



Building Interiors

Grace Kelley

Sponsored By



Published by APPA:

APPA is the association of choice serving educational facilities professionals. APPA's mission is to support educational excellence with quality leadership and professional management through education, research, and recognition.

Reprint Statement:

Except as permitted under copyright law, no part of this chapter may be reproduced, stored in a retrieval system, distributed, or transmitted in any form or by any means - electronic, mechanical, photocopying, recording, or otherwise - without the prior written permission of APPA.

From APPA Body of Knowledge

APPA: Leadership in Educational Facilities, Alexandria, Virginia, 2009

This BOK is constantly being updated. For the latest version of this chapter, please visit www.appa.org/BOK .

This chapter is made possible by



APPA
1643 Prince Street
Alexandria, Virginia 22314-2818
www.appa.org

Copyright © 2009 by APPA. All rights reserved.

Building Interiors

Introduction

Interior design as a profession, a specialized branch of architecture, is a relatively new field. Graduates in this field have a thorough education with strong architectural emphasis, and many are finding careers in facilities management. Simultaneous with the development of the interior design profession, and perhaps related to it, has been the growing emphasis on creating and maintaining a higher education environment that is conducive to learning. Until relatively recently, the principal concerns with interiors were that they were kept painted, clean, and adequately lighted and contained serviceable furniture. Choices of interior colors often were left to the occupants, and economy dominated the selection of furniture and interior materials. Currently, however, the value of professional interior design in creating an effective interior environment is widely recognized. Several large institutions have interior designers on their facilities staffs. However, many facilities organizations do not have the resources to include a professionally trained interior designer.

This chapter provides fundamental information that will be useful to the facilities manager. It includes extensive information on interior issues: interior materials and systems, space planning, acoustics, and lighting. It also includes information on standardization of furniture, flammability regulations, and facilities for the handicapped. Some effort is made to provide a sense of the aesthetic issues with which the interior designer is faced.

All information is tailored to the requirements of the institutional environment. Within this environment a design solution must first be functional, and then cost-effective. It must be aesthetically pleasing and commensurate with other factors such as durability, maintainability, and safety.

Basic Principles of Design

All interior design schemes endeavor to relate functionally and aesthetically to the existing environment. The more appropriate the design scheme, the clearer the perception that it was created as an integral part of the whole. Design fads that prevail over functional appropriateness generally will be perceived as cluttered, disjointed, or dysfunctional. The designer must distinguish good design from inappropriate design.

Good design does not refer to taste. Taste is a matter of preference. Good design has a basic, lasting quality. Most people can recognize a design scheme that works well, even though they may be unable to fully appreciate why it works.

It is relatively simple to state the basic principles of good design: proportion, balance, rhythm, focus, and harmony. Once these principles are understood, they can be applied almost without effort.

Proportion

Proportion in design is the harmonious relationship of one part to another or to the whole. The early Greeks discovered the secret of good proportion and established rules that have been accepted and followed by designers for centuries. Their standard for good proportion was a rectangle with its sides in a ratio of two parts to three; this is called the *golden rectangle*. The *golden section* involves the division of a form so that the ratio of the smaller proportion to the larger is the same as the larger to the whole. The progression 2, 3, 5, 8, 13, 21, 34, and so on, in which each number is the sum of the two preceding numbers, provides an approximation of this relationship. For example, 2:3 is approximately the same ratio as 3:5 and 5:8 is the same ratio as 8:13. These proportions should be applied when planning the dimensions of a room or selecting a piece of furniture for a particular area. Classic rules of proportion also dictate that the division of a line somewhere between one-half and one-third was most pleasing. This concept was called the *golden mean* and

can be applied in interiors when hanging pictures or tying back draperies.

An object is perceived in relation to the area around it. Objects that are too large will crowd a small room, whereas furniture that is too small will seem even smaller in a large room. In addition, a large piece of furniture will seem even larger when surrounded by small furniture.

Form, color, texture, and pattern all influence our perception of scale and proportion. Coarse texture, large patterns, and bold colors will make an object appear larger, whereas smooth textures, small patterns, and light colors will make it appear smaller. Whatever attracts the eye appears larger. These principles can alter the apparent size and proportion of spaces and objects.

Balance

Balance provides a sense of equilibrium and repose, a feeling of the weight of an object. Three types of balance exist: bisymmetric, asymmetric, and radial.

Bisymmetric or formal balance uses identical objects arranged similarly on either side of an imaginary line, such as a sofa with identical end tables and matching lamps on both ends. Every arrangement needs some bisymmetry.

Asymmetric or informal balance is more subtle. This type of balance requires more thought but remains interesting longer than completely symmetric arrangements do. In asymmetric arrangements, objects of different sizes, shapes, and colors may be used in an infinite number of ways. Two small objects may balance one large one, a small shiny object may balance a larger dull one, or a spot of bright color may balance a large neutral area.

Radial balance is an arrangement that radiates from a central point. A round conference table or a dining table with chairs around it is an example of radial balance.

The architectural features of a room, such as doors and windows, should be located in such a way as to give this feeling of balance. A pleasing distribution of highs and lows and large and small features give a room a well-balanced feeling.

Rhythm

In interiors, rhythm is something that allows the eye to move smoothly around the room. It may be achieved by repetition, gradation, opposition, transition, and radiation. By repeating color, pattern, texture, line, or form, a rhythm of a repetitive nature is achieved. Gradation is the succession of the size of objects from large to small, or of colors from dark to light. Opposition occurs wherever lines come together at right angles, or wherever a horizontal line of furniture meets a vertical architectural member. Transition is the rhythm of a curved line that carries the eye over the room, as occurs with an archway. Radial rhythm is a result of lines extending outward from a central axis.

Focus

The focal point is a feature of the room to which the eye is drawn. It creates a feeling of unity and order in the room. A prominent architectural feature commonly serves as a focal point, but if no architectural feature exists, an important piece of furniture can substitute.

Harmony

Harmony involves fitting together parts to form a cohesive whole. Completeness and order are established when the furnishings of a room harmonize in their relationships with other items within the space and with the background. If the room is large or small, furniture should be scaled accordingly. Floor coverings should be selected with a theme or purpose in mind. Fabrics and colors should be appropriate to the style of furniture. Accessories should be appropriate to the style of the other furnishings and should reflect the personality of the space.

Characteristics of Objects

The basic principles of proportion, balance, rhythm, focus, and harmony are achieved by considering the characteristics of the elements in the interior landscape. Much as one looks at a park-like landscape and perceives the characteristics of trees, shrubs, grass, flowers, sky, water, and pathways, one can look at the interior landscape and perceive the characteristics of desks, chairs, files, carpet, walls, and ceilings. These characteristics include the following elements: texture, pattern, line, form, space, color and light, and color schemes.

Texture

Texture refers to the surface quality conveyed by objects within a space and the dominant texture the architectural background establishes. For example, a room paneled in polished wood or papered in a traditional wall covering will require furniture woods and fabrics with smoother textures than will a room paneled with rough-hewn wood or constructed of masonry.

Pattern

Pattern forms the simplest method of surface embellishment. Too much pattern can make a room too busy. Although the total arrangement of the components of a room creates an overall pattern, the more obvious patterns are in carpet, fabric, and wallpaper. These should be appropriate to the general feeling of the room.

Line

Line is expressed by the sense of composition, direction, and whether motion or repose is felt within a space. Line can seemingly alter the proportion of an object or of an entire room. Vertical lines cause the eye to travel upward, causing the area to seem higher. Horizontal lines direct the eye across the area, making it appear wider. Curved lines are graceful and fluid. Diagonal lines give a room a feeling of action; staircases and slanted ceilings are examples of this. Too much line movement gives an unsettled feeling. A proper balance of the various vertical, horizontal, and curved lines achieves harmony.

Form

Form is a major concern in planning interiors. The shape or mass of objects within a space causes a sense of confusion if an excessive variety is used. A lack of variety creates monotony.

Space

Basic rules govern the use of space. Anthropologist and father of proxemics Edward T. Hall observed that people have specific, culturally prescribed distances in their daily activities. Designers must be aware of these personal and public space relationships and allow for them in their designs.

Color and Light

Color and light are the most interrelated elements of interior design. Color is a quality of light reflected from an object to the human eye. When light strikes an object, some of it is absorbed; the rest is reflected. The wavelength of the light an object reflects determines its color.

To use color effectively in planning attractive rooms or in selecting furniture, draperies, or floor coverings, it is necessary to consider these factors:

- The relationship of colors to each other, and how light affects the apparent color
- The characteristics of colors and their psychological effects
- Which colors harmonize, and which contrast
- Which combinations are appropriate and practical for the specific project

Color Schemes

Red, yellow, and blue make up the three primary colors or hues. The secondary colors (a combination of two primary colors) include orange, green, and violet. Numerous shades result when one of the primary colors dominates the mixture, as in the case of yellow-green or green-yellow.

Three basic color schemes exist: analogous, complementary, and monochromatic.

- *Analogous*. Colors harmonize with each other when they share a common element. Blue, for example, is a basic element of green, blue-violet, purple, and red-violet.
- *Complementary*. Too many harmonizing elements can become tiresome. It is therefore desirable to introduce contrast by adding a complementary color. For example, the complement of red is green, which is a color containing no red but made up of blue combined with yellow.
- *Monochromatic*. Color schemes that use various shades or values of a single color are called monochromatic. Monochromatic schemes can be monotonous unless other elements such as pattern or texture are used.

The color to dominate the room should be the first one selected. This selection is based on the client's preference or the room's size and light conditions. After the dominant color is chosen, the related or harmonizing colors are selected. Most rooms should be decorated in an ascending scale from dark to light: rugs or floors should be darkest, walls lighter, and ceilings lightest. Efforts should be made to avoid pure white in favor of off-white shades. Another style of decorating involves a descending scale of values, with colored walls and ceilings of grayed or darkened hues and light-hued floor covering.

Colors should be distributed throughout the room, avoiding the spotty effect of isolated splotches of color concentrated in one area. One way of distributing colors is to upholster at least one piece of furniture in a fabric containing all the colors in the room.

The main areas of a space usually should be the most neutral in value. As areas are reduced in size, the chromatic intensity can be proportionately increased.

In a color scheme, small touches of bright hues are called *accents*. Accessories or an occasional chair can supply the accent color to heighten the effect of a color scheme. Cooler shades such as blue or green, for example, will make small rooms look larger, whereas yellow, orange, and red can make larger rooms more intimate and cozy. Cool tones are quiet and restful, and warm colors are friendly and cheery.

Interior Materials and Systems

Floor Coverings

This section primarily concerns rugs, carpeting, and resilient tiles. However, flooring is not limited to these materials. Terrazzo, wood, ceramic tile, and marble are flooring materials whose initial high cost can be justified under appropriate circumstances. The best approach to flooring design entails considering the specification of flooring in the initial phases of construction and not as an afterthought, limiting it to surface decoration.

Rugs

In the 17th and 18th centuries, carpets and other floor coverings were rarely found in the homes of ordinary people; textiles were considered precious and were not used on the floor. The word *rug* referred to a handmade coverlet, and *carpet* referred to a table cover. Woven or hand-knotted rugs did not become common as floor coverings until the early 18th century, when Oriental carpets became popular among the wealthy.

The hand-knotted rug is the best rug or carpet, the Oriental rug being a fine example. However, the demand for Oriental rugs has increased to such an extent that their manufacture has become commercialized. Although Oriental rugs are still made on hand looms, quantity production in factories' with less experienced craftspeople, cheaper materials, and aniline instead of vegetable dyes' has become common.

In the university environment, the designer may have an opportunity to specify such a rug in a special setting, perhaps the office of the president or an important public area. In this case, the designer should depend on the advice of an expert or reputable dealer.

Custom-designed tufted rugs also create a rich effect. For those with a tight budget, manufacturers in Puerto Rico, Hong Kong, and Japan produce fine hand-tufted rugs to specification. In addition, larger mills in the United States serve as a source of custom-designed products.

A less expensive way to achieve this custom look is to use broadloom carpet and border it with another broadloom, cut to the desired width. Several borders of varying widths and coordinating colors or patterns can be used. After the border is added by attaching it to the field carpet with seaming tape, the seams can be beveled for a sculptured look.

Carpet

Carpets and rugs represent beauty, luxury, or status, regardless of the actual function of a space. When considering carpeting, perhaps the most important question is, "How will the space be used?" The following is a list of properties carpets can be expected to provide:

- Acoustical privacy
- Ease of maintenance
- Cost-effectiveness
- Design flexibility
- Feel of luxury

The type and quantity of fiber and the carpet's construction determine the quality. The determining factors in manufacturing are the pitch (number of face yarns per inch), the pile height (the height of the yarn above the backing), the ply of the yarn (number of individual ends of yarn twisted together), and the method of weaving or tufting. Ultimately these factors are reflected in the price, and a reputable manufacturer's price is a good indication of its quality.

To make an intelligent decision when specifying carpet, one must have at least a basic knowledge of carpet fibers and how they perform. The following summarizes the types of natural and manmade fibers used in commercial carpet manufacturing (Figure 1).

Natural *carpet fibers* include wool, cotton, and flax. *Wool* carpet has reemerged in prestigious contract interiors and still represents the standard against which all carpet fibers are measured. The surface of wool scatters optical light, thus improving its appearance by diffusing soil visibility. Because of the scaly character of carpet, crevices in the carpet do not hold surface dirt and dust readily. Below-surface particles release with ease, and resilience is outstanding. The significant characteristics of wool fiber are as follows:

Advantages	Disadvantages
Consumer appeal	Initial cost
Appearance	Stain removal
Feel	Abrasion resistance
Resilience	Styling versatility
Flame resistance	
Soil resistance	
Cleanability	
Solvent resistance	

Economics and technology have resulted in the displacement of wool by man-made fibers. Man-made fibers are in liquid form before solidifying at room temperature. Essentially, they are manufactured by heating the polymer (chemical material) and blowing it through a perforated plate called a *spinnerette*. Fine streams of liquid become solid strands of filament as the material cools in a liquid or air bath.

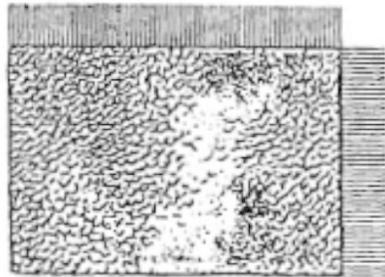
Nylons are the leading petrochemically derived face fiber materials, followed by acrylics and olefins. Made of chemicals from the polyamide group, nylon is the most widely used carpet fiber. The synthetic yarn is not

naturally resilient but is crimped, bent, and twisted to create resilience. Nylon tends to retain its shape because it is nearly 40 percent harder than, for example, olefin. This means that nylon made to the same specifications as olefin and used in the same area will show wear at a lesser rate. However, nylon absorbs and holds limited amounts of moisture, so it is not as stain resistant as olefin, even when solution dyed. (*Solution dyed* means the dye is added while the nylon is still in liquid form, before it is extruded into a fiber.) This capillary characteristic enables nylon to be dyed in many ways, increasing its manufacturing and styling flexibility.

Here is a guide to the various carpet terms you should acquaint yourself with before developing your specification.

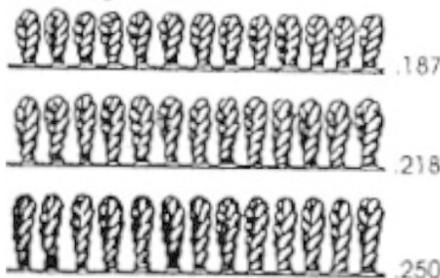


Magnification of continuous filament yarn.

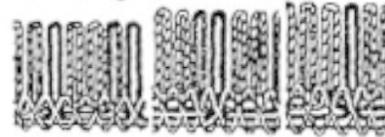


Number of tufts per sq. inch. This is determined by multiplying needles (corresponding to a particular pitch or gauge) by rows or stitches per inch. Example: $\frac{1}{8}$ gauge, 8 needles times 8 stitches per inch equals 64 tufts per square inch.

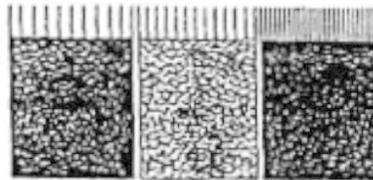
Pile Height



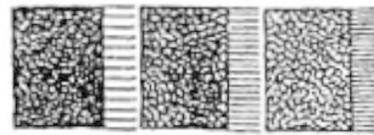
Wire Height



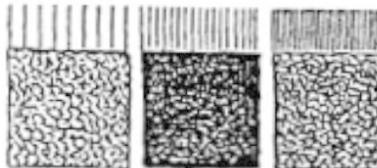
Gauge: (Tufted Fabric) The distance between two needle points, expressed in fractions of an inch.



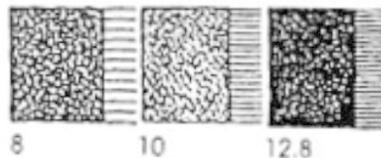
Stitches. The number of lengthwise yarn tufts in one inch of carpet.



Pitch. (Woven Fabric) The number of single ends per 27 inches of width.



Rows. The number of lengthwise yarn tufts in one inch of carpet.



Pitch to Gauge Conversions

Pitch	108	143.9	172.8	180	189	216	243	252	256	270	346
Needles	4	5.3	6.4	6.6	7	8	9	9.3	9.5	10	12.8
Gauge	1/4	3/16	5/32	9/64		1/8				1/10	5/64

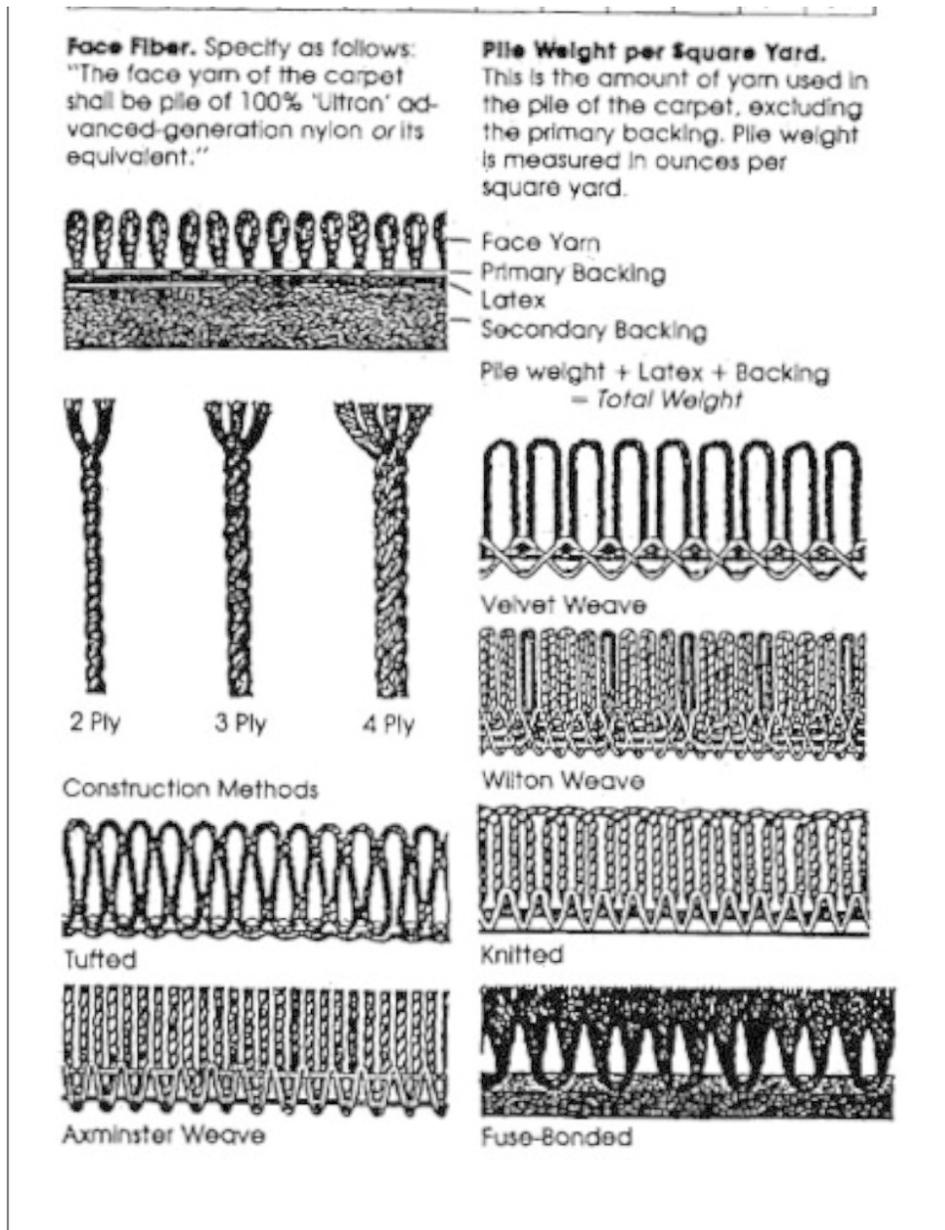


Figure 1. General Carpet Construction Criteria

Nylon's hard, smooth surface reduces the tendency of soil particles to cling to the fiber, so they can be easily removed during vacuuming. The fiber cross-section, with its modified triangular shape, breaks up and scatters light rays and tends to hide the soil on the back side of the fiber, making the carpet appear cleaner. The ability of a carpet to retain a good appearance as long as it lasts is the true measure of its effective life. Appearance-retention qualities are inherent in carpet made from nylon.

Nylon fiber exhibits the following advantages and disadvantages:

Advantages	Disadvantages
Good bulk and cover	High static
Crush resistance	
Wearability	
Takes color well	
Good luster range	
Soil resistant	

Good cleaning	
Mildew resistant	

Acrylic fibers are synthetic fibers whose polymer base is composed mostly of acrylonitrile units. The fiber has a high bulk-to-weight ratio; good acid and sunlight resistance; and a bulky, wool-like appearance. It is produced in staple form only to be spun into yarn. High color, long life, and resistance to mildew characterize this fiber. Color is added by stock dyeing in the spinning mill while the acrylic is still in fiber form.

Characteristics of acrylic fibers include the following:

Advantages	Disadvantages
Low static level	Low abrasion resistance
Excellent cover and bulk	Alkali resistant
Wide color range	
Moisture resistant	
Mildew resistant	

Olefin fiber is a synthetic polymer whose base is ethylene, propylene, or other olefin. It is the lightest commercial fiber, has excellent strength, and is resistant to chemicals and abrasion. It is dyed in liquid form prior to being extruded into continuous filament yarns. Thus it is solution dyed. It is highly moisture- and stain-resistant; however, olefin is a petroleum-based product, and the oily residue in soil will bind more readily to its surface. If spillage is a problem in an area being considered for carpeting, olefin will provide excellent protection against stains. Proportionally more soiling will occur, however, with a resulting increase in maintenance costs. The following advantages and disadvantages characterize olefin:

Advantages	Disadvantages
Color solution dyed	Low resilience
Good cover and bulk	Limited color
Abrasion resistant	
Stain resistant	
Low static level	
Mildew resistant	
Initial cost	

The text that follows describes the major manufacturing processes for carpeting.

Carpet Backing

Carpet specifications must also include the type of backing used, as the backing will seriously affect the quality of the installation. Justifiable arguments exist for both jute and synthetic carpet backings. A choice must be made based on the most appropriate product for the particular installation.

Jute is a natural cellulosic fiber made from certain plants of the linden family that grow in India and Bangladesh. Jute yarns are used for woven carpet backing, yarns, and twine. Woven jute fabrics are used in tufted carpet as primary and secondary carpet backing.

Jute absorbs adhesives well and forms tight mechanical bonds, preventing delamination between carpet and backing. Installers frequently prefer jute backing because it stretches better than synthetics, goes around comers easier, and accommodates irregularities better. It also absorbs moisture, however, and can mold and rot when wet. When wet, jute tends to shrink as it dries.

Synthetics are highly resistant to mold and mildew. They are not damaged by moisture, will not rot, will not

contribute to face yarn stain if the carpet is wet, and remain odor free. Synthetic carpet backings reduce static buildup in computer areas. The addition of carbon to the primary backing, combined with face yarn treatment, reduces static by about 80 percent. Together, they eliminate essentially all noticeable and computer-damaging static.

Attached cushion backings are a special type of carpet backing. Made of urethane foam, this backing forms a built-in carpet pad that is glued directly to the floor. One disadvantage is that at replacement time, most of the pad remains glued to the floor. Another type of cushioned backing is vinyl backing.

Tufts of carpet yarns punched into primary backing will pull out unless a "glue" is applied to the back of the carpet. Sometimes this coat is the final step in backing the carpet. In this case, the carpet is said to have a *unitary back*. The coatings, made of latex or polymer, are spread on at room temperature and then baked dry, or spread on hot and allowed to cool. Both methods lock in each yarn bundle while forming a back ready to be glued down.

Carpeting with unitary backing is made for glue-down installations. Common office areas, libraries, and other heavy traffic areas are ideal locations for glue-down, unitary back carpet. Premium adhesive is essential. Installation of latex unitary tends to be more complicated and therefore more expensive, because installers must follow precise instructions. Latex unitary is nonporous and will resist evaporation. Therefore, it is necessary to let the adhesive tack before the carpet is committed to the adhesive. It is less flexible than conventional backs of jute and must never be folded, creased, bent, or stretched, as it is difficult to flatten. Carpets with unitary backings are extremely durable and provide an exceptionally strong tuft bind. However, the other properties of this thermoplastic backing must be evaluated in relation to the requirements of the specific installation. Just as important, only a crew experienced with this type of backing should be allowed to install it.

Carpet Life Cycle Costing

Low cost is an important consideration, but initial low expense is only one aspect. Although the initial purchase price for carpeting may be higher than for conventional floor coverings such as vinyl tile, long-term cost is demonstrably less, with substantial overall savings from extended wear life at high retention levels for appearance. Total use cost is the best basis for comparison. The use cost concept evaluates the three basic elements of value in relation to cost:

1. How much does it cost to buy and install?
2. How long will it last?
3. What will it cost to maintain?

The installed cost of carpet is, on average, greater than that for noncarpeted floors. However, its combined maintenance costs are so much lower that its total use cost is 45 to 52 percent less than that of noncarpeted floors.

Flammability Testing

It is important to be familiar with potential fire hazards and apply this knowledge in specifying materials and systems. The use of the wrong kinds of interior finishes and furnishings have caused many deadly fires. Often it takes these tragedies to prompt federal or state governments to enact legislation to protect the public.

In the first critical moments of a fire, ignited materials will either contribute to or prevent the fire's spread. Factors to consider when evaluating particular materials for safe use include the amount of heat, smoke, and toxic gases released and interaction with other materials.

Although flammability connotes ease of ignition or flame spread rate, in actual practice it refers to the performance of a product subjected to a specified test. When determining flammability of carpeting, many tests may apply (Figure 2):

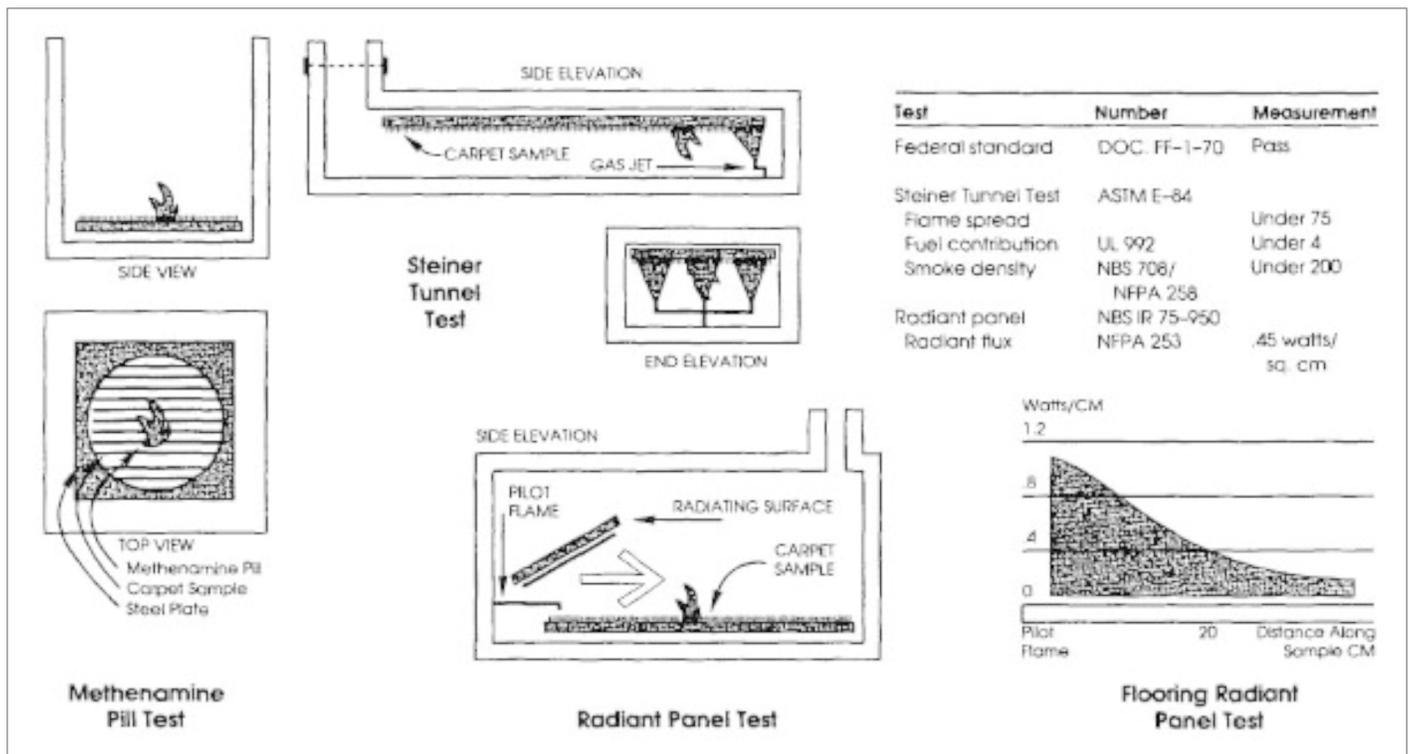


Figure 2. Product Flammability Performance Illustration

- *Methenamine Pill Test: DOC FF-1-70.* DOC FF-1-70 applies to carpet, and DOC FF-2-70 applies to rugs. The National Bureau of Standards developed this test, and the Department of Commerce adopted it in 1970. Since 1971 this test has been required by law for all carpet offered for sale in the United States. It is the Federal Trade Commission standard.
- *Steiner Tunnel Test: ASTM E-84, NFPA 255, UL 723.* The Steiner Tunnel Test, developed by Underwriters Laboratories, is required by the Public Health Service and Life Safety Code for contract carpeting installed in health care units participating in Hill-Burton and Medicare programs. This test subjects carpet specimens to a heavy flame source and uses flame spread as a comparative measure. Hill-Burton programs require a flame spread rating of 75 or less.
- *Flooring Radiant Panel Test: ASTM E648; NFPA 253; NBS IR 75-950, NFPA 101.* This test has been approved as a replacement for the E84 Steiner Tunnel Test and is used by many regulatory agencies; however, some may still require the Steiner Tunnel Test. The Panel Test measures the heat required to sustain combustion in carpets exposed to radiant energy and flame. A pass-fail heat flux level of 0.5 W/cm² or higher is generally recommended for corridors and exit ways in hospitals and other such institutions; 0.25 W/cm² is recommended for corridors and exit ways in schools, offices, and other buildings.

When the Flooring Radiant Panel Test is used to measure flammability, the National Bureau of Standards Smoke Chamber Test is sometimes used to measure smoke density. Most government regulatory agencies approve the Flooring Radiant Panel Test for nonsprinkled corridors and primary exit ways. The Methenamine Pill Test would then be used for room carpet and sprinkled corridors. The rating system is as follows:

Class 1 = Minimum 0.45 W/cm²
 Class 2 = Minimum 0.22 W/cm²

- *Smoke Density Chamber Test: ASTM E662 and NFPA 258.* The Smoke Density Chamber Test is the same as the NFPA 258. It measures solely the smoke density characteristics of carpet under controlled laboratory conditions to determine the specific optical density of smoke within a closed chamber. The rating system includes an index range from 0 to 800 units. Most federal agencies require a smoke density of a maximum of 450 units average of the flaming and nonflaming results.

Carpet Estimating

For planning purposes, a quick estimate of the square yardage required can be figured by calculating the square footage from the floor plan, then dividing by the number of square feet in a square yard (9), and adding 20 percent for waste. This will generally be excessive but will provide a budgetary figure.

Stairs present a special problem. Two methods exist for installing carpet on stairs: the waterfall method, which uses one continuous piece of carpet, and the cap-and-band method, which covers the stairs in separate pieces.

When estimating carpet, include information about special details such as type and condition of floors and whether shoe mold is to be removed. Note existing carpet to be removed, whether it is glued down or over a pad, and the condition of the flooring beneath the existing carpet.

Most carpet experts use the rule-of-thumb formula of $2\frac{1}{2}$ linear feet of tackless strip for each square yard of carpet. When drawings or measurements of the areas are available, a closer estimate can be obtained by computing the total linear feet and adding 10 percent for waste.

Most commonly, carpet used commercially is manufactured in 12-ft. widths. Each width of carpet must lie with its pile going in the same direction. Finding the best layout for the carpet will depend on the most economical use of yardage, maximum performance of the carpet, and desired appearance. When planning layout, factors to consider include placement of seams away from high-traffic areas, no right-angle seams through doorways, and minimum of 1-ft.-wide fill pieces.

Carpet Installation

The following issues should be considered in determining whether an installation should be stretched in or glued down:

1. *Size of job.* Generally speaking, jobs with a long run between anchor points will be difficult to properly stretch. This can be aided where separate offices are involved, permitting a 4 x 4 or 2 x 8 board to be used as a base for the power stretches; otherwise, a 25-ft. run would be the maximum.
2. *Layout of job.* Large open areas with furniture or partitions that interfere with proper original stretching (and hinder restretching) should not be stretched in. Likewise, irregularly shaped or angular areas should be avoided. Multiple office space connected by a maze of corridors also presents a distinct stretch and/or restretch problem.
3. *Underlayment.* Underlays that are too soft can cause problems.
4. *Use.* Heavily trafficked areas or areas in which wheeled equipment is routinely used are to be avoided with stretch-in. Padding accentuates traffic patterns and impedes the movement of wheeled equipment.
5. *Style innovations.* If the designer specifies bias cuts, inserts, or other innovations, proper stretch-in is often impossible.
6. *Flammability.* Flame spread performance of any carpet is dramatically and negatively affected by underlayment owing to the insulating effect of the pad, which prevents heat dissipation through the carpet. Where regulations do not specify that the flame spread test must be made over a pad but it is known they cannot be met in such a system, the stretch-in method should not be used.

When stretch-in is appropriate, the following considerations are important:

1. *Amount of stretch.* Each product should be stretched slightly past its stabilization point to avoid growth and buckling as it relaxes. Most installers take responsibility for the first restretch if difficulty in properly stretching occurs initially.
2. *Layout and carpet care.* Proper stretch-in requires proper fastening around the entire perimeter and at all seams. The carpet must be laid in one direction, and the back must not be abused (dragging heavy furniture, exposure to wheeled traffic) prior to or subsequent to installation. Diagonal cuts are to be avoided.
3. *Mechanical requirements.* Power stretchers are recommended in all sizes of contract installations but are essential in larger ones. Large installations also require commercial tackless strips with three rows of pins.

Carpet Wear

Several factors determine the life expectancy of carpeting: abrasion resistance, appearance retention, maintenance, and traffic patterns. Abrasion resistance relates directly to wearability, whereas appearance retention relates to such characteristics as crushing, fading, soiling, and matting. Improper maintenance can accelerate wear as gritty abrasive dirt accumulates, dulling the color and reducing resilience. High traffic will cause crushing and abrasion problems.

Whether a carpet is functionally acceptable is still a subjective matter. Laboratory methods for measuring abrasion resistance employ the Taber Abraser and Rollstuhl tests, among others. These tests are based on the number of cycles required to abrade the pile fiber completely to the primary backing.

The multilobal structure in various deniers of nylon fibers provides exceptional bulk and gives excellent resistance to crushing and matting, even in high-traffic areas. This high degree of resilience minimizes the traffic lanes and deep indentations from heavy furniture.

Tuft bind is also a measure of how well the carpet will wear. The ASTM Test D1335 determines the pounds of force required to pull the tuft out of the back of the carpet. Tuft bind is obtained by proper application of the back coating. A single tuft in a loop pile carpet should withstand a minimum of 8 lbs. of pull force for most end-use applications; a pull force of 4 to 5 lbs. is generally adequate for cut pile carpet. A higher tuft bind is recommended when the possibility of deliberate raveling exists, such as in grade school installations.

Wear is defined as appearance loss, not as fiber loss. The ability of a carpet to retain a good appearance as long as it lasts is the true measure of its effective life. Appearance retention qualities are inherent in properly constructed carpet, installed with an appropriate end use in mind.

Atmospheric contaminants such as ozone and other gases contribute to color fading. The advanced generation nylons have less open physical structure that provides resistance to gaseous penetration and thus aids in color stability.

Solution dyed yarn discourages fading because the color is permanently locked into the fiber. Proper dye selection and fixation will ensure color clarity through resistance to fading, crocking, and repeated cleanings.

Industry test procedures accepted by the American Association of Textile Chemists and Colorists (AATCC) to determine colorfastness include the following:

- *Atmospheric Fading (AATCC 129)*. This test determines the color change of the carpet when exposed to ozone gas in the atmosphere under high humidities. The International Gray Scale ratings are 5, no change; 4, slightly changed; 3, noticeably changed; 2, considerably changed; and 1, much changed. A shade change rating of at least 3 after three cycles of exposure is desired.
- *Lightfastness (AATCC 16E)*. This method determines the colorfastness of textile materials to light in a xenon arc fadeometer after material is exposed to 60 "AATCC fading units" and judged visually for change. A gray scale rating of at least 4 is desired.
- *Crocking (AATCC 8)*. This is the degree of color transfer from the carpet to a white cloth rubbed in a standard fashion across the carpet's face. After 20 friction cycles, the color transference is rated visually on the AATCC Chromatic Transference Scale. Results should be 4 or above.
- *Shampooing (AATCC 138)*. This measures the color change caused by severe shampooing. Test specimens are rated visually on the gray scale standard. Results should be below 4.

Pile density is important for the carpet to retain its appearance with wear. Dirt tends to remain on the surface of dense pile and can be vacuumed away. Permanent crushing is less likely with dense pile. A dense surface will feel hard underfoot, but comfort underfoot can be improved with a high-density commercial pad. A cushion can also significantly reduce pile compaction. However, in areas of heavy traffic, especially wheeled traffic including carts and wheelchairs, carpet should be glued directly to the floor.

Preventive maintenance is important. Entry points must have walkoff areas: grids, carpet tile, or other removable and cleanable surfaces. Outside entrances should be covered with outdoor carpet and swept daily. Parking lots should also be swept periodically to prevent foot traffic from carrying dirt into the building.

Multicolored or all-over patterns hide soil better than light or dark solids. Loop-pile carpets are most effective in hiding textural change.

Cut-pile fibers become compressed with wear, whereas loop-pile fibers flex and bounce back.

The maintenance required and the cost of materials are closely related. Nylon, which costs more than olefin, requires less maintenance. On the other hand, olefin is a good choice for areas with less traffic.

Because of heavy traffic in school buildings, even the most durable carpets wear at a rapid rate, especially at the seams. Several manufacturers have developed bonding processes for carpets that are guaranteed against edge or seam ravel, at less than 10 percent weight loss of pile face fiber, and with static resistance effective for the life of the carpet.

An antimicrobial treatment also offered deters bacteria growth, which is a problem in health care facilities, cafeterias, and some classrooms. In offices and classrooms, static can cause problems with computers. Total electric compatibility carpets feature a special conductive backing that manufacturers guarantee will not cause disruption or malfunction of electronic equipment.

Static Buildup

Typically applied static treatments are not permanent. With use, these coatings will wear off. The most effective static dissipator for nylon, olefin, or wool is a carbonized fiber added in the construction of the carpet to absorb and discharge excessive static. With a conductive element added to the yarn bundle, carpets will effectively keep static buildup below the sensitivity level. (For cut pile constructions, a conductive back may be required.) An effective test method to determine the static propensity of carpets is the AATCC-134 Step Test with Neolite soles. This test induces and measures static buildup on carpets by simulating conditions under which the static electricity may become objectionable. Peak charge generation (at 70°F and 20 percent relative humidity), developed by walking or shuffling traffic, is monitored under carefully regulated conditions and related to the threshold of charge above which objectionable shock may be experienced. For areas with delicate electronic equipment, the equipment manufacturer should be consulted for maximum static control levels that can be tolerated.

Alternative Floor Coverings

Alternative floor coverings include modular carpet, resilient flooring, and ceramic or quarry tile.

Modular Carpet

Many factors have influenced the popularity of modular carpet, or carpet tile. It is cost-effective, has good quality control, performs well, is easily maintained, and can be used to create unique custom designs. Advantages also include less office disruption during installation, increased flexibility, extended life, and easier access to the subfloor.

The flexibility afforded by carpet modules enables rearrangement in offices without patching the carpeting where power and telephone lines were installed. When workstations are moved in an open-plan furniture system, damaged tiles can simply be picked up and replaced.

The life cycle of carpet modules can be extended from two to five years by selectively replacing and rotating tiles subjected to heavy traffic, excessive soiling, or abnormal abuse. In-house employees can easily perform this task.

Carpet tiles are particularly appropriate in installations using flat cable or raised-access floors. With other systems, such as trench ducts, carpet tiles are the most practical floor covering.

Unique designs are possible with carpet tiles because of the variety of colors, patterns, and textures.

Contrasting colors can be used as borders or to indicate departmental separation or efficient traffic flow. Many carpet modules are available in coordinating broadloom, so that it is possible to denote a hierarchy of areas with a cut pile broadloom in one area and a coordinating looped pile carpet module in another.

Resilient Flooring

A wide selection of resilient flooring materials exists in prices ranging from inexpensive linoleum to the more costly vinyls. Installation is simple and inexpensive; however, some of these materials cannot be installed on grade-level or below-grade floors. Resilient flooring materials on the market include linoleum, asphalt tile, cork, vinyl composition tile, vinyl, and rubber.

Linoleum is a synthetic material manufactured mostly in sheet form. Linoleum has limited resistance to acetone and is unstable with strong alkaline solutions. It was the first synthetic flooring available and has been widely used for heavy-duty installations, including flooring for battleships.

Asphalt tile, although still available, has generally been phased out in favor of newer synthetic tiles. It was widely used simply because it was the least expensive flooring. Asphalt tile was used in factories, housing projects, and many other facilities where durability and economy are important. It is brittle and hard underfoot, but practical.

Cork is the only natural material used in resilient flooring. It is resilient and has acoustic properties but is not appropriate for heavy-duty use. Cork must be kept waxed to preserve the surface. It can become more attractive with age, developing a rich warm patina from many applications of wax.

Vinyl composition tile, previously vinyl asbestos tile, reflects the current concern over asbestos, which has been eliminated from many commonly used products. This type of tile is only slightly more expensive than asphalt but has many advantages, as it is softer underfoot, grease resistant, easily maintained, and available in many colors and patterns. Solid vinyls are the most durable, and many designers prefer their natural appearance over that of imitations made from other materials. A solid-color floor will show heel marks and other dirt more readily than a patterned or textured floor. In high-traffic areas, a marbleized appearance or a textured surface is more appropriate.

A current trend in flooring is 100 percent rubber flooring in the form of studded tile. These tiles have raised circular or rounded square patterns and are attractive, resilient, long wearing, and nonslip; they also have excellent acoustic properties, resist burns and most chemicals, and minimize breakage. The manufacturer has resolved the problem of dirt accumulation around the raised studs by sloping the sides of each raised stud.

An accessory item used in commercial installations to trim off many resilient floors is vinyl wall base, which is available in cove or toeless base. In finishing resilient flooring, a cove-style base is generally preferred, as it hides the uneven cut edge of the flooring. It is available in the following heights: 1~½ in., 2~½ in., 3 in., 4 in., 6 in., and 7 in., with 2~½ in., 4 in., and 6 in. being the most commonly used. It comes in 4-ft. pieces or 100-ft. rolls and molds to form inside and outside comers. Preformed comers are available. Vinyl wall base is unbreakable and easily cleaned and never needs painting.

Ceramic or Quarry Tile

Tiles are one of the most attractive, durable, and versatile surfacing materials for indoor and outdoor use. They offer tremendous design potential as borders and in patterns. Ceramic tiles come in many colors, from bold shades to subdued hues. For warm colors and earth tones in numerous shapes, textures, shades, and sizes, quarry tile provides a rich, natural look. It exhibits the strength and durability needed in educational environments. In addition, some quarry products are finished with abrasive grain surfaces to improve slip resistance.

Although tiles provide a durable surface in hard-wear areas, they cannot tolerate direct blows, as in the dropping of heavy objects. Cart traffic can crack and break them, especially along unprotected edges. In work areas where people must stand for long periods, rubber mats can cushion the surface and help reduce fatigue.

Trim pieces for tiles come in all colors, with a flat or roll top. Outside corners are precast, and the straight base will not shrink or pull away if properly installed. When selecting tiles, be aware that some imported tiles do not come with a full line of trim pieces.

Wall Coverings

Every wall is a material in itself, and ideally no material need be covered. Designers currently prefer honesty of materials (e.g., brick walls) and will remove many surface layers of old paint and plaster to reach these structural walls in old buildings.

Wallpaper is the material commonly associated with wall coverings for interiors. Many patterns and solids exist in every imaginable color. If the intent is to achieve a particular effect, and if a strong pattern or color is desired, a well-designed wallpaper can be a meaningful asset. Often a strong paper works better on one wall, instead of surrounding the entire space with a dominating pattern.

Most designers note that a well-planned interior, conceived as a total design, does not need the superficial decoration of printed paper; the superfluous pattern and color might actually detract. Plain walls, walls of solid colors or textures, or walls of natural materials are usually more acceptable, especially in the institutional environment.

Attractive wallpapers, however, can serve a specific purpose and have some intrinsic qualities of their own. These include textured papers, often made from natural materials such as silk and grass cloth. Advantages include improved acoustic properties and an atmosphere of interest and warmth. The lamination of linen, burlap, or other textures onto paper backing provides an attractive background in areas where an elegant image is desired. These natural fibers should, however, be treated with a protective sealant to prevent excessive soiling.

Plastic-coated or vinyl wallpapers are useful wall coverings in kitchens and bathrooms. Washable, they stand up better than painted surfaces to steam or grease. The best of these wall coverings are vinyl-coated fabrics rather than coated papers, which are appropriate in all high-traffic areas. Vinyl-coated fabrics come in different weights; the heavier the anticipated wear, the heavier the material should be. The cost of some of the heavy vinyls is quite high but is justifiable, as the material can withstand countless scrubblings.

One special-purpose wall covering provides advance warning in case of fire before there is actually smoke or open flames in the room. Early-warning-effect wall coverings, when heated to 300°F, emit a colorless, odorless, and harmless vapor that will activate ionization-type smoke detectors, which represent 85 percent of those installed. The 300°F trigger point for these wall coverings is well below the ignition temperatures of most common room materials, including paper, cotton, polyethylene, and polyurethane foam. The early-warning effect may be triggered by electrical outlet overloads that heat wall surfaces, electrical fires in walls, fires started in other rooms or in core service areas, and other situations where smoke and fire danger may not be readily detected by smoke alarms.

Depending on the project budget and the designer's imagination, there is almost no limit to the materials that might be used for wall coverings: fabric, leather, wood veneers, wall carpet, or metallic materials. Cork is frequently used for practical purposes, such as tack space or sound-absorbing properties, as well as for its appearance.

Textiles

In judging a fabric for durability, the weave should be examined: The tighter the weave, the longer the fabric will wear. Fabrics in which the colors and pattern are tightly woven in with colored threads will wear better than a printed fabric. To check a fabric, hold it up to the light. The less light showing through, the tighter the weave.

The blending of fibers combines the unique properties of each and can produce a more attractive and durable fabric than a fabric made of one fiber. For example, a fiber that takes color well and is lustrous but not

particularly sturdy can be woven with one that is duller but more durable to produce a vivid heavy-duty fabric. The appearance of a fiber can be altered by its construction or by blending. Textiles can be divided into natural or man-made fibers.

Natural Fibers

Natural fibers of animal origin include wool, silk, mohair, felt, and leather. Silk and wool, luxurious and costly natural fibers, offer durability, resilience, and beauty. To clean silk, professionally dry clean. Wool can be spot dry cleaned or washed in a cool, sudsy water solution.

Natural fibers of vegetable origin include cotton, linen, and jute. Cotton has fair resistance to wear and sunlight and a soft feel; it dyes well but must be treated to avoid excessive soiling. Care involves dry cleaning or washing, depending on the other fibers with which it is blended.

Man-Made Fibers

Acrylic, nylon, olefin (polypropylene), polyester, and rayon are man-made fibers of chemical origin.

- *Acrylic (Orlon, Creslan, Acrilan, Zefran)*. Acrylic has a soft woolly feeling, with fair resistance to sunlight. It has good cleanability characteristics and takes vivid color well. Acrylic is normally used to create plush velvet looks. It wears well and will not bag or stretch after continued seating. It should be cleaned with mild, water-free solvents.
- *Nylon (Antron, Enka, Chemstrand, Caprolan)*. Exceptionally rugged and durable, nylon resists signs of wear and tear. A man-made fiber offering the best resistance to soil, it dyes well and will not fade. Professional dry cleaning is recommended.
- *Olefin or Polypropylene (Herculon, Vectra)*. Olefin offers high resistance to abrasion and stains. It has a softer feel than nylon, has good resistance to fading when solution dyed, and is very sensitive to heat. In humid climates where mildew can be a problem, it is a good choice. Only water-based cleaning solutions should be used for its care.
- *Polyester (Dacron, Fortrel, Kodel)*. Polyester is crisp and strong and fairly resistant to wear and sunlight. It is most like natural cotton in its appearance and physical properties. Its resistance to heat is low. This fabric accepts color well and is easy to clean using mild, water-free solvents.
- *Rayon (Avril, Enica, Fortisan)*. Rayon is composed of regenerated cellulose (a wood by-product). It dyes well, is soft to the touch, and has fair resistance to wear and sunlight. Rayon can be constructed to look like cotton, silk, or wool. It can be dry cleaned or washed, depending on other fiber blends.

There are also fibers of metallic origin. These fibers are made of aluminum, silver, or gold threads, usually in combination with natural or man-made fibers.

Woven Fabrics

When any fiber or blend of fibers is woven together, the visual texture and pattern of the fabric are created. Two basic methods of weaving upholstered fabrics exist: flat and pile. Flat weaves include tweeds, twills, and satins. They have no pile, although they may be coarse and nubby because of the uneven size of the yarns. Woven pile fabrics are those in which an extra set of warp or filling yarns is interlaced with the ground warp and filling. In this way loops or cut ends are produced on the surface of the fabric. The base or ground fabric may be either plain or twill weave.

Nonwoven Fabrics

Nonwoven fabrics are knitted, flocked, or tufted. Knitting is a method of construction in which yarns are looped and interlocked instead of woven. Flocking involves creating a velvet effect using cut fibers applied electrostatically. Tufting is another method of locking yarns on the surface; the loops can then be cut to create a velvet surface. Another classification of nonwoven fabrics includes those fabrics created through a process of pressing or bonding fibers together with an adhesive.

Window Treatments

Window treatments include many decorative or functional methods for finishing a room. Aside from aesthetics, they have great practical value. They can insulate against winter heat loss and summer heat gain, control glare, provide privacy, absorb noise, and lower maintenance costs. The total environment should be considered when determining whether blinds, shades, draperies, or any other treatment is used. Cost-effectiveness is always an important aspect of window treatments in an institutional environment.

The following items are components of cost-effectiveness. They should be considered when making a decision regarding the least costly window treatment that will satisfy requirements.

- *Initial cost.* Materials, fabrication, and installation costs vary. For example, costs for draperies are considerably higher than those for roller shades.
- *Energy conservation.* This depends on window orientation and could amount to a sizable reduction in air conditioning and heating capacity. The American Society of Heating, Refrigeration, and Air Conditioning Engineers has extensive information on the impact of interior shading on heating and cooling loads in its Handbook of Fundamentals.
- *Expected service life.* The amount of use and type of maintenance determines service life. Blinds have a service life of approximately 10 years; shades, 3 to 5 years; and draperies, 5 years.
- *Maintenance.* Vacuuming and periodic professional cleaning should be included in regular maintenance costs.

Blinds

Flexibility is the key to the popularity of blinds. Many options address every type of window requirement. Blinds that are one color inside and another color outside ensure a unified building exterior appearance while maintaining inside design flexibility. Blinds can be custom made to almost any shape opening: A-frame, bay window, inclined, tapered, cutouts, circular, or arched. Installing two blinds on one headrail enables one to be raised while the other is lowered.

Blinds are available with heat-absorbing or heat-reflecting finishes to help cut energy costs. If heat buildup between the blind and glass is a concern, as it may be with thermal glass, special drop-down brackets allow an additional 1/4 in. gap at the top of the blind. This permits the heat buildup in the airspace to be vented. Another alternative involves eliminating the top slat from the blind to increase the air gap. Additional air gaps at the sides and bottom of the blind can also be specified.

Vertical blinds combine the flexibility of blinds with the luxury of draperies. They give a dramatic, contemporary look to a room while controlling light and privacy. Vertical blinds are available in many colors and materials, including fabrics, plastics, and aluminum. Replacement fabric vanes allow easy repair; fire-retardant vanes are also available.

When specifying blinds, it is best to require that the contractor be responsible for inspection of the site, approval of the mounting surface, installation conditions, and field measurements, rather than simply furnishing measurements to a vendor. Costly mistakes can occur if measurements are not exact.

Types of blinds include painted aluminum, in \sim 2-, 1-, 1 \sim 2-, and 2-in. slats; natural wood, in 1 or 2-in. slats; audiovisual, in 2-in. slats; sun controller for the exterior and interior, in 1-, 2-, and 3 \sim 2 -in. slats; and vertical, in 2 and 3 \sim 2-in. vanes of aluminum, fabric, or plastic

Shades

Shades control light and privacy, maintain interior temperature levels, and accent windows. There are shades for exterior use, pleated shades, and blackout shades for those areas where complete blackout of light is necessary. Shades are available in fiberglass-coated polyester or can be fabricated in the designer's own fabric to coordinate with an interior decorating scheme. Shades present many creative options, provide superior light control, save energy, and are convenient to install, adjust, and remove.

Pleated shades come in many weights: sheer fabrics to filter light, semi-opaque fabrics to provide more privacy, and thicker fabrics to keep out the sun. Various types of shades include blackout shades, solar screens, and pleated shades.

Curtains and Draperies

Some commonly held misconceptions exist regarding the terminology associated with window treatments. The following definitions will clarify interpretations of these words, which are often used as synonyms.

- *Curtains*. Window coverings fabricated from sheer or lightweight material such as cotton, polyester, rayon, or blends of these fibers are called curtains. They are used in less formal interiors. Curtains may be used alone or in combination with overdraperies. They may be lined or unlined and are generally shirred on a rod but may also be pinch pleated. Hung inside a window casing, they should reach to the window sill. Hung on an outside casing, they should hang to the bottom of the apron or to the floor.
- *Draperies*. These are also commonly called drapes. They create a more formal mood and are generally of heavier fabrics. They are usually lined, of pleated construction, and weighted at the bottom. Draperies are generally hung on traverse rods that allow them to open and shut. They may be hung to the bottom of the apron or to the floor.
- *Valance*. A separate top or horizontal portion of the drapery treatment is called a valance. Valances were originally used to hide drapery hardware but have survived for decorative reasons. Valances are generally 4 to 6 in. deep and made of softly draped, gathered, or pleated fabric.
- *Cornice*. A three-sided box-like top used for a window treatment, with the open side of the box facing the wall, is a cornice. This overhanging box is sometimes used, like a valance, to hide drapery hardware. A cornice is generally from 4 to 7 in. deep and fabricated of wood, plaster, or metal. It can be upholstered in a fabric to match the draperies or in another coordinating fabric. A properly designed cornice can add height to short windows.

Although there are no hard-and-fast rules, the following will generally apply:

- Valances should not be used in rooms with extremely low ceilings. A valance with curved lines makes the window appear wider; one with square lines makes it seem narrower. Straight draperies without a valance or cornice make windows seem taller.
- Draperies that are tied back soften a room's severity. A pair of looped-back curtains makes a window seem narrower than a single curtain tied back.
- Tiebacks should be located either above or below the centerline of the window. Usually, the higher the tieback, the taller the window appears. Straight, plain draperies, as a rule, are not looped back.
- French doors should be treated as windows. If located between rooms, they should not be draped. For privacy, they can be fitted with sheer curtains gathered on small rods at the top and bottom.
- Bay windows or two adjacent windows should be treated as one, with a single drapery at the outer edge of each. This gives the effect of one large window and makes them appear much wider. If a valance is used, it should run across the windows.
- Casement windows require special treatment. Those that swing inward are generally fitted with shirred curtains fastened to the top and bottom. Those that swing out are usually fitted with straight-hanging curtains or draperies.
- Draperies and curtains should present a uniform appearance from the street. All windows, at least those on the same level, should have the same kind of curtains, or draperies with white linings.

Maintenance, obstruction of view when closed, and possible glass breakage when used with heat-absorbing glass are some disadvantages of draperies.

Four major types of drapery construction are used in commercial installations: pinch pleat systems, stack pleat systems, roll pleat systems, and accordion-type pleating systems. Pinch pleat systems are probably the most commonly used. They are constructed with pleater tape and are generally attached to the slide carriers of a standard traverse rod. Installation specifications should include a drawing of the window and wall with bracket locations clearly marked. The drapery workroom will need specific instructions and a sample of the drapery fabric. To avoid delays caused by flaws in the fabric, order extra yardage.

Draperies Flammability Regulations

Many codes recognize draperies covering more than 10 percent of the wall area of an interior finish. The most frequently quoted flammability codes are those of New York City, Boston, and California:

- New York City requires all flame-retardant chemicals to be approved by a board of standards and appeals. After approval is received from the board, a number is issued. This number is used on a certificate stating that the fabric has been treated with the approved flame retardant.
- The city of Boston requires that a sample of the treated fabric be tested by the Boston Fire Department. A certificate of flame retardancy and a statement of intended use must be furnished with the sample provided to the fire department.
- The state of California requires that the state fire marshal approve all flame-retardant chemicals. California law also requires that the flame-retardant treatment be applied in an approved manner by a licensed finishing company.

Fabrics such as fiberglass, wool, and some modacrylics are considered inherently flame resistant. These fabrics do not require flame-retardant treatment. Fabrics containing a blend of Saran, Verel-modacrylic, and rayon are mildew, rot, and vermin proof and will melt rather than support flame. Even though these fabrics are inherently flame retardant, designers should have materials tested to determine whether fabrication or finishing has impaired their natural properties.

Cabinetry

One indication of quality in cabinetry and case goods is drawer construction. The drawers should have concealed dovetail construction at the front and, in better quality cabinetry, also at the back. The drawer bottom should be substantial and grooved into the sides. For added strength, small glue blocks are used. Better grades of cabinets have side and back panels of five-ply veneer. The sides and usually the back should be grooved into the posts.

If a project includes custom-built cabinetry, it is sometimes preferable to separate the cabinetry contract from the general contract. This permits careful selection of a cabinetmaker. Drawings should be prepared covering type and grade of materials, finishes, hardware, and special equipment. Cabinet details are usually drawn on a large scale (e.g., 1 in. equals 12 in.) or even full scale. If the designer is not familiar with detailing, he or she may prepare small-scale drawings and require shop drawings from the cabinetmaker for approval.

Furniture

Furniture Styles

Designers should know the history of furniture and be able to recognize the more important periods. The strongest influence on the current interpretation of traditional furnishings originated in the 17th century. In general, period furniture can be divided into two major categories: formal and informal styles. Formal styles consist of furniture originally designed for the royal courts and for spacious homes of the wealthy. Informal styles include simpler pieces made by local craftspeople using crude tools and local woods. Provincial styles and Early American furniture are examples of informal furniture.

Modern furniture consists of a new design form that breaks away from previous forms. An expression of the 20th century, it uses new materials in new ways. Functionalism is the key and determines form, with an emphasis on line, proportion, color, texture, and finish.

Both traditional and contemporary furniture is used in institutional settings. For the most appropriate selection, the total environment, rather than personal stylistic preferences, should be considered.

Well-designed furniture exists in both contemporary and period styles. In planning furniture requirements, consider the desired image: solid, traditional values or modest, efficient simplicity.

Seating

The selection of seating is important. Workers spend many hours each day at a desk, and the right chair promotes efficiency, relaxation, and production. A determination must first be made of the functions the seating must perform. Then it should be evaluated for comfort, durability, cost, ergonomics, appearance, space savings, safety, and availability.

Seating comfort is important, as it can affect the degree of learning in a classroom situation, the acceptance of waiting in a lounge area, and the pleasure of a banquet event. Comfort in office seating increases efficiency and job satisfaction.

Durability ensures the institution's investment. Test the seating under actual conditions, and ask for references of others using the product under similar conditions. If it is a new product, ask to compare test laboratory results with existing lines of seating to determine suitability for particular applications.

In addition to the initial cost, consider the handling and maintenance costs. The cost of arranging and moving furniture to and from storage or rearranging or moving seating for cleaning purposes can become greater than the initial cost.

Ergonomics relates to all elements in the person's work environment, including sound and lighting, layout, carpeting, desks, files, and seating. The following factors should be taken into consideration when evaluating seating: seat height, appearance, space savings, safety, and availability. Occupational Safety and Health Administration (OSHA) guidelines currently require that businesses and public institutions provide seating that offers adjustable seat height, arms, back, and seat pan angle if requested by an employee to reduce the occurrence of various physical ailments caused by long hours spent seated with little range of motion.

Upholstered Furniture

Upholstered furniture can be deceptive. Unlike case goods, quality construction in upholstered goods can be difficult to detect. An attractive fabric can hide inferior products and workmanship. Items to be considered when evaluating upholstered furniture are frame construction, springs, padding material, and fillings.

Upholstery Flammability Regulations

The designer must be aware of particular flammability hazards in certain types of installations (e.g., areas where smoking is permitted; places where people sit for extended periods, such as transportation seating; and lounge areas in public buildings). Areas where the lighting level is low and where live-in accommodations include bedding, such as dormitories, are also hazardous.

When planning upholstery for these areas, the fabric should be inherently flame resistant or protected by a flame-retardant treatment. Upholstery fabrics that do not meet the Class 1 requirements of the U.S. Department of Commerce Commercial Standard 191-53 should not be used on upholstered furniture. Self-extinguishing foam cushions are also available from major seating manufacturers at a slightly higher cost than normal polyurethane, but peace of mind is well worth the extra expense.

Surface treatments such as tufting and seams on seat areas should be avoided. Tufting should be limited to vertical surfaces. Cigarettes rank high among ignition sources, and each tuft in a seat cushion provides an area where a cigarette can burn unnoticed. Seams in seats tend to split, exposing the filling to possible ignition. If possible, specify seating with at least a 1-in. gap between the seat and the back.

Office Landscaping

Office landscape designates an informal, open, flexible system of furniture arrangement based on the interrelationships among groups to allow more efficient communication. Partitions and components required

to support the work of each area compose the landscape. The partitions are available in various heights to provide different levels of privacy. Generally, they do not reach the ceiling; however, some manufacturers, in an effort to make them more appealing, have provided a complementary line of partitions that reach the ceiling, forming private offices where required.

Because these systems are open, provisions for noise control must be carefully planned. Ceilings should be of acoustic materials, and floors should be carpeted. Acoustic panels should be placed where noise is generated to absorb as much of it as possible. Sound-masking systems can be helpful in lowering the noise level. Draperies and plants are also effective.

Although some form of flexible office furniture system has been available since the late 1940s, this type of furniture became popular during the 1970s and seemed to be the answer to all office layout problems. However, in the late 1970s this trend began to change as management and staff complained about the lack of privacy and problems with noise. Full-height partitions (called by various names, including movable, demountable, or relocatable) became popular. Their popularity seems to be continuing, as these partitions are compatible with and offer the flexibility of the lower height systems but provide greater privacy and sound control. Current open offices use both types of systems. More consideration is now given to the employee's need for privacy, as well as to the need for accessibility.

Many important factors should be considered before purchasing a system; these include flexibility and ease of reconfiguration; simplicity of installation; capability for handling electrical requirements for power; and communication and data processing equipment, as needed. It should provide design options such as a variety of panel sizes, components, and finishes.

Furniture Standards

The objectives of a standards program are as follows:

- *Volume purchasing savings.* Vendors will often offer advantageous terms above and beyond the usual quantity discounts when the line is made "standard."
- *Management time savings.* Streamlining the selection and acquisition process eliminates catalog skimming.
- *Reduced competitive behavior among employees.* Consistently applied standards reduce competitive behavior among employees while helping eliminate jealousy and resentment over office size and furniture quantity.
- *Aesthetic consistency.* Furniture standards programs often deal with visual design and attractiveness of office environments.
- *Improved environmental function.* Problems of using furniture and space to the best functional advantage are often addressed through standards, rather than leaving each employee to use trial and error to find the best arrangement for a particular job function.
- *Multiple workstation enhancement.* Function problems involving the arrangement of many employees and such overall considerations as OSHA's fire and safety regulations are more easily and consistently dealt with on a standards level than case by case.

Lighting

Four general categories of light sources are available: natural daylight, incandescent electric light, fluorescent light, and high-intensity discharge lighting.

Daylight constantly changes throughout the day in position, intensity, diffusion, and color. In any design using natural daylight, three conditions should be considered: light directly from the sun combined with reflected light from a clear sky, light from a clear sky only, and light from an overcast sky. Various indirect variables, including local terrain, landscaping, water, fenestration, daylight control systems (shades and louvers), decor, and artificial light, also affect daylight.

Acoustics

Sound masking is one effective way to increase sound privacy. By slightly increasing the ambient sound

level, sound masking covers distracting noises. Sound masking can be adjusted and fine-tuned to give exactly the right level of acoustic privacy without becoming a nuisance. Masking systems must be programmed to their most desired level in each particular case.

In an open office environment, sound masking is critical. For the closed office, sound masking can result in confidential privacy without resorting to more expensive conventional construction techniques, such as insulating the drywalls or extending the walls through the suspended ceiling to the structural ceiling above. The masking system can also accommodate other audio functions, such as paging and music, utilizing the same speaker system.

Furniture Arrangement

Standardized furniture arrangements are almost useless, as each client's needs are unique. To provide a furniture arrangement that will be both aesthetically and functionally successful, the designer must analyze the space, determining the flow of traffic and activities. Relationships of scale, mass of furniture to the area, and contrast of elements all must be considered, as follows:

- *Analysis of space.* The designer should first make a thorough analysis of the space. On the first visit to the area, the designer should note dimensions and indicate all architectural features; existing lighting; heating, ventilation, and air conditioning supply; electrical outlets; and existing finishes in the area. Photographs are particularly helpful.
- *Flow of traffic.* The designer must know the intended use to determine furniture requirements and assign activities to zones based on the square footage required for each activity.
- *Scale and mass of furnishings.* Scale and mass of furnishings in an interior are based on the relative proportion of such furnishings to persons, other objects, and the space they occupy. An interior should appear neither crowded nor underfurnished. If an object were removed from a properly furnished space, the space would appear incomplete. Large areas allow large-scale furnishings. Small-scale objects generally look insignificant in large spaces. Distribution of mass should be balanced throughout the space. The specific location, as well as the overall space, must be considered. For example, a piece of furniture should relate in proportion to the wall against which it is placed.
- *Contrast of elements.* To avoid monotony, the lines of furnishings and architectural features should vary. A room whose focus is high windows and doors needs horizontal balance. Conversely, a space with strong horizontal architectural accents needs the balance of high pieces of furniture to heighten the vertical line of the space.

Balance in the space and between objects gives a harmonious composition. Too much similarity or lack of contrast causes a space and the objects in it to appear dull and uninteresting. The success or failure of the design depends on how well the space functions and how well it serves the needs of the client.

Basic Guidelines

The following general guidelines offer suggestions for planning the arrangement of furniture:

- Plan each room with a purpose. Decide what the room will be used for and by whom.
- Use furniture in keeping with the scale of the room.
- Provide space for traffic. Doorways should be free, and major traffic lanes must be unobstructed. It is sometimes necessary to redirect traffic. This can be accomplished by turning a sofa, a desk, or chairs toward the room and at right angles to the door, with a passageway left for traffic.
- Arrange furnishings to give the room a sense of equilibrium.
- Achieve a good balance of high and low, angular and rounded furniture. Where furniture is all or predominantly low, the feeling of height may be created by incorporating shelves, mirrors, and pictures in a grouping.
- Consider architectural and mechanical features. There should be no interference with the opening of windows, swinging of doors, or heating or air conditioning devices. Lamps should be placed near electrical outlets.

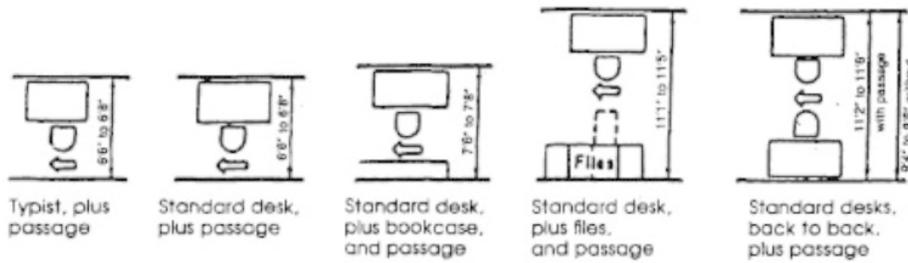
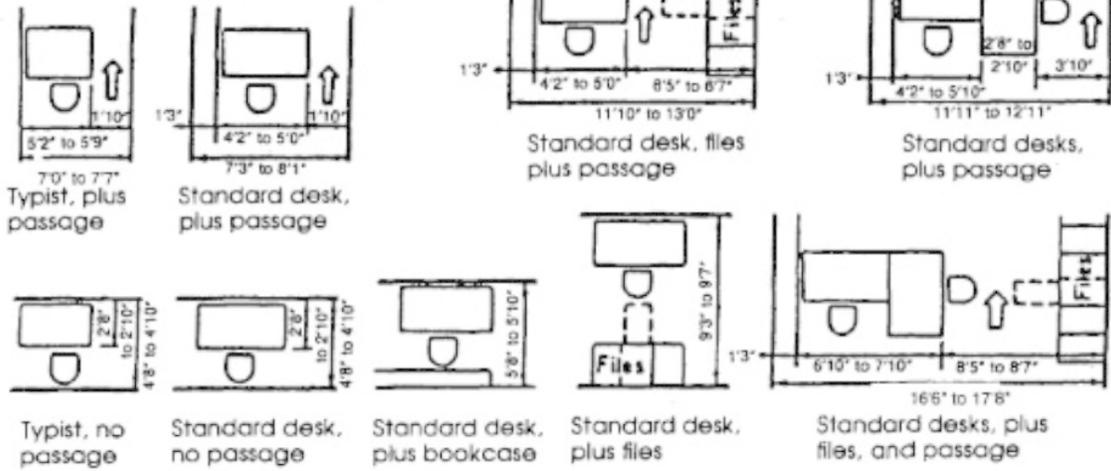
- Do not overcrowd a room. It is always better for a room to be underfurnished than overfurnished.
- Generally, large pieces of furniture should be placed parallel to the walls.
- Avoid pushing large pieces tightly into a corner or close against floor-to-ceiling windows where a passageway should be allowed.
- Arrange the heaviest furniture grouping along the highest wall in rooms with slanted ceilings.
- Provide adequate lighting for all activities.

In planning office layout, the following may be helpful (Figure 3):

- Office floor space must be conserved, but not at the expense of appearance, production, or comfort.
- Place related departments near each other.
- Each employee, including his or her desk, chair space, and share of the aisle, requires a minimum of 50 to 75 sq. ft. of working space.
- A general conference room where confidential meetings may be held will eliminate the need for many private offices.
- A minimum of 9 ft. x 12 ft. is a standard size for small private offices.
- Standard widths for main circulating aisles vary from 5 ft. to 8 ft. Less important aisles vary from 3 ft. to 5 ft.
- Allow 7 sq. ft. for computers and related items.

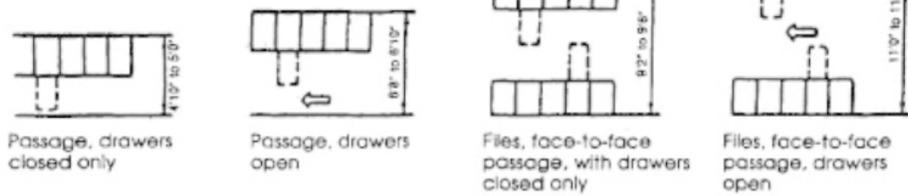
DESKS

Average minimum clearances around typical units



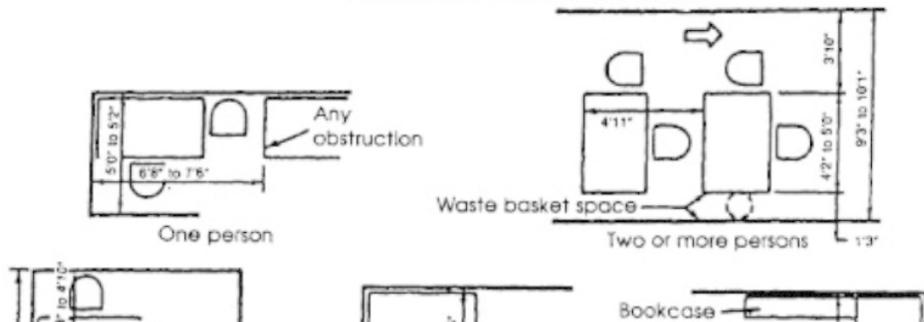
FILES

Standard clearances for both legal and letter sizes



PRIVATE OFFICES

For single desk, desk and table, two desks, and more than two desks



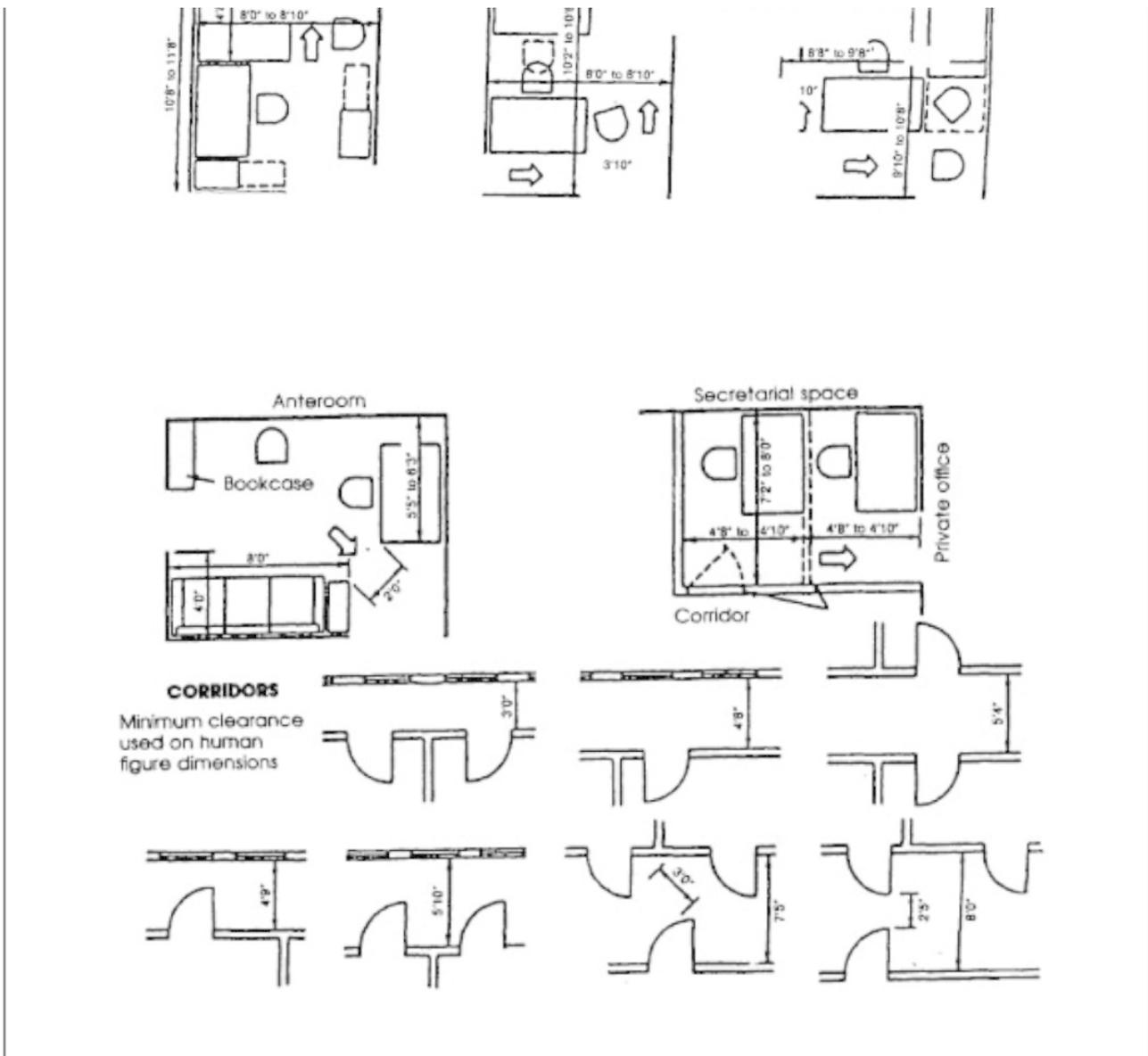


Figure 3. Space Planning for Building Interiors

Space Planning

Programming

Programming is the determination of the parts and their interrelationships. Precise information is vital to the effective planning and layout of office environments. Considerations to address include the amount, kind, and configuration of space and the relative closeness or relationships of each unit.

Space determination should begin early in the planning process. Decisions must be made as to which location is appropriate for each function. This preliminary figure, however, is only an estimate, determined without detailed analysis. Functional relationship should be established before the division of space gets too involved. Later, particular pieces of equipment may necessitate detailed planning.

A flowchart, sometimes called a *bubble chart* or *space relationship diagram*, should be prepared to indicate all related activities and groups, without concern for actual space required by each. Next, through careful programming, the designer establishes the space required for each activity. Then the area is fitted into the relationship diagram. This preliminary layout, once refined, becomes the final floor plan.

Several ways of establishing space requirements are calculation, conversion, space standards, and rough layout.

The *calculation method* involves a physical inventory prepared for each area. Inventory control lists are usually available for this purpose. Each activity or area is broken down into subareas. An assessment of space required for each subarea is made. This is then multiplied by the number of elements required to do the job, with extra space added for storage and service.

The *conversion method* establishes the space presently occupied and converts it to the proposed amount. Before making the conversion to the new plan, the designer must decide if the occupied space is less than the amount actually needed.

Another method, *established space standards*, is a practical way to determine space requirements any time a given situation arises. Standards must be applied consistently. It is important to record how the standards were established and apply them fairly if they are to have credibility.

The planner or designer should meet first with management and establish goals. An organizational chart should be obtained. Meetings should be scheduled with personnel in various departments. Questions that should be asked are: How many people are in the group? What are their jobs? What are the furniture and equipment requirements to support the work performed there? and Are there any plans for expansion?

After the planner obtains this information, it must be evaluated for actual needs versus wants of the client. The planner will prepare a written program, listing personnel, furniture, equipment, and services. He or she will then compute the square footage required for these functions. Finally, approval must be obtained on the program.

During this phase a furniture, furnishings, and equipment inventory should be prepared. Three categories of furnishings and equipment must be listed:

1. *As is*: Items that can be moved without any attention.
2. *Refinish*: Items that must be refinished or reupholstered before they are acceptable.
3. *New*: Items that must be purchased.

In purchasing furnishings and equipment, count back from the planned moving date to determine the lead time necessary, always allowing extra time for unexpected delays.

The most precise method of determining space requirements is the *rough layout method*. This method is advisable in certain critical areas involving fixed equipment, large machinery, or multiple workstations. With this method, scale floor plans and templates are used to determine exact location of furniture and equipment.

Most projects are restricted by space limitations. As a rule, they are more restrictive than any other factor except funding. If requirements exceed availability, reductions must be made. Lower priority area reductions are preferable to across-the-board cuts.

The problem of limited space can be solved in the following ways:

- Authorize overtime.
- Improve procedures.
- Organize wasted space.
- Move storage areas to leased spaces.
- Divide operations into groups and spread to available buildings.

Preliminary Design

At this point, a cost analysis should be made for comparison and justification. During this phase the analysis of the written program and the flow diagram are turned into a floor plan. With this floor plan, a construction estimate can be prepared by multiplying the floor area required by the square foot construction cost. The furniture and equipment budget should be prepared at this point, and then the total preliminary budget can be quoted. This phase of design is sometimes called a *feasibility study*.

Final Design

The floor plans are prepared during this phase. The space should be accurately measured, including the size and location of structural elements. Furniture and equipment layouts are drawn, architectural materials are chosen, and finishes are specified. Mechanical engineers are retained, and air handling equipment is located and sized. This plan and an outline specification of materials and equipment permit refinement of the initial estimate.

Presentations

Presentation to the client is generally done in graphic form, arranging floor plans and elevations, rendered perspectives, samples of fabrics and floor coverings, and photographs of furniture on display boards. Computer graphics can aid in the client's understanding. With information on plans and elevations, many computers can create perspective drawings. Some even "walk through" the space, simulating reality for the client, who is usually less able to visualize the space from a two-dimensional drawing. Computer simulations are still a costly venture and are reserved primarily for large projects, where they serve as funding tools.

Working Drawings, Specifications, and Bidding

The general contractor, the facilities department, or both use the final drawings and specifications to properly estimate the job for bid. The drawings should contain all the information necessary to complete the project. Any item not accounted for in these documents may necessitate a change order, with an almost certain increase in costs.

All necessary approvals should be in writing. The specifications should be designed to protect and provide the quantity and quality of work expected. After bids are received and approved, the drawings and specifications, approvals, and costs are incorporated into the contract and actual work begins.

Many public institutions issue a contract (usually on a yearly basis) for furniture, equipment, and carpet. These represent desired products at guaranteed rates of sale and may include installation and delivery. This alleviates the need for bidding every small project, with a considerable savings in time and paperwork.

Supervision

The last phase of a project involves supervision. If the job is a large one, a representative should be on site at all times. At this stage a designer's job involves, at the least, interpreting the documents; approving shop drawings; making decisions regarding alternate submittals; preparing change orders; expediting purchases; coordinating contractors' installations of new furniture and equipment, the physical move into a new space, and "punch lists"; and making pay estimates.

Installation

In most institutions the designer supervises furniture and equipment installations. Preparation for installation is most important and includes preparing installation plans and drawings, arranging for any maintenance work needed, scheduling the moves, and notifying everyone involved. Drawings and written instructions are the best way to communicate. Every drawing should show the north arrow, the scale being used, identification of the building, sheet number, project identification, date, and the name of the person preparing the drawing.

There are three basic phases to an installation: planning, actual installation, and follow-up.

In the first phase, planning and scheduling begin, inventories are prepared, disposition of any existing equipment and furnishings is determined, communications are set up among in-house personnel and contractors, work orders are prepared, departmental personnel are notified, and decisions are made regarding furniture or equipment to be relocated. In coordinating the installation, the designer should use checklists of items likely to be overlooked. These lists should establish what is to be done, when it is needed, and who is to

do it.

In the second phase, the actual installation, the designer must be on hand for layout interpretation. As the installation proceeds, the designer makes periodic checks on the status of the work and keeps work crews informed and coordinated.

The third phase, follow-up, requires the designer to inspect the installation to verify that all items are delivered undamaged and the layout conforms to the drawings. If not, the designer must have any discrepancies corrected.

Barrier-Free Accessibility

"Barrier-free" does not merely imply ramps and adequate door widths for accessibility. *Removing the Barriers: Accessibility Guidelines and Specifications*, published by APPA: The Association of Higher Education Facilities Officers, provides technical data and illustrations of standards. Aside from the obvious architectural barriers, psychological barriers exist. When persons must enter by a service entrance or ask for assistance in opening doors, they feel humiliated and helpless.

There are two major federal acts guaranteeing the right of equal access for the disabled. The first is the Rehabilitation Act of 1973, Section 504, which states that "no otherwise qualified handicapped individual in the United States . . . shall, solely by reason of handicap, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." The second is the Americans with Disabilities Act of 1990, which prohibits discrimination on the basis of disability and requires that all new places of public accommodation and commercial facilities be designed and constructed so as to be readily accessible to and usable by persons with disabilities. The act also prohibits discrimination against qualified individuals with disabilities in all aspects of employment.

Colleges and universities are required to make reasonable adjustments to enable disabled students to fulfill academic requirements and to ensure that these students are not excluded from programs because of the absence of necessary modifications. Depending on the nature of the disability, modifications may include changes in the length of time required for completion of degree requirements, substitution of specific courses required, and changes in the way specific courses are conducted.

Most colleges and universities have taken the position that all common space should be accessible, with other areas made accessible on an as-needed basis. It is not necessary to modify every structure if programs can be offered in an already accessible space, but areas that might not have been altered for student use may have to be changed to accommodate a qualified individual who becomes employed there.

On a campus-wide basis, curb cuts, ramps, beepers for street intersections, and less hazardous signage and landscaping are necessary. On an individual building basis, restroom modifications, lowered telephones and water fountains, widened doors, ramps, and, where feasible, accessible elevators are needed.

Mobility-impaired individuals are commonly provided with housing on the ground level of dormitory buildings. This policy is not well received by many proponents of rights for the disabled, as they believe this is discriminatory and isolates the person from the mainstream of activity.

There are exceptions to the rules and regulations requiring elimination of architectural barriers. The following exceptions are currently allowed by the federal government in accordance with Public Law 90-480, Subpart 101-19.604, "Exceptions," paragraphs a through d, as amended in 1968:

1. The design, construction, or alteration of any portion which need not, because of its intended use, be made accessible to, or usable by, the public or physically disabled people.
2. The alteration of an existing building if the alteration does not involve the installation of, or work on, existing stairs, doors, elevators, toilets, entrances, drinking fountains, floors, telephone locations, curbs, parking areas, or other facilities susceptible to installation or improvements to accommodate physically disabled people.
3. The alteration of an existing building, or of such portions thereof, to which application is not

structurally possible.

4. The construction or alteration of a building for which plans and specifications were completed or substantially completed on or before September 2, 1969. However, any building constructed under the National Transportation Act of 1960, the National Capital Transportation Act of 1965, or Title III of the Washington Metropolitan Area Transit Regulation Compact shall be designed, constructed, or altered in accordance with American National Standards Institute standards regardless of design status or bid solicitation as of September 2, 1969.

In many states a state governmental agency (e.g., in Texas, the Texas State Purchasing and General Services Commission's Architectural Barriers Department) will review for compliance and approve plans and specifications submitted prior to bidding and award of contract. In other states a separate agency reviews only college and university construction plans. In still others the college or university is governed by its own board of regents.

Whatever the governing body, after review it will decide to what extent the project shall be made to comply. Plans and specifications will be approved only when the documents reflect compliance with the appropriate accessibility standards and specifications, generally those of the American National Standards Institute, found in *Providing Accessibility and Usability for Physically Handicapped People* (ANSI A117.1-1986).

Upon completion of projects, on-site inspectors determine whether the appropriate standards have been met during construction. All complaints received by the commission or board must be investigated and resolved or referred to the proper authority, with possible legal recourse.

Summary

This chapter is intended to provide an understanding of the critical issues of building interior design. It serves to assist the facilities manager in developing guidelines for making routine in-house decisions, as well as in communicating better with consultants.

Additional Resources

American Society of Heating, Refrigeration, and Air Conditioning Engineers. *Handbook of Fundamentals*. Atlanta: ASHRAE, 1993.

Antes, Victor. "Some Viewpoints on Office and Task Lighting: A Recent Seminar." *Architectural Lighting*, Vol. 1, No. 7, 1987.

Bell, Doreen. "Efficient, Effective Lighting." *School and College Product News*, September 1987.

Coons, Maggie, and Margaret Milner, eds. *Creating an Accessible Campus*. Washington, D.C.: APPA, 1979.

Cotler, Stephen R. *Removing the Barriers: Accessibility Guidelines and Specifications*. Alexandria, Virginia: APPA, 1991.

Friedman, Arnold, John Pile, and Forrest Wilson. *Interior Design - An Introduction to Architectural Interiors*. New York: American Elsevier Publishing Company, 1976.

McMillan, Lorel. "Carpet Backs: The Underside View of Your Carpet Selection." *Facilities Design & Management*, Vol. 5, No. 7, 1986.

Reznikoff, S. C. *Specifications for Commercial Interiors - Professional Liabilities Regulations and Performance Criteria*. New York: Whitney Library Design, 1979.

Whiton, Sherrill. *Interior Design and Decoration*. New York: J. B. Lippincott Company, 1974.

