SCALE MODEL STUDY

OF

LIGHTING AESTHETICS

by

PERVAIZ ASIF ALI

B.E. (Mechanical), N.E.D. Engineering University,

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Approved by:

Major Professor

Dedicated to my late father who always was and will be a guiding spirit in my life.

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INTRODUCTION

Light may be a source of vision, a source of comfort, an inspiring influence, or an element of the beautiful. A means of generating light has long been recognized as a basic need in man's attempt to control his environment. A source of illumination is basic to visually-oriented man — to his activities, to his ability to perform, and to his sense of well being and security. In this sense, light is fundamental to man's environment. It affects the usefulness and the enjoyment — for in darkness, the environment becomes inadequate for most human activities.

In this regard, one can characterize the term "comfort" as implying a reduction of the stresses caused by negative influences such as excessive glare, darkness etc. The lighting designer must understand the nature of such distracting and disconcerting influences, because over a period of time they cause strain and fatigue in a participating individual. One objective of the controlled environment, then, is the organization of facilities, forms, and systems to minimize such stresses; for with fatigue, a space or activity can become offensive to an individual, and his emotional attitude toward work or toward an organized activity becomes impaired.

The goal of a good lighting design is to create an efficient and pleasing interior. These two requirements, that is, the utilitarian and aesthetic, are not antithetical as is demonstrated by every good lighting design. Non-uniform lighting seems to be generally preferred over uniform lighting when aesthetic evaluations are made. The possibilities for providing adequate, interesting, and unusual lighting are much greater today than ever before by using incandescent, fluorescent, and mercury vapor sources in a wide range of convenient forms.

Scale Modeling Technique

One major problem is how to represent a designed environment before it is built. Real or proposed physical spaces are difficult to model or manipulate experimentally, not only because they are expensive and time consuming to construct but also because they are highly complex, and their connotations will vary with different kinds of self selected users in variously-defined groups.

Although extensive research has been done to establish the visual performance basis for lighting system design, there haven't been effective methods to portray the aesthetics of an environment except through an artist's rendering. A rendering is only the artist's conception of the results, and may not provide much detail on brightness ratios, shadows, and highlights which the system creates. The question, therefore, is how a lighting system can be evaluated as part of a total environment prior to actually creating the environment. Perhaps even more important is how different lighting systems can be evaluated to establish a system design.

Designers in architecture, and in lighting, must work through some predictive or representational technique: The traditional medium of an architect is a pencil sketch. In contrast, a lighting engineer tends to work with and look for meaning in numbers, equations, and tables. Unfortunately, the numbers of a lighting engineer do not constitute a meaningful language for an architect's concern with visual form and arrangement, and an artist's sketch does not communicate much with regard to his wishes on the quantities of the luminous environment.

One can attempt to experiment with structures, either in full scale or real time or in terms of simulated settings abbreviated in time and space. Full scale, real time simulations are relatively rare, they are expensive to create realistically and difficult to investigate because often the process of investigation itself reduces their realism. Accordingly lighting designers have turned to small scale simulations which allow them to make evaluations of real lighting environments.

Small scale representations, simulations or mockups of built spaces can be used for lighting design study. Some simulations can be effective for some purposes but not for others; thus, in experimentation the simulation technique one uses will vary with the kinds of forms and spaces to be represented. Although one cannot say with certainty whether responses to a simulated lighting environment using scale models will be the same as when expressed in full scale, it would not be unreasonable to say that scale models can to a large extent realistically represent lighting systems. Scale models have been used by lighting designers to evaluate the luminous environment and to demonstrate system performance differences.

Lemons and Macleod (1971) did a study on scale models for lighting system design and evaluation. They used a scale of one to eight for their model. The actual size of the model was four feet by four feet by one and one-half feet, two back walls were fastened to the frame. The top enclosure of the model was a light chamber housing ten 300-watt reflector lamps, two, four, six, eight, or ten of which could be operated at one time. The chamber was white on the inside to keep the light level as high as possible. To provide indirect lighting from the side walls four-foot fluorescent units were mounted on the backs of the walls. Light was directed through slots in the wall and was reflected into the model off curved reflectors mounted over the slots.

Lemons and Macleod emphasized that in simulating a lighting system great care must be taken to make sure that the principle of the lighting fixture being used is followed. There is no basis for comparison between systems unless each simulated system is performing as nearly like the actual one as possible. The ceilings used in the model were painted with flat white ceiling paint, the walls were also finished with a flat white paint. The floor finish simulated a high reflectance, glossy tile floor. A simulated rug was also used to provide a low reflectance as a standard variation in all system evaluation. The model according to the authors could provide unlimited variations to reproduce any lighting system and environment.

Lemons and Macleod used different lighting systems, among them were luminous ceiling panels provided by recessed troffers or luminous panels — with the rug removed increased reflection from the floor was obtained. Reflectance of the walls were changed which provided increased contrast, a coffered ceiling provided a downlight type environment. A batwing-type lighting system was used which might be classified as a directional downlight system. An indirect system was also used which had no defined shadows. The authors concluded that horizontal illumination has limited meaning, and the primary factor in determining system quality is the luminance ratio of the ceilings, walls, and floors.

Another study was done by Lemons and Macleod (1975) which used scale models to demonstrate "Equivalent Sphere Illumination" (ESI). The need for a better method of specifying lighting system quality has led to replacing standard footcandle levels with levels of ESI. Based on the previous success of models, the authors felt they might help demonstrate ESI concepts. The model was 48 inches wide, 24 inches deep, and 18 inches high made on a scale of 2 inches equals 1 foot.

Lemons and Macleod found that working with models provides the designer with the opportunity to make value judgments about several types of lighting systems. Using the model to keep the environment identical, but changing the light system, the real system differences become apparent.

Rodman (1970) used a slide model technique for the study and evaluation of luminous environment of interiors. The models are usually of cardboard with numerous planned provisions for variations in colors, textures, patterns, shapes, and lighting arrangements. Various methods are used to introduce light to the modeled spaces. In one of the simplest arrangements, the boundaries of the model contain openings of various shapes and sizes, often covered with diffusing panels or containing some kind of shielding. The models are placed in a "light box" formed of a cube of plywood, four feet on a side, painted white inside, and illuminated at the top with a variety of fluorescent and incandescent luminaires. Light enters the model through openings provided in the rough approximation of a number of kinds of light fixtures, and the interior responds in accordance with its various characteristics. Rodman found the technique to give a good simulation of full scale reality.

Seaton and Collins (1972) made a study of the exterior form of four different buildings on the University of British Columbia campus. The four test buildings were each visually represented to judges in four different ways: in full scale, in scale models, in color photographs, and in black and white photographs. Each subject evaluated one of the four experimental simulation modes. The authors found that the qualities that buildings impart to viewers are generally similar over different types of simulations.

Semantic Differential Technique

A tool to evaluate the environmental quality of lighting is the semantic differential technique. Each semantic rating scale consists of two words, one on each side of the scale, these words are opposite in meaning. The scale is divided uniformly from one end to the other into a convenient number of segments, the segments convey degrees between the two anchor words in an ascending or descending order. For example, the scales shown below might be semantic differential rating scales

UNPLEASANT	1	2	3	4	5	6	7	PLEASANT
SPACIOUS	1	2	3	4	5	6	7	CROWDED

The semantic differential technique was developed by Osgood et al (1957). It is the most widely used technique in the study of subjective responses to the built environment. The scales correspond to the verbal mode by which occupants most often express their perceptions, thoughts, feelings, attitudes, and behaviors concerning their environment. An advantage of the semantic differential technique is that it can be applied to a wide area of research. One of the most important requirements of the semantic approach is representative sampling. One may have a large number of scales which convey the same meaning or similar meaning. This is why factor analysis is used; factor analysis reduces the data of a large number of scales which are to some degree correlated, to that of a smaller number of factors which are independent.

Several studies have been conducted on semantic scales, some of the recent studies were by Vielhaver (1965), Canter (1968), Craik (1968), Collins (1969), Brittell (1969), and Hershberger (1972). There was noteworthy agreement between all of the above researchers on the first dimension or factor, which is usually labelled "aesthetic evaluation". This factor had substantial loading of such scales like pleasant, cheerful, colorful, comfortable, bright, impressive, gay, etc. A second factor "organization" was also found to be common among all the research. It had substantial loadings of such scales like neat, orderly, tidy, organized, clear, calm, etc. A third "space" factor was evident for four of the researchers with loadings of such scales like roomy, large, wide, flexible, spacious, open, etc. A "potency" factor was also found by three researchers with loadings of such scales like rough, course, rugged, strong, etc.

Hershberger (1972) reviewed the studies on semantic scales and stressed the importance of developing a working set of semantic scales for measurement of environmental meaning. Hershberger wanted to seek a set of semantic scales which represent all meaningful aspects of the physical environment; and describe potential human responses to the attributes of the physical environment. He found five dimensions of architectural meaning: (1) Aesthetic (evaluative), (2) Friendliness, (3) Organization, (4) Potency, and (5) Space, illustrated by the following scales:

1. Aesthetic: Pleasant - Unpleasant
2. Friendliness: Friendly - Hostile
3. Organization: Ordered - Chaotic
4. Potency: Rugged - Delicate
5. Space: Loose - Compact

While some authors have disclaimed interest in being "definitive", a rather common objective has been to find the factors or dimensions of aesthetic reactions to the built environment (interiors and facades have been lumped together in some reviews).

Aesthetics of Lighting

The design of lighting systems requires a combination of scientific and aesthetic considerations. The engineer may use all of the technical material available to him and yet be unable to create an environment that is aesthetically pleasing. The interior designer may provide the correct combination of surface finishes, textures and elegant furnishings, but improperly illuminated, the environment may still not be pleasing. A marriage of these skills is therefore imperative to create environments that are aesthetically pleasing to the inhabitants.

In recent years increasing attention has been paid to the complex problem of lighting quality. Without downgrading the obvious influence of light in facilitating visibility (and thus performance) of a visual task, it seems equally obvious that light contributes in other ways to the visual quality of a room and to the sense of well-being felt by the users of that room. Some psychological aspects of lighted space can be recognized and documented if lighting design is studied as an exercise in visual communication. This suggests that as the designer changes lighting modes (_i.e._, the patterns of light, shade, and color in the room), he changes the composition and relative strength of visual signals and cues; and this in turn alters some impressions of meaning for the typical room occupant or user.

Aldworth (1970) studied variety in lighting using a room furnished as a modern "prestige" office. There were two basic kinds of lighting, "static" lighting and "varied" lighting. "Static" lighting was general or uniform illumination whereas "varied" lighting was non uniform illumination. The results were that the subjective appraisal of the visual impression of the room showed varied lighting was generally preferred. On the ratings of "good-bad", static lighting was judged to be bad. For "comfortable — uncomfortable," varied lighting was clearly rated as comfortable. For the "pleasant — unpleasant" rating for static lighting, a progressive trend towards unpleasant occurred whereas the varied lighting was consistently rated as pleasant. Aldworth concluded that the visual impression of the room under varied lighting is favored as one would expect from other appraisal work carried out in recent years.

Hawkes, Loe, and Rowlands (1975) studied lighting aesthetics of an office using eighteen lighting situations. They achieved this by using various luminaires (central downlighters and central fluorescent fixtures, fluorescent along walls, and spot light luminaires) at three levels. They used 15 semantic differential scales. An interesting result found in the study was that the regular arrays of recessed luminaires (central fluorescent), the most common way of lighting offices, was the least preferred. The authors felt that complexity and brightness is perhaps what people want in the lighting of their offices.

A very important study was done by Flynn, Spencer, Martyniuk, and Hendrick (1973) of Kent State University entitled "Interim Study of Procedures for Investigating the Effect of Light on Impression and Behavior". The study was conducted in a room set up as a conference room. This room was rectangular in shape with a rectangular conference table in the middle with ten chairs around it. The room had a number of lighting arrangements that permitted significant variation in the visual character of the space without changing any of the other conditions. There were six lighting arrangements for the experiment and judgments were obtained for all of the six lighting arrangements. Ratings were analyzed from 12 groups with a total of 96 subjects who were distributed in groups of eight.

The six lighting arrangements of the study were:

1. Overhead downlighting, low intensity - 10 fc.
2. Peripheral wall lighting, all walls - 10 fc.
3. Overhead diffuse, low setting - 10 fc.
4. Combination: overhead down lighting (1) + end walls - 10 fc.
5. Overhead diffuse, high intensity - 100 fc.
6. Combination: Overhead down lighting (1) + Peripheral (2) + Overhead diffuse (3) - 30 fc.

The principal factors of the semantic scales used in the study were a general "evaluative" factor which had scales like pleasant - unpleasant, a "perceptual clarity" factor which had scales like clear - hazy, and a "spaciousness" factor which had scales like spacious - cramped.

The results showed that the highest condition on evaluation was the combination arrangement: Overhead downlighting (1) + Peripheral (2) + Overhead diffuse (3). For perceptual clarity, overhead diffuse, high intensity (5) was the best, it is obvious that the higher level of illumination was the factor. Impressions of spaciousness resulted from peripheral rather than overhead lighting. This study has contributed useful information on how lighting environments should be designed and what particular features will have positive reinforcements for the inhabitants.

A similiar study on subjective responses to low-energy and non-uniform lighting systems was done by Flynn (1976). He used three broad factors of impressions, namely evaluative, visual clarity, and spaciousness. Each of these factors had appropriate semantic scales. He used seven light settings with variations in levels: central downlighting, peripheral (wall) lighting, and central diffuse lighting. Flynn found when impressions of general clarity and utility are important, overhead lighting shows the highest evaluation. Furthermore, non-uniform overhead systems that light the central portions of the room appear to be more effective in this regard than overhead systems that permit noticeably lower light levels in the central areas. Also when evaluative impressions and/or impressions of spaciousness are desired, peripheral (wall) lighting is the most effective.

Most of the studies done so far on lighting environments have been on public spaces like offices, conference rooms etc, very little has been done on private spaces like living rooms. Living rooms, for example, generally have different types of lighting than public spaces and their study could provide insight into future lighting system designs. In a study (Bennett,

1975) of campus offices, lobbies, and other spaces a public-private factor was found. It is felt that people have different preferences for lighting for public and private spaces. This is one of the objectives of this research, to find if there are any differences in aesthetic reactions between public and private spaces. In this study public is represented as a waiting room and private as a living room.

PROBLEM

The objective of this research is to validate the results of the study by Flynn, Spencer, Martyniuk, and Hendrick (1973) using scale models of a living or waiting room. It is believed that scale models can realistically represent real conditions. The lighting arrangements used in the study by Flynn and others (1973) will be incorporated in the model to a great extent.

Specifically the following hypotheses are made:

(1) A combination of central and peripheral fluorescent lighting + Incandescent lighting will have the highest evaluation.

(2) For perceptual clarity, peripheral (wall) fluorescent lighting at high level (205 fc) would be the best.

(3) Impressions of spaciousness will result from peripheral lighting.

METHOD

In this study sixty subjects made subjective evaluations of a scale model designed as a living/waiting room. The lighting conditions were varied and judgments were made by the subjects on semantic differential rating scales. There were seven lighting conditions in all and each subject evaluated all of these. Half the subjects evaluated the model as a living room and half of them as a waiting room.

Model

The model was made to a scale of one inch equals to one foot (Figure 1). The dimensions of the model were 20" x 12" x 8", thus the model simulated a living/waiting room 20 feet x 12 feet with a ceiling height of 8 feet. The inside of the model had sofas and easy chairs and wall hangings. (Figures 2, 3 and 4). The walls and ceiling of the model were white, the floor had a grey dull surface simulating a carpet. Above the ceiling was the lighting arrangement, it consisted of four 40 watt cool white fluorescent lamps and four six watt incandescent lamps. The lighting arrangements were achieved by changing the type of openings in the ceiling. The openings served as different types of fixtures through which the light could come through (Figure 5). Thus, by changing the ceiling different lighting patterns were obtained. For fluorescent light there were two basic openings: rectangular one inch wide openings around the edges for peripheral (wall) lighting and a central rectangular 3" x 12" opening in the center for central lighting. For the incandescent light four circular openings of

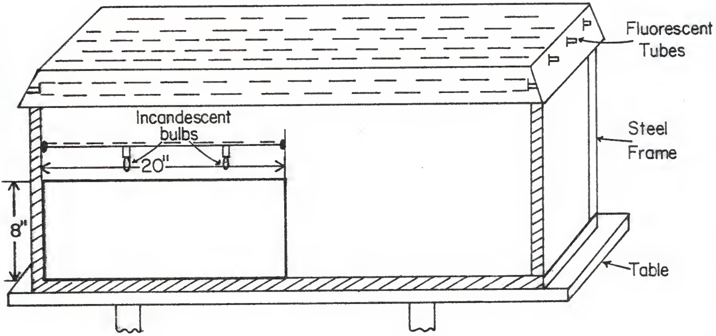
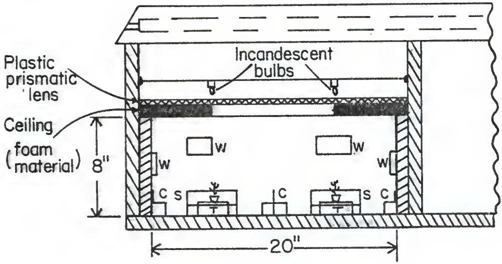


Figure 1. Structure of the scale model



C – Chair

S – Sofa

T – Table

W – Wall hangings

Figure 2. Front view of the model

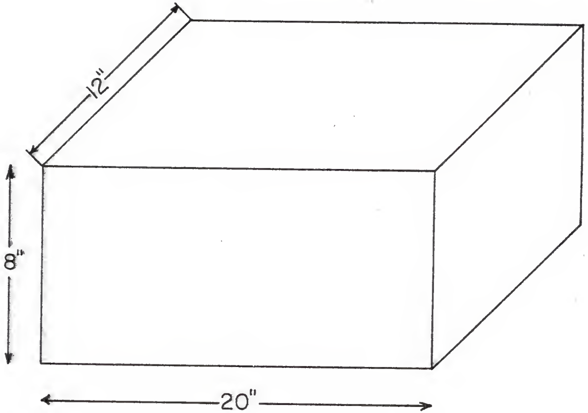
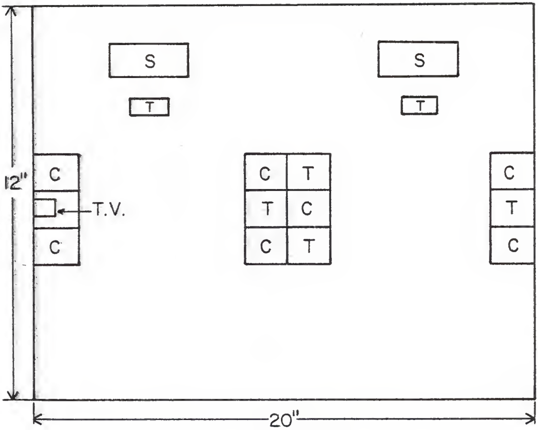


Figure 3. Three dimensional view of the model



C – Chair

T – Table

S – Sofa

Figure 4. Plan of the scale model

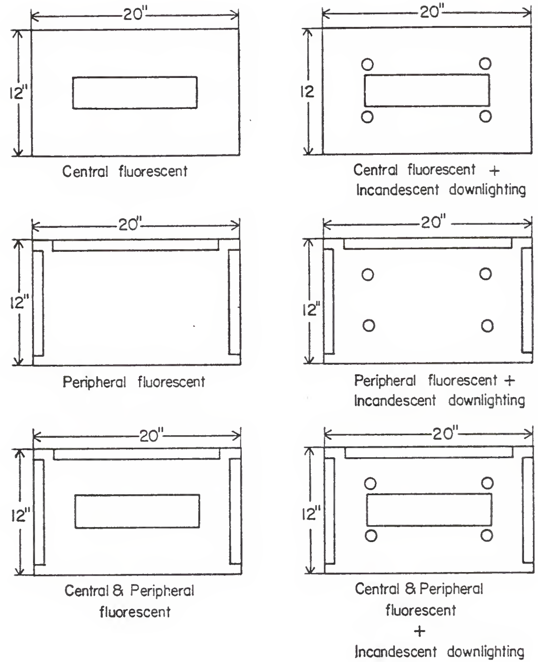


Figure 5. Types of Ceiling Patterns

seven eights of an inch near the four corners of the central rectangular opening were made. The model was constructed inside a larger lighting "booth" 46" x 23" x 19". This booth was made of a steel frame and its ceiling housed the four 40 watt fluorescent lamps. These lamps could be operated at variable illumination levels.

With the basic ceiling patterns as shown in Figure 3, the following seven lighting conditions were obtained:

(1) Central fluorescent lighting (35 fc)

(2) Central fluorescent lighting + Incandescent downlighting (35 fc)

(3) Peripheral fluorescent lighting (35 fc)

(4) Peripheral fluorescent light + incandescent downlighting (35 fc)

(5) Combination of central & peripheral fluorescent lighting (35 fc)

(6) Combination of central & peripheral fluorescent lighting + incandescent downlighting (35 fc)

(7) Peripheral fluorescent lighting at a high illumination level (205 fc)

The first six conditions were all at the same low level of illumination of 35 footcandles (fc). This level is within the recommended illumination level for lobbies which is 10 to 40 footcandles. The seventh condition, which is the ceiling pattern of condition (3) at a high level of illunination, was at 205 footcandles. The reason for selecting a high level condition is that it is similar to one of the conditions studied by Flynn, Spencer, Martyniuk, and Hendrick and it is expected to be associated with visual clarity.

Task

The subjects were asked to make their judgments of the seven lighting arrangements one after the other. The subjects evaluated the model either as a living or as a waiting room. They were handed the informed consent and instruction form which briefly explained the experiment. An illumination level adjustment period was allowed before the subject made his judgment. After he had finished evaluating the first arrangement he was shown the other arrangements till he had completed all seven. The judgments were made on 11 semantic differential rating scales. Four broad factors of scales were chosen: "evaluative" which had the scales pleasant-unpleasant, relaxed-tense, and interesting-monotonous; "perceptual clarity" which had the scales clear-hazy, bright-dim, and distinct-vague; "spaciousness" which had the scales large-small, long-short, and spacious-cramped; "color" which had the scales warm-cool and sunny-cloudy. The first three factors are the same as those chosen by Flynn, Spencer, Martyniuk, and Hendrick. The fourth factor was selected due to its relevance to this study. Thus, on the whole the subjects made their judgment on eleven scales. The scales and an example of a response sheet are shown in Figure 6. Each subject took approximately fifteen minutes to make evaluations for all seven conditions.

Experimental Design

The scale model was used to study lighting aesthetics for two types of rooms, a living room and a waiting room. Half the subjects evaluated the model as a living room and half as a waiting room, in all they judged seven lighting conditions. The subjects judged the conditions on eleven semantic scales, these evaluations would provide information as to what are the general preferences for lighting. Six conditions were at a low level of 35 footcandles and a seventh condition was at a much higher level of 205 footcandles.

The independent variables in this experiment were the lighting conditions and the room instructions and the dependent variables were the subjective evaluations made by the subjects. The lighting conditions and the rooms were assigned numbers and random number tables were used for randomization of sequence of the lighting conditions and the rooms.

In this study all the other variables except lighting were kept constant like furniture arrangements, wall hangings etc. Thus any differences in evaluations would be due to the lighting only. The living room represented a private space and the waiting room represented a public space.

Subjects

Most of the subjects recruited were on a voluntary basis, and tney were students of Kansas State University. The experimenter asked any students at random passing by whether they were interested in being subjects on a study of lighting. The study was briefly explained and if they were then interested they became subjects. About five subjects were obtained by sign ups which had been distributed in the classes. In all sixty subjects were used for the study and they were from nearly all curriculums at the campus.

After the subject sat down he was given the "Informed Consent and Instructions" form which he read before making the evaluations (Figures 7 and 8). After reading the form which told him what the study was about and what he was supposed to do, he then signed the "Informed Consent Statement" form (Figure 9) and then began making the evaluations.

FOR EXPERIMENTER USE ONLY:

TYPE OF ROOM: LR/WR
TYPE OF SOURCE: F/I
LUMINAIRE PATTERN: 1/2/3/4/5/6/7

GRADING SHEET

Name: ______________________, AGE: ________yrs, SEX: M/F

AVERAGE

unpleasant	1	2	3	4	5	6	7	pleasant
warm	1	2	3	4	5	6	7	cool
vague	1	2	3	4	5	6	7	distinct
short	1	2	3	4	5	6	7	long
cloudy	1	2	3	4	5	6	7	sunny
small	1	2	3	4	5	6	7	large
tense	1	2	3	4	5	6	7	relaxed
cramped	1	2	3	4	5	6	7	spacious
hazy	1	2	3	4	5	6	7	clear
monotonous	1	2	3	4	5	6	7	interesting
dim	1	2	3	4	5	6	7	bright

DATE: ____________

____
(signature)

REMARKS:

Figure 6. An example of the grading sheet.

INFORMED CONSENT AND INSTRUCTIONS

LIVING ROOM

This experiment is designed to study subjective evaluations of lighting environments using scale models.

Your task will be very simple. You will be asked to sit down in front of a scale model of a living room, lit by a particular kind of lighting. You will be shown this condition briefly, then you will judge the lighting. Altogether you will be exposed to seven light settings. The judgments will be made on scales as shown below. For example, if you feel that a particular lighting is very pleasant, very friendly, and is average in beauty, circle the number close to your judgment on the sheet, as shown below.

				Average				
UNPLEASANT	1	2	3	4	5	6	(7)	PLEASANT
UNFRIENDLY	1	2	3	4	5	6	(7)	FRIENDLY
UGLY	1	2	3	(4)	5	6	7	BEAUTIFUL

There will be no discomfort nor risk in this experiment. However, you are free to stop your participation at any time. Naturally I would prefer that you continue until the end so that I can get all of the needed data. If you have any questions, now or later, feel free to ask.

If you have any comments about the procedure and experiment, please feel free to write them at the end of the experiment in the space provided below the scales.

Now if you are ready for the experiment, please sign the informed consent statement form given by the experimenter.

Thanks for your cooperation.

Figure 7. "Informed Consent and Instructions" form.

INFORMED CONSENT AND INSTRUCTIONS

WAITING ROOM

This experiment is designed to study subjective evaluations of lighting environments using scale models.

Your task will be very simple. You will be asked to sit down in front of a scale model of a waiting room, lit by a particular kind of lighting. You will be shown this condition briefly, then you will judge the lighting. Altogether you will be exposed to seven light settings. The judgments will be made on scales as shown below. For example, if you feel that a particular lighting is very pleasant, very friendly, and is average in beauty, circle the number close to your judgment on the sheet, as shown below.

				Average				
UNPLEASANT	1	2	3	4	5	6	(7)	PLEASANT
UNFRIENDLY	1	2	3	4	5	6	(7)	FRIENDLY
UGLY	1	2	3	(4)	5	6	7	BEAUTIFUL

There will be no discomfort nor risk in this experiment. However, you are free to stop your participation at any time. Naturally I would prefer that you continue until the end so that I can get all of the needed data. If you have any questions, now or later, feel free to ask.

If you have any comments about the procedure and experiment, please feel free to write them at the end of the experiment in the space provided below the scales.

Now if you are ready for the experiment, please sign the informed consent statement form given by the experimenter.

Thanks for your cooperation.

Figure 8. "Informed consent and instructions" form.

Informed Consent Statement

Having read the informed consent, I hereby freely agree to be a subject in the research entitled "SCALE MODEL STUDY OF LIGHTING AESTHETICS."

S. NO.	SIGNATURE	AGE	SEX (M/F)	DATE

Figure 9. "Informed consent statement" form.

RESULTS

The subjective reactions of the subjects for each lighting condition on each scale are given in the Appendix A. The corresponding factor scores are also given. The type of room is specified by a "W" or "L" which represents the waiting room and living room respectively. The letters R1, R2, ..., R11 used are the eleven semantic differential rating scales which have been numbered 1 to 11, these are listed in Figure 10. P is the ceiling luminaire pattern and it is numbered 1 to 7 which represents the seven lighting conditions, these are listed in Figure 11.

Table 1 shows the correlation matrix for the semantic scales. Factor analysis of the eleven scales was carried out with the correlation matrix using the Statistical Analysis System computer program (1976). Four factors were extracted from the analysis.

Table 2 shows the four factors found for the scales with their respective loadings. Loadings greater than 0.49 will be considered to be high. In this respect high loadings on factor 1 occur with the scales 3, 5, 6, 9, and 11, which are vague - distinct, cloudy-sunny, small-large, hazy-clear, and dim-bright respectively; factor 1 was named "clarity". High loadings on factor 2 occur with the scales 1, 7, and 10, which are unpleasant-pleasant, tense-relaxed, and monotonous-interesting respectively; factor 2 was named "evaluation". High loadings on factor 3 occur with the scales 2, 4, 6, and 8, which are warm-cool, short-long, small-large, and cramped-spacious respectively; factor 3 was named as "spaciousness". The only high loading on factor 4 is scale 2 which is warm-cool; factor 4 was named as "warmth".

R1 unpleasant - pleasant

R2 warm - cool

R3 vague - distinct

R4 short - long

R5 cloudy - sunny

R6 small - large

R7 tense - relaxed

R8 cramped - spacious

R9 hazy - clear

R10 monotonous - interesting

R11 dim - bright

Figure 10. The eleven semantic scales.

P1 Combination of central & peripheral fluorescent lighting + incandescent downlighting

P2 Combination of central & peripheral fluorescent lighting

P3 Central fluorescent lighting + incandescent downlighting

P4 Central fluorescent lighting

P5 Peripheral fluorescent light + incandescent downlighting

P6 Peripheral fluorescent lighting

P7 Peripheral fluorescent lighting at a high illumination level

Figure 11. Types of ceiling luminaire patterns.

CORRELATION MATRIX

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
R1	1.00000	-0.22835	0.00837	0.15663	0.19692	0.15407	0.63560	0.28502	0.02794	0.51666	-0.11362
R2	-0.22835	1.00000	-0.00540	0.02351	-0.28612	0.04235	-0.20954	-0.04055	-0.00081	-0.25291	0.00148
R3	0.00837	-0.00540	1.00000	0.19306	0.41580	0.29757	-0.08867	0.17764	0.64747	0.11588	0.62875
R4	0.15663	0.02351	0.19306	1.00000	0.15387	0.52761	0.17626	0.46613	0.17786	0.13070	0.20119
R5	0.19692	-0.28612	0.41580	0.15387	1.00000	0.27272	0.09789	0.17134	0.51215	0.26301	0.53172
R6	0.15407	0.04235	0.29757	0.52761	0.27272	1.00000	0.09633	0.55294	0.33700	0.06789	0.33158
R7	0.63560	-0.20954	-0.08867	0.17626	0.09789	0.09633	1.00000	0.22121	-0.07590	0.48973	-0.24456
R8	0.28502	-0.04055	0.17764	0.46613	0.17134	0.55294	0.22121	1.00000	0.23145	0.23127	0.20654
R9	0.02794	-0.00081	0.64747	0.17786	0.51215	0.33700	-0.07590	0.23145	1.00000	0.13701	0.72982
R10	0.51666	-0.25291	0.11588	0.13070	0.26301	0.06789	0.48973	0.23127	0.13701	1.00000	0.03993
R11	-0.11362	0.00148	0.62875	0.20119	0.53172	0.33158	-0.24456	0.20654	0.72982	0.03993	1.00000

TABLE 1. Correlation matrix of the scales.

FACTOR PATTERN

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
R1	0.35172	0.73868	-0.09345	0.19540
R2	-0.17605	-0.35625	0.50181	0.72714
R3	0.66885	-0.39198	-0.20253	0.19714
R4	0.54157	0.11984	0.57824	-0.17829
R5	0.67466	-0.07348	-0.41350	-0.14633
R6	0.66277	-0.02556	0.51645	-0.15719
R7	0.22925	0.80629	-0.02895	0.18890
R8	0.59414	0.22398	0.47606	-0.12079
R9	0.72043	-0.38757	-0.21432	0.16898
R10	0.41546	0.59937	-0.29397	0.26288
R11	0.67156	-0.51588	-0.17790	0.03633

TABLE 2. Factor pattern for the scales.

A Chi-square test was done to test the homogeneity within co-variance matrices. The purpose of this test was to see whether multi-variate analysis could be done taking all the factors together as one group. Table 3 shows the results; as the Chi-square value is significant multi-variate analysis cannot be done; univariate analysis had to be conducted taking each factor separately.

First the analysis was done for room differences - whether there would be any significant differences in reactions comparing the waiting and the living room. The level of significance chosen for all analyses was 5%. The results of the analysis are shown in Tables 4, 5, 6, and 7 which are for "clarity", "evaluation", "spaciousness", and "warmth" factors respectively. The results indicate that there was no significant difference between rooms for any of the four factors. The second set of analyses of variance were done for pattern differences — whether there would be any significant differences for different ceiling luminaire patterns. The results of the analysis are shown in Tables 8, 9, 10, and 11 which are for "clarity", "evaluation", "spaciousness", and "warmth" respectively. The results indicate significant differences among patterns for "clarity", "evaluation" and "spaciousness" factors but no significant difference among patterns for "warmth" factor.

Further analysis for pattern differences was carried out using Duncan's multiple range test. The results are shown in Tables 12, 13, 14, and 15 respectively which show the factor means for each pattern and the means with the same letter are not significantly different.

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DISCRIMINANT ANALYSIS     TEST OF HOMOGENEITY OF WITHIN COVARIANCE MATRICES

      NOTATION:   K    =    NUMBER OF GROUPS
                  P    =    NUMBER OF VARIABLES
                  N    =    TOTAL NUMBER OF OBSERVATIONS
                  N(I) =    NUMBER OF OBSERVATIONS IN THE I'TH GROUP

                                                 N(I)/2
                            __  |WITHIN SS MATRIX(I)|
                  V    =    ------------------------------------
                                                 N/2
                                |POOLED SS MATRIX|

                                  _                           _      2
                                 |           1          1      |  2P  + 3P - 1
                  RHO  =    1.0 - | SUM  ------   -   ---      |  -------------
                                 |_        N(I)-1       N-K   _|  6(P+1)(K-1)

                  DF   =    .5(K-1)P(P+1)

                              _                    _
                             |   PN/2               |
                             |  N          V        |
UNDER NULL HYPOTHESIS:  -2 RHO LN |  -------------------- |  IS DISTRIBUTED APPROXIMATELY AS CHI-SQUARE(DF)
                             |             PN(I)/2  |
                             |_  __  N(I)          _|


TEST CHI-SQUARE VALUE =           33.31481904    WITH       10 DF     PROB > CHI-SQ = 0.0002

SINCE THE CHI-SQUARE VALUE IS SIGNIFICANT AT THE 0.0500 LEVEL, THE WITHIN COVARIANCE MATRICES WILL BE USED IN
THE DISCRIMINANT FUNCTION.

REFERENCE: KENDALL,M.G. AND A.STUART  THE ADVANCED THEORY OF STATISTICS VOL.3 P266 & 282.
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TABLE 3. Chi square test for multivariate analysis.

STATISTICAL ANALYSIS SYSTEM

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: FI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	34.00943375	34.00943375	3.46	0.0678	0.056337	99999.9999
ERROR	58	569.66797339	9.82186161		STD DEV		FI MEAN
CORRECTED TOTAL	59	603.67740714			3.13398494		0.00000000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
R	1	34.00943375	3.46	0.0678

TABLE 4. Analysis of variance for room differences for "CLARITY" factor.

STATISTICAL ANALYSIS SYSTEM

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: F2

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	8.12380137	8.12380137	1.15	0.2874	0.019492	99999.9999
ERROR	58	408.64450695	7.04559495		STD DEV		F2 MEAN
CORRECTED TOTAL	59	416.76830831			2.65435396		0.00000000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
R	1	8.12380137	1.15	0.2874

TABLE 5. Analysis of variance for room differences for "EVALUATION" factor.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: F3

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	5.03146805	5.03146805	0.57	0.4522	0.009782	99999.9999
ERROR	58	509.34528520	8.78181526		STD DEV		F3 MEAN
CORRECTED TOTAL	59	514.37675324			2.96341277		0.00000000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
R	1	5.03146805	0.57	0.4522

TABLE 6. Analysis of variance for room differences for "SPACIOUSNESS" factor.

STATISTICAL ANALYSIS SYSTEM

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: F4

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	0.14493382	0.14493382	0.01	0.9115	0.000215	99999.9999
ERROR	58	673.90409632	11.61903614		STD DEV		F4 MEAN
CORRECTED TOTAL	59	674.04903013			3.40867073		-0.00000000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
R	1	0.14493382	0.01	0.9115

TABLE 7. Analysis of variance for room differences for "WARMTH" factor.

STATISTICAL ANALYSIS SYSTEM

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: FACTOR1

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	65	156.58506007	2.40900092	3.35	0.0001	0.380873	99999.9999
ERROR	354	254.53607374	0.71902846		STD DEV		FACTOR1 MEAN
CORRECTED TOTAL	419	411.12113381			0.84795546		0.00000000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
ID	59	86.23962959	2.03	0.0001				
P	6	70.34543048	16.31	0.0001	6	70.34543048	16.31	0.0001 *

* Significant at $\alpha = 0.05$

TABLE 8. Analysis of variance for pattern differences for "CLARITY" factor.

STATISTICAL ANALYSIS SYSTEM

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: FACTOR2

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	65	200.02261408	3.07727099	5.17	0.0001	0.487218	99999.9999
ERROR	354	210.51750003	0.59468220		STD DEV		FACTOR2 MEAN
CORRECTED TOTAL	419	410.54011411			0.77115641		0.00000000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
ID	59	59.53832976	1.70	0.0021				
P	6	140.48428432	39.37	0.0001	6	140.48428432	39.37	0.0001 *

* Significant at α = 0.05

TABLE 9. Analysis of variance for pattern differences for "EVALUATION" factor.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: FACTOR3

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	65	106.41846588	1.63720717	1.90	0.0001	0.258763	99999.9999
ERROR	354	304.83949640	0.86112852		STD DEV		FACTOR3 MEAN
CORRECTED TOTAL	419	411.25796228			0.92797011		0.00000000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
ID	59	73.48239332	1.45	0.0238				
P	6	32.93607256	6.37	0.0001	6	32.93607256	6.37	0.0001 *

* Significant at $\alpha = 0.05$

TABLE 10. Analysis of variance for pattern differences for "SPACIOUSNESS" factor.

STATISTICAL ANALYSIS SYSTEM

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: FACTOR4

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	65	105.77018319	1.62723359	1.89	0.0001	0.257801	99999.9999
ERROR	354	304.50817848	0.86019259		STD DEV		FACTOR4 MEAN
CORRECTED TOTAL	419	410.27836167			0.92746568		-0.00000000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
ID	59	96.29271859	1.90	0.0002				
P	6	9.47746460	1.84	0.0912	6	9.47746460	1.84	0.0912

TABLE 11. Analysis of variance for pattern differences for "WARMTH" factor.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE FACTOR1

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=354   MS=0.719028

GROUPING	MEAN	N	P	
A	0.511626	60	7	Peripheral at high illum.
A				
A	0.361570	59	1	Comb. of central & periph. + Incand.
A				
A	0.216102	60	6	Peripheral + Incand.
A				
A	0.186194	61	5	Peripheral
B	-0.157206	60	2	Comb. of central & periph.
B				
B	-0.393905	60	3	Central
C	-0.721457	60	4	Central + Incand.

TABLE 12. Duncan's multiple range test for "CLARITY" factor.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE FACTOR2

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=354   MS=0.594682

GROUPING		MEAN	N	P	
	A	0.595596	59	1	Comb. of central & periph. + Incand.
	A				
B	A	0.428532	61	5	Peripheral
B					
B	C	0.186759	60	2	Comb. of central & periph.
B	C				
B	C	0.180793	60	3	Central
	C				
	C	-0.018985	60	4	Central + Incand.
	C				
	C	-0.053045	60	6	Peripheral + Incand.
	D	-1.316866	60	7	Peripheral at high illum.

TABLE 13. Duncan's multiple range test for "EVALUATION" factor.

STATISTICAL ANALYSIS SYSTEM

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE FACTOR3

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=354 MS=0.861129

GROUPING			MEAN	N	P	
	A		0.405289	60	6	Peripheral + Incand.
	A					
B	A		0.358906	60	2	Comb. of central & periph.
B	A					
B	A	C	0.063644	61	5	Peripheral
B		C				
B	D	C	0.033469	60	4	Central + Incand.
	D	C				
	D	C	-0.250071	60	7	Peripheral at high illum.
	D	C				
	D	C	-0.290215	60	3	Central
	D					
	D		-0.327542	59	1	Comb. of central & periph. + Incand.

TABLE 14. Duncan's multiple range test for "SPACIOUSNESS" factor.

STATISTICAL ANALYSIS SYSTEM

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE FACTOR4

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=354 MS=0.860193

GROUPING		MEAN	N	P	
	A	0.251164	60	2	Comb. of central & periph.
B	A	0.068377	60	4	Central + Incand.
B	A	0.066080	60	7	Peripheral at high illum.
B	A	0.044124	60	6	Peripheral + Incand.
B	A	-0.049999	59	1	Comb. of central & periph. + Incand.
B	A	-0.121152	61	5	Peripheral
B		-0.257408	60	3	Central

TABLE 15. Duncan's multiple range test for "CLARITY" factor.

A one-tail *t* test was then carried out on the means; between the highest mean and the average of the means of the remaining six. The hypothesis set was that the highest mean is greater than the average mean of the rest. Table 16 shows the results which indicates that the test was not significant from which it can be concluded that the patterns with the highest means were not significantly different from the patterns with the lower means.

	d.f.	$t_{calculated}$	t_{tables}
FACTOR 1	354	0.703 *	1.645
FACTOR 2	354	0.900 *	1.645
FACTOR 3	354	0.51 *	1.645

* Not significant at $\alpha = 0.05$.

TABLE 16. One tail t test for factor means.

DISCUSSION

Factor Structure

As this research is based on the study of Flynn, Spencer, Martyniuk, and Hendrick (1973), the scales were chosen from their study. In their study the scales were listed under three main factors, namely "evaluation", "perceptual clarity", and "spaciousness". Three scales were selected from each factor.

Evaluation. This factor had the scales unpleasant-pleasant, tense-relaxed, and monotonous-interesting. Evaluation was considered to be high when subjective judgments were towards pleasant.

Perceptual clarity. This factor had the scales hazy-clear, dim-bright, and vague-distinct. Perceptual clarity was considered to be high when subjective judgments were towards clear.

Spaciousness. This factor had the scales small-large, short-long, and cramped-spacious. Spaciousness was considered to be more when subjective judgments were towards large.

Warmth. This factor was chosen for this research and two scales were chosen to represent it; warm-cool and cloudy-sunny. Warmth was considered to be more when subjective judgments were towards warm.

As the scales were the same it was expected that this research would show the same factors as those found by Flynn and others (1973). This is shown in some ways in the correlation matrix (Table 1) and the factor pattern (Table 2). Correlations of 0.4 or higher are considered to be high. The matrix shows high correlations between unpleasant-pleasant, tense-relaxed, and monotonous-interesting; between vague-distinct, cloudy-sunny, hazy-clear, and dim-bright; between short-long, small-large, and cramped-spacious; the scale warm-cool did not have a high correlation with any other scale. The factor analysis found four factors and they are listed in Figure 12 with their scales and loadings.

Looking at the factors it can be seen that the first three factors and scales are the same as in the study by Flynn and others (1973) which was expected. There were a few unexpected scales found in the factors such as cloudy-sunny in the "clarity" factor, warm-cool in the "spaciousness" factor. The cloudy-sunny scale should have been in the "warmth" factor.

The percentage of variance represented by the four factors was 0.310 for the "clarity" factor, 0.216 for the "evaluation" factor, 0.136 for the "spaciousness" factor, and 0.078 for the "warmth" factor; these four factors together accounted for 0.74 of the variance among the factors. Thus, "clarity" accounted for the largest percentage of variance and "warmth" the least. It was also observed that the subjective judgments made by the subjects were made over a wider range on the scales for the "clarity" factor as compared to the "evaluation" and "spaciousness" factors, and for the "warmth" factor there was very little difference in the judgments on the scales for the seven ceiling luminaire patterns.

Room Effects

The analysis of variance for room differences (Tables 4, 5, 6, and 7) showed that there was no significant difference in the subjective judgments

FACTOR 1 - CLARITY

vague - distinct	0.69
cloudy - sunny	0.69
hazy - clear	0.75
dim - bright	0.71

FACTOR 2 - EVALUATION

unpleasant - pleasant	0.76
tense - relaxed	0.81
monotonous - interesting	0.60

FACTOR 3 - SPACIOUSNESS

short - long	0.58
small - large	0.53
cramped - spacious	0.49

FACTOR 4 - WARMTH

warm - cool	0.72

Figure 12. The factors with the scales and loadings.

between the type of room for any of the four factors. In other words there was no difference in the reactions made by the subjects, whether the model was a waiting room or a living room. A possible explanation for this is that the subjects did not pay attention to the instructions which indicated whether the model was a waiting or living room. It may also be that people in general are not very particular about the kind of lighting they would prefer for a living or waiting room or for any other kind of room. This could mean that the same kind of lighting can be used for public and private spaces or in general types of rooms, whether it is fluorescent lighting or incandescent lighting.

Pattern Effects

The analysis of variances for pattern differences (Tables 8, 9, 10, and 11) showed that there were significant differences in the subjective judgments for the "clarity", "evaluation", and "spaciousness" factors but no significant differences among patterns for the "warmth" factor. It is conceivable that the pattern differences didn't show up for the "warmth" factor because it had only one scales whereas the other factors had three scales. Further, there was very little incandescent lighting in the model compared to the fluorescent lighting, which would make it difficult to differentiate between the patterns for the "warmth" factor.

To find the differences among the ceiling luminaire patterns for each factor, Duncan's multiple range test was conducted (Tables 12, 13, 14, and 15). The hypotheses set for this research were that for "evaluation" a combination of central and peripheral fluorescent lighting + Incandescent lighting would be the best, for "clarity" peripheral fluorescent lighting at the high illumination level would be the best, impressions of "spaciousness" would result from peripheral lighting. The hypotheses were based on the results found by Flynn and others (1973). This research was expected to show similiar results - for each of the first three factors a particular pattern would be the most preferred.

The Duncan's test showed the means for each of the patterns and to find whether the pattern with the highest mean was the most preferred, a one-tail t test was conducted to find any significant difference between the highest mean and the sum of the means of the other six. The results of the t test (Table 16) indicate that the test was not significant for any of the three factors, thus, the hypotheses set for this research were not confirmed.

However, numerous interpretations can be drawn from the Duncan's test for the four factors. Although it could not be concluded with certainty that the patterns with the highest means were the most preferred, the patterns that were expected to be preferred for the particular factor did have the highest means. For example in the "clarity" factor, peripheral fluorescent lighting at the high illumination level had the highest mean, similarly for the "evaluation" factor, the combination of central and peripheral fluorescent lighting + Incandescent lighting had the highest mean, similarly for the "spaciousness" factor, peripheral lighting had the highest mean. Some future research might look at these patterns further.

Looking at the Duncan's tables some interesting observations can be made. For "clarity" the combination of central and peripheral fluorescent lighting + Incandescent lighting was rated high, it is conceivable that the greater number of lights gave feelings of clarity. For "evaluation" the patterns with incandescent lighting were rated higher than patterns without incandescent lighting, the small amount of incandescent lighting seemed to be preferred as an addition; the high illumination condition was the lowest for "evaluation", too much light might have given feelings of unpleasantness. For the "warmth" factor patterns with fluorescent lighting were rated as cool but when incandescent lighting was added to them they were rated towards the warm side as should be expected.

Implications

The results validated the study of Flynn and others (1973). Their study was conducted in a conference room and this study simulated the conditions using different types of rooms. The same factors were found which shows that factor analysis can be done for these kinds of research. Moreover as scale models were used in this research to study real conditions it can be concluded that scale models can simulate real conditions effectively and they could be used more often in lighting research. The preferences for a particular kind of lighting for any kind of room does not seem to be very strong. One of the limitations of the scale model used was that all the luminaires were in the ceiling; these days increasing attention is being given to task ambient lighting and this wasn't done.

Further research might look into this possibility of designing such models. More research needs to be done with scale models and factors using different variables which would provide insight in the design of better lighting environments.

CONCLUSION

The following conclusions can be drawn from the present research work:

1. The results validate the study by Flynn, Spencer, Martyniuk, and Hendrick (1973).
2. Factor analysis can be done for these kinds of research.
3. Scale models can simulate real conditions effectively.
4. There are no significant differences in the subjective judgments between the type of room for any of the four factors.
5. There are significant differences in the subjective judgments among patterns for the "clarity", "evaluation", and "spaciousness" factors, but no significant differences among patterns for the "warmth" factor.
6. The hypotheses that for each factor a particular pattern will be most preferred could not be confirmed.

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APPENDIX

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

OBS	ID	R	P	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	FACTOR1	FACTOR2	FACTOR3	FACTOR4
1	8	L	5	6	6	5	4	6	5	3	2	4	3	5	-0.2224	-0.8687	-0.4157	1.0304
2	8	L	4	5	5	4	5	5	4	5	3	4	5	4	-0.2870	0.4771	-0.2730	0.8097
3	8	L	6	4	4	5	4	5	5	4	5	5	5	5	0.4072	-0.2144	-0.3498	-0.0212
4	8	L	7	6	6	6	5	6	6	4	4	6	5	5	1.1511	-0.3727	0.0914	1.5753
5	8	L	1	6	4	5	5	5	4	4	4	5	6	4	0.3629	0.5552	-0.7069	0.5853
6	8	L	3	6	5	4	5	4	4	4	5	5	5	4	0.0169	0.4839	0.3101	0.8003
7	8	L	2	6	5	5	5	6	5	6	5	4	5	6	0.8767	0.6705	0.0016	0.9151
8	9	L	5	5	3	6	4	5	4	5	6	7	5	6	1.1173	-0.0266	-1.1141	0.1443
9	9	L	4	5	4	5	3	3	4	5	3	5	6	3	-0.5607	0.6556	-1.1799	1.2887
10	9	L	6	5	3	5	4	5	3	4	3	5	3	6	-0.2447	-0.5487	-1.5026	-0.4935
11	9	L	7	5	4	6	3	5	3	4	2	6	4	6	-0.1455	-0.9481	-2.2548	1.0580
12	9	L	1	6	6	5	3	3	4	6	5	6	6	4	0.0293	0.8134	-0.3729	2.8935
13	9	L	3	6	6	5	3	3	4	6	4	6	6	3	-0.2344	0.8633	-0.5482	2.9643
14	9	L	2	7	7	6	4	3	4	7	5	6	7	4	0.5446	1.3051	-0.0786	4.1441
15	13	L	4	4	5	4	3	3	4	3	3	4	3	4	-1.2982	-0.7468	-0.1998	0.3977
16	13	L	2	5	4	5	5	4	5	5	5	6	5	5	0.6648	0.2531	0.0790	0.3268
17	13	L	7	3	5	6	5	3	5	2	3	6	3	6	-0.0180	-1.9634	0.2973	0.1935
18	13	L	6	3	4	4	5	3	5	4	5	4	5	4	-0.2769	0.0949	0.7765	-0.5054
19	13	L	1	5	4	5	5	5	4	5	5	5	4	5	0.3782	0.1295	-0.1605	-0.0018
20	13	L	5	5	4	5	5	5	5	4	6	4	5	5	0.6248	0.2498	0.3352	-0.2916
21	13	L	3	3	4	4	3	5	4	3	4	5	4	5	-0.4782	-0.8875	-0.9354	-0.3318
22	14	L	4	3	5	5	4	3	5	4	3	5	4	5	-0.4242	-0.8351	0.0347	0.6600
23	14	L	2	6	3	5	4	3	5	5	4	5	6	5	0.2738	0.8592	-0.7124	0.3778
24	14	L	7	2	6	6	5	4	5	3	3	6	4	6	0.1877	-1.8516	0.2137	1.0390
25	14	L	6	4	3	4	5	3	5	5	6	4	5	3	-0.1000	0.9136	0.7926	-0.9965
26	14	L	1	6	3	5	5	5	6	5	5	6	5	6	1.2414	0.4169	-0.2080	-0.4194
27	14	L	5	4	3	4	5	5	5	4	6	5	3	5	0.3480	-0.2555	0.4724	-1.7227
28	14	L	3	4	3	5	4	5	5	4	3	5	4	5	0.0487	-0.4561	-0.9497	-0.7414
29	15	L	4	3	5	4	3	4	4	4	3	6	5	5	-0.5187	-0.6654	-0.9970	1.1077
30	15	L	6	5	4	3	3	4	3	4	6	6	4	3	-0.6212	0.3113	-0.4385	0.0522
31	15	L	7	2	5	6	4	3	5	3	5	6	3	7	0.2080	-1.9283	0.3840	0.2312
32	15	L	1	6	5	5	4	5	4	5	5	5	5	6	0.4823	0.2765	-0.5557	1.3292
33	15	L	5	4	3	4	5	5	4	4	5	5	4	5	0.1296	-0.0980	-0.2539	-1.1877
34	15	L	2	5	3	5	3	4	4	3	5	3	5	5	-0.3308	0.1039	-0.9102	-0.4707
35	15	L	3	3	4	3	5	3	4	4	5	3	5	3	-0.9105	0.5062	0.7730	-0.6872
36	16	L	4	3	4	4	3	3	4	5	4	5	4	5	-0.7147	-0.2421	-0.5399	0.2244
37	16	L	6	3	6	4	5	5	5	4	6	4	3	3	-0.2336	-0.4725	1.5619	-0.0559
38	16	L	7	1	5	6	5	3	5	2	5	6	3	7	0.2513	-2.3825	0.8055	-0.2959
39	16	L	1	5	3	5	4	5	5	4	5	6	6	5	0.7792	0.2225	-0.9253	-0.1551
40	16	L	5	5	4	3	5	5	3	5	6	5	4	4	-0.1372	0.6426	0.1098	-0.3649
41	16	L	2	4	3	5	4	3	5	5	5	6	4	6	0.3280	-0.1907	-0.2166	-0.4194
42	16	L	3	3	5	3	5	4	3	4	3	4	4	3	-1.2233	-0.1315	0.0913	0.1039
43	17	L	4	6	7	5	3	2	2	4	2	3	1	2	-2.3104	-0.4891	0.0639	2.2234
44	17	L	2	6	5	3	4	3	4	3	4	4	4	4	-0.9261	0.1845	0.2955	0.4756
45	17	L	5	7	4	5	5	5	5	6	5	6	4	5	0.8965	0.7152	-0.0481	0.4346
46	17	L	6	4	4	5	6	4	5	4	3	3	4	3	-0.3839	0.0510	0.6218	-0.6727
47	17	L	7	6	5	6	7	6	5	6	5	7	6	7	2.0490	0.3372	0.0738	1.3529
48	17	L	3	6	5	4	5	4	5	4	5	4	4	5	0.0601	0.2536	0.8063	0.2954
49	17	L	1	6	6	5	6	5	5	6	6	5	6	5	1.1168	0.9286	0.9050	1.7281
50	18	L	4	3	7	1	3	1	3	4	1	1	1	1	-3.7675	-0.2191	1.2052	0.7882
51	18	L	2	3	3	3	4	2	3	3	2	2	3	4	-2.1008	-0.2965	-0.3433	-1.3452
52	18	L	5	4	4	6	3	5	4	3	4	6	4	4	-0.0238	-0.9704	-1.2408	0.2793
53	18	L	6	4	4	6	3	4	3	4	3	6	4	5	-0.3519	-0.8305	-1.6765	0.8640
54	18	L	7	1	2	7	1	7	1	1	1	7	5	6	-0.5349	-2.6126	-5.0035	-0.2289

APPENDIX A. Subjective judgments for each scale for the seven conditions.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

OBS	IO	R	P	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	FACTOR1	FACTOR2	FACTOR3	FACTOR4
55	18	L	3	6	6	2	6	3	6	6	5	3	4	2	-0.5789	1.5640	2.5090	0.4471
56	18	L	1	2	6	3	6	2	6	6	6	2	3	3	-0.8386	0.4264	3.2017	-0.3301
57	22	L	4	5	6	2	5	3	6	3	6	4	2	3	-0.7401	-0.1516	2.6232	-0.5062
58	22	L	3	3	1	5	2	7	2	1	3	5	3	6	-0.6053	-1.7535	-3.3832	-2.3098
59	22	L	5	6	5	2	4	2	4	6	6	2	6	2	-1.1669	2.2920	1.1157	0.9146
60	22	L	1	6	3	5	5	4	3	4	5	2	6	5	-0.1331	1.0525	-0.5900	-0.2365
61	22	L	6	6	6	4	5	7	7	5	7	7	4	7	1.8987	-0.2122	1.0928	0.7006
62	22	L	7	2	2	6	3	7	7	3	5	6	2	7	1.0794	-2.0250	-0.8357	-2.5969
63	22	L	2	5	5	1	4	3	7	5	7	3	3	5	-0.4167	0.7894	2.4189	-0.8669
64	23	L	4	5	4	6	5	3	2	6	4	5	5	4	-0.2483	0.6368	-0.8280	1.2303
65	23	L	3	5	3	6	5	7	5	3	4	6	5	6	1.2560	-0.6612	-1.2406	-0.6728
66	23	L	5	6	3	3	6	4	6	6	5	4	6	5	0.6138	1.6769	0.7119	-0.7236
67	23	L	1	4	3	4	4	6	5	3	4	5	3	4	-0.0970	-0.6482	-0.5251	-1.6204
68	23	L	6	5	5	5	6	3	5	6	6	5	7	4	0.7568	1.2549	1.0029	1.3448
69	23	L	7	2	2	4	2	7	2	2	3	6	2	7	-0.6891	-2.1278	-2.9749	-1.9244
70	23	L	2	3	6	3	5	1	2	5	4	2	3	1	-2.3994	0.5163	1.4457	0.7466
71	28	L	5	7	5	6	4	4	5	6	6	6	6	5	1.0823	0.9452	-0.1568	2.0266
72	28	L	3	5	4	6	7	6	6	5	6	6	5	5	1.8050	0.1693	0.8413	-0.3703
73	28	L	2	7	2	6	7	4	6	6	6	3	6	4	1.2829	1.9301	0.8460	-1.1362
74	28	L	6	3	5	6	3	3	2	1	3	6	3	6	-0.9290	-2.2973	-1.3445	0.9069
75	28	L	7	1	6	7	5	6	6	1	3	7	3	7	0.8774	-3.3467	0.0322	0.2435
76	28	L	1	7	2	6	4	4	4	7	4	5	6	4	0.5025	1.7034	-1.5911	0.4081
77	28	L	4	7	5	6	7	4	6	5	6	3	3	3	0.6650	0.7562	2.2389	-0.1296
78	29	L	4	5	3	6	5	4	6	5	6	5	2	4	0.6076	-0.1231	0.9386	-1.3761
79	29	L	2	4	6	2	4	3	6	3	5	3	2	3	-1.2600	-0.3694	2.1391	-0.4677
80	29	L	5	4	5	3	3	3	3	6	5	2	2	3	-1.7769	0.5563	0.5438	0.1297
81	29	L	3	3	3	4	6	2	3	4	2	2	5	5	-1.2277	0.2370	-0.1501	-0.8183
82	29	L	6	6	2	5	6	4	5	6	3	4	2	3	-0.1495	0.7386	0.2333	-1.7789
83	29	L	7	5	4	2	3	4	3	5	3	3	2	4	-1.7428	0.3360	-0.5212	-0.4828
84	29	L	1	4	2	6	5	6	6	3	6	7	4	6	1.5795	-0.9256	-0.3787	-1.9192
85	30	L	4	4	2	6	6	5	5	5	7	7	3	5	1.3872	-0.2841	0.3789	-1.9230
86	30	L	2	5	4	5	6	4	7	5	4	4	4	5	0.6343	0.2295	1.1748	-0.5851
87	30	L	5	4	5	3	6	2	6	3	6	4	2	3	-0.5976	-0.3133	2.8565	-1.2375
88	30	L	3	4	2	6	7	5	7	3	5	6	3	5	1.3889	-0.8466	0.9706	-2.6862
89	30	L	6	6	5	3	4	4	5	4	4	5	2	6	-0.3676	-0.3952	0.4660	0.0377
90	30	L	7	5	5	5	3	6	5	6	3	5	6	3	0.1113	0.6725	-1.2454	1.6482
91	30	L	1	6	5	7	7	7	7	7	7	7	3	6	2.6363	0.0131	1.4357	0.2317
92	32	L	1	5	4	6	6	3	7	6	4	5	2	4	0.5020	-0.0346	1.5694	-0.5719
93	32	L	6	6	4	5	5	5	5	3	4	6	3	5	0.4430	-0.6361	-0.0607	-0.3906
94	32	L	7	3	3	3	4	3	4	3	4	3	3	2	-1.5545	-0.0837	0.3126	-1.7891
95	32	L	3	6	6	6	4	4	6	5	5	5	5	6	0.8287	0.0191	0.4010	1.9752
96	32	L	5	3	3	5	4	6	6	4	5	6	4	7	1.0051	-0.9562	-0.5644	-1.1900
97	32	L	2	3	5	4	4	4	5	3	4	3	3	2	-1.1118	-0.5349	0.8156	-0.5260
98	32	L	4	4	5	3	2	3	3	4	4	4	3	4	-1.6293	-0.2755	-0.5099	0.6331
99	34	L	2	1	7	7	6	4	6	1	5	6	2	6	0.5756	-3.1611	1.9382	0.2915
100	34	L	5	2	6	6	6	4	6	2	5	6	2	6	0.5515	-2.3865	1.7450	-0.2424
101	34	L	3	3	4	5	4	4	3	4	5	4	5	5	-0.3457	-0.2430	-0.6074	0.1362
102	34	L	1	3	5	6	6	6	6	3	6	6	3	4	1.0423	-1.3130	1.2529	-0.7196
103	34	L	6	4	6	6	5	5	6	3	5	5	3	6	0.6987	-1.4135	1.0058	0.4827
104	34	L	7	2	6	6	6	6	6	2	6	6	3	6	1.1291	-2.1816	1.4121	-0.2993
105	34	L	4	3	5	5	5	4	5	4	6	3	5	5	0.1334	-0.1481	0.9879	0.0605
106	35	L	2	1	6	5	6	3	4	3	3	6	2	6	-0.4721	-2.2526	0.9924	0.2297
107	35	L	5	5	3	3	3	3	6	5	6	6	5	4	0.0889	0.8102	0.1551	-0.5189
108	35	L	3	2	5	2	3	2	3	4	2	2	2	2	-2.8914	-0.3474	0.2915	-0.3163

STATISTICAL ANALYSIS SYSTEM

OBS	IO	R	P	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	FACTOR1	FACTOR2	FACTOR3	FACTOR4
109	35	L	1	5	5	5	6	6	6	5	5	3	4	4	0.6037	0.3548	1.1522	-0.2299
110	35	L	6	2	7	5	6	5	5	3	4	4	3	6	0.0176	-1.7151	1.3878	0.6065
111	35	L	7	5	6	7	5	6	4	3	5	7	5	7	1.3792	-1.2952	-0.5885	1.8422
112	35	L	4	3	6	2	3	2	5	5	5	2	3	2	-1.9054	0.4419	1.7001	0.3004
113	36	L	4	6	6	7	6	5	5	6	6	6	4	6	1.5193	-0.0560	0.8253	1.7273
114	36	L	6	5	4	5	5	4	5	5	4	5	5	4	0.2499	0.4262	0.0042	0.2816
115	36	L	7	6	6	6	4	5	5	6	3	5	4	5	0.3285	0.0292	-0.3772	2.1125
116	36	L	1	4	2	3	4	3	4	5	4	4	4	4	-0.8568	0.6672	-0.4381	-1.5062
117	36	L	3	4	3	4	5	3	4	5	4	4	4	4	-0.5649	0.4405	0.0767	-0.8475
118	36	L	5	5	3	4	5	4	5	5	4	5	4	4	0.0024	0.4824	0.0314	-0.8443
119	36	L	2	5	3	4	5	3	4	5	4	4	4	3	-0.6155	0.7846	0.1143	-0.7300
120	38	L	5	5	2	7	6	7	6	6	4	7	5	6	2.0949	0.0588	-1.0823	-0.8884
121	38	L	6	6	4	6	4	5	5	6	5	7	6	5	1.2221	0.6068	-0.9424	1.3175
122	38	L	7	6	2	7	6	7	7	5	6	7	4	7	2.6033	-0.2075	-0.2108	-1.5099
123	38	L	3	7	1	5	4	4	3	7	6	5	7	4	0.5795	2.3536	-1.7018	-0.2420
124	38	L	1	7	2	7	5	5	6	7	6	7	7	4	2.0688	1.6462	-0.8083	0.2484
125	38	L	4	3	6	3	3	2	3	6	3	1	3	1	-2.6155	0.6966	0.6354	1.0445
126	38	L	2	5	3	5	6	4	3	6	4	5	5	5	0.2376	0.7783	-0.5822	-0.0610
127	39	L	5	5	6	5	6	6	7	4	6	6	5	6	1.6539	-0.3852	1.3553	0.6904
128	39	L	6	6	5	6	6	5	6	6	6	6	5	6	1.6797	0.4216	0.8144	0.9728
129	39	L	7	6	2	6	6	7	7	6	6	7	7	7	2.8028	0.8763	-0.6110	-0.7298
130	39	L	3	7	4	5	7	5	7	7	7	5	7	4	1.9722	2.1066	1.4632	0.3095
131	39	L	1	7	4	5	7	4	6	6	6	7	4	7	1.7666	0.5425	1.2027	0.0616
132	39	L	4	7	4	5	4	3	3	4	4	3	3	3	-0.9871	0.5456	-0.2159	0.2492
133	39	L	2	5	4	4	6	3	5	5	5	3	4	3	-0.3220	0.8928	1.4067	-0.6451
134	40	L	2	4	4	6	4	4	4	3	4	5	4	4	-0.1807	-0.7576	-0.5611	0.0694
135	40	L	4	4	4	5	3	3	3	5	4	3	5	3	-1.0850	0.5499	-0.8184	0.6878
136	40	L	1	5	2	5	4	5	5	5	4	5	5	5	0.4566	0.4569	-1.1818	-0.9289
137	40	L	3	5	5	5	4	4	4	5	4	3	5	5	-0.3142	0.3944	-0.2824	1.1202
138	40	L	6	3	5	4	4	4	4	3	4	3	4	4	-0.9466	-0.5502	0.1870	-0.0242
139	40	L	7	3	4	4	4	5	4	3	4	5	4	6	-0.2029	-0.9636	-0.6415	-0.4954
140	40	L	5	4	4	5	4	3	4	4	4	4	4	4	-0.6270	-0.1599	-0.1416	0.0427
141	43	L	2	3	4	5	6	4	3	4	2	4	5	5	-0.4665	-0.3684	-0.6231	0.0590
142	43	L	3	5	4	3	4	3	4	6	3	2	4	3	-1.3916	1.2212	0.0667	0.0008
143	43	L	1	5	3	6	4	6	4	3	3	5	4	6	0.3473	-0.8193	-1.6893	-0.4773
144	43	L	6	3	4	6	6	7	5	4	3	6	6	7	1.3626	-0.8769	-1.0355	0.0696
145	43	L	7	2	3	6	5	6	5	3	3	6	3	7	0.6406	-1.9124	-0.9025	-1.4170
146	43	L	4	7	2	5	4	4	5	6	4	5	5	4	0.3570	1.3448	-0.9864	-0.3782
147	43	L	5	4	3	3	5	2	4	4	3	3	5	5	-1.0103	0.4997	0.0149	-0.8038
148	44	L	5	6	3	7	5	7	6	6	7	6	7	6	2.4710	0.8883	-0.7110	0.2299
149	44	L	4	5	4	4	4	2	2	3	2	2	4	2	-2.1402	0.3486	-0.5981	0.1763
150	44	L	6	7	3	7	5	6	6	6	6	6	5	6	2.0127	0.6445	-0.4553	0.0686
151	44	L	7	5	2	7	6	7	6	5	5	6	5	7	2.1645	-0.1478	-0.7966	-1.2459
152	44	L	1	5	6	3	4	2	3	5	5	4	6	4	-0.9305	0.9654	0.3969	2.0246
153	44	L	3	6	5	4	4	3	4	3	4	4	3	4	-0.8603	-0.1847	0.3447	0.3984
154	44	L	2	5	5	4	4	4	5	4	4	5	3	4	-0.3884	-0.3050	0.3695	0.2622
155	47	L	2	5	5	4	4	3	5	4	5	4	5	5	-0.2148	0.2456	0.5119	0.7147
156	47	L	4	3	4	3	5	4	3	4	4	4	5	4	-0.8078	0.1576	-0.1685	-0.3719
157	47	L	1	6	4	5	4	5	4	6	4	5	7	4	0.4046	1.2855	-1.2688	1.3942
158	47	L	3	4	3	5	3	5	4	3	5	4	5	4	-0.2074	-0.1602	-1.1007	-0.6548
159	47	L	6	5	4	5	4	3	5	5	6	4	5	4	0.0699	0.6913	0.4467	0.2573
160	47	L	7	3	4	7	5	3	5	3	5	7	3	6	0.6816	-1.6908	0.3069	-0.2187
161	47	L	5	5	4	3	4	5	4	5	5	3	4	5	-0.4334	0.6328	-0.0886	-0.4101
162	49	L	3	4	5	4	5	4	5	5	4	5	4	3	-0.2677	0.1410	0.6782	0.3050

STATISTICAL ANALYSIS SYSTEM

OBS	ID	R	P	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	FACTOR1	FACTOR2	FACTOR3	FACTOR4
163	49	L	1	5	3	4	5	4	5	5	4	5	6	4	0.2247	0.9171	-0.3096	-0.3123
164	49	L	5	4	5	5	4	4	6	5	7	5	5	4	0.6021	0.2424	0.9989	0.5129
165	49	L	4	3	4	3	4	5	4	3	5	4	3	5	-0.6180	-0.7098	0.0814	-1.2122
166	49	L	6	4	4	5	5	5	5	4	6	4	4	5	0.4444	-0.1886	0.5457	-0.7127
167	49	L	7	2	5	5	4	4	5	3	5	6	2	7	0.0813	-2.0365	0.4681	-0.3308
168	49	L	2	5	4	4	5	4	5	4	5	4	5	4	0.0228	0.4944	0.4888	-0.3024
169	50	L	3	4	3	5	4	4	3	5	4	4	5	4	-0.4567	0.4296	-1.0972	-0.1381
170	50	L	1	5	3	4	5	4	5	6	5	5	6	4	0.4117	1.2701	-0.0666	-0.2498
171	50	L	5	4	4	5	5	4	6	5	6	6	5	5	0.9252	0.0918	0.6748	-0.0974
172	50	L	4	3	5	5	4	4	3	5	4	4	4	5	-0.5983	-0.3751	-0.4352	0.8205
173	50	L	6	3	4	5	6	4	5	4	6	4	3	5	0.2583	-0.5373	1.3354	-1.2278
174	50	L	7	1	6	6	5	2	5	1	5	6	2	7	-0.1047	-2.9586	1.4582	0.0455
175	50	L	2	4	5	4	5	6	5	4	5	4	5	5	0.3554	-0.0568	0.3004	0.0367
176	52	L	2	6	6	7	4	3	7	3	7	7	4	6	1.4229	-0.9808	1.2856	1.5180
177	52	L	1	6	2	6	4	6	4	6	5	6	7	6	1.3586	1.0382	-2.1298	0.2165
178	52	L	6	3	6	6	4	3	4	2	6	7	4	4	0.0548	-1.5595	0.5306	1.2079
179	52	L	7	3	6	7	4	6	7	3	6	7	4	7	1.6750	-1.9683	0.4520	0.8769
180	52	L	3	7	1	3	4	3	2	7	4	3	3	2	-1.3957	2.1904	-1.0220	-1.5062
181	52	L	4	4	5	5	4	5	4	3	5	5	3	5	-0.0843	-1.0373	-0.0371	0.1076
182	52	L	5	7	3	5	4	6	3	7	5	4	6	4	0.4147	1.8577	-1.5700	0.6121
183	57	L	2	4	3	6	5	5	5	3	5	7	5	6	1.1592	-0.8470	-0.6328	-0.6059
184	57	L	4	5	3	5	4	5	5	6	5	5	4	4	0.3721	0.5939	-0.4261	-0.4990
185	57	L	1	6	2	6	7	7	6	6	6	7	6	6	2.5417	0.8421	-0.2941	-1.0741
186	57	L	3	4	5	4	3	3	3	4	4	3	3	3	-1.5678	-0.1344	-0.0815	0.4672
187	57	L	6	4	4	5	7	5	7	5	6	5	6	5	1.5432	0.4701	1.4430	-0.6175
188	57	L	7	1	2	7	7	7	6	2	7	7	6	7	2.4641	-1.5850	-0.0004	-2.4151
189	57	L	5	6	1	6	5	4	4	7	7	3	6	4	0.7589	2.1164	-0.4843	-1.1763
190	58	L	2	4	5	4	5	3	5	4	3	5	4	5	-0.3764	-0.4152	0.4876	0.4251
191	58	L	4	3	4	5	6	5	4	4	5	4	5	4	0.1925	-0.0823	0.3085	-0.5717
192	58	L	1	6	3	5	3	5	4	6	4	5	5	5	0.1872	0.8027	-1.6416	0.4299
193	58	L	3	4	3	5	4	5	3	5	3	5	3	5	-0.3906	-0.3669	-1.3949	-0.5154
194	58	L	6	5	4	5	5	3	6	4	5	5	5	5	0.4950	0.1258	0.6999	-0.0133
195	58	L	7	3	6	6	5	3	5	3	5	6	3	6	0.2724	-1.6590	1.0578	0.8186
196	58	L	5	5	4	3	5	3	5	5	3	5	5	4	-0.4092	0.6997	0.2015	0.1196
197	60	L	5	5	4	3	5	6	3	4	5	5	4	6	0.0768	0.0009	-0.4962	-0.4593
198	60	L	4	3	5	3	3	4	4	5	3	4	3	4	-1.2970	-0.2988	-0.2661	0.2882
199	60	L	6	6	5	5	7	6	5	6	7	6	5	4	1.5383	0.9099	1.2049	0.4525
200	60	L	1	2	3	2	4	3	4	2	3	2	3	3	-2.0190	-0.5057	0.2537	-2.2738
201	60	L	3	3	2	3	2	4	6	3	4	3	2	3	-1.2838	-0.4654	-0.2041	-2.7146
202	60	L	2	7	6	5	7	4	3	7	6	6	5	4	0.7722	1.3283	0.9762	2.0935
203	60	L	7	5	4	4	5	6	5	4	4	6	4	7	0.7520	-0.4967	-0.4428	-0.3297
204	1	W	5	5	6	6	6	4	6	6	7	6	3	6	1.3304	-0.2400	1.9206	0.9555
205	1	W	3	5	4	5	5	5	5	6	6	5	3	5	0.6397	0.2520	0.5558	-0.3660
206	1	W	2	4	6	4	4	3	4	5	4	4	4	5	-0.7222	-0.0943	0.4212	1.4045
207	1	W	6	6	3	5	6	6	6	5	7	6	5	7	1.9659	0.4442	0.3841	-0.9070
208	1	W	7	5	3	6	5	6	6	5	6	7	4	7	1.8141	-0.3892	-0.2517	-0.7138
209	1	W	4	3	6	4	4	2	4	4	4	3	4	3	-1.3865	-0.1835	0.9346	0.9946
210	1	W	1	6	2	5	6	6	6	6	7	6	5	6	1.9297	0.9688	0.1872	-1.4448
211	2	W	4	3	4	5	4	3	5	4	3	5	5	5	-0.2725	-0.4961	-0.4004	0.2550
212	2	W	1	4	3	5	4	5	3	5	5	6	5	5	0.2706	0.0906	-1.3305	-0.0843
213	2	W	3	3	3	4	4	5	3	5	4	5	4	5	-0.3817	-0.1458	-1.1512	-0.7018
214	2	W	2	5	4	4	5	5	3	5	5	4	4	4	-0.2553	0.5408	-0.1640	-0.1836
215	2	W	7	2	5	6	5	3	5	2	5	6	2	6	0.0896	-2.2557	1.0136	-0.4444
216	2	W	6	5	4	4	5	4	5	4	6	3	5	4	0.0156	0.6906	0.8422	-0.5267

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

OBS	ID	R	P	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	FACTOR1	FACTOR2	FACTOR3	FACTOR4
217	2	W	5	5	4	4	5	5	4	5	6	5	4	5	0.3452	0.3545	0.2137	-0.2991
218	3	W	5	4	4	5	4	5	6	5	6	4	5	6	0.7485	0.1256	0.2189	-0.1976
219	3	W	6	4	5	5	5	2	5	4	6	3	3	4	-0.4621	-0.1532	1.7319	-0.1395
220	3	W	7	2	5	5	5	4	5	2	4	6	4	7	0.2721	-1.9080	0.2557	-0.0625
221	3	W	2	5	5	5	3	3	4	4	5	5	4	5	-0.3390	-0.2804	-0.2138	1.1153
222	3	W	4	5	4	4	3	4	3	5	4	5	4	5	-0.6006	0.1706	-1.1305	0.5880
223	3	W	1	5	3	5	4	5	5	5	6	5	6	6	0.9349	0.5757	-0.6595	-0.1710
224	3	W	3	4	3	4	4	5	4	5	3	5	5	5	-0.1597	0.2063	-1.3118	-0.3328
225	4	W	4	4	4	3	2	3	3	3	3	5	3	4	-1.6246	-0.6301	-1.1179	0.0156
226	4	W	1	6	3	5	5	6	6	7	6	6	6	5	1.6240	1.3474	-0.2755	-0.0649
227	4	W	3	5	4	5	5	5	5	5	4	4	5	5	0.3799	0.3837	-0.1807	0.0961
228	4	W	5	5	3	5	5	5	7	6	7	5	4	5	1.3066	0.6374	0.9794	-1.2006
229	4	W	6	5	4	4	6	3	6	3	7	4	3	5	0.3451	-0.1207	2.1501	-1.4390
230	4	W	7	3	6	7	5	3	5	2	5	7	4	7	0.7884	-2.1197	0.5978	1.2562
231	4	W	2	5	5	6	4	3	5	3	5	6	5	6	0.5181	-0.7074	0.0006	1.1911
232	5	W	4	3	3	4	3	2	3	3	2	4	3	4	-1.7772	-0.7416	-1.0371	-0.7233
233	5	W	1	7	2	6	6	6	6	6	7	7	5	5	2.2071	1.0377	0.0031	-1.0226
234	5	W	3	5	3	5	4	5	5	5	4	5	5	4	0.2962	0.4582	-0.8396	-0.2955
235	5	W	5	6	3	5	5	6	6	6	6	5	6	5	1.4298	1.1906	-0.1651	-0.3517
236	5	W	6	4	4	5	6	3	5	3	6	4	4	5	0.2343	-0.3362	1.3425	-0.8703
237	5	W	7	3	7	7	5	2	5	2	5	7	3	7	0.4754	-2.4159	1.2405	1.7684
238	5	W	2	5	6	6	5	2	5	4	5	6	5	6	0.5149	-0.4595	0.8345	1.9390
239	6	W	5	4	5	4	3	3	2	4	3	4	5	4	-1.4042	-0.0057	-1.1565	1.4218
240	6	W	3	6	3	5	5	5	4	6	5	4	4	5	0.3799	0.8754	-0.3746	-0.4628
241	6	W	2	4	6	3	5	4	4	3	5	3	5	3	-0.8041	0.1613	1.0645	0.5320
242	6	W	6	5	4	6	4	6	6	5	5	6	5	6	1.3143	-0.1674	-0.6040	0.3794
243	6	W	7	5	3	7	4	6	6	7	6	6	2	6	1.4284	-0.2166	-0.2452	-0.6676
244	6	W	4	4	5	3	4	3	4	4	3	2	4	2	-1.7073	0.4415	0.4688	0.1374
245	6	W	1	5	5	4	4	5	4	5	4	3	4	4	-0.5608	0.4092	-0.1206	0.5205
246	7	W	6	4	6	6	3	3	6	3	7	6	3	6	0.5041	-1.3989	1.0834	0.9988
247	7	W	7	2	7	7	2	6	4	2	3	7	2	7	0.0001	-3.2988	-1.3030	1.8994
248	7	W	1	4	3	5	3	4	4	3	3	3	3	4	-1.0300	-0.5750	-0.9574	-0.9787
249	7	W	2	5	5	6	5	3	4	6	5	5	5	5	0.3462	0.4387	0.2176	1.5094
250	7	W	3	3	4	3	5	4	3	4	3	4	3	3	-1.2939	-0.2272	-0.0028	-0.8332
251	7	W	4	6	5	5	3	3	4	6	4	5	6	3	-0.3450	1.1081	-0.7123	2.1773
252	7	W	5	5	3	3	5	5	3	6	4	3	6	4	-0.4215	1.5791	-0.8107	-0.3482
253	10	W	4	3	3	5	4	6	5	3	5	7	4	6	0.8077	-1.2232	-0.8802	-1.1219
254	10	W	3	3	3	4	3	3	4	6	4	3	4	3	-1.1730	0.6517	-0.4582	-0.5830
255	10	W	1	6	5	4	4	4	5	5	4	4	5	5	-0.0852	0.6309	0.0013	1.0419
256	10	W	6	3	4	4	5	3	6	6	4	5	4	4	-0.1092	0.2280	0.8766	-0.3660
257	10	W	7	4	5	6	4	7	6	3	5	6	5	7	1.3995	-1.2357	-0.5648	0.4840
258	10	W	5	5	3	4	5	4	4	6	3	4	4	3	-0.5551	0.9488	-0.3562	-0.5580
259	10	W	2	6	3	4	3	4	5	5	4	4	5	4	-0.2794	0.9503	-0.8217	-0.1366
260	11	W	4	4	3	4	6	3	4	3	3	4	3	3	-0.8703	-0.2399	0.4633	-1.5856
261	11	W	3	4	2	6	3	4	3	3	4	3	4	4	-0.7431	-0.3016	-1.5637	-1.1427
262	11	W	1	5	4	5	4	5	4	5	5	5	5	4	0.2140	0.4229	-0.6249	0.4278
263	11	W	6	4	3	3	3	3	3	4	2	2	3	2	-2.2225	0.3608	-0.8172	-1.0005
264	11	W	7	4	3	5	3	3	3	3	4	5	4	5	-0.6998	-0.5979	-1.2488	-0.2838
265	11	W	5	4	3	4	4	3	4	5	4	4	5	3	-0.7291	0.7339	-0.3877	-0.4179
266	11	W	2	4	4	5	5	5	5	5	4	3	5	4	0.0398	0.4087	0.0374	-0.2126
267	12	W	4	4	5	5	3	4	3	3	3	5	4	5	-0.7635	-0.9570	-1.1803	1.0595
268	12	W	1	5	3	5	4	5	5	6	5	5	4	5	0.4919	0.4710	-0.5037	-0.4614
269	12	W	3	4	3	5	4	3	4	5	4	5	3	5	-0.3836	-0.2217	-0.4238	-0.5699
270	12	W	2	5	4	5	3	5	5	5	4	5	6	5	0.3311	0.3841	-1.1947	0.8804

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

OBS	ID	R	P	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	FACTOR1	FACTOR2	FACTOR3	FACTOR4
271	12	W	7	3	6	6	4	3	4	3	6	5	5	4	-0.0933	-0.8159	0.5511	1.4128
272	12	W	6	4	5	4	5	3	5	4	5	5	4	4	-0.2083	-0.1461	1.0711	0.1707
273	12	W	5	5	4	5	3	6	3	4	5	5	6	5	0.2220	0.1609	-1.7452	0.8152
274	19	W	3	3	5	3	3	3	3	4	3	4	2	2	-2.0377	-0.4942	-0.0255	0.0439
275	19	W	1	4	4	5	5	4	5	3	3	4	5	5	-0.0806	-0.4276	-0.1661	-0.1851
276	19	W	6	6	6	5	5	6	5	6	5	7	7	5	1.3920	0.7368	-0.2986	2.4283
277	19	W	7	7	5	6	7	7	6	5	6	6	7	7	2.5261	0.6358	0.3219	1.1111
278	19	W	5	6	5	4	4	4	4	5	3	4	4	4	-0.6457	0.4768	-0.3063	1.0072
279	19	W	2	4	4	4	5	3	4	5	5	4	4	4	-0.4615	0.3919	0.5942	-0.2849
280	19	W	4	3	3	2	3	3	3	4	4	3	3	3	-1.9098	0.1916	-0.3281	-1.4077
281	20	W	2	4	5	3	6	2	5	3	6	4	3	3	-0.6721	-0.0827	2.3831	-0.8109
282	20	W	6	4	3	5	3	4	4	4	4	5	5	5	-0.1987	-0.1567	-1.3340	-0.1148
283	20	W	7	3	4	7	2	6	2	3	2	7	4	7	-0.0590	-2.0446	-3.3463	1.1738
284	20	W	1	6	1	4	4	5	4	6	4	5	7	3	0.2295	1.9253	-1.8636	-0.8454
285	20	W	5	6	2	4	4	5	4	5	5	6	6	5	0.5695	1.0104	-1.4214	-0.5284
286	20	W	3	6	2	4	5	3	5	5	5	4	6	4	0.1660	1.4988	-0.0531	-0.9453
287	20	W	4	4	5	2	5	2	5	4	5	4	5	4	-0.7634	0.5409	1.4513	0.0503
288	21	W	2	7	5	3	5	5	4	6	4	5	5	4	0.0127	1.3010	-0.0891	1.1095
289	21	W	6	4	5	5	6	6	6	3	4	5	4	5	0.7265	-0.8686	0.6806	-0.3488
290	21	W	7	2	5	6	5	6	6	6	5	6	4	7	1.2733	-0.9657	0.2351	0.3262
291	21	W	1	5	3	3	3	2	4	5	4	3	5	3	-1.3047	1.2259	-0.3698	-0.2591
292	21	W	5	4	4	4	4	3	4	5	5	4	5	4	-0.5059	0.5623	0.0521	0.1824
293	21	W	3	6	2	4	3	3	3	6	4	4	5	3	-0.8482	1.5441	-1.4166	-0.2461
294	21	W	4	4	5	5	4	5	4	4	4	5	4	5	-0.0741	-0.6131	-0.4705	0.6529
295	24	W	2	5	3	3	5	3	5	6	6	3	5	3	-0.3158	1.6897	0.9644	-0.9753
296	24	W	6	6	3	6	4	6	4	6	4	6	6	6	1.0630	0.6262	-1.9476	0.7299
297	24	W	7	4	3	6	5	7	5	2	5	6	4	7	1.2963	-1.4295	-0.8448	-1.3356
298	24	W	5	6	5	4	3	3	4	6	5	3	4	3	-0.9025	1.1448	0.2039	1.1162
299	24	W	3	3	3	4	2	3	2	4	3	3	3	3	-2.0410	-0.2189	-1.4980	-0.5598
300	24	W	1	5	3	4	5	3	5	4	5	3	4	4	-0.3602	0.5646	0.7029	-1.2481
301	24	W	4	4	5	2	5	3	4	5	5	2	6	3	-1.0557	1.3780	1.0389	0.2711
302	25	W	2	4	6	3	6	3	6	5	6	3	3	3	-0.4308	0.4227	2.8235	-0.1820
303	25	W	6	5	3	5	6	4	5	4	5	4	4	6	0.5243	0.0478	0.4897	-1.1766
304	25	W	7	6	3	5	4	6	4	5	6	5	5	6	0.8687	0.5501	-1.0395	-0.2285
305	25	W	5	4	6	3	5	3	5	6	5	3	3	2	-0.9927	0.7190	1.9638	0.4214
306	25	W	3	6	2	6	5	5	5	4	5	4	4	5	0.6969	0.2720	-0.4377	-1.4473
307	25	W	1	5	3	4	5	3	5	4	5	3	3	3	-0.5912	0.4703	0.9511	-1.5518
308	25	W	4	5	5	4	5	3	4	5	5	3	4	3	-0.7037	0.7375	0.9969	0.3878
309	26	W	3	3	6	5	5	3	4	3	3	5	3	5	-0.6490	-1.3938	0.5484	0.8536
310	26	W	1	7	4	5	5	5	5	5	5	5	6	5	0.9246	0.9931	-0.2787	0.6799
311	26	W	4	3	5	4	3	2	3	3	4	4	3	4	-1.5704	-0.8389	-0.0021	0.4020
312	26	W	6	6	5	4	5	3	5	4	6	4	4	4	-0.0770	0.4923	1.3445	0.2566
313	26	W	7	3	5	6	4	2	5	2	4	7	3	7	0.0801	-2.1406	0.2082	0.5471
314	26	W	2	5	5	4	5	3	5	4	5	4	3	5	-0.2815	-0.1421	1.2244	-0.0185
315	26	W	5	5	3	5	4	4	5	4	6	5	4	5	0.3885	0.0268	-0.0232	-0.8042
316	27	W	4	5	2	5	5	2	5	5	5	2	4	3	-0.5319	1.1032	0.6929	-1.6058
317	27	W	1	6	3	4	5	3	5	6	5	4	6	4	0.1685	1.6571	0.2015	-0.1034
318	27	W	3	4	3	4	4	3	5	6	5	4	3	2	-0.6985	0.7620	0.5768	-1.0857
319	27	W	5	6	5	5	4	4	4	6	5	3	5	4	-0.1778	1.0914	-0.0017	1.3002
320	27	W	6	4	6	3	4	3	4	5	4	3	4	2	-1.4097	0.5497	0.8759	0.9868
321	27	W	7	4	3	5	4	3	4	5	5	4	4	3	-0.5193	0.4377	-0.0856	-0.6035
322	27	W	2	3	6	2	3	2	3	4	3	2	4	3	-2.3766	0.1368	0.3503	0.9712
323	31	W	3	3	5	4	4	4	4	5	3	5	3	4	-0.8134	-0.5270	-0.1163	0.3917
324	31	W	1	6	3	5	5	5	4	5	5	5	6	5	0.7103	0.9069	-0.8061	0.0143

STATISTICAL ANALYSIS SYSTEM

OBS	IO	R	P	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	FACTOR1	FACTOR2	FACTOR3	FACTOR4
325	31	W	4	4	6	4	3	2	4	3	3	4	4	5	-1.2691	-0.7314	0.0243	1.4797
326	31	W	6	5	6	5	5	3	5	5	6	5	4	5	0.3041	0.0315	1.3397	1.2858
327	31	W	7	2	6	7	4	2	4	2	5	7	3	7	0.1056	-2.5490	0.3416	1.3041
328	31	W	2	5	5	4	5	3	5	5	4	5	6	5	0.1021	0.5935	0.3496	1.1747
329	31	W	5	5	3	4	5	5	5	4	6	5	6	5	0.7506	0.6175	-0.0791	-0.7695
330	33	W	6	5	4	4	5	3	5	3	6	5	4	5	0.1222	-0.1332	0.9518	-0.5868
331	33	W	7	2	6	7	5	3	6	2	5	7	3	7	0.7937	-2.5714	1.1112	0.6744
332	33	W	1	6	2	4	5	5	4	5	3	5	6	4	0.1661	1.1573	-1.3776	-0.6664
333	33	W	3	3	5	4	3	5	4	6	3	5	4	5	-0.5336	-0.2423	-0.9536	0.9602
334	33	W	2	5	3	5	4	3	5	3	5	4	5	5	0.0002	0.0571	-0.1286	-0.6094
335	33	W	5	5	3	5	5	3	5	5	6	4	5	5	0.3858	0.7369	0.4760	-0.5773
336	33	W	4	3	5	4	5	4	5	3	5	3	5	4	-0.3504	-0.2263	0.9438	-0.2284
337	37	W	6	5	6	4	3	3	5	4	7	4	4	5	-0.2341	0.0059	1.0813	1.1042
338	37	W	7	2	6	6	5	4	3	5	3	7	3	6	-0.0575	-1.6057	-0.3418	1.5518
339	37	W	1	6	3	5	4	5	3	5	5	4	5	5	0.1068	0.7792	-1.2096	-0.0058
340	37	W	3	5	4	3	5	3	5	3	5	3	5	4	-0.5096	0.5322	0.9282	-0.6707
341	37	W	2	5	3	4	3	5	4	4	3	5	4	5	-0.4002	-0.1168	-1.5428	-0.4133
342	37	W	4	3	5	3	5	4	3	5	4	5	4	5	-0.6455	-0.1476	0.0785	0.3575
343	37	W	5	5	4	3	5	4	3	5	6	5	5	6	0.0523	0.6567	-0.0084	0.0836
344	41	W	3	4	4	4	5	4	3	4	5	4	4	5	-0.4090	-0.0404	0.0160	-0.3647
345	41	W	2	5	4	4	3	4	5	4	4	5	4	3	-0.5120	0.1100	-0.3595	0.0207
346	41	W	5	4	5	5	4	5	6	4	5	5	4	5	0.4412	-0.5666	0.3881	0.2233
347	41	W	1	6	4	4	5	4	5	5	5	4	6	5	0.3660	1.0898	0.1907	0.3272
348	41	W	6	5	4	5	5	4	6	4	6	5	4	5	0.6891	-0.0612	0.9157	-0.4950
349	41	W	7	2	6	6	5	3	4	3	5	6	2	6	-0.0936	-2.0841	0.9654	0.5580
350	41	W	4	4	3	5	4	5	4	5	3	5	4	5	-0.0939	-0.1629	-1.2625	-0.4100
351	42	W	3	3	4	5	4	3	4	5	4	4	5	4	-0.5421	0.1163	-0.2821	0.3245
352	42	W	2	5	5	4	5	3	4	5	4	5	5	4	-0.3145	0.5125	0.2949	1.0317
353	42	W	5	4	3	4	5	4	6	4	6	5	5	4	0.4748	0.3315	0.7196	-1.2816
354	42	W	5	6	3	4	5	5	4	5	5	5	6	5	0.5333	1.0588	-0.6848	-0.1745
355	42	W	6	4	4	5	6	3	5	4	6	3	5	4	0.1176	0.4072	1.3401	-0.5870
356	42	W	7	3	6	6	4	5	4	5	4	6	3	7	0.3158	-1.4142	-0.3824	1.4536
357	42	W	4	3	4	5	4	3	4	5	4	3	4	3	-0.9242	0.1451	0.0665	-0.0951
358	45	W	5	5	4	3	5	4	5	4	6	5	6	5	0.3719	0.6905	0.5144	-0.1800
359	45	W	2	5	4	5	4	5	4	5	5	5	4	5	0.2227	0.0826	-0.5321	0.1994
360	45	W	6	3	5	4	5	4	5	5	7	4	5	4	0.1747	0.3566	1.3293	0.0124
361	45	W	7	2	5	6	5	3	5	2	5	7	2	7	0.3605	-2.5019	0.8355	-0.2909
362	45	W	1	5	3	5	4	5	4	5	5	4	6	4	0.2146	0.8850	-0.9596	-0.0932
363	45	W	4	3	4	3	5	4	3	4	5	4	3	4	-0.8861	-0.2040	0.4254	-1.0123
364	45	W	3	4	4	4	3	4	3	4	3	4	5	4	-1.0167	0.0599	-1.3259	0.4829
365	46	W	5	5	3	5	5	5	6	5	6	5	4	5	0.9340	0.2977	0.4335	-1.1025
366	46	W	2	5	5	4	3	5	4	3	4	5	5	4	-0.3890	-0.2267	-0.8437	0.8779
367	46	W	6	4	3	4	5	3	5	4	6	5	4	5	0.1366	0.0473	0.7173	-1.2422
368	46	W	7	1	6	7	5	2	4	2	5	6	2	7	-0.0704	-2.8173	1.0241	0.5658
369	46	W	1	6	3	5	4	5	4	6	4	5	5	4	0.2229	0.9726	-1.1924	0.1911
370	46	W	4	3	4	3	4	3	4	4	3	4	3	4	-1.3052	-0.3675	0.0585	-0.6477
371	46	W	3	3	4	5	3	5	4	3	5	4	4	5	-0.3085	-0.8432	-0.7033	-0.3673
372	48	W	3	5	2	2	4	3	3	6	6	5	6	3	-0.5656	1.9139	-0.5276	-0.8149
373	48	W	5	6	2	3	4	3	3	3	5	2	3	4	-1.2595	0.6649	-0.1767	-1.9833
374	48	W	6	5	5	6	2	2	3	4	2	3	4	2	-1.7581	-0.0271	-1.1268	1.7536
375	48	W	7	6	2	5	5	5	5	6	5	5	3	6	0.7659	0.5204	-0.3439	-1.4069
376	48	W	1	3	6	3	3	3	2	2	4	3	3	2	-2.2460	-0.7490	0.1390	0.5756
377	48	W	4	6	2	2	5	3	5	4	6	6	4	2	-0.2466	1.1606	0.7478	-1.9776
378	48	W	2	6	2	3	5	5	5	6	5	6	5	5	0.7767	1.4758	-0.6357	-0.9083

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

OBS	ID	R	P	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	FACTOR1	FACTOR2	FACTOR3	FACTOR4
379	51	W	3	3	4	6	3	5	5	4	4	5	4	5	0.1043	-0.9246	-0.8851	0.0561
380	51	W	5	6	3	4	4	4	4	5	5	4	5	3	-0.2854	1.2064	-0.4224	-0.3233
381	51	W	6	3	5	5	4	3	4	4	4	3	4	3	-1.0078	-0.2565	0.3411	0.4051
382	51	W	7	3	4	5	4	5	4	4	3	4	4	5	-0.3978	-0.6624	-0.8476	-0.1808
383	51	W	1	5	3	3	4	3	4	5	3	3	5	3	-1.1319	1.1570	-0.4589	-0.4591
384	51	W	4	4	4	4	4	3	4	5	4	3	4	3	-1.0319	0.5181	0.1478	-0.1288
385	51	W	2	5	3	4	4	3	4	5	4	3	4	3	-0.9221	0.8609	-0.1567	-0.6447
386	53	W	2	5	4	5	6	3	5	6	6	3	4	3	0.0419	1.0939	1.5284	-0.3938
387	53	W	4	5	4	5	5	6	6	4	6	6	4	6	1.2826	-0.3928	0.3223	-0.5559
388	53	W	1	6	4	6	4	5	5	6	5	6	6	5	1.0709	0.7300	-0.8419	1.2016
389	53	W	6	5	4	4	6	5	5	4	5	6	4	5	0.6505	-0.0881	0.5446	-0.6074
390	53	W	7	4	5	5	4	6	4	3	4	6	4	6	0.3151	-1.1819	-0.8464	0.5284
391	53	W	5	5	5	4	4	4	5	5	4	4	5	4	-0.2742	0.5327	0.1190	0.8491
392	53	W	3	5	3	5	4	4	5	5	5	4	5	4	0.1278	0.6972	-0.2785	-0.4126
393	54	W	2	4	5	4	5	4	3	5	4	5	5	3	-0.5279	0.3848	-0.0980	0.8923
394	54	W	5	5	4	5	5	4	6	4	5	4	3	5	0.2829	-0.2284	0.9338	-0.7685
395	54	W	1	7	3	5	3	5	5	6	5	4	5	5	0.4348	1.2068	-1.0253	0.2002
396	54	W	4	3	4	3	3	5	5	4	3	5	3	5	-0.6816	-0.7593	-0.6036	-0.6680
397	54	W	3	3	4	3	5	4	3	4	4	3	4	5	-0.9503	-0.0595	0.0248	-0.7162
398	54	W	6	4	5	4	4	5	6	4	6	4	5	4	0.2484	0.1218	0.7700	0.0385
399	54	W	7	2	7	6	5	3	5	2	3	6	2	7	-0.1596	-2.7681	0.9593	1.1521
400	55	W	2	4	3	5	4	5	4	3	5	3	4	4	-0.3141	-0.2074	-0.4582	-1.2379
401	55	W	5	3	4	4	5	4	3	4	6	4	3	5	-0.4454	-0.4058	0.4794	-0.8943
402	55	W	1	6	3	5	4	5	4	5	4	5	0	5	0.4108	0.7870	-1.4306	0.3239
403	55	W	4	3	3	4	3	5	4	3	5	3	4	3	-0.8356	-0.2006	-0.5908	-1.4183
404	55	W	3	3	4	3	4	3	4	3	5	4	3	5	-0.9405	-0.6243	0.4967	-0.9977
405	55	W	6	4	3	5	4	4	5	4	6	4	5	4	0.1595	0.2692	0.0244	-0.8469
406	55	W	7	2	4	3	4	3	4	5	4	3	5	4	-1.1163	0.3222	0.1010	-0.3243
407	56	W	2	5	6	4	4	2	4	3	5	2	3	3	-1.4094	-0.0423	1.3884	0.6437
408	56	W	1	5	3	4	4	5	5	5	3	4	3	4	-0.3980	0.2256	-0.5298	-1.0239
409	56	W	6	4	5	3	5	4	5	4	5	4	3	4	-0.4862	-0.1311	1.2557	-0.5073
410	56	W	7	5	2	5	5	6	5	2	6	6	3	6	0.9809	-0.9134	-0.3193	-2.3451
411	56	W	3	4	5	3	3	3	3	4	3	3	3	3	-1.8887	-0.0556	-0.2132	0.3868
412	56	W	4	5	6	3	4	4	4	3	3	3	3	2	-1.5204	-0.1222	0.5657	0.5354
413	56	W	5	5	4	3	4	6	5	5	3	6	3	5	-0.0321	-0.1562	-0.6301	-0.3794
414	59	W	3	6	5	5	4	7	6	5	6	6	6	7	1.7022	0.2087	-0.4610	1.1047
415	59	W	5	7	6	4	4	5	4	6	5	5	6	5	0.3684	1.1480	-0.3126	2.3658
416	59	W	6	7	5	5	3	5	3	4	4	5	5	5	-0.0964	0.2339	-1.4354	1.7461
417	59	W	7	2	2	6	3	7	3	2	3	6	3	7	0.1171	-2.1807	-2.7136	-1.6425
418	59	W	1	7	7	5	4	4	4	7	4	6	6	4	0.2739	1.1239	-0.2474	3.6905
419	59	W	4	5	4	4	3	5	3	4	5	5	5	5	-0.2273	0.1383	-1.2458	0.4675
420	59	W	2	7	6	6	6	5	6	6	6	6	6	6	1.8195	0.7384	0.8684	2.0650

SCALE MODEL STUDY

OF

LIGHTING AESTHETICS

by

PERVAIZ ASIF ALI

B.E. (Mechanical), N.E.D. Engineering University,

Karachi, Pakistan, 1975

AN ABSTRACT OF A MASTER'S THESIS

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MASTER OF SCIENCE

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ABSTRACT

This report describes research on subjective judgments to different lighting conditions using a scale model. The basic purpose of this research was to validate the results of an important study by Flynn and others (1973) by using scale models. The lighting arrangements used by them were incorporated in the model to a great extent. The model was studied as a waiting room and a living room.

The subjects made subjective judgments for seven lighting patterns on semantic differential rating scales. Half the subjects judged the model as a living room and half of them judged it as a waiting room. Factor analysis of the semantic scales was carried out. Four factors were extracted.

Results of this research validate results by Flynn and others (1973), the same factors were found in this research as those found by Flynn and others (1973). Scale modeling technique proved to be an effective tool in simulating conditions in lighting design.

There were no significant differences in the subjective judgments between the type of room for any of the four factors. This may indicate that people in general are not very particular about the kind of lighting they would prefer for a living or waiting room or for other kind of rooms.

Significant differences were found among patterns for the "clarity", "evaluation", and "spaciousness" factors but no significant differences among patterns for the "warmth" factor. The hypotheses set that for each factor a particular pattern will be the most preferred was not confirmed though the patterns that were expected to be preferred did have the

highest means. Some future research might look at these patterns further. More research is needed on scale models and factors which will provide better understanding of lighting environments.