

CONCEPTS IN ARCHITECTURAL LIGHTING

M. David Egan

College of Architecture
Clemson University

~~KT 2-19~~

McGraw-Hill Book Company

New York St. Louis San Francisco Auckland Bogotá Hamburg
Johannesburg London Madrid Mexico Montreal New Delhi Panama
Paris São Paulo Singapore Sydney Tokyo Toronto

Contents

Foreword	xi	Brightness Control	38
Preface	xiii	Human Biological (or Psychological) Needs for Visual Information	40
Acknowledgments	xv	Checklist for Good Lighting	41
Chapter 1 VISION AND PERCEPTION	1	Chapter 2 LIGHT SOURCES	42
Seeing Light and Color	2	Incandescent Lamps	43
Schematic of How Human Eye Functions	3	Voltage Effects on Incandescent Lamp Output and Life	44
Human Eye and Formation of Images	4	Fixtures and Lamp Beam Spread	45
Schematic of Retina	5	Incandescent Lamp Data	46
Human Brain and Vision	6	Flourescent Lamps	47
Visual Field	7	Flourescent Lamps and Temperature	48
Binocular Visual Field Profile	8	Heat from Light Sources	49
Vision and Age	9	Typical Fluorescent Lamp Output Depreciation	50
Object Size and Visibility	10	Flourescent Lamp Use and Life	51
Color Spectrum	11	Ballasts	52
Color of Objects	12	Flourescent Lamp Data	54
Munsell Color System	13	High-Intensity Discharge Lamps	55
Color Content of Light Sources	14	High-Intensity Discharge Lamp Data	56
Color Perception	15	Lamp Color Spectrum	57
Day and Night Vision	16	Lamp Color Rendition	58
White-Dog Effect	17	Color Rendering Index	59
Gestalt Theory	18	Lamp Mortality	60
Visual Perception of Images	19	Color Temperature	61
Sound and Light	21	Incandescent Lamp Efficacy and Color Temperature	62
Brightness Levels	22	Heat and Light from Lighting Fixtures	63
Brightness Differences	23	Shielding of Lamps	64
Surface Reflectance and Apparent Brightness	24	Reflectors and Diffusers	65
Brightness Adaptation	25	Lenses	66
Surface Reflectance and Daylight	26	Brightness and Glare	67
Reflectance of Materials	27	Scissors Curve	68
Recommended Reflectances	28	Visual Comfort Probability (VCP) Index	69
Example Reflective Surfaces	29	Fixture Glare Control	70
Transmittance of Materials	30	Efficacy of Light Sources	71
Types of Glare	31	Lamp Efficacy and Wattage	72
Reflected Glare and Veiling Reflections	32	Lighting Load	73
How to Find Light Sources in Offending Zone	34	Characteristics of Electric Light Sources	74
Surrounding Brightness and Vision	35	Daylight	76
Surrounding Brightness and Contrast	36		
Task Brightness	37		

Chapter 3 LIGHT MEASUREMENT	77	Light Source (Concentrated Beam Spread)	139
Introduction to Light Measurement	78	Light Source (Medium Beam Spread)	140
Lumen and Footcandle Units	79	Light Source (Wide Beam Spread)	141
Color Temperature and Illumination Level	80	Point Method for Horizontal and	
Inverse-Square and Cosine Laws for Light	81	Vertical Illumination	142
Illumination Level and Visibility	82	Right Triangles	144
Visual Task Performance Studies	83	Trigonometric Table	145
Hawthorne Effect for Light	84	Example Problem (Point Method)	146
Light Measurements with Light Meters	85	Coefficient of Utilization	149
How to Use a Light Meter	87	Room Size and Room Cavity Ratios	150
Reflectance Measurements	89	Effect of Reflectance on Coefficient of Utilization	
Transmittance and Candlepower Measurements	90	and Loss of Light from Dirt	151
Illumination Level Worksheet	92	How to Find Coefficient of Utilization	152
Illumination Gradient Measurements	94	Coefficient of Utilization Worksheet	153
		Lumen Method	154
Chapter 4 LIGHT AND FORM	96	Coefficient of Utilization Worksheet	156
Lighting Design and Form	97	Example Problem (Lumen Method)	157
Room Use and Light Distribution	98	Luminaire Dirt Depreciation	158
Location of Light Sources	100	Effective Ceiling and Floor Cavity Reflectances	159
Accent Light	101	Coefficient of Utilization Data (Direct-Indirect	
Scallops of Light	102	Luminaire)	160
How to Plot Scallop Patterns of Light	103	Factors for Effective Floor Cavity Reflectances	
Wall Washers	104	Other than 20%	161
Ceiling Layouts	105	Example Problem (Cove Lighting)	162
Luminous Ceilings	107	Coefficient of Utilization Worksheet	163
Illuminated Ceilings	108	Coefficient of Utilization Data (Cove)	164
Task-Ambient Lighting	109	Checklists for Energy-Conscious Design of	
Cove Lighting	110	Lighting Systems	165
Lighting of Stairs	111		
Sensory Cues and Stairs	112	Chapter 6 DAYLIGHT AND DESIGN	167
Stair and Handrail Visibility	113	Illuminance and Creativity	168
Signage Lighting	114	Natural Light in Buildings	169
Openings and Brightness	115	Clear Sky Conditions	170
Natural Baffles for Light	116	Cloudy Sky Conditions	171
Black Hole Effect	117	Solar Angles	172
Subjective Impressions from Lighting Designs	118	Daylight Illuminance	173
		Opening Locations for Sidelighting	174
Chapter 5 LIGHTING SYSTEMS	120	Opening Height	176
Factors of Vision and Lighting Conditions Affecting		Opening Width	177
Design Illumination Levels	121	Room Depth	178
IES Recommended Illumination Levels	122	Roof Overhangs	179
Illuminance Recommended for Use in Selecting		Bilateral Openings	180
Values for Interior Lighting Design	123	Isoilluminance Contours for Sidelighting	181
Weighting Factors to Be Considered in Selecting		Toplighting	182
Specific Illuminance Values	124	Light Wells	185
ESI Method	125	Rules of Thumb for Clerestories	186
ESI Contours	126	Reflected and Beam Daylighting	187
Nonuniform Overhead Lighting Layouts	127	Reflected Daylighting Examples	188
ESI and Energy Consumption	128	Glare Control for Windows	189
Generic Types of Luminaires	129	Low-Transmittance Glass	190
Shape of Candlepower Distribution Curves	132	Glare Control for Skylights	191
Point Sources	134	Building Shapes and Layouts	192
Rules of Thumb for Point Sources	136	Daylighting Terms for Daylight Factor Method	193
How to Read Candlepower Distribution Curves	138	Example Problem (Daylight Factor Method)	194

Daylight Factor Method	195	Illuminated Model – Case Study 2	221
Sky Component	198	Illuminated Model – Case Study 3	222
Transmittance	199	Selected References on Interior Models	223
Obstructions	200		
Daylight Factor for Illumination by Windows	200	Chapter 8 ILLUSTRATED GLOSSARY	224
Average Overcast Sky Illuminance	201	Glossary of Lighting Terms	225
Checklist for Daylighting Design	202		
Chapter 7 ILLUMINATED MODELS	207	SELECTED REFERENCES ON LIGHTING	241
Illuminated Model Studies	208	Lighting Fundamentals and Vision	241
Scale of Models	208	Lighting Calculations	242
Room Finish Materials and Furnishings for Illuminated Models	209	Daylighting	242
Luminaire Modeling Techniques	212	APPENDIXES	243
Light Sources for Illuminated Models	214	A Summary of Useful Formulas	243
How to Photograph Illuminated Models	215	B Conversion Factors	249
Model Setup	216	C IES Tables for Lumen Method	251
Suggested Films	217	D Electrical Symbols for Lighting Layouts	263
Daylighting Model Setup	218	E Lighting Organizations	264
Artificial Skies	219		
Illuminated Model – Case Study 1	220	Indexes	265