The Illuminating Engineering Society has a new publication "Design Criteria for Lighting Interior Living Spaces" which contains the design considerations for the illumination of paintings, tapestries, and murals. These design considerations are: (17)

1. Lighting equipment should be placed so that the light rays reach the center of the painting at an angle of 30 degrees with the vertical. This prevents specular reflections in the direction of the viewer's eye from frame, glass, or surface of the picture, and also avoids disturbing shadows of frame, heavy paint, texture, etc.

2. A study of the sight-lines of people seated and standing anywhere in the room should be made, to ensure that no unshielded sources are in view.

3. Excessive luminance differences between the lighted object and surrounding areas is undesirable. Higher levels of illumination applied for extended periods may cause deterioration of the paint surface.

4. Above all, the primary consideration is the intent of the artist.

The typical techniques used to implement these design considerations are:

1. Entire picture wall lighted by cornice or wall-wash equipment.

2. Individual frame--mounted luminaires.

3. Individual framing spotlights.

4. Individual spot or floodlamps not confined to picture lighting.

5. Lighting from below by luminaires concealed in decorative urns, planters, mantels, etc.

Design considerations were also given for sculpture.

1. A sculpture is a three-dimensional object in space. A certain amount of specular reflection is often pleasurable; experimentation with diffused and/or a directional source or sources will help to determine the most acceptable solution for a specific situation.

2. A luminance ratio between 2 and 6 usually results in a good three-dimensional effect with transparent shadows. If the modeling ratio is reduced below 2, the lighting becomes too "flat" and solid objects appear two-dimensional. If the ratio is above approximately 6, the contrast tends to become unpleasant, with loss of detail in the shadows or in the highlights. (14)

The typical techniques used to implement these design considerations for sculpture are adjustable spots, floods, individual framing spots and back lighting.

Victoria K. Ball has written in her book, The Art of Interior Design, some general suggestions concerning design through light and the lighting of art objects.

> Spottiness, meaning spots of light which have no apparent relation to the design of the room, should always be avoided. The use of directional light to create definite areas of light for design purposes is another matter. Such light can be given shapes which will aid the shape design of a room, and will act as powerful visual forces in setting up the desired rhythms, centers of interest and balance. (1:151)

> Lighting can be planned so as to display art objects to best advantage. The ideal light source for illuminating paintings should be similar in all respects to that under which the painting was made. Care should be taken to see that no reflection of the light source rebounds from the painting to the eye of the viewer. A

> good position for the light is a high one from whence relatively diffused light falls on the painting at an angle of 45°. (1:159)

In reference to the lighting of paintings Mrs. Ball states that the "surface surrounding a painting should be between fifty to 100% as bright as the average brightness of the picture." This will make visual adaptation easier. The background which is neutral in tone will have little chromatic light to be reflected to interfere with the colors of the picture.

Concerning the illumination of sculpture, Mrs. Ball states that because sculpture was designed to be viewed from all sides it should be displayed in this manner. "Light directed upon a piece of sculpture should create shadows which will display its three-dimensional shape to good advantage. A satisfactory light source is a low brightness unit directing light from an overhead angle of about 45°." (1:159)

> The sculpture should be placed so that reflected light from its surroundings will come from 2 or 3 sides and from below. Thus the environment should be light enough to be an efficient reflector but should not be brighter than the sculpture surface.
>
> A translucent or transparent object is best displayed by introducing light through one or more of its edges if it is flat or by illuminating it through opal glass from below if it is three-dimensional. A dark surrounding is advised in order to minimize distracting reflections and to make the sparkle of the transparency more evident. (1:160)

Robert T. Dorsey, the Manager of Lighting Development at General Electric Company, has developed a four-step design

procedure for the specification of the luminous environment and for adding variety to lighting. The procedure is: (18)

1. Determine the visual composition for the space. Considerations include:
   a. First views upon entry into the space
   b. Selection of the area intended to receive the first focus of attention
   c. Selection of secondary zones of attention
   d. Transition from one space to another.

2. Determine the desired appearance of objects within the space with special emphasis on those objects involving visibility and the seeing task. Considerations to deal with:
   a. Surfaces. Specular surfaces reflect the brightnesses and colors surrounding them. Diffuse surfaces respond to variations in level and direction of illumination which produce modeling. Most surfaces are a combination of first surface specularily, and under surface diffusers, and respond to the combination of diffuse and directional lighting.
   b. Shadows, their usefulness, their possible interference with visibility, as well as planned prevention of excessive and unpleasant harshness.
   c. Color rendition of light sources.

3. Select luminaires that fit the visual composition concept and implement the desired appearance of objects.
   Considerations deal with the selection of luminaires involving:
   a. Implementation of at least two lighting techniques used in meaningful ways in any space
   b. Characteristics of cost, maintenance, ruggedness, candlepower distribution, brightness, all being the same as for current uniform-standard practices.

4. Plan and evaluate a layout.
   a. Calculations - of average illumination by the zonal cavity system, of vertical surface brightnesses, of vertical and horizontal surface properties of seeing tasks and, with increasing importance, calculation of illumination variation.
   b. Evaluation of visual comfort probability which can be simplified by tables supplied by lighting equipment manufacturers.

c. Operational planning for lighting maintenance and cleaning scheduling, including group lamp replacement.
d. Economics that apply for various lighting techniques to be calculated and compared by computer programs.

The January 1945 issue of the Illuminating Engineering journal contained some specific warnings against making specifications based solely on scientific measurements and equations. The 1940 display of Renaissance Art at the Museum of Modern Art, a situation previously mentioned, was an example of such planning where the initial specifications were based solely on scientific measurements and equations. The specifications required the objects to be so highly illuminated that the viewer's eye could not adjust; therefore, the specifications had to be modified. In order to provide the smooth visual adaptation of each view, great contrasts in illumination must be avoided. No exhibit should be presented with startling vividness nor in comparative gloom. An engineer can determine the footcandles and consequent footlamberts, but only a person who is familiar with the esthetic values of the object can make the final decision on the success of the lighting design and its relationship to the illuminated object. (10:18)

Laurence S. Harrison, former consulting engineer for the Metropolitan Museum of Art in New York City states that cultural objects of different materials and treatment cannot often be revealed to equally good advantage by the same kind of lighting, or similar "surround" treatment.

Each object worthy of public exhibition should be so displayed that its beauty and power are evident even to the casual observer. Many objects, both sculpture and painting, require individual study and treatment. They may be of canvas, wood, papyrus, paper, silk, velvet, leather, textiles, plaster, tile, terra cotta, marble, gold, silver, bronze, iron and a variety of other materials having their own special modification of the lighting.

The amount of light which will give sufficient illumination on an art object is not a single, fixed quantity. It will depend upon the location of the object, i.e., whether alone or displayed in a group; upon the general brightness of the field of view; upon the percentage of light received that the object can send back to the observer; and upon whether the object is diffusely or specularly reflecting. It will also depend upon the retinal adaptation of the observer. However, if the relationship between the object and surround brightnesses has been properly adjusted, the retinal adaptation will be satisfactory for the normal observer, and so it need not be considered as an additional factor. (10)

Miss Rose Coakley, Specialist in Residential Lighting for General Electric wrote, concerning the type of lamp she felt should be used as part of the Chinqua-Penn accent lighting project: (21)

> The most practical answer for this kind of work is low voltage. There are lamp bulbs designed to operate at

> 6 volts, 12 volts, and some 28 volts. Because of these voltages we are able to make smaller sources with greater optical control. Choosing the right optical control is as important as the right size for the job.

Mr. C. M. Crysler who is with Research and Development at General Electric also discussed the advantages of low voltage. There is greater efficiency and greater beam control with low voltage. At 12-v, the filament of a given wattage must carry ten times the current of a 120-v filament; therefore, the filament must be thicker and shorter. There is less heat loss because being shorter there is less surface area. Since it can get hotter because there is less heat loss, it is more efficient. Other advantages include a whiter light and more compact size. (8)

Hewitt and Vause conclude that another advantage of low-lamps is "the low brightness of the reflector when seen from all angles outside the narrow beam." (3:466)

The review of the literature has revealed that the most notable installations incorporated structural changes in the architecture to provide for the best lighting design. It may be that the absence of structural change makes the installation less than newsworthy.

Museums and not manufacturers are the leaders in the research of the deterioration caused by electric lighting. Since the museum's concern is the relationship between object and viewer, its staff has become very innovative in the types of test situations employed to protect, preserve and display the object to its best advantage.

The recommendations for lighting design found in the literature all have as their basis the quantity and quality of illumination which is necessary for a pleasing visual experience. Mr. Laurence Harrison sums up the essence of this experience as he wrote: (20)

> Museum lighting should be designed to stimulate and entertain while providing an environment which favors examination and study. It must promote the accurate perception of Form, Pattern, and Color.

CHAPTER III

PROCEDURE

This study was undertaken to determine how objects displayed on tours in older homes may best be lighted. Chinqua-Penn Plantation was used as the site of this study because it is an example of an older home containing objects on display for a visiting public. The identification of types of lighting and lighting apparatus was a necessary step in determining the best methods for lighting areas of interest in an existing building. A possible installation that fitted into the setting and that did not interfere with the architecture was diagrammed for each object to be lighted. These installations can be applied to older buildings for lighting various types of wall, floor and surface objects.

Prior to the study a group of the most interesting objects in the Plantation House had been chosen by Mr. Gilbert, Mr. James Tucker of the Art Department of The University of North Carolina at Greensboro, and Mr. Frank Caro of New York, an authority on Oriental Art. In selecting the objects in the house to be used in this study, primary consideration was given to the objects in this group.

The writer attended two separate guided tours to become familiar with the path of the visitors on entering and leaving each room. Measurements of objects to be illuminated and measurements of distances between the objects and various structural elements within each room were taken on a subsequent trip to the plantation house. No objects were moved from the position in which they were found for this lighting experiment.

By reviewing the literature from museums and lighting manufacturers certain specifications for the lights and lighting apparatus were made. Recessing the fixtures was considered unfeasible because of the intricate design and value of the ceilings; therefore, only surface mounted fixtures were to be used in this study. Sizes and positions of objects to be lighted, and distances and possible positions of light sources were factors considered when the lighting and lighting apparatus were chosen. Fixtures that were unobtrusive and of simple design were to be selected. Flexibility of fixtures was an important factor to be considered because of the possible rearrangement of objects. Specific recommendations from the literature concerning the use of low voltage lamps were contributing factors in the choice of these particular light sources. After these requirements for the lighting equipment were decided upon, specific selections were made from lighting manufacturers' catalogues. Lamps, in particular,

were chosen on the basis of their varying brightness and beam control as discussed in the literature. All the equipment was obtained on loan from a Greensboro lighting distributor.

During the installation consideration was given to the sight line of the viewer, approximately 5 feet 4 inches from the floor, in order to avoid a glare spot from the source. Regular extension cords were used from the nearest outlets, to the light fixtures. Temporary installations were made to avoid marking the interior of the rooms in any way. In some situations the fixtures were held in place by members of the Chinqua-Penn staff so that evaluations could be taken, measurements of distances made, and footcandle readings and photographs taken.

Photographs were taken with an F Nikon camera using 21mm, 35mm, 50mm, and 105mm lens. The film used was black and white Tri X. The camera was placed on a tripod corresponding to the sight line of an adult viewer. Photographs included a view of the object as seen with its original lighting, either natural or artificial. Another photograph was taken of the same view to show the effects of the accent lighting on the object.

Footcandle readings were taken with a General Electric Type 213 Light Meter. Readings taken were approximate values indicating the general magnitude rather than precise values. Photographs and readings were made on an

overcast day. All window shades were left open for the natural lighting normally seen in the rooms.

A diagram was drawn of each lighting installation. The diagram includes the wattage and type of lighting used and the relative placement of the lighting to the objects illuminated. Accompanying each set of pictures and diagram was a brief explanation concerning both good and bad effects achieved. Further recommendations pertaining to the installation are included in this explanation.

The following chapter contains the findings and a discussion of the study which were the results of the procedure as explained in this chapter.

CHAPTER IV

FINDINGS AND DISCUSSION

As more historic homes and buildings become open for viewing by the public, it seems reasonable that the viewing experience in these structures should be analyzed. Chinqua-Penn Plantation House is an example of such a home, and this study is an analyzation of the viewing experience which thousands of people have as they pass through this house on guided tours. The house contains the same lighting it had when it was constructed as a residence in 1925. There has been no additional lighting since then, even though the house is now open to the public for guided tours.

The writer felt that in order to improve the viewing experience there was definite need for accent lighting. Therefore, it was necessary to identify types of lighting and lighting apparatus available that might be used to focus on areas of interest in an existing building.

Because the problems presented in the design for lighting Chinqua-Penn Plantation House can be found in many other historic houses and buildings open to the public, a list of considerations was developed to be used as a guide for solving similar problems in existing structures.

Because of the nature of the architecture in many historic houses and buildings the installations for Chinqua-Penn were developed to fit into the setting without interfering with the architecture. The presentations of these installations are considered solutions that would be applicable to older buildings for lighting various types of wall, floor and surface objects.

I. TYPES OF LIGHTING SYSTEMS USED TO FOCUS ON AREAS OF INTEREST

To accommodate changing exhibits, the accent lighting must have maximum flexibility. From time to time objects are rearranged. At Christmas, religious objects are featured at Chinqua-Penn, and a Christmas tree is placed in the reception hall where during the rest of the year other objects are featured.

It is likely that other existing buildings could use the recessed lighting installation where holes are cut into the ceiling and the lights and a variety of different housing units can be placed flush with the ceiling line. However, because of the extraordinary value of the ceilings at Chinqua-Penn no recommendations were made for recessed lighting in any situation. For this reason the lighting systems that were used were of the surface mounted variety. Compact swivel reflectors, containing a lamp, clip on a light track which comes in 4 foot and 8 foot units. These

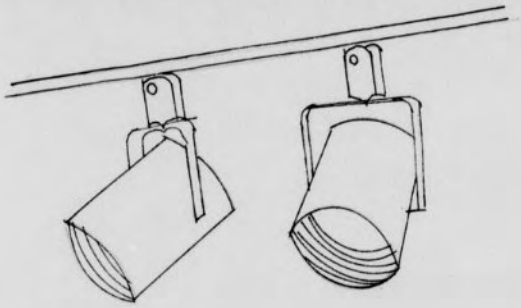
tracks can be placed anywhere on the ceiling. The reflectors can slide along the track and can be aimed as desired. On the following page is a diagram of such a ceiling track system.

The framing projector as mentioned in the literature was not used in the temporary installations at Chinqua-Penn. There was no situation which required the use of this expensive fixture. The framing projector casts a sharp-edge beam of light that precisely illuminates objects with square corners, and the light is confined within the boundary of the four corners of the object. An overspill of light was found desirable in the several situations where rectangular objects were illuminated because either there were other objects included in the display or the whole general area needed lighting. An example of the latter situation was the dark oak paneled stairwell. During the construction of the house Mr. Penn had a framing projector lamp placed in the end of a beam in the solarium. The light from this lamp shines on an East Indian marble panel. The lamp is rarely turned on because of the heat build-up within its housing in the beam.

For smaller three dimensional objects the low voltage lamp proved very successful. The base of this fixture contains the transformer used to transform 120 volts to 12 volts. This fixture can stand on a horizontal surface or can be wall mounted, and it delivers a powerful,

FIGURE 3

SKETCH OF REFLECTORS IN A CEILING TRACK



A bullet shaped, swivel reflector can be mounted either on the ceiling or on a wall. Once mounted it is in a permanent place, but because it is designed with a swivel component it may be aimed in any direction.

FIGURE 4

SKETCH OF REFLECTORS MOUNTED DIRECTLY ON CEILING AND WALL

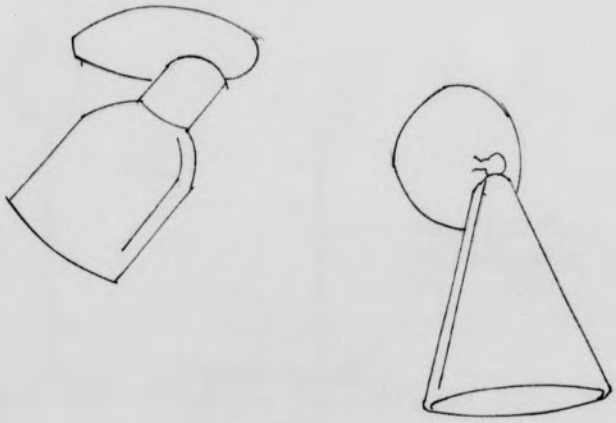
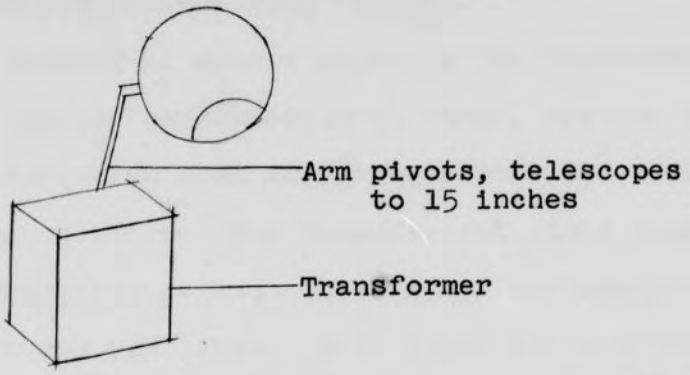


FIGURE 5

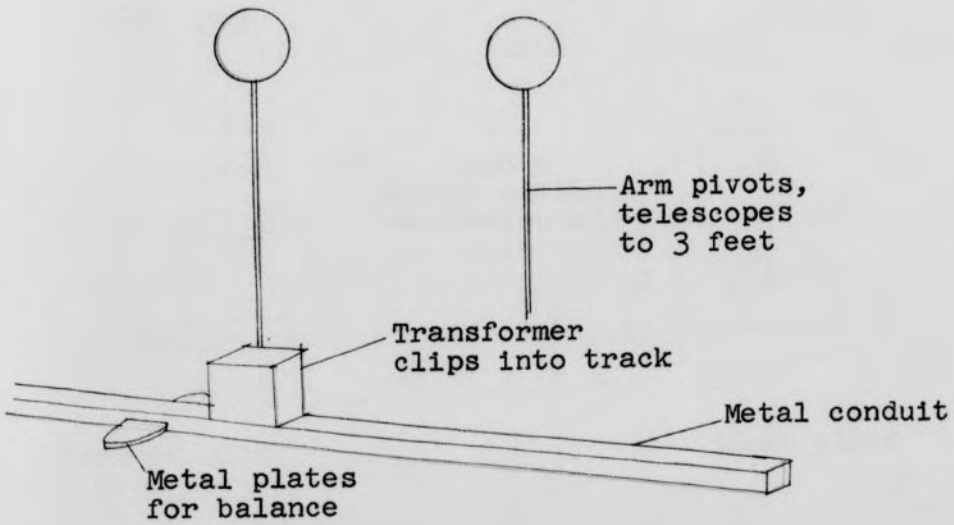
DIAGRAM OF LOW VOLTAGE LAMP FIXTURE FOR WALL MOUNTING AND HORIZONTAL SURFACES



No fixture could be found which was really suitable for illuminating objects low on the floor. Therefore, a floor track system was created. This system combines the characteristics of the ceiling track with the low voltage lamp fixture.

FIGURE 6

DIAGRAM OF FLOOR TRACK SYSTEM

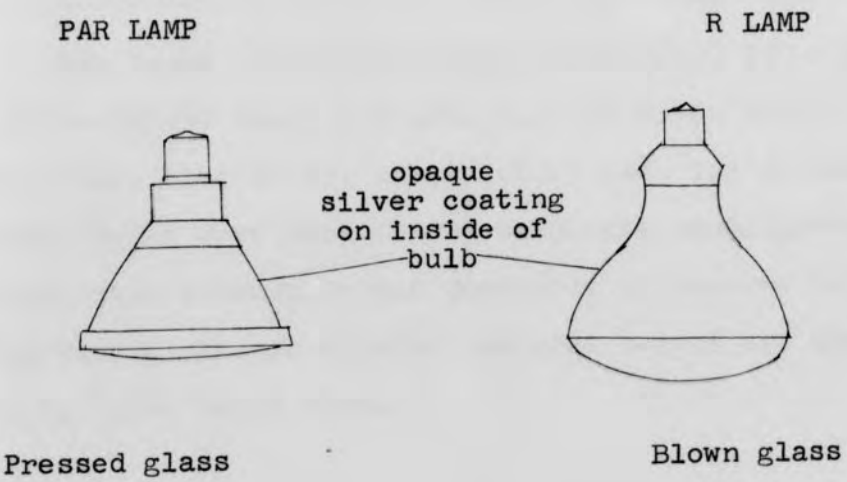


concentrated white light. The arm pivots and telescopes to 15 inches. A 25 watt lamp is used. The preceding page has a diagram of the low voltage lamp fixture.

For the purpose of accent lighting the incandescent lamps are more useful than fluorescent lamps, because the light from a fluorescent lamp cannot be controlled into a concentrated beam pattern. The incandescent lamps come in reflector and projector types. These lamps are popularly known as R lamps and PAR lamps. Both types are available either as a narrow beam spotlight or a wider beam floodlight called "spots" or "floods," respectively. Projector and reflector lamps have built-in reflectors that provide directional control of light. The following diagram shows the difference in the physical appearance of the two types.

FIGURE 7

DIAGRAM OF THE PHYSICAL APPEARANCES OF PAR AND R LAMPS



The data in the table below show the average performance characteristics of PAR and R lamps commonly used for interior lighting. (16)

TABLE I

APPROXIMATE INITIAL OUTPUT OF TYPICAL PAR AND R LAMPS

Reflector	R-20		R-30		R-40	
Watts	30	50	75	75	150	150
Beam Type	FL	FL	SP	FL	SP	FL
Beam Spread	80°	80°	50°	130°	40°	110°
Beam Lumens	145	378	400	610	810	1500
Total Lumens	200	430	770	770	1780	1780
Diameter in inches	2½	2½	3 3/4	3 3/4	5	5

Projector	PAR-38				
Watts	75	75	100	150	150
Beam Type	SP	FL	FL	SP	FL
Beam Spread	30°	60°	color	30°	60°
Beam Lumens	480	600	lamps	1110	1350
Total Lumens	750	750	only	1730	1730
Diameter in inches	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4

For beams of colored light, 75-w R-30, 150-w R-40, and 100-w PAR-38 lamps are available in seven colors: amber, blue, blue white, green, pink, red, and yellow. No colored lights were used in the temporary installations at Chinqua -Penn because it was desirable to present each object in its truest natural colors. Natural colors are best shown by using white lights.

The following table gives the comparative performance of mains voltage lamps with low voltage lamps. (3:465)

TABLE II

COMPARATIVE PERFORMANCE OF INCANDESCENT DISPLAY LAMPS

Lamp	Peak Illumination 3 ft	6 ft	9 ft	Rated Life (hours)	Beam Spread
Mains Voltage					
150-w R flood	140	35	16	1000	110°
150-w R spot	400	100	44	1000	60°
100-w R spot	240	60	27	1000	60°
150-w PAR flood	330	80	37	1500	35°
150-w PAR spot	820	200	90	1500	20°
Low Voltage					
50-w 12-v reflector spot	1000	250	110	1000	15°
50-w 12-v crown silvered	3000	750	330	1000	8°
50-w 12-v tungsten-halogen	6900	1650	740	2000	6°

It should be noted that there is a higher degree of precise beam control obtainable from PAR lamps compared to that of R lamps. The table shows that the beam control from the low voltage lamps is even more controlled than from either the PAR or R lamps.

There are lamps and fixtures available to meet the lighting requirements of most situations. However, there was found to be a need for the creation of a lighting system as shown in Figure 6.

II. CONSIDERATIONS TO BE USED AS A GUIDE IN SOLVING THE LIGHTING DESIGN PROBLEMS IN EXISTING STRUCTURES

In approaching the problems of the design for lighting Chinqua-Penn there were definite areas of consideration that had to be analyzed. These areas of consideration are present in all existing structures; therefore, their analyzation should be a part of the method of solving all lighting problems. These considerations are:

1. The architectural factor, such as sizes, shapes, heights, and fenestrations of the rooms. The rooms' sizes and shapes were varied in Chinqua-Penn. They included a very long, narrow solarium with windows down one side; an extremely large living room three stories high with balconies along one side from which lighting fixtures could be directed down on wall tapestries and statues; and a curved stair well panelled in very dark oak with no fenestration. It was noted that rooms with dark panelling required more light than rooms painted with a light color. This fact is due to the greater absorbtive characteristics of dark material. The installation of recessed lighting was not considered because of the quality of the ceilings; therefore the lighting in most cases was suspended from the walls and ceilings.

2. The necessity for maximum flexibility, to accommodate changing exhibits. Flexibility of positioning all concentrating light sources is a basic requirement when there is any chance that a display may be rearranged.

3. The numbers, shapes, sizes, and location of art objects. The art objects illuminated in this study were classified as floor, surface, and wall mounted. The sizes and shapes of the art objects varied from a small individually displayed three-dimensional statuette to a 14 foot x 16 foot wall hung Beauvais tapestry. The size of each object and its placement in the room were important factors in determining the size, type and number of lamps and fixtures used their placement in relationship to the illuminated object.

4. The presence or absence of natural light. The amount of natural light which enters a room and the relationship between the placement of the object and the location of the window were important factors in analyzing the lighting problem. An object placed in front of a window was seen in silhouette. Care was taken in the placement of the light fixture so that the window glass would not reflect the light source, thereby causing a glare spot.

5. The limitations imposed by technical restructions. Equipment that was available in Greensboro, North Carolina, was used for this study. This equipment is considered easy

to assemble, install and maintain. Lamps included the reflector and the projector types in spots and floods and the low voltage high intensity type as recommended in the literature. Before a design for lighting could be permanently installed a qualified electrical engineer would have to evaluate the power presently available. Then he would make provisions for getting enough electricity into the building with the use of branch circuits for the additional recommended wattage capacity. There would be provisions for safety such as circuit breakers for overload and a fire warning system. These safety factors would be followed according to the state laws and ordinances concerning the wiring of houses. All wiring could be put in metal conduits to prevent the exposure of wire, and the conduits would be painted to match the background on which they are attached. Electrical cables could be routed so as not to destroy the woodwork. These cables could run through the attic and basement to a central supplementary lighting switch box.

6. The visitor's view. The direct light from the source must not be visible to the viewer. It is important to know what the movements of the viewers are so that the fixtures can be properly placed and aimed. It should be noted that all the scientific recommendations in the world will be valueless if the visitor does not enjoy his viewing

experience. This fact is the ultimate criteria for a successful lighting design.

III. THE PRESENTATION OF SOLUTIONS FOR INSTALLATIONS APPLICABLE TO OLDER BUILDINGS FOR LIGHTING VARIOUS TYPES OF OBJECTS

This section describes the temporary installations that were developed to light various types of wall, floor, and surface objects. The installations were developed specifically to fit into the setting of the interior areas of Chinqua-Penn Plantation House and not to interfere with the architecture. The house presented some problems which would be found in other existing structures, therefore it was used as an example of what could be done in the area of lighting design. The solutions are presented through diagrams describing the installations and photographs revealing the effect of the installations. The order in which they are presented corresponds to the order in which they are seen on the guided tour through the house.

Lighting Design 1

The first lighting design installation began in the solarium, a long corridor-like room with windows and glass doors along the left side as the viewer walks through.

Within a niche on the right wall is the Head of Buddha. The background of the niche is an ornately carved and pierced wooden panel, causing competition between the object and the background (Figure 8A). Below this niche there is a shelf, and the low voltage light fixture was placed on it. The arm of the fixture was extended up to the level of the bottom of the niche, as shown in Figure 8B.

An eerie, mystical quality, oriental in character, was the effect of up-lighting (Figure 8C).

Lighting was mounted from above the niche to achieve an effect of down-lighting (Figure 8D).

The light was aimed at the top half of the niche, leaving the bottom half in relative darkness (Figure 8E). Rather than the two lighting effects illustrated, it is recommended that the arm of the light fixture be extended and aimed in a more downward position, so that the beam of light will be in a central location upon the object.

FIGURE 8A

HEAD OF BUDDHA--NATURAL LIGHTING

Statuette: Cast bronze, Chinese Ming, late 15th Century
Height: 11 inches
Base: Ebony
Height: 4 inches

Location: Inside niche in Solarium

Brightness: 5 footcandles. Opposite a long row of windows

Camera Lens: 50 mm

FIGURE 8B

DIAGRAM OF LIGHTING INSTALLATION
FOR HEAD OF BUDDHA--UPLIGHTED

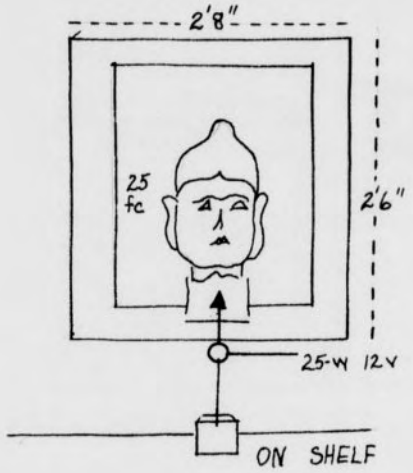


FIGURE 8C

HEAD OF BUDDHA--UPLIGHTED

FIGURE 8D

DIAGRAM OF LIGHTING INSTALLATION
FOR HEAD OF BUDDHA--DOWNLIGHTED

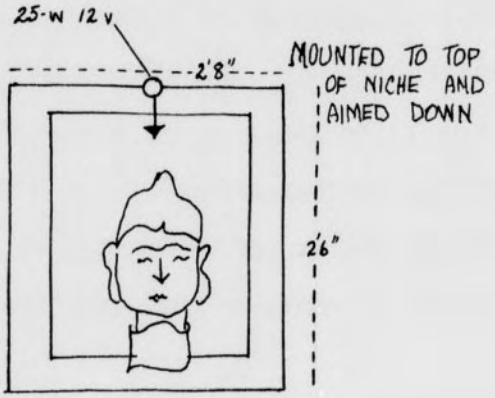


FIGURE 8E

HEAD OF BUDDHA--DOWNLIGHTED

Lighting Design 2

Farther down the Solarium the viewer sees a display of some Chinese art objects. On the right wall hangs a Chinese painting of watercolor on leather. Below the painting on a narrow table is a grouping of objects. On the far right (Figure 9A) is an object of particular significance, a Chinese candlestick. The lighting was designed to illuminate the entire display including the painting on the wall.

Two lighting fixtures were placed on the ceiling against the opposite wall 9 feet apart (Figure 9B). The lamp on the left was aimed down center, and the lamp on the right was aimed up center in relationship to the entire display.

The lamp at the left caused undesirable, dark shadows on the wall behind the objects on the table (Figure 9C).

It is recommended that the two fixtures be placed together directly in front of the display. One light can be aimed at the painting, and the other can be aimed down at the table. This center placement will eliminate those shadows and any possible glare that might be seen from along the viewer's path.

FIGURE 9A

CANDLESTICK AND PAINTING--NATURAL LIGHTING

Candlestick: A Pilgrim Arms Upraised to His Hat, terra cotta, Chinese, Ming Period
Height: 17½ inches

Painting: Watercolor on leather, Chinese, 15th Century
Dimensions: 38 inches by 30½ inches

Location: Solarium

Brightness: 5 footcandles. Opposite a long row of windows

Camera Lens: 35 mm

FIGURE 9A

CANDLESTICK AND PAINTING--NATURAL LIGHTING

Candlestick: A Pilgrim Arms Upraised to His Hat, terra cotta, Chinese, Ming Period
Height: 17½ inches

Painting: Watercolor on leather, Chinese, 15th Century
Dimensions: 38 inches by 30½ inches

Location: Solarium

Brightness: 5 footcandles. Opposite a long row of windows

Camera Lens: 35 mm

FIGURE 9B

DIAGRAM OF LIGHTING INSTALLATION
FOR CANDLESTICK AND PAINTING

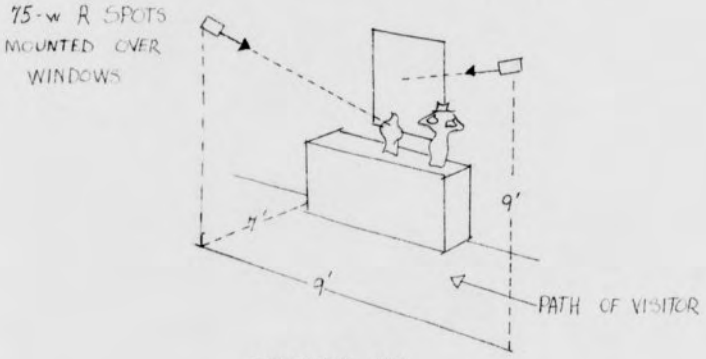
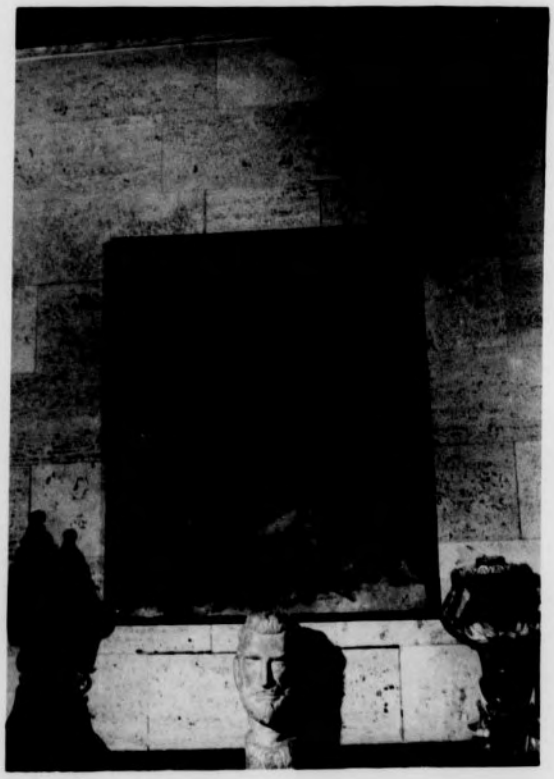


FIGURE 9C

CANDLESTICK AND PAINTING--ACCENT LIGHTED



Lighting Design 3

The first room upstairs to be shown on the guided tour is the Chinese Room. The viewer must stand behind a rope in an area at the entrance. A silhouetted effect is created by a statuette which is placed in front of a window (Figure 10A). The detail becomes lost in shadow, and the low contrast of the object gives a "flat" effect.

A projection in the wall is the architectural feature in the room that was used to conceal the wall mounted fixture (Figure 10B). The projection in the wall ends where the table and the statuette are placed. The projection is nine inches in depth and adequate for the concealment of the light fixture which was placed 5 feet from the floor, one foot above the top of the statuette.

The low voltage light was a 25-w 12-v lamp which cast a narrow beam of light defining the three-dimensional quality of the object (Figure 10C).

FIGURE 10A

STATUETTE OF BUDDHAS EMBRACING--NATURAL LIGHTING

Statuette: Two Triple Face Buddhas Embracing--Shamvaro and Shakti in Yab-Yum Position, oval molded base, leaf pattern gilt bronze, studded with semi-precious stones, Nepalese, 18th Century
Height: 13¼ inches

Location: Chinese Room

Brightness: 5 footcandles
Silhouetted against a window

Camera Lens: 105 mm

FIGURE 10B

DIAGRAM OF LIGHTING INSTALLATION
FOR BUDDHAS EMBRACING

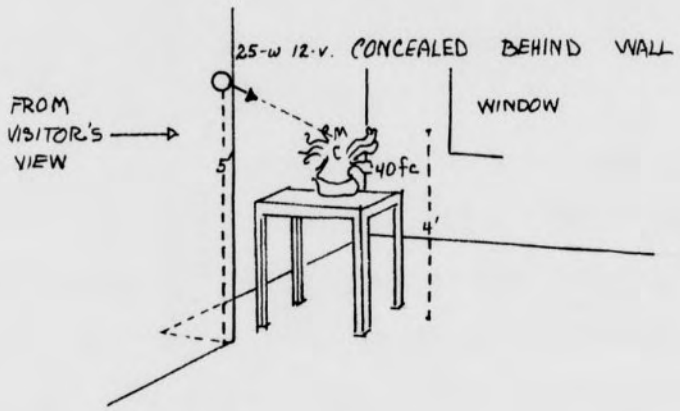


FIGURE 10C

STATUETTE OF BUDDHAS EMBRACING--ACCENT LIGHTED

Lighting Design 4

Also in the Chinese Room against another wall is a chest which has a mirror for its surface top. Placed on top of the mirror are a pair of statuettes and a small carved temple (Figure 11A).

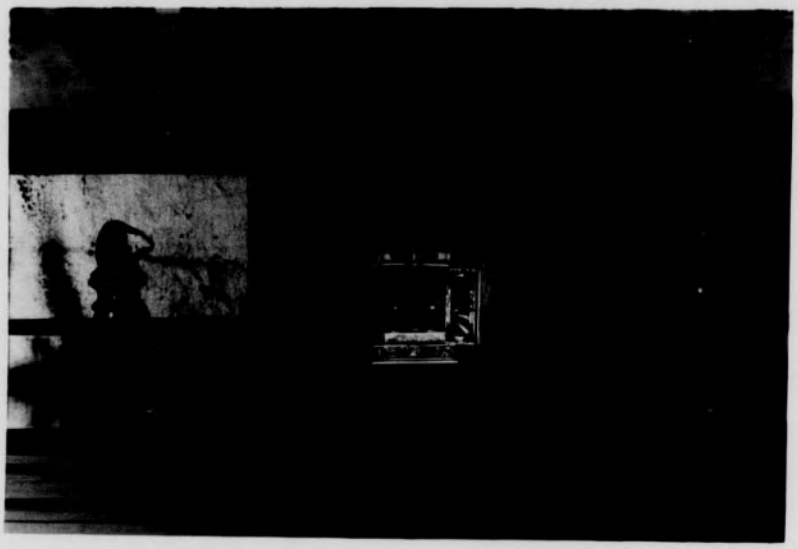
The ceiling mounted lights for the installation were placed about 6 feet apart (Figure 11B). The light on the left was aimed down to the center of the display. The light on the right was aimed higher to illuminate the pictures on the wall behind the chest. Natural lighting came from windows in adjacent walls.

The angles used caused the statuettes to be under-lighted (Figure 11C). The mirror-top on the chest made lighting this display very difficult. The fixtures were mounted 5 feet from the wall in order to avoid a reflection in the mirror. However, a shadow from each object was cast on the wall because the fixture could not be moved closer to the display.

It is recommended that a different surface be used for the top of the chest and that each light be aimed directly on the statuette to which it is closer. There will be a sufficient overlap of light in the center to adequately illuminate the temple.

FIGURE 11A

CHINESE STATUETTES AND TEMPLE
NATURAL LIGHTING



Statuettes: Bodhisattva Praying and Making Offering, bronze, Chinese, Yung Chen Period, 17th Century
Height: 8 3/4 inches

Location: Chinese Room

Brightness: 5 footcandles. Windows are left and right.

Camera Lens: 50 mm

FIGURE 11B

DIAGRAM OF LIGHTING INSTALLATION
FOR CHINESE STATUETTES AND TEMPLE

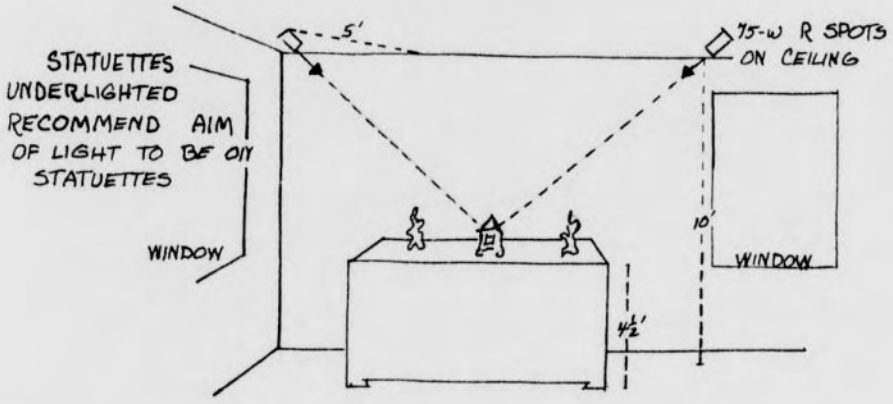
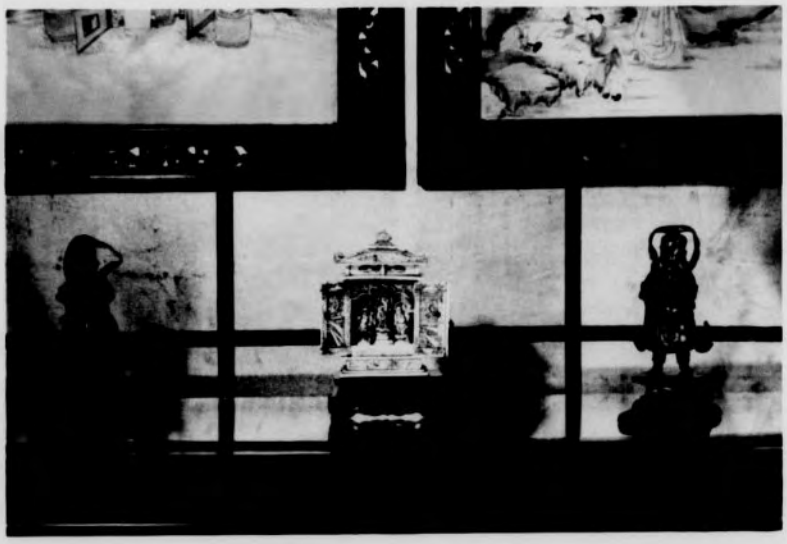


FIGURE 11C

CHINESE STATUETTES AND TEMPLE--ACCENT LIGHTED



Lighting Design 5

The setting for the next installation was the dark oak paneled Upstairs Hall. There were no windows in this area, and the only lighting came from a wall mounted lantern (top left corner of Figure 12A) and from a ceiling mounted chandelier (not shown) about 10 feet directly in back of the viewer of this scene. The absorptive characteristics of dark material, in this case the wood paneling, were apparent (Figure 12A). The chest was also of dark wood with brass trimmings and was barely discernible.

The accent light was in an undesirable location because it was in the visitor's view (Figure 12B). If it were moved to the left, over the chest, the viewer would not notice it as he walks toward the display.

Accent lighting brought out the details of the chest (Figure 12C). A comparison between Figures 12A and 12C fails to reveal the great difference in the visual impact of the painting before and after it was accent lighted. Actually, the accent lighting greatly emphasized the painting and brought out its vivid colors.

FIGURE 12A

INDIAN PAINTING AND CHINESE CHEST
ORIGINAL LIGHTING

Painting: Figural Pavilion Court Scene, tempera, North India, Safavid Dynasty, 18th Century
Dimensions: 10¼ inches by 14¼ inches
Framing: Gold galloon braid and gilt wood frame

Chest: K'ang Hsi All Chien Lung (1736-1795)

Location: Upstairs Hall

Brightness: 2 footcandles. Wall lanterns; no windows.

Camera Lens: 21 mm

FIGURE 12B

DIAGRAM OF LIGHTING INSTALLATION FOR PAINTING AND CHEST

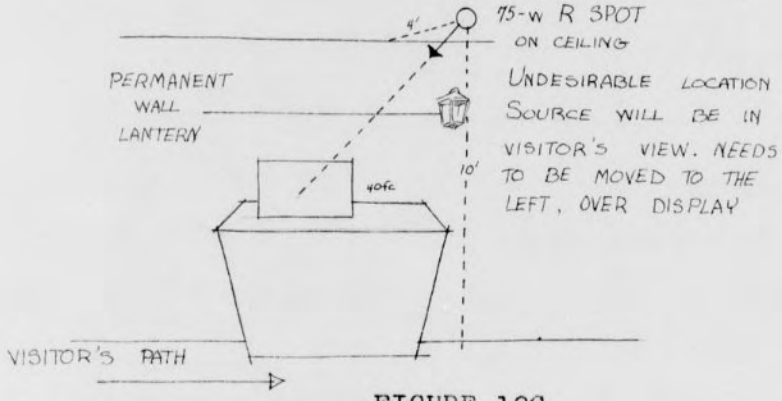


FIGURE 12C

PAINTING AND CHEST--SUPPLEMENTARY ACCENT LIGHTING

Lighting Design 6

The Velvet Room leads off from the Upstairs Hall. In the Velvet Room there is a statuette situated below a wall sconce. None of the light from the sconce reaches the object, but rather leaves it in darkness by contrast (Figure 13A).

There is a wall opening to the right of the object where a ceiling beam in the living room is located. This architectural feature of the room was used for the placement of the light fixture. The actual installation was positioned underneath the living room beam (Figure 13B).

The wall sconce was kept lighted, and the spotlight proved effective in bringing the statuette into view (Figure 13C).

In another experiment the wall sconce was not lighted (Figure 13E). A comparison was made between this effect and the one in which the sconce was kept lighted. The unlighted bulbs were distracting. They should be kept lighted, as in Figure 13C, where a pleasing balance of light was achieved.

FIGURE 13A

JAPANESE BUDDHA--ORIGINAL LIGHTING

Statuette: Buddha Seated in Buddha Posture, carved and gilt lacquered wood, pierced panel canopy back, Kamakura Period, 14th-15th Century
Height: 12 inches
Base: Lotus pattern
Height: 2½ inches

Location: Velvet Room

Brightness: 2 footcandles. Lights are above.

Camera Lens: 50 mm

FIGURE 13B

DIAGRAM OF LIGHTING INSTALLATION NO.1
FOR JAPANESE BUDDHA

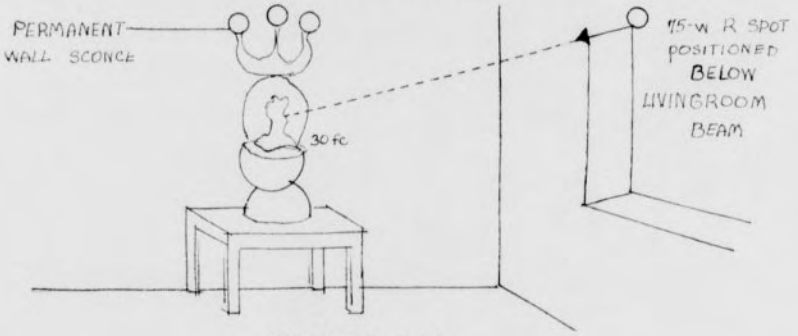


FIGURE 13C

JAPANESE BUDDHA--SUPPLEMENTARY ACCENT LIGHTING NO.1

FIGURE 13D

DIAGRAM OF LIGHTING INSTALLATION NO.2
FOR JAPANESE BUDDHA

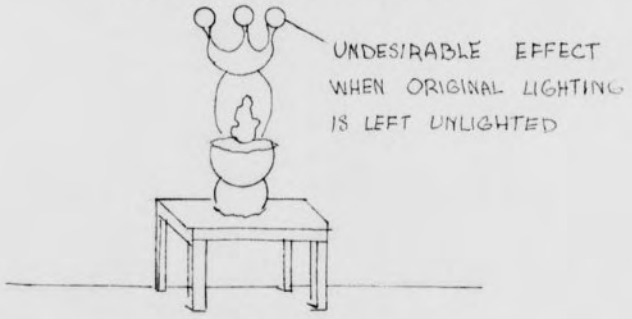


FIGURE 13E

JAPANESE BUDDHA--SUPPLEMENTARY LIGHTING NO.2

Lighting Design 7

From the Velvet Room the viewer goes to the Library which is a mezzanine-type room overlooking the Main Living Room. There are two small windows which are to the viewer's right as he enters the Library. There is an area of interest in the Library that contains a Persian Chair and a shelf holding an elaborate alter set of candelbra and tabernacle (Figure 14A).

Two floodlights mounted on opposite walls were used in this design (Figure 14B). Since the light on the left wall was a source of glare for the viewer as he enters the room, a better solution would be to use the illumination from the light mounted on the right wall alone.

FIGURE 14A

PERSIAN CHAIR AND GERMAN ALTER SET
NATURAL LIGHTING

Chair: 17th Century Persian, Kokrodum wood, inlaid with ivory

Alter Set: 18th Century German, candelabra and tabernacle, gilt brass, colored enamels, semi-precious stones

Location: Library, overlooking the Main Living Room

Brightness: 2 footcandles. Two small windows are to the left.

Camera Lens: 35 mm

FIGURE 14B

DIAGRAM OF LIGHTING INSTALLATION
FOR CHAIR AND ALTER SET

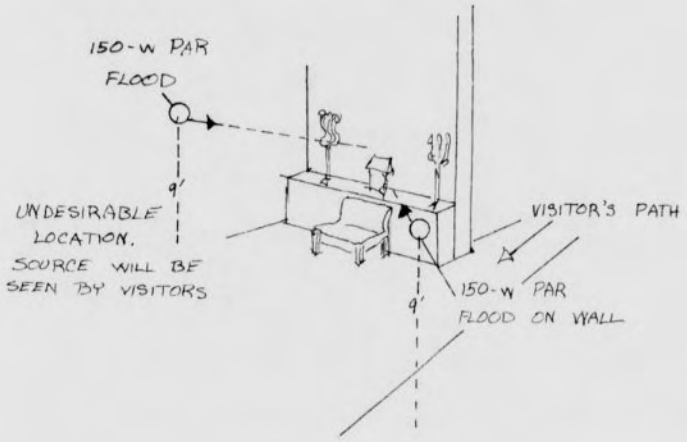


FIGURE 14C

CHAIR AND ALTER SET--ACCENT LIGHTED

Lighting Design 8

The Library is the last room upstairs which is seen on the guided tour. To go downstairs the visitor returns to the Upstairs Hall and descends a curved staircase. A large 9 feet by 12 feet tapestry is hung on the wall along the staircase. The tapestry in Figure 15A appears deceivingly bright. Actually it is very dark and is hardly noticeable to the viewer. The dark paneling of the wall absorbs much of the light from a chandelier.

On either side of the second floor staircase landing there are archways which were used for the placement of the light fixtures. The chandelier gives a small amount of light to the area.

The two floodlights had a brightening effect on the paneling and evenly illuminated the tapestry (Figure 15C).

FIGURE 15A

FLEMISH TAPESTRY--ORIGINAL LIGHTING

Tapestry: Verdure landscape
Dimensions: 9 feet by 12 feet

Location: Upstairs Hall along the curved staircase

Brightness: 2 footcandles. Light comes from a suspended chandalier.

Camera Lens: 21 mm

FIGURE 15B

DIAGRAM OF LIGHTING INSTALLATION
FOR FLEMISH TAPESTRY

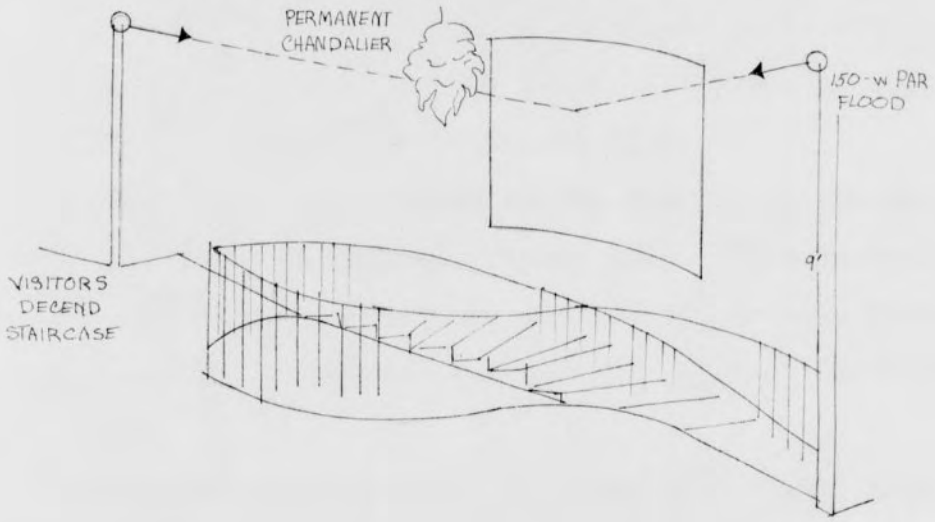


FIGURE 15C

FLEMISH TAPESTRY--SUPPLEMENTARY ACCENT LIGHTING

Lighting Design 9

At the bottom of the curved staircase is the Clock Hall. The dark paneling and the absence of natural light also make this hall very dark (Figure 16A).

Mounted over the doorway at the foot of the steps was the lighting installation (Figure 16B). This location proved to be undesirable because the aim of the beam shown directly into the doorway at the opposite side of the hall (Figure 16C).

Another installation was designed in the same area. At the foot of the steps was a tall floor stand candelabra. It was constructed so that a floodlight could be placed within the arms and be concealed, yet there was space enough to allow the light from the floodlight to shine through. The aim of the beam shown across the hall instead of down the hall, and there were no glare spots from this position (Figure 16D).

The ornate design of the ceiling made recessed lighting impossible (Figure 16E).

FIGURE 16A

CLOCK HALL--ORIGINAL LIGHTING

Clock Hall: Paneled in dark English oak
Settee (right): Portuguese, circa 1750
Chair (left): Italian, walnut, 16th Century, seat covers of Brussels tapestry
Mirror(right): Florentine, circa 1770

Brightness: 2 footcandles. Double wall sconces are at left. Dark paneling absorbs a great deal of light.

Camera Lens: 21 mm

FIGURE 16B

DIAGRAM OF LIGHTING INSTALLATION NO.1
FOR THE CLOCK HALL

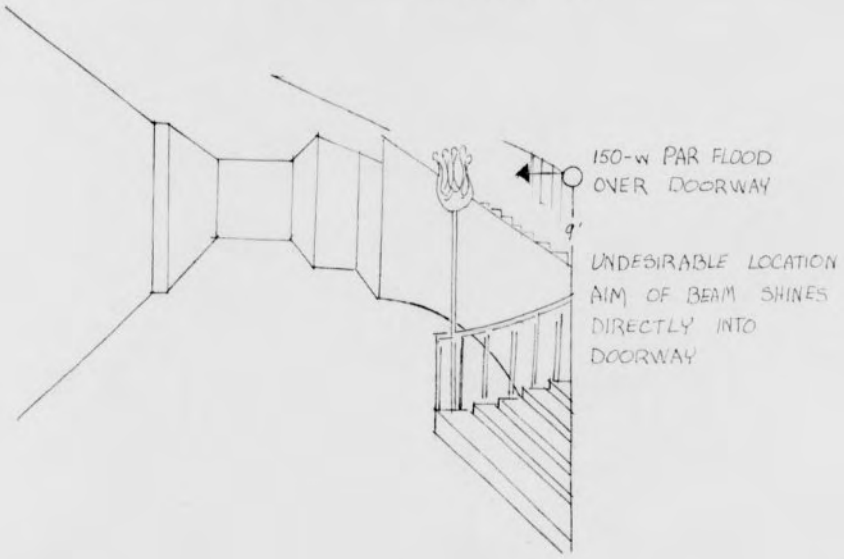


FIGURE 16C

CLOCK HALL--SUPPLEMENTARY LIGHTING NO.1

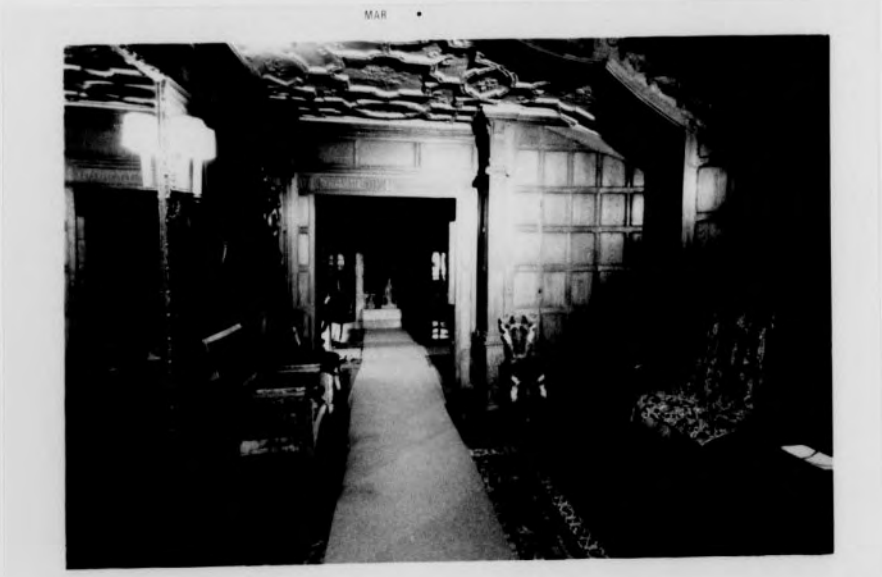


FIGURE 16D

DIAGRAM OF LIGHTING INSTALLATION NO.2
FOR THE CLOCK HALL

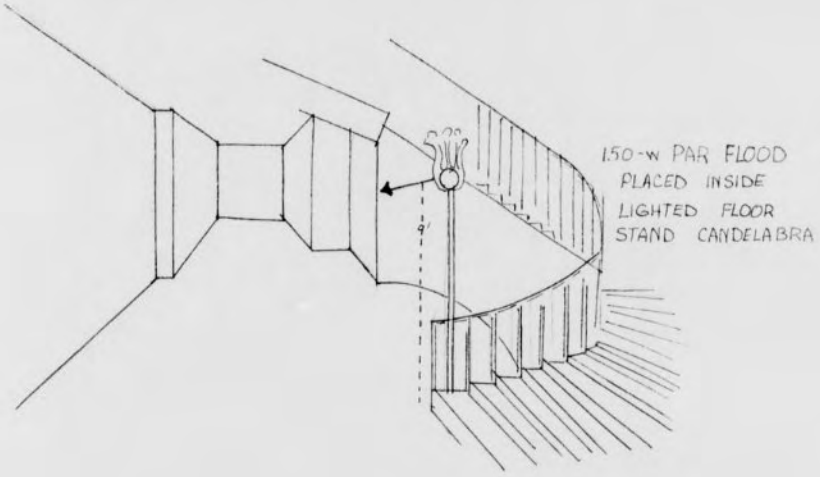


FIGURE 16E

CLOCK HALL--SUPPLEMENTARY LIGHTING NO.2

Lighting Design 10

The Clock Hall is so named because of a Louis XV clock standing in the hall. The clock is barely discernible from the paneled wall which is its background (Figure 17A). The detail and trim of the clock go completely unnoticed as the viewer walks past this object.

A floodlight was used in this installation. It was located at the point below where the staircase joins the second floor landing (Figure 17B).

Accent lighting brought out the rich colors of red, black, and gold, and clearly illuminated the intricate details of this object (Figure 17C).

FIGURE 17A

LOUIS XV CLOCK--ORIGINAL LIGHTING

Clock: Boulle ebony case, gilt applique
Height: 7 feet

Location: Clock Hall

Brightness: 2 footcandles. Wall sconce is to the left.

Camera Lens: 21 mm

FIGURE 17B

DIAGRAM OF LIGHTING INSTALLATION
FOR THE LOUIS XV CLOCK

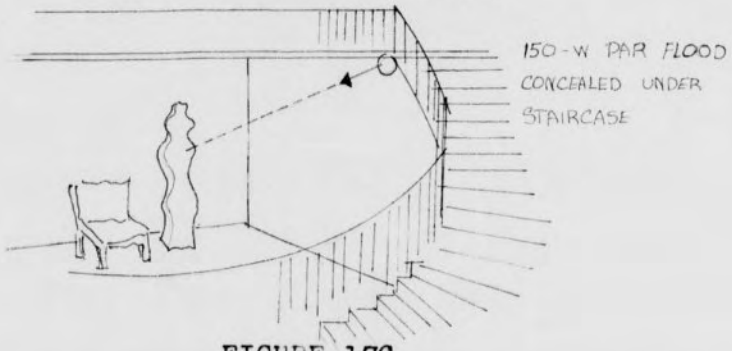


FIGURE 17C

LOUIS XV CLOCK--SUPPLEMENTARY ACCENT LIGHTING

Lighting Design 11

The Reception Hall was the location for the next three installations.

A glass floor screen is positioned in front of a fireplace alongside the path of the visitor (Figure 18A).

Because the screen is translucent, it reflects light shining upon it. For the best display of this object light was introduced through it by placing lamps on metal stands on the floor six inches behind the screen. A shield was placed perpendicular to the screen (Figure 18B). The use of a shield was made to block out the view of the lamps as the viewer approached the area of the screen.

The color and detail of the painted figure on the screen were greatly enhanced by the light shining through this translucent art object (Figure 18C).

The screen is perpendicular to a very large six by twelve foot plate glass window. A recommendation is made to relocate the screen in front of the window so that the natural light can shine through. If this were done there would be no need for any artificial light.

FIGURE 18A

JAPANESE GLASS FLOOR SCREEN--NATURAL LIGHTING

Screen: Clear glass painted figural allegorical pattern in colors, carved teak frame, fret pattern, late 18th Century
Dimensions: 36 inches by 53½ inches

Location: Reception Hall

Brightness: 10 footcandles at top, 30 footcandles at base
Perpendicular to window, 6 feet by 12 feet

Camera Lens: 105 mm

FIGURE 18A

JAPANESE GLASS FLOOR SCREEN--NATURAL LIGHTING

Screen: Clear glass painted figural allegorical pattern in colors, carved teak frame, fret pattern, late 18th Century
Dimensions: 36 inches by 53½ inches

Location: Reception Hall

Brightness: 10 footcandles at top, 30 footcandles at base
Perpendicular to window, 6 feet by 12 feet

Camera Lens: 105 mm

FIGURE 18B

DIAGRAM OF LIGHTING INSTALLATION
FOR JAPANESE FLOOR SCREEN

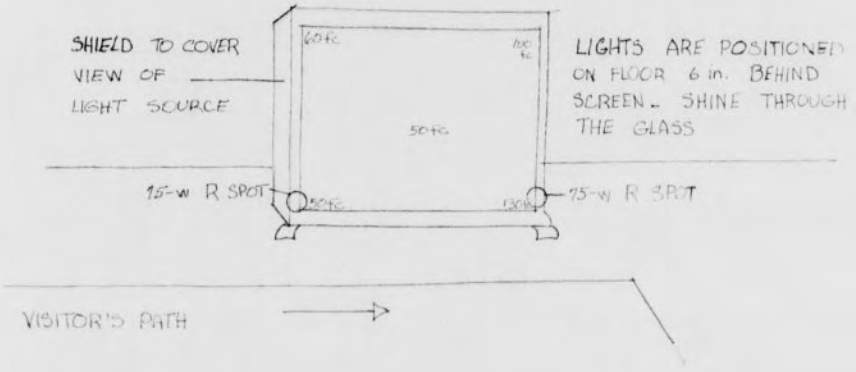


FIGURE 18C

JAPANESE GLASS FLOOR SCREEN--ACCENT LIGHTED

Lighting Design 12

Standing on the floor next to the floor screen in front of the large window is the Camel Boy statue. Light coming from the rear creates a silhouetted effect on that object (Figure 19A).

The location of the lighting installation was 5 feet 4 inches to the right of the statue (Figure 19B).

The features on the face of the Camel Boy, Figure 19C, reveal the "flat" look which was the effect of overlighting from a lamp which was too powerful for the object it was illuminating (75-w R spot). It is recommended that a low voltage 25-w 12-v be used to achieve the modeling effect best suited for three-dimensional objects.

The display of this object could be improved by placing it on a pedestal to raise it for better viewing. An object 2 feet high placed on the floor is easily overlooked. It should be relocated away from the window to avoid the silhouetted effect.

FIGURE 19A

CAMEL BOY STATUE--NATURAL LIGHTING

Statue: Terra cotta, white patina and amber glaze, Chinese, T'ang Dynasty, 618-906 A.D.
Height: 23½ inches

Location: Reception Hall

Brightness: 45 footcandles
Silhouetted against a window,6 feet by 12 feet

Camera Lens: 105 mm and 50 mm

FIGURE 19B

DIAGRAM OF LIGHTING INSTALLATION FOR CAMEL BOY

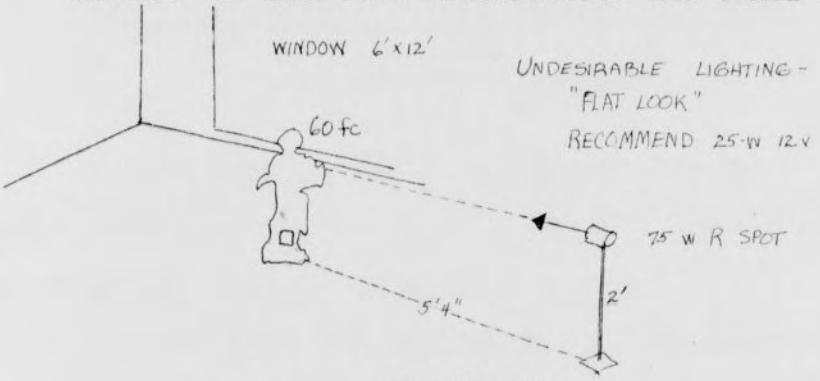


FIGURE 19C

CAMEL BOY--ACCENT LIGHTED

Lighting Design 13

To the side of the Camel Boy is the Camel. This statue is also standing in front of the plate glass window and is silhouetted (Figure 20A).

A floodlight was positioned at the same height of the statue and 4½ feet in front of it (Figure 20B).

A "flat" look like the effect of the Camel Boy, Figure 19C, would be expected on the Camel because the two installations were similar; however, this was not the case. The deeper surface indentations on the Camel created shadows which resulted in a modeling effect which was better than in the Camel Boy (Figure 20C).

Recommendations were made to improve the method of display for the Camel Boy. The Camel should also be included in these recommendations which involve relocating the object away from the window, raising it for better viewing and applying a more concentrated light.

FIGURE 20A

CAMEL STATUE--NATURAL LIGHTING

Statue: Terra cotta, tan, green and white glaze, ogre mask caparison, Chinese T'ang
Height: 33½ inches

Location: Reception Hall

Brightness: 30 footcandles
Silhouetted against a window,12 feet by 6 feet

Camera Lens: 50 mm

FIGURE 20B

DIAGRAM OF LIGHTING INSTALLATION
FOR CAMEL STATUE

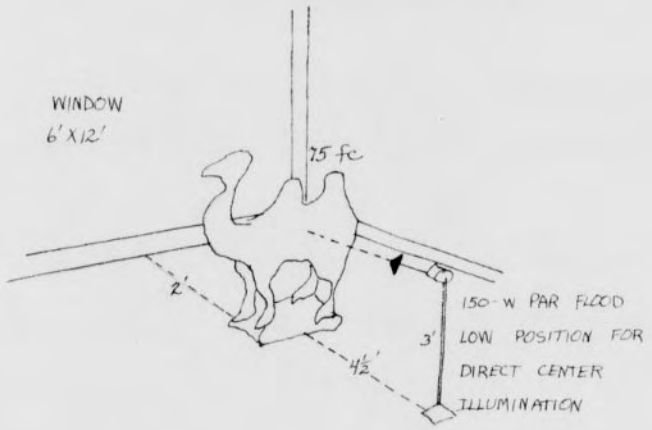
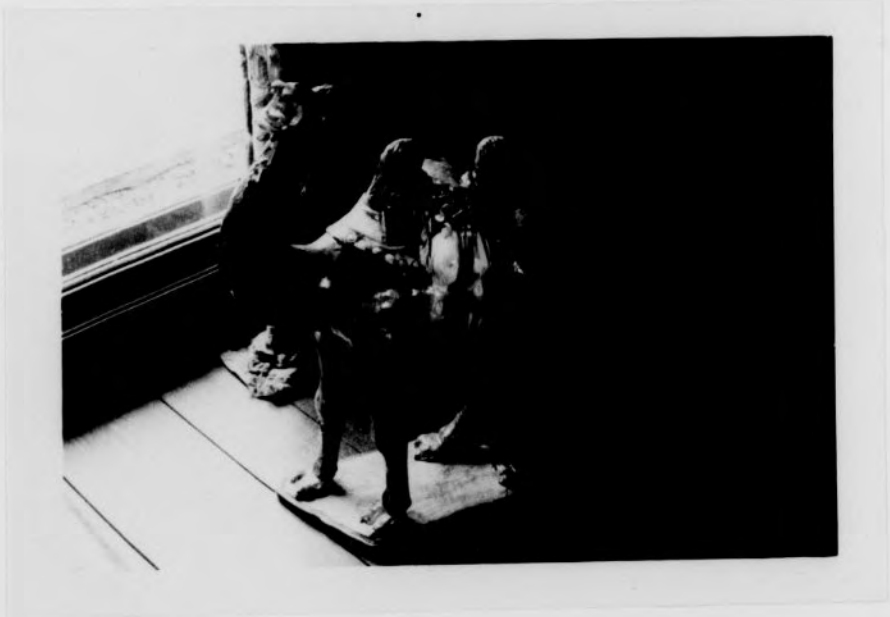


FIGURE 20C

CAMEL STATUE--ACCENT LIGHTED



Lighting Design 14

From the Reception Hall the viewer enters the Main Living Room. On either side of the entrance is a statue placed against the wall (Figure 21A).

The Library balcony overlooks this area of interest in the Main Living Room. The top of the statue is seven and one half feet from the floor, and the balcony is four and one half feet above the top of the statue. A floodlight was located in the grillwork of the balcony and aimed down to the center of the statue (Figure 21B).

The light cast a deep shadow on the rear wall behind the statue (Figure 21C). There is a ceiling beam (not shown) twenty-five feet from the floor which runs across the room over the balcony. If a spotlight were placed on this beam and positioned to the right of the statue, the shadow cast would be minimized and would also be on the other side of the statue out of the visitor's view.

FIGURE 21A

MOON SPIRIT STATUE--NATURAL LIGHTING

Statue: Terra cotta, white patina, tan and green glaze,
Chinese, T'and Dynasty
Height: 34 inches

Location: Main Living Room

Brightness: 2 footcandles. Windows are to the right.

Camera Lens: 105 mm

FIGURE 21B

DIAGRAM OF LIGHTING INSTALLATION
FOR STATUE OF MOON SPIRIT

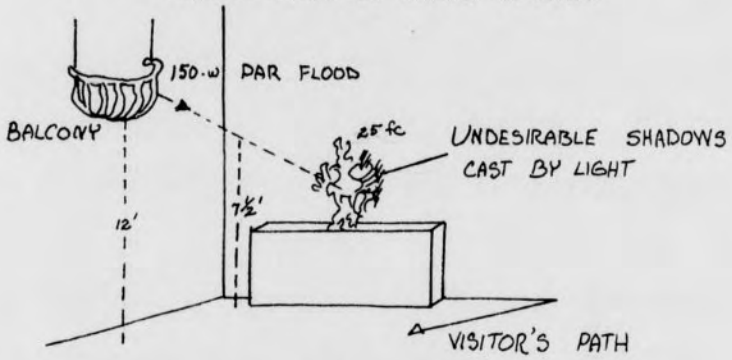


FIGURE 21C

MOON SPIRIT STATUE--ACCENT LIGHTED

Lighting Design 15

At the end of the Main Living Room opposite the entrance is a large fourteen by sixteen foot tapestry. The original accent lighting is a floodlight placed on a beam to the right of the tapestry. The aim of this light is too high and leaves all the objects on the mantelpiece unlighted including the madonna in the center (Figure 22A).

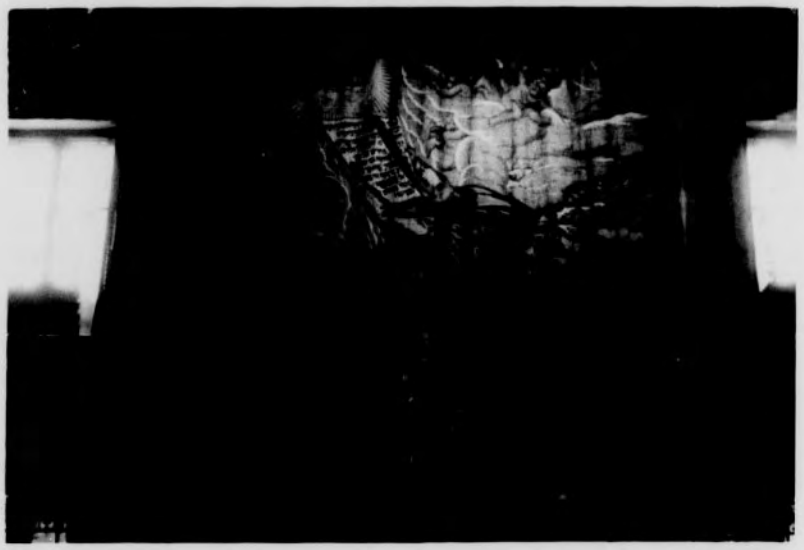
Two floods were placed in the grillwork of the balcony. One was aimed at the center of the tapestry, and the other was aimed down to the madonna. There were three lights all coming from the right. Natural lighting comes from windows on either side of the tapestry (Figure 22B).

The effect of this lighting design was too one-sided. Dark shadows were caught in the left side of the folds (Figure 22C).

It is recommended that to evenly distribute the light over the tapestry, an equal amount of light must come from the beam from the left of the tapestry. One flood from the right and one flood from the left should be sufficient to adequately illuminate this display.

FIGURE 22A

BAUVAIS TAPESTRY AND SPANISH MADONNA
ORIGINAL ACCENT LIGHTING



Tapestry: Moses Receiving the Ten Commandments
Dimensions: 14 feet by 16 feet

Madonna: Carved wood and gesso, polychrome and gilt

Location: Above the manel in the Main Living Room

Brightness (at the base): 2 footcandles
Original lighting: One spotlight aimed too high, leaving the Madonna unlighted

Camera Lens: 50 mm

FIGURE 22B

DIAGRAM OF LIGHTING INSTALLATION
FOR THE BAUVAIS TAPESTRY AND SPANISH MADONNA

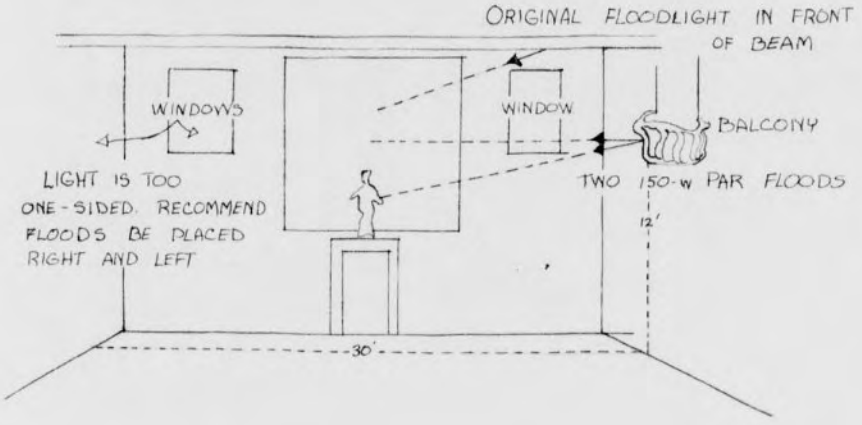


FIGURE 22C

BAUVAIS TAPESTRY AND SPANISH MADONNA
SUPPLEMENTARY ACCENT LIGHTING

The use of Chinqua-Penn Plantation House as the place for this study was desirable because it presented many varied lighting problems.

Samples of lamps and fixtures which were obtainable in Greensboro, North Carolina, and were recommended in the literature were used for the purpose of illumination.

After consideration was given to the recommendations found in the literature, installations were developed, and the solutions to the lighting problems were presented through the use of diagrams and photographs.

The following chapter contains the summary and conclusions for this study.

CHAPTER V

SUMMARY AND CONCLUSIONS

I. SUMMARY

There have been many older homes and buildings containing objects of interest which have been opened to the public. The change in use of these buildings from residence to house-museum required that the lighting also be redesigned. Residential lighting is inadequate for lighting objects that are displayed for the purpose of study and examination. The illumination levels used to focus on areas of interest must be higher than on the surrounding areas. Since the reason people go on these tours is to see the objects on display, it is reasonble to assume that they expect the objects to be lighted so they can comfortably and clearly see these objects to their best advantage. Too often the illumination in many older buildings is so dim that the viewer feels he has missed seeing many things on the tour. The viewer is even more frustrated when he is not allowed to enter a room for close examination of objects in which he is particularly interested. This is an instance when the lighting plays an important part in defining the object and in helping the viewer focus his attention on the object.

This study was undertaken to study the effects of accent lighting on displays and to provide a basis for further application of the lighting design methods in the field of restoration and preservation. The purpose of the study was threefold: (1) to identify types of lighting and lighting apparatus available that might be used to focus on areas of interest in an existing building, (2) to develop possible installations that will fit into the setting of existing structures and will not interfere with the architecture, and (3) to present solutions that would be applicable to older buildings for lighting various types of wall, floor and surface objects.

Chinqua-Penn Plantation House near Reidsville, North Carolina was used as the site for this experiment in lighting. Photographs and diagrams were used to illustrate the varying effects which were achieved from the lighting installations.

Identification of Types of Lighting Systems

Certain specifications were made for the lighting systems before any lamps or light fixtures were selected for use in this study. The selection of various lamps and fixtures used in this study was based on recommendations of the literature. To accommodate changing exhibits, the accent lighting was to have maximum flexibility. Since recessed lighting could not be used because of the types of ceilings in existence at Chinqua-Penn, only surface mounted

fixtures were considered. This was a situation peculiar to Chinqua-Penn, but it was assumed that other older homes would also be unable to accommodate recessed lighting. Lamps used in the study represented types PAR and R in both spots and floods. It was found that the beam control and the durability of the PAR lamps was greater than in the R lamps of the same wattage. For the illumination of smaller three-dimensional objects, the concentrated narrow beam of the low voltage lamp proved very successful. There were many successful applications of this light source, and its use should receive further consideration in other similar installations. No situation could be found at Chinqua-Penn to justify the use of the relatively expensive framing projector which casts a sharp edge beam of light of a rectangular pattern. However, in another situation where valuable paintings were to be illuminated, the use of framing projectors would be desirable.

Factors in the Lighting Design Problem

There are no exact formulas which can be used to solve the lighting design problems. Each problem embraces its own set of difficulties. Although each situation was approached as a separate problem, there were common factors that had to be considered in each. These factors were:

1. The architectural factor, such as sizes, shapes, heights, and fenestrations of the rooms.
2. The necessity of maximum flexibility, to accommodate changing exhibits.

3. The number, shapes, sizes and location of art objects.
4. The materials of which objects are made.
5. The presence or absence of natural light.
6. The limitations imposed by technical restrictions.
7. The visitor's view.

The analyzation of these factors is the fundamental basis for all further lighting design applications in older buildings.

Installations and Solutions

The lighting installations presented in this study represent different methods of lighting various types of wall, floor, and surface objects. The interior areas of Chinqua-Penn Plantation House were used for the lighting experiments because they presented examples of problems which would be found in other existing structures.

One of the major specifications of the lighting in this study was to develop solutions which would not interfere with the architecture. In many cases the architecture in a room was used in conjunction with the installation. Beams, balconies, projections of the walls, wall openings, columns, arches, doors, niches, and windows were all part of the interior architecture which was used for the placement of installations. Non-architectural elements in a room were also used. An example of such an element was a floor stand candelabra.

Knowledge of the path of viewers is important so that glare spots can be avoided. Glare is present when the light source is seen directly by the viewer or when the light source is reflected into glass or mirror. Careful positioning of the light sources is very important; therefore knowledge of the path of the viewer is essential. The viewer should be unaware of where the light is coming from; thus the lamps should be concealed from view wherever possible.

The dark shadows cast by objects can be avoided by the proper positioning of lamps. Usually a more vertical angle from a more central location over the object will eliminate most undesirable shadows. These shadows are particularly noticeable when the object is placed against a vertical background. If the object can be moved away from the wall, the shadow will be less conspicuous. It will also be less discernible if there is a sufficient quantity of diffuse light on the surrounding areas.

The relationship between windows and object was of importance in the way the object was seen. An object placed in front of a window was silhouetted against the bright background of the window. The front of the object, the side seen by the viewer, was left obscured in shadows.

Rooms with light colored walls required much less additional lighting than rooms with dark paneled walls. Dark colors absorb light, while light colors reflect it.

It was found that windows are an important source of diffuse light. This diffuse light supplies general overall illumination. Diffuse light also contributes to the accurate and comfortable viewing of objects and tends to eliminate sharp contrasts.

Accent lighting was determined to have certain advantages and disadvantages. The over-employment of concentrated light is responsible for photochemical damage to objects. This deterioration is caused by the heat from the lamps. Short time exposure, ventilation cooling and the use of filters are ways of preventing heat build-up within the illuminated objects made of fragile material. Highly concentrated light also decreases visual efficiency because the eye needs longer to adjust to the sharp contrasts of high and low brightness levels. However, there are also some advantages with the use of accent lighting. It draws the viewer's attention to the object illuminated. Accent lighting also aids in focusing the attention on the object and encourages examination of details. Its use supplies important dramatic emphasis to sculpture and enhances the esthetic quality of most objects. Accent lighting is equally as important as diffuse lighting. Actually it is a balance between accent and diffuse lighting that is desirable.

It is hoped that this study may make a contribution in the area of lighting design for art objects in inadequately lighted museums. Some possible installations using differing types of lighting were shown here. Diagrams of the installations were given in all instances. The solutions were photographed so that others might use them as a visual guide for other problems in the area of accent lighting.

II. CONCLUSIONS

The light source, the illuminated object and the viewer constitute a triangular relationship in planning lighting for residential art museums. Conclusions regarding each of these three facets are given here as recommendations for future applications.

Recommendations pertaining to the light source:

1. Use low voltage lamps on small objects.
2. Employ PAR lamps rather than less durable, less accurate R lamps on large objects and areas.
3. Utilize white lights which produce the most natural colors in illuminated objects.
4. Apply lighting that is flexible to accommodate changing exhibits.
5. Achieve a balance between accent and diffuse lighting.

Recommendations pertaining to the object:

1. Lighting must be applied to enhance the appearance of art objects and to create a focus of interest in a particular area.

2. Lighting from one direction is best suited for three-dimensional objects.

3. For two-dimensional objects the lighting must be equally balanced from both sides.

4. Translucent and transparent objects are most suitably lighted from the rear.

5. Lighting solid objects from the rear creates a silhouetted effect.

6. Areas that have dark ceilings, floors and walls require more illumination than those areas which are light colored.

7. Lights can be turned on and off in areas where objects have a tendency to deteriorate from heat.

8. Objects made of reflective materials require less illumination than objects made of diffuse materials.

9. Objects made of materials which give a specular reflection require a more careful lighting installation than objects made of materials which give a diffuse reflection.

Recommendations pertaining to the viewer:

1. The viewer must be unaware of the light. Architectural features in a room can be used to conceal the placement of fixture.

2. The path of the viewer must be known so that lighting can be applied to avoid violations of normal standards of good seeing. These standards are the exclusion of glare, of distracting reflections and of sharp contrasts in illumination in the line of vision.

The development of additional lighting studies and the results of future studies may lead to the expansion and modification of these recommendations.

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