Part I

Design Considerations

Finish Selection and Specification 1

There are thousands of products available for use in interior environments, and each has its assets and disadvantages. The process of selecting the right interior material for the job is sometimes bewildering. The purpose of this book is to serve as a guide for designers to learn about, evaluate, and select materials that will look good, work well, and respect human and environmental needs.

As interior designers select finishes for projects and present them to clients, they assess each alternative for its aesthetic contribution to the design concept. In addition to a material's appearance, they consider its acoustic properties and light reflectance. The material's shape, texture, proportion, and scale are related to the balance and symmetry of the space and the harmony of the design. Whether or not a material transmits light influences how it can be used to open or enclose a space. Each selection becomes part of complex relationships between unity and variety, rhythm and repetition, and emphasis and hierarchy. The way a material expresses its function is also part of its aesthetic quality (Figure 1.1).

Figure 1.1: Materials in Trinity Church Undercroft, Boston, Massachusetts

The selection of materials is restrained by codes and regulations that have been instituted to ensure the public's safety. For example, interior materials can either contribute potential fuel to a fire or resist ignition and flame spread. The materials that line the paths to exits—the means of egress—are especially important.

Interior materials often affect human health and well-being, so designers must review materials for their ability to prevent slips and falls and to cushion surfaces from impact. They check details of product manufacture and installation for exposed sharp edges and shatter resistance. Electrically conductive materials are selected where static

electricity is likely to cause a painful shock or affect electronic equipment. Materials that are likely to become very hot or cold require insulation from contact. Where potentially dangerous chemicals are in use, materials are selected to protect both surfaces and people. Designers should avoid materials that expose people to harmful chemicals or unsafe conditions during manufacturing, delivery, installation, use, or disposal, or that degrade **indoor air quality (IAQ)**.

Designers consider how a material will perform under the conditions of the project. They rate materials for durability, colorfastness and fading, and stain and water resistance, and evaluate them for ease of maintenance. Materials may be tested and labeled for light, moderate, or heavy use by their manufacturer.

A material's availability during a project's schedule is related to manufacturing schedules and shipping and warehouse arrangements. Custom-ordered items often require longer lead times and additional paperwork. Special government conditions apply to the export or importation of rare and antique materials.

Describing the Properties of Materials

Color: property dependent on the quality and quantity of light; one or more innate colors, and possibly other colors if processed
Durability: ability to resist destructive forces, retain original appearance, and continue to function as intended
Elasticity: resiliency or flexibility; the ability to return to initial form after deformation
Form: the three-dimensional quality defined by length, width, and depth; may be linear, planar, or block-like
Plasticity: ability to be formed or shaped; allowing continuous deformation without rupturing or relaxing
Refinement: ability to form and retain precise, thin, closely spaced elements; depends on strength, durability, and manufacturing process
Strength: ability to resist stress, to bend without breaking
Texture: relative smoothness or roughness of a surface; may be large- or small-scale
Workability: the ease of altering a material from its primary form

FUNCTIONAL CRITERIA

The basic functional qualities of materials suggest their appropriate uses. These include safety, durability, comfort, ease of care, fire resistance, and acoustic properties.

Safety issues for interior materials include toxicity, health effects, slip resistance, and shatter resistance. Not only should designers select a material to be safe for use as intended, but they should also consider the unexpected; for example, wired glass will not break when hit by water from a fire hose (its intended function), but it will break if struck hard by a fist, causing cuts and bleeding. It is important to keep in mind that safety concerns change over time; when asbestos was introduced to prevent the spread of fire, its effect on human health was not clearly understood or was not considered.

Durability involves evaluating a material for its ability to stand up to its intended use. Materials may be rated for their resistance to abrasion. Some materials will melt when they come in contact with a heat source; others will deteriorate from contact with alcohol or acetone. Water will damage or weaken some materials, while others will dry out in low humidity. The preparation of the underlying **substrate** and the use of proper installation procedures affect the durability of a material, as does its finish.

Comfort is a functional criterion for interior materials that come in contact with the human body. A sturdy but hard chair may encourage short visits in a food court; in contrast, a cozy, large one is more likely to induce lingering. Materials that carry heat away from the human body may be welcome in a tropical climate but can feel unpleasantly cold to the touch elsewhere. The texture of a floor becomes critical for those who spend their workday on their feet.

Ease of care affects a material's continued performance over time. A material that can be used in a carefully controlled environment with excellent maintenance procedures may not withstand exposure to unsupervised users and less diligent maintenance. Products with frequent, complex, or expensive maintenance requirements often fail to retain their initial appearance, especially if untrained personnel are performing the maintenance.

Fire resistance is such an important topic that designers often limit their initial material selections to those that meet the requirements of fire codes. Codes consider not only the ability of a material to ignite and burst into flame, but also how much smoke it will produce and whether fire will quickly spread across its surface. When exposed to fire, some materials produce toxic chemicals that may be odorless and produce no smoke or flame.

The acoustic properties of interior materials affect the acoustic quality of a space by absorbing or reflecting sound within it, and by transferring sound from one space to another (Figure 1.2).

Within a space, a sound generated from one location will spread out and away from its source; this is referred to as **diffusion** (Figure 1.3). It continues to spread and gradually becomes weaker, which is called **attenuation** (Figure 1.4), until it is either absorbed or reflected by an intervening material. In some spaces, a designer will want sound to be reflected and spread around. In other interiors, a high level of sound absorption will keep noise at an acceptable level. Within a single interior space, there may be areas of relative quiet and noise.

The materials chosen for the ceiling surface usually have the greatest impact on sound absorption. Next in importance are the surfaces behind the source of the sound. The surfaces in front of the sound source are also important, while the flooring material is generally the least important in terms of sound absorption.

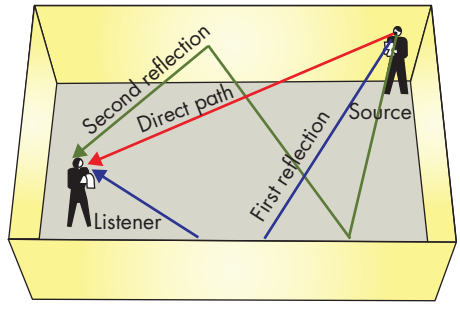

Figure 1.2: Reflected sound

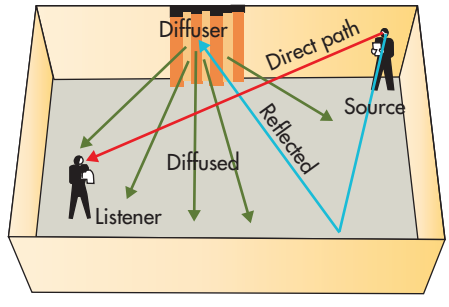

Figure 1.3: Sound diffusion

The sound of footfalls and chairs scraping on a hard-surfaced floor can add a considerable amount of noise to a space. **Impact noise**—the sound made by one object striking another, such as a shoe on a floor—will reflect into the room where it originates but may also pass via the building structure to another location (Figure 1.5).

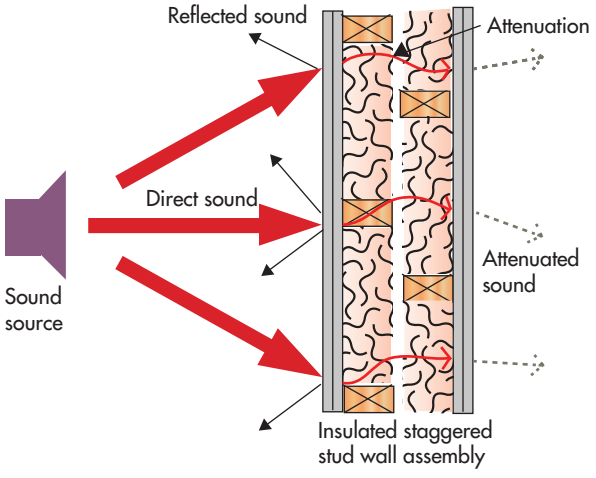

Figure 1.4: Sound attenuation

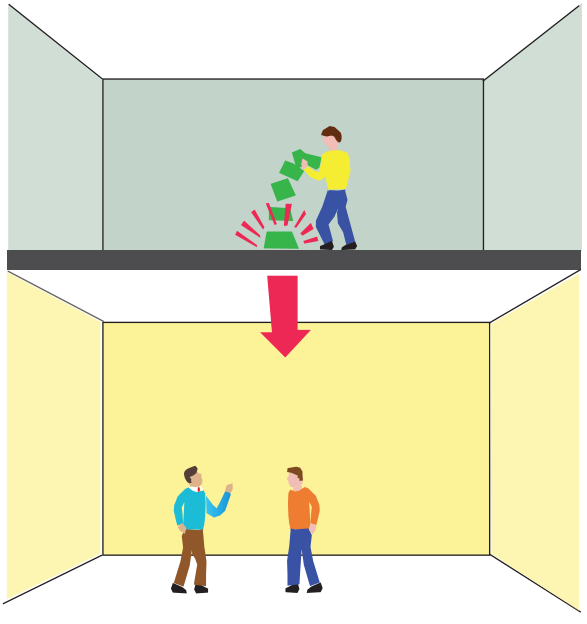

Figure 1.5: Impact noise transmission

Some materials tend to block the transfer of sound. These include large amounts of sound-absorbent material as well as massive materials. Other materials are considered to be acoustically transparent, allowing sound waves to pass directly through to the other side; open-weave fabrics and perforated panels are used this way. Certain panel materials will pick up the vibration of a sound wave and amplify it, much like the head of a drum.

HEALTH AND SAFETY CODES

Interior designers share in the responsibility to create buildings that support human health and safety. Whether a project is large or small, the interior designer benefits from an awareness of the impact it will have on the welfare of its users and the community of which it is part.

Building Codes

Before starting to select the finishes and furniture for a project, a designer determines which codes are applicable. The International Code Council (ICC) publishes the International Codes (I-Codes). The International Building Code® (IBC) or codes based on it have been widely accepted throughout the United States. Other I-Codes with provisions related to interior materials include:

- International Residential Code for One- and Two-Family Dwellings® (IRC)
- International Existing Building Code® (IEBC) (also chapters on existing buildings in other codes)
- International Green Construction Code® (IGCC)

The C3-Codes, published by the National Fire Protection Association (NFPA), are newer than the IBC and not as widely adopted. NFPA 5000® Building Construction and Safety Code is a C3-Code relevant to interior materials.

Note: Code information in this text is meant for general reference only; see *The Codes Guidebook for Interiors* by Sharon Koomen Harmon, IIDA, and Katherine E. Kennon, AIA, published by John Wiley & Sons, for more detailed information.

Occupancy Classifications

Occupancy classifications were developed to address risk factors associated with specific types of building use. They consider the way a space is used: the amount of finish materials, upholstered furniture, and other flammable contents; and the concentration and characteristics of occupants, among other things. The **occupant load**—the number of people that is assumed to safely occupy a space or building—is closely related to the occupancy classification. Interior materials–related code issues affected by occupancy include accessibility requirements, finish and furniture selection and placement, and means of egress.

Building Construction Types

Building construction types are classified by building codes according to their resistance to fire. Building elements rated in hours include bearing and non-bearing walls and partitions and floor

construction and secondary members. Building types and elements are important considerations when adding walls, finished ceilings and ceiling elements, doors, and interior glazing.

Materials and material assemblies are rated based on their fire resistance (ease of ignition, length of burn, flame spread, and heat generation). Most products are classified as either noncombustible, fire-resistant, limited combustible, or combustible. Fire-resistant and limited combustible materials may be combined with other materials in rated assemblies. Some combustible materials are allowed in rated spaces with proper installation.

Noncombustible materials will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. They are used to prevent substantial fire spread, and do not contribute to fire. Fire-resistant materials will delay the spread of fire for a designated time period. They can prevent or retard passage of heat, hot gases, or flames. Limited combustible materials do not meet noncombustible material requirements, and do have some capacity to burn. Combustible materials will ignite and continue to burn when the flame source is removed.

Means of Egress Issues

Means of egress is defined as a continuous and unobstructed path of travel from any point in a building to its exterior or a public way. Both horizontal and vertical passageways, including doorways, corridors, stairs, ramps, enclosures, and intervening rooms, are included. Requirements tend to become stricter as the occupant moves toward the exit.

Compartmentation

Compartmentation involves the separation of various areas of a building to control fire and smoke by wall, floor, and ceiling assemblies, which may be required to be fire-rated, smoke-rated, or both. Fire-rated assemblies include fire walls, fire barriers, horizontal assemblies, and fire partitions. Smoke barriers and smoke partitions may also be required in some cases. The combination of walls, floor, and ceiling together creates a compartment or enclosure.

There are two basic types of tests for fire-rated wall and floor/ceiling assemblies. Fire-resistance tests evaluate how long an assembly will contain a fire, retain its own structural integrity, or both. Other tests measure how a material contributes to the dangerous elements of a fire such as heat, smoke, combustion products, and flame spread.

Sound Transmission

Codes address efforts to prevent airborne sound transmission between specific types of spaces, such as hotel rooms, dormitory rooms, or apartment units. These requirements for specific **sound transmission coefficient (STC)** levels affect the selection of materials and their use in assemblies. The IBC requires that walls, partitions, and floor/ceiling assemblies separating dwelling units from each other or from public areas limit sound transmission and impact noise.

Residential Codes

Historically, building codes have focused on commercial, institutional, and multiple-occupancy residential buildings rather than on single- or two-family residential buildings. However, most fires occur in

smaller residential buildings. According to the NFPA, 92 percent of all civilian structure fire deaths in 2010 resulted from home structure fires, with cooking the leading cause of fires and home fire injuries. Smoking is also a major cause of civilian home fire deaths.

Tip: For more information on home fires, see www.NFPA.org

International Residential Code

The ICC has developed a residential code, the International Residential Code (IRC), which is required by many jurisdictions and referenced in some other I-Codes and standards. The IRC specifies both the types of materials and requirements for proper construction for foundations, floors, walls (including interior walls), ceilings, and roofs. It includes provisions relating to floor finishes, shower and bath area finishes, wall and ceiling finishes and trims, wood finishes, and mattresses. Other codes and standards may also apply to residential projects. (Table 1.1).

Other Regulations and Standards

Other provisions relating to interior materials include federal regulations and state and local codes. Standards are often referenced by building codes, the federal government, or a code jurisdiction. There are also optional industry standards that can be specified.

Federal Regulations

The federal government regulates the building of its own facilities, including federal buildings, Veterans Administration hospitals, military facilities, and other buildings built with federal funds. Government

Table 1.1: Residential Codes and Standards

Code	Comments
International Residential Code (IRC)	Single- and two-family homes, duplexes, and townhouses
ICC 700, National Green Building Standards (NGBS or ICC 700)	Used with IRC; requirements for resource, water, energy efficiency, and indoor environmental quality
ASHRAE/IESNA 90.2, Energy-Efficient Design of New Low-Rise Residential Buildings	Energy efficiency standard
International Energy Conservation Code (IECC)	Includes chapter on residential buildings
Fair Housing Accessibility Guidelines (FHAG)	Accessibility requirements

agencies may require use of a number of codes, including the Life Safety Code and the IBC. Designers should contact the appropriate federal agency to determine which codes and standards apply.

State and Local Codes

State governments also have regulations that affect interiors. In addition, there are local municipal ordinances, health codes, zoning regulations, **historic preservation** laws, and neighborhood conservation restrictions. Many jurisdictions are developing green building programs as well.

Standards Organizations

A **standard** is a definition, a recommended practice, a test method, a classification, or a required specification that must be met. Standards are developed by trade associations, government agencies, and standards-writing organizations (Table 1.2). Although standards have no independent legal standing, they are typically referenced by codes using the standard organization's acronym and standard number, with the year of the required edition at the end. There are also optional industry standards that can be specified.

Note: Standards for specific materials and furnishings are included in the appropriate chapters later in this book.

Building materials and products must meet tests required by standards, which are administered by independent testing agencies. Products that pass are given a label or certificate, or verification is available on product samples or from the manufacturer. Testing agencies and certification organizations may have their own marks of approval, such as the UL (Underwriters Laboratories) label.

Table 1.2: Standards Organizations

Organization	Description
American National Standards Institute (ANSI)	Methods for defining and developing standards
ASTM International	Over 12,000 standards in 15 categories, including construction and textiles
International Code Council (ICC)	Develops codes, standards, and guidelines for building safety and construction
National Fire Protection Association (NFPA)	Over 300 standards, including testing requirements for textiles, means of egress design
NSF International	Plumbing and sustainability standards
Underwriters Laboratories (UL)	Tests building materials, finishes, upholstered furniture

Finish and Furniture Selection and Codes

Fire resistance relates to building materials and assemblies, while flame resistance is used with finishes applied to assemblies. Codes typically consider most finishes and furnishings to be combustible and impose some flame spread and smoke development restrictions for many interior uses. The term "flameproof" is usually not used in codes; "flame-retardant" or "flame-resistant" are used instead.

Note: For information on codes and standards for specific finishes and furnishings, refer to the chapter that covers the material in question.

IBC and NFPA codes each have a chapter on interior finishes and furnishings, with restrictions on wall and ceiling finishes, floor finishes, and decorations and trim. Finishes for restroom surfaces and fixtures are found in the plumbing codes and in the environmental chapter of the IBC. The federal government, as well as some cities and states, have their own regulations.

Accessibility requirements for finished floors that address slip resistance and level changes are found in the 2010 ADA Standards for Accessible Design and ICC/ANSI A117.1 (Accessible and Usable Buildings and Facilities), both of which also cover accessible furniture. Finishes and furnishings are also covered by sustainable code requirements for interior air quality.

Code requirements for interior finishes and furniture often refer to standards developed by NFPA, UL, or ASTM. There are also federal, state, and local government standards.

The International Standards Association (ISO) establishes procedures use by other standards-developing organizations. Some ISO standards conflict with ASTM procedures, resulting in ISO standards being less widely used in the U.S., but that is starting to change. In particular, the sustainability standards of ISO's 14000 series are gaining popularity.

Finish and Furniture Tests and Classifications

The process of identifying the appropriate finish classification begins with identifying the occupancy classification of the building or space, and whether it is a new or existing building. Each finish chapter in the building code includes a finish table specifying required finishes for the different means of egress components (exits, exit access corridors, and other rooms and spaces) and types of buildings.

Interior wall finishes that are subject to code provisions include most of the surfaces applied over fixed or moveable walls, partitions, and columns. Interior finishes for ceilings are covered in codes. Coverings applied over finished or unfinished floors, stairs, and ramps are also included.

Building and fire safety code requirements affecting furnishings include exposed finishes found in furniture and window treatments (fabrics, wood veneers, and laminates) as well as nonexposed finishes, such as the foam in seating and the linings in draperies. Whole pieces of furniture and upholstered seating, as well as panel systems, are included.

Residential wall and ceiling finishes may be covered. Finishes in showers and bath areas are also regulated; they must be smooth, hard, and nonabsorbent.

Standards and testing requirements for interior finishes and furnishings change often. Codes set minimum requirements, and it may be prudent to be more stringent.

Table 1.3: Finish and Furniture Tests

Test	Description
Mattress Test	Pass/fail test used to determine heat release, smoke density, generation of toxic gases, and weight loss when a mattress is exposed to a flame
Methenamine Pill Test	Pass/fail flammability test required for all carpets and certain rugs manufactured for sale in U.S.
Radiant Panel Test	Measures tendency to spread a fire, and minimum energy required to sustain a flame for carpet, resilient and hardwood flooring, wall base
Room Corner Test	For napped, tufted, or looped textiles used as coverings on walls and ceilings
Smolder Resistance Test	Tests how new upholstered furniture smolders before either flaming or extinguishing (Cigarette Ignition Test)
Steiner Tunnel Test	Tests flame spread and smoke developed for interior finishes applied to walls, ceilings
Toxicity Test	Measures the amount of toxicity a material emits when it is burned (LC50 or Pitts Test)
Upholstered Seating Test	Pass/fail flame-resistance test for entire piece of furniture
Vertical Flame Test	Pass/fail test for vertical treatments (window treatments, large wall hangings, and decorative plastic films)

Tests for finishes and furniture look at the potential of the material to contribute to the overall fire and smoke growth and spread (Table 1.3). Typically, the fire source for the test is a lit cigarette or small fire. Small-scale tests are performed on a small sample of the finish or furnishing. Large-scale tests use a larger sample or full assembly including the finish, substrate, adhesive, fasteners, and other parts. They may include an entire room or a whole piece of furniture.

Sustainability considerations focus on toxicity of finishes and furniture that can affect the health, safety, or welfare of people exposed to them on a daily basis. Tests focus on detecting the off-gassing of **volatile organic compounds (VOCs)** at room temperature.

HUMAN FACTORS AND MATERIAL SELECTION

The selection of materials and furnishings involves considering which are culturally and age-appropriate, and designed to fit a variety of human sizes and shapes. Interior materials intended to

create privacy are used to screen views. Materials intended to provide security are often designed to do so unobtrusively, to avoid the perception of being watched.

Intimate interior spaces invite the use of precious or delicate materials. Small-scale and intricate details are best appreciated with close observation and personal attention. Maintenance of intimate spaces may be more refined than for more public spaces.

Personal interior spaces reflect the character of their owners. Therefore, materials are selected with attention to individual taste and personal history. Because access to personal spaces is ordinarily limited, materials can be selected to support specific lifestyles and maintenance requirements.

The materials for social spaces are usually chosen to suit the intended group of users. The materials used in an office workspace, for example, will be subject to spilled coffee and rolling desk chairs, whereas the materials in a day care center must respond to the safety and durability needs of small children. Materials for hospitality spaces and restaurants demand a high level of aesthetic discrimination, matched with heavy use requirements. Health care facilities have special requirements for cleanliness, maintenance, and durability.

Materials used in public spaces must withstand a higher level of abuse than those intended for private use. The use of public spaces for larger groups suggests a larger scale of interior material treatment. Issues of public security and safety require materials to be durable, securely fastened, and vandal-resistant.

Durability must be considered and factored into the long-term cost of a material. Materials used overhead are generally out of reach, but may be handled to access equipment above the ceiling. A corridor must withstand floor traffic and people leaning against the walls. The edges of counters are rubbed against and sometimes picked at. Chairs are scraped on floors, rubbed against walls, and turned onto tabletops for cleaning. Cleaning equipment that bumps into walls and furnishings can also cause damage.

Accessible and Universal Design

Accessible design addresses the requirements of a single group within the larger population, specifically, people with disabilities. There are differences between appropriate accessible design for public facilities and the best approach for custom-designed, private, accessible projects. An accessible design for a public space should meet the needs of a broad range of users. Slip-resistant materials without irregularities should be selected for walking surfaces. Surfaces will require protection from contact with wheelchairs (Figure 1.6). The height and extension from the wall of wall-mounted materials should be limited. Materials should be carefully chosen to indicate changes in location.

Universal design is inclusive of all people with respect to human factors. It differs from accessible design by addressing as widespread a group as possible. Many of

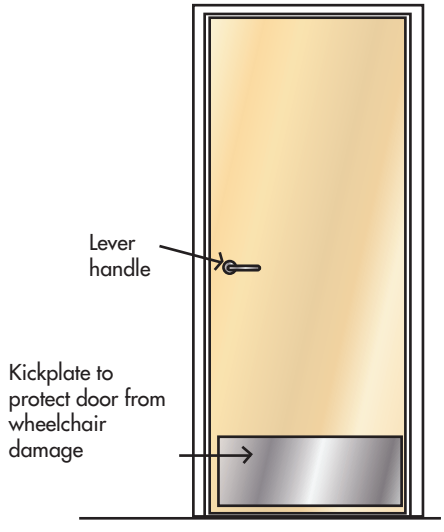

Figure 1.6: Wheelchair footrests and door protection

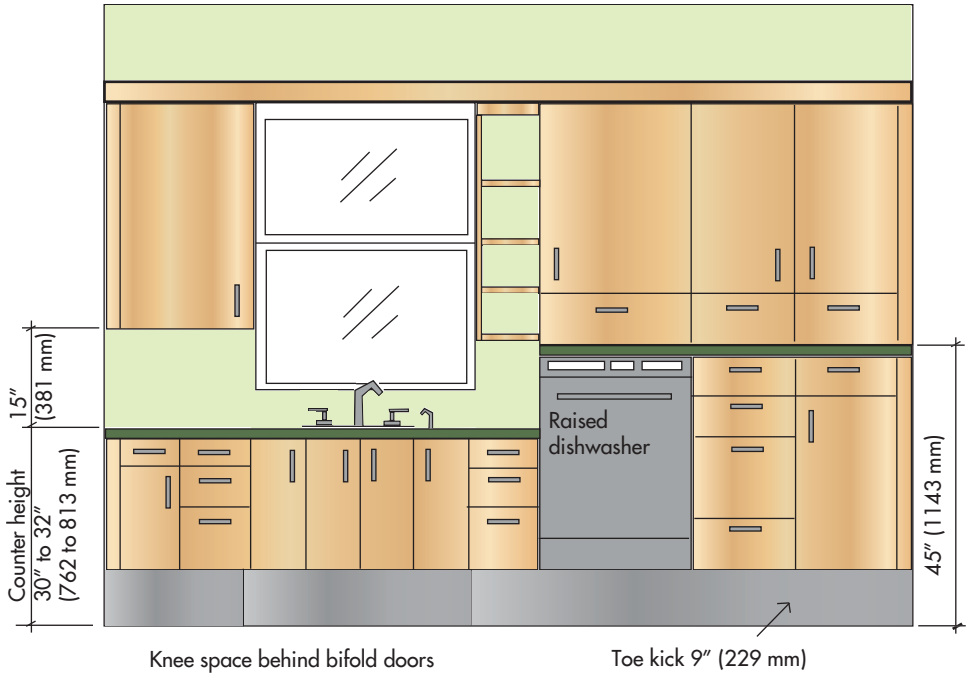

Figure 1.7: Universal design kitchen

the same features that promote safety and independence for seniors, such as handrails and nonslip flooring, also function well for the general population (Figure 1.7).

Accessibility Codes

Many interior projects are required to be accessible to all, and accessibility requirements are included in most building codes. Federal law requires the use of the ADA Standards for Accessible Design in many projects. Many codes reference the ICC/ANSI A117.1 accessibility standard. Projects for federal agencies may require use of the ABA portion of the 2004 ADA-ABA Accessibility Guidelines, called the ABA Standards.

Tip: The 2010 ADA Standards for Accessible Design are available as downloads from the United States Access Board at www.ada.gov/2010ADAstandards_index.htm.

Note: For more information on codes and standards for specific finishes and furnishings, refer to the chapter that covers the material in question.

Cost Estimating

To respect a client's budget, a designer should provide guidance as to where money can be spent wisely, and where it makes sense to economize. Creativity need not be limited by financial constraints, however, and interior designers who find creative solutions without breaking the budget are highly prized.

One of the most important budgetary considerations for interior designers is the **life-cycle cost** of a product. The life-cycle cost of a material includes its purchase price as well as costs for transportation, installation, maintenance, upgrade, refurbishment, disposal, and recycling (Figure 1.8).

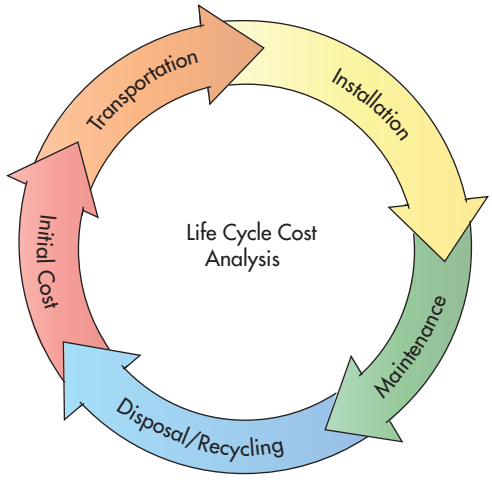

Figure 1.8: Life-cycle cost analysis

Interior designers prepare cost estimates to give clients an accurate and detailed idea of project costs. Estimates aid in creating design solutions that fit the client's budget. They are also used to verify figures prepared by subcontractors and to compare bids. It is important to emphasize to clients that estimates are not firm quoted prices, and may not reflect actual costs.

When providing purchasing services for a client, it is important to emphasize that switching from a selected item to another, perhaps less expensive, source may result in additional costs for design services to hunt down alternatives. On the other hand, upgrading a design element to a more expensive selection can result in money not being available in the budget for other work.

Interior designers may be asked by clients to prepare a construction estimate for budgeting purposes prior to soliciting construction estimates from contractors. These estimates may be based on previous similar projects, square footages, or barebones drawings reviewed by contractors or subcontractors. Depending on the project, an estimate may include furniture, window treatments, accessories, cabinets and millwork, and installation of specified furnishings and equipment.

The cost of interior design and construction work will vary from region to region and country to country. The cost of local materials and local labor will affect the estimate, as will the currency exchange rate. When economies of scale are taken into account, the cost of improving a single room will be higher than the cost per room of a project with 100 rooms.

Scheduling affects costs as well, with aggressive timelines typically increasing the cost. Work in occupied buildings may have to be done at night or on weekends, adding to labor costs. When work has to be done during a contractor's busy season, the contractor may ask for more money than if the work is taken on during a slow season. Similarly, prices may be higher in a booming economy than in a slow one.

A number of other design factors have budgetary ramifications. Designs that are highly detailed and include unusual or unique features may be more expensive to build than conventional designs. A design that takes advantage of stock material sizes and uses materials efficiently is generally less expensive to build. Materials that are difficult to acquire, rare, or unusual tend to increase overhead as well as materials costs. The level of refinement that the designer specifies will also affect costs. An experienced designer can create designs that achieve aesthetic and functional goals while simplifying the fabrication process.

Many interior design projects involve modification of existing buildings. Site visits by an estimator familiar with the types of construction and materials are recommended.