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U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

Color in the Health Care Environment

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Color in the Health Care Environment

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FOREWORD

For over 50 years the National Bureau of Standards has directed a substantial quantity of time and expertise to developing requirements and methods for the measurement of color. Recently, this activity has been applied to the standardization of safety colors that are now being widely utilized by other government agencies as well as by the voluntary standards community to ensure the greatest degree of safety in the workplace, on our highways, and to the general public. The application of color theory must necessarily include consideration of color blindness and color contrast, in addition to the traditional and well-recognized meanings for color such as yellow for "caution" and red for "stop."

We are now faced with further challenges related to color specification, which on the surface appear much more elusive and difficult. At present, the selection and specification of color in certain areas of our manmade environment, as buildings, is largely related to anecdotal evidence of effectiveness or only to changing styles and the variable tastes of individual designers. While this condition may only result in superficial displeasure of users, in some instances it results in critically altered functions and goals.

Medical facilities represent perhaps the most critical category of buildings in need of proper criteria. The requirements for accurate medical diagnosis, exacting surgical performance, and other therapeutic and rehabilitation services set medical facilities apart from other buildings vis-à-vis their critical need to be effective.

This document reflects the concerns of physicians, architects, designers, and administrators for sensible technically-based design of medical facilities.

Dr. William Beck, President of the Donald Guthrie Medical Foundation, provided the keynote address of the workshop. Dr. Beck stressed the point that the medical profession is just beginning to show interest in the lighting, color, and decor of the hospital environment. Within the patient-user group, further distinction between ambulatory and nonambulatory and between his family or friends is also important.

Dr. Thomas Sisson of the Temple University School of Medicine reinforced these concepts by stating that the use of color in hospitals is often inconsistent and potentially detrimental to the feeling of well-being by the patient. Though functional (nurse and doctor tasks) requirements for lighting come first, these needs must be moderated or added to by the requirements for patient comfort. These two requirements need not conflict. Wall coverings, for example, can be used which are not only cleanable and can be kept antiseptic, but at the same time will provide supportive visual environment to the patient. Accordingly, two lighting systems may be in order: one for the diagnostic purposes and another for the feeling of well-being. Color intensity, reflectance, and texture are important.

In addition to the sensory and psychological effects, light exhibits further important physiological and medical effects. Some of these play a role in:

- detection and treatment of jaundice in infants
- cyclic rhythmic effects in infants
- damage to eyes
- destruction of hormones
- detection of cyanosis

Thus, light and color may be important to function (shadowless illumination for the surgeon, white light for diagnostics, UV for certain therapeutics, etc.); however, these are needs which constitute expert requirements that must be specified by the medical profession. The more general psychological needs must also be learned and applied for various types of patients and the general public. They should then have further application to other structures.

Ms. Marcella Graham, an independent hospital designer, contributed information regarding the psychological influences of color. She stated that in addition to known physiologic effects, color is expected to influence cognition, mood, impression, and association. Subjective terms such as warm, cool, soft, clean, clear, comforting, relaxing, cheerful, depressing, irritating, discomfortable, and noisy are some of this vocabulary utilized by designers to cope with non-objective or empirically-based observations and beliefs about the subjective influence of color on people, particularly health care patients.

Blue, red, black, and yellow have been found to be generally detrimental to patients and therefore should be avoided. Additionally, Ms. Graham offers suggestions for the color treatment of each major area within the hospital, e.g., dining, waiting, nursing, operating, recovery, etc.; however, these are given in subjective terms such as were cited above, i.e., cool, gay, soft, etc.

Evidently more method is required for the identification and proper specification of color preferences of patients and others working and living in the hospital environment.

Mr. John Flynn, School of Architecture, Pennsylvania State University, has been conducting research in the influence of color and light on human feeling. He stated that, in addition to the role which color can play in communicating information (e.g., yellow—caution, black—grief, white lines—space definition), color can also affect attitude, well-being, and motivation. Some studies and experiments were performed in which various lighting variables (distribution, source location, horizontal intensity, and tone (warm vs. cool)) were shown to cue impression of clarity, space, complexity, private vs. public space, relaxation vs. tension, and pleasantness. Evidence for confidence in the results was not presented, rather the terms "suggestive" and "tentative" were used to describe same. Accordingly, the most which can be claimed at this time is that some significant effects on the general feeling of well-being are conditioned by the lighting/color treatment of the environment.

The experiences of an art therapist were presented by Ms. Susan Castelluccio of the National Institutes of Health, U.S. Government. Ms. Castelluccio stated that guidance in the design of a pediatric oncology unit was obtained from an analysis of patients' drawings, particularly from their use of color.

Generally, ill patients selected red, blue, purple, and black (out of 24 choices) indicative of their illness (blood, bruises). The very ill tended to choose black which is believed to symbolize death and depression. Green, however, was observed to be a prominent choice for patients recovering and anticipating discharge to the outside. When asked about preferences for environmental colors both patients and their families expressed choice for "earth colors" and *not* red, blue, purple, black.

These observations and preferences are in general agreement with the report given above by Ms. Graham. Accordingly, these constitute rather definite guidelines for the designer-decorator of the health care facility.

Mr. Alex Styne, a lighting consultant and professor at the University of Florida, related his experience regarding light and color in design. As with the several guidelines and suggestions offered above, this paper also supports patient preference for light, pale, warm colors, and also for "quiet" patterns having "strong tactile" appeal. Patients are said to reject involved patterns and highly saturated colors.

It should be noted at this point that the concept of pattern (i.e., in addition to color) offers a whole new dimension and complication in dissociating/relating color to these other significant environmental characteristics.

Again it must be stated that much more knowledge, guidance, and research must be undertaken to provide the designer/engineer with information required at the construction stage.

Finally, Mr. Robert Spiegel presented a summary of his concept of mood change using audio-visual techniques. That paper has been omitted from these transactions since the topic more appropriately deals with psychological techniques, not dependent on color alone. Mr. Spiegel's mailing address appears with the others at the end of these transactions for readers who require information in that area.

It is hoped that this document presents both an overview of the subject of color in health care facilities as well as the sense of urgency for the development of substantive guidelines in order to avoid misuse of color.

ACKNOWLEDGMENTS

The accomplishment of this Special Workshop regarding Color in the Health Care Environment would not have been possible without the ideas, planning, and perseverance of a number of devoted people. Among them are Mr. Corwin Strong, National Institutes of Health; Mr. Alexander Styne, IDSA, University of Florida; Mr. Kenneth Kelly, National Bureau of Standards; and of course, the workshop speakers as well as the administrative personnel who provided substantial assistance.

ABSTRACT

The Proceedings contain invited papers regarding the use of color in Health Care Environments. The subject matter includes the perspective of medical doctors, architects, designers, researchers, and standards writers concerning proper and effective color and light selection and use in all phases of hospitals and medical facilities. Particular problems and cautions are related regarding the use of colors in surgical theaters and pediatric as well as psychiatric wards.

Key words: Architecture; buildings; color; design; hospitals; light.

CONTENTS

OVERVIEW OF THE CENTER FOR BUILDING TECHNOLOGY, NBS

Richard N. Wright

Welcome to the workshop, COLOR IN THE HEALTH CARE ENVIRONMENT. I am Richard Wright, the Director of the Center for Building Technology here at the Bureau of Standards. I am very happy to have the opportunity to welcome you here. I think this is the first visit for a number of you to the Bureau of Standards and the Center for Building Technology, so I am going to take a few minutes in my introduction to give you an overview of the things we do in the Center for Building Technology, and fit this into the context of the programs at the Bureau of Standards. I do this, not to weaken your concentration today on Color in the Health Care Environment, but so that while you are here you can become familiar with the other things we are working on, and so that you will feel welcome to get back in touch with us about other types of interests you have in buildings.

This workshop is representative of one of our efforts to maintain effective communications with the building community. When we speak of the building community we mean all the people who are concerned with the production and use of buildings: the architects and engineers who design them, the financial institutions which provide the capital for them, the builders who construct them, and really, most importantly, the people who use them. I think you are very much concerned with that last group—the people who use buildings. We need this type of communication for two purposes. One, to learn from you about the most important needs for improved building technology. This helps us guide our program to meet certain of those needs. Two, as an opportunity to tell you about the work that we have underway and the work that we have completed to help us disseminate results to those who can use them.

The activities of the Center for Building Technology are summarized in the goal statement: "To advance building technology to meet the changing needs of the building community by providing technical information, measurement methods, and criteria for improving the usefulness, safety, and economy of buildings." It is important to indicate that we do not regulate building. Neither do we promulgate standards. But, we work with Federal agencies that do promulgate standards, and we work with the voluntary standards community: The American Society for Testing of Materials; The American Society of Heating, Refrigerating and Air-Conditioning Engineers; The American National Standards Institute; etc., to help deliver standards to use in the building community.

We are ourselves concerned with four principal types of knowledge about buildings. First is the better understanding of human behavior in the built environment. That is very much the thrust of this workshop. Second is the actions of normal and extreme environments on buildings. Here we are working with earthquake loads, wind loads, temperature, and other environmental effects. Third, we work on the physical responses of buildings to those natural and human environments, how the building performs throughout its entire service life. Fourth, we provide technology for the processes of building design, construction, and use. This too relates closely to the subject of this workshop.

Our programs are focused on five major objectives:

(1) energy conservation in buildings and communities;
(2) effective use of solar energy in buildings;
(3) safety in the construction and use of buildings;
(4) efficient use of existing buildings; and
(5) more useful and economical buildings.

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This list is closely related to the subject of today's workshop, because we are concerned not only with buildings which are more economical for certain levels of performance, but also for buildings that better carry out their intended purpose.

We conduct a variety of activities contributing toward these objectives. One is relatively fundamental research, similar to that conducted in the nation's universities, development and verification of new hypotheses. Second is technical problem solving. An example of this is the development of improved energy conservation performance standards based on the best available knowledge. Third is use of our laboratories to develop new technical data to be used by designers and others in the building community. Fourth is to provide technical policy assistance to decision makers in government agencies and the private sectors. Fifth, we provide program management for technical activities done elsewhere in the building community. A current example of this is the development of new earthquake design standards for buildings. We are managing the program under sponsorship of the National Science Foundation. More than 80 expert design engineers and researchers from across the country are contributing to the development of this design standard. Sixth, we participate in standards writing organizations. Our highest priority standards activities include the standard for mobile homes, the national plumbing code, the requirements for design loads on buildings, performance standards for foundations and excavations, building code requirements for masonry, standards for energy conservation, standards for solar energy, and the standard for safety color coding. We are also working with the International Standards Organization on committees for building construction and for bases for the design of structures. I will now illustrate a few representative programs.

We have studied wind forces on mobile homes to improve their wind safety. The Department of Housing and Urban Development sponsored the study and will incorporate the findings in standards for the design and installation of mobile homes.

We placed a four-bedroom house in our large environmental chamber and simulated conditions of winter and summer extremes of environment. The results were used to investigate and improve the effectiveness of computer programs in predicting the energy and thermal performance of buildings. These computer programs give our nation's designers a tool of known effectiveness to assist them in providing energy conservation and comfortable thermal environments in the buildings that all of us use. Results from that experiment show how successfully the computer program matched the measured energy requirements.

In the summer of 1973 the National Conference of States on Building Codes and Standards foresaw the energy crisis and requested NBS to draft energy conservation standards for new buildings. We drafted the document in a period of 6 months, then turned it over to the American Society of Heating, Refrigerating and Air-Conditioning Engineers who promulgated it as a standard after 18 months additional work of several hundred participants and reviewers. That standard when implemented, and the implementation is proceeding, was estimated by A. D. Little Co. to save as much as 60 percent of the energy required for the average office building, without increase in first cost; it is a substantial technical accomplishment.

Our plumbing laboratories can simulate the performance of plumbing systems up to six stories in height. This allows us to explore the hydraulic performance of new types of plumbing systems and to develop standards which will allow improved plumbing systems to be accepted in our commerce and building codes. We also carry out field studies in order to document performance under real conditions of use. A recent program, including field and laboratory studies, has led to reduction of vent sizes for one- and two-family homes. The savings is about $100 per dwelling unit.

We have studied the safety of stairs for the Consumer Product Safety Commission. These programs have evaluated how people use stairs under normal conditions and how the geometry, the lighting, and patterns or color contrasts affect the possibility of accidents.

We at the Bureau of Standards are serving our building community. It's the nation's largest industry amounting to about $145 billion this year. Our program amounted to about $12 million last year. Of this, 70 percent was funded by other Federal agencies to work on their problems of

applied research, and 30 percent came from Department of Commerce funding. We hope you will take advantage of our results that can assist you and that you will inform us of your needs for improved building technology.

HOSPITAL LIGHT AND COLOR FROM THE PHYSICIAN'S STANDPOINT

William C. Beck

At ones' first visit to the National Bureau of Standards one can only wish that its functions would become better known, particularly to those interested in the design and function of our health care facilities. It is sad that some of us know more about the Buildings Research Institute of Pretoria, South Africa, or the British Building Research Station, than we do about our own. This is particularly evident when one realizes that this Bureau has been the home of the sage of color sciences, Dr. Deane B. Judd. The activities of the branches of the Bureau of Standards having concern for Building Technology deserve to become better known to the medical profession.

Mr. Faber Birren, one of the most knowledgeable and widely-read connoisseurs of color has said, "The medical profession has always been wary of any claims for color therapy chiefly because all color experience is highly personal and difficult to test and verify." This wariness can be overcome as it is now possible to quantify moods, attitudes, and reactions to space, color, and design.

The members of the medical profession are just beginning to develop an interest in their surroundings, which, in the past, they have left to the architect and the designer. The American College of Surgeons, an organization of 40,000 surgeons, has now a standing committee on the operating room environment to investigate the ecology of this important part of the hospital. The surgeons are cooperating with the Health Sciences Committee of the Illuminating Engineering Society which is concerned with the quantity and quality of light in all parts of our hospitals, nursing homes, and other health-related institutional quarters. The latter is trying to qualify and describe good lighting practice.

The health care facility is the site of a tremendous diversity of occupations involving individual visual tasks for the benefit of the patient. Physicians are concerned with the visual milieu of the patient in all of the task areas from the operating rooms to recreational areas. They are showing an increasing interest in the patient rooms which are the home of the patient during an often emotionally vulnerable and traumatic period. The physician is also exposed to this environment but carries out his examinations for a relatively short span of time. The nurse performs her duties over a longer span so her opinions must be given much consideration.

Most of all we must consider the patient, who carries out a wide variety of visual activity. Much of the lighting designers' study should reflect serious consideration of these. For example, much of the illumination equipment in a patient's room is designed for bed-confined patients. This is obviously incorrect, for as much as 80 percent of the waking day is spent by the hospital patients who are ambulant. The patient duties include eating, reading, and watching television. All are visual tasks.

Most important is the patient's need for an environmental setting for self appraisal, as well as appraisal by his family and friends. This can be most valuable in stimulating convalescence, and is influenced by both light and decor.

The hospital setting faces its greatest challenge in the unlovely circumstance of the dying patient. Often he is made to look even worse by poorly-designed illumination. We observe this effect when we compare how much better they appear in the funeral home as a result of well-designed illumination [1].

Many illnesses are accompanied by a sallow complexion. A light which would omit yellow from its spectrum (such as those in a neodymium envelope) will make everything appear far healthier. Yellow is a color to be avoided where any persons seriously ill are able to be observed, yet incandescent light with a preponderance of red and yellow is preferred to the lamping with a fluorescent tube emphasizing the blue end of the spectrum.

The appearance of a patient to his loved ones is of great significance. Patients look to them for encouragement which they cannot give if they show undue concern at the patient's appearance. For this reason, the I.E.S. strongly recommends that all fluorescent lamps used in health care facilities be of the color-improved (Deluxe) type. The warm type of fluorescent lamps are often more flattering than the cool types. Added incandescent lamps also are useful in not only giving a home-like atmosphere, but also giving warm tone to the complexion.

The visual task performed in the hospital varies with its size, its contrasts, complexity, and luminosity. The task may be a very critical one as in a surgical operation or noncritical as in those of housekeeping. Yet this is relative, as poor housekeeping may spell infection and vitiate the most meticulously performed operation.

The light varies in its quantity and directionality. The physician may need a great deal of light to perform his task, yet this same light may discomfort the patient if he must look into it's glare. This usually does not constitute a problem for the short period of the physician's activity. But if the light source is arranged purely for the benefit of the attendant, the patient may look directly into it. We see this particularly in critical care units. This must be controlled in nurseries where the patient cannot articulate his complaint.

It is also important to mention windows as they are expensive both in construction and in the energy cost of heating and cooling. Yet in many areas of the hospital they are most valuable in preserving the patient's, and even the staff's contact with the outside world. Such contact can be particularly significant in critical care areas and in long-term facilities such as nursing homes.

In choosing the lamp quality in the hospital one is faced with a variety of requirements so that the employment of a single source is impossible at the present. The variety offered to us by manufacturers is truly tremendous. We are interested in the effect of the light source upon the efficiency with which we can carry out tasks and the quality of the appearance of people and objects under its illumination. We are also interested in the costs of producing optimum performance and ideals of both complexion appraisal and color appearance of objects. These, of course, require study of the quantity as well as the quality of the light.

It is well recognized that objects and human complexions have different colors in different sources of illumination and at different light intensities, due to the spectral energies of the reflected light from the object and their effect upon the viewing eye. Certain light sources apparently also affect the clarity by which the details of the objects become visible. Furthermore, certain sources make the viewed area appear brighter than do others.

Some of these factors are capable of measurement as Richard Hunter has amply described [2]. Others are far more difficult to evaluate, although the British have simplified the matter by prescribing exactly the lamp types of which they approve in clinical areas [3].

It appears to me that no one lamp type is applicable to all hospital areas [4]. They must be chosen for their suitability to the tasks being performed by the patient and his attendants and secondarily by their cost effectiveness.

There is a wealth of information presently available on the use of light and color in industry and business. Much of it has been subjected to carefully controlled scientific investigation. Yet in the health care industry there has been very little scientifically verifiable information. Our problems here are compounded because we are dealing with such a tremendous variety of tasks, and concomitantly variables and also with a population which is physically and often mentally abnormal.

Through thoughtful workshops, such as this, by the stimulation of interest on the part of the hospital user, patient and professional, as well as by the careful considerations of engineers, architects, and designers, we may together make progress.

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HEALTH FACILITIES: COLOR THEM CARING

Marcella Graham

"We shape our buildings and they shape us."
Winston Churchill

Color—The magnificent! "Color is a science, an art, and a language. It is a medium that facilitates expression yet at the same time requires the ultimate exercise in control."

The skillful and educated use of color is best equated with the skillful and educated use of any language. It provides information. It is a means of communicating with people. Communication, when successful, is a transfer of meaning. Color plays a significant role in our perception, knowledge, and understanding of the world around us, and, in our health and feelings of well-being.

The human response to color falls into six categories which we identify at this time.

A. Organismic or Physiological:	Changes in blood pressure, pulse rate, autonomic nervous system, hormonal activity, rate of tissue oxidation and growth.
B. Within the eye:	Changes in size of pupil, shape of lens, position of eyeball, chemical response of retinal nerve endings.
C. Cognitive:	Memory and recall illusion and perceptive confusion, values judgment, associative response.
D. Mood:	Stimulating, irritating, cheerful, relaxing, boring, exciting, melancholy, gay.
E. Impressionistic:	Space seems larger, smaller, warmer, cooler, clean or dirty, bright or drab; people appear healthy or unhealthy, food is appetizing or not, older, younger, old, new.
F. Associative:	With nature, with technology, religious and cultural traditions, with art and science, typical or atypical.

These are a few among the many meanings attached to the skillful use and the successful practical application of color in supportive environments.

In our experiences with elderly and psychiatric patients who are the largest group of people sensorily impaired, we have found that appropriate color is the simplest, most inexpensive, and most effective way of erecting "landmarks" by which people can remain oriented. The elderly and psychiatric individual and the well person tend to prefer small areas which have specific function—meaning for them. The smaller area is more welcoming, less confusing, and fosters involvement. With the application of appropriate color and illumination, we achieve a therapeutic environment which is supportive of the people confined within it and which enhances treatment modalities.

At one institution where I am an environmental design consultant, color is a tremendous asset in the overall treatment plan. The majority of patients enter this psychiatric rehabilitation center apathetic, confused, and apprehensive. Any patient hospitalized for a long period of time will have accumulated a catalogue of major and minor grievances and suffers from numerous chronic or progressive diseases. Patients with organic mental syndromes are likely to be confused by almost any change in their environment. As a resident of this hospital, the patient lives with

the controlled, judicious use of color—or the lack of it. Accepting the fact that the human response to color is not neutral, we capitalize on the psychological, functional, and aesthetic uses of color to enhance light, provide sensory stimulation, give direction, control temperature, optically improve proportions, define specific areas, and supply information. This judicious use of color helps us to minimize any sense of confinement and to neutralize any atmosphere of apprehension, pain, or resignation. We use saturated colors to make many areas more inviting and to reassure the people using them. We use color to stimulate movement and to support activities. It is important to protect vision and to maintain the patient's spirits at a moderate level of stimulation for emotional and psychic balance. Warm colors in bathrooms appear to aid patients with their elimination. Warm saturated colors appear to stimulate appetite and other biological functions. With the judicious application of color, attention is directed away from the self. This is beneficial and an agreeable sensation.

In patient rooms the colors should be soft, clean looking, clear, comforting, relaxing, and yet cheerful. The light reflectance value of colors chosen should be between 40 and 60 percent. For the orthopedic and burn wards where patients may be confined in a supine position for long periods at a time, the ceiling should be treated interestingly to invite repose and be free from any depressing or irritating colors, designs, or contrasts.

In radiology, clinical laboratories, surgical departments, otorhinolarangology departments, colors should be low to medium reflectance so they can be easily controlled and reflected light will not interfere with delicately calibrated instruments used in treatment procedures. The colors and contrasts used in these areas should be free from discordant or distracting effects. The obstetrical department should be colored in bright, gay, cheerful colors; carefully controlled, which create an awareness of aesthetics, provide mental stimulation, information, and define patient areas.

Public areas should utilize a palette of warm, relaxing, and subtle shades of colors. Saturated colors should be avoided as they tend to stimulate and produce visual noise. We suggest monochromatic color schemes with medium shades used to define the perimeters of many small areas. Generally, people in various stages of illness or wellness are less intimidated by small, clearly defined areas. The public areas should be free from discordant effects and super-saturated colors, which are sometimes used as a designer's statement.

Certain shades of blue, red, black, and yellow should be avoided in health care facilities because of psychological and cultural connotations. Passageways should be light and bright and landmarks should be used. The end result should reflect warmth, attractiveness, safety, and information.

The business offices should be colored to avoid distractions, create favorable subtle contrasts, support a satisfactory level of activity, avoid monotony, and support productivity.

The controlled and judicious use of an appropriate palette in the confined environment of the health care facility will create an atmosphere conducive to the maintenance of individuality, comfort, and dignity of the patients and aid in avoiding their submergence in the hospital machine. The paramount concern of the designer is not so much a matter of what color as it is a decision to create favorable subtle contrasts and avoid unfavorable contrasts. The paramount concern of the designer should also be a therapeutic environment which supports the humans within it.

Dining areas may be colored in a clear, bright, gay, warm palette. Here the color imagery may have a nearly free rein. Kitchens may be painted in cool and pale colors to control temperature and noise visually.

In waiting rooms, the palette should be subdued and pale—an atmosphere conducive to repose and relaxation. Nursing stations may be colored in bright, clear colors as landmark and visual anchors.

The operating and recovery rooms should be painted in soft and pale cool colors to reduce glare, provide a suitable contrast to blood and tissue, promote the feeling of tranquility and coolness, and aid the visual acuity of the staff who spend hours every day in this environment. Shades chosen should be in the 30–50 percent reflectivity range and high gloss finishes should be avoided.

In pediatric wards, many bright, gay, clear, saturated colors can be used in unorthodox ways and combinations to keep children amused and occupied.

In psychiatric wards only a few saturated colors should be used and with discretion. Generally pale, warm colors for larger areas with cueing, and cool landmarks and visual anchors painted in. There should be areas well defined, in which the palette is stimulating and other areas where relaxation and repose are possible. Bizarre contrasts and abstract art generally should be avoided. Very important in this area is color-coded signage, elevator systems and patient areas with perimeters clearly defined. Stairwells should be brightly colored and well illuminated to reflect the colors used correctly. Doors to various floors from inside the stairwell may be color-coded.

In geriatric wards skill, consistency, and an appreciation and knowledge of the rehabilitative nature of the programs used, the special physical and emotional handicaps of the elderly, and the particular types of chemotherapy used should be taken into account. Some types of drug therapy offer interesting and difficult problems in perception and an effective color palette with correct levels of illumination and multiple sources of illumination will be positive support to an ever-increasing segment of our population.

In health care facilities, the biological and psychological responses may become inseparable from the healing processes which are the purposes of the institution's existence. Most people, regardless of age and physical condition, relate to their environment to the degree in which it contains information of relevance to them. Color can provide cues, orientation, landmarks, direction, and information and can be used to break the monotony of long halls and very large areas. It is important to relate color to function when possible and to use strong colors carefully and only where their stimulating effects are appropriate. For instance, in one facility where I am a consultant we have a red 3-inch-wide stripe across the headboard and a red name badge for all diabetic patients.

For the aged ill, there is frequently a visual problem in distinguishing boundaries such as the corners where walls meet, the boundary between wall and floor, or a door and the wall in the same color. The use of bright color contrasts and different colors can clarify these boundaries. Approximately 80 percent of the information we gather is accomplished with vision. It should be borne in mind that the glare from pale, highly polished floors and pale gloss enameled walls can pose a serious handicap to ill and elderly people. Visual distortions must be anticipated and dealt with by using matte finishes, suitable contrasts, and various sources of lighting. A particular patient in one hospital I visited regularly would hallucinate and cry to be spared "from walking on the water." The pale one-color floor with a high gloss undulated to her, hence the unusual plea.

In intensive care units, patients should have sufficient color interest to maintain sensory diversity and the opportunity to enjoy visual repose and relaxation.

With age or illness, people experience a deterioration in the sensory apparatus. This deterioration can be a sudden crisis or insidious, but the result is the same—a deprivation of sensory information. These changes as a result of age are different for each person and each sensory organ. Environmental information is decoded by the senses; therefore, sensory changes have special meaning and are important to the individual's ability to function in his environment. If the information and cues provided by the environment are not organized or understandable, the ill or disoriented person will be without an opportunity to communicate and be communicated with. The environment should be organized for orientation, information, safety, function, and pleasure. Design, color, and illumination for supportive environments should organize the space so that its function and other information is clearly understood.

Recently I visited a psychiatric facility close to my home. Shortly after entering, I began to feel assaulted by orange, red, and design. It was necessary for me to wait in this area for approximately 25 minutes until the director arrived. It was one of the longest 25 minutes of my life. Interior designers had been retained to "make the place cheery;" so they had enveloped the area—approximately 40 feet by 24 feet in total and unrelenting color. While it was a positive statement by the designers, it was not in any sense of the word a therapeutic environment. Color

used to convey information must be judiciously applied. The major effort should be to make the visitors and patients as comfortable as possible as quickly as possible. Research has indicated that while sensory diversity is of significant importance in confined environments, and in fact, is an adjunctive therapy in the healing process, visual relief is also necessary. Here is where appropriate and necessary contrasts in color must be used. The contrasts should be chosen with care and an appreciation of the psychological, physiological, and emotional stress of the people in the spaces. Ideally, the consultant making the decisions should have some knowledge of the hospital processes, the degree of wellness or illness of the patients in the area, the rehabilitative therapies used, and the fact that two important facets of environmental design are (a) to inhibit the submergence of the patient in the hospital machinery; and (b) to create a supportive space. Again, the problem in the health care facility is not really so much what color, as how and where to use it. It is of significant importance to the patient, for instance, for him to see himself in his mirrors and mind as "looking well"—or "better." In a truly therapeutic and supportive environment there is no "room" for the designer's personal taste or "signature."

The successful use of color in health care facilities will introduce sensory stimulation, establish an interesting change of pace for maintaining necessary levels for psychic rest or stimulation. Further, in the self-care units, it is important to create and maintain a sense of unity and continuity for the benefit of elderly or mentally disorganized, or partially-sighted people who are constantly moving through various areas.

In one psychiatric-geriatric facility where I have worked as a consultant since 1971, the treatment modalities include behavior modification, reality orientation, resocialization, continence training, and token economy. There is also a model self-care unit which is assessed as highly successful. The physician/director of this hospital has stated categorically that my applications of color and overall environmental design have made a positive contribution to the rehabilitative patient program. Color coding was extended into the dietetic department and self-care units. Overall, the patients are reported to enjoy better morale, and show an interest in accepting responsibility for self-care; feeding, socialization and dress habits have improved markedly. There is now spontaneous socialization and interaction. With a noticeable shift in patient response, staff morale improved. With this improvement, several new progams were attempted and are evaluated as being successful. With the "new look/new attitude" programs, it was decided to secure approximately 100 volunteers to assist in the adjunctive therapies. It had been exceedingly difficult to obtain volunteers to work in the hospital which is located 22 miles each way from the nearest town. When the effort concentrated on color coding the numerous buildings and extensive grounds was completed, two dozen representatives were invited to tour the hospital with the unhospital look. The gratifying response was summed up in the statement "*This* mental hospital is like going to a party." The project was started 3 years ago. The hospital now has a roster of over 2,000 volunteers who return again and again to engage in patient-oriented activities.

Our sensory organs envelope each of us in our personal, special boundaries within which these messages are perceived and decoded. They differ in scope for each person. With aging and illness the ability to decode and perceive environmental information may be impaired. The aging process and illness each have their particular languages. It is just as wrong to neglect the benefits which carefully chosen color can convey as it would be to pour wisely prescribed medicine down the drain. As we find more satisfactory ways to improve communication between people and their environments, we will prevent or reduce the withdrawal, apprehension, or despair common among the aged and ill.

STUDIES OF THE SUBJECTIVE INFLUENCE OF LIGHT AND COLOR

John E. Flynn

We have been investigating evidence which suggests that human responses to patterns of spatial light and surface color are, to some extent, shared experiences. As this study has progressed, we have come to consider the more specific possibility that some patterns of light and color might be communicative, in the sense that these patterns suggest or reinforce ideas and impressions that are shared (in some degree) by people who share the same cultural background.

I'll begin by expanding briefly on the theoretical context that underlies this work.

Individuals exchange ideas and information in many ways; and while we share much information through spoken and written words, other categories of information are communicated more subtly with visual patterns and symbols. Commercial trademarks are one example of this; railroad signals and traffic signs are another. In the former case, impressions of identity and quality may be communicated through the use of somewhat abstract visual patterns (not words). In the latter case, visual patterns are used to guide individual and group behavior. Color may reinforce the communication, as when yellow is used to suggest caution, or when black is used to suggest grief or sorrow.

We also obtain impressions of meaning by recognizing the symbolism of visual forms—such as the Christian cross, the Star of David, and other artifacts that relate to cultural and social rituals. On the other hand, some visual forms provide a sense of spatial limits. A simple example might be the white lane lines that are painted along a road pavement; or a carpeted area in one portion of a room can define a space within a larger space.

Considered together, these examples suggest a complex system of designed patterns that guide our behavior and affect our sense of place. Each of these examples involves the visual sense and has the capacity to communicate impressions of "meaning" that are not readily communicated with words. This suggests that the experience of vision is, in part, an experience of recognizing and assimilating communicative patterns.

"MEANINGS" ASSOCIATED WITH PATTERNS OF LIGHT AND COLOR

The theory referred to here is the idea that some psychological aspects of light and color can be recognized and perhaps documented if we are prepared to discuss and study the design of institutional rooms partly as an exercise in visual communication. It suggests that as the designer changes the patterns of light, shade, and color in the room, he changes the composition and relative strength of visual signals and cues; and this, in turn, alters some shared impressions of meaning for the room occupants and users. Many interior designs are intended to function in a "permissive" way (i.e., to *permit* performance or participation in some activity that involves vision, without attempting to influence user behavior or impressions). However, there is evidence that other interior designs may function more actively as selective intervention in human visual experiences—guiding circulation, focusing attention, and otherwise affecting impressions of a room, an activity, or an institution.

This discussion implies a very broad definition of the function of light and color in health facilities. It requires a perspective that function cannot be limited to ideas associated only with concepts of "utility," "task," "ease of maintenance," or "physiological needs." If we are also concerned with the sensitivities and socio-psychological needs of the users, a truly functional design must come to include the qualitative ideas of user "attitude," "well-being," "motivation."

SPATIAL PATTERNS OF LIGHT AND COLOR AS A SYSTEM OF VISUAL CUES

With these background ideas in mind, I will call attention to a series of studies that is exploring the effects of light and color as part of a system of visual cues in a room. This work is being undertaken in the Department of Architectural Engineering at the Pennsylvania State University—and is assisted with financial grants from the Illuminating Engineering Research Institute in New York [1-4].

Briefly, we have been testing the cueing influence of light and color by using Semantic Differential Scaling [5] and Multi-Dimensional Scaling [6-8] as methods for gaining insight into the process of subjective judgment of visual space.

In the manipulation of the study room to date, we have been working rather intensively with several basic lighting variables:

(1) the distribution of light from the luminaires;
(2) the location of luminaires in the room;
(3) the intensity of light on the horizontal activity plane;
(4) the color tone of the light (warm or cool).

More recently, we have expanded the study to include the influence of surface color.

These studies suggest that there are several broad categories of impression that are cued or modified by lighting design. The following six are of particular interest:

(1) impressions of VISUAL CLARITY
(2) impressions of SPACIOUSNESS
(3) impressions of COMPLEXITY (sometimes LIVELINESS)
(4) impressions of PRIVATE SPACE and PUBLIC SPACE
(5) impressions of RELAXATION and TENSION
(6) impressions of PLEASANTNESS.

The following figures show representative plots of computer-analyzed rating data in a form that suggests the influence of the visual setting on subjective impressions.

Investigation of similar light settings in different rooms indicates that the modifying effect is reasonably consistent in different rooms. This tends to reinforce the theory that we are dealing with light cues and patterns that signal or communicate subjective associations, and that the direction of the associations can be somewhat independent of the physical size and shape of the room in which they are viewed.

More recent work is suggesting that variations in room surface color exert similar (or seemingly related) influences on subjective impressions. Very preliminary evidence suggests that light and surface color may be affecting the same categories of subjective impression (as listed above). In this sense, it appears that when reinforcement of specific socio-psychological environmental effects is intended (such as reinforcement of impressions of "relaxation," "spatial intimacy," "playfulness or liveliness," etc.), these can be augmented with either (or both) lighting and surface color.

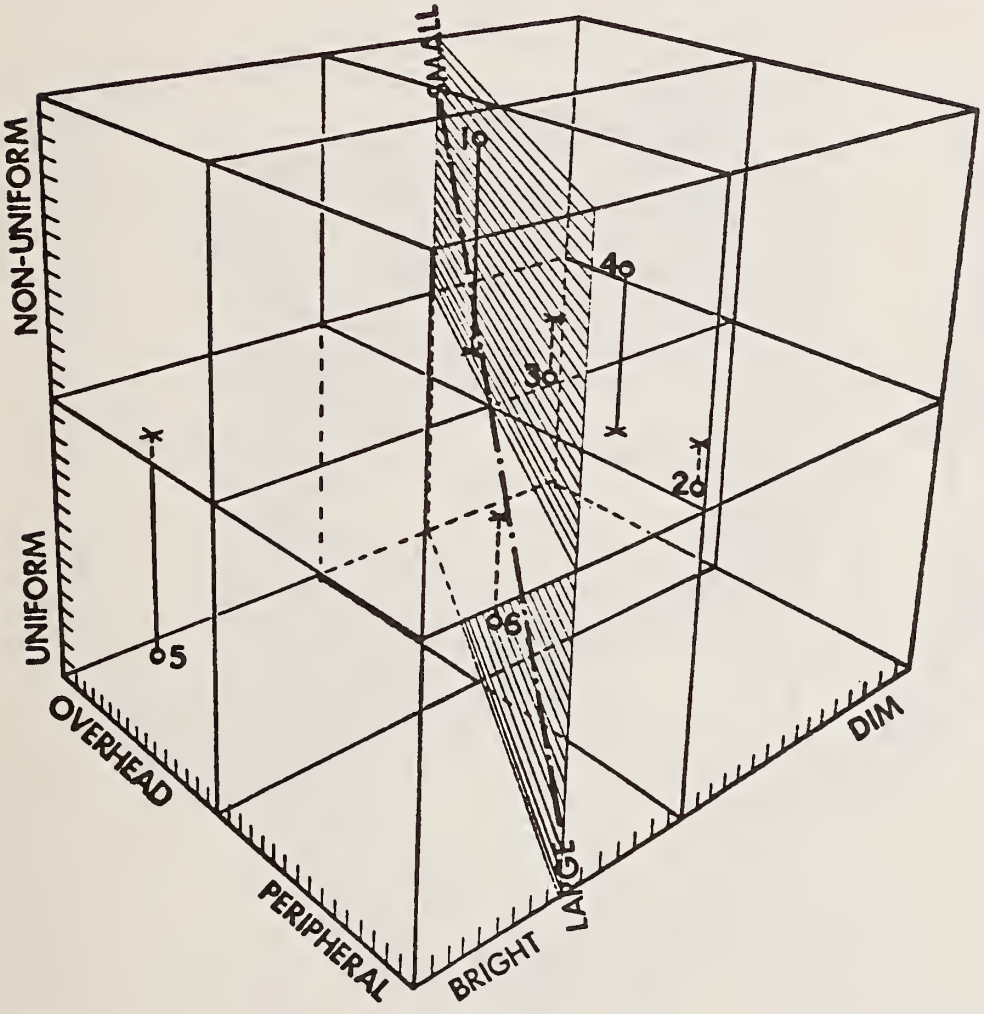
CONCLUSION

Recognizing that we are discussing an incomplete line of inquiry, our findings nevertheless suggest that recent evolving procedures for rating subjective impressions and experiences can be applied usefully in programming and planning light and color for institutional interiors—and it appears that a definitive pattern of data is beginning to emerge.

At this point, our work seems to support the theory that the subjective experience of spatial light and color is, to some extent, a measurable experience. Furthermore, the findings seem to sustain the idea that light and color can be discussed and studied as a vehicle that alters the information content of the visual field—and we may be able to document how this intervention affects behavior and sensations of patient well-being.

INDICATED LIGHTING DESIGN DECISIONS FOR
AFFECTING IMPRESSIONS OF

SPACIOUSNESS :



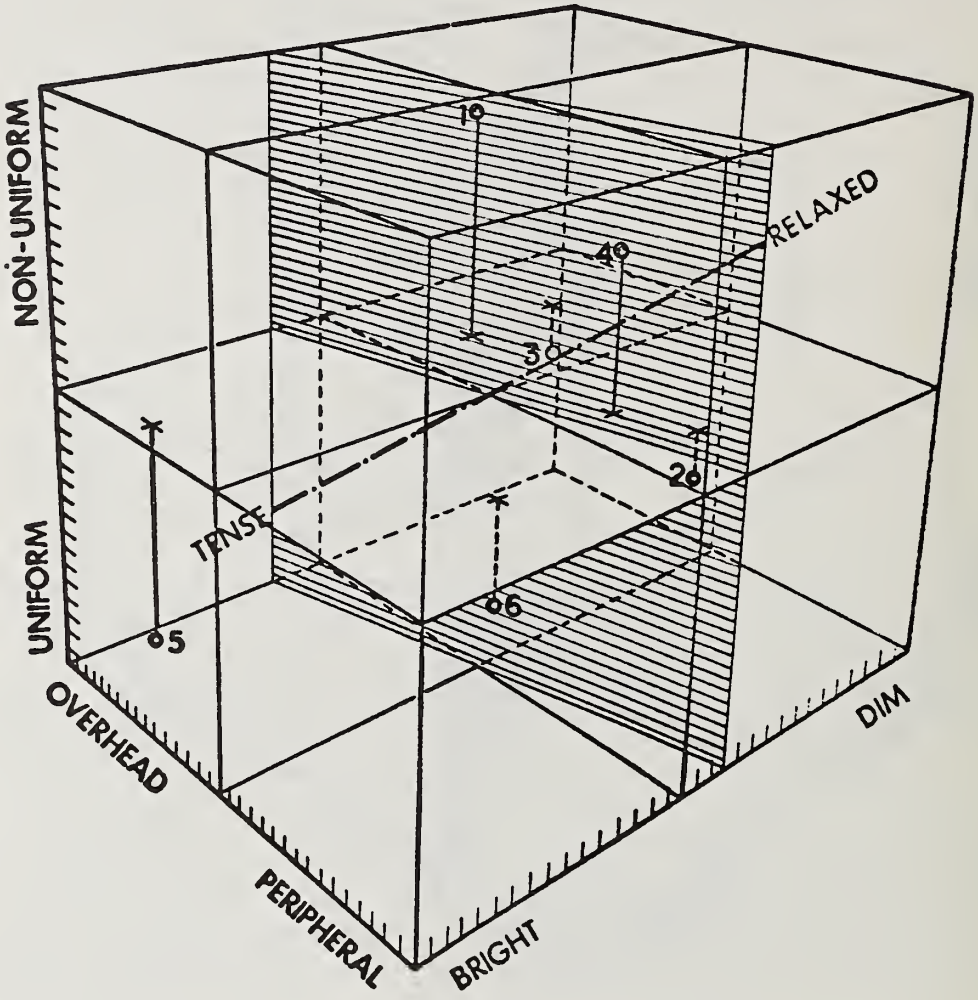
MULTIPLE REGRESSION COEFFICIENT

U	UNIFORM	O OVERHEAD	B BRIGHT
NU	NON-UNIFORM	P PERIPHERAL	D DIM

DIMENSION	SPACIOUSNESS FACTOR
NU/U	.685
NU/U + O/P	.940
NU/U+O/P + B/D	.984

INDICATED LIGHTING DESIGN DECISIONS FOR
AFFECTING IMPRESSIONS OF

RELAXATION (AND TENSION):



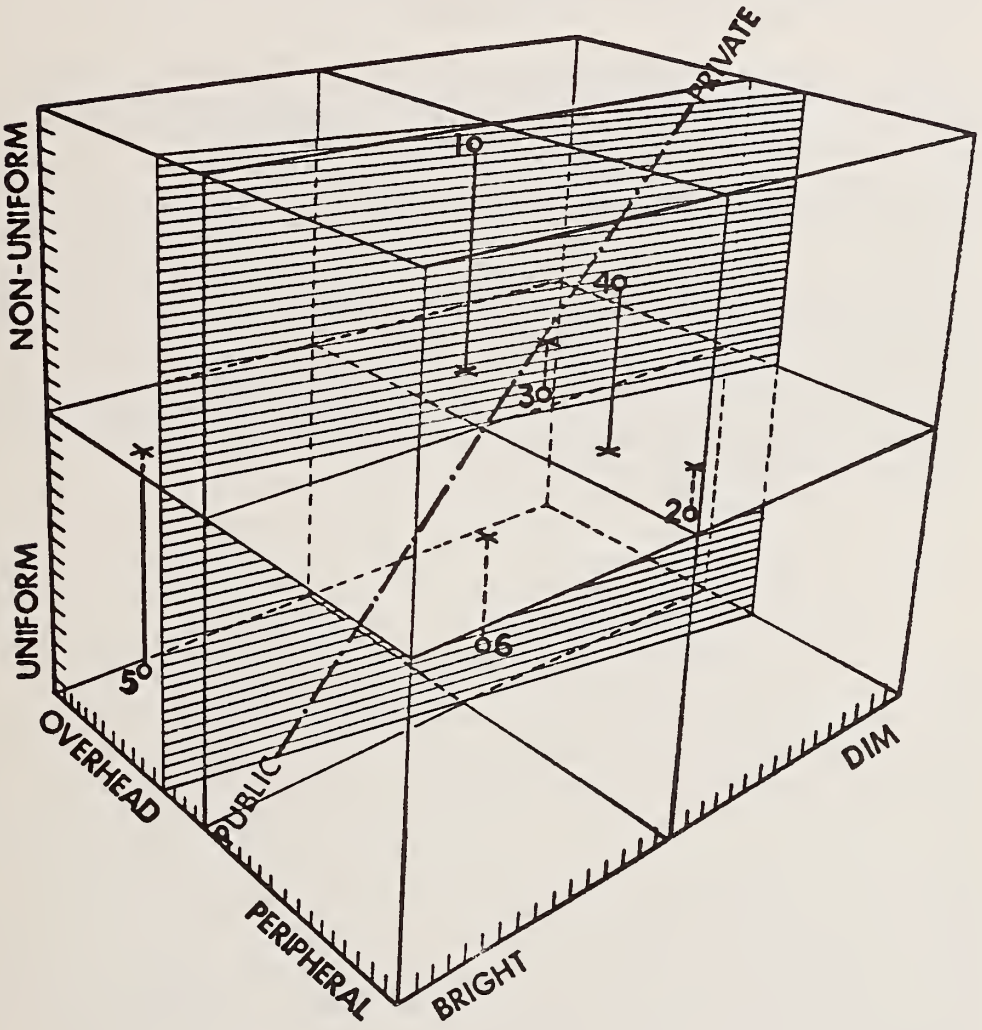
MULTIPLE REGRESSION COEFFICIENT

U	UNIFORM	O	OVERHEAD
NU	NON-UNIFORM	P	PERIPHERAL
B	BRIGHT		
D	DIM		

DIMENSION	RELAXED-TENSE SCALE
O/P	.770
O/P+U/NU	.978
O/P+U/NU+B/D	.987

INDICATED LIGHTING DESIGN DECISIONS FOR
AFFECTING IMPRESSIONS OF

PUBLIC - vs - PRIVATE SPACE :



MULTIPLE REGRESSION COEFFICIENT

U	UNIFORM	O	OVERHEAD	B	BRIGHT
NU	NON-UNIFORM	P	PERIPHERAL	D	DIM

DIMENSION	PUBLIC-PRIVATE SCALE
U/NU	.910
U/NU + B/D	.994
U/NU + B/D + O/P	.999

If confirmed, this would suggest that when institutional planners alter light and color, they are intentionally or unintentionally exerting a potentially significant influence on patient and visitor impression. This influence should be recognized for the potential interaction with therapeutic or other socio-psychological goals—and for other effects on behavior patterns when individuals or groups are confined in institutional settings for sustained periods.

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SOME RELATIONSHIPS OF COLOR AND LIGHT TO PATIENT CARE

Thomas R. C. Sisson

The use of color in hospitals is unevenly, if not inconsistently, applied. No one is surprised to find the lobby and administrative areas rather well done up, an attractive entry to a house of the sick, nor should it be otherwise. However, when one arrives in medically functioning areas where the ill abide, the appearance is usually quite different. Patients are often maintained in cell-like rooms of spartan simplicity, deadly decor, if any, and exposed to all the visual distractions that may be encountered in an empty refrigerator.

Not enough attention is given to the contentment of the patient's state of mind when in a hospital. We are charged to comfort the sick, and there is no better place to carry out this charge with sensitivity than in a hospital. Rather than an atmosphere of warmth and cheer for people who are distressed, apprehensive, and uncomfortable at the least, we provide instead the environment of a penitent, and not a willing one at that.

The ambulatory patient is perhaps less affected than the bed-fast for he can have a change of scene. The sick person, however, is a captive in a strange and vaguely hostile world where he is stripped of power over himself, his accustomed and comfortable routines, and reassuring personal surroundings. The reassurance of nurses and physicians can be seriously weakened if the patient's environment in a hospital does not reinforce it. If his surroundings are seedy in appearance, dreary, and not altogether clean, his anxieties (often formless) can hardly be relieved. It does not require a graduate psychologist to recognize that his recovery is not likely to be hastened.

Unquestionably, the enormous costs of patient care have contributed in a measure to the lack of some amenities to which patients are entitled. Solaria are often turned into patient rooms; two and three beds are crowded in once single rooms. The social dictum that all patients must be considered "private" has led to the construction of single-room hospital wings, and this has met head-on with budget restrictions. Many rooms are now private as can be, and as spacious as a closet. The lack of space, or the sense of it, is made more distressing by ill-considered use of color and light in the patient's hospital surroundings.

It is impossible to separate light and color in respect to this environment. "In the dark all cats are grey," and far from being kept in the dark, patients are often over-illuminated, revealing thereby all the deficiencies of hospital decor. The choice of lighting is frequently based upon considerations of economy, not upon appropriateness of need, color rendition, function, or visual appeal. Fluorescent light is less expensive than incandescent, and cooler. It now forms the bulk of all hospital lighting. This would not be a matter of concern if the choice of fluorescent lamps were made in regard to what they were meant to illuminate. From personal experience I can cite the poor lighting design of many hospital nurseries.

The Roman architect Vetruvius wrote with great perception of the relation of light and color to function. He said, "Not less should the picture galleries, the reading rooms, the embroidery rooms, the studios of painters, have a North aspect, so that in a steady light the colors in their work remain of unimpaired quality."

We have taken this so to heart that we maintain the need for illumination that will imitate the northern light of the sky regardless of its utility or effect. During the second World War much effort was put into the development of suitable phosphors for industrial use and for office work. At that time the war effort went on around the clock and artificial illumination became a necessity. In Great Britain the so-called "warm white" fluorescents were chosen, but in this country "cool

white," because of its rough similarity to Vetruvius' light "of North aspect," gained popularity with lighting engineers and architects. As a result, we have been flooded willy-nilly with poor imitations of daylight. It is almost Holy Writ that the purest and best light is daylight, and it remains a major reference standard for many measurements in respect to color, color rendition, color temperature, illuminance, and so on. The function of artificial light sources to illuminate work areas is not appropriate for a living area, which a patient room is. On the other hand, soft shaded light is inadequate for the *care* of a patient. The priority given to this function over the comfort of the patient can be adjusted. Merely settling for the satisfaction of function by equipping patient areas with brilliant harsh light is not only thoughtless, but is poor design.

No one has yet succeeded in standardizing color perception of the individual human eye, and it is the perception of color which is important in medicine. The eye cannot readily analyze the spectral distribution of light producing a simple color impression, nor can it distinguish the sources of different spectra which may produce the same integrated color sensation. Dichroism, which will give different color rendition by sources which look alike but are dissimilar, will obviously affect the perception of different people in differing ways. This cannot be reduced to a mathematical quantity or index—desirable as that may be.

Consideration of color requires more than standardization, necessary though it is for paints, dyes, traffic signals, and other uses of relatively easy quantification. There should be a consideration of function as well as appearance. To use and to perceive color, to live in color, means that the function of the human in that particular environment must be appreciated. For this it is necessary to deal with two environmental factors: color, and the light by which the eye sees it. Since light can have a color property in itself, and can render color of the objects it illuminates, other factors are introduced: reflectance and texture.

I would like to speak in particular of an intriguing aspect of color as a functional attribute—of its effect, to be precise, on the function of the human who perceives it.

As a physician, a neonatologist, I am concerned with two aspects of the management of my newborn patients: recognition of disease and treatment of it. A very common condition of the newly born is hyperbilirubinemia or jaundice of the newborn, which is a paradigm of color-oriented disease states. It is color-oriented because it is made known first by a yellowish cast to the skin of the face of the infant. Measurement of the concentration of bilirubin (a breakdown product of hemoglobin) in serum is needed to monitor the extent of rise of this yellow pigment, which, if in too high concentration, may damage the brain. Should bilirubin reach a critical level, or predictably do so, it may be decreased by two methods. The traditional treatment has been exchange transfusion, in which nearly all the infant's blood is removed and replaced by fresh whole blood containing none of the pigment. The second method is based upon the happy fact that bilirubin is highly photoreactive. Exposed to light whose wavelength matches the peak absorption of the pigment, it will rapidly decompose in the body to other compounds which are not toxic to the brain and which can be readily excreted.

Bilirubin in plasma absorbs light most effectively around 450 nm. Therefore, if sufficient photons in the blue range of the visible spectrum irradiate the body of a jaundiced newborn, the pigment will absorb the energy and decompose in the body. The method is known as "phototherapy." This direct photochemical reaction can occur under the influence of any light source as long as the source contains, in its spectral emission, a significant portion of its output between 420 and 490 nm.

This is an example of both diagnostic and therapeutic use of color, and is employed worldwide. It is diagnostic, because the human eye is able to detect the yellow color of the skin of affected infants, and therapeutic because a light of specific color uses the photochemical change.

The use of colored light in medicine is not new. One hundred and one years ago a book appeared, bound and printed in blue—the compiled addresses of a General Pleasanton to the Philadelphia Society for the Promotion of Agriculture. The General was not too rare an individual in that time—the talented amateur scientist. His scientific pretensions did not outlive him, but he was responsible for the "blue glass mania" that swept America and Europe in the late 1800's. He

claimed that blue light and the blue light of the sky would cure all manner of diseases, increase the yield of crops and the fecundity of domestic beasts. He recommended the use of greenhouses with alternating panes of clear and blue glass—on which he secured a patent—and the installation of blue glass in house windows before which the body could be exposed for curative effects. The system failed miserably, of course, and not only because it was a cumbersome way of producing blue light.

The blue glass craze died after a decade. There was slight resurgence of interest in colored light as a medical treatment in the 1920's as a result of the work of the distinguished Professor Finsen and his use of ultraviolet in the treatment of tuberculosis of the skin—known as heliotherapy.

Interest was again excited by the report of the British physician, R. J. Cremer, in 1958, which documented a remarkably effective treatment of jaundice in the newborn by blue light. Banks of 8 or 10 fluorescent lamps irradiate the unclothed infant, whose eyes must be shielded from the intense light. Exposure to the light lasts usually from 2 to 5 days. There is a dose: response relationship, so that the greater the light energy output in the blue portion of the spectrum, the more rapid and marked is the photodestruction of bilirubin, although the optimum energy is not yet known. Fluorescent lamps that radiate entirely in the range 420-490 nm, a saturated blue-violet, are also employed.

Pigmentation of the skin, as in infants of black ancestry, does not diminish the effectiveness of phototherapy. We have found that the light of fluorescent lamps, whether of a saturated blue or of the "daylight" type, will penetrate deeply into the body tissues in significant amounts. Twenty-three percent of incident phototherapy light will be transmitted through the skin, subcutaneous tissues and muscle of the abdominal wall of a 6-week-old pig—a distance of at least 0.6 cm. Three percent will pass through the entire liver of the animal.

In our studies of the photobiologic effects of light, we have observed that the effectiveness of phototherapy may be accompanied by deleterious effects as well. Riboflavin, a vitamin essential for respiration of the red blood cell, absorbs at the same wavelength as bilirubin. Phototherapy will cause an average 25 percent drop in whole blood levels of this coenzyme, which in turn will result in red cell hemolysis (in few infants) and a consequent further increase of bilirubin rather than a decrease. The treatment in these few cases, then, exaggerates the disease.

I mentioned earlier the inappropriate lighting of many nurseries. The usual practice is to over-illuminate. In the case of intensive care nurseries, high levels of illumination are maintained 24 hours a day.

It has been thought for many years that newborn infants do not possess identifiable biologic rhythms, since their environment *in utero* is in a sense controlled, and the developing fetus exists in a supposedly stable internal milieu. It was believed that at birth the infant has had too little prior exposure to the external world, and is too immature to have developed rhythmic biological processes. Professor Theodore Hellbrugge of Munich, and Dr. Marcel DuPau in Paris, and others, demonstrated that it was not until about 6 weeks of age that an infant developed periodic alterations in white blood cell production, and a diurnal variation in heart rate and respiration—all common markers of biologic rhythm. However, 5 years ago, these investigators demonstrated that certain physiologic rhythms appeared at about 1 week of age.

Our interest in the effects of light on rhythms led us to investigate the levels of plasma Human Growth Hormone in infants of low birth weight.

Studies in our laboratory demonstrated that, under a regimen of cycled light/dark, plasma Human Growth Hormone levels of the neonate exhibited a circadian as well as ultradian rhythm by the second day of life. That is, peaks and troughs of HGH levels occurred every 4 to 6 hours (ultradian rhythm) and that a major rhythm also occurred with a peak at midnight to 0200 hours and a trough in late morning (circadian). However, we found that under constant light the circadian rhythm disappeared. When infants were treated by phototherapy, both ultradian and circadian biorhythms were obliterated. It was possible to observe the original rhythms if the lighting environment was cycled to permit, not absolute darkness, but only dim light of 5

footcandles for a 10-hour period in the 24-hour day; the other period having standard bright lighting. These observations are of some significance, for at this critical juncture in the development of the newborn, the rhythm of HGH should be cyclic. The erasure of the normal rhythm by an inappropriate lighting environment in the nursery is not physiologic. The implications of these findings are unclear and we do not yet know that clinical effect may result. In any event, they indicate the powerful effect of light on natural biologic events, and they should make us recognize the profound influence of environmental conditions we impose on hospital patients.

One may come to a reasonable conclusion from these studies, that a constant high level of illumination is not a proper environment for the newborn. This may hold true for the adult as well. There is ample evidence to support this contention in the reports of chronobiologists.

The effect of light on the eye has concerned us because of the great intensity of the light from phototherapy units—between 400 and 800 footcandles. We exposed newborn pigs to various phototherapy lamps, both broad-spectrum white and narrow-spectrum blue fluorescence, and in various concentrations of inspired oxygen: 10, 20, 40, and 100 percent. Twenty-four hours of exposure to these light environments destroyed the rods and cones of the piglets' eyes. The combined high concentrations of oxygen had an additive damaging effect on the vasculature of the retinas. It is disturbing to learn that eye damage can occur under an otherwise beneficial form of treatment, and one must wonder if the combined treatment of oxygen therapy and phototherapy is a cause for concern. It would be, unless there should be careful shielding of eyes during these therapies. It is our practice to examine the retinas by indirect ophthalmoscopy in order to discover retinal changes early on, should they occur. Happily, we have not observed damage to this time because of the diligent care of our nursing staff.

Several investigators have reported an inhibition of growth of infants and animals exposed to phototherapy, and to visible light radiation of various color saturations. We exposed over 200 congenitally jaundiced Gunn and normal rats to fluorescent lamps emitting in narrow spectral ranges: blue, green, yellow, red, pink, and broad-range white or "daylight." Contrary to the original reports, we were unable to find growth retardation after exposure to any of these radiances; rather, we found a slight acceleration of growth rate in both types of rats raised until weaned under yellow fluorescent lamps. I might add that ultraviolet emissions were filtered out.

If the color of the light does not affect growth rates, then the use of monochromatic light, rather than a balanced polychromatic light, may not produce effects of physiologic difference, as has been cautioned. Instead one need be concerned only with producing a desired photochemical effect from an irradiance of narrow range in the color spectrum as exemplified by the use of blue light phototherapy. We know that there is a dose/response relationship of the photobreakdown of bilirubin and the energy output of the light source in that spectral range. Of concern is the length of time infants are exposed to these therapeutic light radiations. Excessively prolonged exposure may involve the photodestruction of other natural enzymes, hormones, etc. that is not intended. Therapeutic photochemical reactions should be employed with as much precision as possible. Shotgun approaches have no more place in this than in drug therapy.

An example of this precision appears in the treatment of psoriasis, wherein photosensitizer—8-methoxypsoralen—is given to the patient and after its absorption and distribution throughout the body (including the psoriatic lesions) the patient is exposed to near-ultraviolet light, that is in the the range of 330-390 nm. The U-V is specifically absorbed by the psoralen, which then disorganizes the cells of the lesions in which it lies. This is not really a new therapy, for its elements were described in Sanskrit writings in the 12th century. Sunlight, of course, was the ultraviolet source in that time.

These remarks serve to illustrate the fundamentally physiologic and biochemical influence of light and colored light as therapeutic modalities, and suggest the need to consider the lighting environment as more than a convenience for staff or patients.

The use of certain light sources in hospitals, clinics, and other health care facilities has been influenced, in the greater part, by concerns for effective illumination. Standards and

recommendations have been particularly affected by the requirements established for illumination in business offices and industry where functions are quite different from those in health care establishments.

We are all aware that the surgeon must have brilliant, shadowless light for his operating field, and that he should not have to tolerate blinding reflection of this light from white drapes and towels. Therefore, since the working light is intense, draperies are now made of colored cloths and paper to absorb some of the radiance and to reduce reflectance. Similarly, the walls and other reflecting surfaces of the operating theater are now colored and of dull texture.

Nurses must be able to inspect their patient closely—as must the physician. For this reason patient care areas are usually brightly, even over-illuminated. In the case of nurseries and intensive care units the illumination—almost always overhead—is constant around the clock. In many patient rooms and wards the only adequate light is from the ceiling and for the nurse to tend her patient at night, check vital signs and so on, the whole room must be lighted. This is hardly conducive to a restful night for the sick.

The level of intensity of illumination is not the only concern. The color of the light, its color rendition, and the color of the walls, window draperies, linens and other reflecting surfaces must be of such a character that the appearance of the patient is not altered. For example: it is vitally necessary that cyanosis of a newborn be readily detectable. This requires a light source with fairly natural color-rendering property, such as white or daylight fluorescence. It also requires surrounding surfaces that do not reflect color on the infant's skin to falsify its appearance, as would blue walls and curtains. The development of jaundice in the newborn is detected by a faintly yellow hue of the skin. If walls or gowns are yellow or green, or if the diffusing soffits of overhead lighting fixtures are yellowed, almost any infant may seem jaundiced. On the other hand, bright pink surfaces may give a false tone to the skin of an infant, obscuring the early tint of jaundice, or possibly obscuring the real pallor of anemia. These considerations are of less importance for the adult, perhaps, but are none-the-less of practical importance.

The function of a physician or nurse to perform certain medical procedures at the bedside is a prime responsibility. The necessity of starting and maintaining intravenous drips, of withdrawing blood samples, of dressing wounds, and so on requires special lighting—not of the room but of the patient. The ability to view and interpret skin lesions and subtle changes in skin tone is handicapped by inadequate illumination and false color. The skin of infants is highly reflective and is singularly affected by the color around it; pediatricians are plagued by the good, but misplaced, intentions of decorators who must tart up the nursery for eye-appeal to visitors, in beguiling pinks and blues, or pervasive yellows. All these may be cheerful and pleasing to the eye but are bound to make it difficult to interpret abnormalities of skin color and texture. The function of the physician and nurse in such a hospital area must come first and charm must yield to practical necessity. This is not to say that a nursery should be starkly antiseptic; and compromise can be made to permit neutral colors, and cheerful, but not strident, contrasts in decor.

Cleanliness in hospitals is expected, but not always realized. Though sloth and indifference on the part of hospital personnel may vanquish the expectation, it is possible to keep a hospital clean with less effort than a home. This state is achieved by good design. Rounded baseboards, for instance, are easier to clean than sharply angled junctions of wall and floor, and a minimum of clutter means less dust. Washable surfaces, free of excessive moulding are easily and quickly cleaned. However, it is no longer necessary to sacrifice variety of wall coverings and floors for efficiency in cleaning. Walls can be both colorful and textured rather than mere blank surfaces, completely smooth, or worse, glazed to be dust free. Wall coverings are offered in many washable types that have texture—or the appearance of it—and that are of durable quality. The range of color and pattern is considerable. In short, it is possible to make patient care areas visually attractive yet easy to clean.

The importance of this is often expressed by the delight of patients to find hospital surroundings "home-like." Of course, this is a misnomer, but the meaning is clear—the surroundings offer the *visual* contrast in color, furnishings, and textures found in a home. Equally

important is the use of light to enhance colors and contrasts. Few homes are brightly lighted from above with unrelieved sameness of illumination in all parts of a room. Light is pooled and accentuates the function of furniture groupings, such as chairs for reading. In the home, light has as much variety as the furnishings.

No one can doubt the beneficial effect of an attractive environment on the sick person. Patients enter hospitals in at least an apprehensive frame of mind. To be thrust into a small, bare, totally functional (for the staff) cell cannot fail to depress any but the most insensitive patient. Those confined to bed should have something of interest to look at, a picture, a mural, a variety of pleasing colors in suitable patterns, and a lighting arrangement that is soft, comfortable, not glaring.

Some ingenuity is needed in selecting a wall covering. A blank, palely tinted wall is, if anything, monotonous, matching the monotony of illness. However, a wallpaper with a maddeningly repetitive design can be even worse. Some years ago the actor, Reginald Gardner, made a successful recording of what, to him, were the "sounds" of wallpaper—demonstrating the potent psychologic effect of pattern.

It is the function of the hospital to be a facility for the care of the sick, for amelioration of disease, and to provide specific tools for the physician and nurse and other concerned professionals to do these things. The technical functions of the staff and of the health care institution—hospital or clinic—need not work against another function, which is to comfort the sick; surely an aspect of treatment that is equally important. I believe it is necessary to consider the environment of the patient as vital to all successful management of his health problems. This means that we should provide institutions that utilize design, light and color, that will not conflict with the proper function of professional staff, requirements of health and safety codes, and day-by-day maintenance of the fabric of the institution, yet will promote the mental and physical comfort of the patient—if by nothing more than their atmosphere. In achieving these desirable ends we should think always of the patient. There is no greater tedium than comes during an illness, so the surroundings should provide some visual distraction, though they should not be disturbing. There is no more excuse for assaulting the patient visually than for handling him roughly. As an example, if the nurse needs brilliant light for her work, the patient does not. Therefore, why not provide two lighting systems in the patient's room?

The seemingly disparate requirements of function and ambience are really not mutually exclusive: it is possible, I am convinced, to accommodate both.

THE RELATIONSHIP OF COLOR PLANNING IN DESIGNING A PEDIATRIC ONCOLOGY UNIT TO THE SYMBOLIC MEANING OF COLORS AS SEEN IN PATIENTS' GRAPHIC PRODUCTIONS

Susan Castelluccio

The National Institutes of Health is the main research organization of the Federal Government. The Institutes are primarily located on a 306-acre reservation which houses 41 buildings including the 14-story 500-bed clinical research hospital center. This paper will deal with the National Cancer Institute, Division of Pediatric Oncology.

The patient population ranges in age from 16 months to 29 years. The adult patients are treated in this unit because their illnesses are being studied in the Pediatric Oncology Division, thus making this environment unlike the standard pediatric environment. There are three main patient care centers to treat individuals suffering from leukemia or solid tumors: 2 East, the 20-bed major hospital treatment unit; 2 B, the 6-bed specialized laminar air flow unit; and the out-patient clinic.

The art therapy program in our pediatric units is not a heavily structured program. Individual art therapy is used extensively and group art therapy is utilized whenever possible depending upon the condition of specific patients. In studies conducted by Susan Bach[1] at the University Neurological Clinic in Zurich, Switzerland, it has been determined that spontaneous drawings may be clinically relevant and psychologically significant, although, when first viewed, some might appear odd or senseless. When reviewing these productions certain characteristics seem to appear repeatedly.

As therapists, it is up to us to review these drawings in their proper context. We note what is indicated in the pictures and we also note what is noticeably absent from these productions. Unusual and repeated subjects are recorded because they tell us what the artist expresses in his picture. Last, but possibly most important of all, is the use or lack of use of color. Color is a definite part of our surrounding world, our existence. Whether it be patients on our oncology service or specific psychiatric groups such as schizophrenia and other affective disorders, color does mean something to these people at some time. I strongly feel that color, not only as expressed in graphic productions but in the total environment, is essential to patient care in hospitals, clinics, and other types of treatment centers.

I would like to discuss the use and choice of color from the patient standpoint. The way we react to or use color is in direct relationship to our experience and environment. A normal child usually uses all of the colors that are available to him and will also choose to mix these colors at certain times. However, an ill child is totally different at a critical moment in his illness. Given the same selection of colors, the ill child seems to choose one color or possibly two or three colors which may be characteristic of his condition. Regarding my work with children who have cancer (specifically 4 to 16 years of age), color is definitely an important aspect of their productions. At all times the patients are offered 24 colors including black and white. In fact, the choice of colors is so marked that on our units, certain crayons, felt-tipped pens, and chalks in our boxes are considerably deteriorated. At this point we have replaced four main colors since January 1976. These colors are red, blue, purple, and black. Physically, it is important to note that these patients have heavily bruised bodies. Red, the most prominent color is a daily part of their existence since they receive daily blood tests and procedures such as blood transfusions are a vital part of their

[1] Susan Bach, "Spontaneous Paintings of Severely Ill Patients," *Acta Psychosomatics*, Documenta Geigy, No. 8, 1969 (J. R. Geigy, S. A. Basle, Switzerland).

treatment. Possibly the colors red, purple, and blue, vein-like colors are reminiscent of the child's sickness. Curiously enough, the green color is used in pictures when the patient is feeling better. Green is usually used to indicate an outside environment. Thus, it tends to appear in pictures when the patient is feeling better and is hoping to be discharged soon. We have also noticed that black is used in many of the drawings of depressed children during difficult times in their treatment or those nearing death. However, frequently if a large black area appears on one of the pictures, it is pushed away, covered with paint or something accidently gets spilled on it as if to deny its frightening symbolism.

One interesting point to be mentioned is that when taking polls of colors to be utilized in the renovation of the main unit, staff, patients, and their families voiced their approval of bright light colors or earth colors. The colors red, blue, and black were completely disregarded. This would indicate a direct relationship between the preference for the colors of the environment and the patients' personal experience. Colors red, purple, blue, and black are connected with pain, fear, and death and are eliminated from the preferred color scheme of the environment. Hopefully, this discussion will give others the opportunity to view color as another aspect of patient care and its importance in designing a comfortable environment for the patient and those involved with patient care.

LIGHTING AND COLOR IN HEALTH CARE FACILITIES FROM A DESIGNER'S VIEWPOINT

Alexander F. Styne

Only during the last few years have some people questioned the traditional concept of color selection based on their own experience or on school indoctrination, and searched for methods that would lead to a more rational approach, by exploring the reaction of the user of objects or the inhabitants of spaces.

Upon her question on how she could make her students aware of the social significance of interior design, Mr. John Capitman, a social researcher, suggested to Mrs. Penny of Bauder College in Miami, to let the students find out what colors the patients and staff in the psychiatric ward of the V.A. Hospital would like for their day room. He suggested the methodology for the study and results have been recorded. After the selected colors and materials are installed, a follow-up study will be undertaken. It might be interesting to note that there was a significant preference for light, pale, and warm colors, for medium-sized, quiet patterns and for textures with strong tactile appeal. Large and involved patterns and highly saturated colors were rejected.

Unanswered questions abound and the research that has been conducted seems still quite limited. It is important to note that some testing methods have become established and that results can be presented in an objective way. Current results will be linked to further work and to bring deeper understanding for the application of color not only in health care facilities, but in other places where it counts.

I find the selection of lighting and surface colors for health care facilities of significance, because I am convinced that environmental factors have their greatest impact on people under stress.

Although it has been known for a long time that light—as part of radiant energy—acts upon biological functions, it is only in recent years that research uncovered the causes and mechanisms by recognizing those wavelength groups that produce specific reactions [1]. We are not far from the time when psychological responses can be traced to such physiological reactions, when surface colors will be recognized for what they are: PARTIAL ABSORBERS AND PARTIAL REFLECTORS OF ANY IRRADIATION WHOSE COMPOSITION CAN BE MEASURED.

We are not far from the time when the use of colors can be solidly based on physical and physiological facts. Waiting for such research, designers and architects must still rely on what they know empirically of the influences of colors on the behavior of people. While research has confirmed some of this traditional knowledge by measurement of biological responses through polygraphs, EKG and EEG, it could well be that further studies may refute some of our notions and find others acceptable.

We do not know whether reactions change with exposure time. Would, for example, semantic responses to light and color conditions, recorded after a few minutes of adaptation time, be identical to those obtained after several hours or days of confinement? It is easy enough to see the difficulties an investigator must face to obtain such answers. Should a patient, brought to his hospital room, be asked to record his reactions to the lighting and colors that he finds there? Even if such an interview can take place in rare instances, would his responses be valid in the same way as an interview after his recuperation from sickness or surgery?

What do designers do when faced with the selection of colors for patient facilities, operating rooms, or nurses' lounges? So far they can rely only on personal experience, the apparent success or failure of past work in similar facilities, or perhaps on interview studies such as I have related.

Their judgment depends on experience, the keenness of their observation and the sensitivity to environmental conditions. They may accept or reject suggestions or demands from the Medical Board or project manager. In the not too distant future, results from Professor Flynn's [2] research will provide guidance on a more rational basis.

I am convinced that the use of full spectrum light sources with trace amounts of near-ultraviolet radiation and a good color rendition quality is of benefit to any type of population required to be indoors for any length of time. Good color rendition unquestionably assists in the visual recognition of skin color changes, which are observed by nurses and doctors as a signal that indicates change in a patient's condition.

In 1965 the British Medical Research Council proposed the use of a standardized illuminant of good color rendering quality for all health care facilities in the United Kingdom [3].

In 1966 the Department of Health and Social Security endorsed this proposal, recommending *Philips Trucolour 37* as a suitable source [4]. Based on subsequent studies they recommended *Thorn Kilor-rite* as even more appropriate for clinical purposes in 1970. In March 1976 a notice titled "Health Service Management—Good Colour Rendering—Fluorescent Lighting in Health Buildings" [5] confirmed the importance of good color rendition in health care buildings even with lowered efficacy, and a subsequent specification [6] details testing procedures and required results.

Department stores have insisted for years to have cool white fluorescent light in men's wear departments. It appears that men, accustomed to working under this light, feel "safe" when selecting wardrobe colors. Doctors and nurses could find similar assurance in their judgments if lighting conditions would be identical in all hospitals.

All this is mentioned in passing. I really want to tell you what designers are frequently facing when asked to design lighting and color in practically any project. Architects and clients traditionally retain lighting consultants and interior designers as late as possible, often after working drawings and contract documents are completed and even after construction is well underway. It is impossible for the electrical engineer to pin down lighting loads, and wiring layouts for specific areas until the lighting design is established. It is impossible for the lighting designer to determine required task and general illumination unless he knows the purpose of a space, the layout of work stations, machinery, instruments, and so on. To make a reasonably accurate lighting calculation he needs to know reflectance values of finishing materials; THIS MEANS COLORS AND TEXTURES.

If the function of the interior designer is to plan the spaces and not just to purvey some equipment, and if the lighting designer's function is not relegated to that of a fixture specifier, they should be called into a project at the concept stage.

A last point may deserve consideration: The best lighting design and color scheme must be properly maintained to serve the building function. A maintenance manual that explains in detail how to relamp and how to repaint should be required from the designer as part of his service. Some offices make this a practice, but not all. Keeping the roof from leaking and the floors polished is not enough; keeping the visual condition as it was designed and paid for, is as important for the health and the functioning of staff and patients.

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