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ABSTRACT

PSYCHOLOGICAL AND EMOTIONAL EFFECTS OF LIGHTING IN INTERIOR DESIGN: (A REVIEW OF LITERATURE)

by Judith E. Orr

Very little research has been done on the psychological effects of lighting in interior design. Other fields, such as psychology, architecture, and electrical engineering have done research on lighting which provides the necessary background information for this problem.

Artificial lighting is compared to daylighting in terms of physical changes and psychological advantages. Artificial lighting affects the feeling in the interior of a room by changes in the amount of light, color of light, type of light source, system, and equipment, and the location of the fixture. The emotional effects of artificial lighting such as visual appeal, emotional response, hearing response, and changes in environmental conditions are described. The summary explains the psychological importance of lighting; its use to create variety of mood, to achieve visual unity, and to change clarity of form.

There is a definite need for more written research concerning psychological effects of lighting because it is such an important consideration in interior design.

PSYCHOLOGICAL AND EMOTIONAL EFFECTS OF LIGHTING IN INTERIOR DESIGN

(A REVIEW OF LITERATURE)

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(A REVIEW OF LITERATURE)

I. Lighting: A Fundamental Factor in Interior Design

The psychological and emotional effects of lighting are a fundamental factor in interior design. A study of natural lighting and artificial lighting throughout history leads to assumptions concerning lighting techniques. These assumptions are based on the selection and rejection of solutions to lighting problems. Research must be done on these assumptions if man's subjective reactions to his lighting environment are to become an exact science.

Natural Lighting

> Daylight is an integral part of the architectural design of the vast majority of modern buildings. It determines in large part, the utilitarian as well as the esthetic environment provided by the designer....
>
> The requirements for good lighting design can be achieved by skillful application of daylighting techniques. These differ from the design methods for electric lighting because of the variations in the amount of daylight, the changing position of the sun, and the deep-seated desire of many persons for a view of the outdoors....The variations in the amount, the direction and the color of incident daylight, however, add an interest to the daylighted interior which no static lighting system can possibly produce. Daylight, skillfully employed, provides the architect with one of his most effective modes of esthetic architectural expression.[1]

Variable and Uncontrollable Methods

The natural lighting phenomenon is variable and uncontrollable from the outside.

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[1]John Callender, A Handbook of Architectural Design (New York: McGraw-Hill Book Company, Inc., 1966), p. 856.

> Perhaps the most fascinating phase of nature's setting is the variety of lighting effects. Nature's lighting is ever changing.... Here nightly are rendered the great symphonies of light and of color....[1]

One of the reasons that natural lighting is variable and uncontrollable is because of changes in atmospheric conditions. The degree to which the natural environment affects our emotional state is apparent with the change of mood brought about by changes in weather. Phillips states that a bright day usually brings about a state of well-being, while a dull, overcast day can produce a state of depression. Anything between these two extremes has similar but less pronounced effects. If weather changes take place over a long period of time, so that the effects are graded into each other, the emotional change may be less pronounced. If weather changes are sudden or violent as with the appearance of storm clouds on a sunny day, emotional change may be spectacular.[2]

Another reason natural lighting varies is because of the change in time of day. The sight of an early morning sun is enlightening because it is the beginning of a new day. The sky gets lighter as the sun rises and becomes purer in color. Yet at the end of the day the setting sun may be more depressing because the sky continues to get darker as the sun disappears. There is no way to control these natural changes in the time of day, but constant change is what creates variety.

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[1]Mathew Luckiesh, Lighting Fixtures and Lighting Effects (New York: McGraw-Hill Book Company, Inc., 1925), p. 19.

[2]Derek Phillips, Lighting in Architectural Design (New York: McGraw-Hill Book Company, Inc., 1964), p. 48.

Psychological Advantages

Natural lighting has psychological advantages caused by a change in the outdoor conditions which bring about a stimulating effect.

One advantage is that a natural mood is present outdoors. Phillips observes that a bright sunny day with clouds creating light and dark patches is more stimulating than a cloudless day. Also, the changes from rain to sunshine and back to rain provide more stimulation than a steady overcast day. The evening sky has a different character which creates a change of mood. After the working day, thought and contemplation may be stimulated rather than action.[1]

A second psychological advantage is that direct sunlight feels warm. It is a matter of common observation that a bright sunny day produces a warm-hearted and cheerful emotional state. Phillips mentions that the natural environment seems bright and warm because of the yellowish appearance of the sun. The sources of light, both warm direct light from the sun and cool diffuse light of the sky, contain all the colors of the spectrum. This causes the color of the environment to seem balanced with no apparent distortion of any hue. It is clear that these psychological aspects of warmth and balance in color contribute to our state of well-being.[2]

Artificial Lighting

The artificially lighted environment differs somewhat from the naturally lighted environment.

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[1]Phillips, Lighting in Architectural Design, p. 48.

[2]Ibid. p. 49.

> The purpose of lighting is not just that it provides a desired footcandle level at 30 inches above the floor, but that lighting be an integral part of the essential interior space - recognizing that its excellence or failure can make or ruin the essence of a building.[1]

Controllable Methods

The methods of artificial lighting can be controlled by the architect or designer. Artificial lighting differs from natural lighting because it can be controlled for desired mood and environmental function.

According to Phillips, artificial lighting controls the environment by allowing flexibility of planning within a building. If building plans are based on production and function rather than obtaining natural light, then heat losses can be reduced in places that otherwise would be lighted by large areas of glass. Also, dirt and dust can be controlled and environment designed for work areas created where necessary. Deep spaces can be utilized and dead storage areas can be eliminated. Some architectural spaces have several needs, such as lecture halls used for concerts and plays, and assembly halls used for dining, dancing and examination rooms.[2] "The flexibility of artificial lighting solutions enables the right mood to be established and the right light intensity to be realized."[3]

Artificial lighting offers a choice of mood by variation of lighting effects. One way to create mood is by variation of intensity.

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[1]Ernst Payer, "Lighting is to Architecture as Architecture is to Lighting," Light Magazine, XXXVII No. 2 (1968), p. 12.

[2]Phillips, Lighting in Architectural Design, p. 10.

[3]Ibid.

This is achieved by raising the lighting levels so that the body responds favorably. Logan states that:

> ...people feel refreshing certitude in their perceptions, orientation and actions as lighting levels go up, that they will continue to adopt higher levels as fast as they can afford to; up to the point that they can afford to introduce levels indoors characteristic of the daylight range, outdoors.[1]

Variation of mood is also created by distribution of light to enhance appearance. Fairly wide beam distribution illuminates vertical planes and is flattering. However, lighting from one direction is unflattering and creates an unnatural mood.

Psychological Advantages

Artificial lighting has psychological advantages in which the effects are created by emotional appeal, control of changes and imitation of natural lighting.

One psychological advantage is that the illumination level effects both physical comfort and emotional well-being. "As with the natural environment a well-lit, bright appearance assists in promoting a sense of well-being, which can be obtained as easily from medium levels of illumination as with those substantially higher...."[2]

Another psychological advantage of artificial lighting is that it can imitate natural lighting. Luckiesh proposes that:

> Artificial light is a mobil medium of expression, with it, not only may any of nature's effects be reproduced, but the great pageant of lighting moods [in interior design]

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[1]Henry Logan, Trends in Electric Light Source Development and Utilization, Building Research Correlation Conference, Cleveland, Ohio, May 20 - 21, 1959 (Washington, D.C.: Building Illumination, 1959), p. 35.

[2]Phillips, Lighting in Architectural Design, p. 49.

> may be stimulated with the same modulations. These lighting effects are just beginnings for artificial light. The possibilities beyond them and into the realm of the abstract are unlimited.[1]

It is possible to duplicate the effect of the various types of artificial lighting systems to seem like the natural environment. This can be carried out too far where night is made into day and where every environment attempts to reproduce a similar model or a daytime atmosphere. This extreme is a mistake since nature relies on effect of subtle changes requiring dynamic adaptation to environment instead of the static quality of the controlled research experiments. Phillips adds this idea:

> ...On a bright sunny day a person may experience a sense of loss when inside a building where there is neither sun penetration nor view of the outside brightness pattern. On a dull day his emotional state may remain unaffected, while in some weather there may be positive advantages in shutting out visual contact with an unpleasant climate....[2]

A problem develops in buildings where there is no daylight and where emotional effects are of importance. To solve this problem Phillips suggests lighting an entrance hall with a tungsten filament to make it very artificial. Then he recommends lighting the working area by daylight fluorescent lamps of a high illumination level to increase the feeling of naturalness.[3]

A third psychological advantage is that artificial lighting changes can occur at any time for the desired lighting effect. A room in which lighting units give no light to the ceiling may be oppressive.

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[1] Luckiesh, Lighting Fixtures and Lighting Effects, p. 20.

[2] Phillips, Lighting in Architectural Design, p. 52.

[3] Ibid. p. 53.

To change this effect, the light may be directed to the ceiling and the room will appear brighter even if the illumination level is reduced. Rooms may appear to be dimly lighted because of low surface reflectance or lack of light, but the effect can be changed for emotional appeal. Phillips cites examples of a dimmed auditorium to induce anticipation, a dim cocktail lounge to produce an intimate atmosphere, and an exhibition building with high contrast effects to achieve compelling results.[1] It is necessary to strike a balance between the amount of light contrasts within the visual area and emotional effects of the space in order to maintain the psychological advantages.

Integration of Daylighting and Artificial Lighting

To benefit from the psychological advantages of daylight and artificial light, a method of integration is used. Phillips recommends using prediction techniques for daylighting and artificial lighting so that the illuminating engineers can integrate the two lighting systems.[2]

Produces Illumination Most Economically

By incorporating the two lighting systems, the recommended levels of illumination are produced most economically. There is no cost for natural lighting except in controlling it. However, there is an unreliable cost factor because work may be halted or activities stopped until the natural light returns. Architectural structures will function more economically by using artificial light sources rather than by

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[1] Ibid. p. 49.

[2] Ibid. p. 48.

relying completely on daylight.

> ...The architect may still use daylight in the traditional sense - but with a new freedom in design; he may also rely (partially or completely) on electric sources. With the choice of techniques now at his disposal, it is economically feasible to achieve an environment suitable for almost any task or activity....[1]

Logan concludes that it is necessary for survival to extend the working day, at daylight levels, beyond the period when natural light is available. In order to develop a round-the-clock economy, there must be an abundant and cheap high level artificial light source integrated with natural light.[2]

Overcomes High Intensity of Artificial Light

In correlating the daylighting with artificial lighting most of the undesirable effects of poor color rendition, due to high intensity artificial sources, can be overcome. For certain purposes it is necessary to have a light source of constant color that can be controlled. Control is particularly important for accurate color rendering or to enhance objects for display. Phillips suggests that no department store would remain in business if it were lighted with natural light alone, since the appearance of the goods would not be enhanced.[3] However, some daylight may be necessary to prevent undesirable effects on colors from high intensity artificial sources. By integrating daylight and

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[1]John E. Flynn and Samuel M. Mills, Architectural Lighting Graphics, (New York: Reinhold Publishing Company, 1962), p. 7 - 8.

[2]Henry L. Logan, Relationship of Light to Health, National Technical Conference, Minneapolis, Minn., August 21-26, 1966 (New York: Illuminating Engineering Society, 1966), p. 1.

[3]Phillips, Lighting in Architectural Design, pp. 7 - 8.

artificial light, it is possible to attain the desired lighting effect.

II. Artificial Lighting As A Problem

Artificial lighting is a problem to the engineer as well as the designer. "The lighting problem may be summed up as the provision of 'enough light, where you want it, how you want it', and it must be based upon the needs of the individual building program...."[1] In addition, it may be necessary to determine the type of lighting system to be used.

The Amount of Light

In the past, the amount of light may have been a problem because light was not as readily available as it is today. "Also, facilities for artificial light have been very limited and crude throughout historical time, so that it has borne the aspect of a luxury and the nature of an expense...."[2] Lighting may still be a luxury in some areas of the world. However, most Americans have lighting in their homes and would not think of living without it. "...It is something we take for granted; it is part of our daily life, like walking or breathing...."[3]

The designer can assume that the desired amount of light will

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[1] Ibid. p. 16.

[2] Logan, Relationship of Light to Health, p. 1.

[3] Phillips, Lighting in Architectural Design, p. 4.

be available, so he can concentrate on lighting effects.

Effectiveness of Artificial Lighting

The first consideration in planning effective functional and psychological artificial lighting is the selection of the type of lighting source, type of system, and proper equipment for each type. After the equipment is selected, then the control methods, such as techniques and location, must be decided upon. All of these create the design and emotional effect of the room. "Obviously, one must know what is to be illuminated when one designs lighting; and he must know how illumination can be devised to achieve satisfying effects."[1]

Type of Light Source

"The two most commonly used electric light sources are the incandescent lamp and the fluorescent tube."[2]

The incandescent lamp is described by Flynn and Mills as "...'a hot wire in a bottle'. The hot wire (usually a tungsten coil) is heated to incandescence by passing an electric current through it. The bottle is a sealed bulb of glass."[3] Callender continues to say that incandescent lamps:

> ...(1) Provide a point source of light that can be focused or directed over a limited area if desired. (2) Most household bulbs have the same size base, thus lighting from fixtures or

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[1]Payer, Lighting is to Architecture as Architecture is to Lighting, p. 14.

[2]Callender, A Handbook of Architectural Design, p. 872.

[3]Flynn and Mills, Architectural Lighting Graphics, p. 93.

> lamps can be increased or decreased within certain limits by a change to bulbs of different wattage. (3) Most types are less expensive to buy than fluorescent tubes. Incandescent lighting fixtures are also generally less expensive; they require no ballast or starter.[1]

A fluorescent tube is described by Flynn and Mills as:

> ...a discharge source and a rather complex electrical device. Light is produced by an electronic action that consists of a flow of electrons that excite mercury atoms within the glass bulb and cause them to give off radiation. The major portion of this radiation is in the invisible ultra-violet range, and special phosphors coat the glass bulb to convert this energy into visible light.[2]

Callender adds that fluorescent tubes:

> ...(1) Provide a line of light, thus in work areas the light coming from several angles tends to wipe out the shadows...(2) Provide three to four times as much light per watt of electricity as incandescent filament light bulbs, with less heat produced. (3) Will operate about seven to ten times longer than incandescent bulbs before replacement is required.[3]

After the light source is selected, then the type of lighting system must be considered.

Type of Light System

The types of lighting systems are direct lighting, indirect lighting, directional (direct-indirect), semi-direct, semi-indirect, and diffused.

> ...No one system can be recommended to the exclusion of all others. Each has qualities which may match the requirements for a given situation. Selection should be based on the performance, architectural and budget requirements of the particular job.[4]

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[1]Callender, A Handbook of Architectural Design, p. 873.

[2]Flynn and Mills, Architectural Lighting Graphics, p. 103.

[3]Callender, A Handbook of Architectural Design, p. 873.

[4]Ibid. p. 872.

The first type of lighting system is direct lighting. Callender defines direct lighting as "A lighting system or luminaire in which over 90 per cent of the light is distributed downward."[1]

> ...Direct lighting...gets the highest efficiency, quantity-wise, of all systems, but direct or reflected glare results more easily under this system than any other, and so do great contrasts in brightness. Direct lighting may spread in a broad radius or shut down sharply....[2]

Callender mentions that focused, sharply direct lighting may produce disturbing shadows and reflections unless the units are large or are closely spaced. The general qualities of direct lighting may be poor unless special precautions are taken to cut glare.[3]

Another lighting system, besides direct lighting, is necessary to complete the luminal composition, and to provide fill light. Indirect lighting is a reflected light which does provide fill. Callender defines indirect lighting as a "Lighting system or luminaire in which over 90 per cent of the light is distributed toward the ceiling."[4] Anderson states that "...the quantity of light at a work area decreases as the same amount of light gets more indirect, and that the quality of light gets simultaneously better...."[5] Phillips observes that indirect upward lighting results in a uniform brightness pattern and poor modeling. The visual evidence is a diffused light source like an overcast sky. Not all forms of indirect lighting can be criticized. Lighting wall surfaces directly downwards from concealed locations

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[1] Ibid. p. 847.

[2] John Anderson, "Lighting," Interiors, October, 1952. p. 102.

[3] Callender, A Handbook of Architectural Design, p. 872.

[4] Ibid. p. 874.

[5] Anderson, "Lighting," p. 102.

produces qualities of sunlight.[1] General Electric states that indirect lighting is flattering because it is softly diffuse and virtually shadowless. However, it lacks character and lacks the dramatic quality of directional lighting.[2]

Directional lighting is defined by Callender as "A lighting system or luminaire in which light is directed almost equally upward and downward, but with little or none directed horizontally."[3] General Electric confirms that directional sources create shadows and patterns.[4] "The wall brightnesses and the highlight and shadow patterns produced by the directional downlighting are techniques that break up visual monotony."[5] Payer sites an example from adjustable directional units on one wall which add visual interest. Another technique is a ceiling mounted fluorescent valance near the wall to produce a different, but equally pleasing effect.[6]

Other artificial lighting systems include semi-direct, semi-indirect, and diffused. Callender defines semi-direct lighting as a "Lighting system or luminaire which directs from 60 to 90 per cent of the light downward."[7] Anderson adds that the remainder may be sent up to illuminate ceiling and upper walls. Brightness and glare ratios

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[1]Phillips, Lighting in Architectural Design, p. 52.

[2]Frank LaGiusa, "Menu for Lighting," Light Magazine, XXXVII (1968), p. 22.

[3]Callender, A Handbook of Architectural Design, p. 874.

[4]LaGiusa, "Menu for Lighting," p. 21.

[5]Ibid. p. 21.

[6]Payer, Lighting is to Architecture as Architecture is to Lighting, p. 14.

[7]Callender, A Handbook of Architectural Design, p. 875.

of semi-direct lighting are improved over direct lighting. However, semi-direct lighting is used less than direct lighting.[1] Callender defines semi-indirect lighting as a "Lighting system or luminaire which directs from 60 to 90 per cent of light upward."[2] Semi-indirect lighting should be overlapped for general light distribution. Diffused lighting is defined by Callender as a "Lighting system or luminaire in which almost an equal amount of light is produced in all directions."[3] "...General diffuse lighting distributes from 40 to 60 per cent of the light down...."[4] The rays are scattered to emit or reflect over broad angles. This produces a strong horizontal emittence of light which eliminates glare.

Type of Equipment

Proper equipment must be chosen for each type of lighting system. Luckiesh states that lighting equipment is necessary for directing light, diffusing light, and for shading light sources from our eyes. A light source emits raw light and, like most raw materials, is enhanced in value if it is modified. Usually bare light sources are glaring and harsh. They are harmful to the eyes and they contradict the principles of quiet, restful and comfortable surroundings. Therefore, bare light sources can annoy our esthetic sense.[5]

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[1]Anderson, "Lighting," p. 102.

2Callender, A Handbook of Architectural Design, p. 875.

[3]Ibid. p. 874

[4]Anderson, "Lighting," p. 102.

[5]Luckiesh, Lighting Fixtures and Lighting Effects, p. 62.

Lighting equipment must be the proper scale and proportion. According to Phillips, this has a marked effect on the emotional quality of a space.[1] "...The rules of good design apply to lighting equipment as they apply to any article that must be seen as a part of the overall unity of a building...."[2] Phillips continues to say that a single fixture may be striking or decorative, but when many are required, it is necessary that each individual fixture have simplicity, in order that the total effect be a quiet harmony.[3]

Control Methods

An effective lighting system not only depends on equipment, but on control methods, such as special lighting techniques and location of lights.

One of the lighting techniques is downlighting. Callender defines downlighting as a "Fixture producing concentrated direct lighting from a single bulb. It may be recessed in, or mounted on, the ceiling."[4] General Electric describes the emotional effects of 'controlled' downlighting as relaxing, and adaptable to a time-sensitive pace. General Electric also describes the psychological effects of tinted downlighting. This downlighting gives complexion flattering illumination, sparkle on shiny objects, and varied wall brightness.[5] General Electric feels that the proper distribution of downlighting

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[1]Phillips, Lighting in Architectural Design, p. 54.

[2]Ibid.

[3]Ibid.

[4]Callender, A Handbook of Architectural Design, p. 874.

[5]LaGiusa, "Menu for Lighting," p. 17.

imposes highlights and shadows, produces modeled effects, and enhances textures. Downlighting, however, should not be too narrow in beam distribution. If it is too narrow it produces harsh top lighting, excessive modeling, and wrinkles on peoples faces. Wide and smooth distribution downlights are more desirable, so glare is not evident.[1]

According to the Illuminating Engineering Society (I.E.S.), there is a desire for more flexibility in residential lighting control, types of fixtures, and architectural installations. As a result, manufacturers have developed dimming equipment.[2] Callender defines a dimmer as a "Device to control the amount of light by reducing the voltage or the current."[3] Dimmers provide the dramatic changes in mood and atmosphere which can be affected by varying the brightness. A lighting system designed to provide a high level of illumination can be stimulating or relaxing if controlled by a dimmer. "...As dimmers become more and more widely understood and easily obtainable, the limited 'on' or 'off' lighting of today's interiors may become 'yesterday's limited light control'."[4]

Two other techniques of controlling light are cove lighting and valance lighting. Cove lighting is defined by Callender as:

> ...a fully indirect system in which the ceiling is lighted from continuous sources concealed in a cove on one or more

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[1] Ibid. p. 21.

[2] I.E.S., Lighting - Keyed to Today's Home (New York: I.E.S., February, 1960), p. 67.

[3] Callender, A Handbook of Architectural Design, p. 874.

[4] I.E.S., Lighting - Keyed to Today's Home, p. 67.

> walls somewhat below the ceiling. It produces a feeling of height and spaciousness, but if used alone, tends to be flat and monotonous. Direct lighting from downlights or portable lamps should be used with cove lighting to add shadows, highlights, and sparkle.[1]

The other technique, valance lighting, is defined as a "system where light sources are shielded by a panel parallel to the wall, usually across the top of a window [or fireplace.] It usually provides light both downward and upward."[2] Valance lighting, or wall-washing, as it may be called, is a simple, highly effective built-in lighting technique to emphasize an area. It creates a focal interest and brightness pattern.

Another way to control methods of lighting is by proper location of fixtures. Location of lighting fixtures contributes to the mood of the room. If the decorative fixture is meant to be looked at, it must be in normal line of sight. If the fixture distributes direct light in normal line of sight it may present obscuring brightness to the viewer. Decorative fixtures can offer interesting luminous ornamentation, but their location can compete with the environmental lighting by providing too many things to focus upon. "A single elegant chandelier, for example, can be more striking as a focal point in a room than a dozen little chandeliers on six foot centers - a spacing that might be necessary for general lighting."[3] A room may also be illuminated the usual way and secondary lighting may be superimposed. Luckiesh cites an example, that the ceiling

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[1]Callender, A Handbook of Architectural Design, p. 907

[2]Ibid. p. 875.

[3]LaGiusa, "Menu for Lighting," p. 22.

and upper walls may be flooded with a low intensity of illumination from concealed sources emitting a blue-green light. Under some conditions this sky effect is pleasant. When it is not desired, this light may be extinguished by a switch. Other colors may be substituted or them may be put on separate circuits.[1] With this property of mobility, the location of lighting fixtures can control both the design and the mood of the room.

III. Artificial Lighting As A Function

"The lighting function is by definition a physiological problem, which must concern itself with the practical problems of vision rather than emotional and intellectual considerations."[2]

Physical Problems Which Are Tangible

The physical considerations of the architectural function can be systematically outlined because they are of a tangible nature. In order to perceive and respond psychologically, there must be stimuli. The stimuli are physical elements which are the tangible problems. These are discussed by Peterson.[3]

Psychological Problems Which Are Intangible

> ...A more complex side of human beings affected by lighting is the psychological side. Psychological comfort is no less important than ocular comfort.

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[1] Luckiesh, Lighting Fixtures and Lighting Effects, p. 58.

[2] Phillips, Lighting in Architectural Design, p. 17.

[3] Refer to Paper by Kathy Peterson

> Lighting must satisfy the many-sided demands and needs of a diversity of individual psyches. Through a variety of activities and situations an individual requires lighting to fulfill many different psychological needs.[1]

The psychological effects cannot be as systematically organized as the physical considerations. This is because psychological effects are of an emotional nature which are less tangible.

> In the field of light and color, the least explored field is that of psychology....It may be well to realize in doing so, however, that most of the facts of the psychological effects of light cannot be established by the opinions and reactions of one person.[2]

IV. Emotional Considerations In Artificial Lighting

Emotional feelings should be considered in designing artificial lighting. Larson remarked that lighting affects people in a variety of psychological ways according to individual differences in personality. There is no standard relationship between low or high levels of illumination and the presence or absence of visual fatigue, eye strain, disability or discomfort. It is impossible to prescribe illumination levels which are ideal for every situation.[3]

Sense Factors

The interior is experienced not only through our sense of sight, but also through our response of emotion and hearing. "Man's

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[1]Leslie Larson, Lighting and Its Design (New York: Whitney Publications, Inc., 1964), p. 4.

[2]Luckiesh, Lighting Fixtures and Lighting Effects, p. 9.

[3]Larson, Lighting and Its Design, p. 17.

first sensory impression of heat and cold from his environment, from sun or flame, had a distinct visual quality...."[1]

Visual Appeal

Artificial lighting affects our vision in the way we see color, brightness, shadows and modeling, and reflection.

> The visual environment is far from bland or dull. Richard Kelly has introduced an unusual blending of brightness patterns throughout traffic and work areas. Various combinations of lighting effects on surface textures and colors create delightful visual transitions from one area to another. On the banking floor, marble walls are illuminated by lensed reflector lamps above the edge of the dropped ceiling. The lamps are shielded from lengthwise viewing by black louvers spaced about three inches apart. As a result, there is an attractive shadow pattern on the upper walls, and the cut off of light on the floor is truly dramatic.[2]

According to I.E.S. the visual effect of color used in the treatment of major areas of an interior, such as floors, walls, ceilings and large area window hangings, should be considered an integral part of lighting.[3] General Electric defines color as "a concept or human interpretation of the neural impulses transmitted to the brain from the normal eye when it is stimulated by various inbalances of visible radiant energy."[4] The process by which the brain perceives color is not yet defined, but science and technology are being continually advanced toward that end.

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[1]Phillips, Lighting in Architectural Design, p. 51.

[2]W. S. Fisher, "New and Different," Light Magazine, XXXII, No. 1 (1963), p. 13.

[3]I.E.S., Lighting - Keyed to Today's Home, p. 72.

[4]General Electric, "Psychology of Color," Light and Color, Cleveland: General Electric Company, Large Lamp Department, August 1967, p. 8.

A more complete definition of color as a concept can be made if color vision is considered. The totally color-blind person cannot distinguish between various wavelengths of light. He can only distinguish between various amounts of light. Everything he sees is either black or white or values of gray. The physical light waves received by both a color-blind person and a person with normal color vision are not changed by the condition of the receptors. Only the concept or perception of what is seen is changed. Any color is the mental concept resulting from the brain's interpretation of special visual stimuli.

Color is part of what we perceive about objects, situations, attitudes, moods, and environmental conditions. Color is assimilated into impressions or concepts because the eyes supply the brain with color information which is associated with any given subject or situation.

"Perhaps more than any other single element in design, people's reactions to color affect their individual preferences."[1] Some color reactions are almost universal. Certain colors are associated with certain moods. General Electric claims that reds, oranges and yellows are generally accepted as stimulating, while blue, violet and green are less exciting.[2]

Reactions to color associated with materials are not always the

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[1] Ibid. p. 9.

[2] Ibid.

same as those associated with light. For example,

> ...the green in foliage is generally accepted as refreshing, cool, and undisturbing, so people have come to think of trees and shrubs as somewhat neutral or quiescent in effect: hense, green background materials in man-made objects are psychologically restful. But green in a light source is unnatural; and used alone, tends to produce a macabre or sinister effect.[1]

According to Luckiesh there is much emotional appeal to colored light. Chromatic light is very powerful because it tinges the environment. It is even more powerful in arousing emotions than colored paints.[2] Phillips elaborates by saying that the color of light may be changed for variation, and many dramatic effects can be created. There is a potential in colored light sources related to carefully chosen surfaces that have often escaped the architect. Also, the variety that can be achieved by changes in the lighting of space has been overlooked to a great extent.[3]

Variations in chromatic light and colored objects affect the psychological mood perhaps without an awareness of what is happening or without knowing why it is happening. A simple light change can produce an interesting psychological effect by varying chromatic light or colored surfaces.

Another visual appeal is the brightness of the interior. Callender defines brightness as "intensity of optical sensation

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[1] Ibid.

[2] Luckiesh, Lighting Fixtures and Lighting Effects, p. 49.

[3] Phillips, Lighting in Architectural Design, p. 50.

caused by viewing a surface from which light comes to the eyes."[1] Luckiesh comments that if colored lights are properly controlled, a great range of contrast in brightness is possible.[2] On the other hand, he says that without the use of color we may produce a range of moods and emotions by means of brightness.[3] Luckiesh continues by saying that bright surroundings are pleasant and stimulating.[4]

> The brightness of the general surroundings of the interior - the walls, ceiling, floor - should be sufficiently high to bring the eyes to an appropriate state of adaptation and to create an appearance of cheerfulness without, however, causing visual discomfort or distraction.[5]

On the other hand, low intensities of illumination produce subduing effects in which colors appear grayed. Other psychological reactions are also involved in these brightness changes: "high intensity illumination, for example, contributes to a sense of increased activity and efficiency; low intensity lighting tends to create an attitude of relaxation...."[6] Breaking up visual monotony with brightness variations makes the atmosphere brisk and interesting. According to I.E.S., the brightness or darkness plays a vital role in the interior atmosphere and in the visual comfort of the persons

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[1]Callender, A Handbook of Architectural Design, p. 874.

[2]Luckiesh, Lighting Fixtures and Lighting Effects, p. 49.

[3]Ibid. p. 46.

[4]Ibid. p. 46.

[5]I.E.S., The I.E.S. Code - Recommendations for Good Interior Lighting, (London: Illuminating Engineering Society, 1961), p. 4.

[6]Flynn and Mills, Architectural Lighting Graphics, p. 43.

occupying the space.[1] The necessary artificial brightness level for comfort may depend on the natural brightness of geographic locations. Phillips explains that in America, where the level of daylight is high, there is a tendency to cut down brightness of sky glare by shading the windows. Artificial light sources are evenly distributed close to the windows. Here it is necessary to use illumination levels similar to daylight. Higher levels are used in these areas which actually require less light. This may be why the illumination levels in American office buildings are in excess of those used in England, where the general level of daylight is lower.[2] We are emotionally conditioned to high levels of brightness as long as glare is not a disturbing factor.

The modeling effects of lighting are also important visual factors. Phillips mentions that modeling is an essential part of seeing, since it assists in the discrimination of form.[3]

> The direction from which light falls on the surfaces of a three-dimensional object affect its appearance of solidity. By changing the directional component of the light, both the form and surface texture of the object can be emphasized or weakened. This effect is known technically as modeling and can be used to improve the visibility of some task details and also give a more pleasing appearance to buildings and to objects within them....[4]

Modeling is an essential aspect of the environment which has an effect upon emotions. Luckiesh mentions that modeling not only

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[1] I.E.S., Lighting - Keyed to Today's Home, p. 72.

[2] Phillips, Lighting in Architectural Design, p. 53.

[3] Ibid. p. 50.

[4] I.E.S., The I.E.S. Code - Recommendations for Good Interior Lighting, p. 4.

has an influence on objects, but it also affects the character of shadows on the appearance of an interior.[1] Phillips explains that a lack of shadows may be depressing even though the illumination level may be high. This effect is obtained with luminous ceilings when the surrounding surfaces are light and there is an absence of contrast. During the day there may be strong directional shadows from natural light, but at night the effect is monotonous because of lack of accent.[2] Shadows and modeling add to visual appeal because they give a three-dimensional sharpness, making objects realistic to the senses.

Visual appeal is also evident in the reflection of light. Luckiesh refers to the surface reflection of light as a very important factor in lighting. It is not only efficient, but it provides satisfactory vision and cheerful surroundings. Paint or any other medium for walls, ceilings and woodwork would be of little value without light. Johnston and Parks state that the amount of light reflected depends on the angle. Surfaces may appear to be the same when viewed at one angle, but different when viewed at another.[3] Luckiesh continues to say that a surface as a diffuser and reflector of light is of no interest unless in connection with lighting.[4] Phillips supports this idea: "Light [artificial] is one of the most potent methods of achieving...reflectance...."[5]

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[1]Luckiesh, Lighting Fixtures and Lighting Effects, p. 57.

[2]Phillips, Lighting in Architectural Design, pp. 49 - 50.

[3]Ruth M. Johnston and Robert E. Parks, "Color and Appearance," Color Engineering, November - December, 1966, p. 14.

[4]Luckiesh, Lighting Fixtures and Lighting Effects, p. 61.

[5]Phillips, Lighting in Architectural Design, p. 50.

Emotional Responses

Surface qualities (textures) which vary from rough to smooth, hard to soft, etc., cause an interior to seem to have a certain temperature such as hot or cold, cool or warm. Artificial lighting also adds to this emotional response by its effect on the surface qualities, making a room seem warmer or cooler depending on the quality and quantity of light used.

> The psychological effects of the surroundings are very important in many aspects of lighting and may be taken advantage of in solving some problems. Some examples may be drawn from experiences with artificial daylight and ordinary artificial light for the former is white and relatively cold as compared with the yellowish artificial light.[1]

In general we expect the artificial illuminant (incandescent) to emit a warm tint. "This has led some to express their displeasure with the psychological effect of the cold, artificial daylight [fluorescent] despite its superior rendition of colors...."[2] The cold impression of the artificial daylight lamp may be deleted by designing an interior with warm colors and textures. I.E.S. explains that both daylight and white sources vary from reddish or warm to bluish or cool white. Incandescent lamps are rich in red, deficient in blue, and therefore accentuate the warm colors while subduing the cool colors. They create a warm atmosphere in which the heat produced may be a problem. The improved color rendition warm fluorescent tube can be blended with

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[1] Luckiesh, The Lighting Art, p. 78

[2] Ibid.

incandescent lamps. This does not distort colors and it provides a warm atmosphere. If a cool atmosphere is desired the color rendition cool white fluorescent tube may be used.[1]

Colored lamps also produce an effect of temperature change. The chromatic light makes a room feel cooler or warmer than it really is because the light tinges everything. Luckiesh cites an example:

> ...A theater illuminated in the summertime by a light which seems bluish-white will feel cooler than one in which light of the warm flame-tint is used. A room that may appear too cold at night may be warmed by a yellowish light.[2]

It is evident that temperature of a room is affected by surface quality and type of the source (incandescent or fluorescent) as well as the actual color of light.

Hearing Response

Another response affected by artificial lighting is hearing. Psychologically, the hearing response may be affected by the noise associated with a fluorescent tube. A noise may be caused by the ballast which is defined by Callender as the "Electrical device required to operate fluorescent tubes."[3] However, the noise can be muted.

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[1]I.E.S., Lighting - Keyed to Today's Home, pp. 69 - 71.

[2]Luckiesh, Lighting Fixtures and Lighting Effects, p. 49.

[3]Callender, A Handbook of Architectural Design, p. 874.

> An occupied classroom is rarely quiet. Shuffling feet, rustling papers, even sounds from outside the room contribute a background of noise that is usually high enough to mask ballast sounds.... This is substantiated by actual tests. In study halls and libraries, where the noise level is lower, it may be desirable to remotely locate the ballasts for these lamps.[1]

As long as the ballast sound is controlled, the problem can be eliminated. However, if any noise is present it may cause psychological reactions against the fluorescent source. Other sound problems of fluorescent sources may be caused by radio interference.

> The mercury arc in various discharge sources (mercury, fluorescent) causes a sparking action at the electrodes which emit low-power radio waves. These waves may be picked up and amplified by near-by radios, causing a 'buzzing' interference. This is not cumulative for a group of lamps, but is related to the lamp producing the greatest amount. Also, interference varies over the life of each lamp.[2]

All of these sense factors should be considered in the emotional and psychological effects of lighting experiences.

Environmental Influences

Fischer expresses a concern about how new sources and higher levels of light will affect the appearance of environment. This would present some questions concerning the psychological as well as the physical environment created by light. Since artificial lighting is an essential component of building, the architect should start from the very beginning to establish some lighting goals. Unfortunately,

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[1] L. A. Roehr, "Power Groove Goes to School," Light Magazine, XXXII, No. 1 (1963), p. 17.

[2] Flynn and Mills, Architectural Lighting Graphics, p. 211.

today we start with the mechanics of lighting and not the basic needs. Light is viewed in terms of hardware rather than the effects to be created.[1]

Measurement of Emotions

Phillips claims that:

> ...it is impossible to measure subjective reactions in quantitative terms. There are no instruments so far developed that can assist the architect and the lighting engineer. The best instrument is the eye, and the best data are obtained by questioning observation of person and place.[2]

Influence Upon Emotion

> The subject of emotion is one that architects cannot be qualified to understand with the clarity of the psychologist, and yet the architect [and interior designer] is responsible in his art for the creation of environment, which by common observation has a marked influence upon emotion. A study of past periods of architecture shows that this influence has, in fact, always been present, and that the empirical judgment of the architect has often achieved the type of environment most suited to a building program....[3]

The architect's role is "...to interpret the findings of scientists, and utilize the knowledge of engineers in relation to the needs of his client...."[4]

> ...It is becoming more apparent that the architect should be able to knowledgeably specify performance. The engineer should effectuate it. In some cases, the architect is the lighting designer. At other times, the services of an independent lighting [designer] consultant are called for. Regardless of how the final result is

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[1]Robert Fischer, "Keynote Address", Building Research Correlation Conference, Cleveland, Ohio, May 20 - 21, 1959 (Washington, D.C.: Building Illumination, 1959), p. 33.

[2]Phillips, Lighting in Architectural Design, pp. 46 - 47.

[3]Ibid. p. 45.

[4]Fischer, "Keynote Address", p. 33.

> accomplished, these people should be able to create a total environment that is comfortable, attractive, economical and above all - suited to the purposes of those human beings who occupy the space.[1]
>
> The architect, who needs to be the coordinator of all efforts, must know how far he can carry his work alone, and when he has to ask for consultants; and he must know how to evaluate advice.[2]
>
> He works through collaboration with people from many fields to bring about a successful total design. He analyzes the problem; he divides it into manageable segments; he guides his collaborators toward workable solutions; then one by one, he fits the solution segments into a total solution for the total problem.[3]

The designer should create an environment which is emotionally appealing to residential people as well as business people. "...The intuition of a designer is no better than his knowledge; few really satisfying emotional effects have been the result of chance."[4] Rudolf remarks that the architect must learn how to make a quiet, enclosed, isolated space or a space full of hustling, bustling activities, pungent with vitality. He should be able to make a dignified, vast, and even awe-inspiring space. Transition spaces can be created that define, separate, and join juxtaposed spaces of contrasting character.[5] The

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[1] W. D. Riddle, "Off to School Again," Light Magazine XXXIV, No. 3 (1965), p. 23.

[2] Payer, "Lighting is to Architecture as Architecture is to Lighting", p. 12.

[3] Ibid. p. 11.

[4] Phillips, Lighting in Architectural Design, p. 57.

[5] "The Six Determinants of Architectural Form", Architectural Record, October, 1956, quoted in Phillips, Lighting in Architectural Design, p. 48.

architect and designer

> ...will have many thoughts which are not immediately obvious from the plan: color sequences, harmonies or contrasts, uses of light against dark,...the emphasis of lighting on a wall or an object, a dimmed passageway leading to brightness. Innumerable similar subtleties which are affected by lighting are often planned and sometimes determine the plan, but are not visible on the working drawings - they must be brought to life by the architect with the help of his collaborators.[1]

Residential designing is one area where an environment can be created by lighting. At the Architectural and Consulting Engineers Conference at General Electric's Lighting Institute, the chairman, F. A. Dickey, explained that lighting is not a question of what type is best, but how you want the lighting to look in a room. Interesting lighting does not have to be produced by expensive and complex systems. One way to create interest is by changing the lighting effects with color.[2]

"Lighting can augment or mar the beauty of colors in a room. Just as a color will appear to be modified under the influence of other colors close by, so also will it be modified under the influence of artificial lighting."[3] One must understand the effect of light sources on interiors.

> Two objects identical in color may appear different when viewed side by side - one under fluorescent lighting and the other under incandescent lighting.... If a feeling

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[1] Payer, "Lighting is to Architecture as Architecture is to Lighting," p. 14.

[2] F. A. Dickey, "Keynote Address," General Electric Lighting Institute, Cleveland, Ohio, Architectural and Consulting Engineers Lighting Conference, December 4-6, 1968.

[3] Myrtle Fahsbender, Residential Lighting, (New York: D. Van Nostrand Company, Inc., 1947), p. 255.

> of warmth is desired and fluorescent lighting is to be used, it is recommended that wall, ceiling and floor colors be of warm hues.
>
> Incandescent lighting is...generally warm and cheery. Warm colors - red, orange, and yellow - will be accentuated. This is especially true if the lamp bulbs are of low wattage, 10-, 15-, and 25-watt sizes. The larger size incandescent bulbs, a 300-watt in a floor lamp for example, give a much whiter light. It is wise to view colored fabrics, wall and floor coverings under the type of artificial lighting that is to be used.[1]

Everyone interested in residential lighting should have knowledge of basic color facts, and an eye for the use of color in light. Unless one is thoroughly competent in the use of colored lights, it is recommended by Fahsbender that white light and tints of light be used, reserving the free use of color for the designer.[2]

Every business must consider the emotional appeal of the environment. This is often done by proper lighting techniques as in the following examples. This area of the study has been limited to stores and restaurants because of the psychological appeal necessary in selling products.

The type and size of store may greatly influence the lighting plan and technique used. I.E.S. recommends that lighting should be designed specifically for the type of merchandise displayed. Usually a combination of fluorescent and incandescent lighting is desirable. They suggest general illumination from fluorescent sources and accent lighting from incandescent sources.[3]

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[1] Ibid.

[2] Ibid. p. 259.

[3] John E. Kaufman, (ed.), I.E.S. Lighting Handbook, (New York: Illuminating Engineering Society, 1966), p. 13-2.

Once the type of store, class of merchandise to be handled, and clientele served are determined, lighting should be designed to suit the character of the store. The creation of the lighting design to enhance the environmental character is important. Environmental lighting involves both variation and balance in brightness on architectural forms such as ceilings, floors, space dividers and walls.

Merchandise should dominate the view by having the highest brightness.

> To attract and retain customer attention, featured merchandise should be on the order of five times as bright as its surroundings. Compelling, brightly lighted displays strategically placed throughout the store can conduct shoppers on a buying tour. Even poorly located areas can be made sales productive.[1]

The direction of light from luminaires may be direct, indirect, or a combination of both. According to I.E.S., the distribution in direct lighting is used to create sharp and dramatic high-lights and shadows. The indirect system produces a softer, general atmosphere of lighting, where shadows are not sharply defined and textures and shapes are less prominent.[2]

The avoidance of glare is an important consideration in both window and shop interior lighting. Small areas of high brightness are often introduced to create liveliness. These differences between maximum and minimum illumination provide variety. The lighting in display areas depends upon attracting attention more by variation than

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[1] Ibid. p. 13-4.

[2] Ibid.

by uniform lighting. "A prime factor is that the source of light shall not compete for attention with the merchandise...."[1] Lighting of good quality should be complementary to the display rather than a competing distraction. Hewitt and Vause site an example of the distraction of a completely exposed fluorescent tube. When a fluorescent tube is viewed across its length or vertically, it can reduce the effectiveness of the illumination due to the eye adapting itself to the brightness of the exposed tube. In order to overcome the distraction of the exposed tube, an unnecessarily high illumination level on the display would have to be provided.[2]

It is evident that the character of the shop and the type of merchandise has an influence on the lighting. Even though the emotional emphasis varies from store to store, the appeal is promoted by lighting.

An emotional appeal is also evident in restaurants and other public dining areas. Dining areas are divided into three classes according to mood and feeling. I.E.S. refers to these as intimate, leisure, and quick service.[3]

The intimate class consists of areas where people want to visit and be entertained as much as to eat and drink. This includes cocktail lounges, and some dining rooms and restaurants. I.E.S. recommends that lighting levels be directed to table height and in some cases individual lighting should be used on the tables. Lower brightness levels are

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[1]H. Hewitt and A. S. Vause, Lamps and Lighting, (New York: American Elsevier Publishing Company, Inc., 1966), p. 453.

[2]Ibid.

[3]Kaufman, I.E.S. Lighting Handbook, p. 12-4.

recommended in areas where subdued environment is desired. Higher brightness levels are used in areas where light environment is needed.[1]

The leisure class consists of most restaurants and hotel dining rooms. Here eating is leisurely but time is also important. I.E.S. recommends lower illumination levels for tables where subdued environment is desired, and higher levels for tables where a brighter environment is wanted.[2]

The quick service class includes lunch rooms and cafeterias, where eating time is limited. The service is also based on a rapid turnover. I.E.S. recommends higher levels of illumination for rapid seeing and for psychologically providing an environment conducive to rapid production.[3]

Food displays should be lighted so that attention is attracted to the details. Lighting levels here should be at least twice that of the surrounding areas. Food looks better when the lighting includes a red component. According to I.E.S., "...incandescent lamps or the improved - color fluorescent lamps are generally preferred. The light from these sources contains more red than that from standard fluorescent or from 'daylight' incandescent lamps."[4]

As I.E.S. has explained, the lighting used in a restaurant is determined by the type of service and the desired mood of the environment.

Another area where lighting is needed to create an environment is in a performance setting. Proper lighting for stage presentations

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[1] Ibid. p. 12-5.

[2] Ibid.

[3] Ibid.

[4] Ibid.

extends beyond visibility to the achievement of artistic composition and production of mood effects. These functions of stage lighting for theaters and churches rely on the manipulation of various qualities, quantities, colors and directions of light.

"... In the theater, all lighting is planned to serve the audience, and the manner in which the observer reacts to light determines the design of stage lighting...."[1] Stage lighting effects the audience by setting the mood of the performance and following the action on the stage. "by far the most important function of light on the stage is to assist in creating an unconscious, convincing reaction of dramatic quality on the audience...."[2]

"... The first visual impact of scenery and lighting must set the stage for something extraordinary...."[3] To set the mood for something special the house lights should be dim and there should be a warm, glowing light on the curtains. This light commands full attention.

> ... Beyond a doubt, this magic touch is created by means of light, living light revealing living actors. Light is magic in the sense that it can command attention, establish mood, enrich the setting, and create composition. Light might be said to paint with the painter, act with the actor, and create with the director and playwright. Used with imagination, light is, indeed, the magician of the theater.[4]

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[1] S. R. McCandless, A Syllabus of Stage Lighting, (New Haven Connecticut, Whitlocks Book Store, Inc., 1931), p. 34.

[2] Ibid.

[3] Samuel Selden and Hunton Sellman, Stage Scenery and Lighting, (New York: Appleton-Century Crafts, Inc., 1959), p. 215.

[4] Ibid.

The lighting approach must be subtle and restrained in a play.

> Emphasis of a character or an area of action should be by a slight increase of intensity rather than by a shaft of light stabbing the murky gloom. [Exceptions would be dancers and soloists.] Above all, movement of dimmers can be so slow that the audience are made aware of a shift in emphasis without, so to speak, seeing it....[1]

A similar slow change in which the lighting is reduced can bring a sense of oppression, or a change from general lighting to spot lighting can allow a character to dominate the scene. The slower the change, the more the character will dominate because the reason will not be apparent. There are also instances where lighting must be changed even though there is no action. Bentham feels that it is common sense to hold interest by continually adding light when the action on stage is static.[2]

According to Selden and Sellman there is evidence that higher levels of illumination make people more alert.[3] We know by experience in the theater that audiences enjoy a sophisticated comedy in bright light more than they do one in which the lighting is at a lower level. "... Bright light for comedy and dim for tragedy is an old but useful rule...."[4]

The control of color is just as important as the control of quantity of light.

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[1] Frederick Bentham, Stage Lighting, (London: Sir Isaac Pitman and Sons, Limited, 1950), p. 270.

[2] Ibid. p. 271

[3] Selden and Sellman, Stage Scenery and Lighting, p. 219.

[4] Ibid.

> ... In producing plays in the fifteenth century not only was quantity of light different in comedy and tragedy, but colors differed also. Warm colors were used for comedy and cool ones for tragedy. This conception of color is still in general use today, but there are many exceptions in which color is used intelligently in defiance of this rule.[1]

The effect that artificial lighting has on an audience is also important in churches. It is necessary to create a mood; however, the mood and feeling differs somewhat from a theater.

> Skillfully used lighting can make worship services more meaningful and enhance the architectural design of the space. The lighting can mold and give depth, and can subdue or accentuate, or perhaps change its accent, as the service proceeds. In certain interiors it can add a fourth dimension: a suggestion of the infinite.[2]

In lighting the interior of a church, certain focal points must be chosen. It is possible to have a little brightness on the rafters or beams or these can be left dark so that the accent is on the people in the pews. Decorative features in the front of the church can also be lighted for emphasis. It is important that lighting be arranged to give minimum glare when viewed from any angle. I.E.S. feels that this is particularly necessary when there is a platform for religious services at one end of the room and a stage for religious drama at the other end of the same seating area.[3] It is not only important to light certain focal points, but the right amount of light is necessary to coordinate emphasis and mood in a church.

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[1] Ibid.

[2] Kaufman, I.E.S. Lighting Handbook, p. 12-1.

[3] Ibid. p. 12-2

In lighting both theaters and churches, the main function is mood which includes the emotional and psychological effects on an audience. Since mood is so intangible, it is difficult to accomplish the desired environmental effects without careful analysis.

In conclusion, the appearance of an environment can be enhanced or marred by artificial lighting. It is important to consider lighting as part of the environmental design, rather than as an afterthought. Often the mechanics are planned and the effects are forgotten. The installation of just hardware does not make an environment emotionally satisfying. The total lighting effect in any environment must be planned to suit the individual situation. The environment does not happen by chance, but it must be created.

V. Summary: Psychological Importance Collected From Data

It is necessary that the psychological importance of the artificially lighted environment is understood. The light should achieve the most appropriate psychological use of variety, unity and clarity.

Lighting Used to Create Variety of Mood

The eye reacts to variety by adaptation, and variable changes in the lighting are stimulating. The space may need a variety of lighting

systems to promote different moods and different emotional states.

> Light, therefore, is a variable factor, and changes in color, direction, and diffusion affect the subjective impression of the environment. Whether emitted by a natural or artificial source, changes in the concentration of light, or in the general characteristics of light emission, often induce subconscious responses in the observer.[1]

Phillips concludes that the lighting problem can be met in a variety of ways, and the architectural solution is capable of wide and varied interpretation.[2]

Lighting Used to Achieve Visual Unity

Phillips feels that unity in a work of architecture results from appreciation of all the design considerations, so that a unified theme dominates the individual parts. Decisions made by the architect will affect unity and must be appreciated. Unity should be considered in the individual space, in the way one area connects with another and in their inter-relationship. The choice of lighting system must be decided with unity in mind. Then the final result depends upon close cooperation between the architect and the lighting engineer. Cooperation is necessary to ensure that the equipment is designed with the over-all concept of space contributing to architectural unity. The lighting should appear as a total aspect of design, where nothing is removed without disrupting the unity.[3]

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[1] Flynn and Mills, Architectural Lighting Graphics, p. 40.

[2] Phillips, Lighting in Architectural Design, p. 51.

[3] Ibid. p. 55 - 56.

Lighting Used to Change Clarity of Form

According to Phillips "... the effect upon the individual's emotional state may not be so clearly defined as that produced by other contributing factors...."[1] He continues to say that in a building the natural light enters through openings that control the entrance of light. This gives a specific pattern of light and shade to the interior surfaces. When artificial light sources are added to the interior, it is important not to destroy the clarity of form created by natural daylight. The solution must produce a clear definition of the interior. A straight wall should appear to be straight, and its connection to the floor and ceiling should be defined. A surface should appear as a surface and its texture should correspond to the previous experience of similar textures. There is a sense of dissatisfaction when such information is distorted which may lead to frustration and disillusion.[2]

In conclusion, "... the fundamental relationship between light and 'seeing' is not only a factor in visibility, but can be a controllable element of emotional consequence."[3]

> It is this emotional aspect of the lighting problem that provides the real challenge to the imagination and creative judgment of the individual designer. It requires him to understand the various psychological requirements of vision and satisfy them with comfort and within a suitable psychological and architectural framework. This means that the design analysis of the lighting system must

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[1] Ibid. p. 54.

[2] Ibid.

[3] Flynn and Mills, Architectural Lighting Graphics, p. 40.

be extended far beyond the scope of simple illumination.[1]

VI. The Future of Psychological Effects of Artificial Lighting

"It is vital to the future progress of man that he develops a technology which will substantially duplicate indoors the climate conditions that are optimum for man. Lighting is a most important element of this optimum climate."[2]

> Over the eons past, natural light has, of course been the dominant illumination under which the psysiologic action spectra have arisen. The duplication of this light within the range of its variations would therefore seem to be a logical goal of illuminating engineers until further research dictates an improvement.[3]

The goal of duplicating daylight may never be completely achieved in the future. It will be difficult enough to duplicate the physical characteristics, but to reproduce the same psychological responses with artificial lighting may be impossible. Some psychological and emotional responses to daylight conditions are not understood, so until they are studied further they cannot be duplicated. It is to be hoped that more research will be done concerning psychological and emotional effects of artificial lighting.

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[1] Ibid.

[2] Logan, Relationship of Light to Health, p. 2.

[3] Richard J. Wurtman, Biological Implications of Artificial Lighting, National Technical Conference, Phoenix, Arizona, September 9 - 12, 1968 (New York: I.E.S., 1968), p. 6.

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