# THE EFFECTS OF LIGHTING CHARACTERISTICS ON THE BEHAVIOR OF ELDERLY RESIDENTS IN AN INTERMEDIATE CARE FACILITY

by

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# CHAPTER 1

## INTRODUCTION
## Statement of the Problem and Theoretical Background

Past research has shown that light can affect the mobility, (Koncelik, Ostrander, & Snyder, 1972), visual perception (Pastalan, 1975), and the perception of well-being (Flynn, Spencer, Martyniuk & Hendrick, 1973) of older adults. However, no data exists which compared actual light levels to the behavior of older adults in long term care facilities. This research has studied and reported the implied relationships between three lighting characteristics and selected behavioral attributes of older adults in the public areas within one intermediate care facility.

The lighting characteristics which were shown as graphic lighting profiles and selected for their dramatic effect on the aging eye, were: quantity of light (amount of light), balance of light (distribution of light), and discomfort glare (reflected light). The behavioral attributes of the residents were categorized into two major headings: activity participation and mobility and were recorded as behavioral maps (Ittelson, Rivilin & Proshansky, 1970). Activity participation included many of the activities that could be unobtrusively observed in the public areas of an intermediate care facility, that is, talking, watching, moving, sleeping, and eye-hand tasks. The implied relationship that illumination played on resident mobility was studied while residents moved through a corridor which contained dramatic imbalances of illumination.

The research outlined in this thesis focused on the central question: Can a relationship be found between the selected lighting characteristics and the behavioral attributes of older adults in an intermediate care

facility? In establishing whether or not such a relationship could be assumed, the following specific research objectives were developed:

1. to describe the general lighting characteristics of an intermediate care facility.

2. To construct lighting profiles for individual public areas, in terms of quantity of light, balance of light, and discomfort glare.

3. To construct resident behavioral maps of activity participation and mobility profiles.

4. To determine possible relationships between resident behavior and lighting characteristics.

5. To form hypotheses from observations and field notes about elderly behavior and illumination for further research.

6. To propose design conclusions based on the observational interpretations.

The theoretical framework for this research was based on Lewin's (1951) dictum, $B=f(P,E)$, that is, behavior is a function of both the person and the environment. Lawton (1968) expanded Lewin's ecological equation into the docility hypothesis: as the organism ages, it becomes more susceptible to environmental demands. Later, this hypothesis was expanded conceptually by Lawton and Nahemow (1973) into an ecological model which was the theoretical context for this research (see Figure 1).

This model indicates that adaptive and maladaptive behavior may result from combinations of individual competence (defined as the theoretical upper limit of capacity of the individual to function in the areas of biological health, sensation/perception, motoric behavior, and cognition) and the environment (perceived and objective environment) as press.

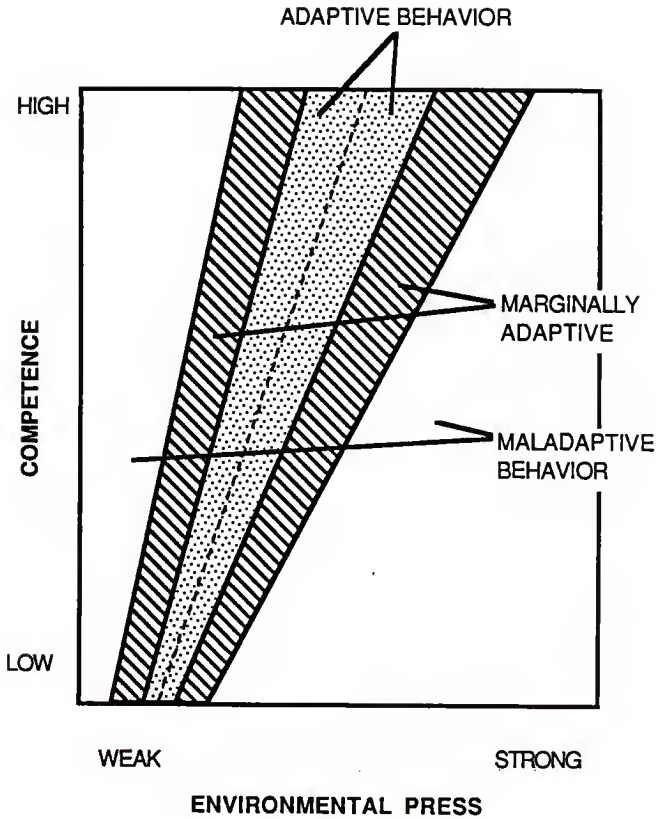



Figure 1. The Ecological Model of Environmental Press (after Lawton & Nahemow, 1973).

Lawton and Nahemow reviewed this ecological model as a relationship between competencies (ordinate of Figure 1), and the demand potential, or environmental press, of the social and physical environment (abscissa). The funnel shaped zone of adaptation represents the point where environmental press may be either positive, neutral or negative, indicating that adaptive behavior may result from varying combinations of individual competence and environmental press (Lawton, 1980).

The research contained in this thesis did not test Lawton and Nahemow's model *per se*; judgements were neither made regarding the adaptive or maladaptive status of resident behavior, nor made regarding social capacities, task performance, or psychological well-being of residents. Rather, Lawton and Nahemow's model was used to first establish the premise in this thesis that behavior is an adaptive outcome of personal competence and environmental demand, and second, to serve as a frame of reference for the generation of hypotheses and conclusions of this study.

## Literature Review

The literature review for this thesis was given in two parts: first, documentation of physiological changes which occurred as the eye ages, and second, relationships between light, the aging eye, and behavior. There was little precedent for the study of the relationship between older adult behavior and lighting characteristics. However, ophthalmologists began documenting the visual changes due to the aging in the 1950s. Once these age related changes were documented, researchers dealing with lighting and older adult populations became aware of the medical information. These researchers found that normal vision capacity can diminish dramatically

with age and that these reductions may lead to: loss of visual field and acuity, decreased color sensitivity, reduced depth perception, delayed pupil dilation in response to rapid shifts in light levels, decreased ability to discriminate detail, and increased sensitivity to glare (cf. Birren, 1964; Comalli, 1967; Corso, 1971; Holladay, 1926; Keller, 1971, & Pastalan, Mautz, & Merrill, 1973).

Physiological Changes of the Aging Eye

The primary light controlling structures of the eye are the iris (which controls the pupil), lens and vitreous. Through this system, light is passed to the retina where it is transformed into light energy and communicated to the brain. Several studies document physiological changes which occur to the eye during normal aging processes.

The reaction time of the dilation of the pupil, in response to changes in light levels, begins to slow as the eye ages (Corso, 1971). The pupil also becomes gradually smaller until it remains almost the same size under all conditions. Comparisons of pupil openings of a 20-year-old and an 80-year-old indicate a decrease in ratio of almost 10 to 1 (Keller, 1971). This aging trait may require higher levels of illumination.

The lens continues to grow in size, becoming one-third larger at the age 65 than it was at 25 years of age (Weale, 1965). Because the rest of the eyeball remains the same size, the increased lens size adds to intraocular pressure (Kornzweig, 1954) and the possibility of glaucoma. The nucleus of the lens also becomes mildly distorted as the eye ages. Color distortion is due to yellowing of the lens (Corso, 1971) which in turn reduces the ability to make fine color judgements (Gilbert, 1957). As a result, the older eye is

much more comfortable performing under yellowish (incandescent) lights than under bluish (fluorescent) lights (Keller, 1971).

Vitreous, a jelly-like substance which fills the body of the eye, thickens with age (Weale, 1965). More illumination is needed to penetrate through it and maintain sufficient light energy to reach the retina, thus only about one third of the visual information is received by an aging eye in comparison to a 20-year-old eye (Weale, 1965). The efficiency of the eye, then, is complicated by age. As the pupil becomes sluggish, smaller, and more opaque, higher illumination levels are required, but opacity also increases the sensitivity to glare (Wolf, 1960).

Wearing specifically prepared lenses, Pastalan and his co-workers (1975) found normal age-related visual losses resulting in faded colors, indistinguishable spatial boundaries, debilitating glare, lack of depth perception, difficulty with light-dark adaptation and contrast, and the inability to discriminate fine detail.

Lighting and Behavior

Previous research has identified important relationships between the concepts of lighting and behavior. One such study was an empirical comparison study, Visual Disability and Home Lighting (Cullinan, Gould, Silver, & Irvine, 1971) on the visual acuity of 53 elderly patients of the Low Vision and Refraction Clinic at Moorefield's Eye Hospital in England. Patients were given visual tests under three conditions: clinical lighting in a hospital, at home under normal conditions, and at home with augmented lighting (a 60 watt lamp). Illumination levels were measured for distance vision at 3 meters and for standard reading distances in both locations. The

median home lighting values were 1/10 of that in the clinic. When home light levels were increased tenfold the visual performance of patients improved by 82%. The study concluded that vision improvement was due to increases in illumination, was unrelated to eye disease, and that older adults are often disabled by poor lighting, and not by a functional disorder.

Environmental analyses of six nursing homes conducted by Koncelik et al. (1972) summarized that institutionalized elderly required increased illumination to perform daily tasks successfully. They reported that the elderly experienced watering of the eyes (due to increased glare sensitivity); experienced reduced visual acuity; noted less difference between the colors of blue and green; and were generally less comfortable under fluorescent lights than younger people. Following Corso (1971), their report suggested that accidents would occur in dark areas directly outside brightly illuminated rooms or lounges due to the delayed light-dark adaptation of the aging eye. Older adults were also observed to alter their walking patterns when they approached the borders of light and shadow. Unfortunately this interdisciplinary study, while supplying valuable information on elderly behavior and problems associated with increased quantity of light resulting from imbalance and glare, did not measure or report illumination levels.

In a report, Falls among the Elderly, Waller (1978) listed lighting as an environmental component involved in falls of institutionalized persons age 60 and older with prosthetic devices. Although 100% of the elderly using prosthetic devices were reported to have suffered from acute impairment such as mobility and vision, no analyses were made of relationships between lighting, vision, and falls of older adults.

In another report, Prevention of Falls in the Elderly, Overstall (1980) discussed physiologic changes, pathologic changes, psychologic factors, and external hazards for older adults but his comment regarding lighting simply stated: "Hospitals and residential homes should be free of clutter and well lit."

Snyder (1978) speculated that reducing glare in a nursing home multi-purpose room may help to increase the attention span and reduce wandering of residents. Snyder stated, "Any efforts made to maximize vision (for older adults) should sharpen memory, reduce accidents, perpetuate independence, facilitate communication, and benefit mobility."

The most informative observations on lighting for older adults in institutional facilities came from Cornell University's Gerontology Project #103 report, (Koncelik, et al. [1972]), which stated:

> Although we did not take specific photometric measurements on hallway lighting, we did observe great variation in illumination level. We also found that hallway lighting is greatly affected by the daylighting available resulting from the placement of bedroom windows. Although adding to corridor brightness, this daylight source sometimes created pools of glaring light on uncarpeted floors. In two facilities, hallway lights were off during the day. The lighting in the dark, shadowy halls was in marked contrast to many of the sunny lounges and bedrooms. At this point, one can only speculate of the exact effect of such differences in light on aged residents ability to see. The fact that dark adaptation requires longer for older persons than for younger persons (Corso, 1971) suggests

> that accidents in the darkened hallways might predictably occur outside of brightly illuminated rooms or lounges. Higher levels of illumination appeared more necessary in facilities with carpeted hallways and darkly colored or textured wall coverings. (p. 4-14)

In summary, previous research was identified regarding important interactions between the concepts of illumination and behavior however, no research was found that operationally defined the lighting characteristics of quantity of light, balance of light and discomfort glare and studied and interpreted the impact on the behavioral attributes of older adult residents in an intermediate care facility.

## Rationale

Lawton and Nahemow (1973) have shown that well-being is the function of adaptive behavior and arises from the interaction between competence and environmental press. The illumination of an intermediate care facility was considered a major component of the facility environment and therefore was directly related to the residents. The outcome of this interaction between the environment and the resident resulted in observable behaviors as well as predictable psychological well-being. This meant that behavior implied the presence of competence therefore, as age related impairments curtailed freedom, flexibility, and overall quality of life, these dysfunctions progressed until the lowered competency required institutionalization in either medical or non-medical care settings.

These settings were designed to provide weaker environmental press with appropriate and desirable behaviors for residents who used the

facility. There were certain anticipated behaviors that residents should engage in as a means of achieving the goals for which the facility was built. If the lighting characteristics of the facility discouraged essential behaviors, then there exists, to some degree, a facility which was non-functional.

In addition, an environmental description which discussed the behavior which occurred provided a better understanding of the resident and professional staff use of an intermediate care facility. The illumination profiles and behavioral maps focused attention on aspects of design related to human function. In doing so, a better knowledge base for architects, designers, and engineers would be provided to construct more supportive settings for older adults.

The findings of this study have led to more sound development suggestions of illumination and other regulatory codes and standards. The illumination for the environments of older adults in health care facilities continues to be controlled by codes. These codes were supplied by the Kansas Department of Health and Environment in the booklet, Regulations for the Licensure and Operation of Adult Care Homes (1987). In addition, KAR codes were inconsistent with the IES (The Illuminating Engineering Society of North America) illumination guidelines for illuminating older adult facilities, and both were vague regarding specific recommendations for elderly. For example, KAR codes stated the artificial light requirements for a nursing home dining room were, "25 footcandles should fall at table level" (p. 94). (A footcandle is a unit of illumination, one lumen is one footcandle (IES, 1981.) However, the illuminance selection table of the 1987 IES Lighting Handbook suggested an increase of 50% to 100% above

normal task levels for older adults but gave no specific light level recommendations for elderly or institutional illumination (see Table 1, Appendix). This was not a criticism of codes but rather a recognition for needed information. This research generated the development of recommendations for more specific codes and guidelines which enable the elderly to achieve a greater measure of independence, security, control, and decision making.

# CHAPTER 2

## METHODS AND PROCEDURES
## Setting and Population Selection

Intermediate Care Facility

Facilities designed for the specific care for older adults are usually characterized by their continuum of care. An intermediate care facility provides supervised nursing care for aging residents who were neither acutely ill nor in need of hospital care or skilled 24-hour nursing care. In an intermediate care facility, the services provided were a reception area for guests, accommodations, meals and supervised nursing care with treatment provided by a licensed nurse during a minimum of 8-hours a day, 5 days a week, plus additional support staff.

In Manhattan, Kansas and the surrounding area, five nursing home facilities were visited and the Administrators were interviewed regarding the potential for inclusion in this research. Each Administrator expressed an eagerness for their facility to be selected which in itself demonstrates a desire by Administrators for more knowledge about illumination, resident behavior and their facilities. The final facility selection for this study was based on several pre-determined physical criteria: 1) the facility contained a variety of natural and artificial illumination; 2) the facility employed a variety of window treatments; 3) windows faced all four compass directions; 4) all furniture styles and types were the same in all public areas (eliminating resident room selection because of preference of furniture comfort); and 5) during inspection and interviews, all public area appeared to function as designed.

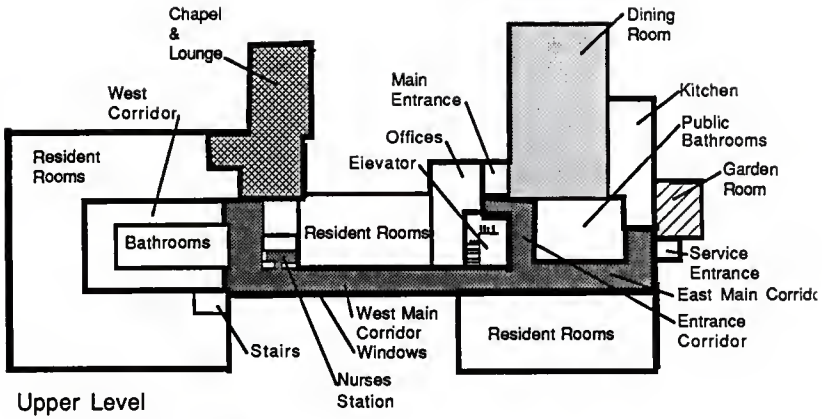
An intermediate care facility which met the five criteria was

in Manhattan, Kansas and included 60 beds in semi-private and private resident's rooms. The facility typically included central bath rooms, activity areas, a group dining area, a kitchen and serving pantry, nursing stations, circulation spaces (corridors), care service areas, plus office and administrative support areas.

The facility was a split-level design with the public and service entry at ground level and the main corridor spine providing a second story southerly view of a park. Figure 2 shows the public areas selected for this research and their relationship to the facility in general. These areas were: (upper level) Chapel & Lounge, Garden Room, Dining Room, Corridor, (lower level) Activity Room and Lower Lounge. Figures 3 through 8 present the individual area floor plans showing the placement of furniture and light fixtures.

Population Sample

This continuum of adult care home was selected because the broadest sample range of institutionalized elderly resided here: residents discharged from a hospital who were terminally ill, residents recovering from surgery or a fracture, or medically stable but functionally impaired older adults who usually were admitted from their homes. This facility housed 56 male and female residents who ranged in age from 57 to 102-years-old. It included 18 ambulatory residents (older adults who walked independently or with help of a walker or cane), 16 self-propelled residents (elderly who moved their own wheelchairs), and 22 assist-propelled residents (those who required assistance from others). Staff assistance in eating was needed by 16 of the 56 residents.



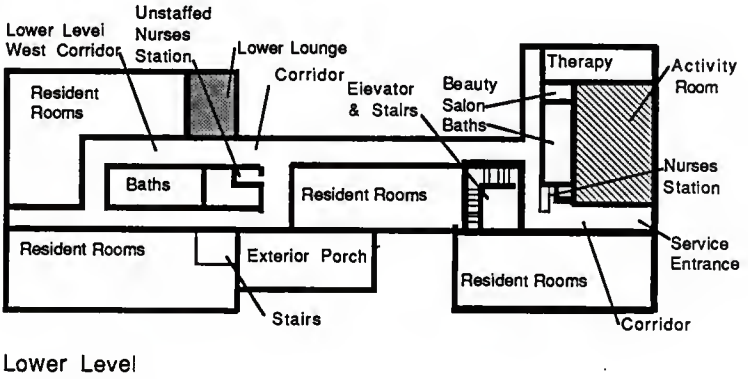




Figure 2. Floor Plans of the Intermediate Care Facility. (The public areas used in this study were noted on this plan with patterned backgrounds and included: [Upper Level] Chapel & Lounge, Garden Room, Dining Room, Corridor, [Lower Level] Activity Room and Garden Room. Scale: 1' = 20' 0" North Δ).

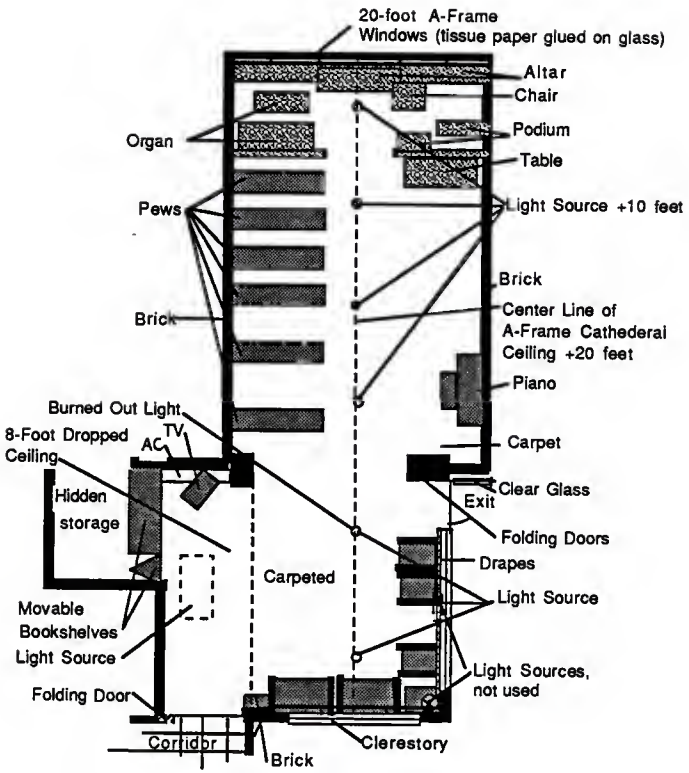



Figure 3. The Chapel & Lounge Plan. (Scale: 1/8"= 1' 0" North Δ).

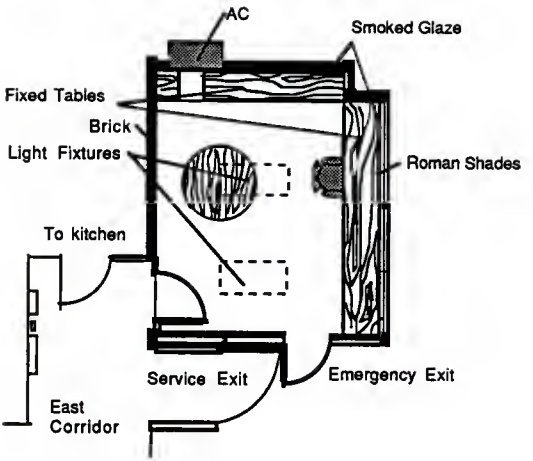



Figure 4. The Garden Room Plan. (Scale: 1/8 = 1' 0" North △).

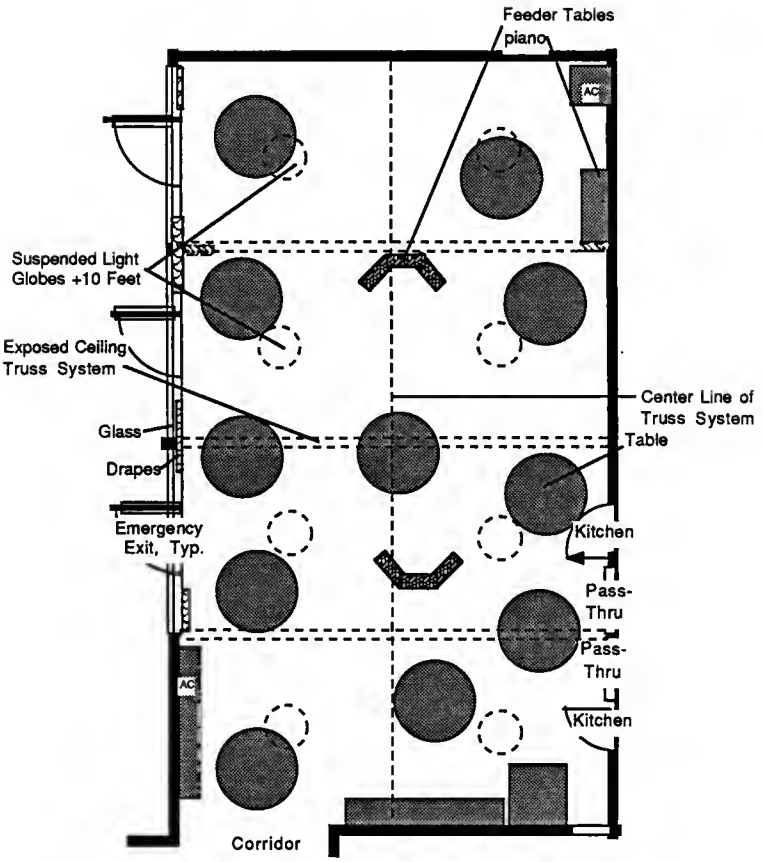



Figure 5. The Dining Room Plan. (Scale: 1/8 = 1' 0" North △).

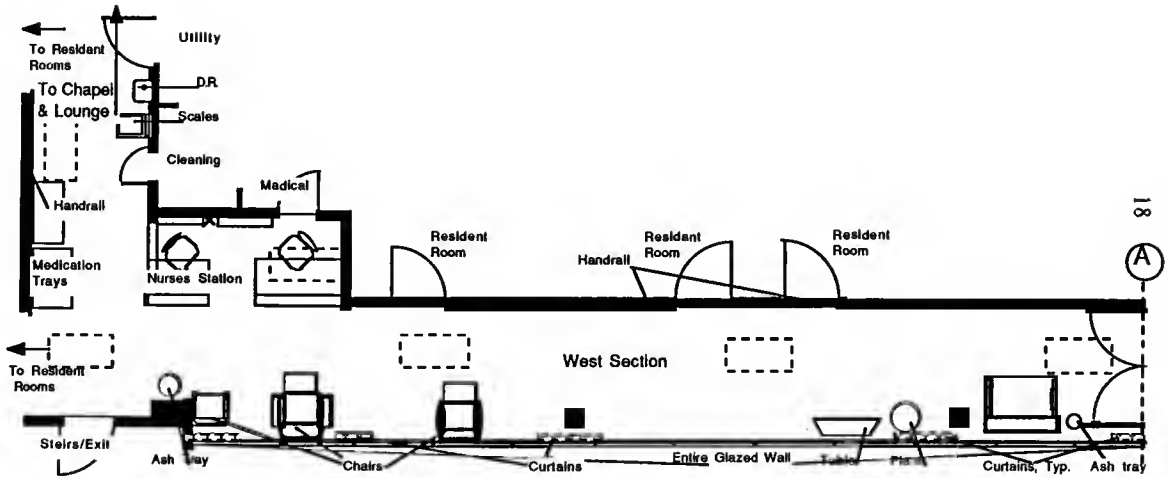



Figure 6. The Main Corridor Plan (Shown was the west section. Scale: 1/8" = 1' 0" North △).

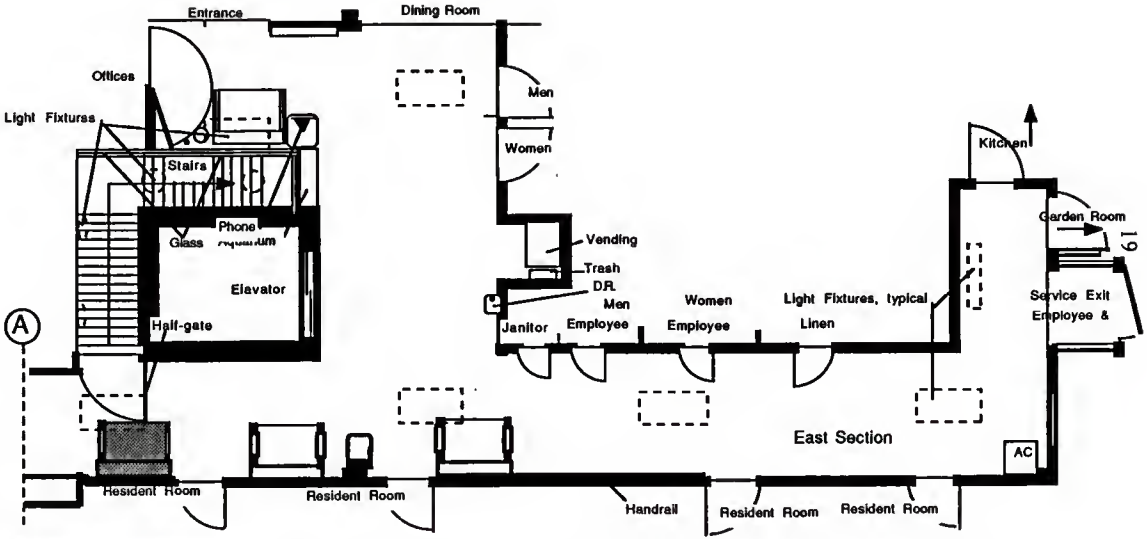



Figure 6, Continued. The Main Corridor Plan (Shown was the east section. Scale: 1/8" = 1' 0" North Δ).

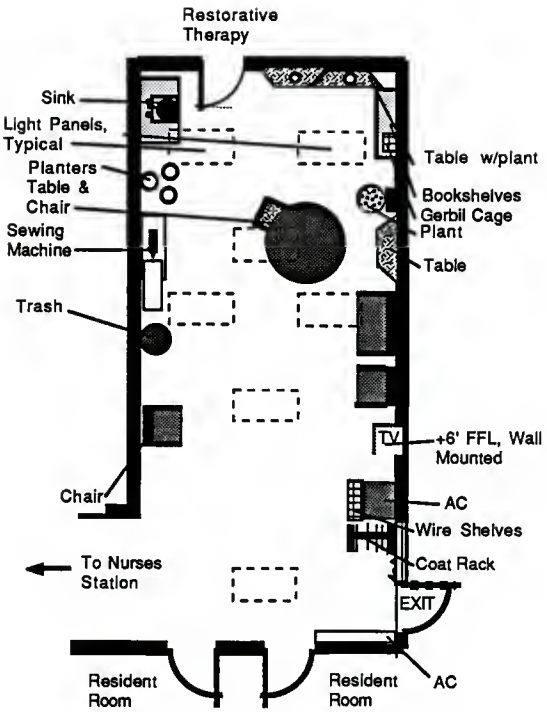



Figure 7. The Activity Room Plan. (Scale: 1/8" = 1' 0" North Δ).

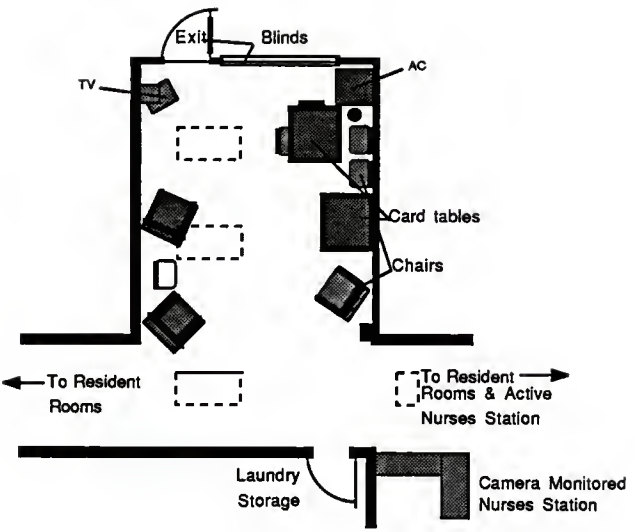



Figure 8. The Lower Lounge Plan. (Scale: 1/8" = 1' 0" North Δ).

## Operational Definitions

The independent variables for this research were the three lighting characteristics: quantity of light, balance of light, and discomfort glare. The dependent variables in this research thought to be affected by light were the behavioral attributes of activity participation and mobility.

### Lighting Characteristics

The IES Lighting Handbook (1981) served as a reference for the operational definitions and also recommendations for the categorization of the eleven lux levels used in this research (see Table 1, Appendix). To further understand the operational definitions, each public area was drawn and divided into 2 foot grids to serve as individual boundaries for defining all three lighting characteristics. For example, the definition of quantity of light was applied to every 2 foot grid to provide a complete quantity of light profile for the area.

Quantity of light was defined as the amount of illuminance (lux) recorded at 4 feet from the floor (4' FFL) and was assigned one of eleven lux level categories.

Balance of light was defined as the non-sequential shift in lux level categories of adjacent grids. This was determined by the recorded lux distribution which fell on the floor (0' FFL) and the classification of this measurement into lux levels. In reviewing the total area profile, if any grid adjacent to the 2-foot grid was non-sequential in lux level (skipped one or more lux levels either higher or lower) then both grids would be noted as areas in which imbalance of light was present.

Discomfort glare, measured by nits (a metric unit of luminance), was

calculated as follows:

Nits = lux (illuminance) X 3.14 X the percentage of reflected light (reflectance).

Bennett (1972) discovered that 850 nits or less can cause discomfort glare in adults age 65. A nit is the internationally accepted unit of luminance equal to 1 candela per square meter and a candela per square meter is the international standard unit of luminance. (The spot meter used to measure this research was calibrated metrically.) As older adults age, their tolerance of higher nit levels decreases; thus, an 850 nit level will produce discomfort glare in an older adult age 65 but will not at age 60.

Reflectance was defined as a quality of the surface and a percentage of the reflected luminance to the incident illumination (lux). Reflectance, then, was not dependent on light level. This meant that where a surface material was continuous, glare would vary only as a function of the light level For example, a floor surface is continuous and yields only one reflectance; however, direct sunlight and the resulting high levels of illumination may have produced glare in one area but were not present in another portion of the same surface.

Behavior

Activity Participation included observable resident activities such as talking (defined as audible communication, whether with others or with oneself), watching (viewing other activities or movements), sleeping

(judged to occur when a subject rested with eyes closed for a period exceeding two minutes), moving, and eye-hand tasks. Moving was defined as: 1) body movement that was undirected toward another activity (for example, sitting in geriatric chairs and spontaneously moving limbs), or 2) ambulatory movement from place to place. Eye-hand tasks included activities such as eating, sewing, reading, and playing bingo.

Resident mobility was divided into three subsets: mobility status of residents (ambulatory, self-propelled, and assist-propelled which were defined earlier), body flow movements (changes in continuity of body movement) and speed of movement (elapsed time of residents moving through a designated space).

A factor that was also recorded concurrently with both activity participation and mobility was gesturing; that is, obvious motions of the body or changing of the environment while displaying activity participation. For example, residents could talk with each other while shielding eyes with a paper or they might remove their glasses and rub their eyes while looking out a sunny window. There are six gesturing categories: 1) physical touching of the eyes/face (wiping away tears, squinting and/or rubbing of the eyes); 2) shielding of the face (by hiding the face with a hand and/or other objects or closing the eyes in an obvious manner); 3) optical adjustment,an adjustment or change of eyeglasses; 4) body position adjustment (either into or out of the light source or grasping walls or handrails); 5) environmental change of furniture, or illumination; and 6) unacceptable behavior (screaming, undressing, hitting, crying or other behavior unacceptable for public areas).

## Instrument Development

Mobility observation sheets were designed for use in recording the resident mobility information when residents traversed a corridor which included two differently illuminated sections (see Appendix A, Figure 1). The instrument was designed to record time, resident mobility status, changes in body flow, and gestures of residents. The corridor was marked at 10-foot intervals so residents could be timed.

Floor plans showing furniture and light fixture placement for each area were drawn and divided into 2-foot grids for the recording of light levels and resident behavior locations.

The selection of a location for resident mobility initially began with an attempt to time residents while walking through a room but due to crowding, residents stopping to visit with other residents, and an inability to judge the random and sporadic distances traveled by residents, a 20 foot corridor section was selected. This corridor section was selected because it contained extreme light level changes, provided unobtrusive observation of residents, and it was a central location in the facility which provided equal use of the area and random selection for observation. The first 10 foot corridor section contained lux levels which began at 980 lux and quickly dropped to 30 lux. The beginning of the second section measured 30 lux and increased to 690 lux (see Figure 9).

## Data Collection

Two types of data were collected only on full-sun days in the Summer of 1987: the lighting characteristics and the behavioral attributes of the

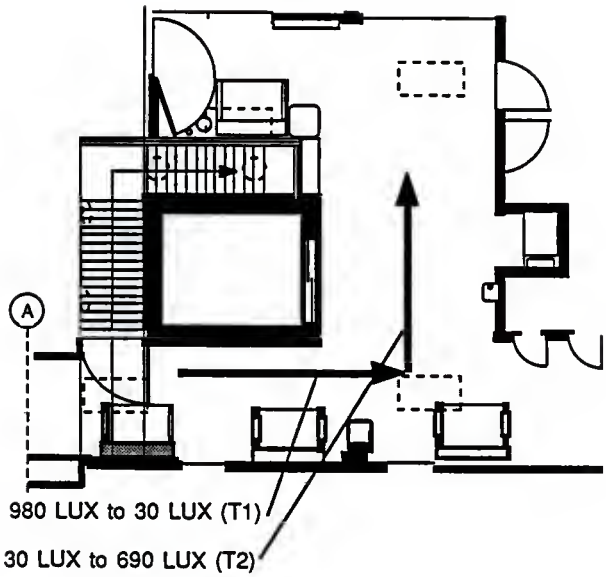



Figure 9. Corridor Plan Showing the Location of Resident Mobility Observation. (Scale: 1/4"=1' 0" North Δ).

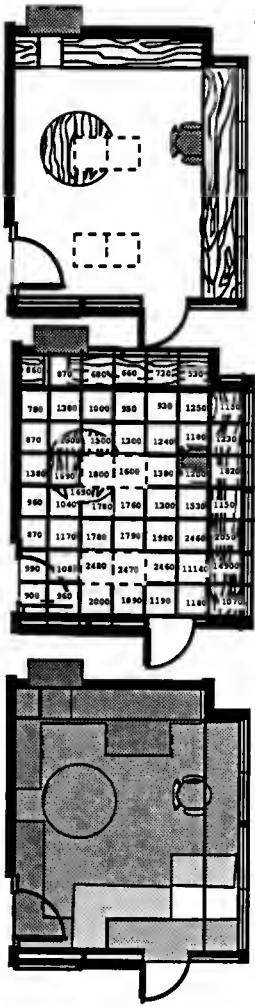
residents. All data were collected during five different times of day to assure a random sample of resident behaviors in public areas: 6:30-7:30 a.m., 9:00-10:00 a.m., 11:30-12:30 p.m., 2:00-3:00 p.m., and 5:30-6:30 p.m. The behaviors were recorded in two 10-minute sessions during three non-consecutive days to provide a variety of resident observations for the public areas.

Data collection of Light Characteristics

Recording and collecting data for light characteristics involved two stages: First, the light levels at 4' FFL (quantity of light) and at 0' FFL (balance of light) were measured and recorded in two-foot grids using a Topcon II digital light meter. Illumination contours were then drawn. These contours were based on the IES Handbook (1981) which utilized the following eleven lux contour levels for all possible activities: up to10 lux, 11-20 lux, 21-50 lux, 51-100 lux, 101-200 lux, 201-500 lux, 501-1,000 lux, 1,001-2,000 lux, 2,001-5,000 lux, 5,001-10,000 lux and over 10,001 lux. The specific lux levels are explained in more detail in Table 1 in the Appendix. Second, a digital photo research spot meter, model UBD 1/20 was used to measure surface reflectance at 4' FFL and discomfort glare was calculated. A position of 4' FFL was selected because it paralled the same measurement heights as quantity of light. A representative example of the lighting data collection procedures was shown in Figure 10.

Data Collection of Behavioral Attributes

The behavioral attributes of activity participation were recorded and matched on the grid plans of each room. These behavioral maps located and

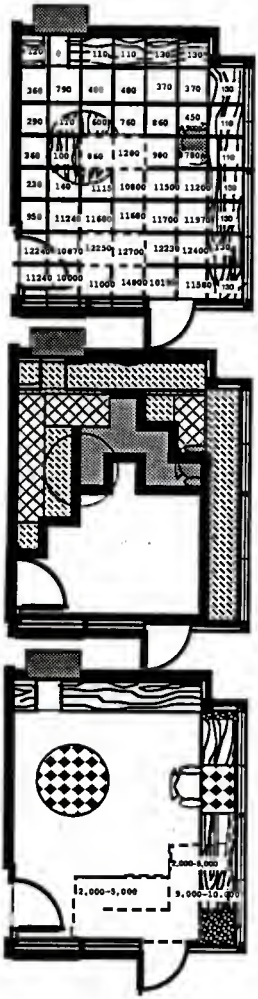


1. The garden room floor plan with furiture and light fixture placement was drawn (Scale: 1/8" = 1' 0").

2. Illumination measurements were recorded in lux on a 2' x 2' grid map. This map shows 4' FFL lux readings.

3. An illumination Contour map was prepared which categorized the lux into one of eleven levels and a graphic shading scale was designated to represent each level.

Figure 10. A Representative Example of the Data Collection and Transformation Procedure for the Garden Room During 6:30 a.m. to 7:30 a.m. (Scale: 1/8" = 1' 0" North Δ).

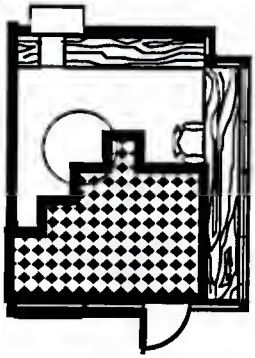


4. A grid map was also used to record illumination readings at 0' FFL and was used to determine balance of light and discomfort glare.

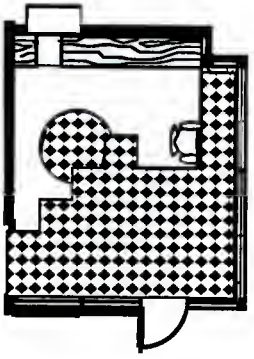
5. This contour map shows the balance of light at 0' FFL. The point of imbalance was noted when the lux level changed from a sequential lux level to non-sequential lux levels. This shift indicated imbalance of light was shown as a dark line on the plan.

6. The reflectance of surfaces was measured in nits and discomfort glare calculated. Shown here is discomfort glare (checker-board pattern) using the 4' FFL contour map.

Figure 10, Continued. A Representative Example of the Data Collection and Transformation Procedure for the Garden Room During 6:30 a.m. to 7:30 a.m. (Scale 1/8" = 1' 0" North Δ).



7. Shown here were the discomfort glare (checkerboard pattern) which used only the 0' FFL grid maps. Nit readings were measured at 4' FFL thus the two contour maps could be combined for a total profile of discomfort glare. (However, for clarity, both 4' FFL and 0' FFL were shown separately here).



8. Both discomfort glare maps have been combined to provide a total profile of the existing discomfort glare for the Garden Room.

Figure 10 Continued. A Representative Example of the Data Collection and Transformation Procedure for the Garden Room During 6:30 a.m. to 7:30 a.m. (Scale: 1/8" = 1' 0" North Δ).

identified each resident observation by mobility status and activity/gesture (see Figure 11). In addition, field notes on observations were explained in the descriptive section of this paper.

Data Collection of Mobility

Data gathering for mobility included the timing (by stop watch) of residents traversing a 20-foot portion of the corridor which had been divided into two 10-foot connected sections (labeled as T 1 and T 2) and the completion of the mobility observation sheet (see Appendix). Each resident was classified according to a mobility status of ambulatory, self-propelled, or assist-propelled. Body flow movement while going through each section was noted as 1: reduction in movement, 3: no change in movement, or 5: increase in movement. In addition, speed of movement was recorded in seconds using a stop watch and the presence or absence of physical gesturing were noted (see Behavioral Attributes). Observations were taken from 2:00 p.m. to 3:00 p.m. when all residents had the opportunity to use the corridor and congestion was low so as not to affect the factors of body flow and speed.

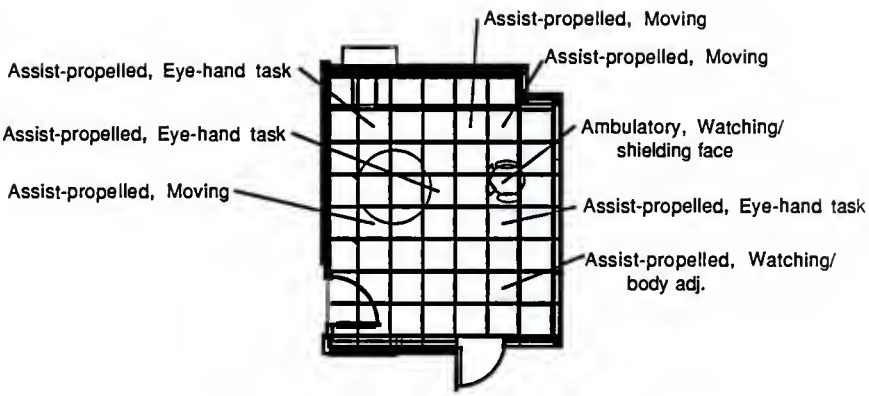



Figure 11. A Representation of Behavioral Mapping of Resident Activity. (Shown were the Garden Room activities during 6:30-7:30 a.m. which described each resident location, classified the mobility status, and listed the resident behavior/gesture. Scale: 1/8"= 1' 0"" North Δ).

# CHAPTER 3
# DESCRIPTION

An important objective in this research was to observe and graphically describe the profiles of quantity of light, balance of light, and discomfort glare in an intermediate care facility. In addition, the behavioral mapping of the resident behavior with field notes provided a rich descriptive base for environment/behavior interpretations. The rationale for this study was based on the man-environment relationship, and the descriptions supported Lawton and Nahemow's theory (1973) which stated that behavior implies the presence of competence; therefore, when the environment (lighting characteristics of an intermediate care facility) failed to meet resident needs, behaviors which implied an attemp to cope by residents were observed.

A general description of the facility and lighting profile preceded the discussion of each public area which included: 1) a description of the physical setting, including the location, function of the area, furnishings and general description of the area, and usage times; 2) a lighting description including type of fixtures and locations, the role that natural and artificial illumination plays on the area with selected lighting profiles being shown on quantity and balance of light, and a discussion of surface reflectances and calculated discomfort glare profiles; and 3) notes and behavioral maps representing one day's observations for each area, and the mobility behaviors of residents described for the corridor.

The lighting profiles were added to the descriptions in the text if they contributed to the understanding of the lighting characteristics, were dramatic in comparison, or supported the discussion. A Shading Key was

shown on the lighting characteristic profiles of quantity and balance of light and included the eleven lux category levels, ranges of lux for each level, and shadings analogous to lux levels (see Table 1, Appendix for more information). Levels 4 through 6 were considered normal ranges by the IES. The behavioral maps shown in this research represented one day's activities and the criteria for their selection was by the highest number of observations per observational hour. All behavioral observations were tabulated and located in the Appendix by mobility status, light quantity, light imbalance, discomfort glare, and were indexed by row-letter column-number to keyed floor plans.

## General Description

### The Facility

The facility, located in Manhattan, Kansas (population 30,000) was situated on a busy major feeder street on the north side of the town with the site bounded by a busy street to the north, car parking and a minor street on the east, and an open parkland to the south and west. The building consisted of two levels and its scale and character were determined by the Chapel which formed a major component of the structure. The building had a brick facade and pitched roofs. A 30-foot long x 15-foot wide canvas awning hung over the approach to the main entrance. This awning covered all the west windows and doors of the Dining Room. The western area adjacent to the entry was surfaced with white gravel which reflected sunlight toward the Dining Room and Chapel & Lounge windows. The northeast corner of the site consisted of a parking lot covered with asphalt. The facility was surrounded by a sidewalk beyond which there was

undulating grassland. Both the facility and the site were owned and administered by the county.

The main entrance was on the north side of the upper level and the major public spaces were also on this level. The residents' rooms on the upper level housed ambulatory or self propelled older adults. Access to the lower level was via one elevator and two staircases.

The lower level consisted mainly of rooms which housed residents who were assist-propelled and/or suffering from senile dementia. Other areas on this level were: an Activity Room, Therapy Room, Beauty Salon, Lower Lounge, and an exterior open slat-covered porch.

All the floors on both levels of the facility (except the carpeted Chapel & Lounge) were finished with beige marbled linoleum tiles; the walls (except for the brick faced Chapel & Lounge and Garden Room) were finished with a fabric wainscoting (rose colored on the upper level and blue on the lower). The walls above the wainscoting were finished with color coordinated patterned vinyl wallcovering. All ceilings were 2 x 4-foot white "acoustic" tiles.

The Chapel & Lounge and Dining Room had suspended lights and the remainder of the facility had 2 x 4-foot fluorescent units with flat prismatic lenses. The overall impression of the lighting in the facility was generally dark with contrasting pools of light, changing with the time of day.

Residents could associate with the reality by season, weather, and time of day via several window areas, particularly from the west section of the Main Corridor. This corridor area provided a southern view of the county parkland. A portion of the east section of the Corridor and the

Garden Room view was of the parking lot, the service entrance, and a nearby ambulance facility. This supplied a full sun view for residents.

It is important for designers and architects to understand the time of day the facility was used. Residents were awakened at 5:00 a.m. (when it was dark, no matter what season) to be bathed and dressed for breakfast which was served about 7:00 a.m. This early awakening caused all public areas to be vacant after dinner. Residents returned to their private rooms immediately after dinner to sleep.

The image of the facility was not institutional, rather an attempt had been made to create a "homelike" atmosphere through the use of color, wall coverings, drapes, blinds, and other window treatments. However, the corridor strip-lighting design of fluorescent lights and highly polished floors gave a slightly institutional flavor.

## Public Area Descriptions

Chapel & Lounge

Physical Setting

The Chapel and adjoining Lounge, located on the upper level were connected to one another but could be separated by a folding partition (see Figure 3). This is the only area in the facility that is carpeted.

The Chapel portion of the room was used once a week in the morning as a religious service. It has been used for many other congregational-type activities including a wedding and a funeral. The Lounge area was used for many activities in the past, teas, meetings, physical therapy/exercise classes and a reading room. Although a large, well illuminated, uncarpeted Activity Room existed on the lower level, this upper level lounge area was

used instead for groups too large for the area and activities that should have had tiled floors. Activities scheduled into the Chapel Lounge were for the convenience of the staff. The Activity Director stated, "Rather than transport the residents in wheelchairs up and down the elevator, we just use the Chapel Lounge, the others (assist-propelled residents) don't have to use the elevator to get here". This decision resulted in over crowding and the results were described later in this section.

The furniture of the Lounge was sparse and lined against the east and south walls. The low number of furniture pieces allowed wheelchair residents to enter the area easily and select positions in the room; however, this did not happen in most cases. There is an unspoken seat or spot assignment and residents may sit in full or partial sun because that is "their spot". The Chapel contained pews the west half of the area and the east half was open for wheelchair and geriatric seating. A few dining room chairs were also in the room.

A 20-foot full-wall cathedral window was located on the northern end of the Chapel. This window was clear but at one time, colored tissue paper had been glued to it. Over the years, it has faded to yellow or dried up and fallen off. The administration was now taping pieces of paper and painting with tempera paint the clear spots to alleviate the glare complaints by residents. No other windows were in the long expanse of the Chapel area. However, the east wall and emergency door of the Lounge were ceiling to floor glass. The windows were covered with casements (with open weave drapes) which permitted direct morning sunlight to be cast on the carpet. The door had no sun shielding treatments.

The area was not used during the 6:30-7:30 a.m., 11:30-12:30 p.m., or 5:30-6:30 p.m. observational times because meals were served during these times and dining received priority over other activities, either scheduled or unscheduled by residents.

Chapel & Lounge Lighting

The illumination features of the Chapel & Lounge were dependent on the sunlight. The Chapel appeared dark with the bright northern window and residents faced north during services. The fixtures were of two different styles. The cathedral ceilings which ran throughout the Chapel & Lounge were lit by four 35 watt suspended single incandescent bulbs. These were spaced 3-feet apart and 10-feet high in the Chapel area and 4-feet apart in the Lounge area (one was burned out in the Lounge). Also in the Lounge a 2' x 4' fluorescent fixture was installed in the ceiling area, a wall-mounted fixture of two incandescent bulbs was centered over the window area. A single portable incandescent lamp was located in the corner of the room which was inaccessible to residents in a wheelchair. The lamp and the wall-mounted light were not used during observations.

The role of artificial lighting in the area was insignificant but the impact of natural light in the area was dramatic. Figure 12 compared the 9:00-10:00 a.m. profile with the 2:00-3:00 p.m. profile for quantity of light (4' FFL). The direct sunlight path changed some with the grids, but the northern illumination levels changed very little. The balance of light profiles (see Figure 13) showed the direct sunlight position on the carpet. The dark bold lines shown on the profile represented abrupt changes in light levels.

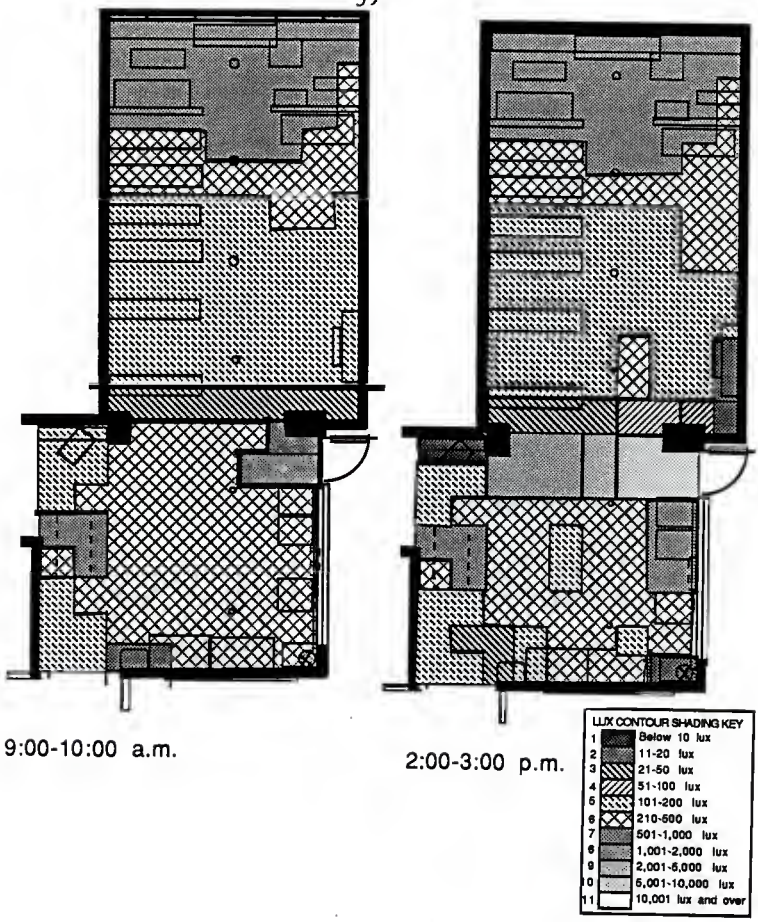



Figure 12. Quantity of Light Profile for the Chapel & Lounge. (The different shaded areas represented the location and level of lux in the area measured at 4 feet from the floor. Scale: 1/8" = 1' 0" North ⍙)

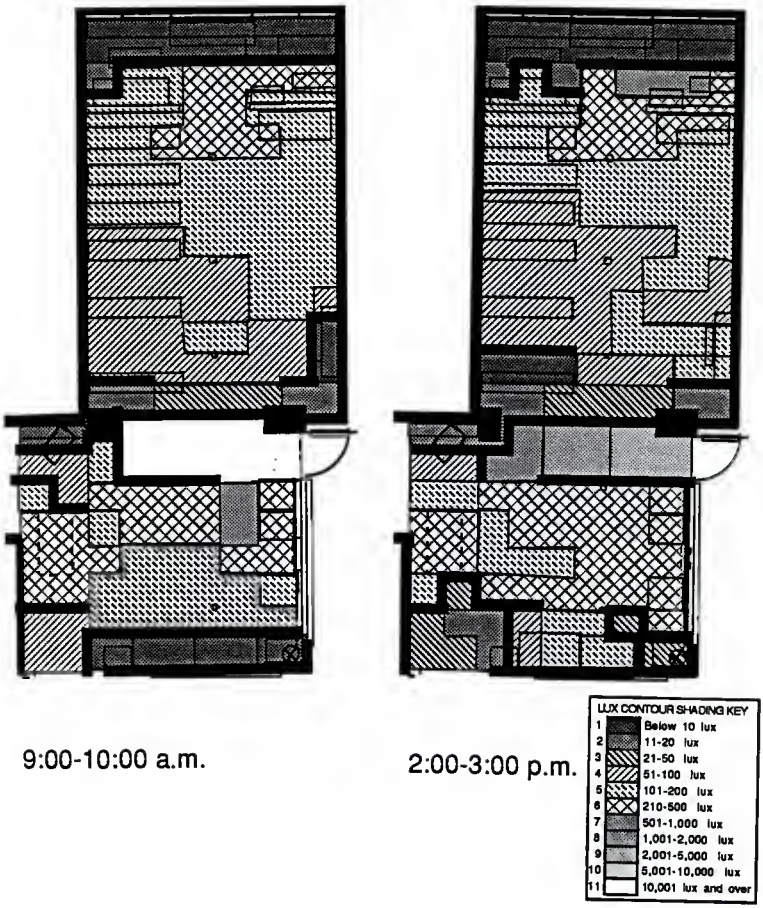



Figure 13. Balance of Light Profile for the Chapel & Lounge. (The different shaded areas represented the location and level of lux in the area measured on the floor. The bold lines on the plans showed imbalance of light. Scale: 1/8" = 1'0" North ∆)

The presence of discomfort glare in the northern Chapel area was not dependent on time of day but the discomfort glare for the Lounge area was dependent on time of day and sun angle. Figure 14 shows the presence of discomfort glare at 9:00-10:00 a.m. and 2:00-3:00 p.m. The reflectance percentages for the northern glass ranged from 70-90%. The dark brick walls and the brown carpeting provided low reflectance percentages: 20% for the walls and only 4% for the floor. The carpeting played a major role in reducing the presence of discomfort glare. The east facing windows with casement drapes had a 48% reflectance while the clear glass door was almost 100%. Therefore, residents facing east in the Lounge area or facing north in the Chapel saw only silhouettes.

Chapel & Lounge Behavior

Figure 15 shows the behavior mapping of residents during one day' observation (9:00-10:00 a.m. and 2:00-3:00 p.m.). A total of 33 observations were recorded in this area.

During morning physical therapy, 16 to 18 residents were typically squeezed into the Lounge portion of the Chapel & Lounge in a circle which resulted in a cramped space in which their wheelchairs were side by side or they were sitting very close to other residents. In these settings they were asked to perform physical exercises such as catch and bounce balls, toss bean bags into a metal can, or play other eye-hand coordination games. Residents who were ambulatory or assist-propelled selected seating or positions with better illumination or less glare than residents dependent upon staff placement, however, the entire area did not provide proper illumination for the tasks required.

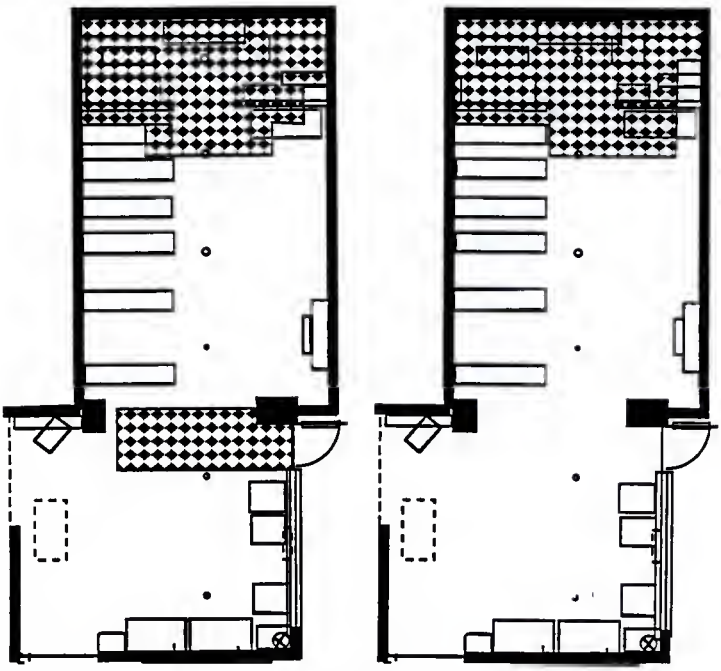



Figure 14. Discomfort Glare Profile for the Chapel & Lounge. (A checkered pattern on the plans showed the presence of discomfort glare. Scale: 1/8" = 1'0" North ∆)

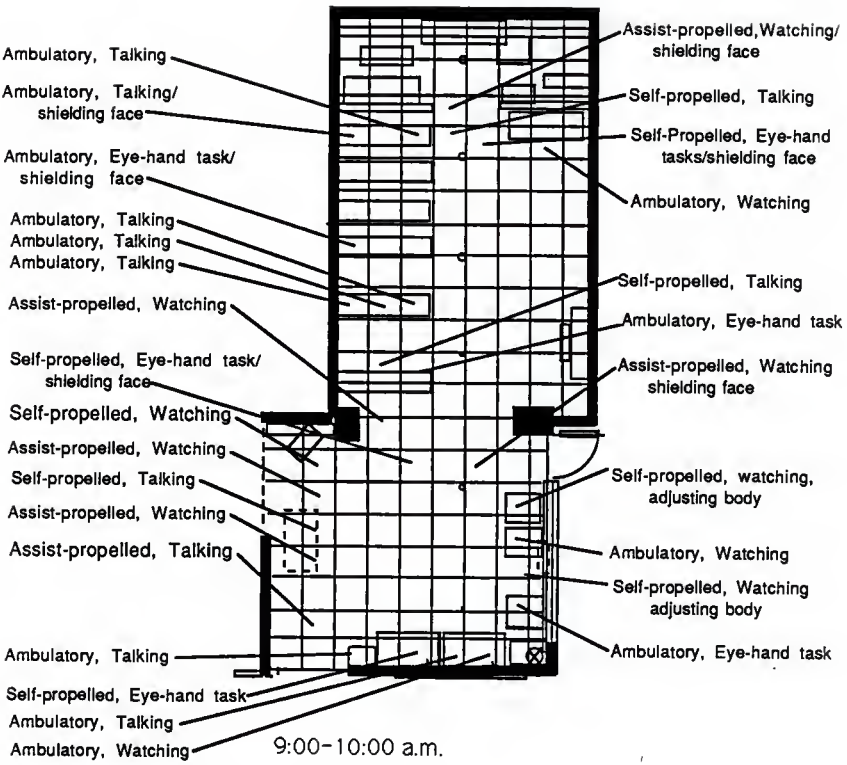



Figure 15. The Behavior Mapping of Residents in the Chapel & Lounge During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North ∆)

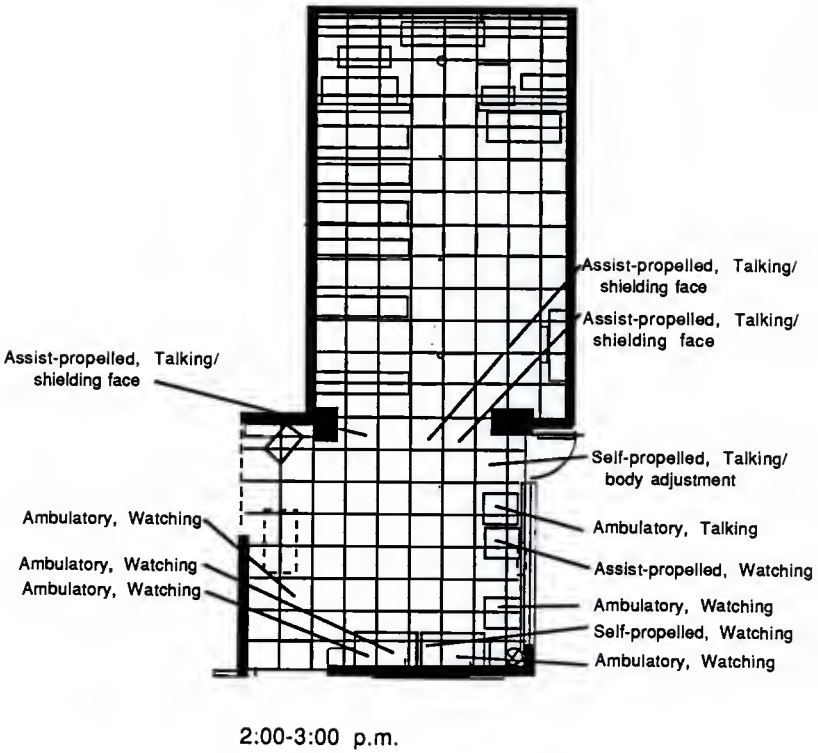



Figure 15, Continued. The Behavior Mapping of Residents in the Chapel & Lounge During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North ∆.)

The closeness of residents sitting next to each other, even ones in wheelchairs had the opportunity to touch other residents without thinking it was too personal. Hand clasping, hugging, arm touching, and other physical support was encouraged during activities. The acceptance of the cramped area and the close physical locations of residents supported talking and allowed residents to be close enough to look directly at other residents. This area recorded the second highest percentage of talking and watching of any room in the facility, and it was thought that the activity itself and the close proximity to other residents encouraged this behavior rather than the illumination.

Some residents, unable to perform eye-hand tasks well, requested the physical therapist to move away from the eastern windows and were then successful in performance. However, other residents who had obvious visual disabilities appeared to use the bright background of the eastern windows (measured at over 1300 lux) to locate staff and play games. This behavior was first observed in this area and again in other areas of the facility and was later labeled Glare Cueing and defined as the use of glare and shadows by elderly for cueing and wayfinding. For example, when the physical therapist held up her hands to toss the ball, older adult residents could see that movement and held out their arms (but appeared surprised when the ball landed in their arms.) Other residents used the movement of shadows against glare to locate empty or occupied chairs. Residents familiar with the area used the glare for wayfinding, for example, one ambulatory centurion resident used the high reflectance of chrome to locate and negotiate around furniture corners and other resident's prosthetic devices.

In the Chapel area, specific behaviors included one resident intentionally sitting beyond the Chapel area during the religious service to make use of the direct sunlight on her song book. The Chapel had a single room air vent which blew directly onto two pews and residents would rather cope with the glare discomfort, by draping napkins over their heads to shield their eyes or facing other directions, than sit in these pews and expose themselves to a draft and possible illness. Residents facing the northern window and podium were observed putting on sunglasses or hats to shield their eyes during Chapel. Many residents had great difficulty finding page numbers after looking toward the podium while singing a familiar song and then looking down to find a page number.

Garden Room

Physical Setting

This 16' x 16' greenhouse-solar room was added to the original structure with the idea of providing horticulture therapy for the residents, thus the name, "Garden Room." It was located on the East side of the upper level, adjacent to the kitchen (see Figure 4). The original intent of this room was for growing plants; therefore, direct sunlight in this area was a design objective. However, when the administration was faced with an increase in senile dementia residents who needed assist-feeding they had two choices, to convert this space into a "feeder room" or provide meals on a staggered schedule. Therefore, this area described by staff as bright, open, and airy functioned only during meal times as a room for feeding (staff hand-feeding) senile dementia residents.

This room was starkly furnished with two built-in shelves which served originally as window sills for plants but now serve as dining tables, and one table, and one chair. The table surfaces were wood toned formica. This unique room design and table placement required several residents to eat while directly facing full sun. Roman shades were installed on the East windows, but the shades were not lowered during any of the observation times. An overgrown evergreen bush provided a little shade to the very edge of the northeast corner of the room. All windows were smoked glass and the two doors of the room were full length reinforced glass. The west wall was brick and the floor was the same tile as the rest of the facility, but instead of being beige, it was dark brown.

Garden Room Lighting

Artificial illumination features were two 2' x 4' fluorescent fixtures that were centered in the room. The natural illumination was intense. Resident were fed in lux levels ranging from 930 to 20,060 lux; 20,000 lux were recommended by the IES as being suitable only for very special visual tasks of extremely low contrast and small size such as diamond cutting! Because of the unique design (see Figure 16) residents physically received more sunlight during the noon meal but were looking directly at the sun during breakfast. In contrast, the evening meal contained no direct sunlight but was still high in illumination levels partly because of natural illumination and partly because of artificial illumination. The profiles of light at 4' FFL showed the high contour levels of illumination did not reduce much with time in this area (see Figure 17). Lux level 6 on the Shading Key for contours was considered by the IES to be on the highest end of normal

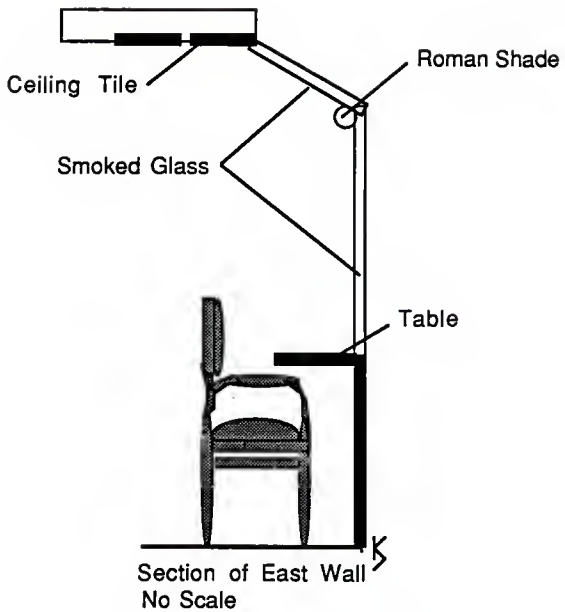
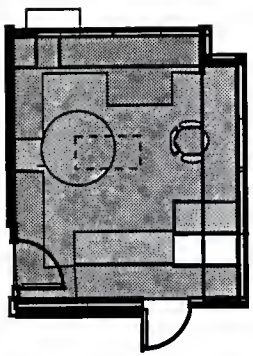
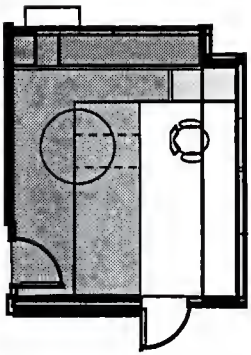


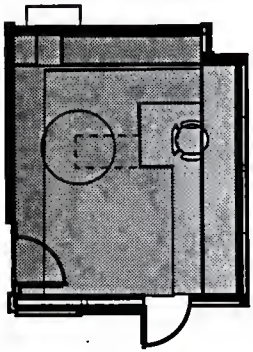

Figure 16. A Detailed Section Of The Garden Room, East Wall. (Shown were the solar design of the windows. No Scale)



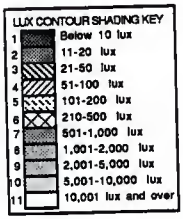
6:30-7:30 a.m.



11:30-12:30 p.m.



2:00-3:00 p.m.




Figures 17. The Quantity of Light Profile for The Garden Room. (The different shaded areas represented the location and level of lux in the area measured at 4 feet from the floor. Scale: 1/8" = 1' 0" North Δ.)

recommendations and the KAR codes recommend only 250 lux for dining. The direct sunlight path and changes throughout the day are shown in Figure 18.

Discomfort glare was experienced by almost all residents because of the room design. The smoked glass reflectance was 69% and the brick was 20% reflectance. If some type of window treatment was used, the higher illumination levels could be reduced and thus the amount of reflectance and potential for discomfort glare. The surfaces were even reflective under these high illumination levels. The table reflectance was 24% and the floor tile was 14%. Figure 19 shows the location of discomfort glare in the Garden Room for the three times of use.

## Garden Room Behaviors

Two of the residents using this area required syringe feeding, while the remainder required all food to be cut and certain foods placed in their mouths. Senile dementia behavior is difficult to understand and observe due to the mental and physical deterioration of the residents. Figure 20 describes the resident behaviors occurring in the Garden Room during one day when 40 observations were made for this area. Residents sitting in full sun for the morning and noon meals exhibited behavior such as crying, hitting, spitting, and undressing. This was characteristic of some senile dementia residents in general, however the same residents observed in other areas, or during evening meal, where the light level was below 1300 lux, did not exhibit such behavior (above 1300 triggered responses). It should be noted that observations were taken only on full sun days and no data were gathered on medication types, dosages, or or other personal data and caution was recommended in applying these descriptive findings to

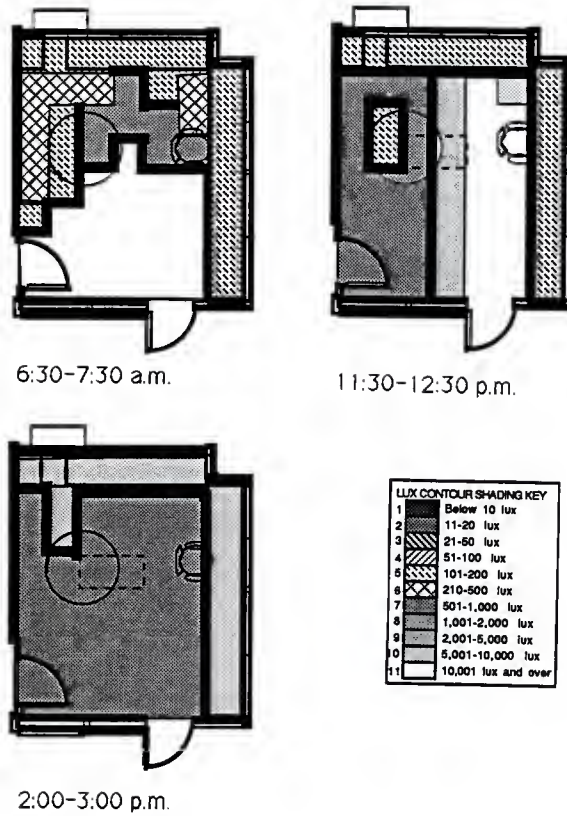
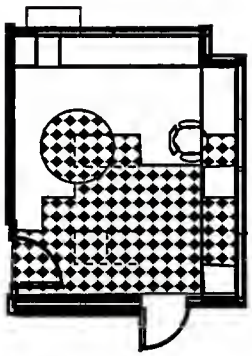
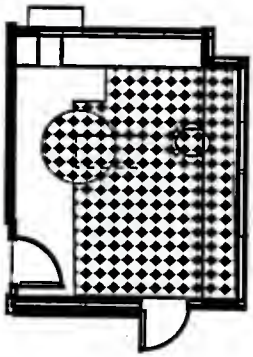


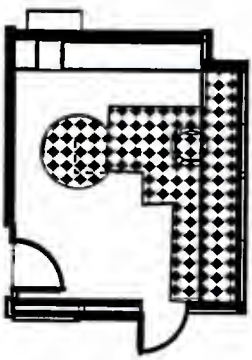

Figure 18. The Balance of Light Profile for The Garden Room. (The different shaded areas represented the location and level of lux in the area measured on the floor. The bold lines on the plans showed imbalance of light. Scale: 1/8" = 1'0" North △)



6:30-7:30 a.m.



11:30-12:30 p.m.



2:00-3:00 p.m.

Figure 19. Discomfort Glare Profile for The Garden Room. (A checked pattern on the plans showed the presence of discomfort glare. Scale: 1/8" = 1' 0" North △)

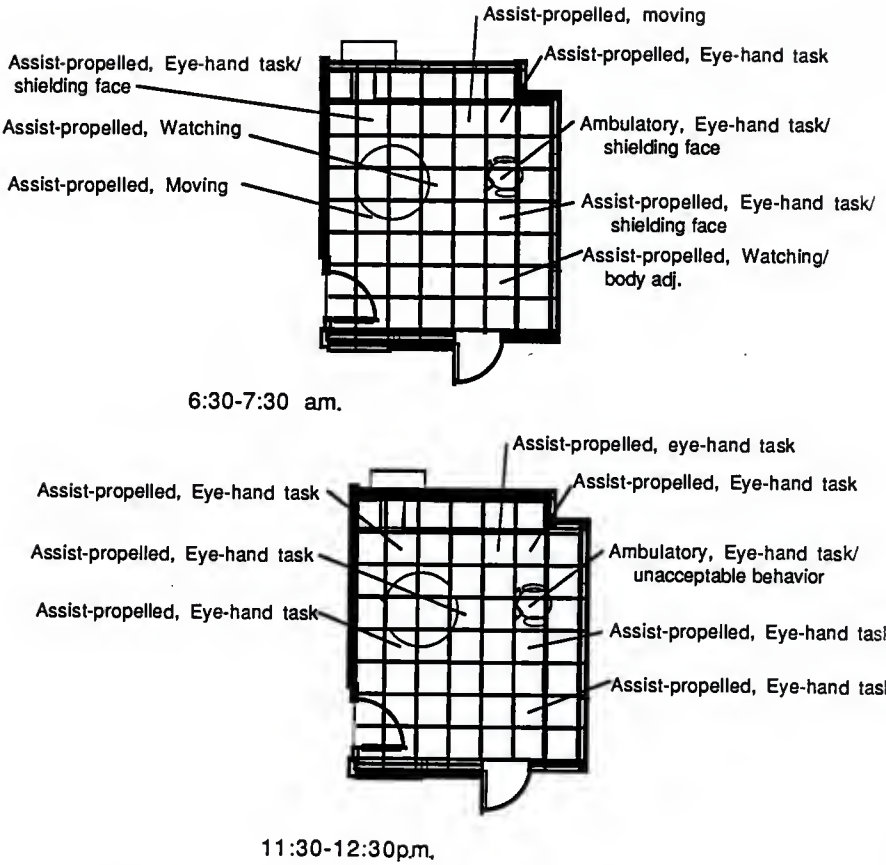



Figure 20. The Behavior Mapping of Residents in the Garden Room During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North ∆.)

other facilities. Snyder (1978) suggested that high illumination levels may attribute to unacceptable behavior and reduced attention span of senile dementia residents. The observations from this study reinforce her statement. During breakfast and lunch, when illumination levels were at their highest, attention span appeared shorter for residents and staff repeatedly had to remind residents to eat, often putting utensils in their hands. More assist feedings were done during the morning and afternoon meals than during the evening meal when food was just cut for residents.

The use of glare cueing was also observed in this area. One resident propped up with pillows and confined with straps to a geriatric chair was repeatedly seen adjusting his head to face the artificial light. When a staff member's hand passed by his face, causing a change in the light level, he opened his mouth. It was believed that this intentional adjustment of the head was the use of Glare Cueing by the resident to facilitate feeding.

Dining Room

Physical Setting

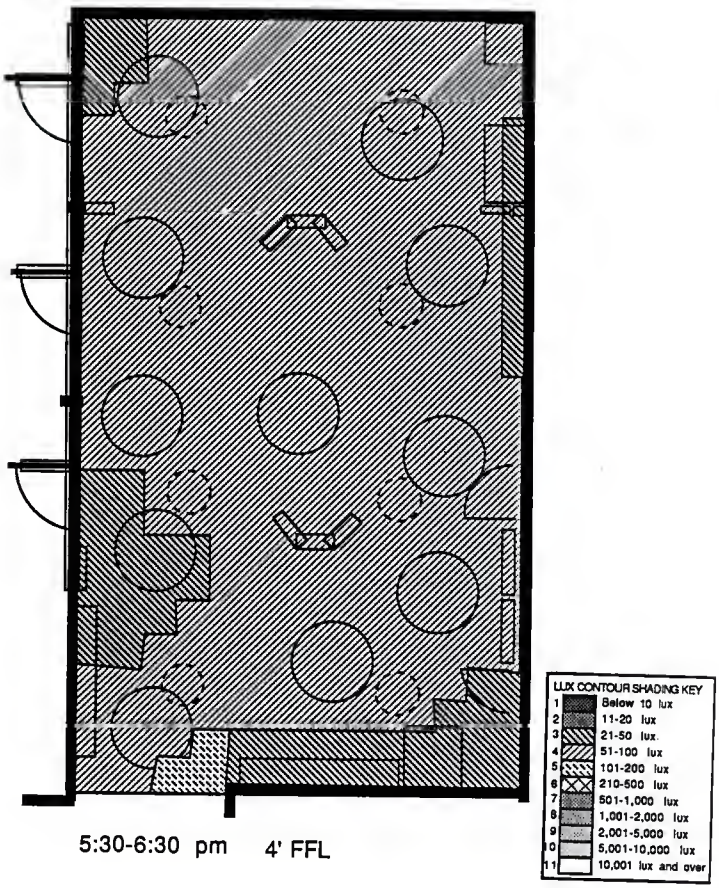
This 47' x 27' Dining Room was located on the upper level of the facility near the front entrance (see Figure 5). This room functioned as the main dining area for 48 residents and also as a game room where residents played bingo and also had group sing alongs. Most residents were self-fed but a few were assist-fed by staff or relatives of the residents. This room was not used very much because housekeeping was busy cleaning up after each meal and re-setting the tables.

The room was furnished with five-foot circular tables and a few chairs that were needed for the ambulatory residents. The room features a

western facing wall that has three full glass doors, evenly spaced, between expanses of windows almost the entire length of the room. Many window treatments were used in this area. The doors were covered with mini-blinds and the entire wall was covered with both sheer drapes and casement drapes. The window treatments remained the same except in one area and the staff intervened if the treatments were changed. Residents could look out the western windows and doors, onto the 15 x 47' porch. There were two eastern doors that lead into the kitchen and two serving windows but, residents were served at their seats. The floor was beige tile, typical throughout the facility. The ceiling had three exposed wooden truss beams.

Dining Room Lighting

The total illumination for this area was supplied by eight shadeless light globes all suspended 8-feet apart at 10' FFL. The average illumination at table height were 70 lux; however, the K.A.R. Codes (28-39-113, 1987) require the minimum illumination level to be 250 lux. The contrast between the lighted globes and the dark room caused the residents to refer to the suspended lights "as appearing like balls of sun," (Administrator, personal communication, May, 1987). Also contributing to this dark environment was the porch which had an additional canvas awning that drooped down to such a low point that the quantity of light and balance of light for this area were not affected by natural light (see Figure 21 and 22). Pools of light existed only in the very entrance to the Dining Room. This dark contrast made other normal illumination more intense. The windows with only 1% reflectance were bothersome for residents as were the suspended globes with 33%




Figures 21. The Quantity of Light Profile for The Dining Room. (The different shaded areas represented the location and level of lux in the area measured at 4 feet from the floor. Scale: 1/8" = 1' 0" North ∆)

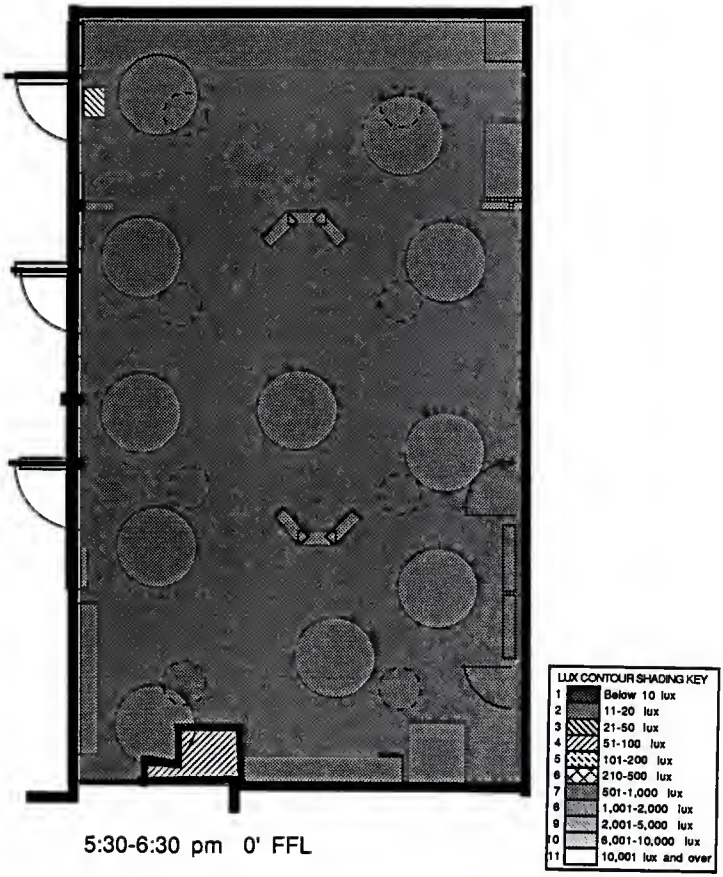



Figure 22. The Balance of Light Profile for The Dining Room. (The different shaded areas represented the location and level of lux in the area measured on the floor. The bold lines on the plans showed imbalance of light. Scale: 1/8" = 1'0" North ∆)

reflectance. The floor reflectance of the beige tile increased to 17% compared to the 14% for the dark brown color.

## Dining Room Behaviors

Residents participating in dining were observed wearing sunglasses, hats, or shielding their faces from the suspended globes while eating, while one resident was observed using a flashlight to illuminate the labeling of condiment packages to assure the correct selection for herself and other residents. Other residents were observed using glare cueing for mobility in and around the table, and another in feeding assistance. One assist-fed resident who faced the windows opened her mouth when a staff member reached in front of her face to hand another staff member an extra sugar package. When the resident was not fed, she raised her hand to shield her face (in the direction of the light fixture and windows) to see why she was not fed. The staff member moved the resident's hand away from her face and fed her. Throughout the feeding, the staff spoke only to other staff members and stood, providing only body movement images against the illumination sources for the resident. Another resident was observed picking up an eating utensil and holding it to reflect the image of whether it was a fork. Unable to receive enough information because of the low light levels, he used his fingers to identify a fork and spoon. The exterior illumination contrasted with the darker interiors and cause residents to shield their faces or turn their backs to the windows. A resident with her back to the windows used exterior light to illumine her plate while the resident sitting in an adjacent position angled her face away from slightly higher level of illumination. As the one resident attempted to close the drapes because of imbalance in light, the other resident attempted to open

them. The Administrator had attempted to resolve the lighting dispute between residents by installing several layers of window treatments (casement drapes, sheers, and drapes). However, no solutions were found.

Dining was a social behavior which recorded the the highest percentages of watching, talking and eye-hand tasks (see Figure 23). A total of 256 behaviors were observed; however talking was done only at tables and usually with adjacent residents. Behaviors were observed during meals and at 2:00-3:00 p.m. when bingo was scheduled in the Dining Room. Residents played bingo during the afternoon with guests using enlarged 3 inch numbered squares. No residents exhibited any difficulty in seeing the squares in the low illumination levels of this area. This was a highly competitive game and residents were actively watching not only their cards, but other cards. No observable differences in activity participation were observed at this time but the relationship may lie in the larger numerals of the board game.

Corridor

Physical Setting

The corridor was 128' x 8' (see Figure 6). It was divided by staff into several sections for resident use. The most easterly section was a waiting area for senile dementia residents, several of which sat in full sun and glare during morning meals. There were no chairs or furniture in this east section of the corridor and only seating for 6 in the central spine of the corridor which contained the only elevator. Seating for two was located

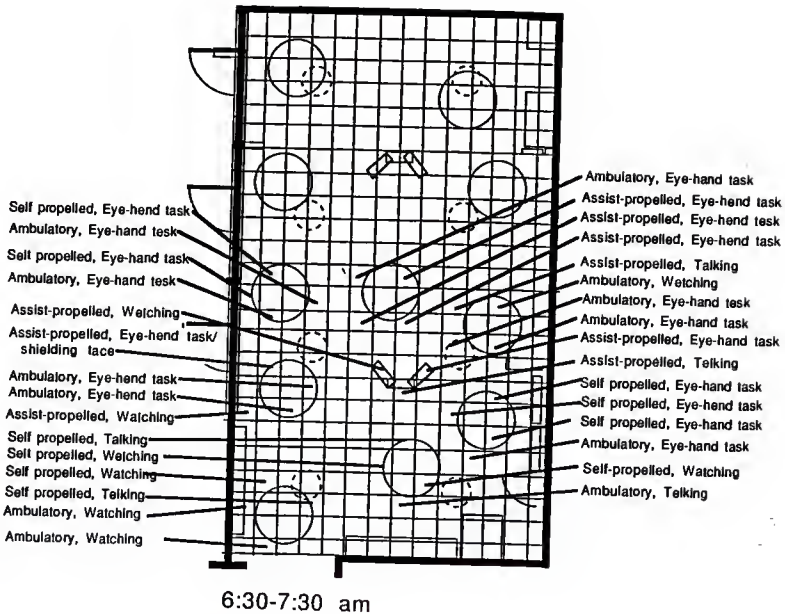



Figure 23. The Behavior Mapping of Residents in the Dining Room During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North △)

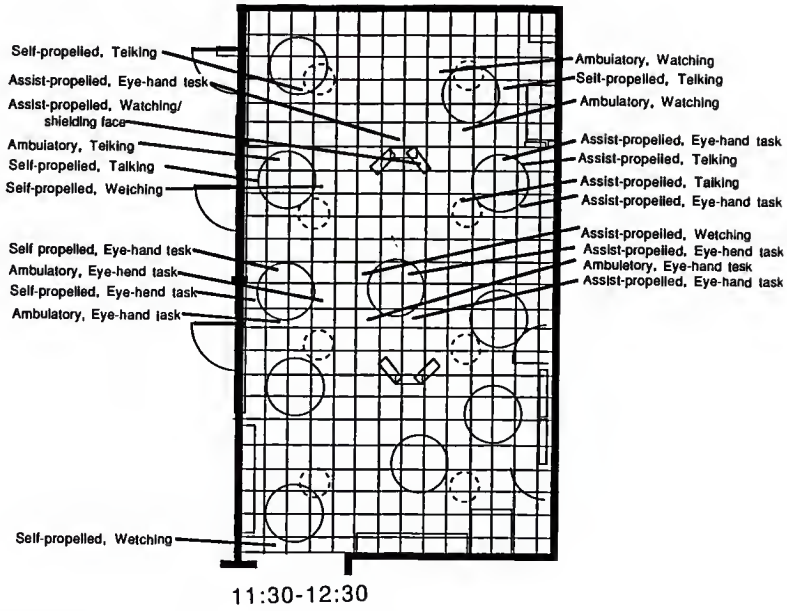



Figure 23, Continued. The Behavior Mapping of Residents in the Dining Room During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North ∆.)

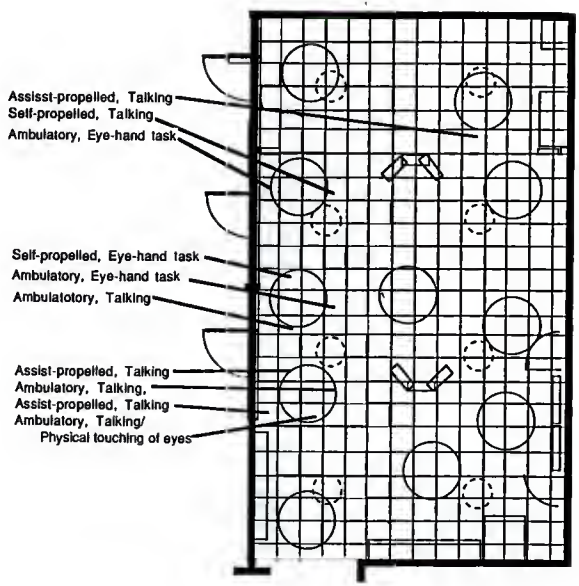



Figure 23, Continued. The Behavior Mapping of Residents in the Dining Room During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North △)

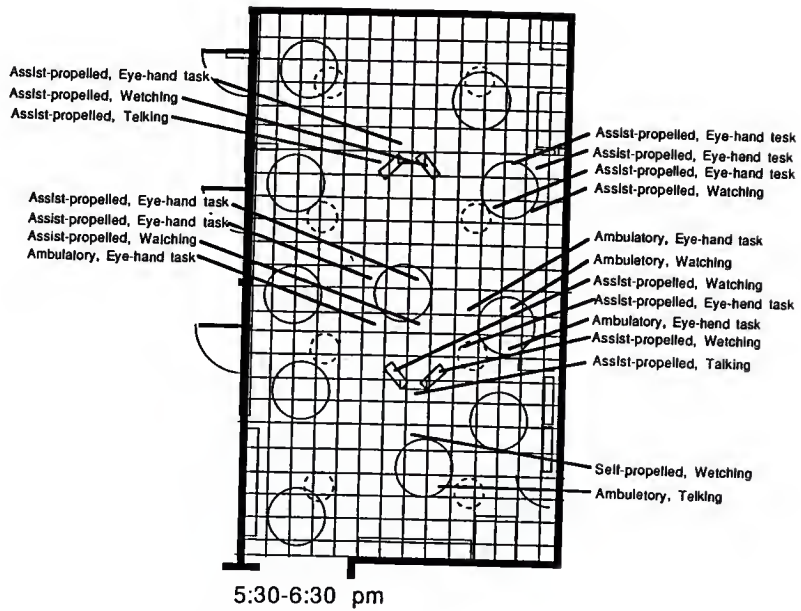



Figure 23, Continued. The Behavior Mapping of Residents in the Dining Room During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North △)

near the entrance and office. The location of the furniture blocked access to the handrails in the central area.

The western section had ceiling to floor non-tinted windows with a rod curtain which was closed only at night. The furniture in this section was the same but two special chairs were available for infirmed residents to lie down while housekeeping prepared their beds. The corridor connected private rooms with the facility and also functioned as an exercise route.

### Corridor Lighting

The light fixtures were fluorescent units with flat prismic lens which were located down the center of the corridor. The role natural and artificial light played on the corridor was dramatic. Due to the age of many fixtures illumination levels changed from fixture to fixture. These fixtures in conjunction with highly polished floors and direct morning sunlight, caused pools of light and glare. By noon, the angle of the sun had changed enough to remove the glare from the east section of the corridor. However, higher illumination levels were then received in the southern windows of the corridor. Because this study was done during the summer, a more dramatic profile would be presented during the winter when sun would shine directly onto the corridor floor increasing the lux levels and producing discomfort glare. No westerly sunlight entered the main corridor. Figure 24 compared two profiles of quantity of light for the main corridor and how the quantity of light changes during the day from an easterly sun direction to a 2:00-3:00 p.m. position. Figure 25 showed the most dramatic profile of balance of light for the main corridor, 6:30-7:30 a.m.

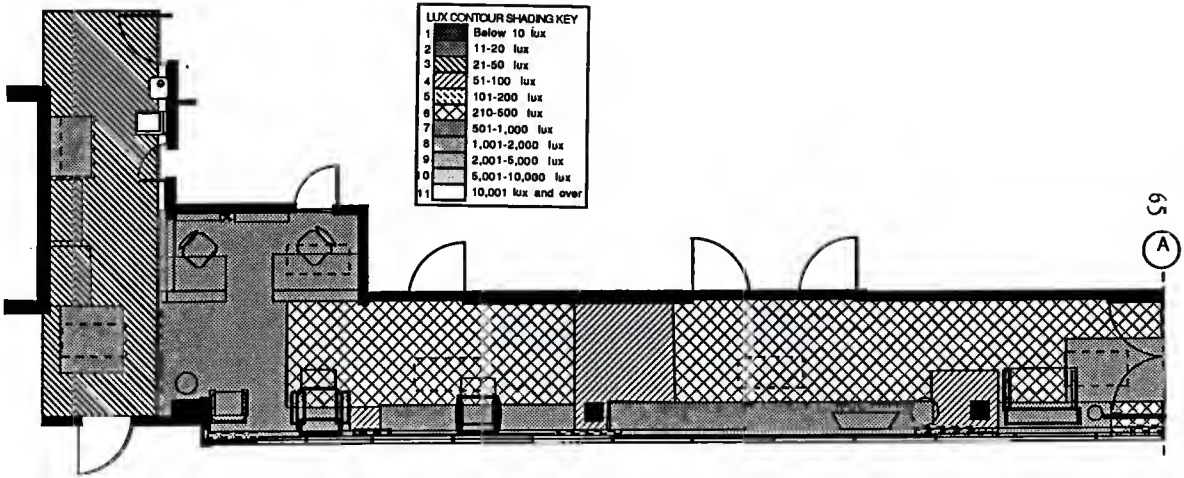



Figure 24 Quantity of Light Profile for the west section of the Main Corridor. (The different shaded areas represented the location and level of lux in the area measured at 4 feet from the floor. Scale: 1/8" = 1' 0" North △)

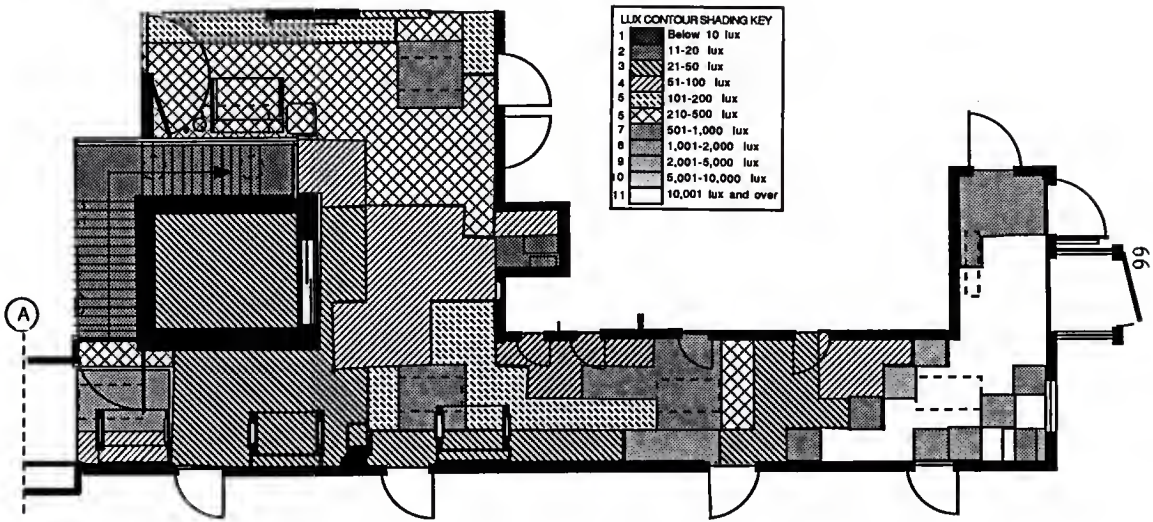



Figure 24, Continued. Quantity of Light Profile for the east section of the Main Corridor. (The different shaded areas represented the location and level of lux in the area measured at 4 feet from the floor. Scale: 1/8" = 1' 0" North Δ)

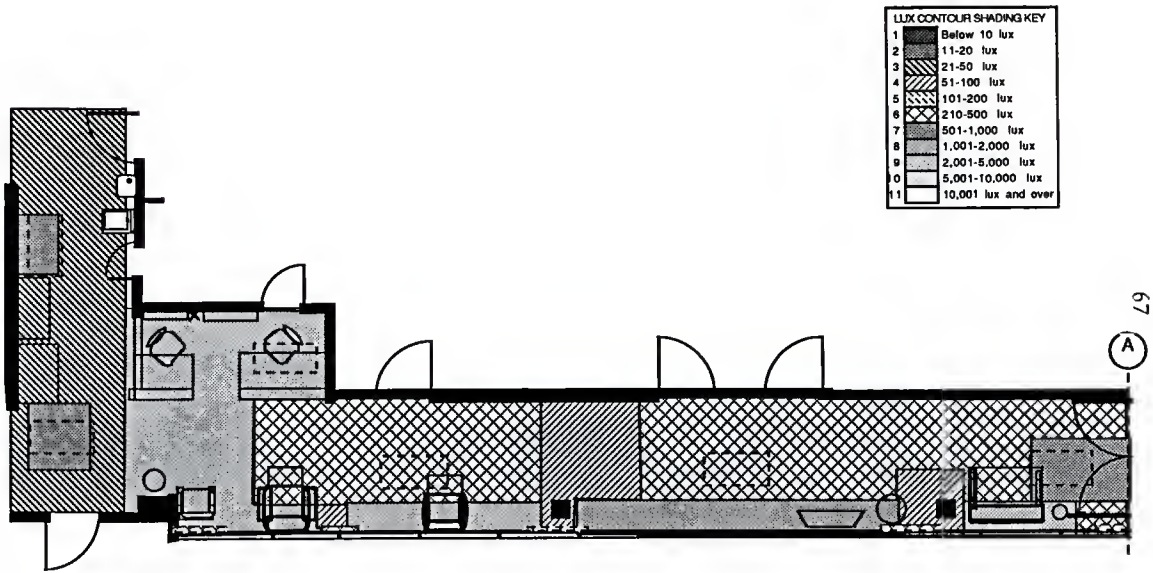



Figure 24, Continued. Quantity of Light Profile for the west section of the Main Corridor. (The different shaded areas represented the location and level of lux in the area measured at 4 feet from the floor. Scale: 1/8" = 1' 0" North ∆.)

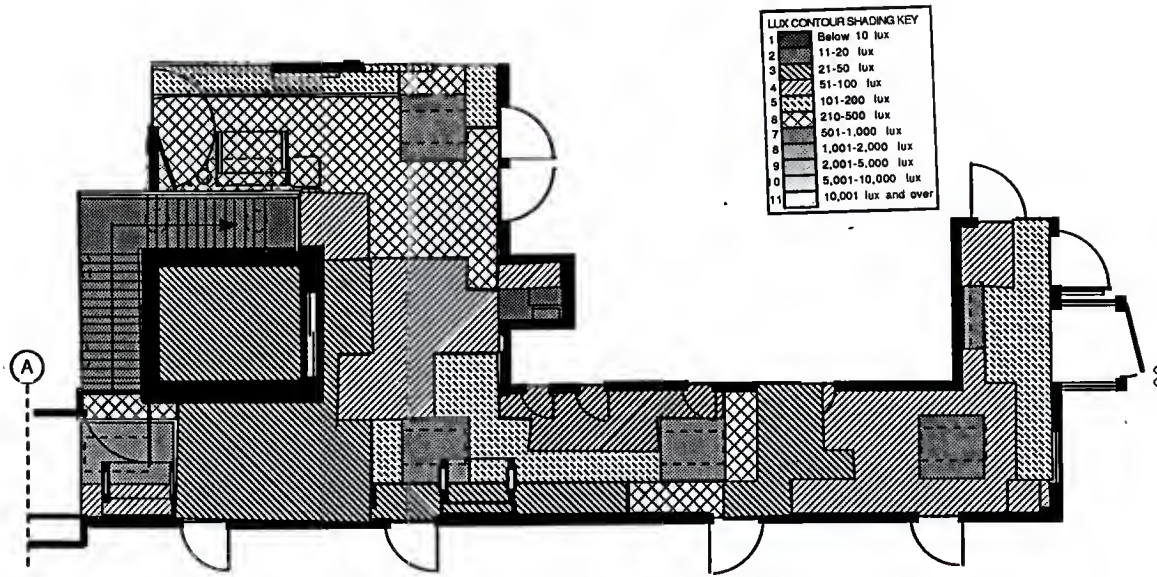



Figure 24, Continued. Quantity of Light Profile for the east section of the Main Corridor. (The different shaded areas represented the location and level of lux in the area measured at 4 feet from the floor. Scale: 1/8" = 1' 0" North ⍙)

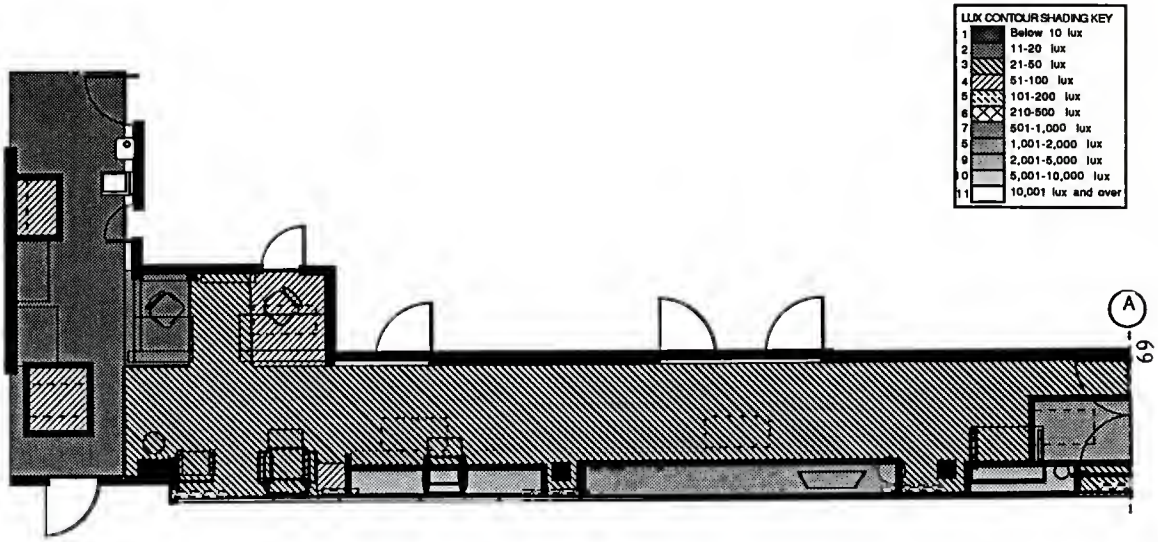



Figure 25. Balance of Light Profile for the west section of the Main Corridor. (The different shaded areas represented the location and level of lux in the area measured on the floor. The bold lines on the plans showed imbalance of light.

Scale: 1/8" = 1'0" North ∆)

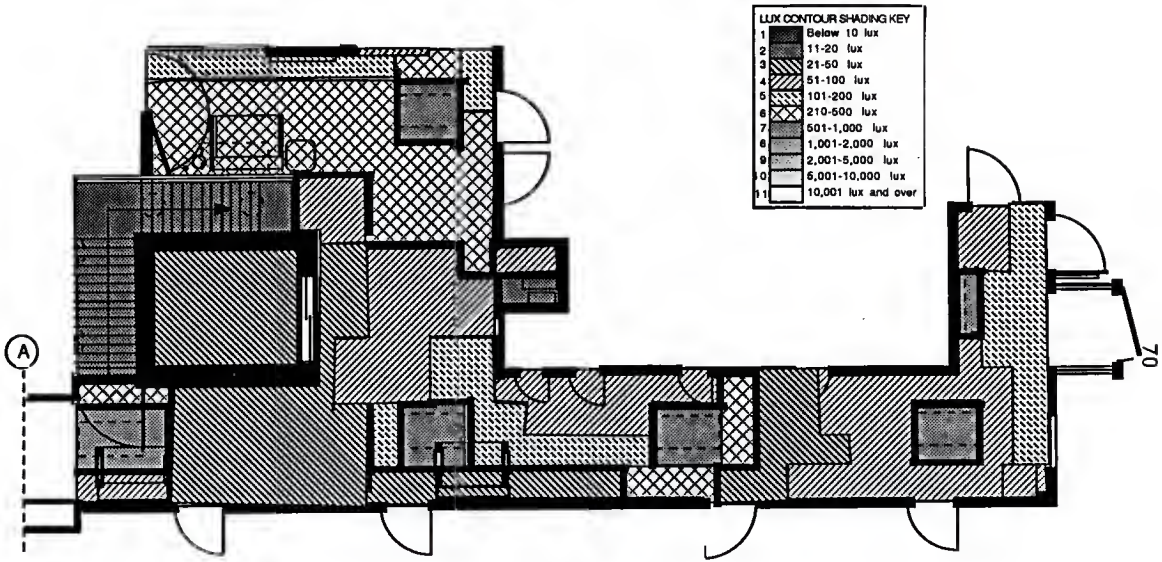



Figure 25, Continued. Balance of Light Profile for the west section of the Main Corridor. (The different shaded areas represented the location and level of lux in the area measured on the floor. The bold lines on the plans showed imbalance of light.

Scale: 1/8" = 1'0" North Δ)

None of the windows were tinted, thus almost 100% reflectance was received. The floor reflectance was 17% , and the window blinds were 27% on the East window. They were always pulled up to their highest point so the reflectance was 97% for this area. The effect the morning sun had on the area was evident with the discomfort glare profile but later in the morning, discomfort glare was not present, at least during the peak summer months. The maximum amount of discomfort glare for the corridor during 6:30-7:30 a.m. was shown in Figure 26.

Corridor Behaviors

Figure 27 described the behavior occurring in this area over selected portions of the busiest day; a total of 77 observations were made.

Resident corridor use relied on two factors, neither of which are based on illumination. First, staff placed assist-propelled residents without thought of illumination, glare or viewing activities, and second, the location of furniture determines the route and seat position of residents. This area served as a holding area for geriatric residents who remained in one place throughout the day, only being taken to meals and the toilet. Therefore, they relied on the staff to position them in optimum situations for illumination. Many times boredom and lack of stimulation gave way to sleep.

Residents' rooms which faced the southern windows and fixture over their doors had problems with light adaptation. They exhibited delayed body movement upon exiting private room, reaching for handrails after exiting rooms, touching walls as they walked, moving pictures and doors to locate themselves in corridor, and paused several seconds or minutes in the

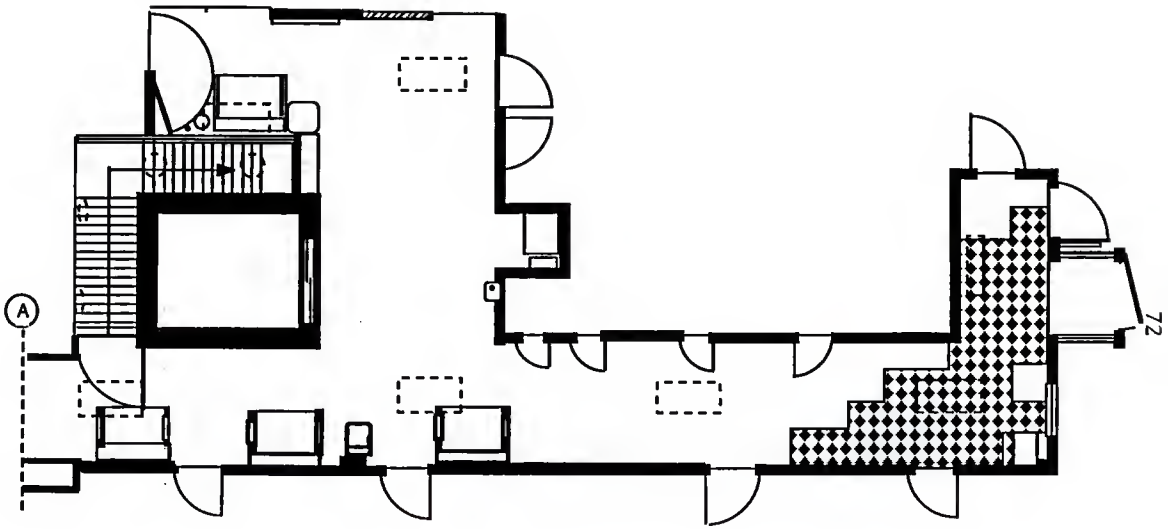



Figure 26. Discomfort Glare Profile for the east section of the Main Corridor. A checked pattern on the plans showed the presence of discomfort glare.

Scale: 1/8" = 1'0" North △)

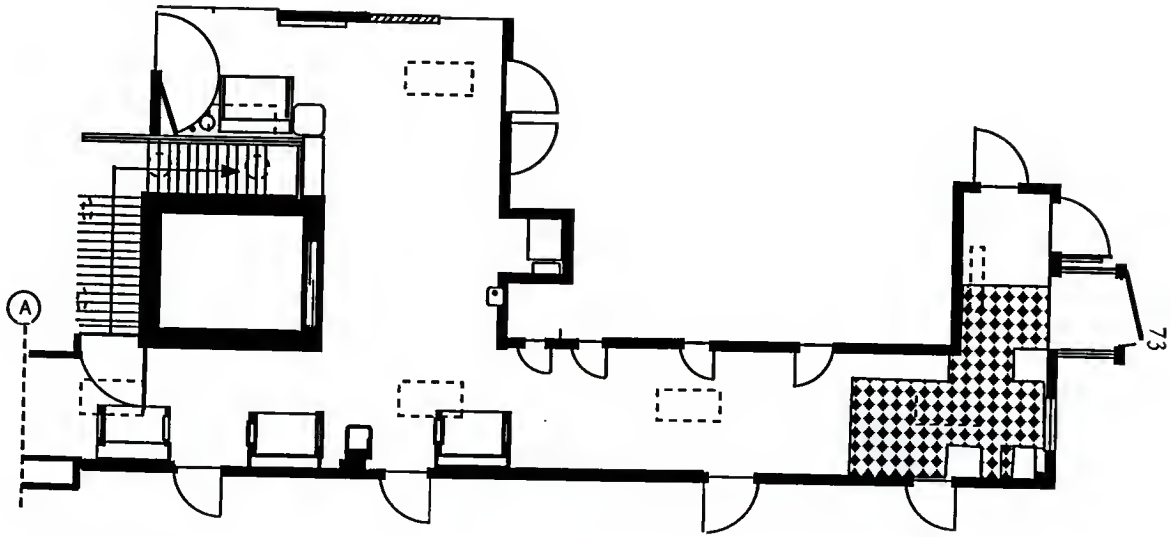



Figure 26, Continued. Discomfort Glare Profile for the east section of the Main Corridor. A checked pattern on the plans showed the presence of discomfort glare.

Scale: 1/8" = 1'0" North △)

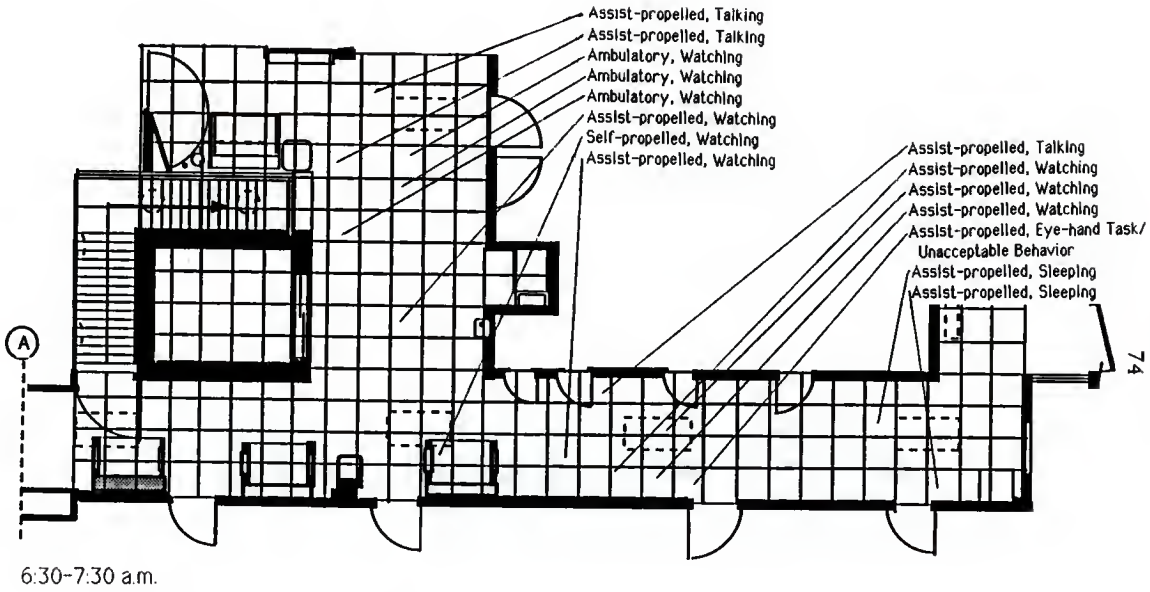



Figure 27. The Behavior Mapping of Residents in the Main Corridor During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North Δ)

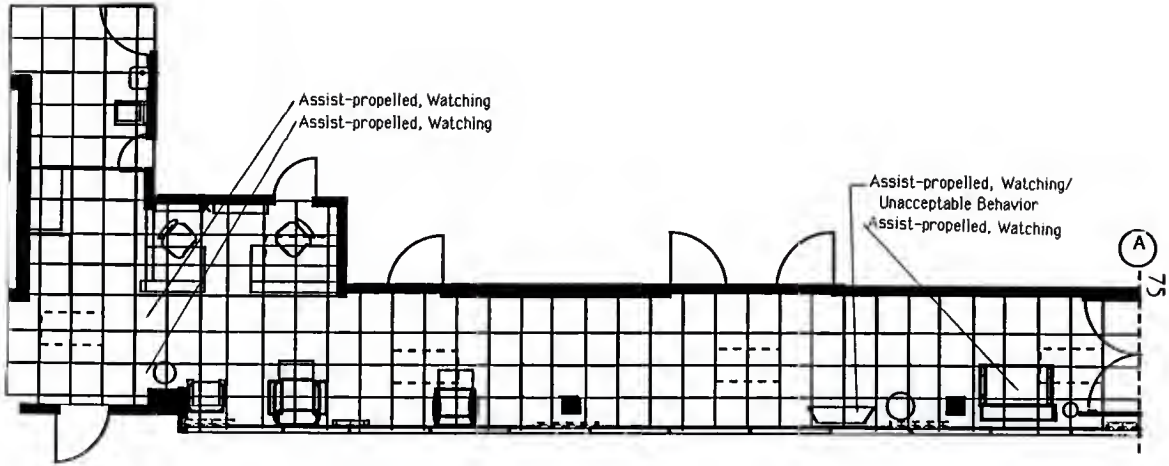



Figure 27, Continued. The Behavior Mapping of Residents in the Main Corridor During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North △)

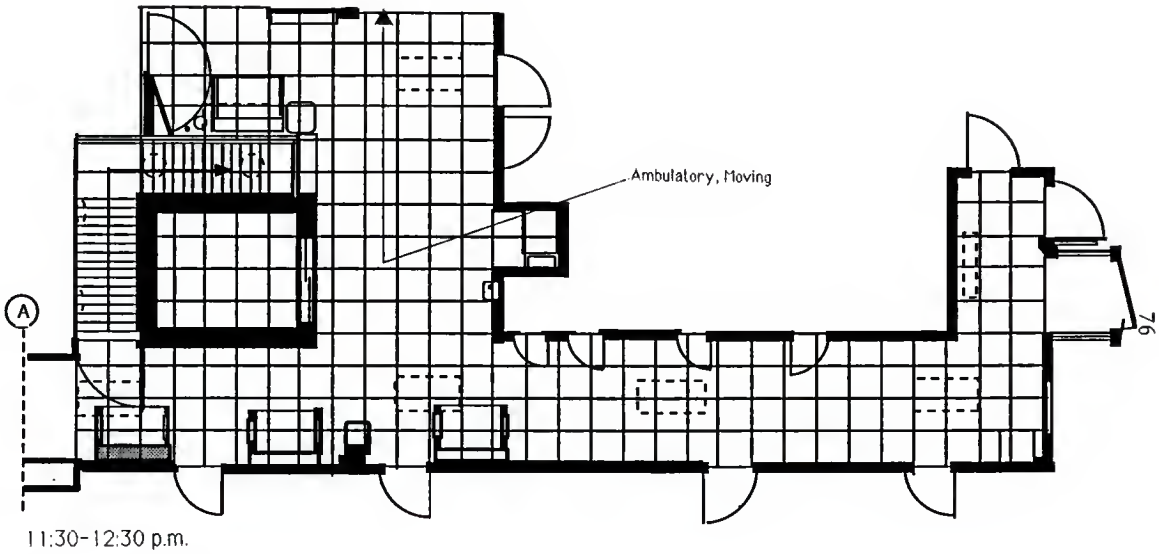



Figure 27, Continued. The Behavior Mapping of Residents in the Main Corridor During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North △)

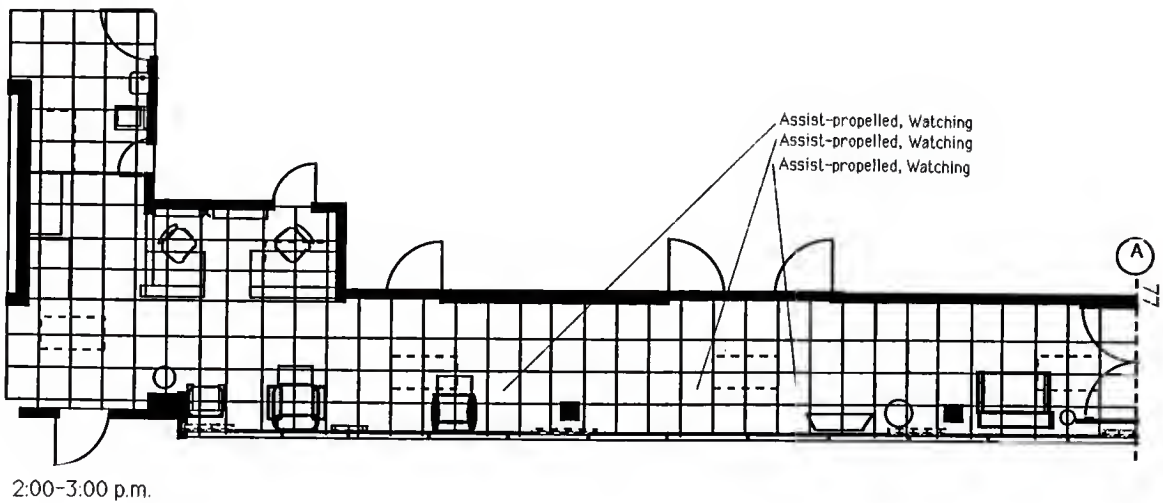



Figure 27, Continued. The Behavior Mapping of Residents in the Main Corridor During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North Δ)

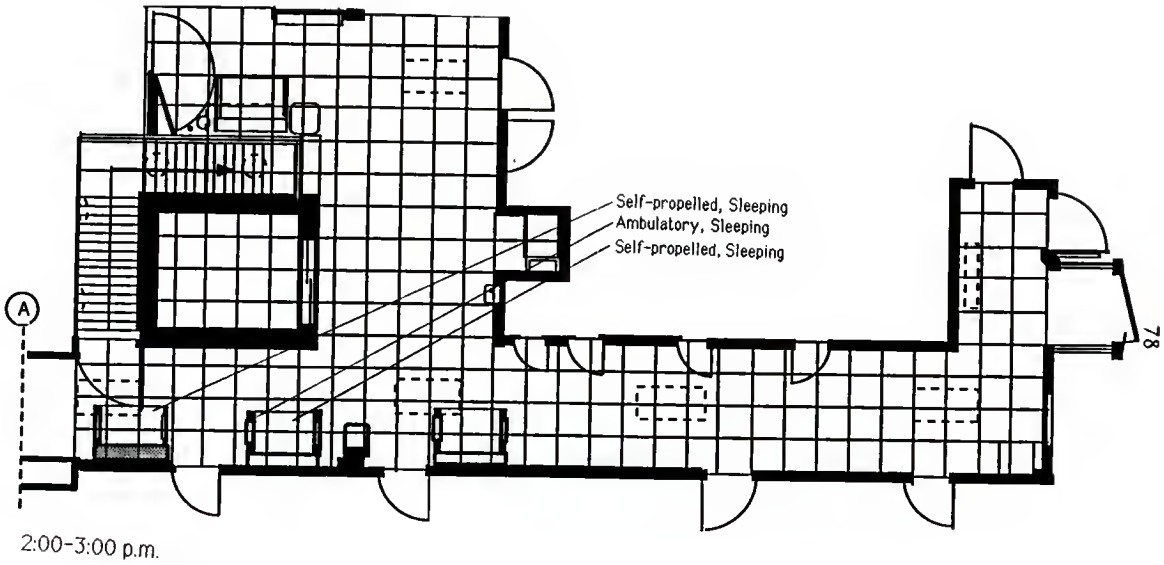



Figure 27, Continued. The Behavior Mapping of Residents in the Main Corridor During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North △)

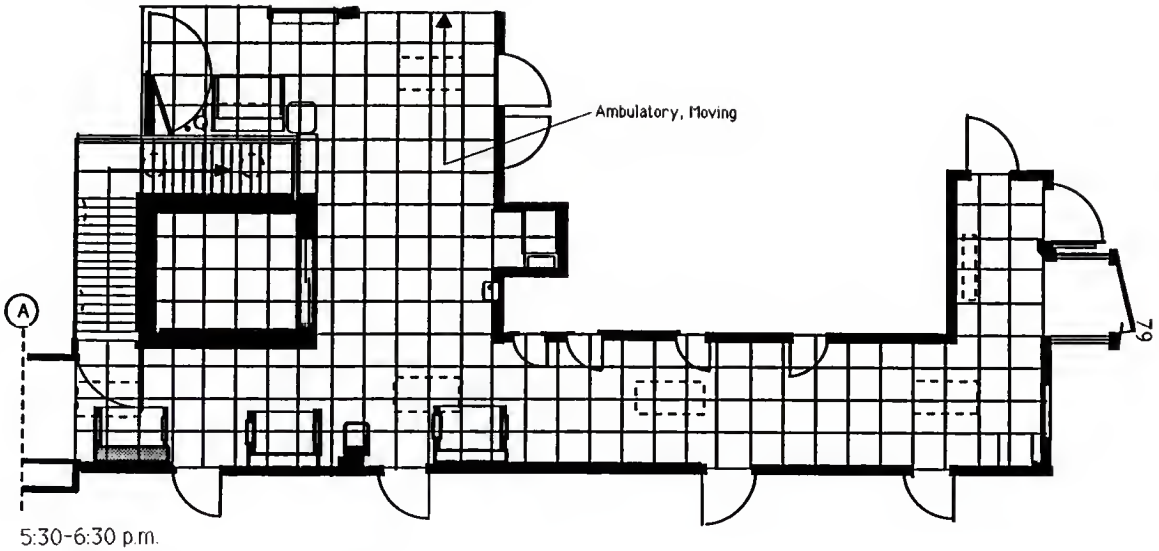



Figure 27, Continued. The Behavior Mapping of Residents in the Main Corridor During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North ⌂)

corridor before moving again. This behavior happened at levels measured over 1300 lux. Archea (1970) discovered in a study of stair accidents by elderly that they typically look out a window (if in a stairway), then turn 90 degrees to a darker view, and fall at the first step. Archea felt adaptation to changing light levels may be involved. This same situation may have been present here. However, one ambulatory resident with vision problems used glare and shadows as cues for traffic congestion in the corridor, and would change her corridor location around floor shadows. She also used Glare Cueing to locate the drinking fountain but tried to turn it on with the reflective chrome water nozzle instead of the cream colored plastic handle.

The corridor windows in the west section gave residents a second story view of a park but residents did not face this direction; they opted to look toward the interior traffic way of the corridor. This may have been due to the greater draw of activity and lower light levels than the exterior view.

Activity Room

Physical Setting

This 16' x 30' lower level area was located on the eastern edge of the facility, around the corner and out of view of the nursing station. An emergency exit door led to a separate laundry facility and another door led to the restorative therapy room which was the office of the activity director. Both doors had windows and the exterior door also had an adjacent window but the height and location of a coat rack restricted access for wheelchair bound residents. The window was covered with a sheer floral patterned curtain and louver blinds were installed on the door.

The blinds were kept open for staff to see staff coming with laundry carts. The intended design of this room was for a variety of activities (see Figure 7); however, no daily activities were scheduled for the room because residents had to be transported up and down the elevator. Instead, the area was used as a temporary laundry storage area for linens carts of clean and soiled linens which were transported to the separate laundry facilities via the emergency exit.

The furniture which was the same style throughout, was located on the parameter of the room with one table toward the center. A sewing machine, bookshelves, caulk board gerbils, and plants were in this area.

### Activity Room Lighting

The room illumination was 2' x 4' fluorescent panels which were located in a staggered pattern throughout the room. Artificial illumination was used in this room. Except for the direct sunlight entering the emergency exit, only artificial light was present. Therefore, the light levels did not change throughout the day. Figures 28 and 29 show the quantity and balance of light for the area and the effect sunlight plays on the area. There are three extreme areas of illumination (1070 to 1560 lux) due to the light fixture locations, two of which are in the center of the room and the third is over the gerbil cage (which caused the gerbils to remain hidden all day). The reason for the large flux in light levels was due to the age of the fluorescent tubes. Because the table reflectance was 24% the location of the table over the light sources could be a source of discomfort glare. The reflectance percentages of the walls and floors were the same as

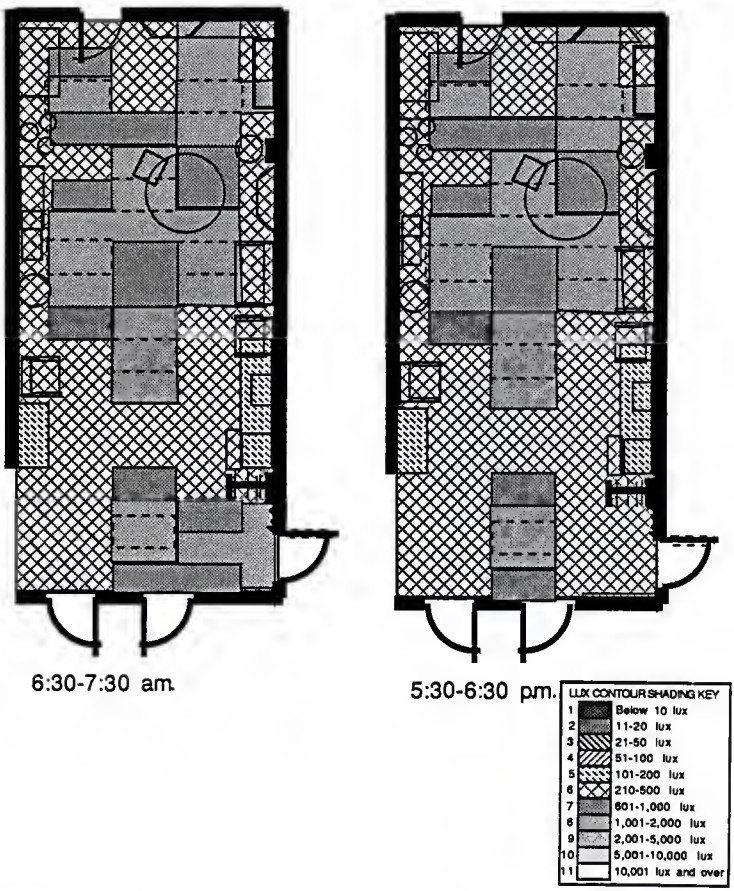



Figure 28. Quanity of Light Profile for the Activity Room. (The different shaded areas represented the location and level of lux in the area measured at 4 feet from the floor. Scale: 1/8" = 1' 0" North △)

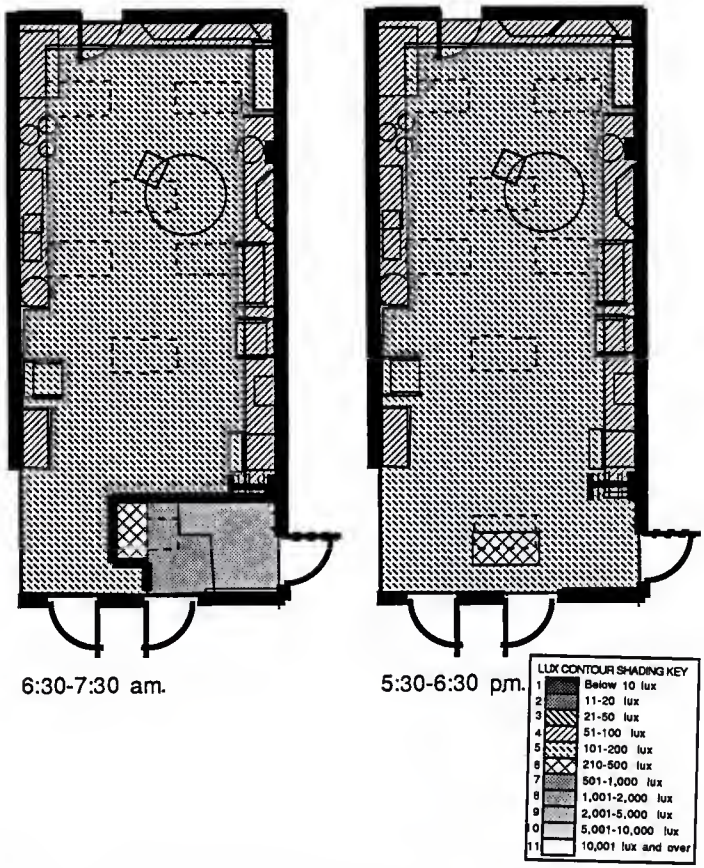



Figure 29. The Balance of Light Profile for The Activity Room. (The different shaded areas represented the location and level of lux in the area measured on the floor. The bold lines on the plans showed imbalance of light. Scale: 1/8" = 1'0" North Δ)

throughout the facility and did not promote glare unless direct sunlight was present. Figure 30 shows the presence of discomfort glare.

### Activity Room Behaviors

This area was not used for scheduled activities except once a month when staff helped residents make centerpieces for the dining tables. This activity was observed and combined with the other few; a total of 33 observations were made of this area. The only other observations included assist-propelled residents moving from private rooms to the elevator and two residents restrained in geriatric chairs sleeping (see Figure 31).

Assist propelled residents are normally not taken to the Activity Room by staff. Rather, they are typically placed near the elevator, nurses station, and in a windowless corridor. Mobility status may be a factor in area use. If residents did use the activity lounge and needed assistance, there would be no direct visual monitoring or routine checking of this area.

## Lower Lounge

### Physical Setting

This small lounge was located on the north side of the lower level (see Figure 8), an emergency exit and full-length windows were placed on the north. Bermed earth and an electrical generator blocked any exterior view. Blinds covered the windows and were slightly open. The seating was typical for the facility but two card tables and chairs were also included. This caused the area to be less open and less accessible by residents using wheelchairs. The wallcoverings and floor remained the same as in the Activity Room. The area was not heavily used.

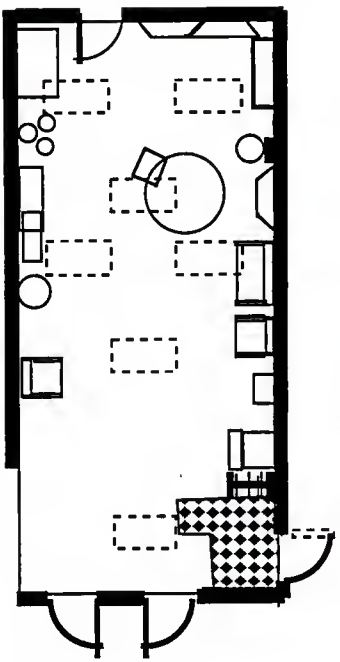



Figure 30. Discomfort glare Profile for The Activity Room. (A checked pattern on the plans showed the presence of discomfort glare. Scale: 1/8" = 1'0" North Δ)

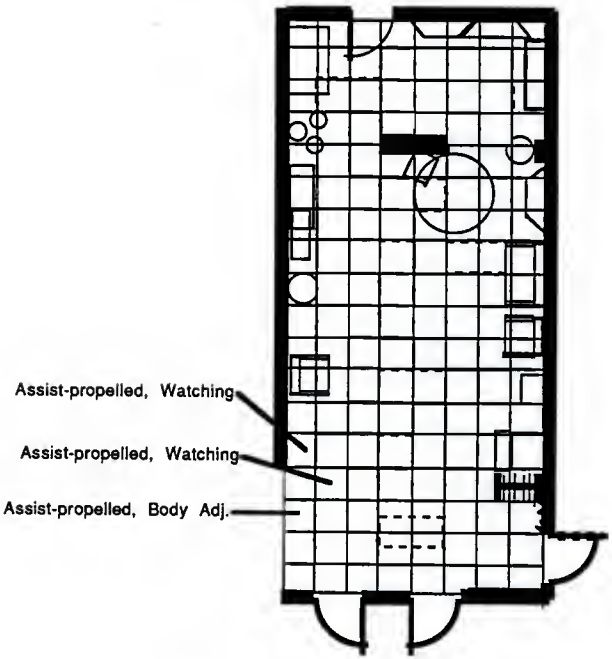



Figure 31. The Behavior Mapping of Residents in the Activity Room During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North ∆)

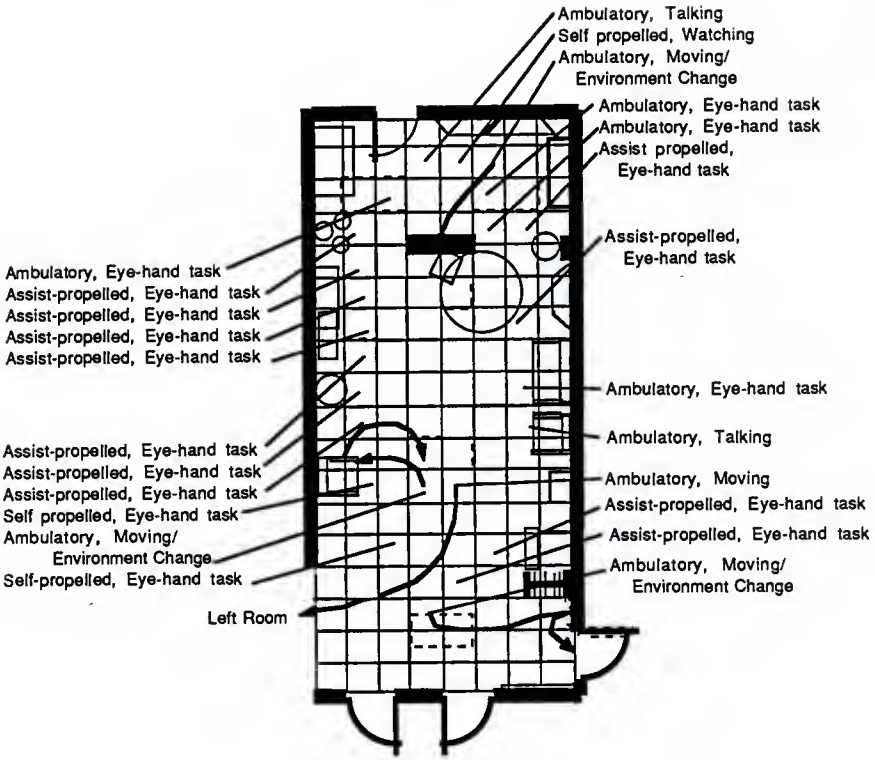



Figure 31, Continued. The Behavior Mapping of Residents in the Activity Room During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North ∆.)

## Lower Lounge Lighting

The two 2' x 4' fluorescent light fixtures were also typical of the facility and were centered in the room. Daylight did not contribute to the area because the blinds were only opened slightly and the room received no direct sunlight, therefore, the illumination profiles remained similar (see Figures 32 and 33). Some problems existed with furniture location matching the illumination locations. Either furniture was not located in areas of adequate illumination or structural walls and furniture prohibited self-propelled residents from maneuvering to those areas. Ambulatory residents did not move furniture to improved illumination areas. Some of the better illumination levels were in the center of rooms and furniture was set around the edge of the room. Lipman (1970), indicated the ways in which chair use in rigid layouts structured the life of residents in a home for the elderly. He further found residents experiencing "difficulties that might have been obviated by the provision of natural and artificial light for all possible chair positions, by windows allowing views of outside activities for all, and by sun protection for chairs exposed to the summer sun."

## Lower Lounge Behaviors

The Lower Lounge was used infrequently as shown in Figure 34 where only 5 total observations were recorded. The illumination levels were constant and not affected by direct sunlight. Observations showed that residents did not use the area because there were no adjacent bathrooms, no supportive services, and no adjacent activities. In addition, the staff were unable to see the residents from the active nurses station. KAR Codes

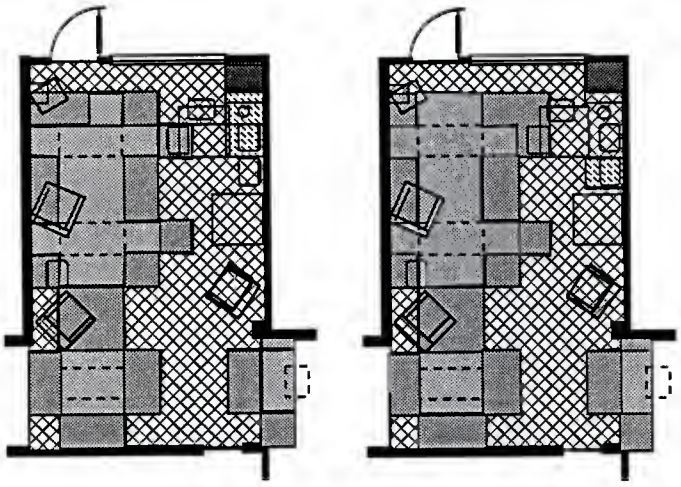



Figure 32. Quanity of Light Profile for the Lower Lounge. (The different shaded areas represented the location and level of lux in the area measured at 4 feet from the floor. Scale: 1/8" = 1' 0" North ⍙)

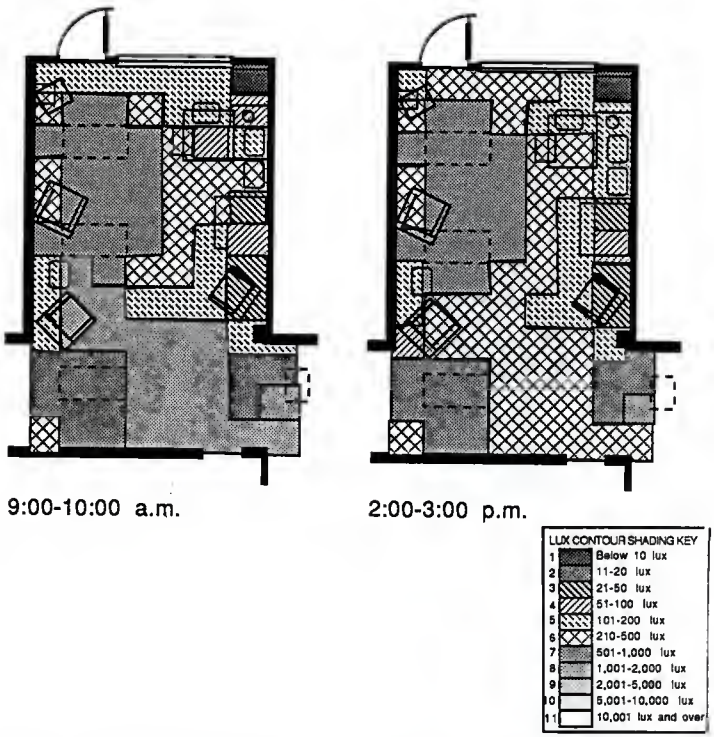



Figure 33. The Balance of Light Profile for The Lower Lounge. (The different shaded areas represented the location and level of lux in the area measured on the floor. The bold lines on the plans showed imbalance of light. Scale: 1/8" = 1'0" North Δ)

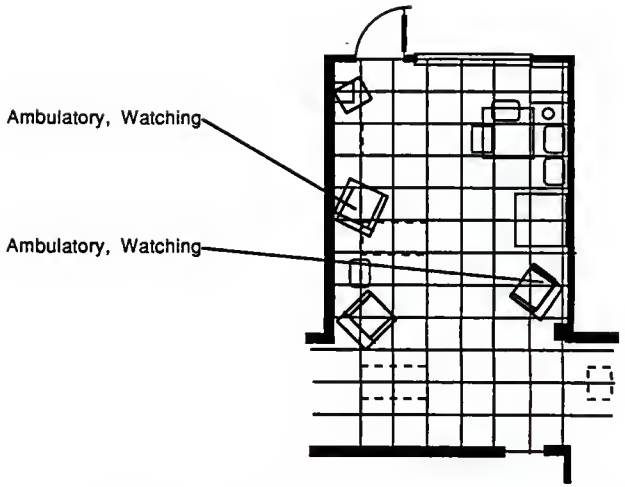



Figure 34. The Behavior Mapping of Residents in the Lower Lounge During One Day. (Observations were listed by mobility status, behavior/gesture, and location on the 2 foot grid plan. Scale: 1/8" = 1' 0" North ⌂)
10:00-11:00 a.m.

(28-39-109, 1987) required a quiet room for each facility for resident reading, meditation, solitude, or privacy with family or other residents and this area did meets those requirements.

Corridor Mobility

Physical Setting

The upper level main corridor was used as the site for the study of resident mobility. The corridor functioned as any corridor, a promenade or walkway. This particular section had handrails on one side of the hall that were blocked by furniture; therefore, residents did not have any structural assists for any of the distances. After walking ten feet east, residents turned and walked north ten feet toward the Dining Room, Entrance, and Offices. Only residents traveling in this direction were timed.

Lighting Description

The illumination was provided by 2' x 4' fluorescent fixtures located in the center of the corridor. The role of natural illumination on this area was controlled by using an afternoon observation, thus eliminating the presence of discomfort glare. Also, the view of residents while traveling T1 was down the east section which is neutral during the afternoon. The view of residents while traveling down T2 was the dining room. Resident selection for observation was random except that direction of travel had to be an east-north direction. As soon as one observation was recorded, the next resident coming into the zone of T1 was observed.

## Mobility Behavior

Residents moving within the corridor experienced an abrupt change in illumination within a short distance which should have created difficulties in light adaptation for aged individuals. It was anticipated that residents would take longer to traverse the first 10 feet due to delayed light/dark adaptation of the eye and other behaviors. Familiarity may have played a role in behaviors because residents showed no gesturing or changed body flow; however, there was a difference in the speed by mobility status.

# CHAPTER 4
# DISCUSSION AND INTERPRETATIONS

This section presents possible relationships between resident behavior profiles and lighting characteristics, constructs hypotheses about behavior and lighting which could be tested by further research, and proposes design conclusions based on the observational interpretations. First, a few general observations will be given.

The interpretation of the public area descriptions implied a strong relationship between the lighting characteristics and the behavioral attributes of residents which supported the theoretical basis of this study; however, the illumination of the area was not a predictor of frequency of area use. Rather, the convenience for the staff, bathroom locations, and adjacent services were more important factors for area selection of resident use.

This study also found that activities took place in areas which did not meet minimum code requirements for levels of illumination by the IES and KAR. The codes need refinement and are discussed later in this section. Interestingly, older adults will function under all levels of illumination but may not perform tasks or activities at optimum performance. For example, residents ate in extremely low or extremely high levels of illumination and the tasks were performed; but, their behavior implied a lower level of competence which increased staff workloads.

During observations, many residents with severe vision problems exhibited a behavior coined, Glare Cueing, which was the use of glare and shadow by older adults to provide additional information to cue

participation in activities and mobility. An example of this type of behavior was observed when a resident used glare as a cue to opening his mouth during syringe feeding by a staff member. The resident positioned his head so he looked directly at a fluorescent fixture. When the staff member 's arm passed in front of the resident's face just prior to inserting the syringe, the resident opened his mouth. However, for other residents (particularly senile dementia residents), discomfort glare and high levels of illumination appeared to contribute to behaviors which increased staff assistance and work. Some of those behaviors included: reduced watching, talking, and eye-hand tasks, increased disorientation and distractions; and increased aggressive acts or unacceptable behavior.

All illumination changes were decided and controlled by staff. It was observed that the more ambulatory the resident, the more likely illumination levels were matched to the resident needs. This was particularly true in the Corridor and Chapel & Lounge where residents positioned themselves in areas to improve singing, watching, or talking.

The familiarity of an area may have contributed to the constant speed of residents moving through a corridor. Even though the corridor contained dramatic imbalances of illumination, resident speed did not change. In some cases, familiarity did not help in mobility. Residents exhibited behavior related to light adaptation problems such as delayed gate, reaching for walls, and slowed mobility when entering brightly illuminated corridors from darker private rooms.

The format for presenting more specific environment/behavior relationships in this section included a statement of hypothesis drawn from the behavior and lighting profiles, design conclusions based on the

descriptive text, observational insights, and field notes. These interpretations were not ranked by importance but were categorized into three areas: Behavior and Illumination, Illumination Design and Facility Use, and Illumination Codes.

In conclusion, a Dining Room illumination design for residents of an intermediate care facility was described incorporating the proper use of lighting characteristics discussed in this study.

Behavioral Attributes and Lighting Characteristics: Research Hypotheses

1. If quantity of light matched the tasks performed by older adults, then independent participation and mobility would increase.

A. If the dining tables had illumination levels of 400 lux minimum but less than 1300 lux, then there would be a greater amount of conversation and social interaction during meals. Higher levels of illumination allow residents to see other faces more clearly which increases socialization. These levels were selected because 1300 lux seemed to spark aggression, unacceptable behavior, and increased demand for assist-feedings from senile dementia residents; but, 400 lux or below instigated coping gestures among Dining Room residents such as the use of flashlights.

B. If the dining tables had illumination levels of 400 lux minimum but less than 1300 lux, then eye-hand tasks would be performed more successfully and at first attempts. A poor fit or match existed between the present illumination levels of the Dining Room and resident needs. This was noted by observing residents using flashlights and feeling utensils for identification.

C. If the Garden Room had illumination levels of 400 lux minimum but less than 1300 lux, then there would be more self-feeding among senile dementia residents.

D. If the public areas were convenient for staff to care and transport residents, and contained or had nearby bathrooms, and provided adjacent services, then the frequency of area use would be determined by resident illumination needs. Illumination of an area was not a predictor of frequency of use or activity, rather staff convenience, bathrooms and adjacent services. Several examples supported this statement: (1) the Garden Room was used for feeding senile dementia residents while it was really suited for horticulture therapy. Even though other alternatives were available, staff convenience precluded resident illumination needs and required residents to sit in full sun. (2) The Chapel & Lounge illumination included discomfort glare, abrupt changes of illumination and did not meet the tasks for residents; it was used frequently for activities which should have been in the Activity Room on the lower level. The use of the Activity Room involved the transportation of residents via an elevator and was considered inconvenient and time consuming by staff. (3) The Lower lounge and Activity Room both provided higher illumination levels for eye-hand tasks with out discomfort glare, but their usage was minimal because of distant bathrooms, no staff supervision, and no scheduled activities.

E. If a variety of illumination types were available and accessible in public areas, then resident tasks would match illumination levels resulting in improved activity participation. Some residents needed specific task lighting in the Chapel & Lounge to participate successfully in group activities. The only portable task light in the facility was inaccessible to

residents using prosthetic devices.

F. If the illumination needs match the resident needs then the more likely the resident was to be ambulatory or self-propelled in mobility status.

2. If the light measured on the floor (balance of light) fluctuated gradually rather than abruptly, then independent activities and mobility of residents would increase.

If residents perceive shadows or pools of light on the floor as changes of floor level or physical obstacles then their mobility will alter to accommodate the imbalance of light. This perception may cause elderly to lose their balance and fall. Residents were observed walking around shadows and taking high steps when being walked for exercise in the corridor where imbalance of light was present.

3. If discomfort glare was removed from the public areas, then independent activities and mobility of residents would increase.

A. If carpeting was installed, then discomfort glare would be reduced or removed in all public areas. The reflectance percentage reduced from 17% for the tiled floor to 4% for the carpeted area. If carpeting was installed, then the mobility of residents would not be affected but imbalance of light and discomfort glare would be reduced. Resident mobility did not vary in carpeted areas of the facility when compared to uncarpeted areas. (It should be noted that the carpet was glued to the sub-flooring and no pad was used.)

B. If discomfort glare was removed, then watching, talking, and self-

feeding would increase as disorientation and distractions decreased, particularly for residents suffering from senile dementia.

C. If direct sunlight and glare were removed from an area, then aggressive behavior in senile dementia residents would be reduced or subside. It was observed that senile dementia residents while sitting in full sun were more irritable and had more emotional outburst (hitting staff while being fed) than during the evening meal when direct sunlight was not present.

D. If Glare Cueing was incorporated in the design of environments used by older adults, then they could function more independently by interpreting their environment better and engage in wayfinding easier. An example would include levers, handles and pulls designed to facilitate locating, grasping and manipulating the hardware visually on doors, drawers, or drinking fountains. Even the controls for window treatments, light fixtures, or equipment dials could be incorporated in Glare Cueing design. These products could be made of nickel/chromium coatings or other high gloss reflective finishes.

4. If illumination levels meet the needs of older adults, then their dependency on staff would be reduced and in effect improve self-image and reduce staff workloads.

If the dining tables had illumination levels of 400 lux minimum but less than 1300 lux, then there would be more food eaten without staff assistance because residents could see utensils, food, condiment packages, and function on a higher level of independence. This would reduce staff workload while improving the self-image of residents. Thus, in terms of

Lawton's ecological model, a fit between lighting and activity would reduce environmental demand which at a fixed level of competency would lead to more adaptive behavior.

5. If residents and the staff were educated regarding the effects quantity of light, balance of light and discomfort glare upon elderly then resident care would improve.

A. If the educational requirements for administrators, professional staff and para-professional staff were improved regarding illumination, then resident care would be improved. For example, during all observations, no employees of the intermediate care facility altered the window treatments in the Garden Room, an area which contained the most extreme levels of illumination. Increased illumination education could begin with in-service days and specific education requirements for staff. All staff dealing with older adults should be able to identify mobility and activity participation problems related to illumination.

B. If residents are educated and encouraged to change the illumination levels themselves, in their own care, then more instances would be observed where residents could be involved.

C. If staff did not encourage eye-hand activities in scheduled group gatherings, then residents would not self-instigate these activities. From all eye-hand tasks observed, 95% occurred during staff scheduled activities. Therefore, staff and residents should be aware that typically, higher levels of illumination are usually required for scheduled group activities and select areas that match need with activity.

Illumination Design and Building Use: Some Design Considerations

The illumination quality of the built environment had a dramatic effect upon the people who used it and the design hypotheses given below should be incorporated and evaluated in all facilities:

1) If the illumination design is flexible, then the residents and staff could more easily match the resident needs with the illumination levels. An example of this follows later in this section.

2) If the light fixtures receive periodic maintenance and cleaning, then the light fixtures would continue to produce maximum lux levels without additional cost to the facility. Dirt can cut light output by as much as 50% over the average life of a lamp.

3) If the potential for sunlight to shine directly inside is reduced, then discomfort glare is reduced. Sun control can be accomplished by using exterior and interior window treatments. Many different styles and types are available which filter sunlight, glare, and untraviolet rays, yet permit vision.

4) If large expanses of windows are used, even northern windows, then interior illumination should match the exterior brightness to reduce discomfort glare resulting from contrast extremes. This problem occurred in the Dining Room; the interior was so dark that the exterior appeared even brighter.

5) If carpeting is used throughout facility, then care should be given in selecting carpeting without intentional patterns or stripes which could be interpreted as steps or floor level changes. The best type of carpet should be a very tight, dense, level weave installed in a direct-glue process. It should also have a dimensional stability to prevent stretching, buckling or

delaminating.

6) If accent illumination is used in a facility, then it should not be installed in corridors or hallways where residents could interpret these patterns as steps or floor level changes. Rather, the fixtures can be used in areas for interest, texture, and variety such as highlighting a cluster of plants in a corner.

7) If administrators are educated on the advantages of low energy tubes and bulbs, then the facility will be more cost-effective. For example, Miser Fluorescent tubes use 34 watts compared to other four foot 40 watt tubes but put off the same lux levels. A Circlite™ 60 unit uses 22 watts and delivers the same amount of light as 60 watt household bulbs.

Illumination Codes: Some Suggestions

The codes are dealt with by all types of people using or working with nursing homes. Researchers and architects trained in environmental analyses should work with state legislators, officials, nursing home owners, administrators and designers to strengthen and expand the illumination codes for nursing homes. The descriptions and interpretations of this research produced number of suggestions for code improvements or recommendations given below. These suggestions are not criticisms of current codes but rather a recognition for needed information.

1) Visibility depends more on the specific task being performed and may not be met by the code for the area; therefore, a review of the current KAR codes is recommended. For example, because the Corridor was wider and used as a holding area for residents who were assist-propelled, reading

was observed in this area. Codes did not allow portable task lighting to be in this area, thus the illumination levels and codes did not meet the reading needs of the resident. (KAR codes do not allow portable lamps in any area except "the living room or recreation room").

2) Administrators rely on architects for initial illumination levels, but as bulbs and tubes are replaced, they may be replaced with lower wattage bulbs which produce lower lumen; therefore, there needs to be a systematic way for health care facilities to be checked regularly regarding lighting levels. Also, facility managers would benefit from a lighting manual prepared by the architect that educated them of the use and versatility of the facility. The facility observed had several public areas that were below KAR codes.

3) Corridors function in multiple ways and therefore require higher illumination levels than the recommended 100 lux, preferably a minimum of 250 lux 0' FFL. Residents were observed in the corridor reading the newspaper while others gathered for socialization.

4) Resident activities took place under all lighting conditions regardless of quantity of light, balance of light, and glare. Codes should address all three characteristics of light, as well as issues of safety. Imbalance of light and glare can cause misinterpretations of surfaces and lead to accidents among residents.

5) Activity participation categories and mobility occurred on a broad spectrum of illumination levels (in and out of recommended state codes for illumination); therefore, the act of task performance does not infer optimum performance and specific illumination levels should have not only minimum but maximum illumination level requirements to control discomfort glare.

6) Illumination codes should meet compliance for wheelchair-bound, as well as ambulatory, residents. For example, a fixture can be shaded for someone standing but becomes a bare bulb exposure for a resident in a wheelchair. Although the KAR codes state that globes and shades for chandeliers are acceptable, a frosted globe or cylinder does not reduce glare and should be considered a bare bulb .

An Illumination Design Example

The following design suggestions for a Dining Room in an intermediate care facility but can be applied to other areas and serve only as an example of the relationship between lighting characteristics and behavioral attributes. The design includes the uniform balance of light, the removal of glare, and a flexible illumination design which meets the quantity of light for resident needs.

Foremost, the Dining Room illumination design should be flexible because the area could serve many purposes in one day. Therefore, track lighting is recommended because of the variety of fixture styles which could be snapped in place along the tracks. For example, if a group would perform, a special spot light could be easily installed during the hour presentation and removed afterwards, or left in place for further performances. Recommended for this area would be height-adjustable suspended lamps covered with a glare preventive shade which would hang low enough to illumine dinner plates at 400 lux yet not shine directly into the eyes of residents (about 2 feet from the table top). The tubes used in the lamps would be a Circlite™ 60 unit which uses 22 watts as compared to a 60 watt household bulb but delivers the same amount of light. This is cost

effective to the facility. After dinner, the track lighting could be pushed up to a higher location or even removed and stored if the task lighting was not needed in that area. The higher illumination levels near the dinner plates would improve vision for eye-hand tasks and activity participation, thus improving resident self-image and independent behaviors. Conversation would increase and socialization would become easier for residents because the lamps would also provide indirect illumination of resident faces which would soften and enhance their facial features. Indirect illumination in cove-type fixtures would also be installed in the Dining Room for better balance of light. These fixtures would be controlled by dimmer switches for the adjustment with exterior illumination on gray or sunny days. This design would increase the likelihood of tasks matching the resident needs. The area would also be carpeted to reduce glare and window treatments installed which could be reached and controlled by residents for visibility to the exterior while simultaneously controlling the direction of natural illumination entering the area.

Illumination can also make an area inviting and need not be harsh or glaring. Indirect illumination such as cove lighting is recommended in hallways, rather than fluorescent strip lighting, to reduce glare potential from reflective surfaces. Indirect illumination can also be used to wall wash the area, define the ceiling, and highlight handrails, all without the type of glare currently experienced in this facility

A need exists for further research in care facilities for older adults in terms of resident needs, usage, vision, and architectural evaluation of illumination. Research should include not only unobtrusive observation but a variety of data collecting techniques. Ideally an area with closed monitored

cameras where illumination could be altered in discrete ways comparing changes in illumination levels and resident behavior should be provided. This area would also include interviews with staff and residents in informal conversations and questionnaires. Such a study should include seasonal changes in illumination, sunlight exposure of residents and also compare medication and treatment schedules. This type of all inclusive study could provide extensive information for improved older adult design, behavior, and illumination.

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# APPENDIX

Table 1, Appendix. IES Recommended Illuminance Categories. (Levels 1-11 were used as guides for this research. Categories in bold type were recommended illuminance levels for specific nursing home resident tasks.)

| Level/ Illuminance (Lux) | | Type of Activities |
|---|---|---|
| level 1: | below 10 lux | |
| level 2: | 11-20 lux | Not recommended for over age 55 |
| level 3: | 21-50 lux | or nursing homes |
| **level 4:** | **51-100 lux** | Public spaces with dark surroundings<br>General lighting throughout spaces |
| **level 5:** | **101-200 lux** | Simple orientation for short temporary visits |
| **level 6:** | **201-500 lux** | Performance of visual tasks of high contrast or large size. No levels recommended above 500 lux for nursing home public areas |
| level 7: | 501-1,000 lux | Performance of visual tasks of medium contrast or small size, Illuminance on task |

Table 1, Appendix, Continued. IES Recommended Illuminance Categories. (Levels 1-11 were used as guides for this research. Categories in bold type were recommended illuminance levels for specific nursing home resident tasks.)

| Level/ Illuminance (Lux) | Type of Activities |
|---|---|
| level 8: 1,001-2,000 lux | Performance of visual tasks of low contrast or very small size Illuminance on task, obtained by a combination of general and local (supplementary lighting) |
| level 9: 2,001-5,000 lux | Performance of visual tasks of low contrast and very small size over a prolonged period |
| level 10: 5,001-10,000 lux | Performance of very prolonged and exacting visual tasks |
| level 11: above10,001 lux | Performance of very special visual tasks of extremely low contrast and small size |

Table 2, Appendix. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 1, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

CHAPEL & LOUNGE

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 a.m. | | | | | |
| No behavioral activities took place at this time | | | | | |
| 9:00-10:00 a.m. | | | | | |
| Eye-hand task | 1260 | Self propelled | N-7 | | □ |
| Eye-hand task | 230 | Self propelled | M-7 | * | □ |
| Eye-hand task | 340 | Ambulatory | M-6 | * | □ |
| Talking | 400 | Ambulatory | M-5 | * | □ |
| Talking | 300 | Ambulatory | T-7 | * | |
| Talking | 230 | Ambulatory | T-6 | * | |
| Eye-hand task | 230 | Ambulatory | T-6 | * | |
| Watching | 300 | Assist-propelled | R-2 | * | |
| Watching | 430 | Ambulatory | P-8 | * | |
| Watching | 130 | Self propelled | N-2 | * | |
| Watching/shield. face | 1260 | Assist-propelled | N-7 | | □ |
| Watching/shield. face | 800 | Assist-propelled | C-6 | | □ |
| Watching | 510 | Assist-propelled | Q-2 | | |
| Watching | 240 | Assist-propelled | R-8 | | |
| Watching/body adj. | 430 | Self Propelled | Q-8 | | |
| Watching/body adj. | 360 | Self propelled | O-8 | | |
| Watching | 320 | Assist-propelled | O-2 | * | |
| Watching | 150 | Assist-propelled | K-6 | | |
| Watching | 140 | Assist-propelled | K-8 | | |
| Eye-hand task | 230 | Self propelled | T-6 | * | |
| Watching | 340 | Ambulatory | D-9 | | |
| Watching | 400 | Ambulatory | M-5 | * | □ |
| Watching | 300 | Ambulatory | T-7 | * | |

Table 2, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 1, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

CHAPEL & LOUNGE

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| Glare 9:00-10:00 a.m. | | | | | |
| Talking | 230 | Ambulatory | M-7 | * | □ |
| Talking | 30 | Ambulatory | T-3 | * | |
| Watching | 300 | Assist Propelled | T-7 | * | |
| Eye-hand task | 430 | Ambulatory | S-8 | * | |
| Talking | 130 | Self propelled | K-4 | * | |
| Talking/adjust body | 1260 | Assist Propelled | N-7 | | □ |
| Talking/Phys. Tch. Eye | 800 | Assist Propelled | P-2 | * | |
| Watching | 510 | Assist Propelled | Q-2 | | |
| Talking | 240 | Assist propelled | D-4 | | |
| Eye-hand task | 40 | Self propelled | T-4 | * | |
| Watching/Optical Adj. | 360 | Ambulatory | O-8 | | |
| Eye-hand task | 320 | Assist propelled | O-2 | * | |
| Eye-hand task | 150 | Assist propelled | K-6 | | |
| Talking | 140 | Assist propelled | S-2 | * | |
| Watching | 230 | Self propelled | M-7 | * | □ |
| Talking | 340 | Ambulatory | E-9 | | |
| Talking | 400 | Ambulatory | M-5 | * | □ |
| Eye-hand task | 300 | Ambulatory | T-7 | * | |
| Watching | 230 | Ambulatory | M-7 | * | □ |
| Talking | 230 | Ambulatory | T-6 | * | |
| Watching | 300 | Assist-propelled | M-4 | * | □ |
| Eye-hand task/ shield. face | 640 | Self propelled | D-7 | | □ |
| Talking | 560 | Self propelled | D-6 | | □ |

Table 2, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 1, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

CHAPEL & LOUNGE

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 9:00-10:00 a.m. | | | | | |
| Eye-hand task/ shield. face | 470 | Self propelled | N-5 | * | □ |
| Talking | 340 | Self propelled | P-3 | | |
| Watching/phys. touch. | 290 | Assist-propelled | E-8 | | |
| Watching/phys. touch | 280 | Assist-propelled | E-7 | | |
| Talking | 410 | Ambulatory | D-5 | | □ |
| Talking | 240 | Ambulatory | E-6 | | |
| Talking/shielding face | 210 | Ambulatory | D-3 | | |
| Eye-hand task/ shield. face | 160 | Ambulatory | G-3 | | |
| Watching | 110 | Ambulatory | G-4 | | |
| Watching | 130 | Ambulatory | G-5 | | |
| Talking | 120 | Ambulatory | I-3 | | |
| Talking | 140 | Ambulatory | I-4 | | |
| Talking | 140 | Ambulatory | I-5 | | |
| Eye-hand task | 130 | Ambulatory | K-5 | | |
| Eye-hand task/Body Adj. | 500 | Assist-propelled | N-6 | * | □ |
| Talking | 340 | Assist propelled | M-6 | * | □ |
| Talking | 130 | Self propelled | N-2 | * | □ |
| Eye-hand task | 400 | Ambulatory | M-5 | * | □ |
| 11:30-12:30 p.m. | | | | | |
| No behavioral activities took place in this area. | | | | | |
| 2:00-3:00 pm | | | | | |
| Watching | 230 | Self propelled | T-6 | | |
| Watching | 160 | Ambulatory | T-4 | * | |

Table 2, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 1, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

CHAPEL & LOUNGE

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 2:00-3:00 p.m. | | | | | |
| Watching | 160 | Ambulatory | R-2 | * | |
| Watching | 210 | Ambulatory | T-5 | | |
| Watching | 270 | Ambulatory | T-7 | * | |
| Watching | 430 | Ambulatory | R-8 | | |
| Watching | 560 | Assist-propelled | P-8 | | |
| Talking | 840 | Ambulatory | O-8 | * | |
| Talking/body adj. | 6000 | Self propelled | N-8 | * | |
| Talking/shield. face | 5300 | Assist-propelled | M-7 | * | |
| Talking/shield. face | 2600 | Assist-propelled | M-6 | * | |
| Talking-shield. face | 1200 | Assist-propelled | M-4 | * | |
| Sleeping | 160 | Self propelled | T-4 | * | |
| Sleeping | 440 | Assist-propelled | Q-1 | | |
| Talking | 1020 | Assist-propelled | N-3 | | |
| Talking | 200 | Assist-propelled | O-1 | | |
| Watching | 230 | Self propelled | T-6 | | |
| Watching | 160 | Ambulatory | R-2 | * | |
| Watching | 160 | Ambulatory | T-4 | * | |
| Watching | 210 | Ambulatory | T-5 | | |
| Watching | 270 | Ambulatory | T-7 | * | |
| Watching | 430 | Ambulatory | R-8 | | |
| Talking | 560 | Self propelled | P-8 | | |
| Talking | 840 | Ambulatory | O-8 | * | |
| Talking/adj. body | 6000 | Self propelled | N-8 | * | |
| Talking/shielding face | 5300 | Assist-propelled | M-7 | * | |
| Talking | 2600 | Assist-propelled | M-6 | * | |

Table 2, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 1, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

CHAPEL & LOUNGE

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 2:00-3:00 p.m. | | | | | |
| Talking | 1200 | Assist-propelled | M-4 | * | |
| Sleeping | 160 | Self propelled | S-4 | * | |
| Sleeping | 440 | Assist-propelled | Q-1 | | |
| Sleeping | 1020 | Assist-propelled | N-3 | * | |
| Talking | 200 | Assist-propelled | Q-5 | | |
| Talking | 230 | Self propelled | S-6 | | |
| Talking | 160 | Ambulatory | S-4 | * | |
| Eye-hand task | 160 | Ambulatory | R-2 | * | |
| Eye-hand task | 210 | Ambulatory | T-5 | | |
| Eye-hand task | 270 | Ambulatory | T-7 | * | |
| Watching | 430 | Ambulatory | R-8 | | |
| Watching | 560 | Assist-propelled | P-8 | | |
| Watching | 840 | Ambulatory | O-8 | * | |
| Watching | 6000 | Self propelled | N-8 | * | |
| Watching | 5300 | Assist-propelled | M-7 | * | |
| Talking | 2600 | Assist-propelled | M-6 | * | |
| Watching | 1200 | Assist-propelled | M-4 | * | |
| Sleeping | 160 | Self propelled | R-2 | * | |
| Sleeping | 440 | Assist-propelled | Q-1 | | |
| 5:30-6:30 p.m | | | | | |
| No behavioral activities observed at this time. | | | | | |

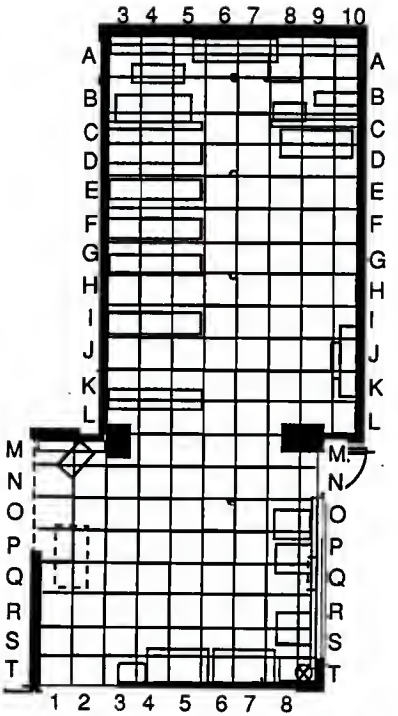


Figure 1, Appendix. A Map Keyed to Locations for Chapel & Lounge Behaviors from Table 2, Appendix. (Behaviors were located by row/letter, column/number. Scale: 1/8" = 1'0" North Δ.)

Table 3, Appendix. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 2, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

GARDEN ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 a.m. | | | | | |
| Watching/body adj. | 11140 | Assist-propelled | G-7 | * | □ |
| Eye-hand task/ shielding face | 1530 | Assist-propelled | E-6 | * | □ |
| Eye-hand task/ shielding face | 1200 | Ambulatory | D-6 | * | |
| Eye-hand task | 1250 | Assist-propelled | B-6 | | |
| Moving | 930 | Assist-propelled | B-5 | * | |
| Moving | 1040 | Assist-propelled | E-2 | * | |
| Watching | 1600 | Assist-propelled | D-4 | * | □ |
| Eye-hand task/ shielding face | 1380 | Assist-propelled | B-2 | | |
| 9:00-10:00 a.m. | | | | | |
| No behavioral activities were observed in this area. | | | | | |
| 11:30-12:30 p.m. | | | | | |
| Watching/body adj. | 13060 | Assist-propelled | G-6 | * | □ |
| Eye-hand task/ shielding face | 12700 | Assist-propelled | E-6 | * | □ |
| Eye-hand task/ shielding face | 12290 | Ambulatory | D-6 | * | □ |
| Eye-hand task | 6440 | Assist-propelled | B-6 | * | □ |
| Eye-hand task | 1270 | Assist-propelled | B-5 | * | □ |
| Eye-hand task | 1800 | Assist-propelled | E-2 | * | |
| Watching | 2060 | Assist-propelled | D-4 | * | □ |
| Watching | 1890 | Assist-propelled | C-2 | * | |
| Eye-hand task | 13060 | Assist-propelled | G-6 | * | □ |

Table 3, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 2, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

GARDEN ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 11:30-12:30 p.m. | | | | | |
| Eye-hand task | 12700 | Assist-propelled | E-6 | * | □ |
| Eye-hand task/ unacceptable behav. | 12290 | Assist-propelled | D-6 | * | □ |
| Eye-hand task | 6440 | Assist-propelled | B-6 | * | □ |
| Eye-hand task | 1270 | Assist-propelled | B-5 | * | □ |
| Eye-hand task | 1800 | Assist-propelled | E-2 | * | |
| Eye-hand task | 2060 | Assist-propelled | D-4 | * | □ |
| Eye-hand task | 1890 | Assist-propelled | C-2 | * | |
| Eye-hand task/ body adj. | 13060 | Assist-propelled | G-6 | * | □ |
| Eye-hand task | 12700 | Assist-propelled | E-6 | * | □ |
| Eye-hand task/ unacceptable behav. | 12290 | Ambulatory | D-6 | * | □ |
| Eye-hand task | 6440 | Assist-propelled | B-6 | * | □ |
| Eye-hand task | 1270 | Assist-propelled | B-5 | * | □ |
| Eye-hand task | 1800 | Assist-propelled | E-2 | * | |
| Eye-hand task | 2060 | Assist-propelled | D-4 | * | □ |
| Eye-hand task | 1890 | Assist-propelled | C-2 | * | |
| 2:00-3:00 p.m. | | | | | |
| No behavioral activities were recorded for this area. | | | | | |
| 5:50-6:30 p.m. | | | | | |
| Watching/body adj. | 1800 | Assist-propelled | G-6 | * | □ |
| Eye-hand task | 1300 | Assist-propelled | E-6 | * | □ |
| Watching/ shielding face | 2060 | Ambulatory | D-4 | | □ |

Table 3, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 2, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

GARDEN ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 5:30-6:30 p.m. | | | | | |
| Moving | 1500 | Assist-propelled | B-6 | * | |
| Moving | 1890 | Assist-propelled | B-5 | * | |
| Moving | 1800 | Assist-propelled | E-2 | | |
| Eye-hand task | 1800 | Assist-propelled | D-4 | | □ |
| Eye-hand task | 800 | Assist-propelled | C-2 | * | |

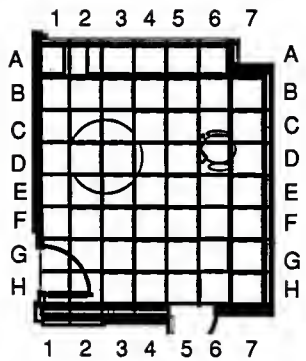


Figure 2, Appendix. A Map Keyed to Locations for Garden Room Behaviors from Table 3, Appendix. (Behaviors were located by row/letter, column/number. Scale: 1/8" = 1'0" North Δ.)

Table 4, Appendix. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 p.m. | | | | | |
| Watching | 90 | Ambulatory | X-2 | | |
| Talking | 90 | Self propelled | V-4 | | |
| Watching | 90 | Self propelled | V-2 | | |
| Watching | 90 | Ambulatory | V-1 | | |
| Watching | 70 | Self-propelled | V-8 | | |
| Talking | 70 | Ambulatory | V-9 | | |
| Talking | 70 | Self propelled | S-8 | | |
| Watching | 70 | Self-propelled | T-7 | | |
| Eye-hand task | 60 | Ambulatory | T-11 | | |
| Eye-hand task | 60 | Self propelled | S-12 | | |
| Eye-hand task | 60 | Self propelled | Q-12 | | |
| Watching | 60 | Self propelled | R-10 | | |
| Eye-hand task | 60 | Assist-propelled | P-11 | | |
| Eye-hand task | 60 | Ambulatory | M-12 | | |
| Eye-hand task | 60 | Ambulatory | M-10 | | |
| Eye-hand task | 60 | Ambulatory | O-10 | | |
| Watching | 80 | Assist-propelled | P-9 | | |
| Watching | 80 | Assist-propelled | Q-8 | | |
| Watching | 80 | Assist-propelled | P-7 | | |
| Eye-hand task | 40 | Ambulatory | R-3 | | |
| Eye-hand task | 40 | Ambulatory | Q-4 | | |
| Eye-hand task/ shielding face | 40 | Assist-propelled | P-2 | | |
| Watching | 40 | Assist-propelled | R-1 | | |
| Eye-hand task | 60 | Ambulatory | L-8 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 a.m. | | | | | |
| Eye-hand task | 51 | Ambultory | L-6 | | |
| Eye-hand task | 51 | Self-propelled | V-6 | | |
| Eye-hand task | 51 | Self-propelled | N-8 | | |
| Eye-hand task | 60 | Assist-propelled | L-2 | | |
| Eye-hand task | 60 | Assist-propelled | J-12 | | |
| Eye-hand task | 51 | Ambulatory | G-12 | | |
| Watching | 51 | Assist-propelled | G-11 | | |
| Talking | 60 | Assist-propelled | I-10 | | |
| Talking | 51 | Assist-propelled | V-2 | | |
| Watching | 51 | Assist-propelled | M-1 | | |
| Eye-hand task | 51 | Assist-propelled | M-2 | | |
| Watching/ shielding face | 51 | Assist-propelled | M-4 | | |
| Eye-hand task | 51 | Assist-propelled | Q-4 | | |
| watching | 60 | Self-propelled | H-3 | | |
| Talking | 60 | Self-propelled | G-2 | | |
| Watching | 70 | Ambultory | H-1 | | |
| Eye-hand task | 80 | Self-propelled | D-3 | | |
| Eye-hand task | 80 | Self-propelled | C-4 | | |
| Talking | 80 | Ambulatory | B-3 | | |
| Talking | 80 | Ambulatory | C-2 | | |
| Talking | 60 | Ambulatory | F-10 | | |
| Watching/ shielding face | 60 | Self-propelled | D-12 | | |
| Eye-hand task | 60 | Ambulatory | D-9 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 a.m. | | | | | |
| Eye-hand task | 90 | Ambulatory | X-2 | | |
| Eye-hand task | 90 | Self-propelled | V-4 | | |
| Eye-hand task | 90 | Self-propelled | U-2 | | |
| Talking | 90 | Ambulatory | V-1 | | |
| Eye-hand task | 70 | Self-propelled | V-8 | | |
| Watching | 70 | Ambulatory | U-9 | | |
| Watching | 70 | Self-propelled | S-8 | | |
| Eye-hand task | 70 | Self-propelled | T-7 | | |
| Eye-hand task | 60 | Ambulatory | T-11 | | |
| Eye-hand task | 60 | Self-propelled | S-12 | | |
| Eye-hand task | 60 | Self-propelled | Q-12 | | |
| Eye-hand task | 60 | Self-propelled | R-10 | | |
| Talking | 60 | Assist-propelled | O-10 | | |
| Watching | 60 | Ambulatory | O-12 | | |
| Eye-hand task | 60 | Ambulatory | M-12 | | |
| Eye-hand task | 60 | Ambulatory | M-10 | | |
| Eye-hand task | 80 | Assist-propelled | P-9 | | |
| Talking | 80 | Assist-propelled | Q-8 | | |
| Watching | 80 | Assist-propelled | P-7 | | |
| Watching | 40 | Ambulatory | R-3 | | |
| Watching | 40 | Ambulatory | Q-4 | | |
| Eye-hand task | 40 | Assist-propelled | P-2 | | |
| Eye-hand task | 40 | Assist-propelled | R-1 | | |
| Eye-hand task | 60 | Ambulatory | N-2 | | |
| Eye-hand task | 60 | Ambulatory | M-3 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 a.m. | | | | | |
| Eye-hand task | 60 | Self-propelled | L-2 | | |
| Eye-hand task | 60 | Self-propelled | M-1 | | |
| Eye-hand task | 60 | Assist-propelled | N-8 | | |
| Eye-hand task | 60 | Assist-propelled | L-8 | | |
| Eye-hand task | 60 | Ambulatory | L-6 | | |
| Eye-hand task | 60 | Assist-propelled | N-6 | | |
| Eye-hand task | 60 | Assist-propelled | I-13 | | |
| Talking | 60 | Assist-propelled | G-13 | | |
| Talking | 60 | Assist-propelled | G-12 | | |
| Talking | 60 | Assist-propelled | I-10 | | |
| Talking | 60 | Assist-propelled | G-8 | | |
| Eye-hand task/ shielding face | 60 | Assist-propelled | F-7 | | |
| Watching | 70 | Assist-propelled | G-6 | | |
| Watching | 70 | Self-propelled | H-3 | | |
| Talking | 70 | Self-propelled | G-2 | | |
| Talking | 80 | Self-propelled | D-3 | | |
| Talking | 30 | Self-propelled | C-4 | | |
| Eye-hand task | 70 | Ambultory | B-3 | | |
| Eye-hand task | 70 | Ambulatory | C-2 | | |
| Eye-hand task | 70 | Ambulatory | F-10 | | |
| Watching | 60 | Self-propelled | D-12 | | |
| Watching | 60 | Ambulatory | D-9 | | |
| 9:00-10:00 a.m. | | | | | |
| No activities were observed during this time. | | | | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Lignt Present | Glare |
|---|---|---|---|---|---|
| 11:30-12:30 p.m. | | | | | |
| Watching/ shielding face | 90 | Ambulatory | X-2 | | |
| Talking/body adj. | 100 | Self-propelled | V-4 | | |
| Watching | 100 | Self-propelled | U-2 | | |
| Watching | 90 | Ambulatory | V-1 | | |
| Watching | 70 | Self-propelled | V-8 | | |
| Talking | 70 | Ambulatory | U-9 | | |
| Talking | 80 | Self-propelled | S-8 | | |
| Watching | 80 | Self-propelled | T-7 | | |
| Eye-hand task | 60 | Ambulatory | T-11 | | |
| Eye-hand task | 60 | Self-propelled | S-12 | | |
| Eye-hand task | 60 | Self-propelled | Q-12 | | |
| Watching | 60 | Assist-propelled | R-10 | | |
| Eye-hand task | 60 | Assist-propelled | O-10 | | |
| Eye-hand task | 60 | Ambulatory | O-12 | | |
| Eye-hand task | 60 | Ambulatory | M-12 | | |
| Eye-hand task | 60 | Ambulatory | M-10 | | |
| Watching | 90 | Assist-propelled | P-9 | | |
| Watching | 80 | Assist-propelled | Q-8 | | |
| Watching | 80 | Assist-propelled | P-7 | | |
| Eye-hand task/ body adj. | 40 | Ambulatory | R-3 | | |
| Eye-hand task/ body adj. | 40 | Ambulatory | Q-4 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 11:30-12:30 p.m. | | | | | |
| Eye-hand task/ shielding face | 40 | Assist-propelled | P-2 | | |
| Watching/ phys. touch. | 40 | Assist-propelled | R-1 | | |
| Eye-hand task | 50 | Ambulatory | N-2 | | |
| Eye-hand task | 60 | Ambulatory | M-3 | | |
| Eye-hand task | 50 | Self-propelled | L-2 | | |
| Eye-nand task | 60 | Self-propelled | M-1 | | |
| Eye-hand task | 60 | Assist-propelled | N-8 | | |
| Eye-hand task | 50 | Assist-propelled | L-8 | | |
| Eye-hand task | 60 | Ambulatory | N-6 | | |
| Watching | 60 | Assist-propelled | L-6 | | |
| Talking | 60 | Assist-propelled | J-13 | | |
| Talking | 60 | Assist-propelled | G-13 | | |
| Watching | 60 | Assist-propelled | G-12 | | |
| Eye-hand task | 60 | Assist-propelled | I-10 | | |
| Watching/ shielding face | 50 | Assist-propelled | G-9 | | |
| Eye-hand task | 50 | Assist-propelled | F-9 | | |
| Watching | 60 | Ambulatory | F-10 | | |
| Talking | 60 | Self-propelled | D-12 | | |
| Watching | 60 | Ambulatory | D-9 | | |
| Eye-nand task | 70 | Self-propelled | D-3 | | |
| Eye-hand task | 70 | Self-propeled | C-4 | | |
| Talking | 70 | Ambulatory | B-3 | | |
| Talking | 70 | Ambulatory | C-2 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 11:30-12:30 p.m. | | | | | |
| Talking | 60 | Ambulatory | F-10 | | |
| Watching/shielding face | 60 | Self-propelled | D-12 | | |
| Eye-hand task | 70 | Ambulatory | D-9 | | |
| Eye-hand task | 100 | Ambulatory | X-2 | | |
| Eye-hand task | 100 | Self-propelled | V-4 | | |
| Eye-hand task | 100 | Self-propelled | U-2 | | |
| Talking | 100 | Ambulatory | V-1 | | |
| Eye-hand task | 80 | Self-propelled | V-8 | | |
| Watching | 80 | Ambulatory | U-9 | | |
| Watching | 80 | Self-propelled | S-8 | | |
| Eye-hand task | 70 | Self-propelled | T-7 | | |
| Eye-hand task | 60 | Ambulatory | T-11 | | |
| Eye-hand task | 60 | Self-propelled | S-12 | | |
| Eye-hand task | 60 | Self-propelled | Q-12 | | |
| Eye-hand task | 70 | Assist-propelled | R-10 | | |
| Talking | 60 | Assist-propelled | O-10 | | |
| Watching | 60 | Ambulatory | O-12 | | |
| Eye-hand task | 70 | Ambulatory | M-12 | | |
| Eye-hand task | 70 | Ambulatory | M-10 | | |
| Eye-hand task | 80 | Assist-propelled | P-9 | | |
| Talking | 80 | Assist-propelled | Q-8 | | |
| Watching | 80 | Assist-propelled | P-7 | | |
| Watching/ phys. touch. | 40 | Ambulatory | R-3 | | |
| Watching/phys. touch | 40 | Ambulatory | Q-4 | | |
| Eye-hand task | 50 | Assist-propelled | P-2 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 11:30-12:30 p.m. | | | | | |
| Eye-hand task | 50 | Assist-propelled | R-1 | | |
| Eye-hand task | 60 | Ambulatory | N-2 | | |
| Eye-hand task | 50 | Ambulatory | M-4 | | |
| Eye-hand task | 60 | Self-propelled | L-2 | | |
| Talking | 60 | Self-propelled | M-1 | | |
| Talking | 60 | Assist-propelled | N-8 | | |
| Eye-hand task | 60 | Assist-propelled | L-8 | | |
| Eye-hand task | 50 | Assist-propelled | L-6 | | |
| Eye-hand task | 60 | Ambulatory | N-6 | | |
| Eye-hand task | 60 | Assist-propelled | I-13 | | |
| Eye-hand task | 60 | Assist-propelled | G-13 | | |
| Talking | 60 | Assist-propelled | G-12 | | |
| Talking | 60 | Assist-propelled | I-10 | | |
| Talking | 60 | Assist-propelled | G-8 | | |
| Talking | 60 | Assist-propelled | F-7 | | |
| Eye-hand/ shielding face | 50 | Assist-propelled | G-6 | | |
| Watching | 70 | Self-propelled | H-3 | | |
| Talking | 70 | Self-propelledq | G-2 | | |
| Watching | 60 | Ambulatory | H-1 | | |
| Watching | 80 | Self-propelled | D-3 | | |
| Watching | 80 | Self propelled | C-4 | | |
| Eye-hand task | 70 | Ambulatory | B-3 | | |
| Eye-hand task | 70 | Ambulatory | C-2 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 11:30-12:30 p.m. | | | | | |
| Eye-hand task | 70 | Ambulatory | F-10 | | |
| Watching | 70 | Self-propelled | D-12 | | |
| Watching | 70 | Ambulatory | D-9 | | |
| 2:00-3:00 p.m. | | | | | |
| Eye-hand task | 50 | Ambulatory | R-3 | | |
| Eye-hand task | 60 | Ambulatory | M-3 | | |
| Eye-hand talk | 50 | Ambulatory | Q-4 | | |
| Talking | 50 | Assist-propelled | R-1 | | |
| Talking | 60 | Self-propelled | H-3 | | |
| Talking | 60 | Assist-propelled | I-10 | | |
| Talking | 50 | Ambulatory | Q-4 | | |
| Talking/phys. touch. | 50 | Ambulatory | R-3 | | |
| Talking | 50 | Assist-propelled | P-2 | | |
| Eye-hand task/ optical adj. | 50 | Assist-propelled | R-1 | | |
| Eye-hand task | 60 | Ambulatory | H-1 | | |
| Eye-hand task | 60 | Assist-propelled | I-10 | | |
| Eye-hand task | 60 | Ambulatory | M-4 | | |
| Eye-hand task | 70 | Self-propelled | G-2 | | |
| 5:30-6:30 p.m. | | | | | |
| Eye-hand task | 60 | Ambulatory | O-12 | | |
| Watching | 60 | Assist-propelled | R-10 | | |
| Watching | 60 | Self-propelled | S-12 | | |
| Talking | 70 | Ambulatory | T-11 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 5:30-6:30 p.m. | | | | | |
| Eye-hand task | 70 | Self-propelled | V-8 | | |
| Watching | 80 | Assist-propelled | P-9 | | |
| Talking | 80 | Assist-propelled | Q-8 | | |
| Watching | 80 | Assist-propelled | P-7 | | |
| Watching/ body adj. | 40 | Ambulatory | R-3 | | |
| Eye-hand task/ body adj. | 40 | Ambulatory | Q-4 | | |
| Eye-hand task/ shielding face | 40 | Assist-propelled | P-2 | | |
| Eye-hand task/ physical touch. | 40 | Assist-propelled | R-3 | | |
| Eye-hand task | 50 | Ambulatory | N-2 | | |
| Eye-hand task | 60 | Ambulatory | M-4 | | |
| Talking | 50 | Self-propelled | L-2 | | |
| Eye-hand task | 60 | Self-propelled | M-1 | | |
| Eye-hand task | 60 | Assist-propelled | N-8 | | |
| Watching | 80 | Self-propelled | D-3 | | |
| Talking | 70 | Ambulatory | B-3 | | |
| Eye-hand task | 70 | Ambulatory | C-2 | | |
| Eye-hand task | 70 | Ambulatory | H-1 | | |
| Watching | 70 | Self-propelled | H-3 | | |
| Eye-hand task | 70 | Self-propelled | G-2 | | |
| Eye-hand task | 50 | Self-propelled | D-12 | | |
| Eye-hand task | 60 | Ambulatory | F-10 | | |
| Watching | 60 | Assist-propelled | I-13 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 5:30-6:30 p.m. | | | | | |
| Eye-hand task | 60 | Assist-propelled | G-13 | | |
| Eye-hand task | 60 | Assist-propelled | I-10 | | |
| Watching | 60 | Assist-propelled | N-8 | | |
| Eye-hand task | 60 | Assist-propelled | L-8 | | |
| Watching/ shielding face | 50 | Assist-propelled | P-2 | | |
| Watching | 80 | Assist-propelled | P-7 | | |
| Watching/ physical touching | 40 | Ambulatory | R-3 | | |
| Watching/ physical touching | 40 | Ambulatory | Q-4 | | |
| Eye-hand task | 50 | Assist-propelled | P-2 | | |
| Eye-hand task | 40 | Assist-propelled | R-1 | | |
| Eye-hand task | 60 | Ambulatory | N-2 | | |
| Eye-hand task/ optical adj. | 60 | Ambulatory | M-4 | | |
| Eye-hand task | 60 | Self-propelled | L-2 | | |
| Talking | 60 | Self-propelled | M-1 | | |
| Talking | 60 | Assist-propelled | N-8 | | |
| Talking | 60 | Assist-propelled | L-8 | | |
| Eye-hand task | 60 | Assist-propelled | L-6 | | |
| Watching | 60 | Ambulatory | N-6 | | |
| Watching | 60 | Assist-propelled | I-13 | | |
| Eye-hand task | 60 | Assist-propelled | G-13 | | |
| Talking | 60 | Assist-propelled | G-13 | | |

Table 4, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 3, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

DINING ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 5:30-6:30 p.m. | | | | | |
| Eye-hand task | 60 | Assist-propelled | I-10 | | |
| Eye-hand task | 60 | Assist-propelled | G-8 | | |
| Watching | 70 | Self-propelled | D-3 | | |
| Talking | 70 | Ambulatory | B-3 | | |
| Eye-hand task | 70 | Ambulatory | C-2 | | |
| Eye-hand task | 70 | Ambulatory | F-10 | | |
| Eye-hand task | 70 | Self-propelled | D-12 | | |
| Eye-hand task | 70 | Ambulatory | D-9 | | |
| Talking/shielding face | 50 | Assist-propelled | R-1 | | |
| Eye-hand task | 60 | Ambulatory | N-6 | | |
| Watching | 60 | Assist-propelled | N-8 | | |
| Eye-hand task | 60 | Assist-propelled | L-8 | | |
| Eye-hand task | 60 | Assist-propelled | L-6 | | |
| Talking | 60 | Assist-propelled | F-7 | | |
| Eye-hand task | 60 | Assist-propelled | G-6 | | |
| Watching/shielding face | 50 | Assist-propelled | R-1 | | |

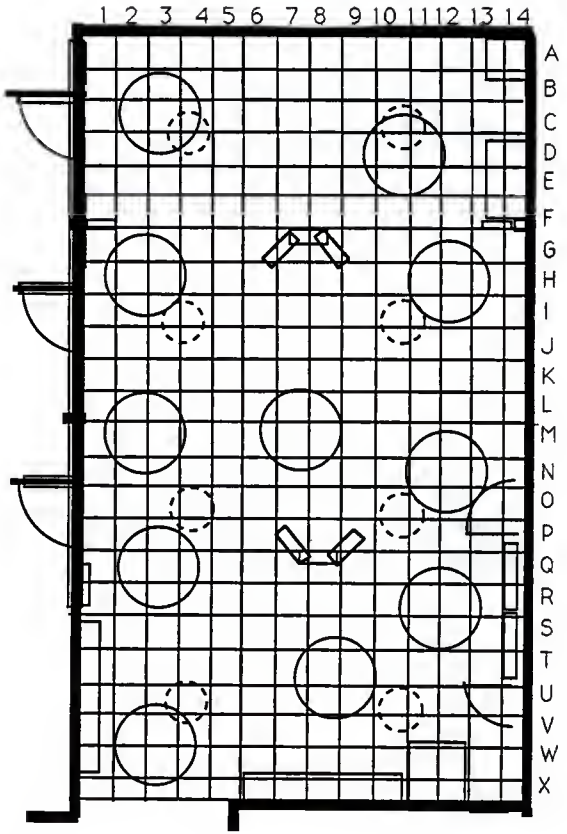


Figure 3, Appendix. A Map Keyed to Locations for Dining Room Behaviors from Table 4, Appendix. (Behaviors were located by row/letter, column/number. Scale: 1/8" = 1'0" North ∆.)

Table 5, Appendix. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 4, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

MAIN CORRIDOR

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 a.m. | | | | | |
| Talking | 330 | Assist-propelled | C-44 | | |
| Talking | 410 | Assist-propelled | E-44 | * | |
| Watching | 360 | Ambulatory | E-47 | | |
| Watching | 460 | Ambulatory | F-47 | | |
| Watching | 180 | Assist-propelled | K-47 | | |
| Watching | 530 | Self-propelled | N-47 | * | |
| Watching | 100 | Assist-propelled | M-52 | | |
| Sleeping | 1230 | Assist-propelled | O-58 | * | □ |
| Sleeping | 940 | Assist-propelled | O-63 | * | □ |
| Eye-hand task/ unacceptable behav. | 1430 | Assist-propelled | O-54 | * | |
| Watching | 1410 | Assist-propelled | O-53 | * | |
| Watching | 570 | Assist-propelled | M-54 | * | |
| Watching | 750 | Assist-propelled | M-53 | * | |
| Watching | 50 | Ambulatory | H-44 | | |
| Watching | 200 | Assist-propelled | M-52 | * | |
| Watching | 180 | Assist-propelled | K-47 | | |
| Talking | 330 | Assist-propelled | C-44 | | |
| Talking | 410 | Assist-propelled | E-44 | * | |
| Sleeping | 1230 | Assist-propelled | N-64 | * | □ |
| Sleeping | 940 | Assist-propelled | O-63 | * | □ |
| Eye-hand task/ unaccept. behav. | 1430 | Assist-propelled | O-54 | * | |
| Watching/ shielding face | 1410 | Assist-propelled | O-53 | * | |

Table 5, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 4, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

MAIN CORRIDOR

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 a.m. | | | | | |
| Talking | 570 | Assist-propelled | M-53 | * | |
| Talking/body adj. | 750 | Assist-propelled | F-45 | * | |
| Watching | 60 | Ambulatory | J-46 | | |
| Watching | 50 | Ambulatory | N-43 | * | |
| Eye-hand task/ body adj. | 230 | Ambulatory | D-41 | * | |
| Moving | 1230 | Assist-propelled | 0-62 | | □ |
| Moving | 940 | Assist-propelled | 0-63 | * | □ |
| Moving | 1430 | Assist-propelled | 0-54 | * | |
| Moving | 1410 | Assist-propelled | 0-53 | * | |
| Moving | 870 | Assist-propelled | M-55 | * | |
| Moving | 870 | Assist-propelled | M-53 | * | |
| Moving | 870 | Assist-propelled | M-52 | | |
| 9:30-10:30 a.m. | | | | | |
| Watching | 460 | Ambulatory | 0-50 | * | |
| Talking/ unacceptable behav. | 60 | Ambulatory | M-50 | | |
| Sleeping | 750 | Ambulatory | N-48 | * | |
| Watching | 100 | Assist-propelled | N-49 | * | |
| Watching | 770 | Assist-propelled | N-7 | | |
| Watching | 610 | Assist-propelled | L-5 | | |
| Watching/ unacceptable behav. | 780 | Assist-propelled | 0-27 | * | |
| Watching | 440 | Assist-propelled | N-32 | * | |
| Sleeping | 870 | Assist-propelled | N-7 | | |

Table 5, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 4, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

MAIN CORRIDOR

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 9:00-10:00 a.m. | | | | | |
| Sleeping | 320 | Self-propelled | 0-51 | * | |
| Watching | 320 | Self-propelled | 0-52 | * | |
| Talking | 570 | Self-propelled | 0-15 | | |
| 11:30-12:30 p.m. | | | | | |
| Moving | 30 | Ambulatory | H-2 | | |
| Moving | 90 | Ambulatory | H-45 | | |
| Moving | 460 | Ambulatory | L-10 | | |
| 2:00-3:00 p.m. | | | | | |
| Watching | 530 | Assist-propelled | M-38 | * | |
| Watching | 520 | Assist-propelled | M-39 | | |
| Watching | 1070 | Assist-propelled | 0-21 | * | |
| Watching | 640 | Assist-propelled | N-22 | * | |
| Talking | 980 | Assist-propelled | N-38 | * | |
| Eye-hand task/ unacceptable behav. | 810 | Assist-propelled | N-40 | | |
| Watching | 910 | Assist-propelled | 0-36 | * | |
| Sleeping | 320 | Assist-propelled | E-46 | | |
| Watching | 1070 | Assist-propelled | 0-21 | * | |
| Watching | 640 | Ambulatory | C-45 | * | |
| Watching | 640 | Assist-propelled | N-22 | * | |
| Watching | 540 | Assist-propelled | N-25 | * | |
| Watching | 950 | Assist-propelled | N-16 | * | |
| Watching | 300 | Assist-propelled | D-46 | * | |
| Watching | 810 | Assist-propelled | N-36 | * | |
| Watching | 980 | Assist-propelled | C-45 | * | |

Table 5, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 4, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

MAIN CORRIDOR

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 2:00-3:00 p.m. | | | | | |
| Sleeping | 30 | Ambulatory | N-41 | | |
| Sleeping | 50 | Self propelled | N-42 | | |
| Sleeping | 60 | Self propelled | N-38 | * | |
| Talking | 930 | Ambulatory | C-45 | * | |
| Talking | 530 | Self propelled | C-47 | * | |
| Walking | 1020 | Assist-propelled | O-21 | * | |
| Walking | 1000 | Assist-propelled | O-36 | * | |
| Sleeping | 200 | Assist-propelled | J-48 | | |
| 5:30-6:30 p.m. | | | | | |
| Moving | 30 | Self-propelled | K-4 | | |
| Moving | 60 | Self-propelled | N-10 | | |
| Moving | 350 | Ambulatory | F-47 | | |
| Moving | 410 | Ambulatory | E-47 | | |
| Moving | 100 | Self-propelled | K-47 | | |

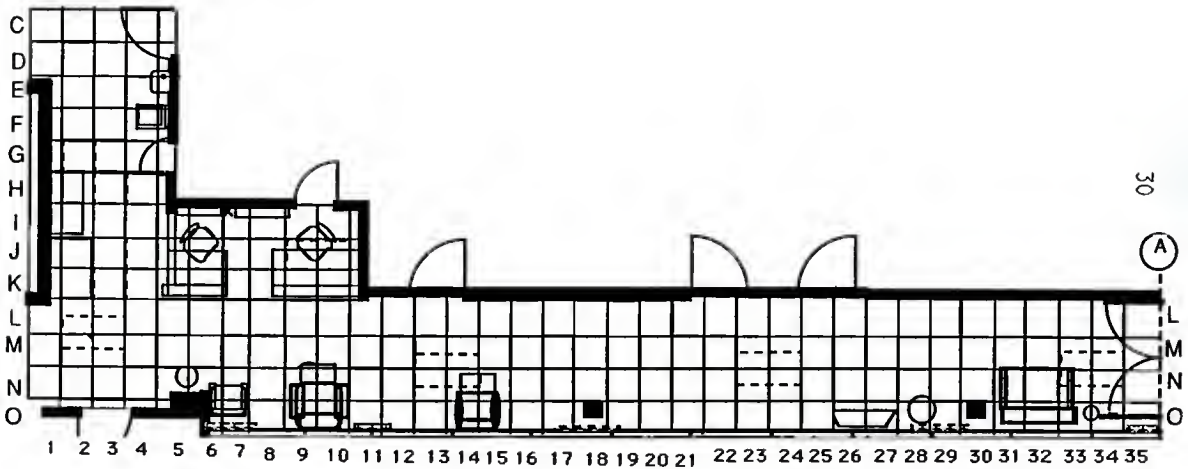


Figure 4, Appendix. A map Keyed of Locations for Corridor Behaviors from Table 5, Appendix. (Behaviors were located by row/letter, column/number. Scale: 1/8" = 1'0" North Δ.)

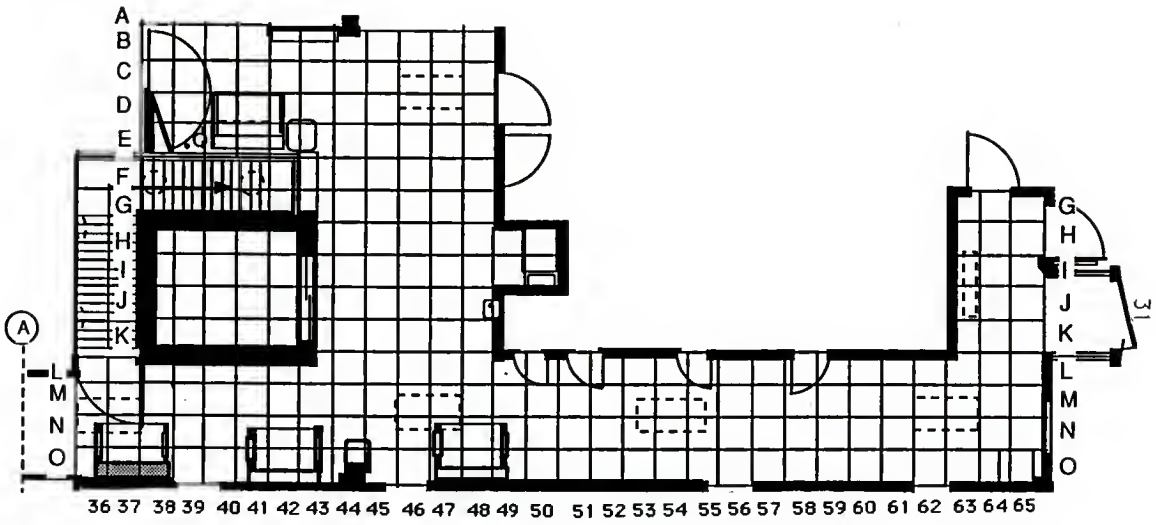


Figure 4, Appendix, Continued. A map Keyed of Locations for Corridor Behaviors from Table 5, Appendix. (Behaviors were located by row/letter, column/number. Scale: 1/8" = 1'0" North Δ.)

Table 6, Appendix. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 5, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

ACTIVITY ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 a.m. | | | | | |
| Watching | 350 | Assist-propelled | R-2 | | |
| Watching | 200 | Assist-propelled | N-1 | | |
| Watching | 210 | Assist-propelled | O-2 | | |
| Watching | 420 | Assist-propelled | Q-2 | | |
| Watching | 60 | Assist-propelled | O-4 | * | |
| Moving | 200 | Ambulatory | N-1 | | |
| Watching/ shielding face | 390 | Assist-propelled | O-2 | | |
| Watching/ body adj. | 390 | Assist-propelled | P-1 | | |
| 9:00-10:00 a.m. | | | | | |
| Sleeping | 320 | Assist-propelled | M-6 | | |
| Sleeping | 420 | Assist-propelled | K-6 | | |
| 11:30-12:30 p.m. | | | | | |
| No activities were oberved at this time. | | | | | |
| 2:00-3:00 p.m. | | | | | |
| Eye-hand task | 1560 | Ambulatory | C-6 | | |
| Eye-hand task | 1530 | Ambulatory | C-3 | | |
| Eye-hand task | 1530 | Assist-propelled | H-2 | | |
| Eye-hand task | 1320 | Assist-propelled | G-7 | | |
| Eye-hand task | 1320 | Assist-propelled | G-2 | | |
| Eye-hand task | 1180 | Assist-propelled | I-2 | | |
| Eye-hand task | 1140 | Ambulatory | I-7 | | |
| Eye-hand task | 1070 | Assist-propelled | D-7 | | |
| Eye-hand task | 810 | Assist-propelled | O-5 | | |
| Eye-hand task | 790 | Assist-propelled | J-2 | | |

Table 6, Appendix, Continued. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 5, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

ACTIVITY ROOM

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| Eye-hand task | 730 | Assist-propelled | F-2 | | |
| Eye-hand task | 730 | Assist-propelled | D-2 | | |
| Eye-hand task | 480 | Self propelled | L-2 | | |
| Eye-hand task | 480 | Self propelled | N-3 | | |
| Eye-hand task | 480 | Assist-propelled | N-6 | | |
| Eye-hand task | 370 | Assist-propelled | E-2 | | |
| Talking | 810 | Ambulatory | J-7 | | |
| Talking | 320 | Ambulatory | B-4 | | |
| Watching | 420 | Self propelled | B-5 | | |
| Moving/ environ. chg. | 1300 | Ambulatory | P-4 | | |
| Moving/environ. chg. | 1300 | Ambulatory | L-5 | | |
| Moving/eniron. chg. | 1300 | Amboulatory | B-6 | | |
| Eye-hand task/ optical adj. | 1300 | Ambulatory | L-4 | | |
| 5:30-6:30 p.m. | | | | | |
| No activities were observed during this time. | | | | | |

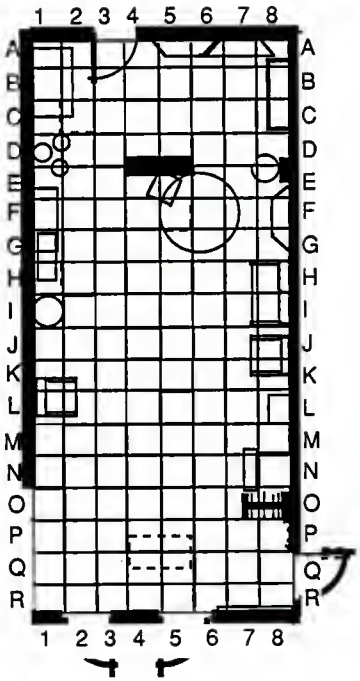


Figure 5, Appendix. A Map Keyed to Locations for Activity Room Behaviors from Table 6, Appendix. (Behaviors were located by row/letter, column/number. Scale: 1/8" = 1'0" North ∆.)

Table 7, Appendix. Behavioral Attributes and Lighting Characteristics Summary Tabulation. (Data were tabulated by: resident behavior/gesture, resident mobility status, time of day, quantity of light, and "map" coordinates for locating the resident in room grid plans [see Figure 6, Appendix]. Behaviors which occured in imbalance of light and/or discomfort glare were also noted as * and □ respectively.)

LOWER LOUNGE

| Behavior/ Gesture | 4' FFL Lux | Mobility Status | Room Coordinates (Row-Column) | Imbalance of Light Present | Glare |
|---|---|---|---|---|---|
| 6:30-7:30 a.m. | | | | | |
| No activities were observed during this time. | | | | | |
| 9:00-10:00 a.m. | | | | | |
| Watching | 550 | Ambulatory | E-1 | | |
| Watching | 550 | Ambulatory | E-1 | None present | |
| Watching | 550 | Ambulatory | E-1 | | |
| Watching | 550 | Ambulatory | E-1 | | |
| Watching | 250 | Ambulatory | H-7 | | |
| 11:30-12:30 p.m. | | | | | |
| No activities were observed during this time. | | | | | |
| 2:00-3:00 p.m. | | | | | |
| No activities were observed during this time. | | | | | |
| 5:30-6:30 p.m. | | | | | |
| No activities were observed during this time. | | | | | |

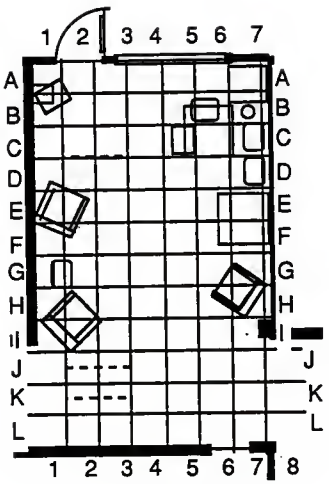


Figure 6, Appendix. A Map Keyed to Locations for Lower Lounge Behaviors from Table 7, Appendix. (Behaviors were located by row/letter, column/number. Scale: 1/8" = 1'0" North Δ.)

Table 8, Appendix. The Tabulated Results of Resident Mobility by Mobility Status, Body Flow Movements, Gesture, and Speed in Seconds Through Areas T 1 (an area where illumination began at 980 lux and dropped to 30 lux) and T 2 (an area where illumination began at 30 lux and rose to 690 lux). (Mobility status was coded: A, ambulatory, B, Self-propelled, and C, Assist-propelled. Body Flow was ranked as 1: reduction in movement, 3, no change in movement, or 5: increase in movement.)

| Mobility status | T 1 Body Flow | T 2 Body Flow | T 1 Time | T 2 Time |
|---|---|---|---|---|
| Ambulatory | 1 | 1 | 40 | 45 |
| Ambulatory | 1 | 1 | 43 | 54 |
| Ambulatory | 2 | 2 | 82 | 80 |
| Ambulatory | 2 | 2 | 65 | 63 |
| Ambulatory | 3 | 5 | 118 | 163 |
| Ambulatory | 5 | 5 | 225 | 315 |
| Ambulatory | 2 | 2 | 105 | 75 |
| Ambulatory | 2 | 2 | 73 | 60 |
| Ambulatory | 5 | 5 | 155 | 143 |
| Self-propelled | 1 | 1 | 15 | 12 |
| Self-propelled | 1 | 1 | 23 | 16 |
| Self-propelled | 3 | 3 | 57 | 45 |
| Self-propelled | 2 | 2 | 49 | 57 |
| Self-propelled | 2 | 2 | 49 | 47 |
| Self-propelled | 1 | 1 | 12 | 14 |
| Ambulatory | 1 | 1 | 10 | 9 |
| Ambulatory | 1 | 1 | 9 | 10 |
| Self-propelled | 1 | 1 | 82 | 82 |
| Self-propelled | 4 | 4 | 32 | 35 |
| Self-propelled | 3 | 3 | 42 | 39 |
| Self-propelled | 3 | 3 | 32 | 23 |
| Ambulatory | 1 | 1 | 17 | 15 |
| Ambulatory | 2 | 2 | 14 | 17 |
| Ambulatory | 3 | 3 | 27 | 52 |
| Ambulatory | 3 | 3 | 22 | 23 |
| Ambulatory | 3 | 3 | 45 | 47 |

Table 8, Appendix, Continued. The Tabulated Results of Resident Mobility by Mobility Status, Body Flow Movements, Gesture, and Speed In Seconds Through Areas T 1 (an area where illumination began at 980 lux and dropped to 30 lux) and T 2 (an area where illumination began at 30 lux and rose to 690 lux). (Body Flow was ranked as 1: reduction in movement, 3, no change in movement, or 5: increase in movement. There were no gestures observed)

| Mobility status | T 1 Body Flow | T 2 Body Flow | T 1 Time | T 2 Time |
|---|---|---|---|---|
| Ambulatory | 3 | 3 | 21 | 19 |
| Assist-propelled | - | - | 7 | 4 |
| Assist-propelled | - | - | 9 | 5 |
| Assist-propelled | - | - | 4 | 5 |
| Assist-propelled | - | - | 6 | 8 |
| Assist-propelled | - | - | 20 | 20 |
| Assist-propelled | - | - | 12 | 7 |
| Assist-propelled | - | - | 6 | 5 |
| Self-propelled | 1 | 1 | 15 | 19 |
| Self-propelled | 4 | 4 | 54 | 51 |
| Self-propelled | 3 | 3 | 34 | 36 |
| Self-propelled | 3 | 3 | 82 | 105 |
| Ambulatory | 5 | 5 | 132 | 193 |
| Ambulatory | 3 | 3 | 95 | 75 |
| Self-propelled | 4 | 4 | 82 | 94 |
| Self-propelled | 1 | 1 | 77 | 82 |

| T1 | | | Observation # | |
|---|---|---|---|---|
| Mobility Status: | | Body Flow | Gestures | Time |
| A | B C | 1 3 5 | | |
| | | | | |
| T2 | | | | |
| Mobility Status: | | Body Flow | Gestures | Time |
| A | B C | 1 3 5 | | |
| NOTES | | | | |

Figure 7, Appendix The Mobility Observation Recording Instrument Used to Record Resident Reactions Through Areas T1 and T2 of the Main Corridor.

# THE EFFECTS OF LIGHTING CHARACTERISTICS ON THE BEHAVIOR OF ELDERLY RESIDENTS IN AN INTERMEDIATE CARE FACILITY

by

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## ABSTRACT

This research described the relationship between selected lighting characteristics and the behavior of 56 residents age 57 or older who used the public areas of an intermediate care facility in Manhattan, Kansas.

Three lighting characteristics were defined and measured: quantity (amount of light), balance (distribution of light), and glare (light reflected off a surface). Behavioral attributes of residents were defined and observed as activity participation and mobility. Activity participation included talking, walking, sleeping, moving, and eye-hand tasks; mobility included the ambulatory status of residents, body flow movement, and speed of movement.

This study was undertaken with the following objectives: 1) to describe general lighting characteristics of an intermediate care facility; 2) to construct lighting profiles for individual public areas in terms of quantity of light, balance of light, and discomfort glare; 3) to construct resident behavioral maps (Ittelson, Rivilin, & Proshansky, 1970) of activity participation and mobility profiles; 4) to determine possible relationships between resident behavior and lighting characteristics; 5) to form assumptions about elderly behavior and illumination for further research; and 6) to propose design conclusions based on the observational interpretations.

The lighting profiles, area usage, and behavioral maps implied that the illumination of an area was not a predictor of frequency usage or activity, rather staff convenience, adjacent services, and bathrooms. This study also found that activities took place in areas which did not meet minimum code requirements for levels of illumination by the IES

(Illuminating Engineering Society) and KAR (Kansas Illumination Codes for Nursing Homes).

During observations, a unique behavioral phenomenon was noted and labeled, Glare Cueing. This was defined as the use of glare and shadow by elderly residents suffering from obvious visual impairments to provide themselves with additional information for activity participation and mobility. However, for other elderly (particularly senile dementia residents), discomfort glare and high levels of illumination appeared to contribute to behaviors which increased staff workload.

Additional assumptions were posited for lighting characteristics and elderly behavior which included design implications and illumination recommendations for senile dementia residents, improved behavior, facility staff education, and illumination codes.