

## Technique of Increasing Brightness Sensation in Lighting Design

Anake Teeraviwatchai

Ph.D Student, Faculty of Architecture, Chulalongkorn University, Bangkok, Thailand  
E-mail: anake.t@airporthai.co.th

### Abstract

Brightness perception, which is one of the most important of five senses, has impacted about 70% of all the body's sensory receptors. ( Soonthorn Boonyatikarn, 2004) From interior brightness system survey, it is found that building designed with CIE brightness standard or higher with high capacity of electrical consumption but people still feel dark inside the building. Therefore, this paper objects to analyze interior lighting design factors to increase brightness as well as eye perception and also search for new design implementation to make an effective brightness. Then, it would save electrical consumption of lighting system. The concourse area were selected and surveyed including passenger terminal of Suvarnabhumi Airport.

The study started from questionnaire survey for the advantages and disadvantages of architecture interior design which has impacted the brightness perception. Then, brightness data was measured of fore view vision and peripheral vision with statistical questionnaire. Which focused on visual sensation, inspection of void and opening, light beam control and Glare Ratio. The results indicated that existing interior design was decorated with dark color which absorbs a lot of light. The remainder surfaces only allowed day light reflecting as diffuse surface. The fore view and peripheral vision ratio is only 20% of electric lights within the terminal. The interior glass wall decoration effect on brightness glare ratio of both inside and outside the terminal. When passengers walk pass many areas. It caused high level of discomfort glare and make eyes feel uncomfortable.

After the development from results constant glare light ratio would be well controlled, the contrast ratio should not exceed 1:3, and use bright painted wall. Furthermore, the lamp could reduce about five times of all serviced electric lights to reduce glare light while passenger pass along. The results illustrate that brightness level can be lower than IEC standard with satisfaction of passenger in the concourse.

**Key Words:** *Luminous efficacy, Luminance, Illuminance, Brightness sensation*

### 1. Introduction

Human could percept the brightness from eyes perception. The response of eyes to brightness environment wills active brightness. From the building designed with CIE brightness standard or higher survey that using high energy, but it is still a dark in the building. Normally it will be improved by increasing lighting level or expanding size of light source to get more brightness. By this way will increase both energy and waste energy. It will make more global warming also. From the survey found the second floor (arrival passenger's area) in concourse building at Suvarnabhumi Airport where a large building and usage all time has used energy in high level to produce brightness, but it is still a dark in the building.

## 2. Method

The study of dark perception in the second floor (arrival passenger's area) in concourse building at Suvarnabhumi Airport by checking lighting and brightness by illuminance meter (Fig.2) and luminance meter ( Fig.3) parallel with brightness perception statistic questionnaires in each area ( total 8 areas) for searching brightness perception factors.

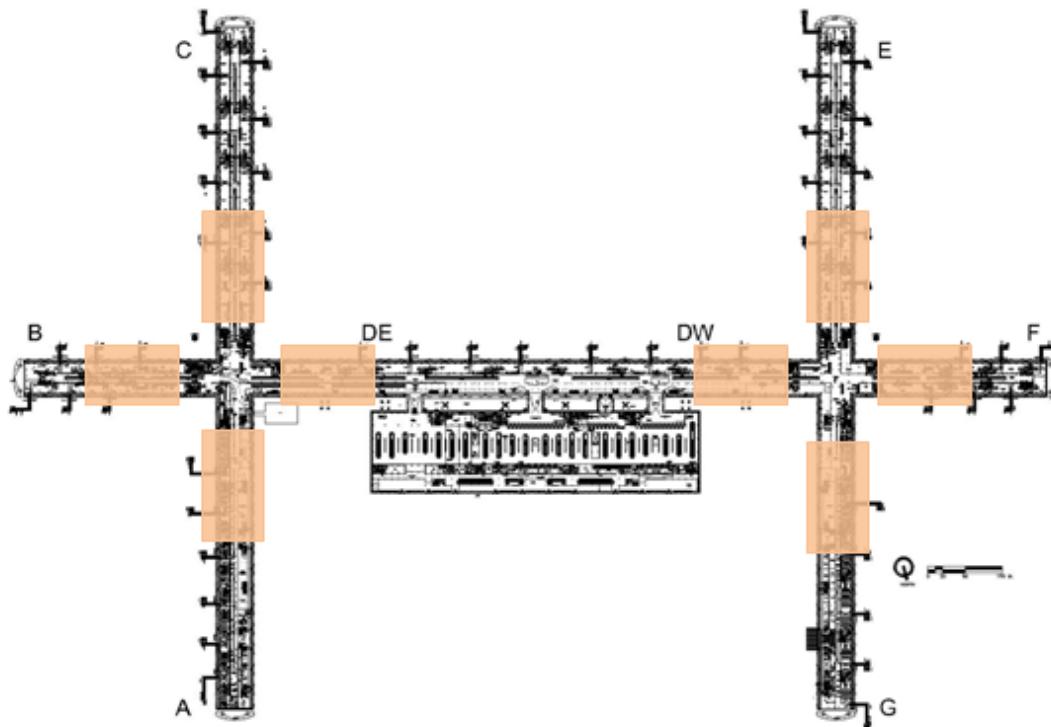


Fig.1 To show the 8 studied areas in second floor (arrival passenger's area), concourse building at Suvarnabhumi Airport



Fig.2 Brightness Checking Instrument



Fig.3 Surface Brightness Checking Instrument

The study has two steps which contain;

Step 1 Survey, verify, brightness checking and illuminance of lighting parallel with statistical data from questionnaires in each area.

Step 2 Improving and checking brightness perception in sample area.

1. Improve electrical material according to IES brightness standard.
2. Improve architecture environment for supporting brightness perception.

### 3. Result

#### 3.1 Result of survey (step 1)

3.1.1 Result of survey in artificial lighting found out that the second floor (arrival passenger) use light fixture type F5 in up light, power supply 2 x 150w have a illuminance of lighting.( In Fig.4)



Fig.4 Lighting fixture type F5: Metal Halide Lamp 2 x 150w

The up light fixture have utilize coefficient in low level only 50% and surface could reflect lighting in low level only 27% also. That made the brightness lower than standard level. The effective of up light fixture will decrease quickly because of dust on the fixture's surface. It will make lower illuminance (In Fig.5) that made higher cost of maintenance and cleaning.

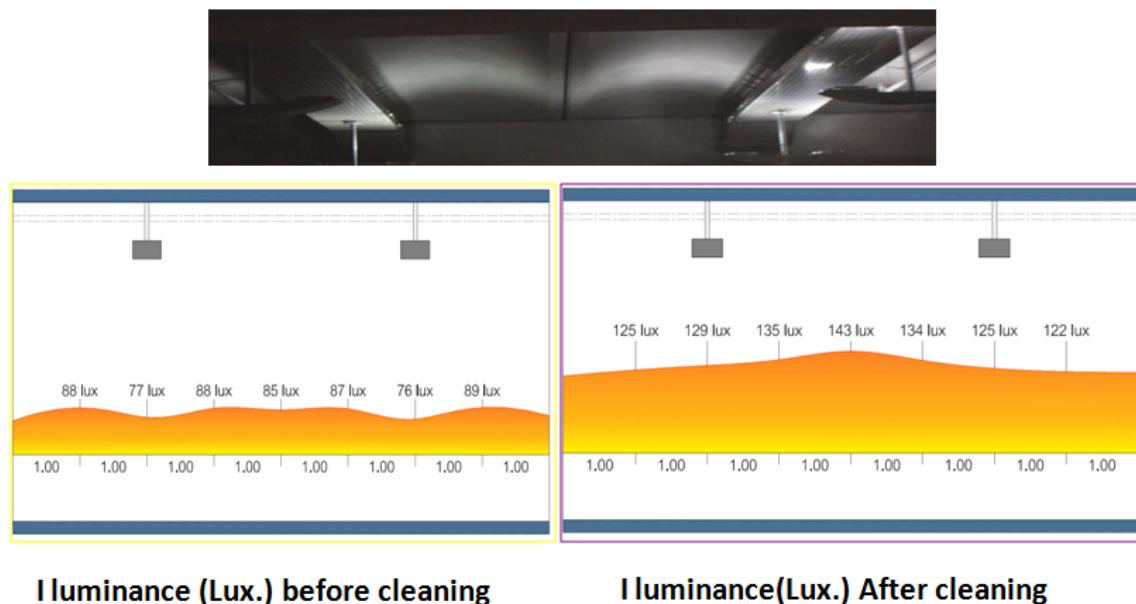


Fig.5 To comparative the effective of F5 lighting before and after lighting fixture cleaning in longitudinal section

### 3.1.2 Result of survey in architecture environment

The condition of the second floor (arrival passenger area) in terminal has brightness of contrast of level control problem from side window opening and direct light from sunlight into building in spite of using low reflective finishing decoration. (In Fig 6)

Fig.6 The reflective coefficient of lighting in arrival passenger's area, concourse Building at Suvarnabhumi Airport (Chamnarn Hokiat, 1998)

Location	Characteristic of surface	Co-efficiency of reflective
Wall finishing	-dark grey metal matt surface -clear glass surface -exposed concrete matt surface	0.10-0.15% 0.06-0.08% 0.10-0.15%
Ceiling finishing	-exposed concrete matt surface	0.10-0.15%
Floor finishing	-white terrazzo surface	0.70-0.80%

That made the artificial lighting area has brightness different from the sunlight area. The void and opening in Fovea Vision will made glare. From the survey assign dark perception equal to 1 and glare perception equal to 7 by questionnaire found out that 720 passengers satisfy brightness level in each area between 1.2 to 3.3 point. (In Fig 7)

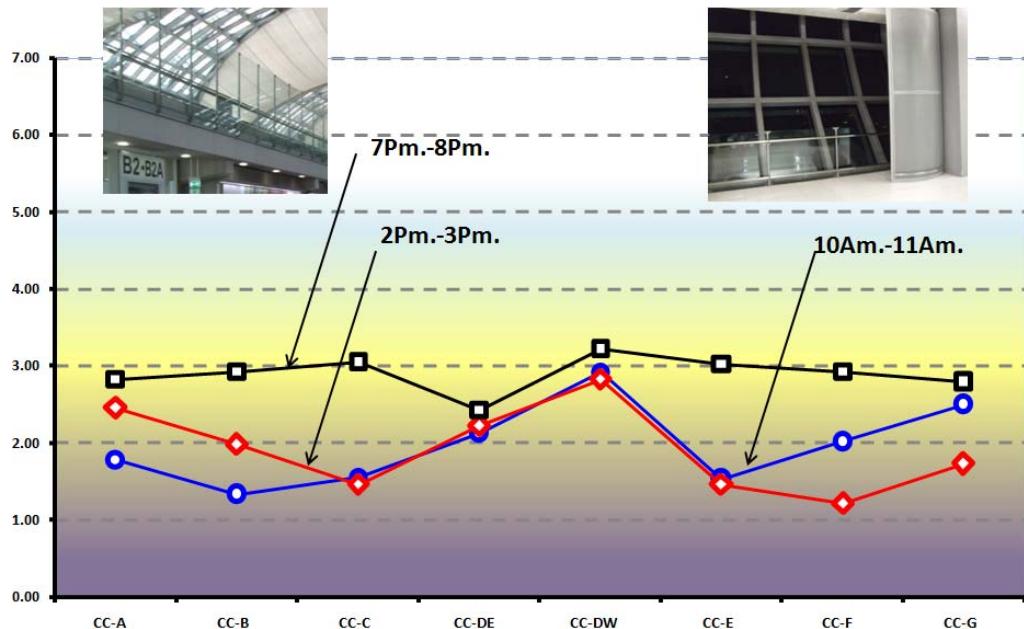


Fig.7 To show the feeling of brightness at 10.00am.-11.00am., 2.00pm.-3.00pm., and 7.00pm.-8.00pm.

### 3.2 Level of brightness perception after improving area

3.2.1 The Result of improving Lighting system, Airport Of Thailand Plc., has improved F5 Lighting as the following (In Fig.8, 9 and 10)

	Before	After
<b>Fixture Direction</b>	Up light	Up light 40% down light 60%
<b>Average of Brightness</b>	100-130 lux.	150-200 lux.
<b>Power Supply</b>	2x150w Metal Halide Lamp	2x28w Fluorescent T5

Fig.8 To show the comparative of F5 fixture between the previous and the new fixture

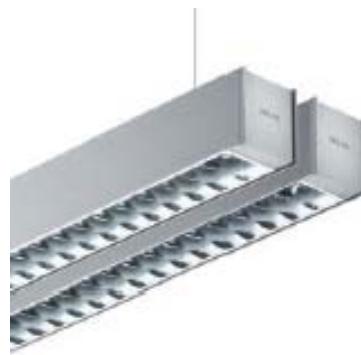


Fig.9 The new type of fixture 2x28w. Fluorescent T5 used for F5

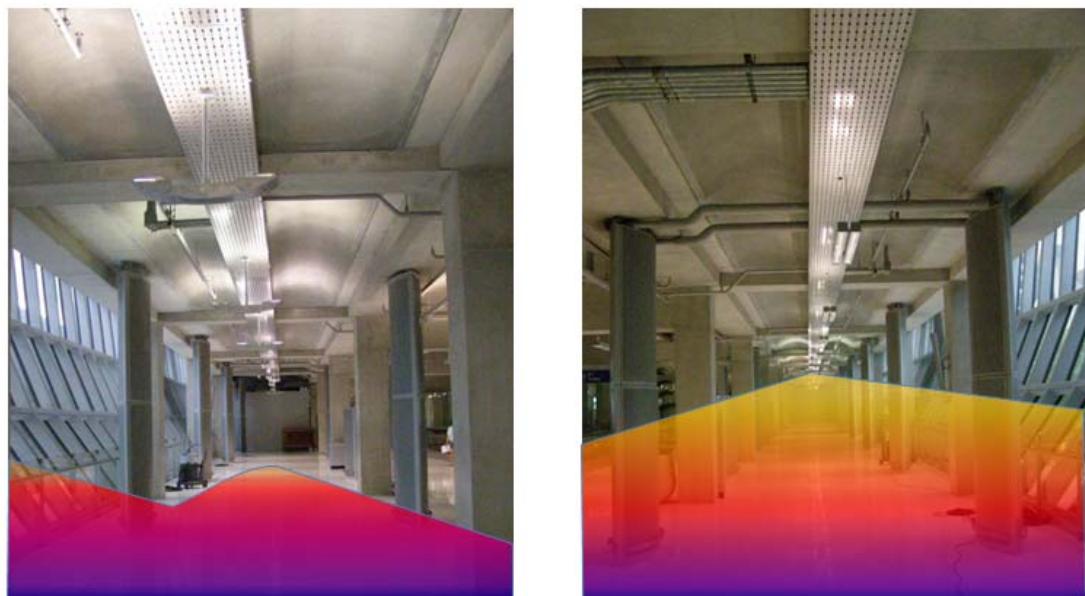


Fig.10 The brightness in working plane area.

After change fixture could check brightness according to IES standard in picture 4 and could decrease using energy 5 times. The brightness perception from questionnaire got average 2.5.

3.2.2 The Result of changing colour of architecture surface for changing contrast of brightness both artificial lighting and sunlight by;

-Control quantity of sunlight trough void and opening add the picture of sticker for decorating at the glass wall to decrease glare.

-Use light colour for increasing reflective and brightness of surface and ceiling and artificial light area decreased contrast of brightness less than 1:3 (In Fig 11, 12)

The result of study gets the average of brightness reception equal to 3.9



Fig. 11 The surface and ceiling brightness before studying



Fig.12 The surface and ceiling brightness after studying

From the comparative with lighting engineering improvement and architecture environment improvement inside the studying area found the energy using and lighting direction could increase the brightness according to CIE standard and decrease the usage energy 5 times, but it feel a little more brightness because the present environment still obstruct the brightness perception process of eyes. From the study found out that eye perception is the brightness, caused by lighting from original shine to object and effect to eyes which the illuminance is a working plane and eyes will percept when object reflect lighting into eyes. Meanwhile the lighting design must be control the brightness and glare in Fovea Vision because it will effective with iris response, made iris shrink and feel dark. The design should control contrast at level 1:3 for general area and 1:10 for exclusive area. From this studying made the passenger feeling more brightness (In Fig.13).

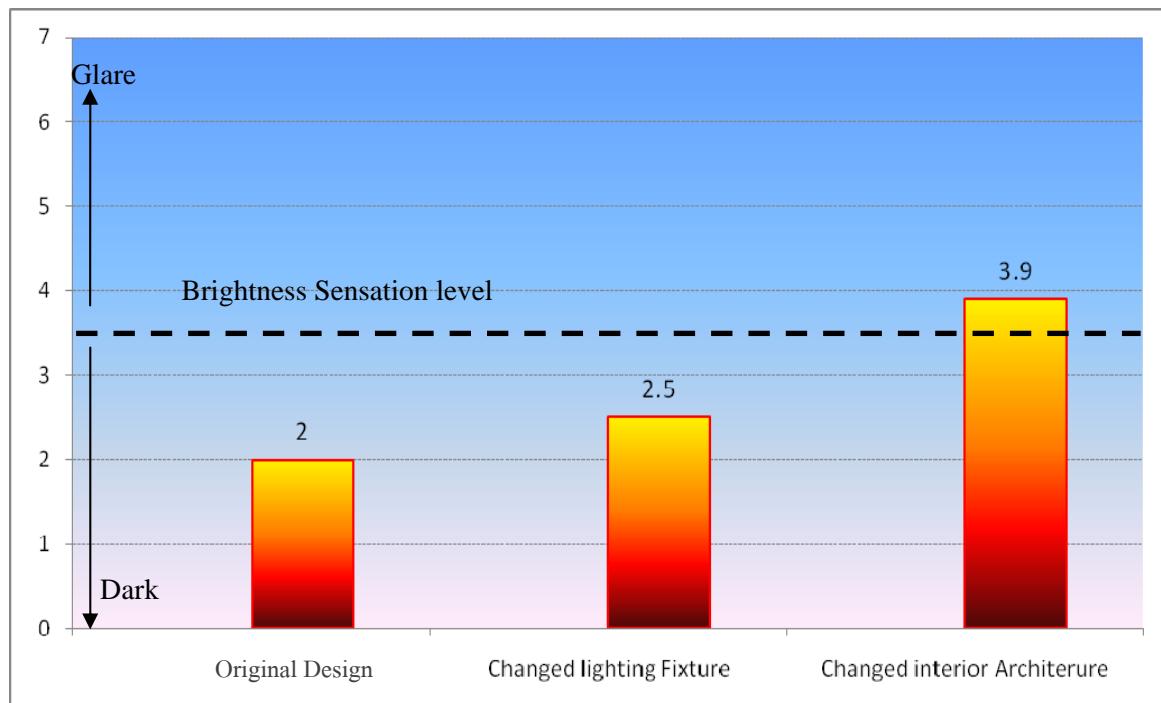


Fig.13 The brightness feeling level before and after fixture improvement and the architecture condition in arrival passenger area, concourse building, Suvarnabhumi Airport

#### 4. Conclusion

The architecture was used to be climatic modification for environmental adaptation suitable for all 5 senses of human perception. The designing of brightness system not only engineering design but also consider the comfort of lighting and visual relevant perception process of eyes. To study factors relevant visual found the quality of visual task contain of 4 principle factors and characteristic of composition. Moreover it still group of visual supporting factors in fig.14 which relevant environment and characteristic of sampling both visual composition and visual supporting factors made impression level of impression which be important basics of information technology in visual perception in learning process

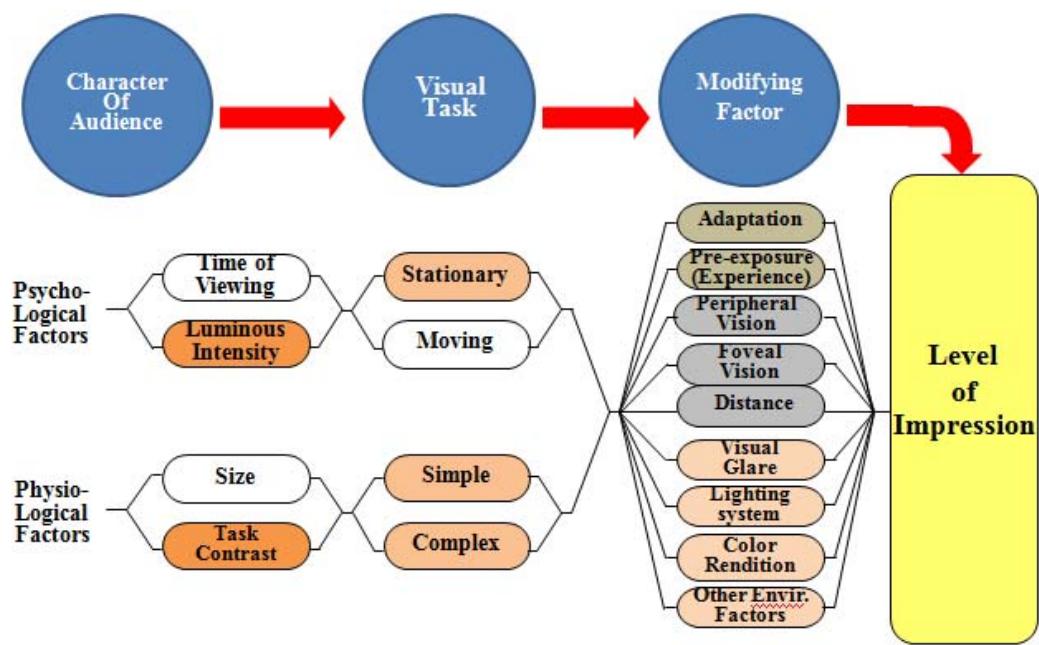


Fig.14 To show factors relevant visual perception sense (Soonthorn Boonyatikarn, 2006)

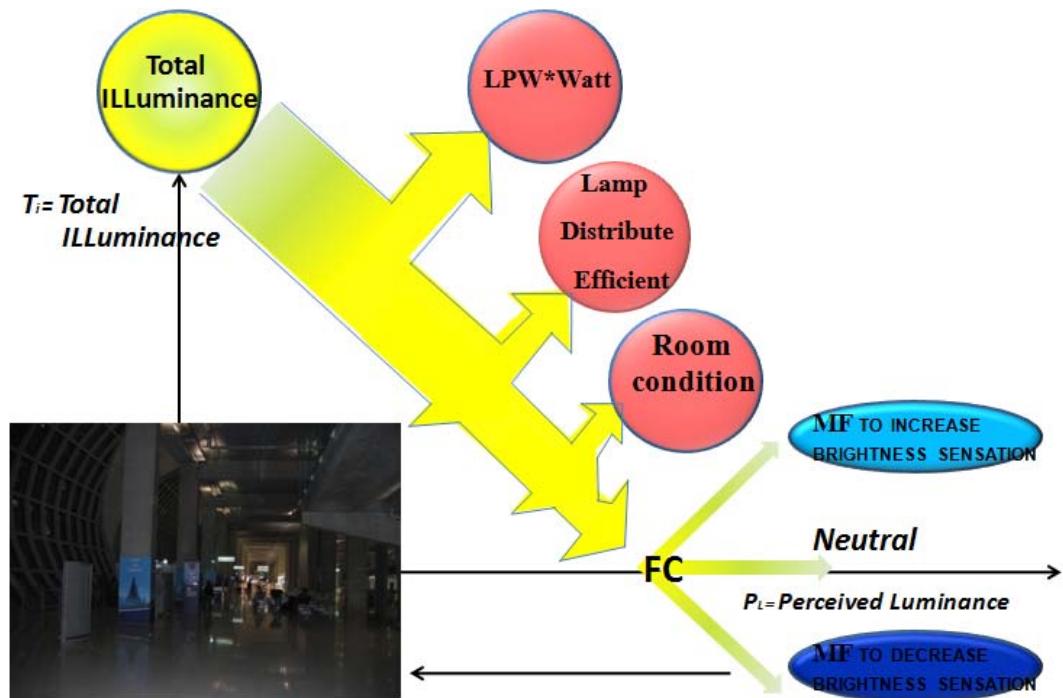


Fig.15 To show the influence of factors relevant visual supporting

Meanwhile, interior architecture design which increasing brightness perception of human eyes by controlling modifying factors will able to increase brightness feeling, brightness comfortable and visual comfortable by the less energy usage, was integrated design with natural capital in brightness perception process in designing, as interior architecture design was miss modifying factors controlling would effect to lower brightness perception, made it add more energy that mean to waste energy.

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