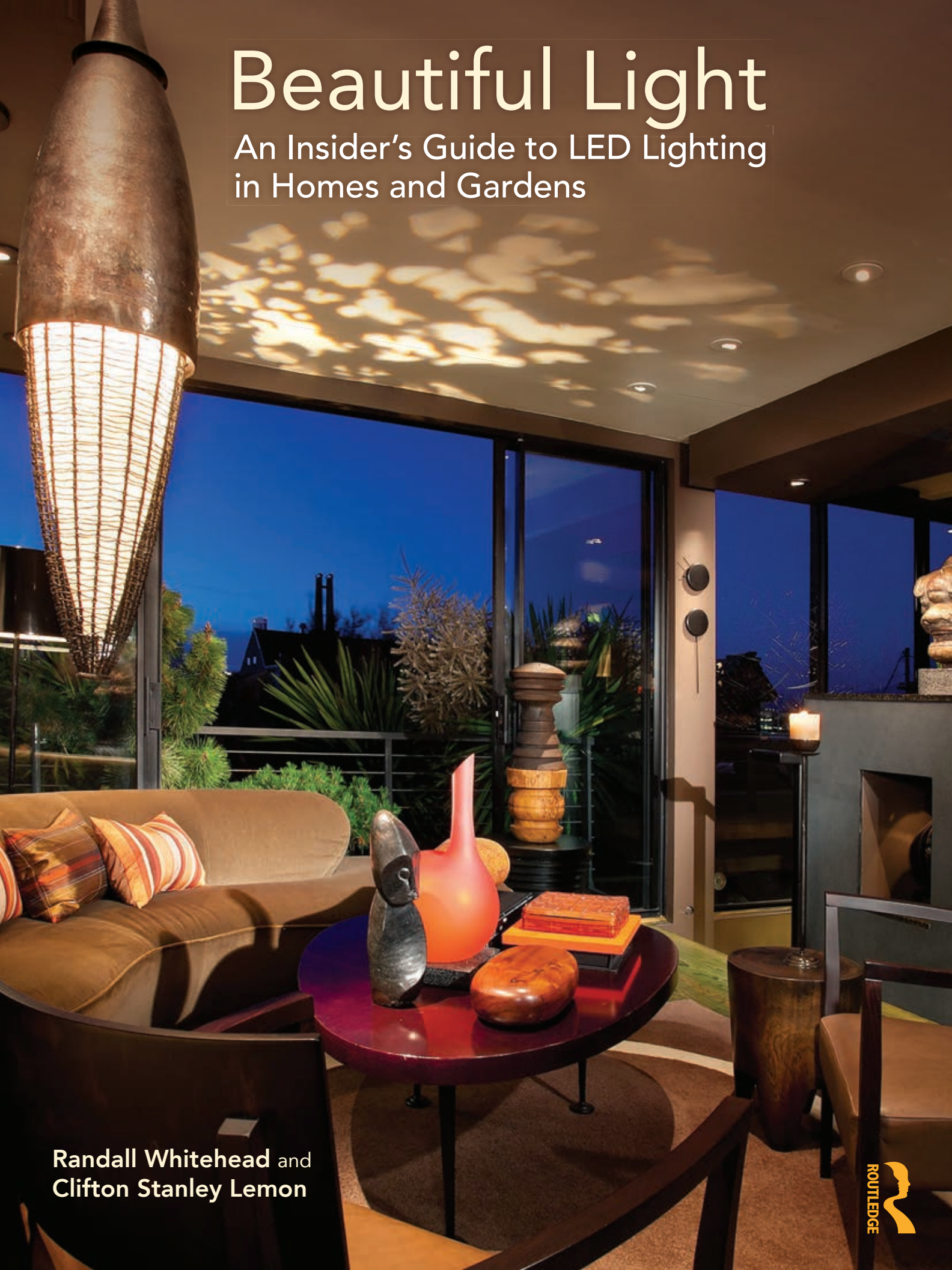


Beautiful Light

An Insider's Guide to LED Lighting
in Homes and Gardens

Randall Whitehead and
Clifton Stanley Lemon

ROUTLEDGE



Beautiful Light

Beautiful Light by internationally acclaimed lighting designer Randall Whitehead and lighting industry expert and educator Clifton Stanley Lemon is a combination of idea book, design resource, and product guide. It explores the transition in residential lighting from incandescent light sources to LEDs, and how to apply LED lighting with great success.

It begins with the fundamental characteristics of light, including color temperature, color rendering, and spectral power distribution, and how LEDs differ from older light sources. Combining innovative graphics with the enduring design principles of good lighting, the book explains how to design with light layers, light people, and balance daylight and electric light. Every room of the house, as well as exterior and garden spaces, is addressed in 33 case studies of residential lighting with LEDs, with a wide variety of lighting projects in different styles.

Showcasing over 200 color photographs of dramatic interiors beautifully lit with LEDs, and clear, concise descriptions of design strategies and product specifications, *Beautiful Light* helps both professionals and non-professionals successfully navigate the new era of LEDs in residential lighting.

Randall Whitehead is one of the foremost authorities on residential lighting and has written six books on the subject. *Beautiful Light* will be the seventh. His work has appeared in many publications including *Architectural Digest*, *House Beautiful*, *Esquire*, *Horticulture*, and *Architectural Record*. He writes a monthly column for *Furniture, Lighting and Décor Magazine* called "The Lighting Doctor" where he discusses lighting trends and addresses lighting dilemmas. He has given presentations for LightFair, LightShowWest, Strategies in Light, the American Society of Interior Designers (ASID), the American Institute of Architects (AIA), the National Kitchen and Bath Association (NKBA), the American Lighting Association (ALA), and the Illuminating Engineering Society (IES). He has also appeared as a guest expert on HGTV, the Discovery Channel, CNN, and Martha Stewart Living Radio.

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Clifton Stanley Lemon

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Foreword

We wrote this book in order to help designers, architects, and homeowners improve the lighting of their residential and landscape projects by sharing the techniques of well-integrated lighting design and light layering.

Even though for the past ten years or so we have gotten used to the exciting new technology for lighting – Light Emitting Diodes (LEDs) – the fundamental principles of good lighting haven't changed. What's happened instead is that LEDs, when selected and used correctly, can do everything incandescents could do even but better, while saving energy and lasting longer. They even allow us to do new fabulous things with light we never imagined before.

This is a learning look-book. We begin by showing you the principles of good lighting design, and even some examples of what not to do, then provide profiles of residential projects in different styles. In each of these we explain how the look was accomplished, what components were used to create the effects, and how the different layers of light interact to create Beautiful Light.

Introduction

The basic premise of *Beautiful Light* is threefold: first, we explain the transition in residential lighting that's taken place over the last fifteen years or so – from incandescent light sources to LEDs (light emitting diodes) Second, we provide some grounding in the fundamental qualities of light as they relate to residential lighting. And third, we will show how LEDs can be applied with great success, following the enduring design principles of good lighting.

The transition from incandescent and fluorescent lighting to LEDs was relatively rapid, but it's notable in that it was the first such change in technology since fluorescent light sources emerged in the 1940s. The incandescent lightbulb was invented and brought into widespread use in the late nineteenth and early twentieth centuries, and fluorescent light sources did not see the wide adoption in residential use that was expected, due to poor light quality. In essence lighting innovation has been extremely slow in terms of the pace of innovation technology compared to almost every other area of technology in the past century or so. Another notable characteristic of the LED revolution is that the shift in energy efficiency from incandescent lightbulbs to LEDs has been dramatic – on average, energy use for lighting has dropped to less than 20% of what it was before LEDs. This is largely a success story, because while early LED products were of poor quality, mature LED products now offer not just equal, but better quality than fluorescent and incandescent light sources. They also bring many other benefits, including longer lifetimes, flexibility, and affordability.

Beautiful Light is a practical guide to interior and exterior residential lighting, focusing on our combined understanding of the basic art and craft of residential lighting design, developed from over four decades of professional design practice – in Randall's case lighting design and writing, and in Clifton's multidisciplinary design, writing, and education. The two of us have collaborated on lighting books for many years. We don't claim to present the definitive theory for or approach to residential lighting – the field of lighting design is still young, and there are many true masters of lighting design all over the world (several of whom we count as dear friends and colleagues), with their own styles and finely honed practices. We do share with most of the best practitioners the belief in a well-balanced layering of light from various sources to shape spaces in the built environment, give them meaning, and make them inviting, nurturing, sustainable, and safe. Some designers may refer to what we call "light layering" by different terms, postulate more or fewer layers, or offer varying approaches. Many of today's lighting designers also believe in lighting people first, although this is less common. Randall has always been one of the leading proponents of this approach, probably because of his origins as a photographer, an art form

where lighting faces correctly is crucial to success. We think of this as the original “human centric” lighting.

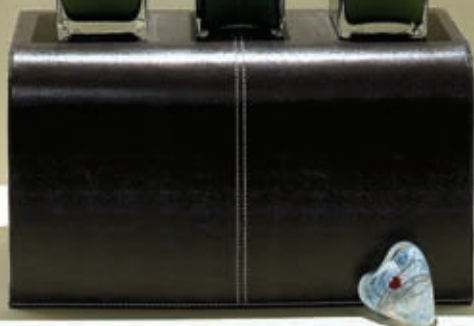
Our book is not meant to be a detailed technical manual for electrical engineering, lighting calculations, or lighting controls, as there are many excellent sources for this information, some of which are listed in the bibliography. We do provide an index of useful technical design and installation details used in many of the projects. We focus on residential lighting design, as this comprises Randall’s main expertise, and applies to an increasing variety of building types, including multifamily structures. But we don’t cover commercial or industrial lighting – there are many excellent sources that focus on these applications. We also do not delve too deeply into the more theoretical aspects of light and lighting, as this direction is a path that is long, fascinating, and complex – but still tangential to a working understanding of basic craft. The more you learn about the physics and science of light, color, perception, and behavior, the more you realize that each is a main branch in the trunk of knowledge, and worthy of entire research disciplines. With all the different technical developments and advancements in myriad scientific fields, in many ways we’re just at the beginning of understanding the interrelationships between light, color, biological processes, and behavior. We cannot even begin to claim a deep understanding of, for instance, circadian processes, quantum physics, and neuroscience – all, by the way, fields eagerly embraced by many leading innovators in the lighting industry.

Beautiful Light is intended for an audience with one thing in common – the need to understand how to use LEDs in residential lighting following the time-honored design principles of light layering and lighting people. Within this purview are three basic groups – students, practicing design professionals, and homeowners. For students, most design programs in educational institutions today don’t yet include much in the way of lighting courses, and it’s fairly typical for those studying interior design, architecture, landscape design, or electrical engineering to be offered only one or two courses on the subject in their entire course of study: this book is intended to serve as a resource for these kinds of courses. For practicing design professionals, including lighting designers, *Beautiful Light* is a fundamental introduction to residential lighting design and a source of new ideas. For homeowners, the book will serve as a strong introduction, an idea book, and a guide to working with design professionals or for doing your own design and installation to the extent that you are comfortable and capable.

A few notes on terminology we use throughout the book are in order here. When referring to fixtures and lightbulbs we use the industry insider terms “luminaire” for fixture and “lamp” for lightbulb, unless we’re talking about a floor lamp or bedside lamp. Most LEDs are not bulbs at all, and only imitate incandescent forms so they can fit in existing luminaires originally intended for incandescent bulbs. When we refer to the old-fashioned non-LED light sources (except for CFLs, compact fluorescents, which in our opinion have no real place in good residential lighting), which are all lightbulbs, we use the terms “incandescents” and “halogen,” which is a specialized form of incandescent bulb. When we refer to color rendering we do not as a rule use the term CRI (Color Rendering Index) exclusively, as there are

► **Figure INT.1**

Photo and Lighting Design:
Randall Whitehead.



now metrics for color rendering that differ significantly from CRI, although CRI is still the standard term for most lighting designers, and manufacturers. When referring to electrical power we use V for volts and W for Watts, as in 12V, 75W. When referring to color temperature we often use CCT (for Correlated Color Temperature), and express the measurement with the number followed by K, as in 2700K, where K is understood as “degrees Kelvin.”

We limit our theoretical approach more to aesthetic, cultural, behavioral, and historical considerations. We know from long experience what people in residential settings prefer, how they are inclined to behave, and what makes them look and feel their best.

Randall Whitehead
Clifton Stanley Lemon

► **Figure INT.2**

Photo and Lighting Design:
Randall Whitehead.



Part I

The Story of Beautiful Light

Overview

This section is the story of how we've come to integrate the relatively new technology of solid state lighting (LEDs) into our traditional design practice of architecture, interior, and lighting design. While the transition from incandescent and fluorescent to LEDs has not been without bumps in the road, we show how it's possible to strike a beautiful balance between natural daylight and electric light in residential design today, and that LEDs are perfectly suited to the task – in many, if not most, ways they're superior to the older lighting technologies.

It's true that technology never seems to want to stop evolving, and we will certainly see more improvements to LEDs. But for now we're no longer in the adoption phase of the technology where we're waiting for high quality products to become affordable or practical. Many of the advances in the near future are likely to be incremental rather than revolutionary, and this is not a bad thing. Designers as craftspeople need time to get used to their tools stabilizing so that they can develop best practices.

A key idea in our understanding and practice of residential lighting design, and one that we repeat many times in this book, is the focus on lighting people and skin. The location in the home where this is most critical is in the bathroom, at the vanity. Architects and interior designers don't have much control over their clients, the human beings who inhabit the spaces they design, so they care mostly about the things they do control – the materials, finishes, furniture, and colors in the environment. Subsequently lighting designers, who are largely following the lead of architects and interior designers, often forget about lighting people. Truly human-centric design is a holistic process of making people look better throughout the day and into the evening, not only at the vanity, but in all rooms of the house, in the context of fabrics, furniture, food, finishes, and materials.

In this section we review the basic properties of light and the techniques and tools in the lighting designer's palette: light layering; types of lamps and luminaires; controls. We also talk about how to do this sustainably and as part of an integrated and collaborative design team.

Finally, we've learned that studying lighting fails is one of the best ways to learn to "see" and create good residential lighting, and we provide many very typical examples of lighting as an afterthought to what is often very good residential design. Once you've learned to identify the common mistakes, you'll be in a much better position to transform your clients' (and your own) spaces with beautiful light.

► Figure SBLO.1

Photo and Lighting Design:
Randall Whitehead.



Chapter 1

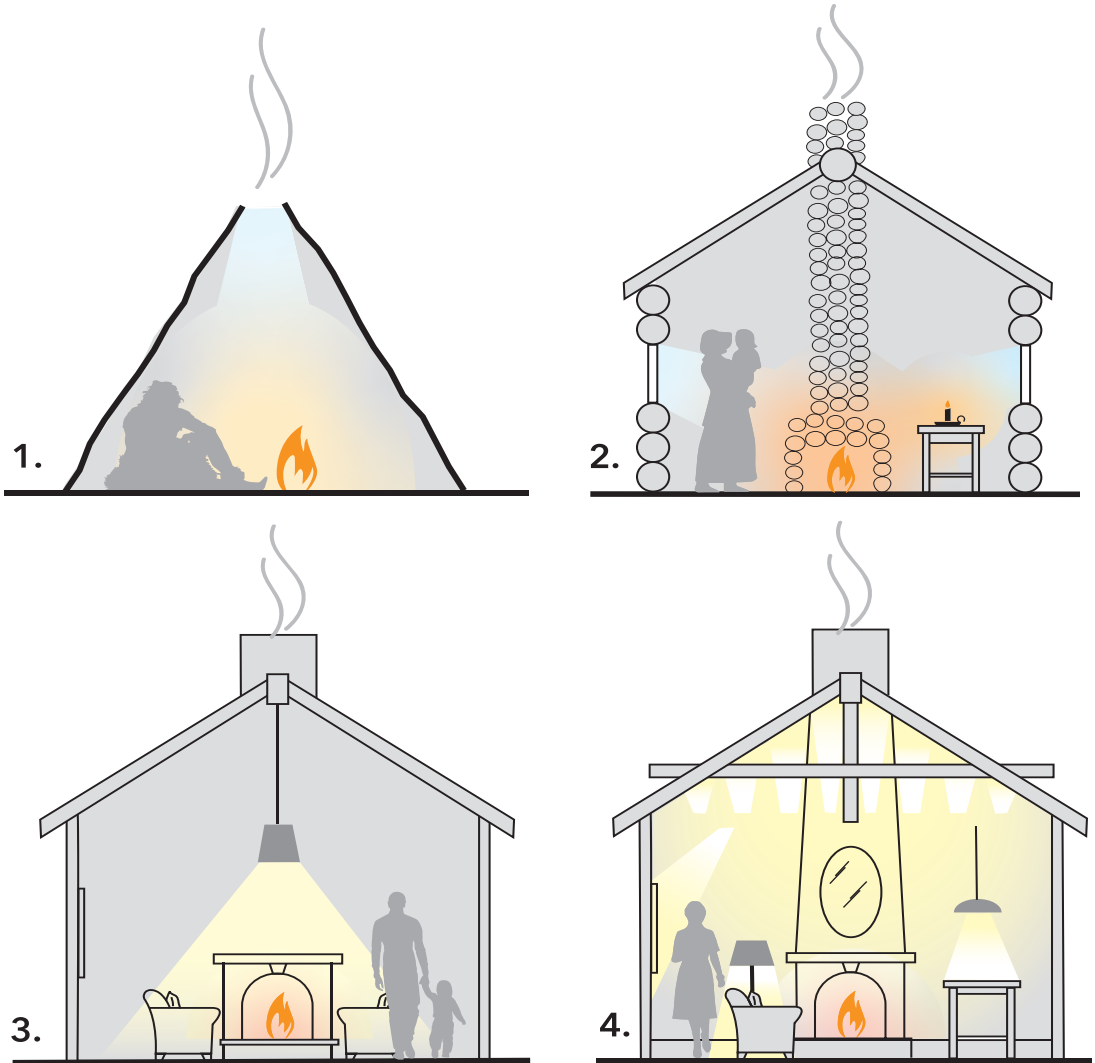
Evolution of Interior Lighting

In order to explore the evolution of lighting in the home we start with a brief examination of our modern Western concept of the home, the archetypal structures that embody it, and how they evolved. Even though the ideas of family and, indeed, “home” are fluid social and cultural constructs and are constantly shaped by the combined forces of technology, economics, and urbanization, for the purpose of focusing our discussion to perhaps the most commonly understood model in the United States today, we’ll talk about the single-family home. Whether single- or multi-story with detached walls on a separate plot of land or as part of a larger multi-family building, this layout is typically comprised of a collection of single purpose rooms – living room, dining room, kitchen, bedrooms, bathrooms, multipurpose open plan rooms, miscellaneous utility rooms, and outdoor spaces. This particular arrangement has not been the norm for the majority of human history.

The most primeval dwellings made use of shelter to mitigate, and harness, the effects of the environment. Our basic physiological needs demand a roof over our heads and walls to create an envelope for protection from the elements, predators, and enemies and a place for fire, gathering, and preparing and consuming food. A completely dark enclosure is not useful. One of the earliest innovations was an opening in the top of a hut, tipi, or other enclosure that not only let in daylight but allowed for the exhaust of smoke and fumes from the cooking fire and oil lamps which were necessary to dispel the darkness.

Before advanced lighting technology (candles, gas lamps, then electric lights) humans evolved under conditions of light that centered around the daily rhythms of sunlight during the day and firelight at night. It’s easy to imagine that our visual equipment –our eyes and brain – are hardwired for these two conditions and the transitions between them. Indeed, vision science has identified parts of the eye – rods and cones – that process light at different levels. There are three kinds of vision: scotopic vision, or night vision, which uses only rods to see (objects are visible, but appear in black and white); photopic vision, or daytime vision, which uses cones and provides color; and mesopic vision, the in-between vision, which we use most of the time in mid-level light conditions.

As tribal groups grew in size and complexity, communal dwellings evolved that were organized around a central fire. People all slept in the same large lodge or room, along with the dogs. Light was provided by oil lamps, fire, and openings which were often no more than holes in walls or ceilings that let in light and air and allowed smoke to escape.



▲ Figure 1.1

Four stages of complexity in the evolution of interior lighting: 1. Sky light and firelight in a primitive hut. 2. Sky light and firelight in a log cabin with small windows. 3. Single source ceiling lighting in a modern home. 4. Balanced layers of light: ambient, task, accent, and decorative. Illustration: Clifton Stanley Lemon.

Our current arrangement of single purpose rooms seems to have begun in 12th century Northern Europe with the innovation of the chimney. This was the era of a mini Ice Age, and temperatures were much colder than what we're experiencing today. Chimneys allowed multi-story buildings to share distributed heat from one shaft. This hastened the development of smaller rooms which were more economical to heat, which contributed to the modern idea of domestic privacy – a “room of one's own,” so to speak. Windows in these buildings were expensive and were sometimes glazed with thin sheets of animal horn, a material also used for lanterns.

The ancient Romans had developed advanced glass manufacturing methods that made glass windowpanes affordable for many buildings by 200 CE, but this technology was lost during the Dark Ages between 400 and 800 CE. In the 14th century however, French glassmakers perfected the technology of making flat panes of transparent glass, which were initially small and required assembly in lattices or window frames. Gradually window openings became larger and allowed buildings to make more use of daylight. Before gas and then electric light, an architectural tradition had developed that made skillful use of buildings' volume, surfaces, and windows to modulate daylight for lighting the home. In fact, an archaic architectural term for windows is “lights.”

At night though, interior lighting for most homes consisted of fires, candles, and eventually more sophisticated lamps using oil and kerosene. The next lighting technology revolution was gas lamps, which produced a much brighter light and began to dispel darkness at sufficient levels to extend working hours and, along with many other rapidly evolving technologies, impact forms of social organization and family structure. Ingenious devices were invented that multiplied the fragile, precious light as much as possible – chandeliers for instance were devised to amplify candlelight and were a great status symbol as only rich people could afford candles in medieval times. The forms of these luminaires persisted long after fossil fuel-based lighting gave way to electric lighting. Also, all fuel-based lighting produced noxious, unhealthy fumes and coated interior surfaces (and lungs) with soot and other chemical deposits.

When electricity as a distributed power source emerged in the 19th and early 20th centuries, electric lighting was the first application of this groundbreaking new technology. The cost and effort involved in running power lines from the local coal gas burning power plant to the home meant that typically only one light per room was feasible, and it was placed in the center of the room in the ceiling. This remains a default lighting strategy in many homes today, even though it's entirely inadequate for providing a well-lighted environment.

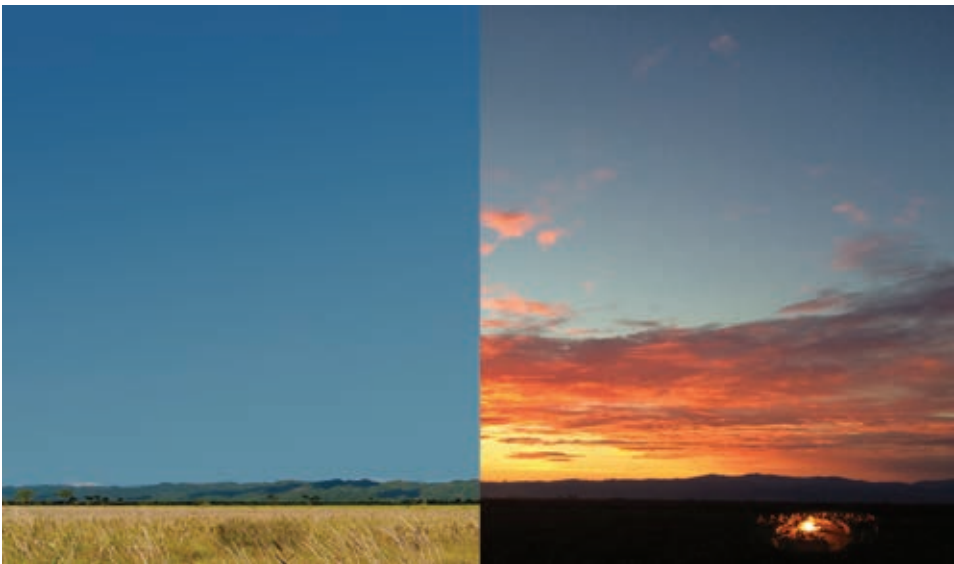
As electric lighting expanded and became ubiquitous in residential use throughout the 20th century, the modern practice of lighting design was born, exemplified by designers like Richard Kelly, who articulated the theory of light layers. Even though electric incandescent light had technical limitations we no longer have today with LEDs, designers like Kelly established a solid methodology that involves identifying the various purposes for types of lighting and blending them carefully into an integrated whole.

What LEDs have done is allow us to use the light layering approach to much greater advantage, with better light that is much more efficient, lasts longer, and can be applied easily in more locations than ever before. It also allows us to improve lighting so that people look and feel better – this is the most important benefit of beautiful light with LEDs.



▲ Figure 1.2

This home shows a well calibrated balance between cooler daylight and warmer electric light in ambient, accent, and decorative layers. Photo: Dennis Anderson, Lighting Design: Randall Whitehead.



▲ Figure 1.3

What we call the skyline/fire line theory of lighting says that humans evolved to see brighter, cooler ambient light (sky light) from above and warmer light (firelight) from below. Photos: Clifton Stanley Lemon.

Chapter 4

Lighting People

We believe that our first principle of residential lighting – lighting people – is the real “human centric lighting.” It’s not only about how light makes you feel but about how it makes you look (of course the two are obviously connected). But we are definitely in the minority – most people, including lighting designers, architects, interior designers, and homeowners, only conceive of lighting as something that illuminates furniture, art, finishes, and materials – all the stuff we are keen to show off in order to demonstrate our exquisite taste and confer status! The best designers have an intuitive understanding of the fact that for better or (usually) for worse, the need for status trumps almost all other human drives. This frequently results in poor quality lighting that can ruin an otherwise beautiful architectural, interior, or landscape design.

Few lighting designers today are trained from the beginning in lighting design, as the profession is relatively young and does not yet have a large academic infrastructure behind it. Most study architecture, engineering, and theatrical design, and a few study photography. It’s the designers with theatrical or photography backgrounds that best understand lighting people. Many top lighting designers consider Stanley McCandless to be the father of modern lighting design and have been strongly influenced by his work, which includes one of the seminal works on the theory of stage lighting. Many valuable lighting lessons come from the theatrical tradition, where the actor’s ability to communicate emotion relies strongly on the face.

The effects of lighting on people are almost never considered by architects and interior designers. Single source lighting is dramatic for lighting objects but is not flattering for faces. Harsh shadows distort the face and can make people look scary or unfriendly, even when they’re not, as in the first example in Fig. 4.1 with downlights only, unfortunately a “default” condition favored by architects as fixtures are recessed into the ceiling and preserve the clean lines of spare, modernist design. Gentle fill light softens shadows and makes people look better, which is why it’s used traditionally in photography and film.

Illuminating humans – especially faces – presents several specific technical challenges, many of which have been successfully met by fashion photographers and theatrical designers for decades or centuries. The areas where most of the problems lighting people happen are 1) direction and balance; 2) color rendering; and 3) color temperature.

► Figure 4.1

The same person lit from different angles: 1. Downlight only, 2. 45° side light, 3. Cross-illumination (Vanity), 4. Even ambient, 5. Even daylight, 6. Harsh side light, 7. Candlelight, 8. Backlit by window. Photos: Randall Whitehead.



Direction and Balance

The same person can look dramatically different under different lighting conditions. When the face is lit with direct overhead light only, harsh shadows appear under the eyes and in other areas of the face, an unflattering effect at best. In full backlit conditions, unmitigated glare from daylight or other sources can obliterate the face. Ambient light softens the face and makes it much more appealing. Well-executed vanity lighting provides cross-illumination that renders the face at its best for the activities focused on attending to it – doing makeup and shaving. Balancing directional and ambient can shape the face and give it character.

Color Rendering

One of the best reasons to use high color rendering LEDs is that they render the tones of skin, hair, and eyes much more accurately and naturally. In choosing LED light sources, narrow your options. CRI is the only current metric for color rendering you can find, but it's not always accurate. Use your own judgment and test everything before you specify and install.

In Fig. 4.2, which shows shots taken in a specially designed photography studio setup, the women's faces are lit with two different 3000K LED light sources – on the left low color rendering (80 CRI, 80 R9), and on the right high color rendering (95 CRI, 95 R9). In real life we never compare light sources like this, and in this direct side-by-side comparison the low color rendering appears somewhat sickly and greenish. This simply demonstrates that our eyes



◀ **Figure 4.2**

The effect of high color rendering light sources on skin. On the left the subjects are lit with a 3000K 80 CRI LED, on the right with a 3000K 95 CRI LED. Photos: Russel Abraham, courtesy Soraa.

are very good at detecting subtle but powerful color differences. The dramatic comparison emphasizes what we're really missing with poor color rendering in LEDs. In our experience, we've found that this is still not widely understood, and even the cosmetic industry doesn't recognize it to the extent you might expect, as evidenced by the lighting in a typical department store cosmetic counter.

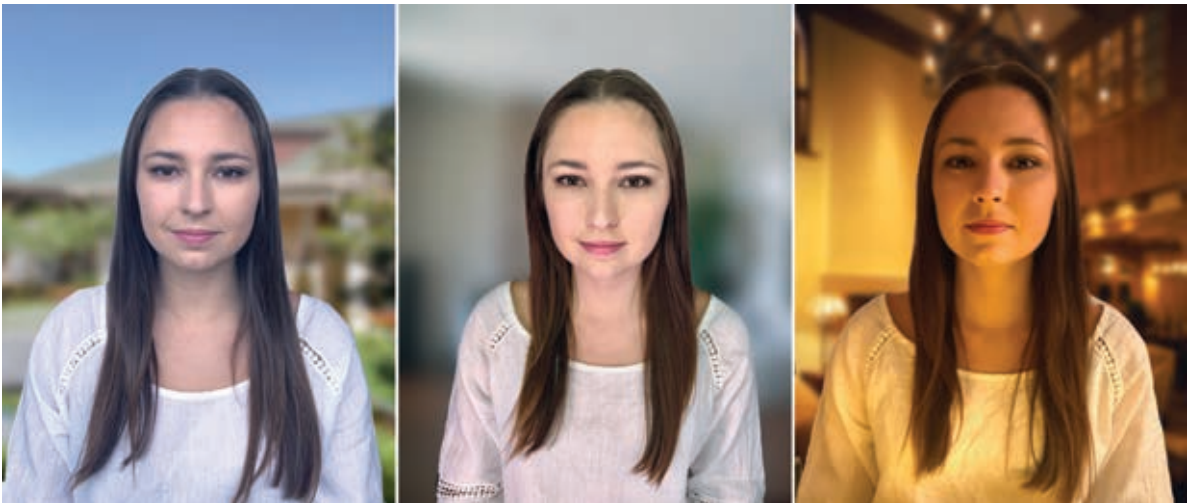
When lighting people you want everyone to look as good as possible. A subtle rosy glow that suggests a few hours outside in the sun enjoying yourself is flattering to most skin types, and all benefit from optimal color rendering.

▼ **Figure 4.3**

Left: 4000K for daytime use. Middle: 3000K for vanity lighting. Right: 2400–2700K for evening use. Photos: Randall Whitehead.

Color Temperature

Choose the temperature that's best for the use of the room – if it's used mostly at night, warmer temperatures are better, if during the day, cooler.





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Randall Whitehead



Clifton Stanley Lemon