

DESIGNING WITH LIGHT

» THE ART, SCIENCE, AND PRACTICE OF
ARCHITECTURAL LIGHTING DESIGN



JASON LIVINGSTON

WILEY

Designing with Light

Designing with Light

The Art, Science, and Practice of
Architectural Lighting Design

Jason Livingston, IALD, LC

WILEY

Cover Design by Wiley

Cover Photographs: Left top and left center: R2Architects; Left bottom: Ella Bromblin; Right: Jason Livingston

This book is printed on acid-free paper. 

Copyright © 2014 by Jason Livingston. All rights reserved.

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

Published simultaneously in Canada.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 646-8600, or on the web at www.copyright.com. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at www.wiley.com/go/permissions.

Limit of Liability/Disclaimer of Warranty: While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with the respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor the author shall be liable for damages arising herefrom.

For general information about our other products and services, please contact our Customer Care Department within the United States at (800) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley publishes in a variety of print and electronic formats and by print-on-demand. Some material included with standard print versions of this book may not be included in e-books or in print-on-demand. If this book refers to media such as a CD or DVD that is not included in the version you purchased, you may download this material at <http://booksupport.wiley.com>. For more information about Wiley products, visit www.wiley.com.

Library of Congress Cataloging-in-Publication Data:

Livingston, Jason, 1965-

Designing with light : the art, science, and practice of architectural lighting design / Jason Livingston.

pages cm

Includes index.

ISBN 978-1-118-74047-7 (paperback); ISBN 978-1-118-74039-2 (ebk.); ISBN 978-1-118-74040-8 (ebk.)

1. Lighting, Architectural and decorative. 2. Light in architecture. I. Title.

NK2115.5.L5L58 2014

729'.28—dc23

2014002868

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

To My Parents, who have given me so much

Contents

Preface	xiii
Acknowledgments	xiv
About the Author	xv
 Chapter 1: The Lighting Design Profession	1
The Lighting Designer's Scope of Practice	2
Professional Lighting Design Credentials	4
Online Resources	5
References	6
 Chapter 2: Designing with Light	7
What Is Lighting Design?	7
Beginning the Design	8
Thinking about Light	9
Thinking about Luminaires	14
Thinking about Architecture	15
Thinking about Everything—Layers of Light	16
Communicating Design Ideas	17
Approaches to the Lighting Design Process	22
Additional Considerations	34
Online Resources	34
References	35
 Chapter 3: What Is Light?	37
Light Is Illumination	37
Light Is Rays of Vision	38
Light Is Material	38
Light Is Waves	39
Light Is Particles	39
Light Is Waves, Again	40
Light Is Waves and Particles, aka Quanta	41

- Light Is Art 41
- Light Is a Tool 43
- Online Resources 45
- References 45

- Chapter 4: How We See. 47**
 - The Path of Light 47
 - The Eye 48
 - How We See Color. 51
 - Visual Performance. 53
 - Online Resources 55
 - References 56

- Chapter 5: Light, Vision, and Psychology. 57**
 - Perception 57
 - Impressions 58
 - Lighting, Architecture, and Impressions 59
 - Online Resources 66
 - References 66

- Chapter 6: Distribution of Light 67**
 - Interaction of Light and Materials. 67
 - Shadows and Luminaires 72
 - Glare 73
 - Types of Distribution 76
 - Online Resources 78
 - References 78

- Chapter 7: Lamps 79**
 - Incandescent Lamps 79
 - Halogen Lamps 81
 - Fluorescent Lamps 82
 - High Intensity Discharge 84
 - Light Emitting Diode. 86
 - Other Lamp Technologies. 88
 - Arriving Technologies. 89
 - Lamp Shapes 91
 - Lamp Sizes. 94
 - Lamp Bases 96

Beam Angle and Field Angle	99
Describing a Lamp	100
Selecting a Light Source	104
Lamp Information for Consumers	106
Online Resources	106
References	108

Chapter 8: Color in Light 109

Colors of White Light	109
Color Rendering	112
Color Stability	117
Colored Light	122
Sources of Colored Light	127
Use of Color	130
Online Resources	139
References	140

Chapter 9: Lighting Fixtures or Luminaires 141

Luminaire Components	142
Common Luminaire Types	144
Luminaire Accessories	154
Mounting Conditions	154
Outdoor Luminaires	157
Luminaire Consideration Summary	158
Reading Manufacturer's Literature	158
Modifying Luminaires	161
Custom Luminaires	161
Luminaire Information and Sales	161
Online Resources	165
References	166

Chapter 10: Daylighting 167

The Benefits of Daylighting	167
Planning for Daylighting	168
Glazing	171
Designing Daylighting	171
Shading Strategies	176
Online Resources	176
References	178

Chapter 11: Documenting the Design 179

 Phases of the Architectural Design Process 179

 Design Documentation 182

 Luminaire Cut Sheets 199

 Luminaire or Fixture Schedule 199

 Specifications 209

 Layout and Installation Details 210

 Online Resources 222

 References 223

Chapter 12: Lighting Controls 225

 Electricity and Electrical Engineering 225

 The Need for Controls 227

 Basic Controls 228

 Types of Dimmers 228

 Intermediate Controls 232

 Large-Scale Control Systems 235

 Control Protocols 237

 Control System Features 239

 Documenting Controls 240

 Online Resources 242

 References 243

Chapter 13: Photometrics and Calculations 245

 Terms Describing Brightness 245

 Units for Measuring Light 246

 Illuminance 246

 Reflectance 247

 How Much Light Is Required? 247

 Illuminance Calculations 248

 Software for Calculations 258

 Online Resources 261

 References 263

Chapter 14: Building and Energy Codes 265

 Model Codes 265

 Verifying Energy Code Compliance 269

 Online Resources 270

 References 271

Chapter 15: Sustainability	273
Voluntary Energy Programs	273
Life-Cycle Cost Analysis	276
Payback, or Return on Investment	278
Online Resources	278
References	279
Chapter 16: Light and Health	281
Biological Rhythms	281
Light Deficiency and Light Therapy	283
Harmful Effects of Light	284
Light and the Aging Eye	284
Online Resources	285
References	285
Appendix I: Lighting Design–Related Professional Organizations	287
Illuminating Engineering Society (IES)	287
International Association of Lighting Designers (IALD)	287
Designers Lighting Forum (DLF)	288
International Commission on Illumination (CIE)	288
National Council on Qualifications for the Lighting Professions (NCQLP)	288
International Dark-Sky Association	288
Appendix II: Lighting-Related Trade Publications	289
Architectural Lighting	289
Theatrical Lighting	290
Architecture and Interior Design	290
Green Building	291
Glossary	293
Index	307

Additional resources for students and instructors are available on the book's companion website at www.wiley.com/go/designingwithlight. The following icon is used throughout the text to indicate content for which a related resource is available on the site:



Preface

Perhaps more than any other design discipline, lighting design is a combination of art, science, and technology. Lighting designers need to understand a wide range of architectural and interior design styles, so that our work supports the aesthetic goals of the owner and the design team. We need to know how light affects vision and perception, and understand the interplay between light and materials so we can extend and reinforce the viewer's response to a space. We need to understand the lamp technologies, lighting hardware, and control systems that will bring our vision of a project to fruition. It sounds like a lot, and it is. The wonderful thing about lighting design is that there is a wide range of projects with room for many types of designers. Some practitioners have a science, math, and numbers orientation. Some lean toward art, aesthetics, and intuition. Most designers fall somewhere in the middle. If you're bright, talented, and have a discerning eye there's a good chance you can have a career as in lighting design. I hope that encourages you.

I came to the practice of architectural lighting design after two decades as a theatrical lighting designer. As a result my design approach, and the emphasis of this book, focuses on aesthetics and design. I outline several approaches to the process of working through a design and present case studies of my own work, walking you through the design from start to finish so you can see how it was done. However, one cannot practice lighting design without a firm grasp of the technical side of the profession. That fact is becoming truer every year. After several decades of relative stagnation, so much of the lighting industry is changing that it's sometimes hard to keep up. New energy legislation, phasing out of old technology, introduction of new technology, and expansion of the body of knowledge that a designer must master are keeping all of us on our toes these days. I've devoted chapters to all of these issues, from lamps and luminaires to controls and codes.

Most books are a reflection of the author, and this one is no different. First, I love history, and I always want to know how things were discovered, not just the outcome of the discovery. As a result, you'll see that I often start with some history on the scientists and researchers responsible for important discoveries to give you some background on the concepts that are covered here. Second, I'm fascinated by science, and try to present some of the dryer material with a sense of excitement and wonder. I hope that comes through. Finally, I love this profession and I have fun at work (almost) every day. I take this material very seriously, and I strive for perfection in my work, but I'm not dour about it. I hope my joy for design and my excitement at solving design challenges comes through, and I hope that encourages you, too.

Acknowledgments

This book would not have made the journey from idea to manuscript to published work without the support and assistance of many wonderful people. My good friends Paul Bartlett and Ed McCarthy generously provided photographs and assistance. Lenore Doxsee gave me thoughtful feedback that clarified the text, and Sabra Zacharias and Lisa Cohen were sources of unfailing support and encouragement. I also want to thank Paul Drougas at Wiley for believing that there was room in the world for another book on lighting design, and that this should be the one.

Architects and manufacturers I've had the pleasure of working with over the years supplied many of the drawings and photographs. I want to especially thank David Rudzensky and John Ruiz of R2Architects, Frank Moya of Matthews Moya Architects, Emma Price of Edison Price, Michael Hewitt and Carolyn Kerr of Philips, and Wendy Luedtke of Rosco Laboratories.

Finally, I want to thank my students whose questions and engagement in class have made teaching both a challenge and a joy, and who have helped me to clarify my own ideas about light, design, and education.

About the Author

Jason Livingston IALD, LC, MIES, LEED Green Associate is the principal of Studio T+L, LLC a lighting design and theatre consulting firm based in New York City.

The first two decades of his career were spent as a theatrical lighting designer before he transitioned to architectural lighting design and theatre consulting. As an architectural lighting designer his projects have included residences, high end retail, corporate offices, restaurants, places of worship, and theatres. He was awarded a 2012 IES Illumination Award of Merit for the Fordham University Church, a 2003 Lumen Award by the New York Section of the IES, and a 2003 International Illumination Design Award by the IESNA for his work on Rewarding Lives for American Express in New York City. His work has been profiled in *Lighting Design + Application*, *Lighting & Sound America*, *Architectural SSL*, and *Design Bureau* magazines.

Mr. Livingston has taught theatrical and architectural lighting design in New York City since 1993. He currently teaches architectural lighting design at Parsons the New School for Design and Pratt Institute. He has also taught theatre lighting design at New York University and architectural lighting design at Fashion Institute of Technology.

He is a member of the IES Color Committee, and is co-author of their Color and Illumination Design Guide. He holds a BFA in Theatre Arts from University of Miami and an MFA in Theatre Lighting Design from New York University, and is a member of Illuminating Engineering Society, International Association of Lighting Designers, and United Scenic Artists Local 829.

CHAPTER 1

The Lighting Design Profession

“Architecture is the correct and magnificent play of forms brought together in light.”

Le Corbusier

Without light there is no vision. Without light we cannot see the work of the architect, interior designer, and others who have contributed to creating a beautiful building. Add enough light to enable vision and we can see the shapes of the architecture and the colors of the materials, although perhaps not see them well. Add thoughtfully designed light, however, and it reveals the beauty of the architecture’s forms and rhythms, and the subtle colors and textures of the materials. Light embraces and unifies the other elements of the space. Light directs our attention to important features and allows us to see our work with comfort and ease. It is the finishing touch on the overall experience that the owner and designers have sought to create. This is the work of a professional lighting designer.

The lighting designer Richard Kelly expressed this when he said, “Visual beauty is perceived by an interplay of . . . light. . . . It is therefore of first importance to plan lighting whether creating a new structure, altering an old or making existing conditions tolerable. By the judicious and artful control of [light] you can make an imagined water-color rendering become the real thing, become your idea of the beauty of architecture or decoration . . . light [can] make it easier to see, make surroundings safe and reassuring and stimulate the spirit. . . . To play with light is like playing with magic and is best done with a trained eye to recognize real and relative values, with experience and knowledge of physical techniques.”¹

Every building needs light, although not every building’s design team will include a lighting designer. Some estimates suggest that less than 10 percent of construction or renovation design teams include a professional lighting designer. The reasons range from the owner’s lack of understanding of what a lighting designer adds to a project to the architect’s desire to keep fees low with the belief that other team members can take care of the lighting just as well as a lighting designer. The “others” who may provide some or

¹Excerpt from “Lighting’s Role in Architecture,” *Architectural Forum*, February 1955. pp 152–153.

all of the lighting design include the architect, interior designer, electrical engineer, electrical contractor, and lighting salesperson. While they each have something to contribute, lighting design is not their primary field, making it is more likely that they will not have the basic and continuing education of a professional lighting designer, that they will not be current with new technologies, and that they will not be skilled in the broadest range of lighting techniques.

These other professionals act as lighting designers because the practice of lighting is so young. The first independent lighting design firm opened in 1935. Compared to the centuries-old professions of architecture and interior design, specialists in light are new. However, as awareness of the importance of lighting increases, and as building codes place more requirements and restrictions on lighting, the need for knowledgeable, professional lighting designers is great and growing.

In this book we will be discussing lighting design as a distinct profession. We will look at the ways in which the lighting designer collaborates with the other design team members, develops the lighting requirements for a project, and applies tools and techniques to achieve a successful lighting design.

The Lighting Designer's Scope of Practice

A lighting designer is someone with the specialized education, knowledge, and experience to apply the art and science of lighting design to the places people occupy. The broad scope of the practice for lighting designers is generally agreed upon, although the details vary by project, organization, and contract requirements. Lighting designers, of course, must possess a great deal of knowledge and skill related to light and lighting, but they are expected to know so much more because their work must fulfill so many functions:

■ **visual task**

A vision related activity, such as reading a book.

Provide light that is appropriate for **visual tasks** by:

- Identifying visual tasks that are to be performed
- Determining light levels that are typically required for the visual tasks
- Considering factors that suggest the light levels be higher or lower than typical, such as occupant's age, then selecting the project's target light level

Design light that supports the room's aesthetics or environment by:

- Providing light of the appropriate brightness and color
- Defining zones, boundaries, links, and/or separation among spaces
- Using lighting techniques to expand or contract the perceived size of a room, indicate activity levels, and influence overall impressions

Create visual interest within the space by:

- Revealing objects, materials, and surfaces selectively and appropriately

- Using variations in **distribution** to emphasize important room elements/areas and deemphasize unimportant ones
- Applying decorative lighting techniques and decorative fixtures to create additional visual variety

Conserve energy, environmental resources, and the client's money by:

- Integrating **daylighting** into the lighting design where appropriate
- Choosing energy efficient light sources and optically efficient fixtures
- Selecting fixtures and lamps that offer the best value by weighing cost, quality, and performance
- Including controls as part of the lighting design for an added layer of energy savings

Comply with building codes and energy usage regulations by:

- Understanding the applicable building code(s) and designing within their boundaries
- Collaborating with the design team to select the best energy conservation strategy to meet or exceed the limitations of the applicable energy code
- Choosing and locating fixtures to comply with the Americans With Disabilities Act (ADA) and other relevant codes

A designer's contract with an architect, interior designer, or owner may have additional project-specific requirements, such as achieving target brightness levels for special applications. Likewise, a designer may limit the scope of work by excluding certain spaces (often spaces with low design requirements, such as stock rooms, loading docks, and electrical and mechanical rooms) or limiting attendance at meetings.

There are several professional organizations that have their own, slightly different, definitions for the role and responsibility of the professional lighting designer. For example, the International Association of Lighting Designers (IALD) cites the following tasks:

- Meet the illumination needs of the people who use the space
- Select cost-effective and energy-efficient products most appropriate for the project
- Create an innovative lighting solution that achieves the perfect balance of function and aesthetics
- Solve the unique lighting challenges of a wide range of interior and exterior environments
- Strengthen and enhance any space through creative, yet functional, lighting plans

Clearly, a lighting designer does so much more than just "light" spaces. The lighting designer is an equal member of the design team who uses his or her specialized knowledge to provide a design in light that meets the project's requirements while supporting and enhancing the work of the other design professionals.

■ **distribution**

The way light is spread over an area or throughout a space.

■ **daylighting**

The use of daylight as a significant source of light in a building.

Professional Lighting Design Credentials

Unlike architecture and engineering, lighting design is not a licensed profession. This is both good and bad. On one hand, it allows designers with a broad range of backgrounds, education, and experiences to enter the profession. On the other hand, it means that anyone can call themselves a lighting designer, regardless of their experience or education. In the past, most lighting designers began their career with an education and work history in one of three other professions—architecture, electrical engineering, or theatre lighting design. A fourth, and the newest, path is to enter the profession after completing an MA or MFA in architectural lighting design.

How do you establish yourself as a talented and knowledgeable lighting designer to potential employers or clients? The first way is by showing your work. Nothing says more about your skills and talents than the designs you've already created. Another way of demonstrating that you are serious about your profession is by holding one or more professional credentials. One form of a professional credential is membership in a lighting-related organization or society. For example, the IALD, mentioned earlier, is dedicated to the concerns of independent, professional lighting designers. The Illuminating Engineering Society (IES) is an organization with membership drawn from the entire range of professionals involved in lighting that includes designers, electrical engineers, lamp and fixture engineers, educators, and researchers.

Another type of professional credential is earned by passing a test of lighting knowledge. The National Council on Qualifications for the Lighting Professions (NCQLP) administers the most important of these, the Lighting Certified (LC) exam. Through a peer-review process, the NCQLP established the education, experience, and examination requirements for baseline certification for anyone involved in the field of lighting, including lighting designers, electrical engineers, architects, sales representatives, and lamp or fixture engineers. The exam, which tests for minimum knowledge and application of that knowledge, is regularly reviewed and updated. The exam content as of 2013 was in these areas:

- Survey/audit of existing buildings and lighting installations
- Design phase
- Financial and energy analysis
- Bid and negotiation phase
- Construction phase
- Operations and maintenance of lighting systems

LC professionals are required to recertify every three years to insure their knowledge of lighting applications and technology is current. Part of what makes the LC credential significant is that the U.S. Government's General Service Administration, the government's landlord, requires that the lighting design for all federal buildings be performed or supervised by a designer who holds the LC credential.

More recently, in 2010, the IALD established a task force to determine the scope of practice and eligibility requirements for a lighting design credential that is more stringent and represents a higher level of knowledge than the LC credential. In 2012 the task force announced the results of a worldwide survey that established seven “domains of practice” for architectural lighting designers:

Goals and outcomes—the design of lighting solutions that satisfy the project requirements and the design intent so the solution performs as predicted

Collaboration—the interaction with other disciplines by serving as an integral member of the team so that lighting relates to its context and adds value to the project

Ingenuity—the contribution of ideas that demonstrate innovation, creativity, originality, imagination, or resourcefulness to foster the goals of the project

Synthesis—the integration of the technical and aesthetic elements of lighting with space and form to shape and enhance the overall experience

Science—the demonstration of how light interacts with people, materials, and building systems by applying the principles of light to meet the relevant technical criteria

Stewardship—the response to known and potential social and environmental impact by designing solutions that avoid or minimize harm, discomfort, and waste

Human experience—the design of lighting solutions that positively affect people

The IALD has decided on a portfolio review format for their credential, but (as of mid-2014) has not announced a timeline for implementation. Readers should consult the IALD Web site, listed at the end of this chapter, for additional and current information.

Finally, the body of knowledge that lighting designers are expected to possess is constantly increasing and changing. As a result, continuing education is an important part of the lighting profession. Keeping up with lamp technologies and changes to building codes is the biggest issue, but sustainability, lighting applications and techniques, vision and psychology, controls, daylighting, and light’s affect on human health are all areas that require continuing education as well.

Online Resources

Illuminating Engineering Society, www.ies.org

International Association of Lighting Designers, www.iald.org

IALD Credentialing Task Force Mini-Site, www.iald.org/about/IALDCertificationNews.asp

National Council on Qualifications for the Lighting Professions, www.ncqlp.org



Designing with Light Resources

Wiley's companion site to *Designing with Light*, www.wiley.com/go/designingwithlight

Author's companion site to *Designing with Light*, www.designinglight.com

References

"About Lighting Design," International Association of Lighting Designers, accessed December 1, 2012, www.iald.org/design/index.asp.

"Candidate Handbook NCQLP Lighting Certification 2013," National Council on Qualifications for the Lighting Professions, Austin, 2013.

DiLaura, David et al., *The Lighting Handbook, Tenth Edition*, New York: Illuminating Engineering Society, 2011.

"IALD Credentialing Task Force Update," International Association of Lighting Designers, accessed December 1, 2012, www.iald.org/about/IALDCertificationOrgUpdate.asp.

"IALD Credentialing Task Force Update: Webinar on IALD's Action to Date to Develop an International Certification for Architectural Lighting Designers," by David Becker and Judy Hale Ph.D., June 30, 2013.

"NCQLP Scope of Practice and Services," National Council on Qualifications for the Lighting Professions, accessed December 1, 2012, www.ncqlp.org/about.

CHAPTER 2

Designing with Light

“Design must be functional and functionality must be translated into visual aesthetics, without any reliance on gimmicks that have to be explained.”

Ferdinand A. Porsche

What Is Lighting Design?

What is a lighting design? How do we conceive of, develop, and execute a design? What kind of framework underpins our design ideas? What criteria do we need to consider, and are those criteria the same for all designs, or do they change with different applications? These are the questions that get us talking about lighting design.

Let’s begin with a few introductory thoughts on design. First, design is as much a *process* of intellect and intuition as it is the *product* delivered at the end of that process. Second, design is exploratory and iterative. Some iterations lead to dead ends or undesirable outcomes. Others lead to refining the design and moving toward a beautiful solution to a problem.

Next, there is not a one-size-fits-all lighting design process. Some designs require careful attention to technical aspects of the lighting system, some designs have very strict illumination or energy consumption criteria, and other designs are exclusively about creating an evocative mood, atmosphere, or environment. Designers should understand a variety of design methods, and apply the most appropriate method or approach to each project.

Finally, the goal of every design is to create, in collaboration with the rest of the design team, an environment that is appropriate to the use and the users, and that meets the owners’ requirements of cost, project timeline, efficiency, etc.

To achieve a design’s goals, architectural lighting designers must have a thorough understanding of both the art of design and the technology used to create and control light. Some aspects of the design process can be organized into checklists, making them fairly easy to address. Other aspects require the lighting designer to understand architecture, interior design, and/or electrical engineering to integrate the lighting with the work of the rest of the team. The biggest challenge a designer faces is to connect a variety of elements into a comprehensive whole: to see beyond what is to what can be or to connect

abstract ideas to real world conditions and, in the process, add layers of intention or meaning to a design. In doing so, we transition from being illumination engineers, to lighting designers, to artists working with light.

There are many paths that a design might take. Each new project begins with exploring and understanding the requirements and expectations for that project, and then adopting an appropriate approach or strategy to develop and execute the design.

Beginning the Design

The first step in any design process is to gather relevant information so we can understand the requirements of the design. General questions will lead to more specific questions until we have a thorough knowledge of those aspects of the design that are required, those that are expected, and those that are desirable but optional. The following sets of questions are typical.

Questions for the owner and/or users:

- “What are your general expectations for the lighting design?” If there are general expectations, and there may not be, this is a good open-ended question to start the conversation.
- “What overall mood/image/feeling(s) do you want the space(s) to have?”
- “What are the activities that occur in each of the spaces?” This information is necessary to begin to establish illuminance (brightness) requirements for each space. This is covered in detail in Chapter 13.
- “Are you asking the design team to achieve any sustainability goals, such as a Leadership in Energy and Environmental Design (LEED) certification?” LEED and other sustainability programs are optional, and have more stringent requirements than building codes. Sustainability is covered in Chapter 15.
- “Do you have any existing facilities that we can tour? What aspects of the lighting do you like or want to retain? What aspects do you dislike, and why?”
- “What is the budget for the project?”
- “What is the timeline for the project?”

Questions for the architect and/or interior designer:

- “What are the applicable building, electrical, and energy conservation codes?” Codes set requirements and restrictions for our designs, and compliance is not optional. Codes are covered in detail in Chapter 14.
- “What is the site like? Do we have the flexibility to adjust the orientation of the building to take advantage of daylight?” In urban areas especially, there may be little or no flexibility.
- “What is the color palette? What is the materials palette?” These will influence the choice of warmth/coolness of the light and the methods used to illuminate some surfaces.

- “Which spaces are dedicated to an activity? Which spaces are flexible?” This will inform us about the need for flexibility in the lighting system.
- “What are your goals or desires for the overall mood/image/feeling of the space(s)?”

Questions for the electrical engineer:

- “Are there power limitations that are more stringent than the energy conservation code?” This question is especially relevant for renovations.
- “What voltage do you plan on providing for the lighting system?” Higher voltage is more efficient. 277V is a common voltage for the lighting system in larger, nonresidential buildings.

It is helpful to summarize the answers to these questions and keep them in one location for future reference. A project summary form is available for download at this book’s Web site.



With answers in hand we can begin to think about how to achieve the requirements and goals for illumination levels, aesthetic values, energy consumption, appropriate lamp and fixture types, control systems, and more. As we develop the design, additional, more specific, questions will present themselves. Questions, answers, ideas, and solutions (even dead-end solutions or those that later are found to be inappropriate) are all a natural part of the design process.

Let’s begin looking at lighting design by examining some ways of thinking about light itself, then move on to thinking about lighting fixtures, architecture, and space. We’ll see that many of these ideas overlap and intermingle in a completed design.

Thinking about Light

Design Elements of Light

A lighting designer selects lighting fixtures and lamps, and determines luminaire placement and quantity in order to control the light in each space to achieve the desired results. One framework we can use to consider our own work, or study the work of another, is to evaluate the controllable elements of light. Of course, we can’t control what we don’t know or understand, so the first question is, “What are the controllable aspects of light?”

Such a list might include brightness, color, direction, the technology used to produce the light, beam spread, illumination angle, beam edge softness/hardness, location and depth of shadows, and many others. To make this list manageable, we can reduce it to four design elements of light: intensity, color, distribution, and movement.

Intensity, or brightness of light in a space, is the most obvious controllable element. The desired intensity is determined by the designer, achieved by fixture quantity and fixture brightness, verified through calculations, and possibly adjusted on-site using a control system if one is part of the project.

■ **intensity**

The amount of light from a source or on a surface.

The brightness of a space affects our expectations about activity levels and overall experience. High illumination levels usually signal high levels of activity, public spaces, and lower product costs (such as in open office plans, fast food, and discount retailers). Lower illumination levels are subjectively associated with reduced levels of activity, higher levels of service, exclusivity, and higher product costs (such as in private offices, expensive restaurants, and exclusive stores).

As we've all experienced, brightness can also draw our interest and focus our attention. Theatre lighting designers use a followspot to draw our attention to the main character on the stage and hold it there. Brightness draws our attention in an architectural setting, too. For example, research has demonstrated that when given a choice of turning left or right at a "T" intersection, the brighter path is chosen 70 percent of the time or more. While light cannot replace signage, barriers, or architecture in controlling movement, we can use light levels to influence movement and the path that people take through a space.

■ **color**

The property possessed by an object of producing different sensations on the eye as a result of the way the object reflects or emits light.

■ **distribution**

The way light is spread over an area or throughout a space.

■ **movement**

A change in the intensity, color and/or distribution of light over time.

Color is another important element of light. Color considerations include the warmth or coolness of the light, how well it allows us to perceive the colors of objects, and whether to use white light or colored light to achieve a project's goals. Color is discussed in detail in Chapter 8.

Distribution refers to the way that light is used to fill a space. Is the light even from wall to wall, or are there areas of either higher or lower illumination, and, if so, why? Distribution is examined in Chapter 6.

Movement is probably the least obvious element of light and refers to a change of any of the other three elements over time. At a music concert the movement of the followspots and moving lights is obvious. In an architectural environment, movement is experienced in more subtle ways: changes in intensity, color, and distribution caused by changes in the daylight entering through windows; changes in intensity and distribution as a control system makes automatic adjustments; changes in intensity, color, and distribution as one walks from one part of a room or building to another. A thoughtful lighting design has considered all of these and minimizes or prevents unpleasant or inappropriate movement.

Richard Kelly's Three Forms of Lightplay

Of course, there are many other ways of considering the use of light as a design medium. The best known is a method developed and practiced by Richard Kelly.

Richard Kelly (Figure 2.1) was one of the great pioneers in the profession of architectural lighting and is often referred to as the "father" of architectural lighting design. He opened his professional practice in New York City in 1935, and over the next four decades worked on over 300 projects with most of the major architects of the mid-twentieth century, including Philip Johnson, Ludwig Mies van der Rohe, Louis I Kahn, I. M. Pei, and Eero Saarinen.

His study of architecture and theatrical lighting design, along with his professional experience, led Kelly to identify three forms of lightplay that became the basis of his

design approach: focal glow, ambient luminescence, and play of brilliants (Figures 2.2, 2.3, and 2.4). Over the years these distribution patterns and their descriptions have permeated the architectural lighting design profession. Today, they are universally understood and employed by many lighting designers. Here are Kelly's own words describing his ideas:

"Focal glow is the campfire of all time, the glowing embers around which stories are told, or the football rally bonfire. It is the light burning at the window or the welcoming gleam of the open door. Focal glow is the limelight of aphorism, and the followspot on the modern stage or the aircraft beacon. It is Klieglight on a theatre façade or flashlight on a stair. Focal glow is the sunburst through the clouds and the shaft of sunshine that warms the far end of the valley. It is the movie screen in the theatre, the pool of light at your favorite reading chair, your airplane seat light. Focal glow is the end of the rainbow. The attraction of focal glow commands attention and creates interest. It fixes the gaze, concentrates the mind and tells people what to look at. It sells merchandise. Focal glow separates the important from the unimportant. It establishes precedence, can induce movement, and direct and control traffic. Focal glow can help people see.

"Ambient Luminescence is a snowy morning in the open country. It is twilight haze on a mountaintop, or a cloudy day on the ocean. It is underwater in the sunshine, or in a white tent at high noon. Ambient

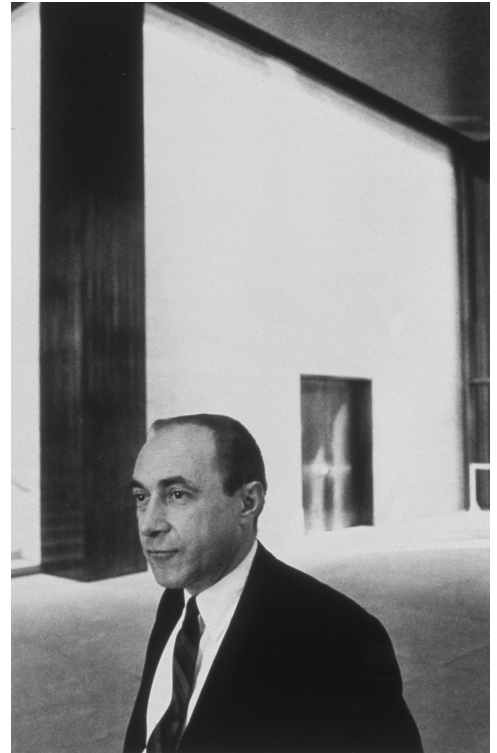


Figure 2.1 Richard Kelly (1910–1977).
Courtesy of Estate of Richard Kelly.



(a)

Figure 2.2 Focal Glow.

2.2a Courtesy of Ed McCarthy, 2.2b Courtesy of Studio T+L, LLC.



(b)



(a)



(b)

Figure 2.3 Ambient Luminescence.

2.3a Courtesy of Paul Bartlett, 2.3b Courtesy of R2Architects.

luminescence is the full cyclorama of the open theatre and a brilliantly lighted room without visible lights. It is vaporous light and all we can sense of indirect lighting. Ambient luminescence minimizes the importance of all things and all people. It fills people with a sense of freedom of space and can suggest infinity. It is usually reassuring and restful. The background of ambient luminescence is created at night by fixtures that throw light to walls, curtains, screens, ceilings, and over floors for indirect reflection from these surfaces. A background of ambient luminescence is created by using light colored walls, curtains and ceilings as part of the lighting fixtures. Even light carpet has reflecting surfaces to light.

“The Play of Brilliants is the aurora borealis. It is a cache of diamonds in an open cave or the Versailles hall of mirrors with its thousands of candle



(a)



(b)

Figure 2.4 Play of Brilliants.

2.4a Courtesy of Paul Bartlett, 2.4b Courtesy of Ed McCarthy.