

Introduction

Every cubic inch of space is a miracle.

Walt Whitman, *Leaves of Grass*, "Miracles"

WHAT THIS BOOK IS ABOUT

This book is meant to serve as a primer on space planning for rooms and spaces in a home. Related information regarding codes, mechanical and electrical systems, and a variety of additional factors that impact each type of room or space is also provided. In addition, this book includes information about accessible design in each chapter in order to provide a cohesive view of residential accessibility. This new edition includes updated 2015 International Residential Code information and additional updates.

Intended as a reference for use in the design process, this book can aid in teaching and understanding the planning of residential spaces. Most chapters follow a similar format, starting with an overview of the particular room or space and related issues of accessibility, followed by information about room-specific furnishings and appliances. Chapters continue with information about sizes and clearances, organizational flow, related codes and constraints, and issues regarding electrical, mechanical, plumbing, and basic lighting.

This book is meant to aid students and designers in understanding the amount of space that is minimally necessary in order for rooms to function usefully. Examples of larger spaces are also given, but at its heart, this book is intended to show students how to use space wisely and make good use of space throughout the dwelling. With clear knowledge about minimums, designers and students of design can learn when it is appropriate to exceed such standards for a variety of reasons that reflect specific project criteria based on client needs, budget, site, and other constraints.

This book is intended as an introduction to the topics covered with the aim of familiarizing the reader with the basic concepts so that he or she might move forward in design education or on to additional research in certain areas. To that end, an annotated references section is provided at the end of each chapter. Thinking of the information provided in each chapter as basic building blocks that allow for the discovery of the issues involved is a helpful approach in using this book (Figure 1-1).

There is much that goes into the design of a dwelling that is not covered in this book; our intent is to focus on the use and

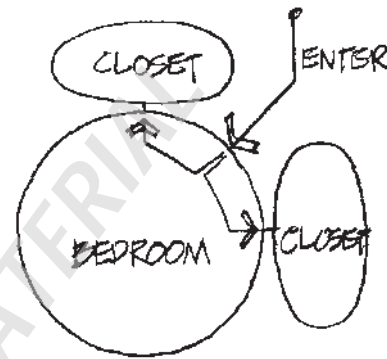


Figure 1-1 This book covers the design of houses using a basic room-by-room approach.

design of individual rooms (again, a building-block approach) so that the reader will have the core information required to understand the design of these individual spaces. This basic informational approach may bring up questions about the role of the interior designer versus the role of the architect. Clearly, the design of the totality of the structure is the role of the architect (or engineer); however, in many cases, the interior designer is taking an increasingly larger role in the design of rooms and spaces.

Interior designers engaged in renovation work can take a lead role in the design of the interior architecture of a space, with a significant hand in the design of a room or many rooms. This is in contrast to notions of the interior designer as the person in charge of materials and furnishings selections only.

The authors believe that interior designers and design students must be well versed in the aspects of residential design covered in this book. For example, readers will note that the detailed kitchen and bathroom information contained in this book is applicable to remodeling as well as to new construction.

AN OVERVIEW: QUALITY AND QUANTITY

Readers may note that, throughout this book, the authors mention the evolution of the use of rooms, room sizes, and the growth of the overall size of the American home. It's worth noting that the authors have a bias toward careful consideration of the *quality* of design rather than the *quantity* of space in a given

home. We hope to make clear that the successful design of space requires careful consideration of the real needs of clients measured against budgetary, code, climate, and site restrictions—all of which require careful development of a project program prior to the beginning of the actual design of the project.

The last hundred years have brought dramatic changes related to the public perception of the design, furnishing, and size of the American house. According to the National Association of Home Builders (NAHB), the “typical” American house built in 1900 was between 700 and 1200 square feet (65 and 111 m²), with two or three bedrooms and one or no bathrooms. The average home built in 1950 was 983 square feet (91 m²), with 66 percent of homes containing two bedrooms or fewer. These earlier homes are quite a contrast to the 2736-square-foot (245-m²) average found in new single-family homes completed in the first quarter of 2015 (Figure 1-2).

The authors argue that a larger house is not necessarily a better house and that designing a house that works well on a functional level is more important than mere size in creating a useful and pleasant environment. Additionally, large single-family homes are currently out of the financial reach of many citizens, driving many into the rental market. Furthermore, such large single-family homes are seen by some as wasteful in a time when issues of sustainability are increasingly engaging many across the globe.

Consideration of housing size and use of related resources is not unique to this publication. Architect Sarah Susanka’s book *The Not So Big House* has proven very popular, helped many people consider quality over quantity of space, and had an impact on the design of many homes (1998). *A Pattern Language*, by Christopher Alexander and colleagues, an earlier book considered seminal by many, has at its core the notion that spaces should be designed for the way people really live and that good design can be accessible for all (1977).

The notion of seeking quality of design rather than quantity of space is shared by many, and yet larger and larger houses continue to be built to house very small family groups. This dichotomy suggests that two opposing popular views of space exist. Although the architect Philip Johnson was once quoted as saying “architecture is the art of wasting space,” clearly that was a bit tongue-in-cheek, and we concur more with Walt Whitman’s notion that “every cubic inch of space is a miracle”—or should be.



Figure 1-2 The average new home in the United States has grown in size over time—despite the fact that family size has grown smaller. However, larger is not necessarily better, and well-planned spaces need not be excessively large. Given land and construction costs, as well as environmental concerns, smaller houses may be a necessity in the future. Numbers for square footage shown do not include garage spaces.

Tiny Houses

While the average home in the United States has reached a new high in terms of square footage, the “tiny house” movement is gaining momentum. Roots of this approach can be found in the work of Jay Shafer, author of *The Small House Book*. Marianne Cusato, designer of the Katrina Cottages, has also been instrumental in igniting this movement. Cusato’s Katrina Cottages were 308 square feet (28.6 m²) and designed as an alternative to the FEMA trailers used to house people who had lost their homes in Hurricane Katrina. The financial crisis of 2007–08, the limited affordability of housing, and a growing interest in sustainability and energy efficiency have combined to create a wave of interest in micro-homes.

Current building and zoning codes can create obstacles to inhabiting these micro-homes. Most building codes require a residence to meet minimum square footage requirements, but micro-homes are often well under this size. Placing the structure on wheels allows the home to meet the legal definition of a recreational vehicle or camper. However, many communities have zoning regulations or laws prohibiting long-term occupation of campers on residential lots. Additionally, some RV parks do not welcome tiny homes. Currently there is an absence of clear legal status of these tiny homes, or legal limitations on their use. Given the growing interest in the concept and issues with affordability and efficiency of traditional homes, the legal landscape may change to become more accepting of this type of dwelling.

The remainder of this chapter covers issues that relate to housing and serve as an introduction to the concepts that are covered in each chapter. In addition, basic interior design graphics are covered as an introduction to chapter illustrations.

HUMAN BEHAVIOR AND HOUSING

Environmental designers—including interior designers—benefit from gaining an understanding of human behavior as it relates to privacy, territoriality, and other issues connected to

the built environment studied. Privacy can be defined as the ability to control our interactions with others.

According to Jon Lang, “The ability of the layout of the environment to afford privacy through territorial control is important because it allows the fulfillment of some basic human needs” (1987). Lang goes on to say that the single-family detached home “provides a clear hierarchy of territories from public to private.”

Lang also states that “differences in the need for privacy are partially attributable to social group attitudes.” He continues, “Norms of privacy for any group represent adaptation to what they can afford within the socioeconomic system of which they are a part.” From Lang’s comments, we can learn that the need for privacy is consistent but that privacy norms vary based on culture and socioeconomic status.

The notion of territory is closely linked to privacy in terms of human behavior. There is a range of theoretical work concerning the exact name and number of territories within the home. One, developed by Clare Cooper, describes the house as divided into two components: the intimate interior and the public exterior (1967). Interestingly, Cooper (now Cooper Marcus) later wrote *House as a Mirror of Self: Exploring the Deeper Meaning of Home* (1995), which traces the psychology of the relationship we have with the physical environment of our homes, and in which she refers to work being done by Rachel Sebba and Arza Churchman in studying territories within the home. Sebba and Churchman have identified areas within the home as those used by the whole family, those belonging to a subgroup (such as siblings or parents), and those belonging to an individual, such as a bedroom, a portion of a room, or a bed (1986). Figures 1-3a and 1-3b illustrate various theoretical approaches to territory and privacy.

The term *defensible space* was coined by Oscar Newman in relation to his study of neighborhood safety and refers to “a

range of mechanisms—real and symbolic barriers . . . that combine to bring an environment under the control of its residents.” Defensible space, as described by Newman, includes *public, semipublic, semiprivate, and private territories* (1972). Newman’s work includes studies of various forms of housing (single-family attached, detached, high-rise, etc.) and the influence of the building type and design on territoriality and safety.

While there is variety based on housing type, Newman defines public spaces as streets, sidewalks, and those areas near or adjacent to the dwelling not possessed by any individual. Semipublic spaces include those areas that may be publicly owned but are cared for by homeowners, such as planted parkways adjacent to sidewalks. Semiprivate spaces can include yards or spaces owned in association. (Some theoreticians include porches and foyers in this category.) Private territory is the interior of a home, fenced areas within a yard, or the interior of a student’s dorm room. Private interiors are seen as distinct from private exteriors in Newman’s work. In addition, Newman pointed to the need for some type of buffer between the public world and private interior.

In the years since Newman’s original work defining defensible space and related territories, his theories have come under some criticism; however, his work continues to have implications for planners, architects, and interior designers because taking these concepts into account in designing homes can help to create spaces in which residents feel safe and have genuine control over their immediate environment. See Figures 1-3a and 1-3b.

In *A Pattern Language*, Christopher Alexander and his colleagues describe territories as falling along an *intimacy gradient*, which is a sequence of spaces within the building containing public, semipublic, and private areas. The bedroom and bathroom are the most private, and the porch or entrance space the most public. Alexander writes, “Unless the spaces in a building

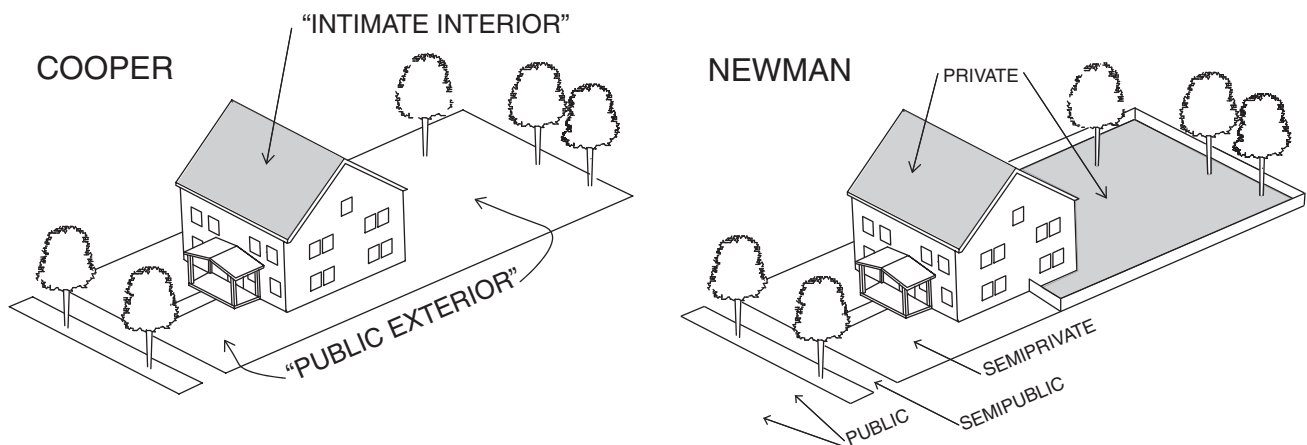
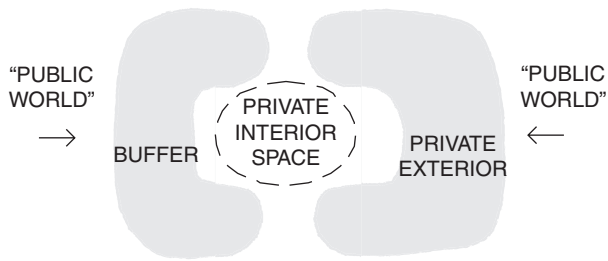
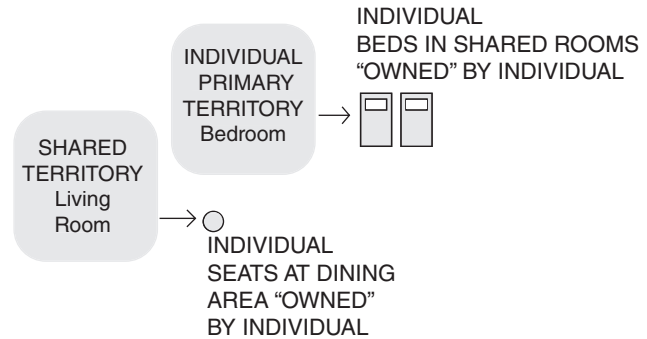


Figure 1-3a An illustration of territories as identified by theoreticians. Cooper identifies a public exterior and an intimate interior. Newman identifies public territories, which are not possessed or claimed; semipublic territories such as sidewalks, which are not owned but are seen as being possessed nonetheless; semiprivate territories, which are shared by owners or seen as being under surveillance by neighbors, such as front yards or shared swimming pools; and private territories, such as the private interior of a house or a fenced-in backyard.

NEWMAN



SEBBA AND CHURCHMAN



ALEXANDER et al. INTIMACY GRADIENT

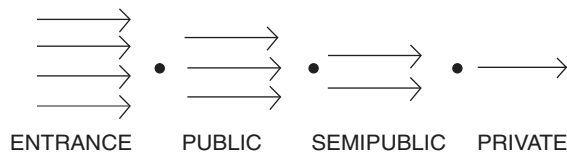


Figure 1-3b An illustration of territories related to interior space. Oscar Newman described the need for some type of buffer between the public world and private interior territories. Sebba and Churchman describe areas within a home that are used by all as “shared territory,” with limited privacy; “individual primary territories” are those seen as belonging to individuals, such as a bedroom, which becomes the private sanctuary of the individual. Alexander et al. describe an intimacy gradient, with the most public spaces related to the entrance leading to a sequence of increasingly private spaces.

are arranged in a sequence which corresponds to their degrees of privateness, the visits made by strangers, friends, guests, clients, family will always be a little awkward.” The intimacy gradient is shown in Figure 1-3b. Chapter 2 provides additional information about public and private spaces as they relate to entry spaces.

Personal space is a term introduced by Robert Sommer in the 1960s. According to Sommer, “personal space refers to an area with an invisible boundary surrounding the person’s body into which intruders may not come” (1969). See Figure 1-4a.

A similar-sounding term, *personal distance*, expresses a different concept and comes from work done by Edward Hall, an anthropologist who coined the term *proxemics*—for the “inter-related observations and theories of man’s use of space as a specialized elaboration of culture” (1966). Hall identified four distinct body distances or boundaries that people will maintain in varying social situations: *intimate* (0 to 18 inches [0 to 0.5 m]), *personal-casual* (1½ to 4 feet [0.5 to 1.2 m]), *social-consultative* (4 to 12 feet [1.2 to 3.7 m]), and *public* (12 feet [3.7 m] and beyond). Each of the four types of boundaries has a close phase and a far phase, as shown in Figure 1-4b. Hall found that while actual spatial boundaries vary based on cultural differences, the concepts of intimate, personal, social, and public distances are consistent cross-culturally.

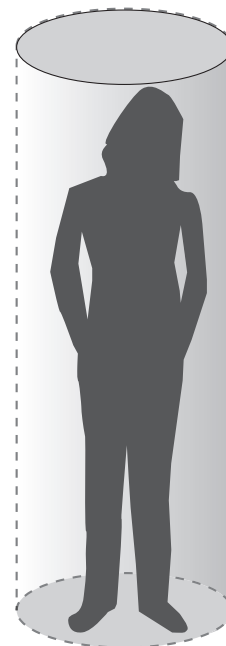


Figure 1-4a Sommer’s personal space, which “refers to an area with an invisible boundary surrounding the person’s body into which intruders may not come.”

Hall's term *personal distance* refers to the distance maintained between friends and family members for discussion and interaction, whereas Sommer's term *personal space* refers to the invisible, territorial boundary around each person. Similarly, Hall's *intimate space* is a "bubble" of space around a person that can be entered only by intimates, whereas *social-consultative spaces* are those in which people feel comfortable engaging in routine social interaction for business or in conversation with strangers. *Public space* is that where there is little interaction and people are generally comfortable ignoring one another; this distance also allows one to flee when danger is sensed.

Considering Hall's spatial boundaries can be useful for designers in planning living spaces. For example, most casual social interaction takes place within personal distances. Later portions of this book focus on specific room-related dimensional information for encouraging interaction and creating privacy. It is also worth noting that in designing public and commercial spaces that encourage interaction and help users attain privacy, the designer will find it helpful to reference the work of social scientists such as Hall, Newman, Lang, and others. For those seeking additional information about environmental psychology and the related work of other social scientists, the references at the end of this chapter include related bibliographic information.

AN OVERVIEW OF CHAPTER TOPICS

Generally, the remainder of this first chapter is organized in a manner that is similar to most of the following chapters covering individual rooms and spaces. This chapter serves as

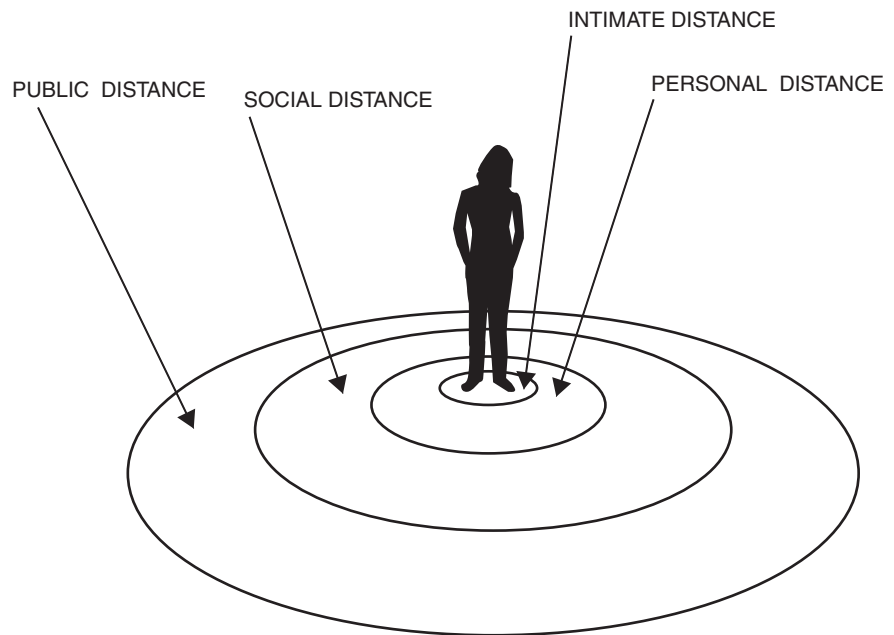


Figure 1-4b Hall's personal boundaries or body distances. Hall identified four distinct body distances or boundaries that people will maintain in varying social situations:

Intimate: 0 to 18 inches (0 to 0.5 m); *close phase* 0 to 6 inches (0 to 0.2 m), *far phase* 6 to 18 inches (0.2 to 0.5 m)
 Personal-casual: 1½ to 4 feet (0.5 to 1.2 m); *close phase* 1½ to 2½ feet (0.5 to 0.8 m), *far phase* 2½ to 4 feet (0.8 to 1.2 m)
 Social-consultative: 4 to 12 feet (1.2 to 3.7 m); *close phase* 4 to 7 feet (1.2 to 2.1 m), *far phase* 7 to 12 feet (2.1 to 3.7 m)
 Public: 12 feet and beyond (3.7 m and beyond); *close phase* 12 to 25 feet (3.7 to 7.6 m), *far phase* 25 feet (7.6 m) and beyond

an introduction to the definitions, concepts, and organizing principles that will be used throughout this book. Topics are as follows:

- Accessibility, universal design, and visitability
- Sustainability (also listed in relationship to specific items as necessary and not covered in detail in rooms that do not present specific challenges)
- Ergonomics and required clearances
- Organizational flow
- Related codes and constraints
- Electrical and mechanical
- Lighting (while lighting is clearly part of the electrical system, it is separated here for purposes of organization)

INTRODUCTION TO ACCESSIBILITY NOTES

Throughout this book, content related to accessible design is treated visually similarly to this section in order to make it easy to reference.

ACCESSIBILITY, UNIVERSAL DESIGN, VISITABILITY, AND USABILITY

The terms *accessible design* and *universal design* are used interchangeably by some; however, for the purposes of this

book they are considered distinct. The nuances involved are discussed below.

The term *accessible* was initially used to describe environments that do not present physical barriers for people with physical limitations, such as wheelchair users. The University of Washington defines accessible design as

a design process in which the needs of people with disabilities are specifically considered. Accessibility sometimes

refers to the characteristic that products, services, and facilities can be independently used by people with a variety of disabilities.

According to Dr. Edward Steinfeld of the Center for Inclusive Design and Environmental Access (IDEA Center):

Accessible design allows people with disabilities to demonstrate that they have capabilities—to work, manage a household, marry and raise children [—that] they can play a vital role in the community (1996).

Generally, the design of private, single-family homes is not mandated by any current accessibility regulations except as noted later in this chapter. However, many homeowners seek residences that are accessible, either because they plan to “age in place” in the home (defined as growing older in one’s home without having to relocate) or because they or a family member have current needs that warrant the design of accessible spaces. These two distinct scenarios present two distinct design criteria.

In cases where current physical or other limitations create the need for accessible spaces, the design should address the specific needs of the owner or family member. For example, designing a home for a specific person who uses a wheelchair requires meeting a set of appropriate criteria and guidelines, whereas designing a home for a person with a vision impairment requires considering a different set of standards and guidelines.

In contrast, designing a home for aging in place or for general accessibility requires making design decisions based on basic accessibility standards and guidelines. These are presented throughout this book as part of the body of each chapter, set apart and identified as an Accessibility Note (as this section is set apart). Incorporating accessibility information for each area is intended to provide readers with a comprehensive view of accessible design. Information about regulations and standards for accessibility is provided in the “Related Codes and Constraints” section of this chapter.

In cases where a home is intended to be wheelchair accessible, adequate clearance space must be provided for the chair as the user accesses items for daily activities; in addition, appropriate circulation space and turning space must be provided. See Figures 2-14b and 2-14c for specific information about wheelchair-accessible circulation and clearance requirements. Additional detailed information is provided in each room-based chapter within these Accessibility Note sections.

The concept of universal design grew, in part, out of the accessible design movement, but it is not synonymous with accessibility. Ron Mace, an architect, product designer, and educator, is credited with coining the term;

he also established what is now the Center for Universal Design at North Carolina State University. According to the IDEA Center (SUNY at Buffalo), universal design can be defined as

an approach to the design of all products and environments to be as usable as possible by as many people as possible regardless of age, ability or situation [and that] results in better design and avoids the stigmatizing quality of accessible features that have been added on late in the design process or after it is complete.

Additional insight is provided by the Center for Universal Design at North Carolina State University:

The intent of universal design is to simplify life for everyone by making products, communications, and the built environment more usable by as many people as possible at little or no extra cost. Universal design benefits people of all ages and abilities.

An example of universal design are lever door handles, which work well for people with limited hand strength but also work well for as many other people as possible. The lever design does not limit use but extends it to the greatest possible number of people.

One approach to universal design in the home is to provide *adaptable* elements designed to offer greater flexibility for a range of occupants. For example, counters can be made so that they are adjustable to adapt for users of varying heights (including those using seats and wheelchairs). Adaptable cabinets can be designed with fronts and bases that can be removed to create a clear area underneath for use by someone in a wheelchair. Illustrations of both of these examples can be found in Chapter 4.

Some common features to include to create a home that incorporates universal design principles are as follows: no stairs (at the entry or within the home); wide doorways to allow for wheelchairs and general ease of movement; wide hallways for wheelchairs and ease of movement; extra floor space, especially in areas such as bathrooms and kitchens and around closets and utility areas, allowing for wheelchair use as well as extra space for movement. Following the specific requirements for space for wheelchair movement included in the accessibility section of each chapter can aid in the creation of a home that meets universal design principles because it is usable by a wide range of people.

Visitability is a concept that shares some commonalities with universal design concepts; it refers to creating homes that can be visited or accessed by people with physical disabilities and is sometimes called basic home access or inclusive home design. Visitable residences must meet three important criteria:

- At least one zero-step entrance approached by an accessible route on a firm surface no steeper than 1:12, proceeding from a driveway or public sidewalk.
- Wide passage doors: all main-floor interior doors, including the bathroom, must provide 32 inches (813 mm) of clear passage space.
- At least a half bath/powder room on the main floor (a full bath on the main floor is ideal).

Eleanor Smith is a founder of Concrete Change, a group that advocates to have visitability ordinances federally mandated or adopted by various jurisdictions. To date, a number of jurisdictions, including Austin, Texas; Vancouver, British Columbia; and Pima County, Arizona, have adopted visitability ordinances. Other jurisdictions have adopted visitability ordinances for residences built using city funds. (It is worth noting, however, that Pima County and Austin allow 32-inch [813-mm] doors, providing only 30 inches [762 mm] of clear space.) While visitability is a distinct concept, its principles also can be seen as universal design because visitable spaces are intended to be used by more people than standard private housing, making them meet the definition of being “as usable as possible by as many people as possible regardless of age, ability, or situation.”

Of the three criteria for visitability, the most difficult to achieve nationally is the zero-step entrance requirement. This could prove problematic in parts of the country where basements are commonplace. Typically, the main floor of a house with a basement is 18 to 20 inches (457 to 508 mm) above ground level, which could require a significant ramp

for a zero-step entry. In some cases, through careful building placement and site grading, the driveway and sidewalk to the entrance can be designed with a slope of not more than 1:12 for a zero-step entry. However, recent surveys of potential homeowners and architects have shown significant interest in accessibility, and using the criteria for visitability is a helpful first step in creating a more accessible home for both homeowner and visitors.

Usability is a word that has meanings related to accessibility. The International Organization for Standardization (ISO) has defined usability as

the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

Usability, also called usable design, can be tested and measured. While most often used in relation to describing electronics and communication, usability testing can be employed to test a range of products and environments. Although usability shares goals with accessibility and universal design, usability studies do not necessarily include testing of people with a range of abilities and are not necessarily conducted for the purpose of achieving universal design. According to the University of Washington’s DO-IT website (2013), if “designers apply universal design principles, with a special focus on accessibility for people with disabilities, and if usability experts routinely include people with a variety of disabilities in usability tests, more products will be accessible to and usable by everyone.”

Table 1-1 Differences among Accessibility, Universal Design, Visitability, and Usability

Term	Definition	Comment
Accessibility	The extent to which design specifically considers the needs of people with disabilities. Accessibility sometimes refers to the characteristic that products, services, and facilities can be independently used by people with a variety of disabilities.	Accessible and universal design both address the needs of users beyond those considered “average” or “typical.”
Universal design	The design of all products and environments to be as usable as possible by as many people as possible regardless of age, ability, or situation.	Accessible and universal design both address the needs of users beyond those considered “average” or “typical.”
Visitability	The extent to which new homes are designed so that they can be visited or accessed by people with physical disabilities.	Visitable homes incorporate concepts of universal design in that they can be used by a wider range of people than standard housing.
Usability	The extent to which products are easy and efficient to use.	While concerned with creating efficiency and ease of use, usability testing may not consider accessibility or the universal design of products because it may be focused on one specific type of user.

Introduction to Sustainability Notes

Throughout this book, content related to sustainability is treated visually similarly to this, in order to make it easy to reference. This section provides an overview, including background and historical information related to sustainability.

According to Alice Rawsthorn (2010),

While most designers would agree that sustainability is important, they're very likely to disagree about everything else to do with it. What exactly is sustainable design? What constitutes success? And failure? On what criteria? Different designers may well give very different answers to all of those questions, and more.

As the previous quote indicates, perhaps more than any current area of design, definitions of sustainable design and green design seem to cause confusion, consternation, contradiction, and a search for clear answers. One way to understand issues of sustainability is to clearly define some commonly used terms and to outline areas of agreement and disagreement.

According to Louise Jones, writing in *Environmentally Responsible Design* (2008), "*sustainable design suggests a macro perspective on environmental responsibility—protection of the health of and welfare of global ecosystems,*" whereas "*green design suggests a micro perspective,*" related to protection of health and welfare of the people in the "built environment." And, according to Jones, *environmentally responsible design* (ERD) is "a combination of green and sustainable design."

Francis Ching (2008), an architect, educator, and author of seminal design books, has defined *sustainability* as "a whole-systems approach to development that encompasses the notion of green building but also addresses broader social, ethical and economic issues, as well as the community context of buildings."

Both Ching and Jones trace the roots of definitions of sustainable design and development to the 1987 United Nations World Commission on Environment and Development. The commission, also known as the Brundtland Commission after Gro Harlem Brundtland, its chairman, defined *sustainable development* as follows:

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

the concept of "needs," in particular the essential needs of the world's poor, to which overriding priority should be given

the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs

Internationally, in 1990 England established the Building Research Establishment Environmental Assessment

Method (BREEAM), the first environmental assessment tool to be used internationally. The tool was created to be used in analysis of new and existing buildings in terms of review and improvement of office buildings. BREEAM has been used as a model for systems developed in other countries. In addition, several European countries have joined efforts to define methodology for life-cycle analysis of buildings.

The World Green Building Council (WorldGBC) is a network of international green building councils that seeks "to promote local green building actions and address global issues such as climate change."

In seeking out helpful definitions, it is worth noting that the U.S. Environmental Protection Agency (EPA, 2010) has defined *green building* as

The practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. . . . Green building is also known as a sustainable or high performance building.

The EPA (2010) also indicates that

Green buildings are designed to reduce the overall impact of the environment on human health and the natural environment by:

Efficiently using energy, water, and other resources

Protecting occupant health and improving employee productivity

Reducing waste, pollution and environmental degradation

According to the EPA, important developments in the United States related to green building history include those listed in Table 1-2.

The EPA has also identified the items covered in Table 1-3 as impacts of the built environment.

As one evaluates products and design solutions, it is worth measuring their impact as indicated in Table 1-3. This means not only assessing initial product sourcing or production but also considering how the demolition (deconstruction) may impact the environment.

Reviewing history and defining terms related to sustainability can provide a context and a framework for understanding this rather complex aspect of current design practice. Based on the definitions found in the preceding paragraphs, for the remainder of this book, we will use the following definitions.

Defining Sustainability

Sustainability can be seen as a "whole-systems approach to development that encompasses the notion of green building but also addresses broader social, ethical and economic issues." (Ching, 2008)

Table 1-2 Recent Green Building History in the United States

Historical Development	Year
American Institute of Architects (AIA) formed the Committee on the Environment (COTE).	1989
Environmental Resource Guide published by AIA, funded by EPA.	1992
EPA and the U.S. Department of Energy launched the Energy Star program.	1992
Executive Order 13123: Greening the Government through Efficient Energy Management.	1992
First local green building program introduced in Austin, Texas.	1992
U.S. Green Building Council (USGBC) founded.	1993
USGBC started Leadership in Energy and Environmental Design (LEED version 1.0 pilot program).	1998
First commercial-scale net-zero building project completed at Oberlin College, in Ohio.	2000
Energy Policy Act: includes building standards for federal buildings.	2005
The Energy Independence and Security Act of 2007.	2007
EPA adopted a new Green Building Strategy guide for EPA buildings.	2008
The International Code Council began development of the International Green Construction Code (IGCC), a model code jointly sponsored by AIA, ASTM International, ASHRAE, and IES.	2009
American Institute of Architects (AIA) created the 2030 Commitment, asking organizations to pledge to advance the goal of carbon-neutral buildings by 2030.	2009
2010 California Green Building Standards Code released (updated in 2013).	2010
ASHRAE (American Society of Heating Refrigerating and Air-Conditioning Engineers) released Standard 189.1: Standard for the Design of High-Performance Green Buildings. Initial draft created in 2007.	2010
The International Code Council (ICC) released the 2012 International Green Construction Code (IgCC), a model code jointly sponsored by AIA, ASTM International, ASHRAE, and IES. An updated version was approved in 2015.	2012
USGBC: Leadership in Energy and Environmental Design, LEED version approved.	2015

Table 1-3 Environmental Impacts of the Built Environment According to the EPA

Aspects of Built Environment	Consumption	Environmental Effects	Ultimate Effects
Siting (building site) Design Construction Operation Maintenance Renovation Deconstruction	Energy Water Materials Natural resources	Waste Air pollution Water pollution Indoor pollution Heat islands Storm-water runoff Noise	Harm to human health Environmental degradation Loss of resources

Green building (or green design) is the design of buildings that are efficient in the use of resources, limit the impact of building on the environment, and incorporate sustainable materials in their construction—all of which make green building part of sustainable development.

Green building standards programs include those certified by LEED, those required by the International Green Construction Code (IgCC); a variety of product standards and certification programs, including McDonough Braungart Design Chemistry (MBDC); and local, tribal, and state codes and building legislation (including CALGreen).

The U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) green building certification system is a set of green construction standards for certification that are widely recognized in the United States. In addition to setting standards that result in a building's receiving LEED certification, USGBC also grants LEED professional credentials for design and construction professionals. (This is done in conjunction with the Green Building Credential Institute [GBCI].) Additional detailed information about LEED building rating systems can be found in Appendix A.

The *International Green Construction Code (IgCC)* is a model code developed by the American Institute of Architects, ASTM International, and others in keeping with the American Institute of Architects 2030 Carbon Neutrality Goal. Additional information about the IgCC can be found in Appendix A.

The California Green Building Code includes *mandatory provisions for residential* and nonresidential buildings as well as voluntary standards for both residential and nonresidential buildings. Residential mandatory requirements include planning/design; water efficiency/conservation; material and resource efficiency; building maintenance and operation; environmental quality, a section containing detailed requirements for sealants, coatings (including paint), carpet (and carpet cushion), and other interior finishes and materials; interior moisture control; environmental comfort; interior air quality; and exhaust.

In some cases, states and cities have LEED-based regulations that govern new projects, while in other cases, states and cities offer incentives for green building and energy efficiency. The State of Minnesota Sustainable Building Guidelines (known as B3 Guidelines) require compliance on projects receiving state funding and can be used voluntarily on other projects.

Another approach to sustainability is known as MBDC and is based on the framework developed by William McDonough and Michael Braungart and described in their book *Cradle to Cradle: Remaking the Way We Make Things*. As indicated on the MBDC website, this framework "moves beyond the traditional goal of reducing the negative impacts of commerce ('eco-efficiency'), to a new paradigm of increasing its positive impacts ('eco-effectiveness')." This approach addresses the use of energy, water, and social responsibility; MBDC sets criteria for C2C certification of products, produces case studies, and consults with a wide range of clients.

In addition to LEED, IGCC, and MBDC, there are a number of programs that provide certification and standards for green products and materials; some of these are listed in Appendix A. Such standards are one way for designers to seek out products that meet some of the criteria set by the EPA, as follows:

Green buildings may incorporate *sustainable* materials in their construction (e.g., *reused, recycled-content, or made from renewable resources*); create *healthy indoor environments with minimal pollutants* (e.g., reduced product emissions); and/or feature landscaping that *reduces water usage* (e.g., by using native plants that survive without extra watering).

Using some type of rating or certification system, in combination with weighing what is called for in the preceding quote, can provide a method for designers to determine whether a product is, in fact, green. Measuring products against such criteria is helpful because *greenwashing*, which is defined as making misleading statements about products or practices relative to issues of sustainability, is an ongoing problem.

Another important approach to analyzing sustainability is known as *life-cycle assessment (LCA)*, which is a process that involves reviewing the total impact of a product's environmental cost over the *lifetime* of the product or building. According to the EPA, LCA "is unique because it encompasses all processes and environmental releases beginning with the extraction of raw materials and the production of energy used to create the product through the use and final disposition of the product. When deciding between two or more alternatives LCA can help decision-makers compare all major environmental impacts caused by products, processes or services."

A life-cycle assessment is an evaluation of the environmental consequences associated with a product or process. According to ISO 14040.2, "The assessment is a systematic set of procedures for compiling and examining the *inputs* and *outputs* of materials and energy and the associated impacts directly attributable to the functioning of a product or service system throughout its life cycle." The term *life cycle* refers to the activities occurring in the course of the product's life span, including use of raw materials and their acquisition, production, shipping, installation, maintenance, and disposal. By evaluating all phases of a product's life span, this assessment can aid in avoiding shifting environmental impact to the future or to future generations.

Issues mentioned thus far regarding sustainability are not specific to the design of houses but rather are intended to provide clarity and background. Some programs specific to the design and construction of homes are listed in Table 1-4.

While there are not currently many *mandatory* green codes regulating private residential design, residences should not be overlooked in terms of environmental impact or indoor air quality. According to the Consumer Reports website Greener Choices, "using green building

Table 1-4 Sustainable, Green, and Energy-Efficient Programs for Homes*

Title	Agency/Sponsor	Description
Built Green	Washington State and participating counties and master building organizations	Voluntary green building certification program.
California Green Building Standards Code, known as CALGreen Code	California Building Standards Commission	Mandatory state green building standards code (the first state-mandated code in the nation). Regulates the design and construction of buildings, including residences, and includes additional voluntary guidelines.
Green Star Home Certification	Alliance for Environmental Sustainability and Minnesota GreenStar	A voluntary residential building standards program that provides third-party rating and certification of new and remodeled homes.
LEED for Homes	U.S. Green Building Council	Designed to be efficient in energy, water, land use, materials, and indoor air quality. Voluntary rating system that promotes the design and construction of high-performance green homes.
REGREEN	American Society of Interior Designers and U.S. Green Building Council	Voluntary guidelines for sustainable residential remodeling/improvement projects. Provides strategies based on project scope, as well as an educational certificate program.
Energy Star Home Program	Federal government (EPA) and partner organizations	Voluntary energy efficiency program. Includes Energy Star rating system and labels for products and homes.
U.S. Department of Energy, Building America Program	U.S. Department of Energy (DOE) in partnership with industry	Voluntary program seeking to reduce home energy use by 30 to 90 percent and improve indoor air quality.
NAHB Model Green Building Guidelines/Certification	National Association of Home Builders (in conjunction with green building professionals)	Resource for builders to build houses that conserve resources, including energy, and have improved indoor air quality.
American Lung Association Health House Program	American Lung Association	Homes are built to be mold, radon, and allergy resistant as well as energy efficient.

* There are additional state and local voluntary programs, but those listed have the most in-depth documentation available.

Also: A number of Native American communities have adopted green building codes that include regulation of residences. These include the Kayenta Township (Navajo Nation) Building Codes, the Pinoleville Pomo Nation Tribal Building Code, and the Confederated Tribes of the Grand Ronde Community of Oregon Tribal Community Code Ordinance.

materials can help to address” a range of health and environmental concerns such as indoor air pollution, which the EPA ranks “among the top five environmental risks to public health. In particular, studies have found levels of certain pollutants, from products such as paints and wood preservatives, to be up to 10 times higher inside homes than outside.”

Consumption and Environmental Impacts

Additional statistics indicate the following:

- In the United States, the buildings sector accounted for about 41 percent of primary energy consumption in 2010. (U.S. Buildings Energy Data Book)
- According to the EPA (2009), of the total energy consumption in an average household,
 - 50 percent goes to space heating
 - 27 percent runs appliances
 - 19 percent heats water
 - 4 percent goes to air-conditioning.

■ Buildings in the United States contribute

38.9 percent of the nation’s total carbon dioxide emissions, including 20.8 percent from the residential sector. A leaky faucet wastes many gallons of water in a short period of time. A leaky toilet can waste 200 gallons (750 L) per day. (EPA 2009)

■ Sources of indoor air pollution may include “combustion sources; building materials and furnishings; household cleaning, maintenance, personal care, or hobby products; central heating and cooling systems and humidification devices; and outdoor sources such as radon, pesticides, and outdoor air pollution.” (EPA 2009)

■ According to the EPA (2015), the average American family of four uses more than 400 gallons (1514 L) of water per day at home.

■ The EPA (2014) indicates that by 2015, consumer electronics and small appliances will be responsible for almost 30 percent of all household electricity use. In 2020, the average home is expected to be 5 percent larger and will rely on even more products powered by electricity.

■ Homes built between 2000 and 2005 used 14 percent less energy per square foot than homes built in the 1980s and 40 percent less energy per square foot than homes built before 1950. However, larger home sizes have offset these efficiency improvements. (U.S. Buildings Energy Data Book)

■ Space heating and cooling—which combined account for 54 percent of site energy consumption and 43 percent of primary energy consumption—drive residential energy demand. (U.S. Buildings Energy Data Book)

Construction of new homes creates waste, with the NAHB estimating that the average single-family house built in the United States generates between 7000 and 12,000 pounds (3200 to 5400 kg) of construction waste. Millions of homes are built each year, so clearly removal, recycling, and reusing construction waste should be considered in seeking green design solutions. And given

A Note on Dimensions

Throughout this book, dimensions are given in imperial units such as feet and inches, with metric (International System of Units, or SI) equivalencies listed, typically in millimeters. In most illustrations, imperial measurements are listed above or preceding the metric measurements. Millimeters are typically listed followed by “mm.” In the text, millimeters are most often given in parentheses following the imperial dimensions. One exception to the use of millimeters in this book is the use of centimeters (with numbers followed by the letters “cm”) for furniture dimensions, which is in keeping with the common practice of many manufacturers. When information is given regarding square footage, it is typically followed by an equivalency in square meters, which is within parentheses followed by “m².”

Ergonomics and Required Clearances

The field of study known as *anthropometrics* provides detailed information about the dimensions and functional capacity of the human body. According to authors Julius Panero and Martin Zelnik, anthropometry is “the science dealing specifically with the measurement of the human body to determine differences in individuals, groups, etc.” (1979). *Ergonomics* is the application of human-factors data, including anthropometric data, to design. Specific ergonomic information and information related to clearance space required for furniture, fixtures, and equipment is included in each chapter.

the statistics indicated here, life-cycle assessments of materials and construction processes are worth pursuing relative to residential design. Further information about resources for assessing sustainable materials can be found in Appendices A and B.

Net Zero Energy Buildings (NZEBS) are seen as a solution to growing energy costs, energy consumption, and climate change. Lacy Johnson wrote in *Scientific American*, “By the purest definition, a net-zero building produces all the renewable energy it needs on site, drawing no more power from the grid than it gives back.” Each NZEB building design uses some mix of renewable energy and architectural design features (strategic use of site and window placement, tight insulation, etc.) to achieve net zero energy use. Generally, these buildings are connected to the power grid, but they produce at least as much energy as they use over the course of a year.

Chapter 2 is devoted to circulation space; the focus of that chapter is movement from room to room. The discussion of room-specific circulation is covered within each chapter.

The introductory discussion of proxemics earlier in this chapter described Edward Hall’s finding that human spatial boundaries vary from one culture to another; readers should note that the clearances and ergonomic information provided throughout this book represent North American norms rather than reflecting a worldview. This is particularly true of dining and leisure spaces.

Many chapters also provide furniture and appliance sizes; these, too, are based on items currently available in North America.

Organizational Flow

The authors use the term *organizational flow* to refer to the use of activity areas or elements within a room in relationship to *traffic flow* or *circulation*. For example, in designing a kitchen, the designer must consider the various activity areas (such as cooking, cleanup, and preparation) and the ease of their use, as well as circulation within the room and to other areas within the residence. Each room in a home serves a distinct purpose, and the design of the room must support that purpose in order for the room to function well.

When considering organizational flow, the designer must review the range of uses of the room and make design decisions that support those purposes. For example, bedrooms are used for sleeping but also have other uses, such as clothing storage (in closets and dressers); the flow of the room should support both sleeping and accessing stored items as well as additional activities that occur within the room, such as watching television or working on a computer. Such issues of organizational flow are discussed in detail in the various chapters of this book.

Related Codes and Constraints

Building codes, zoning regulations, and fire, health, and safety codes all influence the design of buildings and their interior elements and provide constraints to the overall design. A basic understanding of the codes and regulations that affect residential design is required as projects are undertaken.

Building codes generally govern the construction of buildings based on the type of occupancy intended for the building. This means that residences are generally regulated by standards different from those regulating public spaces, and public spaces are regulated in varying ways based on intended use. Building codes are adopted by cities, states, and/or municipalities and, in rural areas, often by county agencies. In some cases, states adopt a statewide residential building code; however, codes adopted within states often can vary. Additionally, states and municipalities can add local requirements or amendments to generally adopted model codes to allow for incorporation of regional variation or geographic factors.

Prior to 2000, three model codes were widely used throughout the United States: the Uniform Building Code (UBC), the Building Officials and Code Administrators (BOCA) National Building Code (NBC), and the Standard Code. In 2000, various code entities came together to form the International Code Council (ICC) and to develop the International Building Code (IBC), which was written to serve as a consolidated model code for commercial and public buildings. Many states and municipalities have adopted the IBC, although it is not currently as consistently adopted as the name implies. Many code jurisdictions have intentions of adopting the IBC in the future, however.

ICC also publishes related codes, including the International Residential Code (IRC)—which is used in the regulation of one- and two-family homes—the International Mechanical Code, and the International Plumbing Code. See the “Electrical and Mechanical” section of this chapter for related information about electrical code requirements called for by the IRC, Section

E. The IRC does not cover multifamily dwellings, dormitories, apartments, nursing homes, or assisted-living facilities; these are covered by the IBC.

Throughout this book, the International Residential Code (2015 edition) is the code that is referenced. Referencing this single code is useful for purposes of clarity; however, not all locales or code jurisdictions have currently adopted this code, and this code does not regulate multifamily housing. Therefore, prior to beginning any project, the designer must research local codes and all related regulations.

Zoning regulations control building size, height, location, setbacks, and use. These regulations are adopted by local municipalities and vary greatly throughout the United States. In some areas, there are very strict zoning codes that control many facets of a building’s design; in others, there are few zoning restrictions. As with the building code, zoning regulations should be researched prior to beginning the design of any project.

Additional codes and regulations that govern the design of buildings include energy codes and fire and flammability standards. There are additional standards developed by testing agencies that are incorporated into model codes and federal regulations. Such testing agencies include the American National Standards Institute (ANSI) and ASTM International (formerly the American Society for Testing and Materials).

Sustainability Note

As stated earlier in this chapter, there are some specific state codes and guidelines related to sustainability, including the California Green Building Standards Code, as well as energy codes such as California’s Title 24. In addition, many municipalities and cities have energy and water conservation codes and guidelines. Therefore, a full review of local restrictions is recommended for all projects.

ACCESSIBILITY NOTE

Federal regulations that govern the design of multifamily dwellings include the Fair Housing Amendments Act of 1988 (FHAA), a civil rights law requiring that privately and publicly funded multifamily dwellings (units on the first floor and all units in buildings with elevators) provide limited accessibility. In addition, the Uniform Federal Accessibility Standards (UFAS) require a percentage of units within federally funded multifamily dwellings to be accessible.

Early residential accessibility standards were published in 1980 in the ANSI A117.1 standards, which included bathroom and kitchen accessibility standards. The most current version, ANSI A117.1-2003, which was approved in 2003, provides standards for two types of accessible units: Type A and Type B. In brief, Type A units (Section 1003) are

fully accessible, while Type B units (Section 1004) provide limited accessibility.

Type B units are consistent with FHAA requirements, while Type A units are consistent with UFAS. A review of Type A and Type B standards will show that Type B standards are less strict; however, Type B standards are more broadly applied. ANSI A117.1-2003 also sets standards for accessible communications features for dwelling and sleeping units (Section 1005).

Information about kitchen and bath layouts that meet ANSI standards for Type A and B units can be found in Appendix D.

The Americans with Disabilities Act (ADA) is also civil rights legislation that includes federal accessibility design standards and guidelines. The ADA requires that *public*

buildings (including those owned privately) be designed so that they accommodate people with disabilities. ADA guidelines share many similarities with ANSI standards. While the ADA has significant implications for the interior

design of public places and should be understood by the practicing designer, it does not directly impact the design of single-family homes—except in a small portion of housing built with public funding.

ACCESSIBILITY NOTE

SWITCHING FOR WHEELCHAIR USERS

The standard placement of outlets (12 inches [305 mm] off the floor) is rather low for wheelchair and other users. For these users, outlets are best placed between 15 and 17 inches (381 and 432 mm) off the floor, and wall switches should be placed no higher than 48 inches (1219 mm) off the floor, as shown in Figure 1-6. The IDEA Center states that “wall outlets should be located no lower than 15 inches

(381 mm) from the floor” and controls “that will be used frequently should be within the 24–48 inch (610–1219 mm) ‘comfort range.’” Such controls include thermostats and alarm systems. It is worth noting that placing controls in this comfort range and locating receptacles between 15 and 17 inches (381 and 432 mm) above the floor meets universal design criteria and adds no extra expense, making it worth considering on many projects.

More about the International Residential Code

As stated previously, the IRC regulates one- and two-family residences and is therefore referenced in this book. In order to understand more about codes as they relate to each room within a house, it is worthwhile to cover some key concepts in advance.

For example, the IRC defines habitable space as “a space in a building for living, sleeping, eating or cooking,” which means that the rooms within a home in which those activities are conducted must follow the guidelines as required throughout the code for habitable spaces. Note that the IRC does not include bathrooms, toilet rooms, closets, halls, and storage or utility spaces in the list of “habitable spaces”; therefore, those follow different guidelines.

In addition, the following sections specify other requirements.

Section R303 of the IRC covers light, ventilation, and heating:

It requires that all habitable rooms shall have a certain quantity of glazing areas (also known as windows) of “not less than 8 percent of the floor area.” This means that the aggregate size and number of windows in rooms is controlled by the floor area and required by the IRC.

Natural ventilation is to be provided through windows, doors, louvers, or other approved openings, with a required minimum openable area to the outdoors of not less than 4 percent of the floor area.

Section R304 of the IRC covers minimum room areas:

Each habitable room in every dwelling unit shall have a gross floor area not less than 70

square feet (6.5 m²) and a minimum dimension not less than 7 feet (2134 mm).

Section R305 of the IRC covers ceiling height:

“Habitable space, hallways and portions of basements containing these spaces shall have a ceiling height of not less than 7 feet (2134 mm).” Minimum listed ceiling height for toilets, bathrooms, and laundry rooms is 6 feet, 8 inches (2032 mm), with exceptions for beams and girders in basements, where 6 feet, 4 inches (1930 mm) is allowed.

Not more than 50 percent of the required floor area of a room or space is permitted to have a sloped ceiling less than 7 feet (2134 mm) in height, with no portion of the required floor area less than 5 feet (1524 mm) in height (see Figure 1-5).

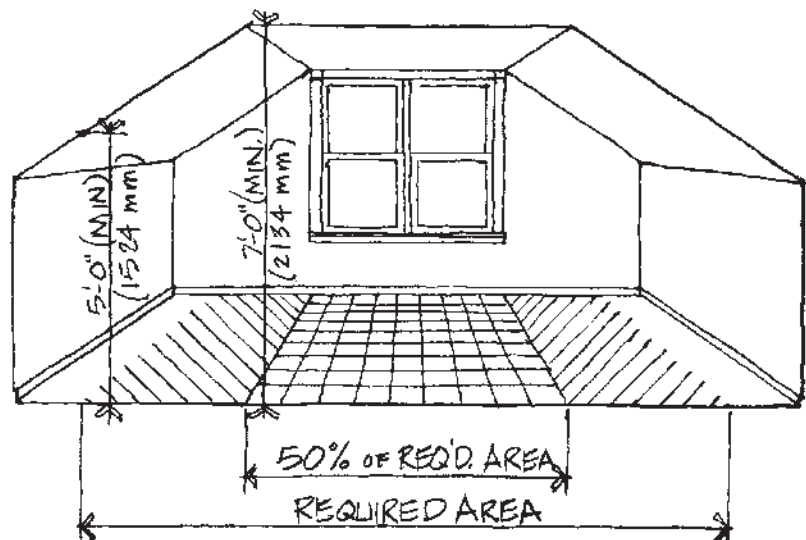


Figure 1-5 IRC required floor area in sloped ceiling situations: The IRC calls for habitable rooms to have a ceiling height of “not less than 7 feet (2134 mm).” It also states that no more than 50 percent of the required floor area of spaces may have sloped ceilings less than 7 feet (2134 mm) in height and requires that no portion of the required floor area be less than 5 feet (1524 mm) in height.

Section R331 of the IRC covers automatic fire sprinkler systems:

New residential town houses and one- and two-family dwellings shall have fire sprinkler systems. The authors of this book do not, at the time of this writing, know how widely this requirement will be applied.

The code issues mentioned to this point relate to single-family homes, which are governed by the IRC.

Electrical and Mechanical

Electrical and mechanical issues are covered in each chapter as they relate to individual rooms and spaces. With that said, there are some general rules for locating electrical switches and convenience outlets, with typical exceptions being in kitchens, bathrooms, and utility spaces. In most other locations, the on/off switches for overhead or general lights are best located close to the room entry door on the latch side of the doorway when possible. In larger rooms with more than one entrance, a second on/off switch can be employed in another convenient location; this is called a three-way switch. Where a number of light fixtures are used for general lighting, a single switch can be used to control several fixtures and outlets.

The IRC (Section E3903.2) requires that “at least one wall-switch-controlled lighting outlet shall be installed in every habitable room and bathroom.” One exception to this requirement is “in other than kitchens and bathrooms, one or more receptacles controlled by a wall switch shall be considered equivalent to the required lighting outlet.” The IRC (Section E3903.3) requires additional locations for a wall-switch-controlled lighting outlet in hallways, stairways, and attached and detached garages with electric power. This section of the code also requires that a wall-switch-controlled lighting outlet be installed on the exterior of egress doors with grade-level access.

The on/off switch should be mounted 44 to 48 inches (1118 to 1219 mm) off the floor. Because there are two receptacles, typical household electrical outlets are referred to as duplex outlets or duplex receptacles. These outlets are commonly placed about 12 inches (305 mm) off the floor, as shown in Figure 1-6.

A general rule of thumb for electrical outlet placement is one duplex receptacle per 12 feet (3658 mm) of wall space in order to avoid the use of extension cords. (Standard appliance cords are often 6 feet [1829 mm] long.) Following such rules can be a good starting point; however, the placement of outlets must be considered in relation to the design and layout of the room. It is important to consider the various possibilities for furniture placement so that the outlets can be designed in a way that is useful for a variety of scenarios. The IRC (Section E3901.2.1) requires that in most rooms receptacles be installed so that no point measured along the floor line is more than 6 feet (1289 mm) from a receptacle.

The term *mechanical* is an umbrella term used to describe the heating, ventilation, air-conditioning (known together as HVAC), and plumbing elements of a building. With very few exceptions, all residences in the United States are required by code to be heated; for example, the IRC calls for heating to a minimum of 68°F (20°C) when the winter temperature is below 60°F (15.5°C). Cooling may not be required by code, but in many parts of the country, most people consider it necessary.

The most common solution for providing heat is a furnace that burns a fossil fuel (such as natural gas, liquid propane, or heating oil) and less commonly wood, charcoal, or coal. Alternatively, some furnaces derive heat from electric resistance coils or a heat pump. In almost all cases, the furnace uses a fan that moves air, via ducts, to the various rooms where heat is required. This type of system can be equipped to clean, with

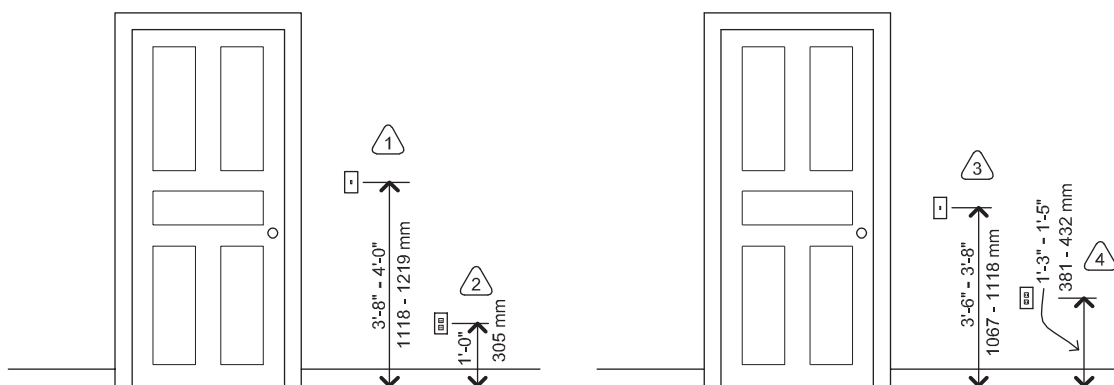


Figure 1-6 Switching and outlet locations for standing adult and seated (wheelchair) users

1. Standard switch placement is convenient to the latch side of the door and centered at 4 feet (1219 mm) above the floor.
2. Standard wall outlet placement is one outlet for each 12 lineal feet (3658 mm) of wall in general living spaces. Actual locations in individual rooms will vary based on room design and possible furniture arrangement.
3. For wheelchair users, switches are best located centered 3 feet, 6 inches to 3 feet, 8 inches (1067 to 1118 mm) above the floor and never higher than 4 feet (1219 mm) above the floor.
4. For wheelchair users, wall outlets are best placed 1 foot, 3 inches to 1 foot, 5 inches (381 to 432 mm) above the floor and never lower than 1 foot, 3 inches (381 mm) above the floor.

with the use of filters; humidify; and, with the addition of a compressor or condensing unit, to cool the air, which in the process dehumidifies the air.

Other heating systems are available, such as a boiler that heats water in tandem with a pump that moves the heated water to a baseboard convactor unit; a similar result can be achieved with electric resistance baseboard units. Hot water can also be delivered to radiant heating pipes located in the floors of a residence, with similar results achieved with resistance heating in the floors. None of these methods accomplish the cooling, cleaning, and dehumidifying that forced-air systems allow; these must be achieved through the use of separate equipment.

Air-to-air heat pumps are commonly used in temperate climates; these remove heat from the inside air in warm weather and work in reverse to provide heat to the interior during colder weather. In these systems, air is delivered much like the forced-air systems described previously.

Increasingly, consumers are seeking alternative sources for heating and cooling homes. Geothermal heat pumps use the relatively constant temperature of the soil, the groundwater, or surface water as a heat source for a heat pump that can provide heating and cooling. These systems use tubing submerged in the soil or a nearby lake or pond. Many consumers find the initial higher cost of geothermal heat pumps offset by energy savings and special tax incentive programs.

For many years, solar energy has been used to heat homes, and advocates see it as providing sustainability, energy independence, and cost reduction. Recent years have seen a significant increase in solar energy capacity, with 36 percent of all new electric capacity in the United States in 2014 coming from solar sources, according to the Solar Energy Industry Association (2015).

A great deal of information is available on designing solar heating and geothermal heating and cooling systems. These areas are clearly not the purview of this book, but designers are encouraged to seek additional information about these systems.

While interior designers are not responsible for the design of heating, ventilation, and air-conditioning systems, they should understand the various types of systems and their impact on the design of interior spaces. For example, knowing that hot water heat may require the use of baseboard convactor units and that the location of such units will have a direct impact on the design and layout of interior spaces is useful.

Forced-air systems require the use of return-air grilles and supply-air registers/diffusers. These are available in a range of styles and in types such as baseboard, wall, floor, and ceiling units. Location of these items has an impact on the layout of a room and the level of comfort found there; for example, a favorite seating location that receives a constant blast of air will not remain a favorite for long. In addition, the visual qualities of grilles, diffusers, and registers should be in keeping with the overall design intent of the project—a Victorian-style grille placed within a mid-century modern interior may look ridiculous. Placement of grilles, diffusers, and registers in relationship to trim and architectural details is also worth careful consideration.

Lighting

Information about lighting specific rooms and spaces is provided in this book as a means of acquainting students with basic concepts related to planning and design. In no way is the information provided intended to be a significant source of a student's lighting design education. Instead, the information offered is introductory in nature and related to the overall design of rooms and spaces. So that the student can understand and work with the information provided in each chapter, an overview of terminology and basic lighting concepts is provided here. The references at the end of this chapter include lighting design publications helpful for more in-depth study.

Types of Lighting

Types of lighting discussed for various rooms include ambient, accent, task, and decorative lighting. See Figure 1-7.

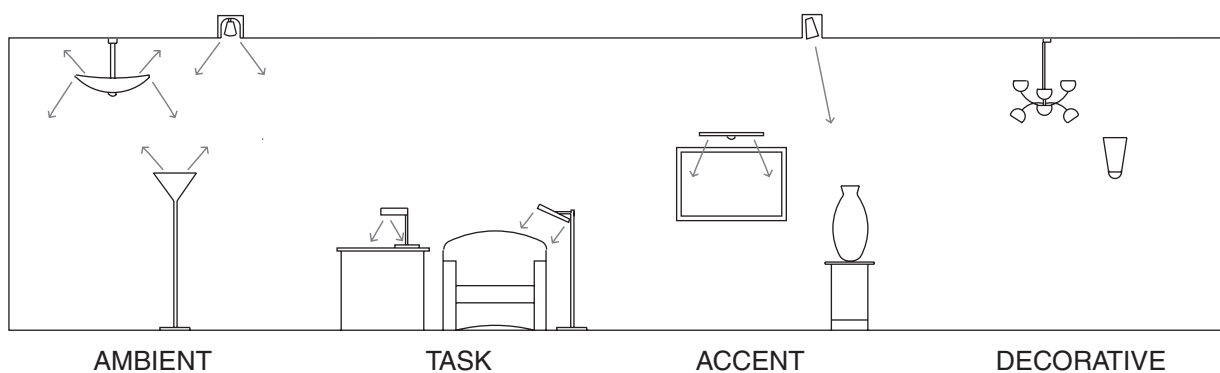


Figure 1-7 Types of lighting include the following: Ambient light is general illumination that provides a uniform light level. Task lighting aids in performing work such as reading or preparing food. Accent lighting functions to illuminate objects or special features. Decorative lighting tends to draw attention to itself in the form of a decorative element such as a chandelier or wall sconce (decorative elements can add to a room's ambient lighting).

Ambient Light

Ambient light provides general illumination that renders a uniform light level throughout the area or room.

According to Randall Whitehead (2004), in residences “the best ambient light comes from sources that bounce illumination off the ceiling and walls.” This is known as indirect lighting, which means that light arrives at a given surface after being reflected from one or more surfaces. This tends to cause less glare than downlights.

Downlights are defined as lighting sources that direct light downward. Whitehead adds that dark ceilings make this type of lighting ineffective.

There are also a number of direct-light sources that provide ambient lighting.

Accent Lighting (Also Referred to as Focal Lighting)

Accent lighting illuminates features, objects, and/or specific areas. This type of lighting accents items or creates focal points and can add a level of interest to the general or ambient lighting.

Well-planned accent lighting puts the focus on the desired objects rather than on the light source or fixture.

Generally, using only accent lighting in a room without giving thought to ambient lighting creates clusters of darkness within rooms.

Task Lighting

As the name indicates, task lighting has a job to do—it aids in performing work and specific tasks.

In residences, many of these tasks are performed at table or counter height, requiring that the work surface be illuminated.

Considering the types of tasks performed and the body positions required to complete them helps the designer make choices about task lighting. For example, at kitchen counters and worktables, light coming directly from the ceiling is blocked by the human body or head, creating shadows on the work surface rather than illumination.

Decorative Lighting

Decorative lighting is ornamental in nature and provides interest based on its design and material qualities.

Unlike accent lighting, decorative lighting functions to show itself off and make a visual statement.

Decorative lighting can be used to accent elements and spaces or to add interest to ambient lighting, yet its function is typically secondary to the visual impact of the light source itself.

More Lighting Basics

Basic lighting design requires an understanding of glare, which the Lighting Research Center at Rensselaer Polytechnic University defines as “loss of visibility and/or the sensation of discomfort associated with bright light within the field of view.” There are two types of glare: direct glare, which results from bright light in the field of view, and reflected glare, which results from reflections in the field of view (including surfaces and reading material). Locating light sources out of the line of vision or shielding them in some manner can prevent direct glare. Reflected glare can be minimized by using less reflective surfaces and placing the light source so that it is not directly above but rather at an angle to the surface and/or viewer.

Luminaire is a term used to describe the complete lighting unit, consisting of the following components:

1. A lamp or lamps (the general public calls these lightbulbs)
2. The parts (housing) necessary to distribute the light, position and protect the lamps, and connect the unit to the power supply

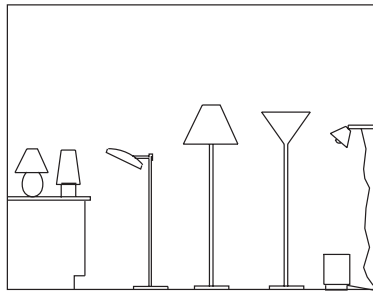
Light fixtures are luminaires that are permanently affixed to the architecture of the building. Portable luminaires are, as the name implies, easily moved; these include what the general public calls table lamps, desk lamps, floor lamps, and so on. A range of luminaires and fixtures may be used to create ambient, accent, task, and decorative light; some of these are shown in Figure 1-8. Recessed luminaires are illustrated in Figure 1-9.

Daylight is a term that correctly refers to what most people call natural light; it is light produced by solar radiation and includes direct sunlight as well as reflected light. The term *daylighting* refers to the process of designing buildings to utilize daylight. True daylighting requires careful consideration of the totality of the architecture of the building, so that the orientation of the building to the site, the location and size of building openings, and adequate shading devices are incorporated into the building design. Daylighting is a useful component of sustainable design because it does not require electricity and when done properly can also save energy on building cooling. Currently, daylighting is a strategy employed more commonly for public buildings than for private homes.

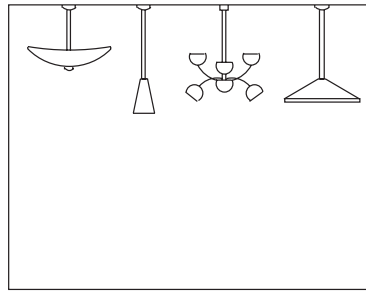
Regardless of how well daylighting is incorporated into a building design, electric light (referred to by the general public as artificial light) is required when it becomes dark outside. The appearance of electric light is rated by the color rendering index (CRI), which, according to the Lighting Research Center at Rensselaer Polytechnic University, is

a technique for describing the effect of a light source on the color appearance of objects being illuminated, with a CRI of 100 representing the reference condition (and thus the maximum CRI possible). In general, a lower CRI indicates that some colors may appear unnatural when illuminated by the lamp.

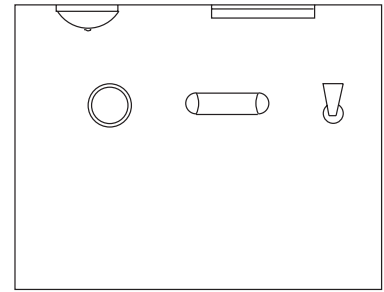
PORTABLE



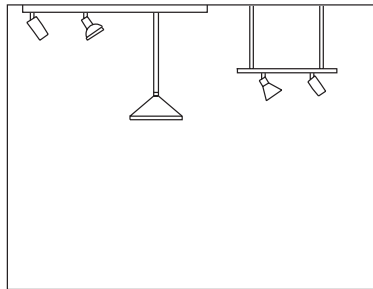
PENDANT MOUNTED



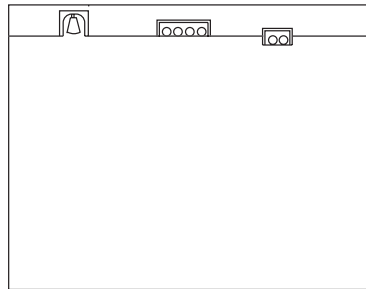
SURFACE MOUNTED



TRACK MOUNTED



RECESSED AND SEMIRECESSED



ARCHITECTURAL

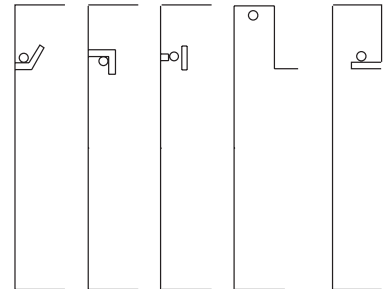


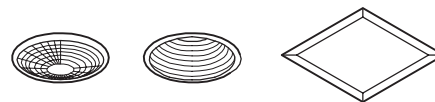
Figure 1-8 *Luminaire* is a term used to describe a complete lighting unit. Luminaires may be portable, pendant mounted (also known as suspended), surface mounted on walls or ceilings (decorative luminaires mounted on walls are often called sconces), or track mounted (the track can be mounted on the ceiling or suspended and can include track heads or pendants). Other options include recessed and semi-recessed fixtures as well as other architectural lighting options (lighting permanently affixed to the architecture of the building), such as cove and valance lighting. More information on recessed luminaires can be found in Figure 1-9.

For residences, a CRI of 80 to 89 provides color rendering where color quality is important in residential applications, such as spaces where the visual quality of colors, materials, finishes, artwork, and accessories are an important part of the experience of the room. In some cases, such as utility and storage spaces, a CRI lower than 80 is acceptable.

Another measure of color appearance, called color temperature or correlated color temperature (CCT), “describes the color appearance of the actual light produced in terms of its warmth or coolness,” according to the Lighting Research Center. Color temperature is measured using the *Kelvin (K)* temperature scale, with lower temperatures (3000 K and lower) used to describe a warm source and higher temperatures (4000 K and above) used to describe a cool source. Typical incandescent lamps and warm fluorescent lamps are lower than 4000 K.

Lumen is a term used to describe the level of light (or brightness) gained from a lamp; it is a technical term measuring the luminous flux. Increasingly, a consideration of lumens produced is replacing a consideration of wattage; watts measure the energy consumed rather than the light produced. In the United States, packaging for lamps generally includes a lighting facts label that states the lumens produced as well as an estimated life of the lamp and the watts used.

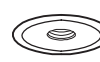
RECESSED DOWNLIGHTS



RECESSED WALL WASH



ADJUSTABLE RECESSED



RECESSED TROFFERS

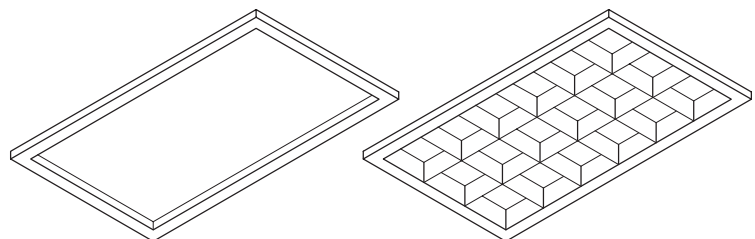


Figure 1-9 Recessed luminaires include recessed downlights (used for ambient lighting) and recessed adjustable downlights (also used for ambient lighting). Recessed wall washers direct light down at an angle and can be used for accent lighting. Recessed troffers are square or rectangular luminaires that house fluorescent lamps. These are available with diffusers or with louvers. Those with diffusers are used to provide ambient light, whereas louvers can direct light for tasks such as computer work. Surface-mounted versions with diffusers are used more commonly in residential settings.

According to the California Lighting Technology Center, in lighting terminology the term *efficacy* “refers to the ratio of luminous output produced by a light source to power consumed by that source (lm/W).”

Efficacy = Lumens/Watts

Varying light sources provide different levels of efficacy; “for example, a 75 W A19 incandescent lamp, a 16 W A19 CFL lamp, and a 15 W A19 LED lamp use different amounts of power to produce the same amount of light (approximately 1100 lumens). Each type of lamp has a different rated efficacy.” It is important to consider the lumens produced (and therefore the efficacy) as well as initial costs and overall lamp life when purchasing lamps.

Designers must understand the roles of lamps in lighting design (remember, these are called lightbulbs by the general public). Lamps are most often discussed as being divided into categories as follows: *incandescent*, *fluorescent*, *light-emitting diode (LED)*, and *high-intensity discharge*. Within each category there is variety in how the lamps look and perform and the quality of light produced.

Incandescent lamps create light as electricity flows through a filament, heating it and making it glow. Incandescent lamps are popular because of the color quality of light that they create (remember the CRI and CCT). However, they use a great deal of energy to produce limited light and are therefore quite inefficient. Only 10 to 15 percent of the energy that goes into the filament is emitted as light; the remainder is generated as heat.

Incandescent lamps come in a range of shapes and sizes, with a letter designating shape and a number indicating the maximum diameter of the lamp (in eighths of an inch). For example, for a common A19 household lamp, the *A* refers to a standard bulb shape (*A* for “arbitrary”), and the *19* stands for 19 eighths of an inch, or $2\frac{3}{8}$ inches. Figure 1-10 illustrates the shapes of other incandescent lamps. Other terms referred to in lamp names have to do with the glass used in the lamp, such as clear or frosted types.

There are also reduced-wattage incandescent lamps, which are shaped similarly to other incandescent types but use a different gas inside the lamp that allows different wattages or, in some cases, a longer lamp life. As standard incandescent lamps are being phased out, more energy-efficient incandescent lamps are under development. (See “Phasing Out Standard Incandescent Lamps.”)

Halogen lamps (also called tungsten-halogen) are another type of incandescent lamp, in which the filament is inside a halogen-filled capsule. The use of halogen gas allows lamps of a similar wattage to produce more light, making these lamps more energy efficient than standard incandescent varieties. Halogen lamps can become quite hot, requiring special care or lamp protection. Dimming these lamps changes the color dramatically and can shorten lamp life. Xenon lamps are similar to halogen but use only xenon gas (and electricity). Xenon lamps are brighter than halogen. They also burn cooler and last

longer. Currently, xenon lamps for residential use are most commonly miniature types, often with pin or wedge bases, or those used in strip fixtures or puck fixtures.

Specialized incandescent reflector lamps have reflective coatings that create a directional light source and are available in a range of beam spreads from spot to flood. PAR lamps (for parabolic aluminized reflector), R lamps (for common reflector), and ER lamps (for ellipsoidal reflector) are all incandescent reflector types.

Incandescent lamps are also available in low-voltage versions, which require transformers to change the primary power (120 volts) to the required low voltage (often 12 volts). This type includes MR16 (the *MR* is for mirrored reflector; the *16* is for 16 eighths of an inch, or 2 inches) and PAR 36 lamps, which are often used for accent or display lighting. Figure 1-10 shows some halogen lamps.

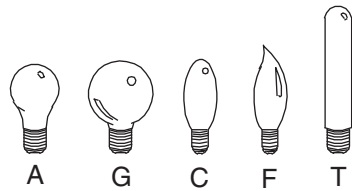
Phasing Out Standard Incandescent Lamps

With the Energy Independence and Security Act of 2007, the United States legislated a gradual phaseout of incandescent lamps. This act required that as of 2014 the United States no longer manufacture or import standard tungsten-filament 40- and 60-watt lamps; however, existing lamps could be sold until supplies ran out. Rather than being a complete ban, however, this legislation requires only that many of the standard A-style lamps in inefficient wattages be phased out; more efficient incandescent lamps will continue to be available. Options for replacing high-wattage incandescent lamps include halogen, LEDs, and compact fluorescent (CFL).

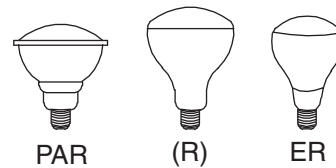
Fluorescent lamps are coated glass tubes filled with gas; light is produced when the gas reacts with electrical energy, producing ultraviolet light, which in turn is absorbed by the coating and produces visible light. Fluorescent lamps require ballasts within the luminaire or lamp. These provide the starting voltage and control the current when in use. Compared to standard incandescent lamps, fluorescent lamps produce minimal heat and are more energy efficient. Lamp color, such as “cool white” or “warm white,” is created by the chemicals (called phosphors) used to coat the lamps and is controlled by the manufacturer.

A range of fluorescent lamp shapes and types are available, including straight tubular (or linear), U-shaped, twin-tube, and circular (properly called circline) lamps. In addition, there are *compact fluorescent lamps (CFLs)*, which, as the name implies, are smaller in size (allowing them to fit in smaller locations). CFLs require the use of a ballast, which may be integral to the lamp or may be part of a separate module that can be replaced separately, and are available in single, double, U-shaped, and

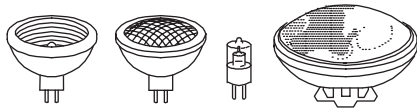
COMMON INCANDESCENT



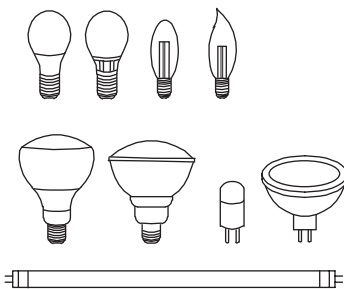
INCANDESCENT REFLECTOR



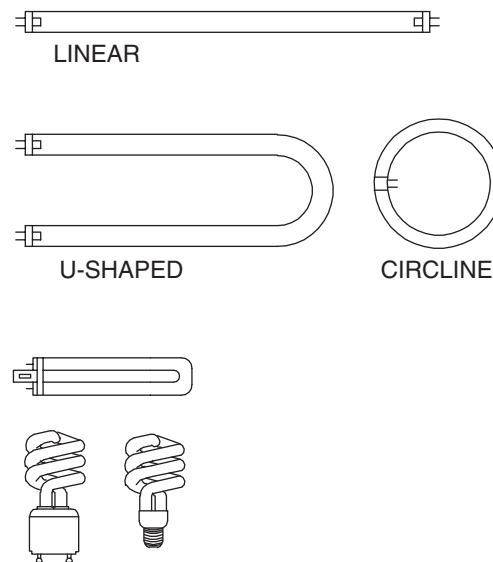
HALOGEN



LED



FLUORESCENT



COMPACT FLUORESCENT

Figure 1-10 Lamps are divided into broad categories: incandescent, fluorescent, light-emitting diode (LED), and high-intensity discharge (not shown). Incandescent lamps come in a range of shapes and sizes, with a letter designation referring to shape (as shown) and a number indicating the maximum diameter of the lamp (in eighths of an inch). Halogen (and xenon) lamps are another type of incandescent lamp. PAR, R, and ER lamps are incandescent reflector lamps that create directional beams. A range of fluorescent lamp shapes and types are available, including straight tubular (or linear), U-shaped, twin-tube, and circular (properly called circline) lamps. In addition, there are compact fluorescent lamps (CFLs), which may have a single, double, or U-shaped tube as well as spiral types with an adapter or with an integral adapter for use in an incandescent lampholder. These have become much more common in residential use in recent years because of their energy efficiency and lamp life. Light-emitting diodes (LEDs), also known as solid-state lighting, are rapidly evolving for residential use (See “Phasing Out Standard Incandescent Lamps”). Note that LEDs are available in a range of lamp shapes and base types that are intended to look similar to incandescent and fluorescent lamps. They can mimic other types of lighting and are also used in strip and rope lighting.

spiral tube types and with an adapter for use in incandescent lampholders. Residential use of CFLs has grown rapidly because of their energy efficiency and long lamp life. Figure 1-10 includes illustrations of some fluorescent lamps.

Light-emitting diodes (LEDs), also known as solid-state lighting, are rapidly evolving for residential use. LEDs use solid-state technology to generate light, making them more like electronic equipment than incandescent lamps. LEDs are long lasting and extremely energy efficient. While LEDs continue to improve in terms of light quality and may represent the future of lighting, they do have some limitations, particularly related to the highly directional nature of the light they generate. The directional light generated by most LEDs is ideal for spotlights and some

task lighting but can fail to fill larger spaces and may only light the top half of some fixtures. Several manufacturers have developed lamps that address this light dispersal problem, creating more flexibility in the use of LEDs. Options should continue to improve in the future as an interest in saving energy has caused some incandescent lamps to be phased out. (See “Phasing Out Standard Incandescent Lamps.”)

Another type of lamp, known as high-intensity discharge (HID), uses a current and gas or vapor under high pressure to produce light. HID lamps also require a ballast. While highly energy efficient, they are not widely used in residential interiors except for applications where lights are left on for extended periods of time, such as for security or in multifamily stairway applications.

It is worth noting that references to bulb shape are different from those used to describe the lamp base; for example, the screw base seen on standard lamps is referred to as a standard base or an Edison base (after Thomas Edison). Lamp bases come in a range of sizes and types and are referred to by name. For example, a standard A lamp with a screw-in base is referred to as a standard base, whereas a smaller, flame-tip-shaped lamp (for use in a chandelier, for example) may have a medium or candelabra base. Also, compact fluorescent lamps are widely available with an integral ballast and a standard screw-in base for use in a standard socket.

Controls for lighting include switches, dimmers, timers, sensors, central controls, and motion detectors. This large family of controls can be divided into two categories: manual controls and automatic controls. Note that for effective use, dimmers require the use of dimmable lamps and often CFLs and LEDs require compatible dimmers (consult the manufacturer's list for dimmer and lamp compatibility).

Commonly used manual controls include switches and dimmers, with switches used to turn lamps on and off and dimmers used to control the light output of some lamps. Timers are automatic controls that are intended to control lamps based on a designated time period. Controls vary a great deal in complexity and cost, with the more advanced and costly options used in some cases as part of a complete home security system.

VISUAL THINKING AND BASIC DESIGN GRAPHICS

This section is meant as an introduction to basic design graphics and the types of visual thinking required in the design and construction of buildings. To introduce readers to the various types, design graphics are covered in two ways in this book: first, in general terms with simple introductory graphics in this chapter, and second, in relationship to a specific sample project with more detailed drawings and graphics in Chapter 8.

A range of types of drawings, sketches, and diagrams are used in the design of buildings and spaces within buildings and are used to explore and refine ideas and information as the design process takes place. Each type of drawing has a specific role or roles in the design process.

Writing in *Interior Design Illustrated*, Francis Ching identifies three basic stages in the design process: *analysis*, *synthesis*, and *evaluation*. According to Ching, analysis involves *defining and understanding the problem*, synthesis involves the *formulation of possible solutions*, and evaluation involves a *critical review of the strengths and weaknesses of the proposed solutions and alternatives*.

To these three stages, Ching adds *design development*, a generally accepted phase of architectural and interiors practice, which is the portion of the process when the design is fully

refined, detailed, and ready for incorporation into construction drawings and documents.

In the early stages of the process, diagrams are used to bring quantitative and qualitative information together with visual information so that the designer can understand and synthesize it more easily. One type of diagram, commonly used as designers begin the preliminary design of residential projects, is known as the *bubble diagram*.

Bubble diagrams serve to visually represent project adjacency requirements and can also represent very rough proportional information. For example, client requirements for an addition that includes a painting studio, with a small bathroom, that is attached to the house through a gallery-like space with a separate entrance could be represented with a bubble diagram in which the bubbles represent not only room locations and adjacencies but also rough proportional information. See Figure 1-11a.

Generally, designers create *many* bubble diagrams as a means of generating multiple ideas. Later, the diagrams are reviewed and evaluated. They may be shown to the client for input and evaluation. On some occasions, another round of diagrams is generated, while in other instances the designer begins more refined project planning based on a successful diagram or a series of diagrams.

Other diagrams and images may be employed as well, including sketches and doodles drawn by the designer to represent some visual imagery suggested in programming or client interviews. Figure 1-11b is a massing sketch of the painting studio that is shown in Figure 1-11a.

It is worth noting that sketches such as the one shown in Figure 1-11b, perspective drawings, and three-dimensional models are used throughout the design process in order to help the designer visualize and refine the design and communicate the design (or design options) to clients and other interested parties. Such drawings and models are incredibly

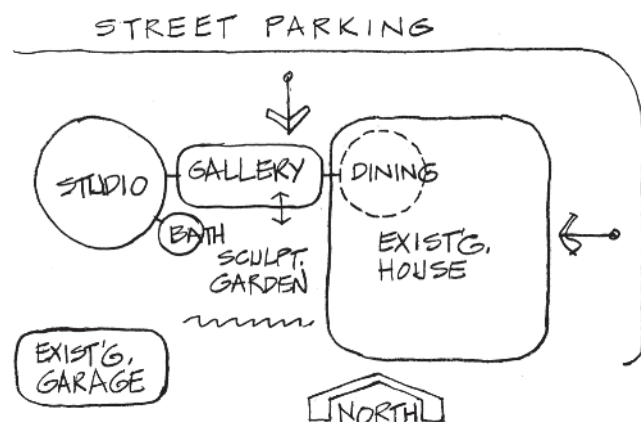


Figure 1-11a A bubble diagram representing client requirements for an addition including a painting studio and a small bathroom. The addition must be attached through a gallery-like space with a separate entrance. The bubbles represent not only room locations and adjacencies but also rough proportional information.

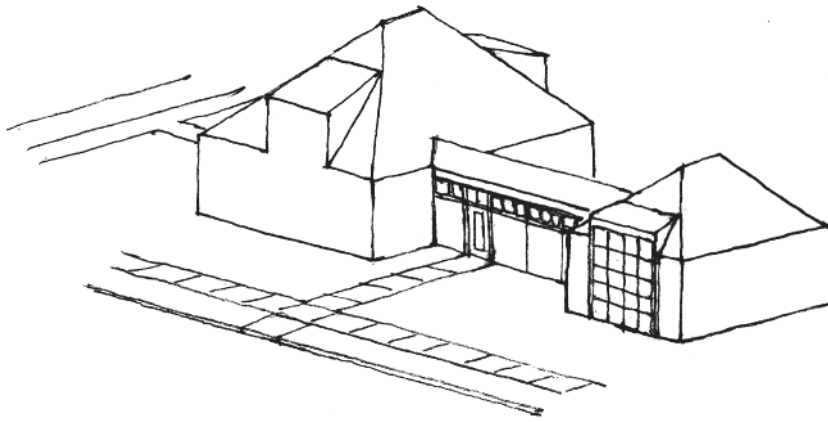


Figure 1-11b A preliminary sketch for the project represented in Figure 1-11a.

important to the overall success of any design project. They are not covered in this book because they fall outside its scope, but they should be seen as integral to the design process and used for every project.

Orthographic Projections

More refined project planning and design, which takes place as the designer moves through the design process, requires very specific drawings known as *orthographic projections*, which include plans, elevations, and sections. These drawings are created by projecting visual information onto an imaginary plane known as the picture plane. This direct projection of an object's dimensions allows for orthographic projections to retain the true shape and proportion, making these drawings accurate and precise and allowing them to be scaled to exact measurements.

Orthographic projection creates fragmentary views of an object, resulting in the need for multiple drawings. This means that, because of their fragmentary nature, orthographic projections become parts of a system and are dependent on one another. By their nature, orthographic projections appear flat and lack the three-dimensional quality of perspective drawings.

One way to visualize orthographic projection is to imagine a small building (in this case a writer's studio) enclosed in a transparent box. Each transparent plane of the enclosing box serves as the picture plane for that face of the object as the drawings are created.

The view through the top plane of the enclosing box is called a *plan* (in this case a roof plan). In a plan view, only those elements seen when looking directly down at the object through the picture plane are drawn, as shown in Figure 1-12a. The views through the picture planes that form the sides of the enclosing box are called *elevations*. Exterior elevations depict only what is visible when viewed directly through the picture plane on that side or portion of the building (Figure 1-12a).

A *section* portrays a view of the object or building with a vertical or horizontal plane sliced through it and removed. One way of understanding section views is to imagine that a very sharp plane has been inserted into the object or building, cutting neatly into it and revealing the structure and complexity of

the object's form. Most building sections are drawn as though the picture plane has been inserted into the building vertically, neatly exposing structural elements and interior details, as shown in Figure 1-12b.

Floor plans are drawn as though a horizontal cut has been made in the building (typically 3 feet, 6 inches to 5 feet, 6 inches [1067 mm to 1676 mm] above the floor), as shown in Figure 1-12b. Cutting into the building at this location exposes the thickness of walls and other structural elements and shows windows, doors, and sometimes floor finishes and furnishings—all of which are located below the location of the cut.

One way to understand the creation of *interior elevations* is to picture yourself inside the room you are drawing. Imagine standing inside a room facing one wall directly, with a large sheet of glass (the picture plane) inserted between you and the wall. The interior elevation can then be created by outlining (projecting onto the picture plane) the significant features of the wall, as shown in Figure 1-12c. Each wall of the room can be drawn in elevation by means of projecting what is visible as you face that wall directly.

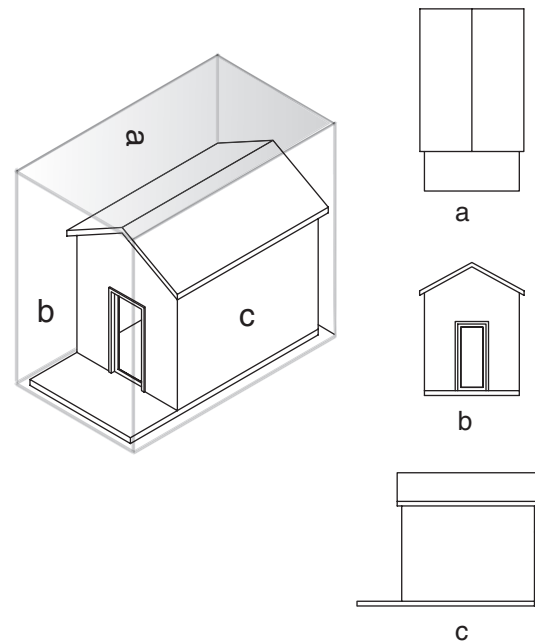


Figure 1-12a Orthographic projection drawings are drawn as though seen through a clear glass box, in which each plane of the box serves as a picture plane for each drawing. Item “a” represents a roof plan, drawn as though traced directly from above using the top plane (shaded for view “a”) of the enclosing box as the picture plane. Item “b” represents the front elevation (front picture plane), drawn as though traced directly using the side (front) plane of the enclosing box as the picture plane. Item “c” represents a side elevation, drawn as though traced directly using the side plane of the enclosing box as the picture plane.

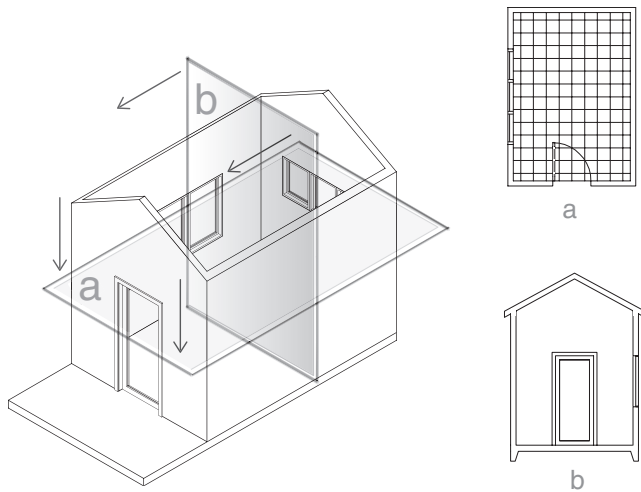


Figure 1-12b Some orthographic projection drawings are sectional views drawn as though the picture plane slices through the building, exposing the structure. Item “a” is a floor plan drawn as though the picture plane has made a horizontal slice. Item “b” illustrates a building section drawn as though the picture plane has been inserted vertically, exposing the building’s structure.

Reflected ceiling plans are specialized drawings used in interior design (more often for commercial projects than for residential projects). Reflected ceiling plans communicate important information about the design of the ceiling, such as height and materials, layout, and locations of fixtures. A

reflected ceiling plan is drawn as though a giant mirror were on the floor, reflecting the elements located on the ceiling. The use of reflective imagery allows for the ceiling plan to have exactly the same orientation as the floor plan.

Orthographic projection drawings are clearly an abstraction of reality and use specific conventions to delineate space and materials. Unlike some other types of drawings, orthographic projection drawings require adherence to conventions, proportional scale, and accuracy of line; these design drawings are highly standardized so that they carry universal meaning. Therefore, items such as walls, doors, windows, property boundaries, references to other drawings, and other items are represented by very specific graphic symbols or combinations of lines. Figure 1-13 illustrates some graphic notation used in these types of drawings, such as wall lines and door and window symbols.

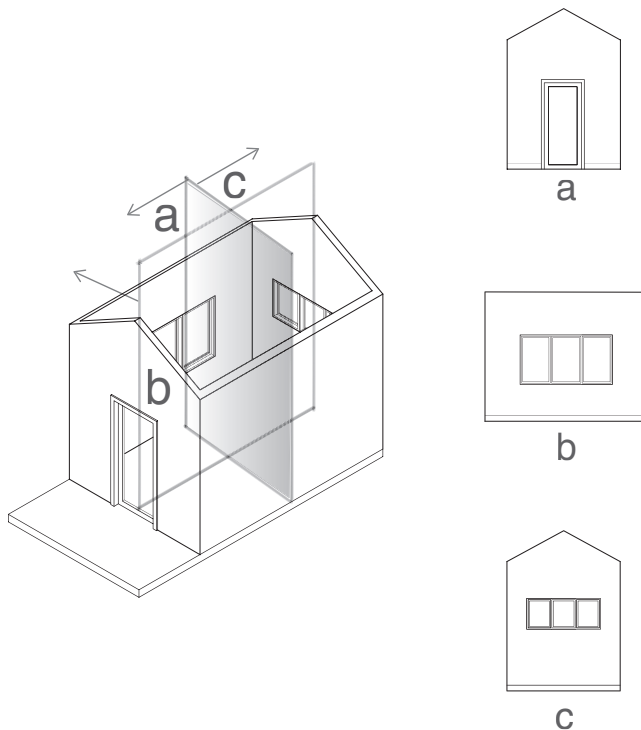


Figure 1-12c An interior elevation is drawn as though the picture plane has been inserted inside the building or room, exposing the interior architecture and details. Only interior elements are included in these drawings, as opposed to building sections, which expose structural elements. Note that the picture plane used for “a” and “c” views is shaded for clarity.

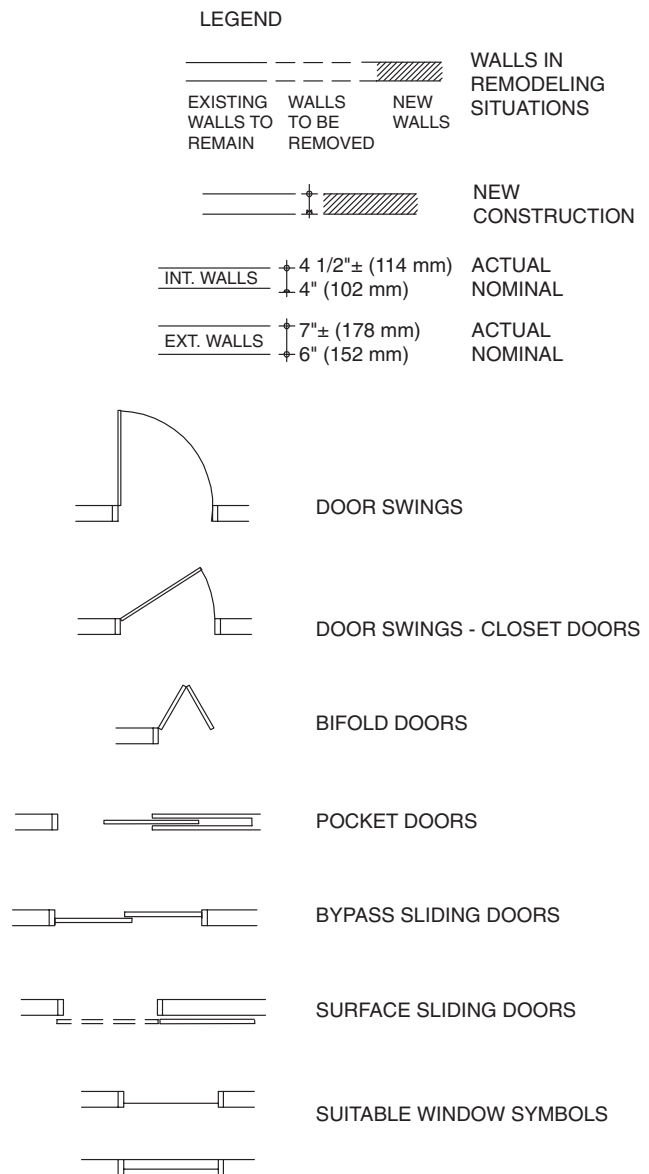


Figure 1-13 Common graphic notation used in orthographic projection drawings. These are standard drawing conventions used to show the items indicated.

Figure 1-14a illustrates graphic symbols used for notes and references, and Figure 1-14b shows graphic symbols used for electrical and lighting. These are standard drawing conventions used to show the items indicated. Figure 1-15 shows additional graphics used to describe construction materials.

In addition to graphic conventions and symbols, design drawings often contain written notes. Over the years, certain

abbreviations have become commonplace for use in design practice. Use of abbreviations can save time in drawing production and space on the actual drawings; however, such use also requires that standard abbreviations be used—as opposed to some creative use of letters that may have no meaning to the reader. A partial list of common abbreviations is given in Table 1-5.

GRAPHIC SYMBOLS


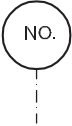







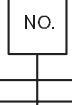



























	OBJECT LINE		COLUMN LINE OR GRID INDICATOR
	HIDDEN, OR EXISTING CONSTRUCTION TO BE REMOVED, OR FUTURE		MATCH LINE (DWG = DRAWING NUMBER FOR CONTINUATION)
	BREAK LINE		WINDOW IDENTIFIER
	CENTERLINE		NOTE IDENTIFIER
	PROPERTY LINE		WALL TYPE IDENTIFIER
SUITABLE DIMENSIONS			EQUIPMENT IDENTIFIER
	HATCH MARK		DOOR/OPENING IDENTIFIER
	ARROW		EXISTING ELEVATION IDENTIFIER
	DOT		NEW (FINISH) ELEVATION IDENTIFIER
	DETAIL INDICATOR		
	SECTION INDICATOR		
	INTERIOR ELEVATION VIEW INDICATOR		
	CONTROL ELEVATION INDICATOR		
ROOM NAME			
	ROOM IDENTIFIER		

Figure 1-14a Graphic symbols used for references and notes. These are standard drawing conventions used to show the items indicated. Note that these symbols include a number on top of another number. The number on top refers to the individual drawing number; the lower number refers to the sheet where the individual drawing may be found.

ELECTRICAL AND LIGHTING SYMBOLS

WIRING AND OUTLET SYMBOLS

	DUPLEX RECEPTACLE (INDICATE NONSTANDARD MOUNTING HEIGHT)
	DUPLEX RECEPTACLE WITH GROUND FAULT INTERRUPTER
	QUADRUPLEX RECEPTACLE (4 PLEX) (INDICATE NONSTANDARD MOUNTING HEIGHT)
	SPECIAL-PURPOSE RECEPTACLE (INDICATE NONSTANDARD MOUNTING HEIGHT)
	CLOCK RECEPTACLE (INDICATE MOUNTING HEIGHT)
	DATA COMMUNICATIONS OUTLET (INDICATE NONSTANDARD MOUNTING HEIGHT)
	TELEPHONE OUTLET (INDICATE NONSTANDARD MOUNTING HEIGHT)
	DUPLEX FLOOR RECEPTACLE
	RANGE OUTLET
	SPLIT-WIRED DUPLEX RECEPTACLE OUTLET
	SWITCH (*D-DOOR; K-KEY OPERATED; LV-LOW VOLTAGE; M-MOMENTARY CONTACT; P-PILOT LIGHT)
	SINGLE-POLE SWITCH
	THREE-WAY SWITCH
	FOUR-WAY SWITCH
	DIMMER SWITCH

ELECTRICAL DEVICES, SWITCHES, AND PANELBOARD SYMBOLS
















	BELL
	PHOTOELECTRIC CELL
	THERMOSTAT
	(RECESSED) PANELBOARD AND CABINET
	CEILING-MOUNTED LIGHT FIXTURE (INDICATE TYPE)
	WALL WASHER (INDICATE TYPE; SHADING INDICATES LIGHTED FACE)
	SPOTLIGHT (INDICATE TYPE; ARROW INDICATES DIRECTION OF FOCUS)
	FLUORESCENT FIXTURE (INDICATE TYPE; DRAW TO SCALE)
	FLUORESCENT STRIP LIGHT (INDICATE TYPE; DRAW TO SCALE)
	LIGHT TRACK (INDICATE TYPE; SHOW NUMBER OF FIXTURES REQUIRED)
	CARBON MONOXIDE DETECTOR
	SMOKE DETECTOR
	SPRINKLER HEAD
	360°
	180°

Figure 1-14b Graphic symbols used for electrical and lighting. These are standard drawing conventions used to show the items indicated.

ARCHITECTURAL MATERIAL SYMBOLS


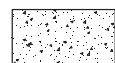


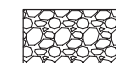


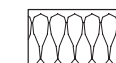



									
EARTH	CAST-IN-PLACE CONCRETE	WOOD; ROUGH WOOD FRAMING	WOOD (FINISH BOARDS)	COARSE POROUS FILL (GRAVEL)	PLYWOOD	BRICK	BATT/FIBROUS INSULATION	RIGID INSULATION BOARD	STEEL

Figure 1-15 Common graphic symbols used to indicate construction materials. These are standard drawing conventions used to show the items indicated.

Table 1-5 Common Abbreviations Used in Construction Notes and Drawings and in Portions of This Book

Abbreviation	Term
ADJ.	Adjacent or adjustable
A.F.F.	Above finished floor
BLDG.	Building
B.M.	Benchmark
BR.	Brick
BRG.	Bearing
CER.	Ceramic
CFL	Compact Fluorescent Lamp
C.M.U.	Concrete masonry unit
CONC.	Concrete
CONTR.	Contractor
D.	Dryer
DBL.	Double
DET.	Detail
DIA.	Diameter
DN.	Down
DW.	Dishwasher
ELECT.	Electrical
EXIST.	Existing
EXT.	Exterior
FDN.	Foundation
FIN.	Finished
FL.	Floor
FLUOR.	Fluorescent
FTG.	Footing
G.C.	General Contractor
G.F.I.	Ground fault interrupter
GL.	Glass
GYP. BD.	Gypsum board
HC.	Handicap accessible
HT.	Height

Abbreviation	Term
HTG.	Heating
KIT.	Kitchen
LAV.	Lavatory
LED	Light-Emitting Diode
CL 	Line of center
MAS.	Masonry
MAX.	Maximum
MECH.	Mechanical
MIN.	Minimum
M.O.	Masonry opening
MTD.	Mounted
N.I.C.	Not in contract
O.C.	On center
OH.	Overhead
OPG.	Opening
PL.	Plate
PLAM.	Plastic laminate
PLAST.	Plastic or plaster
R.	Riser
RAD.	Radius
REF.	Refrigerator
RM.	Room
R.O.	Rough opening
SQ. FT.	Square foot/feet
T.	Tile
TOIL.	Toilet
TR.	Tread
TYP.	Typical
U.G.	Underground
V.	Vinyl
W.	Washer

Additional detailed examples of design drawings and graphics can be found in Chapter 8.

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