POCKET ARCHITECTURE: TECHNICAL DESIGN SERIES

JORDANA L. MAISEL, EDWARD STEINFELD, MEGAN BASNAK, KORYDON SMITH, AND M. BETH TAUKE

INCLUSIVE DESIGN

IMPLEMENTATION AND EVALUATION

ROUTLEDGE

PocketArchitecture: Technical Design Series

Inclusive Design

As part of the *PocketArchitecture* Series, this volume focuses on inclusive design and its allied fields – ergonomics, accessibility, and participatory design. This book aims for the direct application of inclusive design concepts and technical information into architectural and interior design practices, construction, facilities management, and property development. A central goal is to illustrate the aesthetic, experiential, qualitative, and economic consequences of design decisions and methods. The book is intended to be a "first-source" reference – at the desk or in the field – for design professionals, contractors and builders, developers, and building owners.

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Series editor's preface

Although architects and building professionals come in to contact with, specify, design, and build technical practices every day, they actually know relatively little about them. They are "abstract systems" construed and constructed upon industry norms passed through generations of professionals. Most of them are correct, but many, when disassociated with their cultural underpinnings of building vernacular and, more important, their scientific basis and practice contexts, present challenges that cause buildings to not perform as intended or, worse, lead to physical, economic, or social catastrophe.

PocketArchitecture: Technical Design Series fills this void. The series comprises succinct, easy to use, topic-based volumes that collate in one place unbiased, need-to-know technical information about specific subject areas by expert authors. This series demystifies technical design criteria and solutions. It presents information without overladen theory or anecdotal information. PocketArchitecture is on point.

As the name would suggest, the volumes in this series are pocket sized and collectively serve as a knowledge base on technical subjects in architecture, creating a value-added information base for building novices and masters alike. In addition to architects, engineers, and contractors who deliver building projects, the series is appropriate for students and academics interested in accessible information on technical information as it relates to building design and construction.

Despite their size, the series volumes are highly illustrated. Furthermore, the volumes use easily accessible language to succinctly explain the fundamental concepts and then apply these basic ideas to cases of common issues encountered in the built environment. PocketArchitecture is essential, accessible, and authoritative. This makes it important reading for architectural technologists, architects, building surveyors, building commissioners, building engineers, other construction professionals, even owners and clients.

This volume, *Inclusive Design: Implementation and Evaluation*, is written by the following team of researchers from the Center for Inclusive Design and Environmental Access (IDeA Center), University at Buffalo: Jordana L. Maisel, Edward Steinfeld, Megan Basnak, Korydon Smith, and M. Beth Tauke. Since 1984, the IDeA Center has been practicing human-centered design through research, service, and teaching to both academic and professional audiences. As experts, the authors have created a need-to-know volume for any designer of the built environment seeking to be inclusive and implement universal design principles into practice. The volume encourages architects to focus on the process or practice of inclusive design in addition to the end product. Further, inclusive design as presented herein is a means for creative design thinking, giving rise to a more holistic design solution that can meet not only the needs of an immediate client, but also society more broadly with varying abilities. As part of the PocketArchitecture Series, the book includes both fundamental principles and implementation strategies. It is appropriate for the novice and expert practitioner, as its content is fresh and well considered in the field of texts on inclusive design.

Ryan E. Smith,
Senior Editor
Design Management:
PocketArchitecture series

Authors' preface: practicing inclusive design

Twenty years ago, most architects and construction professionals had not heard of inclusive design or any of its synonyms: universal design, design-for-all, life span design, or human-centered design. Today, inclusive design is known worldwide for fostering environments, products, communications, systems, and policies that work for more people. The premise is that, if a design works across the full range of human abilities, it will be more functional, satisfying, and marketable. The recent popularity of this movement has been driven, in large part, by the aging of the world population and renewed global interests in social equity.

Inclusive processes "that enable and empower a diverse population by improving human performance, health and wellness, and social participation" have been around since the mid-twentieth century. With roots in the Civil Rights and Disability Rights movements of the United States, United Kingdom, and elsewhere, inclusive design is socially focused and grounded in democratic values of non-discrimination, equal opportunity, and personal empowerment.[1]

This abbreviated history of inclusive design in the built environment includes key components of its evolution:

1950s

"Barrier-free" designers began the early work of removing obstacles in the built environment for people with physical disabilities, especially in Europe, Japan, and the United States, in response to the aftermath of World War II, that is, severely injured veterans returning home to war-torn cities, and social policies that encouraged people with disabilities to move from institutional settings back into their communities.

1960s

Social empowerment movements (feminism, civil rights, etc.) brought new attention to equal rights and social justice. People on the margins of society (including those with disabilities) rallied for change and influenced designers and policy makers. In the United Kingdom, architect Selwyn Goldsmith wrote the groundbreaking *Designing for the Disabled* (1963), an indispensable architectural access guide for built environment professionals throughout the world. In the United States, new standards and policies were established, such as *American Standard Specifications for Making Buildings and Facilities Accessible to, and Usable by, the Physically Handicapped* (1961), which became the basis for subsequent architectural access codes. The Architectural Barriers Act (1968) required accessibility in all U.S. federally owned or leased buildings, including restrooms.

1970s

Fueled by the Civil Rights and Women's Rights movements, the Disability Rights movement spread throughout Europe and North America. Advocates argued against the *medical model* of disability, in which impairments are considered primarily as medical problems with medical solutions, and toward the *social model*, in which disability is defined by the relationships between people and their built and social environments. Disconnects can be caused by inadequate design, ineffectual services and environments, and/or cultural stereotypes. Activists demanded "accessible design," which moved away from adaptive solutions and toward normalization and integration. Design became part of the social equity equation.

1980s

The concepts of "barrier-free" and "accessible" design evolved into a new concept, coined "universal design" in 1983 by architect Ron Mace, who claimed that design that works for those who are disabled also works better for the entire population. Mace convened a working group of architects, product designers, engineers, and environmental design researchers who developed the Seven Principles of Universal Design (UD), thus, formalizing the UD movement. Three centers were founded in the United States: the Institute for Human Centered Design in Boston, formerly Adaptive Environments (1978), the Center for Inclusive Design and Environmental Access (IDeA) at the University at Buffalo – State University of New York, formerly The Adaptive Environments Laboratory (1984), and the Center for Universal Design at North Carolina State University, formerly the Center for Accessible Housing (1989). These centers developed agendas for research, teaching, and practice and promoted universal design concepts to government entities. In 1988, the Council for Interior Design Accreditation in the United States required that students in accredited programs demonstrate an understanding of accommodations for special populations, including people with disabilities, older adults, and children in both residential and non-residential environments. During this same decade, the United Nations proclaimed 1983 to 1992 to be the Decade of Disabled Persons and encouraged global policies offering their equal rights.

1990s

Influenced by groundbreaking legislation, the concept of universal design spread. The 1990 Americans with Disabilities Act (ADA) outlawed discrimination based on mental and/or physical disabilities and prodded accessibility requirements for public buildings. The 1995 Disability Discrimination Act in the United Kingdom prohibited discrimination against people with disabilities in relation to employment, the provision of goods and services, education, and transportation. Legislation was also passed in other countries throughout the world. Many governments recognized that changes in the built environment were beneficial for the whole population. In response, additional organizations and centers were established in Europe, including Design for All Europe (1993) and the Helen Hamlyn Centre for Design (1999), where director Roger Coleman used the term "inclusive design." During this time, the National Endowment for the Arts also supported the Universal Design Education Project directed by Elaine Ostroff, and university courses in universal design were offered in design programs across the United States and United Kingdom.

2000s

At the start of the next millennium, the concept of universal design went global and widened its focus from design for disabilities to the improvement of people's lives across a range of social groups and human needs. Conferences were hosted throughout the world, including the International Association for Universal Design Conference and the Royal College of Art's Include, both held biannually. In 2001, the World Health Organization (WHO) redefined disability through the International Classification of Functioning, Disability and Health and emphasized functional status over diagnoses. Disability was described as a contextual variable, intersecting with social and economic status. Inclusive design was cited as a strategy for enhancing people's daily experiences and lifelong attainment. In addition, in 2006, the United Nations General Assembly adopted the Convention on the Rights of People with Disabilities. During this decade, a number of African countries passed legislation to improve rights for people with disabilities, including South Africa (2000), Kenya (2003), and Tunisia (2005). In 2009, the Norwegian government published an action plan (via the Soria Moria Declaration), with a goal to have the country universally designed by 2025. Researchers, including Edward Steinfeld, director of the IDeA Center, developed programs that provided the evidence base necessary to help designers develop solid solutions to expand use of the built environment and convince practitioners in the building and manufacturing industries that inclusive design was good business practice. The first graduate program focusing on inclusive design (Master of Architecture with a specialization in inclusive design) was established at the University at Buffalo in 2008.

2010s

Inclusive design impacts on the marketplace became evident at international builders' shows, where manufacturers promoted universally designed building products, especially for entrances, offices, kitchens, and bathrooms. Concomitantly, inclusive design expanded to global issues of social justice, particularly in developing countries. In 2015, leaders at the General Assembly of the United Nations made several commitments (which overlap inclusive design principles) to improve the lives of disenfranchised populations throughout the world, including people with disabilities. Universal design developed into an established field of study and was incorporated into many industrial design, interior design, and architecture curricula. In 2016, an IDeA Center team launched *innovative solutions for Universal Design (isUD)*, evidence-based universal design solutions for the built environment, which were funded by the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR). The United Nations Sustainable Development Goals, adopted in 2015, set aggressive, global targets to be achieved by 2030 in the sectors of health, education, water, sanitation, energy, and nutrition. Underpinning all areas is an emphasis on equality, cross-sector partnerships, and sustainability, key tenets of inclusive design.

Going Forward

Inclusive design has continued to gain momentum for a number of reasons:

- *Demographics are changing*. Over the next twenty years, the older population will increase by more than 50% in many developed countries. The WHO estimates that over 1 billion people, or 15% of the world's population, currently have some form of disability. As demographics change, this number will dramatically increase. Inclusively designed products, systems, and environments that empower this growing population will be in greater demand in the coming years.
- *Social sustainability is a natural part of the environmental sustainability movement and contemporary business practices*. "Social sustainability is focused on the development of programs and processes [and products] that promote social interaction and cultural enrichment. It emphasizes protecting the vulnerable, respecting social diversity, and ensuring that we all put priority on social capital. Social sustainability is related to how we make choices that affect other humans in our 'global community'." Inclusive design is a facet of social sustainability.[2]
- *Mass customization is making it easier to develop inclusively designed solutions*. Mass customization is the application of flexible computer-aided manufacturing systems to produce customized goods and services.

Through this process, products that were once standardized are now able to change to meet the needs of individuals at the same low unit costs of mass production. This approach to manufacturing makes inclusive design more possible and affordable.

- *Digital technologies are augmenting or eliminating static solutions to dynamic conditions*. Many previously fixed products and systems are now active. For example, Global Positioning Systems (GPS) augment environmental signage and provide individual navigation and information that is specific to each user's needs. Dynamic and personalized products and systems add a critical layer of usability for everyone.
- *World economies are changing*. The International Monetary Fund World Economic Outlook states that although downside risks have diminished overall, there is increased financial volatility in emerging market economies, and increases in the cost of capital will likely dampen investment and weigh on growth. This forecast moves attention toward smart conservation – ways to save money that maintain or improve standards of living. As a result, businesses and governments are looking at processes and approaches that change patterns of waste. Inclusive design, then, becomes part of the solution. For example, the cost of assisted living and nursing facility care is expensive, both for national health providers and individuals/families. Vast amounts of money will be saved if people can stay in their houses or apartments longer because they are inclusively designed.[3]
- *Attitudes about consumption are changing*. The concepts of "planned obsolescence" and "consumer waste" so prevalent in the latter part of the twentieth century are giving way to more prudent and conscientious notions of consumption. Rising energy costs and the slowdown in the world economy have encouraged consumers to rethink their purchasing patterns. Quality over quantity is making a comeback. Inclusively designed features save money in the long run and elevate the quality of living for all.

The promise of inclusive design in the built environment has yet to be fully realized, but has made great strides in the past several decades. It has become a foundational element of policy makers, planners, business professionals, manufacturers, design practitioners, design educators, researchers, and government officials. In the end, practicing inclusive design provides access to many worlds – for people who might be physically, cognitively, economically, culturally, or technologically excluded – and offers greater social participation, satisfaction, and achievement.

Notes

1 Steinfeld, Edward, and Jordana L. Maisel. *Universal Design: Creating Inclusive Environments*. Hoboken, NJ: John Wiley & Sons, 2012; and Tauke, Beth. "Universal Design – The Time Is Now." In www.uigarden.net/english/universal-design-the-time-is-now, ed. by C. Li. Apogee, Usability in Asia, 2008.

2 Vavik, Tom, and Martina Maria Keitsch. "Exploring Relationships Between Universal Design and Social Sustainable Development: Some Methodological Aspects to the Debate on the Sciences of Sustainability." *Sustainable Development* 18.5 (2010): 295–305.

3 International Monetary Fund. "World Economic Outlook: Legacies, Clouds, Uncertainties, 2014." www.imf.org/external/pubs/ft/weo/2014/02/pdf/text.pdf (accessed March 10, 2017).

chapter 2

Design

On any given project, architects make thousands of decisions – some major, some minor; some pre-planned, some incremental, and others improvised. These decisions cut across an array of issues: structural limits, budgetary constraints, legal requirements, client goals, performance targets, and aesthetic aspirations. Many issues – and many stakeholders – can be viewed as possessing competing aims and interests, requiring the design and construction team to mediate these factors and often negotiate among themselves. One point of view on this complexity is to see inclusive design, much like sustainability or value engineering, as one more factor to consider. An alternative view, the one we are emphasizing, is that inclusive design is an overarching means of integrating, not competing with, other design factors. Designing from the perspective of human diversity provides a means to evaluate alternative strategies for site design, spatial organization and wayfinding, the design of individual spaces, and the selection of environmental controls and furnishings. Inclusive design provides a framework for making decisions that support the health, safety, productivity, enjoyment, and autonomy of a site and building's occupants.

How does inclusive design influence site design?

When designing sites, several factors contribute to the usability and functioning of the project, such as sensitivity to the social context, sympathy with the local ecology and natural environment, continuity of circulation and movement, and acuity regarding material selection. While manipulating topography, discussed shortly, is one of the first acts, and one of the finishing acts, in the construction of a building, inclusive site design originates with an understanding of the cultural context. Connecting to the surrounding built fabric, such as transportation systems and other buildings/sites of significance, is one facet. Closely aligned is understanding patterns of daily life – where people live, work, play, eat, and so forth; at what times; and in what places – which, in turn, informs when and how people will likely arrive to and leave from the building and site being designed. Cultural norms also play a role. Are there important religious rituals? Are there beliefs regarding building and site orientation? Are there ideals of proportion, materials, or space making? What are the gender norms, and how are aging, disability, and other social constructs understood? The aim in answering these questions is to inform design decisions that reduce stigma and ensure safety, especially for the most vulnerable groups in the community in which the building resides.

Grading, water management, and landscape design

The topography of a landscape, a street, or a sidewalk, and the design of the transition to the building entry, can permit (or limit) access to the building across a range of user groups, particularly people with compromised strength, equilibrium, or stamina, such as older adults, small children, and individuals with acute injuries. Grading, or the manipulation of topography and landscapes, is a core task of site design, particularly for open-site buildings and complexes. The aims are twofold: (1) to effectively manage storm water and other surface waters and (2) to design meaningful building-landscape relationships. These two goals gain added importance through the inclusive design process.

Managing rainwater, as well as underground water flows and surface water bodies such as springs, wetlands, and streams, has been a critical concern of architects and builders since the beginning of civilization, as groundwater impacts the durability of a building, particularly the foundations. More recently, increased attention to design for resiliency has altered the way that topography is transformed and landscape materials are selected. In flood-prone areas, buildings are being raised above grade or designed so that living spaces are not located at grade levels. But both these strategies can introduce significant barriers to physical access, especially in places where the flood plain is quite high like in the Mississippi Delta or along seashores where hurricanes are common. A key inclusive design strategy in such locations is the incorporation of an accessible infrastructure that enables all sites to share expensive vertical circulation elements like ramps and public elevators. Traditional raised boardwalks are a good precedent of such infrastructure.

Increasing the ability of a site to reduce runoff to surrounding areas is another sustainability strategy. Permeable pavements let water seep through them and collect in groundwater or in underground collection areas. Permeable pavement materials include gravel, brick, cobblestones, permeable concrete pavement, porous asphalt, stabilized soils, and gravel. Unfortunately, these materials are also the most difficult for pedestrian travel and wheeled mobility device use. This does not mean that managing surface water and inclusive design are mutually exclusive goals. The consideration of both together leads to creative solutions like paving limited areas in the center or sides of pathways with smooth stable materials like traditional concrete and using porous materials on the rest (see Figure 2.1).

Topography often needs to be adjusted on a site to prepare it for building, but it is also one of the most important decisions regarding ease of access.

2.1 Pavers providing a track for wheeled mobility devices

When modifying site topography through grading, the following three issues need to be addressed:

1 Wayfinding: how can grading and landscape design assist people in understanding the organization of the site, paths of travel, destinations, and entries? Topography and landscape elements can be used to hide secondary or unintended paths and destinations while revealing primary ones, and materials can be used to clarify paths of movement, versus spaces of repose, versus areas not intended for occupancy. In complement, continuity of paths (spatially and materially) along with clear definition of thresholds and entries (again, through changes in materials and spatial definition) can dramatically improve wayfinding among people with visual and cognitive impairments. Acoustic elements, such as fountains or foliage, can enhance the sensory experience and provide additional wayfinding cues.
2 Ease of movement: how can grading and landscape design provide a steady and seamless path of travel? Careful manipulation of topography can ease movement for people using an array of personal modes of transit – from walkers to wheelchairs, bicycles to powered scooters – as well as children, older adults, and people with health conditions that might minimize stamina. Even steep sites and longer paths of travel can become manageable through the creative integration of areas for rest and/or the use of the building and its circulation systems to negotiate changes in elevation.
3 Safety and comfort: how can grading and landscape design improve user comfort, particularly in relation to sun, rain, and wind? Poor management of surface water, for example, can result in slippery, sometimes impassible, areas on exterior paths. By contrast, a well-designed site will help to mitigate extreme heat and cold, as well as wind, humidity, and rain. Again, this concerns the safety and comfort of all users, but is especially important for children, the frail elderly, and people who face difficulty in self-regulating body temperature. Strategies for improving human comfort in the exterior environment, such as planting shade trees or providing windbreaks, can be integrated with wayfinding and other strategies to improve the user experience in both domains (wayfinding and comfort).

2.2 Walkway system connecting two levels on the J. Paul Getty Museum Campus in Los Angeles, California

Suburban and urban development in hilly areas has, for too long, treated steep topography as a territory to be conquered using methods like flattening the hills to build big-box stores and large parking lots. In sustainable development, designers seek to work with the topography. Steep sites are not inherently inaccessible. By planning natural terracing and pathways that use their length to overcome slope differences, natural contours can be maintained and manipulation of topography is less drastic. Elevators in buildings can be used to connect upper and lower levels of sites, and access to buildings can be at mid-floor or top-floor locations rather than bottom floors. Using the natural slope of a site to support access is not only more sustainable than grading sites to be level; it can, if planned well, enhance accessibility of a site for everyone (see Figure 2.2.).

Responding to weather, ecology, and other contextual factors

Noted as early as the first century BCE in Vitruvius' *Ten Books on Architecture*, site selection and design impact well-being. Weather, ecology, and the surrounding built environment especially influence air quality, which, in turn, influences human health. In a growing number of cities and regions throughout the world, buildings must account for outdoor air pollution, natural allergens, and fluctuations in weather that affect indoor air quality. Commensurately, each site design possesses its own microclimate and ecology, which can add to or diminish other health risks. Standing water, for example, can enable mosquito breeding and, thereby, exacerbate the spread of mosquito-borne diseases like malaria, West Nile virus, dengue, yellow fever, and Zika virus. Some plants, like birch trees, produce high levels of allergens in their pollen that can contribute to increased seasonal allergy symptoms.

Integrating modes of transit

A primary goal that underpins all site design is the integration of various modes of human movement, both locomotion and transportation. This begins with an understanding of how people arrive at the site, for example, on foot, bus, train, car, bicycle, and so forth. People in dense, urban areas, as well as those who live in, work on, or visit large-scale complexes like college campuses, often rely on multiple modes of transportation. As each mode is often

2.3 Evacuation of nursing home patients amid Hurricane Katrina in New Orleans, Louisiana
Photo by FEMA/Jocelyn Augustino

designed, maintained, and managed by a different agency or office, the connectivity between systems can be poorly considered. To improve convenience and functionality, the design team needs to consider transportation systems from the users' perspectives and how transitions are made from one mode of transit to another, for example, car to wheelchair, bus to a bike, and how to accommodate the time spent waiting for rides. Design must also consider the continuum from site access to building entry, and all transitions that occur along the way. A failure at any link in the system can unintentionally terminate access, especially for people with mobility impairments. Increasingly, we must also consider how emergency access and evacuation of sites will take place. The most vulnerable populations, like people with disabilities, frail older people, people who are health care patients, and those with low incomes, are, unfortunately, often the last to be evacuated because they are physically unable to respond independently or have no access to private transportation (see Figure 2.3).

How does inclusive design promote convenience and wayfinding inside the building?

Wayfinding is the organization and communication of our dynamic relationship to space and the environment. Successful wayfinding design allows people to: (1) determine their location within a setting, (2) determine their destination, and (3) develop a plan that will take them from their location to their destination. The design of wayfinding systems need to include: (1) identifying and marking spaces, (2) grouping spaces, and (3) linking and organizing spaces through both architectural and graphic means. All strategies used for wayfinding must communicate effectively to the broadest group possible, including people with a wide range of sensory abilities, intellectual abilities, literacy levels, languages, and physical statures. Design for good wayfinding is even more critical when movement through a building must occur under great time constraints, such as evacuation during an emergency.

Spatial organization

Certain architectural and interior design features help users to construct a mental map of a place by creating familiar models of how space is organized, by supporting multisensory access to information, and distinguishing one place from another. There are five attributes of buildings and sites that support the construction of accurate mental maps: (1) clearly defined paths and circulation systems, (2) markers that stand out from the general background stimuli, (3) recognizable nodes where paths intersect, (4) strong edges such as walls or landscape features, and (5) well-defined zones/districts.

Strategy 2.1 Circulation systems

When designing circulation systems, utilize five complementary spatial elements: paths, markers, nodes, edges, and zones.

Paths

The circulation system is the key organizing element of a site or building. Designing an inclusive circulation system includes the following guidelines:

- Communicate the circulation system to the users when they enter. In particular, vertical circulation devices, such as ramps, stairs, escalators, lifts, and elevators, need to be intuitive and perceptible (see Figure 2.4).
- Develop a focal point and a system of circulation paths to help people understand where they are in the system.
- Distinguish paths with width/height, material, and color differences to assist in the comprehension of the circulation system.
- Use a system that has repetition or rhythm to help people determine intuitively where they are going and be able to anticipate destinations.
- Use circulation systems that lead people from node to node (see Figure 2.5).
- In multistory buildings, organize elements such as restrooms, elevators, and exits in the same location on each floor. Remember that people often do not comprehend the overall plan of circulation paths. Whenever possible, design layouts that enable people to identify where they are going well before they arrive.
- Where possible, emergency circulation routes should be the same as those used for regular building functions. Where separate emergency circulation routes are needed, they must be visible to building users during normal use of the building.

2.4 Options for vertical movement within a building

2.5 Tactile floor leading to information desk

Markers

Markers such as arches, monuments, building entrances, kiosks, banners, artwork, and natural features give strong identities to various parts of a site or building (see Figure 2.6). They act as mental landmarks in the wayfinding process and break a complex task into manageable parts. Inclusive guidelines to consider include the following:

- Place markers at focal points that correspond to intersections.
- Locate markers to be detectable from as many positions as possible without physically interrupting the path of travel.
- In interiors, consider hanging markers.
- Mark entrances by adding cues such as recesses, overhangs, and/or landscaping.
- When designing building exit markers, equate light cues with exit conditions.
- Set up primary markers to incorporate tactile, sound, and visual indicators.

2.6 Wayfinding in Stuttgart City Library by Yi Architects. The Stuttgart City Library by Yi Architects is a wayfinding exemplar. Overall circulation is visible from all levels. Each floor contains a multisensory directory. The center is lit by an oculus skylight that emphasizes the square marker below.

- Locate windows to enable detection of markers from inside.
- Establish unique views to the outdoors as interior markers.
- Consider the information desk or kiosk to be a key wayfinding marker.
- Use unique markers to identify emergency circulation systems if they are separate from the normal circulation system.

Nodes

Nodes are places where paths come together. People make decisions at nodes in paths. As a result, nodes might contain graphic and architectural information to assist with those decisions. Inclusive guidelines to consider include the following:

- Distinguish nodes with markers and general architectural features.
- Think of wayfinding as a "connect-the-dots" activity and use only the information that is necessary at each node.
- Consider easy-to-understand node systems such as grids to help people establish a mental map of the wayfinding system.
- Use maps and graphic information to communicate the form of circulation only at primary rather than secondary nodes.
- Make certain that the level of information provided at nodes is not overwhelming, especially for first-time visitors who need to access essential information for finding their way.

Edges

Edges such as walls, handrails, floor strips, and planter rows provide a physical means to orient oneself in space. An edge provides a boundary that people use to move in the right direction. Inclusive guidelines to consider include the following:

- Design edges for both visual and tactile detection.
- Change edge features periodically to provide a sense of progress toward a goal as one is moving along.
- Introduce contrasting floor textures and hardness to establish wayfinding edge conditions and to alert users to changes in height conditions.
- Mark the tops and bottoms of ramps and stairs to emphasize transition points.
- Use tactile marking systems on handrails to inform people of changes in conditions, particularly potentially hazardous conditions (e.g., the top step of a stairway).

Zones

Wayfinding zones are regions either outside or within buildings with a distinguishing character that assist in the general identification of place. Inclusive guidelines to consider when designing wayfinding zones include the following:

- Establish zones at the beginning of the design process.
- Identify each zone as memorable and unique from the other zones.
- Use unifying elements such as a tactile pattern, color, sound, themed images, or even hypoallergenic scent (see Figure 2.7).
- Reinforce the identifying characteristics of the zone with signage prior to arrival in the zone.
- Identify zones with names such as the North Wing or Green Grass South.

2.7 Wayfinding system in medical office. Pictorial cues at multiple scales help all find their way and are particularly beneficial to those with language and memory challenges. At this medical facility, patients are given an image and are instructed to follow the image to find their way to the specialty area.

2.7 Continued

How does inclusive design affect environmental controls?

Intrinsic to the definition of inclusive design is the promotion of human performance, health, and well-being. Environmental controls, such as lighting and HVAC systems, affect the ways that users interact with their surrounding environments. Over the past decade, the sustainability movement has increased its focus on the promotion of human health in addition to the health of the earth. This shared relationship between inclusive design and sustainability continues to strengthen as researchers strive to demonstrate that efforts supporting the health of the environment also support human health. While environmental controls are able to support human functioning in the built environment, they are also capable, if not planned, designed, and installed correctly, of acting as barriers. When designing through an inclusive lens, it is essential to properly select and implement environmental control systems appropriate for the users and function of the space. This section describes the role that lighting and HVAC systems play in promoting human performance and health and wellness.

Lighting

Lighting influences a variety of human factors including task performance, spatial appearance, safety and security, and mental health. While studies repeatedly show proper lighting levels contribute to increased human performance and comfort in a space, recent research in the field of photobiology suggests it also has effects on human circadian rhythms. As a result, both electric and daylighting are necessary elements.[1]

Electric lighting comes in several forms, including the incandescent bulb, halogen lamp, gaseous discharge varieties (e.g., metal halide, fluorescent tubes, compact fluorescents), and light-emitting diode (LED) (see Figure 2.8). No matter the form, electric lighting is most beneficial when provided in a manner in which it is continuous and even. To accommodate the wide range of tasks performed in spaces like offices and kitchens, designers need to provide general, ambient, and task lighting with controls for each type, allowing users to manage the amount and type of light needed for

2.8 LED lighting in retail setting

2.9 General, ambient, and task lighting in kitchen

particular tasks (see Figure 2.9). Positioning fixtures so light is indirect, or otherwise diffused, helps to minimize distracting glare and/or shadows that may contribute to human discomfort, error, fatigue, or injury.

Strategy 2.2 Lighting

To improve human comfort and performance, it is best to provide daylighting and electric lighting, whether independent or in combination, in a continuous, even, and indirect manner, while also enabling user control over the amount and directionality of lighting in critical task areas.

To avoid negative effects on visual perception and comfort when users move from one room to another, such as from assembly spaces to corridors, optimally, light-level changes occur gradually between spaces. Additionally, in dimly lit areas, including performance spaces, designers can use electric lighting or photo-luminescent materials to define path edges. In large spaces with multiple users, for example, open office environments, the design optimally provides task lighting with individual controls to facilitate user control over the amount of light based on individual needs. Emergency circulation routes must be easily perceived when the building loses electrical power and emergency lighting is functioning at lower levels of illumination than normal lighting.

With multiple light sources, though, it is sometimes difficult to avoid having too much light or poor quality of light in a space. Likewise, efficient lighting control is an important aspect of both sustainable and inclusive design. Controls that automatically adjust electric lighting levels based on the amount of daylight available, as well as presence-detection systems, increase usability and promote sustainability. While fine adjustments by users may still be required, automation can reduce the frequency of interventions. It is important that automated systems are understandable to the users and are compatible with their habits. Sometimes manual systems can accomplish the same goals with less cost and greater control. For example, hotels often incorporate a master switch that the guest's card key activates. This may be a better approach to shutting off lights in a hotel room than a presence sensor, since there is relatively little activity in such spaces and lights will automatically turn off even though there may be people in the room. New remote systems that can be operated by smartphones offer greater potential for personalized control over lighting, both natural and artificial.[2]

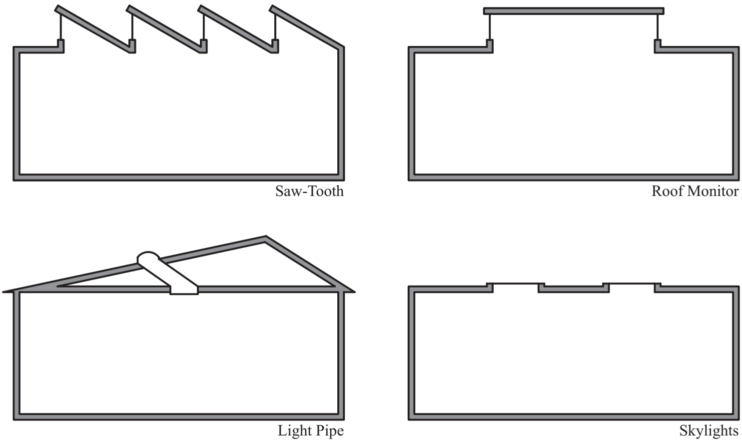
Even with proper planning and design of illumination, without adequate lighting controls, the most efficient artificial lighting system can become inadequate to meet the needs of users. To ensure the most effective use of artificial lighting, utilize the following strategies:

- Lighting controls that are within reach;
- Lighting controls that are labeled to indicate their zone of control;
- Switch plates that contrast in color from the surrounding wall;
- Lighting controls that can be activated by remote control or voice command;
- Automated lighting that also includes an override switch; and
- Lighting controls that have a master switch to control all light.

Case study 2.1 – big-box stores

Historically, time zones and daylight hours set the parameters of business hours for many offices and commercial establishments. With the emergence of chain stores across vast geographies, headquarters centrally monitor and control the lighting and other systems in their big-box stores, turning the lights off shortly after the stores close and on shortly before the stores open. Striving for efficiency, unintended consequences arose. One such consequence related to central managers setting national systems based on local parameters. As a result, franchises with southern headquarters heard from managers of stores in far northern locations who found that employees were arriving to pitch black parking lots early in the morning. To ensure safety of their personnel, they had to break into locked control boxes in their stores and disconnect automated systems. In this case, the problem is not due to the control system itself, but to the limitations of its software and the nearsightedness of its operators. A system like this has to be more sophisticated to address the different contextual conditions of hundreds or thousands of stores, including an understanding that the length of day and night varies not only by time zone, but, also by latitude, as well as daily weather.

As is the case for electric lighting, it is important to provide access to daylight in all habitable spaces. The provision of natural light in a space can be accomplished using two types of systems: side-lighting systems and top-lighting systems. Side-lighting systems provide lateral illumination from the sides of the building, while top-lighting systems provide vertical illumination from the top of the building. Unlike artificial lighting, which is easily controlled by switches and/or knobs, natural lighting is somewhat more difficult to manage because it requires the management of not only the quantity of light, but also the quality. Sidelight systems accomplish this by utilizing features such as light shelves, prismatic glazing, mirrors and/or holograms, anidolic ceilings, and louvers and/or blinds. Top-light systems control the amount and quality of light through skylights, roof monitors, saw-tooth systems, or light pipe systems (see Figure 2.10). One key



2.10 Top-lighting strategies

challenge posed by daylight is that it changes based on the time of day and time of year. In order to lessen the reliance on users to account for these gradual changes, technologies such as shading devices that automatically adjust based on the amount of natural light available and/or time of day/year can be incorporated into the design. This not only will help to ensure occupant comfort but also will lessen the additional load placed on other systems.[3]

HVAC systems

HVAC systems have the ability to affect user comfort and contribute to health promotion and avoidance of disease as well. In studies examining workplace satisfaction, experts cite thermal comfort – the condition of mind that expresses satisfaction with the thermal environment, assessed by subjective evaluation – as the number one complaint of workers. To address this, there are many strategies designers can adopt to ensure user comfort, including specifying HVAC systems that are engineered to provide even and stable temperatures within a zone. This is supported by paying special attention to placement of heating coils, diffusers, and exhaust elements, and also insulation levels in walls, doors, and windows.

Strategy 2.3 HVAC systems

As the leading complaint among employees is thermal comfort, and, as thermal comfort is subjective and highly varied, HVAC systems must be flexible in accommodating an array of user needs and preferences.

In environments such as office buildings, zoning systems allow for the independent control of spaces, facilitating comfort for a wide variety of users at different times of the day. Another option is to include supplemental heating and cooling units in individual task areas. This can assist with maintaining thermal comfort in spaces that may experience significant fluctuations in temperature throughout the day because of their location on certain exposures of the building, for example, north facing vs. south facing, or use of different equipment. Supplemental systems allow for adjustments to easily be made within a space without affecting the comfort of occupants in other parts of the building.[4]

While the type of system provided has the ability to affect user comfort, the design of the system itself can greatly affect occupant health. Ideally, architects and engineers design HVAC systems to: (1) eliminate drafts by design or through controls on airflow, (2) incorporate high-efficiency air filters and allergen filtering systems, and (3) allow for natural ventilation options. Research shows that proper airflow, ventilation, and air quality contribute to increased productivity and reduced incidence of illness.[5]

To maximize system effectiveness, appropriate attention must be paid to implementation. System controls must be reachable by all people and follow a common user interface. While an HVAC system may be designed to achieve the highest level of efficiency, if the controls are not intuitive, accessible, and easy to use, the system will never be used in such a way to achieve this efficiency.

How does inclusive design affect the design of key features?

Parking

Parking is often the first element of a site user's experience when arriving at a building or public space. Accessibility codes specify minimum requirements for parking, including a specified number of reserved spaces for people with disabilities as well as access aisles to facilitate transfer into and out of vehicles. Codes do not, however, address the parking needs of other segments of the population, including pregnant women, older people, families with small children, and incentive programs, such as employee-of-the-month initiatives. In addition, owners often provide spaces reserved for people who pay a fee for greater convenience or with electrical supply for charging electric vehicles as an incentive to promote the purchase of electric or hybrid vehicles, and to encourage ride-sharing. In response to these needs, the term "priority parking" is used here to describe the inclusion of spaces for these groups. Priority parking is most effective when it is located close to main entrances to buildings or public spaces. It may be appropriate that any fees associated with priority parking be waived for people with disabilities. It is important that any type of priority parking that provides unique benefits or services, for example, EV charging stations, include accessible parking spaces as well.

Strategy 2.4 Priority parking

Rather than a binary approach to parking design – that is, design for "handicapped" and general-use parking – consider parking as a spectrum of options for diverse occupants. Proximity to the destination is but one feature in "priority parking." Other features, such as shade, protected walking paths, lighting, and amenities like charging stations, can be deployed to better meet the needs and preferences of various user groups, and incentivize otherwise underused parking areas.

Paving and walkways

The design and construction of walking surfaces is critically important to the safety of users when navigating any site. For public rights-of-way, accessibility codes and standards provide extensive guidance on design for people with disabilities by specifying requirements, for example, ensuring walking surfaces are stable, firm, and slip resistant, and free of objects protruding into the path of travel. Also dictated are maximum running slopes in the direction of travel and cross slopes perpendicular to the path of travel, as well as minimum widths for pathways, typically based on the space needed for one wheelchair user. When approaching paving and walkways through an inclusive lens, the design may include higher-level strategies that address usability, safety, and security on all paths and walkways, not just those addressed by accessibility code requirements. These strategies may include the following:

- Site-related considerations, such as the provision of finished topography that diverts water from pathways;
- Material considerations including the use of permeable pavement to aid in reducing the collection of water on surfaces;
- Material changes signifying pathway and/or walkway edge conditions;
- Lighting to illuminate walking surfaces; and
- Reflective or photo-luminescent materials to mark edge conditions at night.[6]

The ability to detect the edges between pedestrian and vehicular areas is critical to the safety not only of users with visual impairment but also to other users. This can be accomplished by using cobblestone or brick-lined edges, plantings, bollards, spheres, or even guardrails. Designing beyond the minimum regulated standards for individual features also improves usability and functionality for all users. For instance, designing the width of a sidewalk based on the expected capacity rather than the minimum space required for wheelchair use ensures users with and without disabilities are able to comfortably navigate. Moreover, additional width provides an opportunity to include plantings, signage, and furniture to improve aesthetics, support usability, and accommodate user needs.

Case study 2.2 – Botanical Garden, Naples, Florida

The Botanical Garden in Naples, Florida, has a far-flung network of paths and also a large number of older visitors who have difficulty walking. The Garden provides scooters and wheelchairs for visitors who cannot manage the long distances required to see all the facilities. The buildings on-site are concentrated at the entry pavilion where the mobility devices can be checked out. The pavilion and other buildings with a dining area, gift store, offices, and auditorium are raised above grade to protect them against flooding (see Figure 2.11). A continuous deck and bridges connect them all with an accessible circulation

2.11 Raised walkway system at Naples Botanical Garden, Naples, Florida

2.12 Protected walkway at Naples Botanical Garden in Naples, Florida path with ramped access from grade. All circulation areas are wider than the minimum to accommodate both the mobility devices and large crowds. The bridges, ramps, and decks are also covered to protect them during rainy periods (see Figure 2.12).

Ramps

Ramps are an inclusive solution to navigating changes in elevation where stairs would typically be used. Accessibility standards set forth several requirements for the design of ramps including:

- Maximum width
- Maximum length
- Maximum slope
- Railing design
- Edge protection
- Landing design.

Although these requirements begin to address usability and safety for users with disabilities, research shows that these measures are often inadequate to address the needs of many users with and without disabilities. Ramps designed to the maximum slope and length often incite fatigue among manual wheeled mobility device users and their caregivers, and minimum landing sizes are often inadequate to accommodate the turning space needed for larger wheeled mobility devices and even strollers. Additionally, ramps are often implemented as an alternative path of travel to stairs, typically requiring a longer path of travel located outside the main pedestrian path.

Inclusively designed ramps often include programming strategies, such as incorporating a ramp as the main path running in the direction of primary circulation, assisting in reduction of user effort (see Figure 2.13). Reducing the slope below the maximum allowed also helps to minimize user effort. The ramp design must also take into account the expected traffic and largest wheeled mobility device users when specifying the width of ramp runs and dimensions of the landing. Additionally, the inclusion of seating along

2.13 Boardwalk at Cape Cod National Seashore in Provincetown, Massachusetts

the ramp or landings not only benefits users who may fatigue easily or have limited mobility but also provides a space for users to get out of the way while waiting for someone or who may need to stop for any reason, such as to make a phone call.

Strategy 2.5 Ramp design

Rather than a secondary feature, inclusive design practices often position features, such as ramps, as signature building elements – central to the overriding architectural concept and user experience.

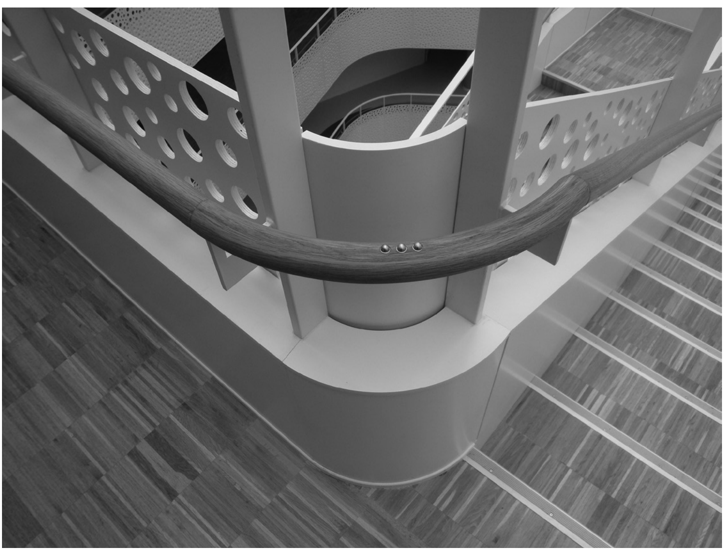
Stairs

In places and spaces where a change in elevation deems it necessary to have stairs, approaching stair design in a thoughtful way can make them more usable for a wider population of users. Existing accessibility regulations apply only to stairs that are part of a means of egress and, at that, specify only the following features:

- Riser height
- Tread and nosing depth
- Tread surface
- Railing design
- Minimum landing sizes.

To make all stairs safer and more usable by people of all abilities, architects can pursue a number of inclusive strategies, including features that support situational awareness for everyone, especially individuals with sensory impairments. These features may include the following:

- Tactile warning-surface indicators at the top of stair runs;
- Tactile and/or auditory cues to indicate changes of direction and the top and bottom of a stair run (see Figure 2.14);



2.14 Cues at transitional moments on stairs in the House of Disabled People's Organisations in Taastrup, Denmark

- Riser and tread proportions that support a comfortable gait;
- Slip-resistant materials on treads; and
- The avoidance of irregularities onto the tread surface that can present tripping hazards.

The visual environment of the stairway is a critical factor in stair safety and usability. Strategies for creating a good visual environment include the following:

- Illuminating stair treads and handrails evenly;
- Using materials that reduce glare;
- Utilizing contrasting colors at the edges and handrails/balustrades to emphasize direction changes;
- Providing a contrasting color to emphasize the edge of stair nosings;
- Deploying non-distracting or non-confusing colors;
- Avoiding the use of textures and patterns on treads and landings that camouflage the edge of the stair treads or that create optical illusions;
- Controlling artificial and natural light to eliminate strong shadows on stair treads; and
- Including reflective or photo-luminescent striping in dark locations.

In addition to the design of stair risers and treads, design features on the landing also support usability. Similar to ramps, going beyond the minimum and including extra space on the landing provides not only an area for users to rest out of the flow of circulation, but also space for the inclusion of seating.

Strategy 2.6 Complementary features

While stairs and ramps are primarily designed as spaces of movement, consider how complementary elements, such as seating, can enhance the user experience. The concept of "complementary design" can be applied to all types of interior and exterior spaces.

Residential entries

No-step access into a home is one way to make a home more usable for people of all abilities. A no-step entry, or a flush entry, from the outside or garage, into the home is equally beneficial to someone with a mobility impairment as it is to a parent pushing a stroller or someone rolling a piece of luggage. No-step entries can be achieved using the following strategies:

- Slab-on-grade or notched foundations;
- Ramps to at least one entrance, including inside attached garages if space permits (see Figure 2.15); and
- Sloped walkways and careful grading of the site to eliminate the need for ramps.

Materials commonly used in the construction of residential ramps include wood, concrete, or composite decking. An alternative means to achieve a no-step entry is to include a platform lift. While not viewed as

2.15 Ramp to entrance of home

attractive as a well-designed ramp, platform lifts require significantly less space than a ramp and may also be incorporated into the entry sequence at any entrance to the home, including in a garage or mudroom, when space and headroom allows. One potential negative to platform lifts is the potential for mechanical failure.

While ramps and platform lifts provide solutions to achieve a no-step entry, both also carry a certain level of stigma and are often associated with disability. In keeping with this, an alternative solution is to construct the entry so it can be accessed from a grade or a sloping walkway – a walkway with a slope of 1:20 or less that requires no handrail (see Figure 2.16). A number of strategies can be used to achieve this condition including a reverse brick ledge foundation. To prevent water infiltration, a no-step entry using this method needs to include both a roof overhang and good outside drainage.

Building regulations do not always require accessibility to balconies, terraces, and decks. They often only require one accessible entry/exit. But

2.16 Sloping residential entry path in home show house by Heartland Homes to participate fully in the life of a household, these outdoor spaces must be accessible – an essential principle of inclusive design in housing. To simplify construction, balconies, decks, and terraces are often designed to be one step below the interior floor level of the dwelling units they serve. The step is provided to prevent wind-driven water from entering the dwelling, prevent moisture from exterior build-up of ice and snow, or to reduce the complexity of the construction detail where the outside floor structure attaches to the building structure. For example, if an on-grade terrace is a poured-in-place slab, lowering it below the interior floor level eliminates the need to ensure the seam between the two structures is perfectly aligned; or, a concrete balcony will be lowered one step and sloped away from the building as an economical way to drain storm water away from the building wall. There is no reason why these spaces, with proper detailing, cannot be made accessible. If the entry utilizes a patio door, slotted decking and flashing can be used to limit the transference of water from outside to inside.[7]

Kitchen workstations and adjustable cabinetry

The inclusion of varied height workstations and adjustable cabinetry in kitchens and bathrooms increases convenience and helps to reduce effort for users of all abilities. Ideally, several counter height options between 28–42 in (715–1070 mm) will accommodate the needs of most users. Countertops at sinks are typically set at 36 in (915 mm) high, and standing workstations for reading and writing typically are best at 42 in (1070 mm). A counter height of 28–32 in (715–815 mm) satisfies the needs of most users when in a seated position. Raising ovens and dishwashers off the floor also reduces effort while cooking and loading dishes (see Figure 2.17).

Adaptable cabinetry is another option to ensure that the needs of diverse users are met. Adaptable cabinetry allows a kitchen or bathroom to be adjusted over time to meet changing occupant needs and preferences. Features like removable cabinet fronts on bases under sinks and workstations can provide knee clearance for someone who needs to sit or make use of a wheeled mobility device while completing tasks. Similarly, modular, stacking drawer units can be used to allow the height of a detachable countertop to be lowered or raised based on the needs and preferences of different users.

2.17 Raised dishwasher in home show house by Heartland Homes

Strategy 2.7 Adaptable kitchens

Kitchens are high-activity areas with diverse users. Designing with adaptability in mind can help accommodate small children and adults, as well as ambulatory and non-ambulatory residents over the life of a home. Adjustable cabinetry, along with work surfaces of various heights, extends the range of usability (see Figure 2.18).

Adjustable cabinetry is a challenge to implement despite the widespread adoption of adjustable storage systems like closet organizers. Kitchen cabinet and plumbing fixture manufacturers in Europe and North America have developed adjustable products, but they are hard to find and often expensive.

2.18 Inclusive residential kitchen

In some countries, the concept of adaptable cabinetry has been included as an option in accessibility codes for multifamily housing. The idea is to design cabinets so that minimal effort is needed to adapt the cabinets to wheelchair access by removing base cabinets and lowering counters. Adaptable cabinetry provides a bonus to the building developer and owner because less space is needed in small rooms to provide wheelchair turning clearances when the cabinets are removed under counters and plumbing fixtures. But it is still not widely used, partly because legacy codes still require a specified number of "adapted" units with knee clearances and lower counter and cabinet heights. This code provision is perceived as the answer to the problem of inaccessible cabinetry. However, having countertops and storage that is adaptable to an individual's needs is a universal need, not something from which only wheelchair users can benefit. For example, people of shorter stature and taller stature are uncomfortable and at risk of injury if work surfaces are not at heights that are appropriate for them. Retrieving objects out of reach can expose people to risks of falling or back injury.

Adaptable cabinetry can have many features:

- Adjustable shelving;
- Full-height pantry storage that provides options for people of different statures;
- Multiple-height work surfaces;
- Counters that can be repositioned to desirable heights for a household without a specialist;
- Automated countertops and cabinets that work for people seated and tall people standing;
- Storage on the back of cabinet doors to bring it within closer reach; and
- Shelving and other accessories that slide out from cabinets.

Case study 2.3 – cabinet design

Simply following the accessibility code for cabinetry design will not lead to good results. For example, lowering wall cabinets above a counter reduces the amount of good storage space on the counter.

A blender or microwave may no longer fit anywhere in the kitchen. Even an individual who uses a wheelchair wants to have small appliances conveniently located. When cabinets are lowered, the kitchen has to be rethought to accommodate small appliances, and, when cabinets are removed, additional storage needs to be provided to compensate. A full-height pantry cabinet, for example, may be a better way to provide accessible cabinet storage, leaving walls free for open shelving and racks for utensils, and so forth. Architect John Salmen had kitchen designer Jane Langmuir create custom cabinets for his own house that are deeper than usual to allow low storage at the back. The counters are supported by legs and base cabinets and can be removed if necessary. This approach provides very convenient storage for items used during food preparation and an attractive solution if knee space is required for seated work in the future. But custom work like this cannot be executed well without a lot of detailed drawings.

Flooring

Falling is one of the most common reasons for injury in building interiors, and floor coverings play a critical role in preventing slipping and tripping. Carpet is one of the most specified materials in commercial and institutional spaces. While it is comfortable under foot, it also reduces reverberation times, helping to reduce background noise and improve situational awareness. The wide variety of patterns and colors available for carpet also contribute to its effectiveness as a wayfinding cue. To ensure carpet selections support safety and usability for diverse users, including those with mobility difficulties, it is important to consider the following factors:

- Colors and patterns: use caution when selecting colors and patterns, especially in settings with users who may have low vision. Busy patterns and color combinations may lead to perception difficulties and cause a feeling of instability among users.
- Height of carpet pile/tuft density: low pile height and high tuft density make the carpet more firm and more usable by people using wheeled mobility devices, walking aids, and even those who shuffle their feet. Recommended pile height is between 1/4–1/2 in (6.4–12.7 mm). A beveled

transition is to be provided between carpet edges and adjacent floor surfaces with a ratio no greater than 1:2.

- Hypoallergenic carpet: carpeting with low volatile-organic-compound (VOC) ratings that incorporates bacteria guard, mildew guard, and non-allergenic fibers is best for the health of occupants.
- Carpet installation: carpet is safer and more user friendly if installed with a firm, rather than soft, cushion, pad, or backing underneath, or with no pad.
- Area rugs: it is best to avoid the use of area rugs if possible. When used, they need to be securely fastened to the flooring below to decrease tripping hazards.

Wood is a renewable resource and is aesthetically pleasing, easy to maintain, and resilient when installed in spaces that do not frequently get wet. When selecting a finish for wood floors, it is important to ensure that the finish is not too slippery or too shiny. Shiny floors can be visually distracting and reflections can be problematic for users with vision loss.

Tile floor coverings are available in a wide range of sizes, styles, finishes, and materials, including ceramic and stone. Although tile floors are easy to clean and durable, they can be problematic if the surface is too smooth and does not provide enough traction, particularly in areas that get wet. To increase safety, select tile with non-skid surfaces, especially in areas that may get wet such as bathrooms, kitchens, and mudrooms. Joints between tiles must not exceed 3/4 in (19.0 mm) to avoid causing difficulties for wheeled mobility device users or users with walking aids.

Other resilient flooring is an inexpensive, durable, and easy to maintain floor covering that, while often used in commercial settings, lends itself to use in a variety of settings including homes and offices. Resilient flooring is generally made from natural materials and includes types such as cork, linoleum, and vinyl composite tiles (VCT). The material properties of this flooring type make it mold and bacteria resistant, as well as make it easier to stand on for long periods in comparison to concrete, stone, or tile. Additionally, the non-slip finish supports safety, particularly in wet areas. Similar to carpet, caution needs to be exercised when selecting color combinations and patterns.[8]

Well-designed floor transitions are critical because of their importance to mobility for people who have a shuffling gait, use wheelchairs, or have vision impairments. They are also important for preventing accidents for all users. Abrupt edges should be avoided, and any difference in height between one floor surface and another should be kept to a minimum. Inadequate design of transitions is one of the leading causes of citations due to building code violations related to accessibility. Oftentimes, higher-end buildings tend to have more problems related to transitions compared with lower-cost buildings. This can be attributed to the presence of more luxurious materials where budgets are more significant.

Case study 2.4 – thresholds

In a large luxury residential building, the on-site building manager supervised the interior design of hallways. Her goal was to ensure a luxurious appearance. As a result, she insisted that all the thresholds be made from slabs of marble with abrupt edges. When the building was completed, the thresholds were cited for not complying with accessibility codes; they were too tall and did not have beveled edges. Since the carpet in the hallways was already installed, the developer had to remove the carpet and install beveled edges on all the thresholds that did not comply. Luckily, after carpet was installed in the hallways, many of the thresholds were compliant in height on that side of the door.

Slippery walking surfaces at entries is a common problem, often not noticed until a building has been constructed because it is hard to imagine how a material in a specification or drawing will perform in adverse weather conditions. All too often, problems with floors will be identified during construction or soon after, but nothing is done to address the problem until someone gets hurt. In most climates, water will be tracked into a building whenever it rains or snows, therefore, designers need to consider weather factors when specifying materials. The design of entries must address water, deploying materials and strategies that are not prone to being slippery when wet. The lack of attention to floor surface transitions that can become slippery is part of the reason why slips and falls are a major source of lawsuits against building owners and architects. Ideally, designers would avoid using slippery floor surfaces, but they are often under pressure by their clients to use luxurious materials like polished stone. Construction drawings and specifications really cannot convey the nature of the materials, so slippery surfaces are often overlooked until samples arrive during submittals. At this point, measures can be taken to ameliorate the problem before someone gets hurt. For example, a vestibule can be redesigned to include transitional entry flooring that will help dry shoes as individuals enter, which also can reduce the need for adding mats in bad weather to soak up the excess water that is tracked into the space.

Use of glass flooring and stair treads is a growing trend that needs to be reconsidered, especially near entries. Although these materials are designed not to be slippery under dry conditions with special surfaces and coatings, they may still be slippery once water is tracked on them.

Case study 2.5 – glass stairs

A major international retailer uses glass floors at the entry on monumental stairs of their stores. In their New York City stores, they have

2.19 Carpet on glass floor and stairway in retail store to cover all the glass with segments of carpet when it is raining or snowing to prevent customers from slipping (see Figure 2.19). Architects have to make prevention of accidents a priority over the creation of "impression" spaces at building entries.

Acoustic control

In inclusive design, it is essential that all the senses receive adequate attention to satisfy the Goal of Awareness. Yet the acoustic environment is one of the most neglected areas of design. Acoustics contribute significantly to the experience of the built environment by assisting with orientation, location identification, and situational awareness. When planning for acoustic controls, it is important to consider the following:

- The space's purpose;
- The number of occupants;
- The length of time occupants spend in the space;
- The activities that take place in the space; and
- The space's location within the building.

At one time or another, a significant percentage of the population will experience some form of hearing loss, either temporary or permanent. As a result, acoustic control is important in all types of spaces, including residences, offices, and schools. There are three acoustic design strategies important for the practice of inclusive design:

- Controlling background noise;
- Ensuring speech intelligibility; and
- Reducing interference from mechanical and electrical systems.

Reducing background noise creates the baseline for a good acoustic environment. Background noise not only distracts all users from their activities but also requires people to raise their voices when talking to others, affecting the quality of interpersonal communications. Further, some individuals with disabilities, like people on the autism spectrum, become agitated with excessive background noise. Those with high tone hearing loss, like most people over the age of 75, will find that they have a hard time understanding the speech of others when background noise is excessive, like in busy restaurants. Speech intelligibility can be enhanced by the acoustic environment. A space with low reverberation times will sound "dead" and speech will not be clear as sound degrades too quickly. A space with high reverberation times will produce too much noise to hear critical information. Sound interference can be created by equipment like loud air conditioning or buzzing lighting fixtures. Light fixtures, air handling systems, and even plumbing can produce unwanted noise. The performance of assistive listening systems can be compromised by electrical interference from equipment that cannot be predicted.[9]

While architects cannot always anticipate these challenges during the design stage, there are solutions to lessen their negative effects. Reduction of background noise from outside the building can be accomplished by providing good acoustic separation and careful window selection. Additionally, reverberation can be reduced by installing carpeting, and in residential environments, by lining draperies. The arrangement of seating and furniture can also affect acoustics within a space. *Sociopetal* seating arrangements, which provide direct visual contact among individuals, encourage social interaction and provide good sight lines for conversation (see Figure 2.20). In offices, barriers between workstations are optimally made of sound absorbing materials and at least 64 in (1625 mm) in height. Finally, ensuring heating and air conditioning systems are quiet also supports good acoustic control within a space.[10]

Both common sense and scientific research emphasize the importance of good communication in education and interpersonal relationships, but somehow, the building community in many societies has not put value on this aspect of design. Although acoustic consultants are available, they are usually hired only to assist and evaluate designs when acoustics are known to be a critical factor for the success of a project, for example, in a performing arts space or open office environment. Even then, their advice is not always heeded.

Buildings with high background noise levels due to lack of sound absorptive materials, proportions that cause high reverberation times, lots

2.20 Sociopetal seating arrangement in university residence hall

of sounds from people talking, or exposed noisy equipment will interfere with the perception of human speech. Such spaces could be planned so that acoustic control can be added after the fact if needed and contribute to the aesthetics rather than detract from them, or provided with flexible acoustic treatment like hanging acoustic panels (see Figure 2.21).

Another problem is exposed mechanical systems, particularly air handling ducts. Good specifications ensure that mechanical equipment and distribution ducts and registers will not generate too much noise, and a budget is needed to fine tune the systems if they do not perform as expected.

Sign systems

As introduced in the wayfinding section, adequate signage complements a clear building layout and circulation system. Proper signage assists users with orientating themselves within the space, finding their destinations, and identifying key locations along the way. Effective signage systems also account for flexibility and can be changed easily and inexpensively. When approaching

2.21 Suspended acoustic treatment in university presentation space

signage inclusively, the following are a few recommendations to ensure the system is usable by as many people as possible:

- Readable from expected viewing distance and not obstructed by objects so people with limited vision can get close to read them;
- High contrast of characters on background;
- Does not produce glare and is protected from reflected glare;
- Provides all information in visual and tactile and/or audible format, including room purpose wherever signs provide room numbers;
- Selected signage uses pictograms and/or more than one language;
- Directory lists building occupants and room numbers under an organizational heading;
- Signage at intersecting routes are perpendicular to the direction of travel from all approaches to the intersection;
- Signage at intersecting routes provides navigation information (e.g., arrows guiding to range of room numbers, organizational headings, areas of primary functions);

- Selected signage links to additional online resources (e.g., QR code);
- Smart signage is provided on the premises (e.g., signs with radio frequency identifiers, near field communication, or other technology that allows communication with a personal computing device);
- Signage located in dark areas or outdoors are backlit, reflective, and/or directly illuminated; and
- Interactive model or plan of the building is available that can provide information through speech, text, or tactile media.[11]

Case study 2.6 – interactive wayfinding

Touch Graphics, in partnership with the Center for Inclusive Design and Environmental Access (IDeA Center), has developed a technology for creating interactive touch-sensitive models and maps (see Figure 2.22). Through several cycles of prototype development and testing, the partners established that these devices improve navigation for people with vision impairments by helping them to learn complex

2.22 Talking map at the Perkins School for the Blind by Touch Graphics Inc. and the University at Buffalo IDeA Center sites. A raised line plan is mounted as an overlay on a touch-sensitive display. Three-dimensional building models can also be fastened to the overlay. Through a proprietary technology, sensors transfer the location of touches to the display. Information about the place touched can then be presented to the user through speech, text display, or even refreshable Braille. Users can explore the models and maps on their own, or be prompted in a sequence of tasks to learn the building or campus. One installation included an interactive game designed to make users familiar with the facility. A new installation is planned that will allow users to drill down and retrieve many other kinds of information like scheduled events at specific locations, descriptions of activities like art exhibits, or historical information on the building.

Furniture and fixtures

Essential to the process of designing through an inclusive lens is specifying furniture and fixtures that support user comfort, safety, and usability. These considerations happen at two scales during the planning process: layout and selection. When planning a furniture layout, key considerations include the following:

- Using sociopetal seating organizations;
- Providing enough room to accommodate several different furniture arrangements where long-term occupancy will occur;
- Integrating space for wheelchair users into the seating arrangement; and
- Providing more than one path of travel through each room without disrupting the viability of conversation and room activities.[12]

During the furniture selection process, it is important to consider the following attributes:

- Ergonomic design;
- Demand low physical effort for use;
- Options for adjustability (e.g., surface/seat height, seat back slant, removable/retractable armrests);

- Flexibility in use (e.g., reconfigurable, removable parts to allow for knee clearance);
- Made of sustainable materials; and
- Materials support human comfort (e.g., low-glare surfaces, breathable upholstery/seating fabrics).[13]

These considerations all support the notion that the user has to adapt as little as possible to the furniture and fixtures used; instead, the furniture and fixtures adapt to the meet the needs of diverse users with a wide range of needs.

What are the design considerations for primary and supporting spaces?

Individual spaces are discussed in a scalar manner, beginning with assembly and performance spaces and culminating in restroom facilities.

Assembly and performance spaces

Depending on the size of the venue, wayfinding is an important consideration. Similar principles apply to these spaces as to the building as a whole. A key difference is the density of occupancy. Adequate room for circulation becomes increasingly important as the size of the space decreases, especially in spaces that serve larger numbers of people using wheeled mobility devices or who may be carrying large personal belongings. Designing circulation in such a way that the intermittent movement of others minimizes distractions for seated listeners/viewers is also a consideration.

Lighting, acoustics, and environmental control systems cannot be overemphasized in the context of designing inclusive assembly and performance spaces. Keep in mind that auditory and visual acuity are not binary, that is, deaf vs. hearing, or blind vs. sighted; vision and hearing exist on a continuum of abilities. As such, the qualities of visual and auditory environments can have tremendous impacts on occupants with small and modest visual or hearing impairments. Of course, all general principles of lighting and acoustics come into play, including the size, proportions, and form of the room, the finish materials, and the technologies used. Though it is often a goal, inevitably, light and sound will not be perfectly uniform throughout the space. This can be used purposefully, if communicated to attendees through a customer service system prior to reserving seats or immediately upon arrival, so that people can select which zones may provide them with the best experience. For this to occur, however, the architectural design team needs to work closely with the lighting and acoustic consultants and the facility management team in order to provide guidance on seating options.

The design of the thermal environment can also affect a wide range of audience members and performers. The practice in many venues is to "supercool" the space in anticipation of the arrival of occupants. While many returning audience members may know to wear layers of clothing, first-time guests with certain health conditions can experience discomfort or threats to well-being as cool temperatures rise rapidly to warmer temperatures as the space reaches occupant capacity. The selection and design of the HVAC systems is one factor. In some applications, for example, radiant floor systems provide more even temperatures than forced air systems. Other strategies may include creating microclimates that are more stable or more easily controlled for temperature-sensitive occupants, selecting flooring and seating materials that assist in maintaining stable body temperatures, or providing customer service options, such as warm clothing or personal heating/cooling devices, to patrons.

Classrooms and offices

The design opportunities and challenges seen in assembly and performance spaces, like lighting and acoustics, remain relevant for classrooms and offices. One difference between these spaces and large assembly spaces is size and complexity. The more important difference, however, is the degree of user control – actual and perceived – over classrooms and offices. Primary occupants often think of these spaces as their own territory, for example, "my office," and frequently exert authority over who enters, what furnishings and objects reside in the room, how they are organized, and the temperature, lighting, and sounds in the room. The territorial behavior that is inevitable in such spaces elevates the importance of both involving end users throughout the design of these spaces and designing for flexibility. Over the life span of the building, classrooms and offices will invariably host multiple "owners." Therefore, the specification of finishes and furnishings must accommodate a range of needs and preferences over time. Commensurately, specifying a variety of task, workstation, and seating types has become common practice for many elementary schools, college classrooms, and office spaces, as it affords diverse ways of working, for example, individually or in teams, standing or sitting, and diverse users, for example tall or short, relaxed or active, near-sighted or farsighted.

As previously stated, occupants also need to possess some degree of control over temperature, daylighting, and electric lighting, though the degree of control intertwines with other budgetary and design factors. The ultimate aims are to enhance work efficacy, improve environmental performance and energy efficiency, and foster self-determinism.

Though seemingly simple, classrooms require a close understanding of diverse learning needs and preferences. Some people are "visual learners," others are "auditory learners," and still others are "tactile learners," each preferring to take in, process, and present information through a particular modality. This becomes more critical among students with hearing or visual impairments, students with physical disabilities, and students with cognitive and emotional challenges, including both child and adult learners. Students with attention deficit or hyperactivity disorders, as well as students with dyslexia or other learning disabilities, also possess distinct educational needs and challenges. Instructional format and classroom design can play a sizable role in fostering or hindering learning. Acoustics, lighting, and furniture matter greatly. So, too, does the spatial and material flow into, out of, and through a classroom. Many students on the autism spectrum, for example, benefit from the thoughtful design of transitional and threshold spaces, as the relationship between the corridor and the classroom in conventional school designs can feel jarring; the same is true when designing classroom activities and activity centers. The key point for the architect is to understand the range of learners a classroom might contain and design both universal elements, such as noise control, and adaptable features, such as movable furniture.

Retail and commercial spaces

Whether in a grocery store, a hairstyling studio, a clothing shop, or a restaurant, self-determinism is a core element of a positive shopping experience. This includes the ability to find information and compare options, find and test those options, and, if desired, easily make a purchase. Retailers and service providers can fail in one or more of these areas; so, too, can designers of commercial and retail spaces. Understanding how people seek, interpret, and use information is key. From an inclusive design standpoint, it is recommended that information be supplied in multiple locations and media – for example, online, on-site, in print, in audio. Information also needs to include what products and services are available to target audiences, such as right- vs. left-handed users, people with sensory impairments, and families with small children. While much of this points to the design of customer services or to the design of products that retailers choose to carry (neither of which is under the purview of the architect), the design team needs to ask questions of the client regarding its corporate and customer service culture, which has implications on how the space is designed. Are customers primarily responsible for making decisions, or are they aided by staff? To what extent does the shopper handle or interact with the merchandise? To what degree are consumers in charge of the payment process? Answers to each of these questions have implications on the layout of spaces, product placement, and the building technologies specified.

Dwelling spaces

Few spaces are more diverse in context, typology, construction materials, finishes, furnishings, and makeup of occupants than dwellings. The variety increases if we expand the view to include not only private homes, duplexes, and apartments but also transitional housing, hotels, long-term health facilities, and other habitats.

Inhabitants use and interact with dwelling spaces more intimately than any other space type. Dwellings are places of child raising and elder care; places of solitude, partner intimacy, and gatherings of friends and family; and places for cooking, sleeping, and bathing. Homes are an extension of the values, behaviors, tastes, and personalities of its occupants. As the varied and complex phrase "being at home" implies, a home is part of the identity and psyche of its residents. A home with design elements that support physical, emotional, and cognitive aspects of its inhabitants can foster self-actualization, self-worth, and self-efficacy, while a home whose design impedes physical, emotional, and cognitive well-being can diminish not only one's value in self but also an individual's or family's role in society.

From an inclusive design perspective, task areas in residences, such as kitchens and bathrooms, need added attention. Activity spaces need to be designed in ways that promote flexible or adaptable use for children and older adults, people with low or no vision or hearing, men and women, very tall people and those who are shorter in stature, and right- and left-handed users. Adequate and adjustable lighting is key, as is variability (or adaptability) in the height and size of work surfaces and the height and operability of appliances and fixtures (see Figure 2.23).

Designers need to reflect on all potential occupants, not just the current or intended occupants, including visitors and future residents. Consider how space and personal belongings are stored, exhibited, and used by a wide variety of potential users, including those with different cultural backgrounds. A home is not simply a shelter; a home is a place of personal memories and artifacts that evoke those memories. A home is a place where people both protect and display a range of artifacts – from furniture to clothes, family photographs to collectibles, books to advanced technologies – a place where people both protect and display themselves. Design techniques for balancing privacy and presentation of identity include the following:

- Mapping the activities of individual occupants throughout the day;
- Mapping the social and spatial relationships among occupants;
- Listing the various ways that domestic tasks, such as preparing food, can be done; and
- Listing the factors that influence the performance of domestic tasks, such as height, strength, dexterity, eyesight, hearing, and cognition.

Inclusive housing must also address social change. Homes last a long time and, at some time, are likely to house one or more persons with disabilities. With increased life expectancy and population growth, designing for the last half of the life span – the second 50 years – is becoming more and more important since no society can afford to re-house all its older citizens in new buildings. Most older people want to remain living in their home as long as possible. To design for aging in place, a home has to be planned for the eventuality that a resident will no longer be able to use stairs. The Lifetime Homes program that the Rowntree Foundation in the United Kingdom developed was the first program to promote the idea of "visitability" – home design that can accommodate visitors with disabilities and that can be easily adapted for a resident with a disability. The basic elements of homes designed for the life span include the following:

- A minimum of one no-step path to a no-step entry that can be at the front, side, rear, or through a garage (1/4–1/2 in [6.4–12.7 mm] threshold);

2.23 Kitchen in the LIFEhouse, a universally designed home developed by New American Homes in Antioch, Illinois

- No-step access to patios, balconies, and terraces (1/4–1/2 in [6.4–12.7 mm] threshold);
- Doorways that have at least a 34 in (865 mm) wide clear opening with appropriate approach clearances;
- Door handles that are 34–38 in (865–965 mm) from the floor;
- Hallways and passageways that are 42 in (1,070 mm) clear minimum;
- Access to at least one full bath on the main floor with reinforced walls at toilets and tubs for the future installation of grab bars;
- Kitchen cabinetry that allows a person to work in a seated position;
- Light switches and electrical outlets 24–48 in (610–1,220 mm) from finished floor;
- Stairways have tread widths at least 11 in (280 mm) deep and risers no greater than 7 in (180 mm) high;
- Good lighting throughout the house including task lighting in critical locations (e.g., under kitchen cabinets);
- Non-glare surfaces;
- Contrasting colors to promote good perception of edges and boundaries;
- Clear floor space of at least 30 in (762 mm) × 48 in (1,220 mm) in front of all appliances, fixtures, and cabinetry;
- Front-loading laundry equipment;
- Ample kitchen and closet storage or adjustable shelving within 28–48 in (715–1,220 mm); and
- Comfortable reach zones.[14]

The Canadian Mortgage and Housing Council developed the concept of "Flexhousing" to accommodate differences in family needs over a life span and differences in neighborhood demographics. Flexhousing plans can be easily converted from a single dwelling to two dwellings and back again.

Restrooms and bathrooms

Ensuring health and safety are primary concerns in designing restrooms and bathrooms. This includes ways to diminish the likelihood of slipping, particularly when floors and surfaces are wet from use or cleaning, as well as providing adequate supports and options for transferring to/from toilets, showers, and other fixtures. Reducing the growth and spread of bacteria and viruses can help promote public health. This can be achieved through the design of easily maintained and fast-drying surfaces, the utilization of antimicrobial materials such as copper, and the specification of fixtures, for example, faucets, paper dispensers, and door hardware that both minimize human contact and reduce the harboring of germs.

Privacy and security are equally important. Women, young children, and people with physical, sensory, and cognitive impairments can be especially vulnerable to verbal harassment or physical assault if the interior and immediate surroundings of restroom and bathing facilities are not thoughtfully designed. Lighting, lines of sight, acoustics, and security hardware need to be considered and designed from the vantage point of vulnerability. Occupants need to both *be* safe and *feel* safe.

Cultural norms and taboos, in part, govern perceptions of privacy and safety. In many architectural projects, it is sufficient to understand the dominant cultural context. For other projects, designing a terminal in an international airport, for example, which likely serves hundreds of different ethnicities, knowing the variety of cultural groups that might use the space, each with its own practices of toileting and ablution, is important. Cultural change is also to be considered. Growing immigrant populations, aging communities, and changing attitudes toward gender all come into play.

There is an array of codes in all countries that apply to the design of public restrooms and private bathrooms. Accessibility codes emphasize the design of spaces and features for people using wheeled mobility devices, such as wheelchairs. Of course, these codes need to be met, but a more inclusive view of restroom design evokes questions about age, gender, and culture, often embedded in plumbing codes or public health ordinances. Recent debates, particularly in the United States, have pointed to the shortcomings of designing for gender as a binary construct (male vs. female), and the challenges and stigmas that transgender individuals face in this context. Caregivers, such as parents of young children or adult children of elderly parents, face a similar difficulty in assisting their loved ones in restrooms when the two people are of opposite genders. Cultural differences also play a role in preferences for types of bathroom fixtures and equipment, for example, squat toilets versus seated toilets or use of paper for cleaning versus use of water. Few areas of design call for more innovation and humane design than restroom facilities.

Notes

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