



Cairo University

DAYLIGHTING DESIGN OPTIMIZATION OF HOSPITAL PATIENTS' ROOM USING LIGHT REDIRECTING SYSTEM FOR VISUAL COMFORT UNDER DESERT CLEAR SKY

By

Aya Mohamed Hisham Ahmed Essa

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Architectural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of
Dr. Ayman Hassan Mahmoud

.....
Professor of Landscape Architecture & Environmental Planning
Department Architecture
Faculty of Engineering, Cairo University

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Approved by the
Examining Committee

Prof. Dr. Ayman Hassaan Mahmoud
Faculty of Engineering, Cairo University

Thesis's Main Adviser

Prof. Dr. Ahmed Ahmed Fikry
Faculty of Engineering, Cairo University

Internal Examiner

Prof. Dr. Mostafa Refaat Ismail
Faculty of Engineering, Architecture Department University of Ain Shams

External Examiner

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2019

Engineer's Name: Aya Mohamed Hisham Ahmed Essa
Date of Birth: 02/04/1992
Nationality: Egyptian
E-mail: aya.essa@gmail.com
Phone: +20 100 907 1910
Address: 44 kasr El-Ainy St., Cairo
Registration Date: 01/10/2014
Awarding Date: 2019
Degree: Master of Science
Department: Architectural Engineering



Supervisor: Prof. Ayman Hassaan Mahmoud

Examiners:

Prof. Mostafa Refaat Ismail (External examiner)
Faculty of Engineering, Architecture Department
University of Ain Shams
Prof. Ahmed Ahmed Fikry (Internal examiner)
Prof. Ayman Hassaan Mahmoud (Thesis advisor)

Title of Thesis:

Daylighting Design Optimization Of Hospital Patients' Room Using Light Redirecting System For Visual Comfort Under Desert Clear Sky

Key Words:

Daylighting, Visual comfort, Light selves, shading devices, Hospital, optimization

Summary:

Daylighting has a positive effect on users' health, physical and psychological. Hence, daylighting use should be maximized to benefit users from its advantages, especially in health care facilities, where visual indoor comfort is more crucial than other building types due to the vulnerability of its users. In patients' rooms specifically, indoor environment quality affects the healing process in terms of time interval and pain reduction. Since reaching visual comfort cannot be achieved by openings design alone, light-redirecting systems are essential. Light redirecting systems, namely light shelves and shading devices, are proved to have an impact on indoor daylight quality and quantity which shows as better distribution, increased quantity in space depth, and reduced glare probability. Accordingly, the aim of this study is to arrive at a range of optimally configured light-redirecting systems for one of most common patient room prototype while gaining a better understating of the effect of each of the independent variables understudy. This study first investigates the various visual comfort assessment metrics as well as how daylighting and visual comfort is evaluated in a number of building performance assessment systems. Followed by daylighting simulation engines and tools overview, the types and effect of light-redirecting systems, including light shelves and shading devices, are investigated. The theoretical section is concluded by a synopsis of similar studies. Succeeding, to explore the effectiveness of the studied systems this study includes a comparative analysis of LEED certified healthcare buildings that have achieved visual comfort. Finally, in an attempt to optimize daylighting in a patient room prototype, an application of a light-redirecting system is carried out using varying rotation angles, horizontal projection, mounting height, WWR and reflectance. The near optimal solutions are determined by LEED v.4 criteria.

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Table of Contents

DISCLAIMER.....	I
ACKNOWLEDGMENTS	II
TABLE OF CONTENTS.....	I
LIST OF TABLES	IV
LIST OF FIGURES	V
NOMENCLATURE	VII
ABSTRACT	VIII
CHAPTER 1 : INTRODUCTION	1
1.1. RESEARCH PROBLEM	2
1.2. RESEARCH QUESTIONS	2
1.3. RESEARCH OBJECTIVES	2
1.4. RESEARCH LIMITATIONS	3
1.5. METHODOLOGY	3
1.6. RESEARCH STRUCTURE	3
CHAPTER 2 : DAYLIGHTING AND VISUAL COMFORT IN HOSPITALS.....	5
2.1. IMPORTANCE OF DAYLIGHTING IN HOSPITALS.....	5
2.2. VISUAL COMFORT AND ASSESSMENT	5
2.2.1. Approaches for assessing visual comfort	6
2.2.1.1. Climate-based daylight metrics	6
2.2.2. Metrics for visual comfort assessment	6
2.2.2.1. Light Quantity Assessing Metrics	6
2.2.2.1.1. Illuminance.....	7
2.2.2.1.2. Daylight Factor	7
2.2.2.1.3. Daylight Autonomy.....	7
2.2.2.1.4. Continuous Daylight Autonomy and Spatial Daylight Autonomy.....	8
2.2.2.1.5. Useful Daylight Illuminance.....	8
2.2.2.1.6. Spatial Useful Daylight Illuminance.....	9
2.2.2.1.7. Annual Sunlight Exposure	9
2.2.2.2. Light Distribution Assessing Metrics	9
2.2.2.3. Glare Assessing Metrics.....	10
2.2.2.3.1. Luminance intensity and Luminance Ratio.....	10
2.2.2.3.2. Discomfort Glare Index.....	11
2.2.2.3.3. Discomfort Glare Probability.....	12
2.2.2.3.4. Predicted Glare Sensation Vote.....	12
2.2.2.3.5. Summary.....	12
2.2.2.4. Light Quality Assessing Metrics	14
2.3. DAYLIGHTING AND VISUAL COMFORT PERFORMANCE ASSESSMENT SYSTEMS	14
2.3.1. BREEAM	14
2.3.2. LEED.....	15
2.3.3. CASBEE.....	16

2.3.4.	SBTool.....	17
CHAPTER 3 : LIGHT REDIRECTING SYSTEMS.....		19
3.1.	LIGHT REDIRECTING SYSTEMS: DEFINITION AND IMPORTANCE	19
3.1.1.	Shading Devices' Concept and Technologies	19
3.1.2.	Light Shelves	21
3.2.	LIGHT-REDIRECTING SYSTEMS' CONFIGURATION AND COMBINATION	23
3.2.1.	Shading devices configuration.....	23
3.2.2.	Light shelves Configurations.....	25
3.2.3.	Light-Redirecting Systems' Combinations.....	26
3.3.	FACTORS AFFECTING LIGHT-REDIRECTING SYSTEMS' PERFORMANCE	27
CHAPTER 4 : DAYLIGHTING SIMULATION AND OPTIMIZATION		
APPLICATION IN LITERATURE		29
4.1.	DAYLIGHTING SIMULATION ENGINES	29
4.1.1.	Radiance	30
4.1.2.	DAYSIM	30
4.2.	DAYLIGHTING SIMULATION SOFTWARE/ TOOLS.....	30
4.2.1.	DIVA	31
4.2.2.	DIALux.....	31
4.2.3.	Relux.....	31
4.2.4.	VELUX.....	32
4.2.5.	IESve	32
4.3.	DAYLIGHT SIMULATION IN LITERATURE	33
4.3.1.	Daylighting optimization.....	33
4.3.2.	Optimization of Light-Redirecting Systems to achieve visual comfort.....	35
4.3.2.1.	Shading devices.....	35
4.3.2.2.	Light shelves	36
4.3.3.	Daylighting Optimization in Hospitals.....	36
CHAPTER 5 : CASE-STUDIES.....		39
5.1.	NATURAL LIGHTING IN HEALTHCARE FACILITIES	39
5.2.	THE UNIVERSITY OF ARIZONA CANCER CENTER.....	39
5.2.1.	Daylight design and nature light enhancing features.....	40
5.3.	UCLA OUTPATIENT, SURGERY, AND ONCOLOGY CENTER.....	42
5.3.1.	Daylight design and nature light enhancing features.....	43
5.4.	ADVOCATE ILLINOIS MASONIC MEDICAL CENTER	46
5.4.1.	Daylight design and nature light enhancing features.....	47
5.5.	SUMMARY	49
CHAPTER 6 : APPLICATION		51
6.1.	DESIGN CASE.....	51
6.2.	EQUIPMENT	51
6.3.	PROCEDURE	52
6.4.	RESULTS	55
6.4.1.	Stage 1: Light Shelf Design: Metal Reflectance vs Mirror Reflectance.....	55
6.4.2.	Stage 2: Light Shelf Design: window lintel height 2.6m vs 3.0m	57

6.4.3.	Stage 3: Room Configuration: Increase WWR	58
6.4.4.	Stage 4: Light Shelf Configuration: Horizontal projection for the metal reflective light shelf	62
6.4.5.	Stage 5: Room Configuration: Inner wall surface reflectivity	63
6.4.6.	Stage 6: Addition of a shading element to the light redirecting system	65
6.4.7.	Stage 7: Additions: Addition of a light control system	67
CHAPTER 7 : DISCUSSION AND CONCLUSION.....		71
REFERENCES		75

List of Tables

Table 1: Visual Comfort Assessment Approaches	6
Table 2: Tolerance ratio limits	11
Table 3: DGI thresholds	11
Table 4 Summary of case studies analysis	50
Table 5 Radiance simulation parameters.....	52
Table 6 Addition of a light control shelf for different WWRs' sDA and ASE values...	72

List of Figures

Figure 1 Workflow followed.....	3
Figure 2 360° Visualization of space showing various glare situations from 09:00 till 14:00.....	13
Figure 3: Design parameters for light-redirecting systems	20
Figure 4: Venetian blinds acting as light shelves, (Kuhn T. , 2017)	21
Figure 5: Daylighting penetration behavior (a) without light shelves, (b) with light shelf installed (Lee, Kim, & Kim, 2013).....	22
Figure 6: Internally installed venetian blinds configuration, (Andersen, Scartezzini, Rubin, & Powles, 2003)	23
Figure 7: Shapes of the accepted blind slat configurations (Sherif A. , Sabry, Wagdy, Mashaly, & Arafa, 2016).....	23
Figure 8: Horizontal, 45° tilted, subdivided and vertical configurations, (Lim, Ahmad, & Ossen, 2013).....	24
Figure 9 Effect of shading device depth (Berardi & Anaraki, 2015)	25
Figure 10 External slats' configurations (Freewan A. A., 2014)	25
Figure 11 Light shelf configuration variables (Shikder, Mourshed, & Andrew, 2010).26	
Figure 12 Calculation methods illustrated (a) Ray tracing, (b) radiosity and (c) photon map, (Ochoa, Aries, van Loenen, & Hensen, 2012).....	29
Figure 13 Exterior shot (https://www.zgf.com/project/ua-cancer-center/)	39
Figure 14 Plans (https://www.zgf.com/project/ua-cancer-center/)	40
Figure 15 Exterior shading system design (https://www.zgf.com/project/ua-cancer-center/).....	41
Figure 16 Lobby exterior sunshades design (a) interior shot, (b) exterior shot (https://www.zgf.com/project/ua-cancer-center/).....	41
Figure 17 Exterior shot (Folonis, n.d.)	42
Figure 18 Floor plans (AIA Academy of Architecture for Health, 2017).....	43
Figure 19 Exterior shot showing boundary extrusion (Folonis, n.d.).....	43
Figure 20 Interior shots for skylights Lobby, infusion bay, and waiting area (from left to right) (AIA Academy of Architecture for Health, 2017)	44
Figure 21 Building section showing (a) skylights and light shelves, (b) sunshades (M.Folonis, n.d.).....	44
Figure 22 Section cut showing the light-redirecting system components (Folonis, n.d.)	45
Figure 23 (a) Light-shelves and louvers combination, and sunshades (Folonis, n.d.), (b) Glass sunshade (Folonis, Case Study: UCLA Outpatient Surgery and Cancer Center, 2016).....	45
Figure 24 Exterior shot (Advocate Illinois Masonic Medical Center, n.d.)	46
Figure 25 Plans (Frederick, 2016)	47
Figure 26 Sunshades (Frederick, 2016).....	48
Figure 27 Examination rooms (Frederick, 2016)	48
Figure 28 Atrium (Frederick, 2016)	49
Figure 29 Studied patient room illustration with daylighting analysis grid	51
Figure 30 The proposed rotation angles in section.....	53
Figure 31 ASE, Sda and glare graphical representations for (a) base case, (b) one of the Successful Cases.....	53

Figure 32 sDA values for the mirror versus the metal reflective light redirecting system	55
Figure 33 ASE values for the mirror versus the metal reflective light redirecting system	56
Figure 34 SDA and ASE Room grid visualization of sDA and ASE for (a) metal and (b) mirror.....	56
Figure 35 sDA values for the patient's room lintel height 2.6m vs 3.0m	57
Figure 36 ASE values for the patient's room lintel height 2.6m vs 3.0m	58
Figure 37 Patient's room WWR configurations	58
Figure 38 sDA values for different WWR	59
Figure 39 ASE values for different WWR.....	60
Figure 40 SDA and ASE Room grid visualization for different WWR (a) 16%, (b) 20%, and (c) 28%.....	61
Figure 41 sDA values for 1.0 m versus 1.5m projection depth in different WWRs	62
Figure 42 ASE values for horizontal projection of 1.0 m versus 1.5m in different WWR	62
Figure 43 sDA values for the room Inner dark wall employment with a metal reflective light redirecting system in different WWRs.....	63
Figure 44 ASE values for the room Inner dark wall employment with a metal reflective light redirecting system in different WWRs.....	64
Figure 45 SDA and ASE Room grid visualization for different wall painting reflectance (a) dark (b) light colored paint	64
Figure 46 The window shading element addition to the light redirecting system.....	65
Figure 47 Additional Shading Element to The Light-Redirecting System Versus WWRs For Their sDA Values	65
Figure 48 Additional Shading element to the Light-redirecting system versus WWRs for their ASE values	66
Figure 49 SDA and ASE Room grid visualization for (a) single light redirecting device vs (b) with addition shading device.....	67
Figure 50 The light control element addition to the light redirecting system	67
Figure 51 sDA values for the light control element addition to the Light-redirecting system in different WWRs	68
Figure 53 SDA and ASE Room grid visualization for (a) single light redirecting device vs (b) with addition of a second light shelf.....	69
Figure 54 The proposed light control system in addition to the light redirecting system in section in case of metal reflectance.....	73
Figure 55 sDA and ASE graphical representation for the successful case of the (metal combined light redirecting/control systems)	73

Nomenclature

ASE-	Annual Sunlight Exposure
BREEAM-	Building Research Establishment Environmental Assessment Methodology
CASBEE-	Comprehensive Assessment System for Built Environment Efficiency
CBDM-	Climate-based daylight metrics
CGI-	CIE Glare Index
DA-	Daylight Autonomy
DACON-	Continuous Daylight Autonomy
DF-	Daylight Factor
DGI-	Discomfort Glare Index
DGP-	Discomfort Glare Probability
ERC-	External Reflected Component
GUI-	Graphical user interface
IEA-	International Energy Agency
IRC-	Internal Reflected Component
L-	Luminance
LEED-	Leadership in Energy and Environmental Design
PGSV-	Predicted Glare Sensation Vote
SBTool-	Sustainable Building Tool
SC-	Sky Component
sDA-	Spatial Daylight Autonomy
sUDI-	Spatial useful daylight illuminance
UDI-	Useful Daylight Illuminance
UGI-	Unified glare index
WWR-	Window-to-wall ratio