MASSACHUSETTS COMMISSION FOR THE BLIND

Inclusive Design of Workplaces for People who are Low Vision or Blind

September 2020

Institute for Human Centered Design

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Part I: Introduction Overview

The fully accessible project report is organized as a set of distinct parts, each of which can be read as a self-contained report. The sections are:

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The Institute for Human Centered Design (IHCD) responded to a call for proposals from the Massachusetts Commission for the Blind (MCB) in May of 2020. The original RFP title was

"The Impact Inclusive Design Principles of Workplaces has on VR Outcomes." At this point in time, the prevalence of inclusive design in workplaces is still too rare and too vulnerable to unwarranted claims to be able to do a simple crosswalk of environmental impact.

IHCD proposed an alternative response for a project that informs MCB of the current state-of-the-art of both practice and research relative to inclusive workplace design with an emphasis on supporting people with vision limitations. The IHCD diverse and multi-disciplinary team offers this report to:

- illuminate the state-of-the-art today
- identify promising areas for replication of proven methods
- and identify needs for new research and ways to address dissemination challenges.

It is important to note that the relationship between rehabilitation and inclusive design have fundamentally different starting places. Rehabilitation seeks to empower people with disabilities to function effectively in the world as it is. Inclusive design seeks not only to remove barriers to full integration but also to create facilitators for participation and well-being in the environment. Addressing this dichotomy is an important by-product of the project.

IHCD's Set of Topical Deliverables

Set the stage - provide a general overview of inclusive design as a clear design framework that builds upon a floor of accessibility.

What is inclusive design…universal design…design-for-all?

…a framework for the design of places, things, information, communication and policy that focuses on the user, on the widest range of people operating in the widest range of situations without special or separate design.

Universal Design Principles

<u>Equitable Use:</u> The design does not disadvantage or stigmatize any group of users.

<u>Flexibility in Use:</u> The design accommodates a wide range of individual preferences and abilities. Simple, Intuitive Use: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

<u>Perceptible Information:</u> The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

<u>Tolerance for Error:</u> The design minimizes hazards and the adverse consequences of accidental or unintended actions.

<u>Low Physical Effort:</u> The design can be used efficiently and comfortably, and with a minimum of fatigue.

<u>Size and Space for Approach & Use</u>: Appropriate size and space is provided for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility.

[Developed by a group of US designers and design educators from five organizations in 1997. Principles are copyrighted to the Center for Universal Design, School of Design, State University of North Carolina at Raleigh. The Principles are in use internationally.]

Relationship between Legally Mandated Accessibility & Inclusive Design

Legally mandated requirements for accessible design, within a civil or human rights context, provide a vital basis for autonomy and equal opportunity for people with disabilities. To be effective, legal mandates require an infrastructure of information and enforcement in order to ensure meaningful compliance. Inevitably, the legal mandates establish a set of minimum standards for some built, information and communication environments and address the needs of people with some types of functional limitations. Too often those minimum standards are understood as maximums.

Accessibility is focused on people with disabilities, especially those who are 'qualified' as defined in the law. The design standards for accessible design focus primarily on accommodating the needs of wheelchair users and, to a lesser extent, people who are blind and read braille. Wheelchair users are a small number of people but their wheeled devices make very clear demands on the built environment and design features that make it possible to wheelchair users to participate benefit the much larger number of people with difficulty walking. Additional requirements for "effective communication" also require taking at least minimum steps to provide for alternative means of communication through auxiliary aids and services.

Accessibility laws and codes on accessibility are a limited indicator of the potential of design to facilitate independence, participation and wellbeing for a growing proportion of people. In a country in which 26% of all adults have a disability, most of us will experience at least periods of functional limitation in the course of our lives. It is not about "special" anymore. And it's critically important to anticipate the broadest spectrum of physical, sensory and/or brain-based functional limitations when designing.

Inclusive (Universal) Design *starts* with accessible design and calls for a more creative and imaginative engagement of designers to design places, products, services and technology that will work seamlessly for the widest possible group of potential users. The goal is to eliminate disabling environments (physical, information, communication, social and policy environments) in favor of enabling ones for everyone.

World Health Organization contextual definition of disability – the Global Gold Standard

The World Health Organization International Classification of Function, Disability and Health (WHO ICF) and its contextual definition in 2001 offered a framework for thinking about impairment as part of a continuum of health that happened within a context of personal and environmental factors. Most importantly, the goal was clear that people with functional limitations should be able to become fully engaged members of society. In the WHO ICF, it was no longer about cause of the limitation but about its impact. It was a radical shift to an emphasis on health at both the personal and the population levels. The model summoned attention to creative intervention. Redesign the context and you minimize the limitation.

The WHO ICF focuses on the context, on the dynamic interaction of a person with a functional limitation and physical, digital and social environments. That interaction is the point at which disability is amplified or minimized. The model invites awareness that environments are not fixed but mutable and inevitably powerful either negatively or positively.

The contextual definition offers a tool for dramatically modifying the impact of a functional limitation if we choose to use it. If we take the opportunity to focus on creating environments - including policies and attitudes - that minimize limitations and support people to live the lives they choose, we minimize negative impacts. This bio-psycho-social model became the global gold standard for understanding and measuring disability at the population level. The WHO recommended Inclusive Design in 2001 as the most promising framework for creating *facilitating* environments that would go well beyond the narrow concepts of barrier removal.

Recommendation

We recommend that MCB consider Inclusive Design as, at minimum, an agency advocacy position whenever possible. It may always be necessary to help clients to function effectively in the world as it is but a focus on the power of the environment to change the impact of a blindness and low vision on functioning would benefit clients and employers.

Part 2: Current State-of-the-Art of Pertinent Research Overview

Academic research in design for functional limitations aims to determine both what basic principles govern the functional limitations of people with low vision, and what strategies can be used to alleviate those limitations (Legge, 2013). Within the academic literature, the term *visual accessibility* has been developed to describe the goals of such work. A visually accessible space has been defined as one that is designed such that people with low vision could use their remaining sight for three primary purposes: 1) to travel safely and efficiently through it, 2) to perceive the spatial layout of key features of it, and 3) to keep track of their location and orientation within it.

The IHCD project team included two doctoral students from Dr. Gordon Legge's lab at the University of Minnesota, the Minnesota Laboratory for Low Vision Research. Given that low vision is the unquestionably a minimum of 85% of people who are legally blind this area of investigation focused on design for low vision. Dr. Legge is a dominant and enduring hub of US research in this area.

A literature review was conducted for all pertinent publications in English. In addition, two interviews were conducted with experts in research for people with visual limitations:

Marcia Mazz, a member of the Committee that created one of the most expansive research publications in this research area, the Low Vision Design Committee of the National Institute of Building Sciences (NIBS) that created Design Guidelines for the Built Environment in 2015. Ms. Mazz also headed the U.S. Access Board's Office of Technical and Information Services and is a person with low vision.

Erin Schambureck, IDEC, IIDA, ASID, who was also a member of the NIBS Committee and created a website - http://designforsight.com/#two - while an Assistant Professor of interior design at Texas Tech University and is now working in an architectural firm.

Recommendations

Design Principles from Studies of Lighting

- Dim lighting conditions, such as illumination at ~1 lux, are hazardous to safety.
- A uniform level of illumination will not suit everyone with low vision – flexibility in workspaces is preferable.
- Areas with sudden reductions in illumination can be difficult to navigate with low vision.
- Directly illuminating the edges of obstacles using assistive LEDs can improve detection of them.
- The HEAVI and HELA are tools designed to measure in-home effectiveness of lighting, but similar methodology could be adapted to assess workplace lighting.

Design Principles from Studies of Contrast

- Sensitivity to contrast varies with the complexity (i.e. spatial frequency) of objects being observed, so contrast that works for a simple sign or target may not work for others.
- It is possible to predict the necessary contrast for target detection with low vision, it is necessary to know the severity of contrast sensitivity loss, which is not widely available.
- Not all contrast textures are helpful – a checkerboard pattern can impair step recognition relative to a solid monochromatic texture.

Design Principles from Studies of Layout

- High contrast boundaries between floors and walls are useful orientation cues.
- The point at which an object appears to contact the floor can affect judgments of its distance. High contrast between the point of contact of furniture (e.g. legs of a table) and the floor can help ensure they do not become hazards.
- When walking alone, people with low vision look downwards frequently, so information may be more visible there than locations with higher elevation (Note: significant primarily in hazardous environments (e.g., stairs or traffic).
- Guide rails or sighted guides can improve the ability to remember landmarks.
- Step-ups are easier to identify than step-downs for people with reduced visual acuity.
- Walking toward a step can improve detection of it.
- Round surfaces are more easily visually identified than flat surfaces for people with low vision.

Recommendation

Design research is still inadequate for designing accessible and inclusive built environments. And what is available has had scant impact on designers' behavior. There is a clear disconnect between research and practice that needs to be understood and then addressed. A study is needed to query the built environment design practitioners about what would make a difference.

Part 3: Global Overview of Pertinent Standards and Guidelines Overview

There are very limited requirements in the Americans with Disabilities Act (ADA) pertinent to people with vision limitations, especially for people with low vision. This analysis took a global snapshot of current standards (legally mandated requirements) and guidelines (recommended and often set as policy but not mandated) in order to identify promised practices for accessibility and inclusive design to consider to inform best practice and policy.

It is not exhaustive but includes a number of the most recent standards and guidelines. Those are from the Middle East and they incorporate a very expansive set of both common requirements that were first in place in the US and Europe and best practice from across the world as well as from their own research.

The material is organized by elements in sequence from the outside of a building. All pertinent material to that element is below it. In sequence you will find:

ADA requirements are first in all cases assuming that there is a pertinent ADA reference.

Massachusetts Architectural Access Board (MAAB) requirements are included only if they exceed the requirements of the ADA.

International Standards Organization (ISO) is next. ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. ISO is considered the gold standard for accessibility and inclusive design in much of the world though not so familiar in the US. One of the advantages of ISO standards is the rigorous revision process that occurs on a five-year schedule.

Specific standards or guidelines in use in other nations that go beyond either ADA or ISO relevant to people with visual limitations. These offer a snapshot of ideas that could be adopted as best practice or formalized as policy.

Recommendation

This initial analysis provides the core of a set of Inclusive Design Guidelines for People with Visual Impairments that can be supplemented by findings from the research, wayfinding and case studies reports from this project. Moving toward generating those draft Design Guidelines for People would need to be Informed by additional interviews beyond the initial set of interviews with MCB staff and user/experts. And there is also a need to unravel the current disconnect between research and design practice to understand the impediments to incorporated needed guidance for innovation.

Part 4: Current State of the Art of Inclusive Wayfinding Overview

The IHCD project team, led by IHCD Director of Wayfinding, Dr. Jan Carpman, explored the state-of-the-art of wayfinding* for people with vision limitations in relation to the workplace.

A Definition of Wayfinding

- Wayfinding means knowing where you are, knowing the name of your destination, finding an effective route, recognizing your destination, and finding your way to your next destination or back to your starting point.
- Wayfinding involves both brain and body. Depending on the individual’s own abilities and limitations, it may involve seeing, hearing, thinking, remembering, moving on foot or in a wheeled mobility aid, moving in a vehicle, etc.
- Wayfinding is influenced by past experience and expectations.
- Wayfinding is not the same as signage, although the two terms are often (incorrectly) used synonymously.

The wayfinding section details an extensive set of recommendations supported by the research literature on creating systems that serve people with vision limitations well and give everyone a greater sense of control and confidence.

One section of the report considers twenty-three (23) options of wayfinding apps for people with vision limitations. There is also a section on talking maps and models.

Recommendations

- Expand the focus to exterior as well as interior environments (including toilet rooms), journey to work, etc.
- Speak with more User/Experts
- Involve more VR staff
- Involve more O & M staff
- Conduct Post Occupancy Evaluations of work environments that include people with vision limitations
- Examine available navigation apps in depth
- Examine more literature

Part 5: Six Case Studies Overview

The IHCD project team created six case studies. In each case, members of the project team had a direct involvement in the design. The projects are the Lighthouse for the Blind in San Francisco, Access Living in Chicago, National Industries for the Blind in Alexandria, Washington State Services for the Blind and Orientation and Training Center in Seattle, Washington Talking Book and Braille Library in Seattle, and IHCD headquarters in Boston. The case studies range from the 1990s to the present.

Each case study includes numerous images and an assessment of what is effective as well as what has not worked well. In each case the projects were mounted to serve people with vision limitations specifically or a wide spectrum of people with functional limitations of all kinds.

IHCD has an Inclusive Design website, https://universaldesigncasestudies.org/, with additional case studies.

Recommendations

- There are valuable precedents to be mined for replication in the six case studies. Precedent is one of the most effective ways to influence the behavior of architects and other designers as well as clients.
- Post and promote the case studies to be visible to architectural students and practitioners.
- Consider mounting a new global solicitation to gather additional workplace and other case studies that include attention to creating facilitating environments for people with visual limitations.

Part 6: Summaries of User/Expert and VR Staff Interviews Overview

The IHCD project team conducted a pilot study examining workplace interior design features for ten (10) clients with vision disabilities and with six vocational rehabilitation counselors and Orientation & Mobility (O+M) specialists. The User/Expert (client) pilot study focused mostly on physical features of work environments in relation to orientation and mobility: how each feature functions well and what the respondent would change about the feature if they could.

Suggested improvements to workplace design from both clients and counselors and O+M specialists are very clear and detailed and make the case for a standard policy of site inspection of client workplaces. It occurs but appears not to be a requirement.

Recommendations

- Make site inspections standard practice for VR Counselors as a part of the placement process.
- Consider the creation of a site assessment checklist that can be tailored to the needs and preferences of individual clients and use it as a way to educate employers.

Project Team

IHCD convened a multi-disciplinary team for this project that is a mix of internal IHCD professionals and external colleagues with pertinent expertise.

Valerie Fletcher, Principal-in-Charge

Fletcher is Executive Director of IHCD, an international education and design non-profit organization committed to advancing the role of design in expanding opportunity and enhancing experience for people of all ages, abilities and cultures through excellence in design. IHCD's mission-driven consulting and design work includes physical, digital environments and service environments in transit, municipalities, public agencies, higher education and culture. She oversees IHCD's extensive contextual inquiry research. She is a member of the board of directors of the International Association for Universal Design headquartered in Tokyo and a Trustee of the Boston Architectural College.

Jan Carpman, PhD, MCP, Lead on wayfinding research & best practice

Janet R. Carpman, PhD MCP, an architectural sociologist and wayfinding specialist, is IHCD's first Director of Wayfinding. Her work with IHCD spans health care, arts & cultural, public transit, higher education, offices, retail, and other complex sites and facilities. Jan works with clients to analyze wayfinding problems and find innovative solutions at the nexus of design, behavior, operations, and technology. Before joining IHCD, Jan was a principal in her own wayfinding consulting firm, Carpman Grant Associates, Ann Arbor, MI, for more than 30 years. Jan Carpman and Myron Grant are authors of the award-winning books, *Design that Cares: Planning Health Facilities for Patients and Visitors,* and *Directional Sense: How to Find Your Way Around* (www.directionalsense.com).

Christopher Downey, AIA, Case Studies plus research, design guidelines, recommended practice

Chris Downey, AIA is an architect with over 30 years of professional practice continuing without sight since 2008. Chris specializes in Universal /Inclusive design within projects specifically for the blind and visually impaired including rehabilitation centers, schools, eye clinics and more generally in office environments, cultural centers and transit projects. He has been featured in numerous media stories including "60 Minutes", speaks internationally, has taught Universal Design for the UCB Department of Architecture and serves on the California commission on disability Access as well as the Board of Directors for the San Francisco LightHouse for the Blind and Visually Impaired.

Susan Duncan, Case Studies plus research, recommended practice

Susan M. Duncan has dedicated her four-decade design and consulting career to enhancing user experience by improving accessibility, inclusion, equality for people with disabilities, and usability. She has woven her hands-on experiences to support custom residential projects for individuals with disabilities to public sector projects required to meet ADA compliance.

An educator at heart, she has taught universal design (UD) for Seattle Pacific University and the University of Southern California and applied the philosophy of UD on every project since the late 1990's. She is an executive producer of an award-winning accessibility video series and an inventor of a patented space planning design tool, the Visualizer® Set.

Andrew Freedman, Research on design for vision limitation in the built environment

Andrew is completing his third year in the Cognitive and Brain Sciences program in the Psychology Department at the University of Minnesota and the Minnesota Laboratory for Low Vision Research. He has been working with Dr. Gordon Legge on projects related to low vision and visual accessibility. He worked in Dr. Legge's lab starting as an undergraduate and was subsequently accepted into the Ph.D. program.

Tzesika Iliovitz, Interior Designer, global design guidelines

Tzesika was born in Lebanon, is of Greek origin, and lived in several countries including Italy, France, and the United Arab Emirates before coming to the US. Tzesika has played management roles on mega projects, such as the Presidential Palace and the Midfield airport terminal in Abu Dhabi, residential skyscrapers, and commercial projects. Tzesika pursued her Master's degree in Interior Architecture at Suffolk University, in Boston. Currently, part of the IHCD team, she is a Project Manager in Inclusive Design Projects. She is taking part in several projects and initiatives such as ADA transition plans in municipalities, accessibility surveys for the DCR parks across Massachusetts, and inclusive design research.

Ana Julian, Associate AIA, lead on ISO guideline review and making the case for good practice

Ana Julian is an architectural designer with expertise in the accessibility requirements of the Americans with Disabilities Act, Section 504 of the Rehabilitation Act, the Federal Fair Housing Act and the International Building Code. Since 2015, she has been Senior Project Manager for IHCD's consulting and design work. Ana has extensive experience managing ADA Transition Plan projects for municipalities, public agencies and public institutions.

Mitali Kamat, Occupational Therapist, lead on state-of-the-art AT & ICT

Mitali is a pediatric occupational therapist working largely in a school-based setting with 6+ years of experience working with children with disabilities. Key interest areas are assistive technologies and inclusive design, I am a certified ATP through RESNA and am currently pursuing my Master's in Inclusive Design (MDes) at OCAD U. I am passionate about building more inclusive environments for individuals living with disabilities both in the physical and digital realm.

Stacy Langton-Toohey, Occupational Therapist, OT & design guidelines

Stacy Langton Toohey, MS OTR/L, is an occupational therapist who has experience working with a wide range of populations within inpatient, outpatient and community-based settings. Prior to becoming an occupational therapist, she worked as a research assistant on multiple psychiatry research projects evaluating and examining neurocognitive and neuropsychological traits associated with schizophrenia. At IHCD, Stacy is enthusiastic about merging her clinical training as an occupational therapist with her research experience to complement inclusive design strategies with the goal of enabling people of all abilities to maximize their participation in everyday activities and improve their quality of life.

Siyun Liu, Research with emphasis on motion and perception

Siyun Liu is a 3rd year Ph.D. student from University of Minnesota and the Minnesota Laboratory for Low Vision Research. Her research interests are navigation and 3D perception in low vision observers, especially in the context of motion. The first three years of her Ph.D. study were devoted to the NIH grant funded project DeVAS (Designing Visually Accessible Spaces), whose goal was to develop a software to predict visibility of indoor architectural features. In 2019, she worked on validating the software with human performance data.

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Introduction

In 2017, there were approximately 5.7 million Americans living with low vision, the chronic visual impairment not correctable by glasses or contact lenses that negatively impacts daily functioning (Chan, et al.., 2017). Of those people, approximately 1.3 million have visual acuities poorer than 20/200, the threshold for legal blindness[1] in the United States. An important note must be made here of the distinction between legal blindness, where in the individual has remaining low-resolution vision, and total blindness, wherein the individual has no light perception at all. Globally, approximately 8% of people with vision impairment are totally blind (Bourne et al.., 2017), though there has not been a major study confirming that proportion is reflected in the United States specifically. Due to the majority of people with vision impairment having low vision or legal blindness, rather than total blindness, this review will focus on research aimed at low vision.

The majority of low vision conditions are age-related, and because the population of the United States is aging, this figure is projected to rise to approximately 9.6 million by 2050, an increase of more than 40%. Furthermore, the number of adults at risk for vision loss due to older age, diabetes, or existing eye disease rose by 28 million from 2002 to 2017, to a total of 93 million total (Saydan et al.., 2020).

Nationally representative studies have found that many people with low vision are actively working, with 44.2% being employed in 2017 (McDonnal & Sui, 2019). With several million Americans with low vision already in the workforce, and millions who will acquire low vision in coming years, designers of workspaces have the opportunity and challenge to create workspaces that are safe and accessible for this growing group of workers.

However, creating such spaces is a difficult task for designers to tackle. In addition to accessibility, they must also simultaneously consider building function, structure, zoning, and many other important factors in the construction of any given space. This is particularly those with normal vision; if they have not experienced low vision themselves, relying on intuitive solutions to the complex perceptual and issues involved in vision impairment is not an effective method for predicting accessibility issues.

A useful tool in this endeavor will be academic research, which aims to determine both what basic principles govern the functional limitations of people with low vision, and what strategies can be used to alleviate those limitations (Legge, 2013). Within the academic literature, the term *visual accessibility* has been developed to describe the goals of such work. A visually accessible space has been defined as one that is designed such that people with low vision

[1] An important note must be made here of the distinction between legal blindness, where in the individual has remaining low-resolution vision, and total blindness, wherein the individual has no light perception at all. Globally, only approximately 8% of people with vision impairment are totally blind (Bourne et al.., 2017), though there has not been a major study confirming that proportion is reflected in the United States specifically. Due to the majority of people with vision impairment having low vision or legal blindness, rather than total blindness, this review will focus on research aimed at low vision.

could use their remaining sight for three primary purposes: 1) to travel safely and efficiently through it, 2) to perceive the spatial layout of key features of it, and 3) to keep track of their location and orientation within it. Key features of a space affecting visual accessibility include lighting (intensity, arrangement), surface properties (contrast, color, texture), and geometrical properties (locations of landmarks and hazards). Visual accessibility can be considered as a parallel to the well-established concept of *physical accessibility*, which is focused on more heavily by the ADA. Notably, both forms of accessibility are important facets of the Principles of Universal Design, which include (among others) equitable and intuitive use for all users (Steinfeld & Maisel, 2012).

Academic research has been underrepresented in the development of the very limited elements related to visual accessibility in the Americans with Disabilities Act (ADA) standards, which primarily cover signage and other forms of communication (e.g. including braille). However, research can inform updated guidelines and policy choices with systematic, tightly controlled data drawn from behavioral studies of subjects with low vision. If leveraged by designers, the data and principles from research can illustrate what features of a design could have the most impact in improving workspace accessibility for people with low vision while enhancing the experience of fellow workers.

For designers to work effectively with the findings from academic research, it will be important to understand the major benefits and drawbacks to such research. One major benefit is that research utilizes large pools of behavioral data from low vision participants. Rather than relying on the intuition of the designer or trial and error, research studies directly observe how vision impairment impacts performance for the target demographic. Detailed statistical analysis of these data allows for the modeling of the mechanisms driving behavior, which can be used to predict how people with low vision will interact with a new space.

Furthermore, such analysis allows the study of the very different types of impairments for people with low vision and what enhances performance. It is important to understand this set of different types of visual impairments: acuity (resolution of the visual image), contrast sensitivity (ability to discriminate light from dark), and/or extent of visual field (area observable without moving the eyes). As the low vision population has highly heterogeneous impairments across each of those three factors, it is important to understand how each type can affect workplace accessibility.

While this does allow for highly targeted designs, it is also important to understand the limitations of conclusions drawn from research. Studies are often structured to focus on very specific mechanisms in rigorously controlled environments, often very unlike naturalistic settings. Though this allows for a high level of understanding, it can also make it difficult to generalize conclusions to an entire building or category of environments. For instance, one study found that loss of visual field can cause distortions in the way that people perceive spatial locations (Fortenbaugh et al.., 2008), but while interesting and potentially useful, it can be difficult to say exactly how this finding could be applied to the design process.

Furthermore, academic work does not always move from findings to practice. It is produced and published but not necessarily widely disseminated to any specific audience that could apply it. Indeed, in academic work, relevant literature is typically sought out via specialized databases, not actively disseminated to interested parties. Considered from a different angle, however, this simply means that there is a significant amount of underutilized information available to designers, waiting to be gathered and applied.

Combined with the difficulty in interpretation of findings, the lack of contact between designers and academics creates a rift between those who could apply research findings, and those who produce them. Fortunately, this need not be the case. A collaboration between academics and designers can lead to a team that can both communicate the applicable portions of the academic literature as well as implement those findings. This describes the goal of the present work, which aims to present a preliminary review of the major methods and findings of academic research on visual accessibility and couch those findings within a design framework.

Moving forward, this review will deliver a preview of research findings which could be applied to the design of the lighting, contrast, layout, and assistive technology to be implemented to create a visually accessible building. At the end of each of those sections of the review, a brief bulleted list will be presented that will summarize the main findings or principles relevant to design that have been gleaned from research related to that topic.

Even if an environment is fully visually accessible, some individuals will need solutions tailored to their specific needs, commonly called ‘assistive technology,’ a necessary complement to accessibility and inclusively designed environments. Assistive technology (AT) for the visually impaired (VI) and blind is concerned with “technologies, equipment, devices, apparatus, services, systems, processes and environmental modifications” that enable them to overcome various physical, social, infrastructural and accessibility barriers to independence and live active, productive and independent lives as equal members of the society.

Research on assistive technology for the visually impaired and blind people has traditionally focused on—mobility, navigation, and object recognition; but more recently on printed information access and social interaction as well. Over recent decades there has been an expansion of research interest in the field and significant developments have taken place in the form of novel (miniaturized) wearable electronic travel aids (ETAs), smart canes, (wearable) form factors, smartphone-based devices and apps, tactile displays and interfaces, cortical and retinal implants (bionic eyes), etc. (Bhowmick & Hazarika, 2016). The use of AT in the workplace has been facilitated by legislation such as Section 508 of the Rehabilitation Act and Title I of the American with Disabilities Act dealing with employment and the provision of accommodations for people with disabilities. Despite some research evidence and the legislative mandates supporting the use of AT in the workplace, employers continue to be concerned about the cost effectiveness and efficiency of using AT in the workplace (Arthanat et al.., 2015).

1) Studies of Lighting

Lighting design is a vital aspect of designing visually accessible spaces, and is therefore the focus of many of the recommendations proposed by the Low Vision Design Committee of the National Institute of Building Sciences (NIBS) in 2015). Lighting impacts not only the brightness of objects, but also luminance, contrast and glare, which can compromise usability for people with low vision. Surprisingly, while extensive guidelines exist for lighting design, they are rarely informed by empirical studies of the impact of varied light levels on low vision behavior. For instance, while the NIBS guidelines include long lists of specific requirements for light in various parts of buildings, the dozens of recommendations were informed by only a handful of studies. This section highlights prominent methods and major findings regarding the effects of lighting.

1.1) Ambient Lighting/Illumination

In a classic study to assess the impact of overall illumination level on mobility, Kuyk and Elliott (1999) tested 41 subjects with age-related macular degeneration (AMD) using an obstacle avoidance course under both photopic (high illumination) and mesopic (low illumination) conditions. The course was comprised of a 30.5 m long and 1.5 m wide pathway with 60 objects, mostly foam cylinders, placed on the path. Some obstacles were laid across the ground and had to be stepped over, while others were upright and could be avoided by walking around them. Subjects were asked to move through the space as briskly as possible while avoiding contacting any of the obstacles, and performance was quantified by time on the course and number of contacts with obstacles. Illumination conditions were characterized by the luminance of the floor, which was 80 cd/m2 under the photopic condition and 3 cd/m2 in the mesopic condition.

Results showed that performance was significantly poorer under mesopic conditions, with average course completion time increasing from 76 s to 104 s, and the average number of contacts increasing from 2.7 to 5.5. While lighting guidelines would not typically allow for a workplace to remain in mesopic conditions during working hours, this study demonstrates that for a low vision worker, such conditions would be seriously detrimental to hazard avoidance. Furthermore, the methodology outlined here is sensitive to variations in lighting and has been leveraged to examine the effectiveness of other lighting setups in many more recent studies. For that reason, this foundational study is an important cornerstone for understanding the procedures involved in academic research.

In another study in 2010, Evans et al. recruited 24 older adults with low vision, caused by either cataract or AMD, to test how they perform daily tasks under three illuminance conditions. The tasks being tested were walking down a corridor, inserting a plug to a socket, sorting pills, and reading. The three illuminance levels were set at 50 lux, 200 lux, and 800 lux. The results showed that most participants demonstrated significant impact from lighting in their performance on at least one task. Also, the subjects would report preference towards bright (800 lux) or medium (200 lux) conditions, while most reported non-preference towards the dim illuminance condition.

However, the average speed of all subjects performing each task did not show significant difference across illuminance conditions. The optimal illuminance condition for the daily tasks showed large variance across individuals. The authors hence suggested that individual assessment is necessary for providing best lighting for older people with low vision. This finding demonstrated that there are significant differences within the low vision population regarding illumination preferences. This suggests that flexibility in working space lighting options, especially individual tailoring of personal lighting, could help workers operate more comfortably.

Two other studies demonstrating the importance of illumination for low vision navigation were conducted by Alexander et al.., in 2014. One examined subjects' ability to walk over a curb, while the other tested subjects' ability to step in a precise location. Both studies included low vision subjects (all diagnosed with AMD) and normally sighted control groups. In the curb navigation study, subjects were asked to approach and step up or step down a 0.15 m high curb.

In the precision walking study, subjects were asked to walk along a 6 m pathway, and to step on four 20 cm x 15 cm flat targets placed on the ground as they walked, without stopping. Importantly, the primary manipulation in each study was the illumination level of the testing room. Subjects were tested in three conditions, normal lighting (600 lx), dim lighting (0.7 lx), and after a sudden reduction in lighting (600 to 0.7 lx). These conditions were created by turning on standard overhead ceiling-mounted fluorescent bulbs and white LED lights. For normal lighting, both sets of lights were turned on, while for the dim lighting condition the fluorescent bulbs were turned off, so that only the LEDs remained on. In the dim condition, subjects were allowed to adjust to the lower light level for 15 minutes. In the sudden reduction condition, subjects were asked to complete the task immediately after the fluorescent bulbs were turned off. Performance was quantified by the speed at which they were able to complete the task, as well as several postural stability measures.

Both studies found that the normally sighted and low vision subjects performed at similar levels in normal lighting conditions, while the AMD group performed slightly worse (slower and less stable) than the control group under dim conditions. However, again for both studies, AMD subjects performed significantly worse than normal for the sudden reduction condition. With regards to design, this study suggests that moving through different levels of illumination, particularly from light to dark, could be particularly difficult for people with low vision. This could be particularly important in entryways, where people often transition from bright sunlight to relatively dim indoor lighting.

1.2) Lighting Arrangement

In architectural spaces, lighting is often more complicated than just the ambient illumination. The lighting arrangement is a design factor that include the number, location, direction, and intensity of the light sources in a space.

Lighting arrangement can have a large influence on the luminance contrast on important geometrical features, such as door frames, steps, and posts. Different lighting arrangements can cast different luminance on the same set of surfaces, inducing different contrasts across edges. Legge et al. (2010) and Bochsler et al.., (2013) investigated how lighting arrangement can affect luminance contrast on steps and ramps and hence affect how people with limited vision would perceive these architectural features. When the same lightbox (a device designed to replicate the natural light created by a window) was placed either nearer (3 m) or farther (6 m) from the target architectural feature, the identification accuracy was improved for normally sighted subjects wearing acuity reduction goggles, yet not significantly different for low-vision subjects.

Kallie et al.., (2012) also found that in subjects with natural low-vision, lighting arrangement did not significantly impact convex object recognition. This might be due to the low-vision viewers being more experienced in utilizing cues in blurred images, or the lighting conditions tested in the laboratory studies being too few to reveal statistically significant differences. These studies suggest that the actual placement of light sources may impact feature recognition for some types of low vision (those affected primarily by blur), but not others. More detailed analysis on contrast and architectural feature perception will be continued in section 3.1, which is devoted to reviewing research studies related to contrast.

Other than artificial light sources, the use of daylight is another important part of lighting arrangement in architectural space design. Daylight has a two-fold effect to people in the workplace (Nylen et al.., 2014). It is important for regulating circadian rhythm, mental health, and general well-being, especially for older people. Yet daylight can also cause glare that impedes many visual functions. It also induces difficulty in performing tasks requiring detailed perception, such as reading. The UV light in daylight also leads to eye and tissue damage. How to incorporate daylight in the design of workspace is a matter worthy of case-by-case consideration.

A study by Katemake et al.., in 2019 was conducted to assess the impact of LED-based assistive lighting on mobility for low-vision people. The study included 134 older subjects, with an experimental group of low vision subjects, and an equal number of normally sighted controls.

The study utilized a design similar to the one outlined previously in Kuyk et al.., (1999). The study investigated both the impact of overall illuminance level and associated color temperatures and edge enhancement localized to obstacles. As in the 1999 study, subjects walked through an indoor space with lightweight obstacles distributed evenly (but randomly) throughout, and performance was quantified using course completion time and number of contacts with obstacles. In the first experiment, focused on overall illumination, subjects completed the course at seven levels of illuminance and color temperature (controlled by LEDs placed throughout the room), ranging from 1000 lx/6500 K to 10 lx/3000 K.

The first experiment confirmed the older results, finding that low vision subjects contacted more objects than normally sighted controls under low illumination, but only at very low illumination levels. In the second study, the edges of obstacles were enhanced by LED strips, which illuminated them to 500 lx/4000 K. They found that obstacle avoidance was significantly improved by the intervention, indicating it was effective. This is noteworthy particularly because it requires significantly less light than increasing the illumination of an entire room.

1.3) Lighting Assessment

Box 1: Design Principles from Studies of Lighting

- Dim lighting conditions, such as illumination at ~1 lux, are hazardous for hazard avoidance
- A uniform level of illumination will not suit everyone with low vision – flexibility in workspaces is preferable
- Areas with sudden reductions in illumination can be difficult to navigate with low vision
- Directly illuminating the edges of obstacles using assistive LEDs can improve detection of them
- The HEAVI and HELA are tools designed to measure in-home effectiveness of lighting, but similar methodology could be adapted to assess workplace lighting

Apart from the NIBS (2015) and IES RP 28-16 (ANSI/IES, 2016) guidelines, other groups of researchers have also developed assessment methods on visual inclusivity of spaces. Some are not targeted to the workplace yet share the purposes and concerns as the assessment tools for the work environments. Home Environment Assessment for the Visually Impaired (HEAVI) is an assessment battery developed by Swenor et al.. (2016), allowing non-expert raters to identify fall-related hazards following a questionnaire. The test includes 45 items that passed inter-rater reliability test. Among them, several items are related to lighting de sign. The HEAVI assessment requires illumination around the assessed space to be above 300 lux. Minimum contrast on important features was also required by some of the items, which will be further discussed in section 3.2.

Another assessment tool, the Home Environment Lighting Assessment (HELA) has been developed and tested (Perlmutter et al.., 2013). Designed to create a structured tool to describe the lighting environment in both quantitative and qualitative terms, the interrater and test-retest reliability of the HELA was tested in this study. The assessment includes four parts, a preintervention environment description, a listing of potential lighting interventions, a post intervention assessment, a lighting modification assessment survey. The experiment showed .83 interrater reliability and .67 test retest reliability.

2) Studies of Contrast

In low-vision spatial perception, luminance contrast is a very important cue. It helps the observer to detect edges and segment areas of the built environment and objects. Luminance contrast is the ratio between the light coming out of two surfaces or two regions. It is determined by both the illumination casting on the two surfaces, and the reflective property of the surface materials. The latter factor is termed as the value contrast, defined as the ratio of Luminance Reflectance Values of two surfaces (Schambureck, 2018).

In the designer's perspective, lighting arrangement, geometrical design, and surface material selection are the major ways to create and control the luminance contrast on the feature for the users of the space to perceive. Although many lighting-related issues were discussed in section 2, the current study will focus on how luminance contrast in general affects the mobility and task performance of low-vision users.

2.1) Contrast and Low-Vision Mobility

A series of studies investigated how the contrast between an architectural feature and its background influences the identification accuracy in low-vision viewers (Legge et al.., 2010; Kallie et al.., 2012; Bochsler et al.., 2012; Bochsler et al.., 2013). The studies used a common architectural feature, up and down steps and ramps, as stimuli. The subjects with acuity-reducing goggles or natural low vision look at the target architectural feature, and verbally report their identification of the target type and direction. When subjects with artificially reduced acuity looked at the gray target against black wall as background, the identification accuracy was 88%. When the background was changed to gray, which created low contrast with the target, the accuracy dropped to 80% (Legge et al.., 2010).

Contrast between surfaces in one object or architectural feature can be the decisive factor of whether a viewer can correctly perceive the object or not. In Kallie et al.., (2012) and Legge et al.., (2010), factor analysis has shown that contrast-related cues in the stimuli explained more than 50% of the variance in report accuracy. Bochsler and colleagues (2012) found that with normal-sighted subjects wearing blur-goggles, checkerboard texture applied on steps and ramps made the identification accuracy decrease compared to when they are in solid gray color. This could be due to excessive luminance of contrast edges that does not correlate to any geometrical changes. The extra contrast edges could blind the key contrast feature that supports accurate feature identification.

However, the result was not replicated in the Bochsler et al.., (2013) experiment, where low-vision subjects were recruited in the same task and stimuli. With low-vision subjects, texture and background did not make significant difference. It will be helpful if future studies conduct factor analysis on low-vision subjects' performance on the architectural recognition tasks. Such analyses will help us better understand what cues are most effective for people with low vision to perceive objects and architectural features.

In the major categories of symptoms caused by visual impairment, contrast sensitivity is not a definition standard of low vision, legal blindness, or visual impairment severity. However, it is a better predictor of mobility than visual acuity (Marron & Bailey, 1982). Contrast sensitivity measures the minimal luminance contrast that can be perceived in a target with a certain visual angle size.

Contrast sensitivity varies with the spatial frequency of the target, with the function curve similar to a bell shape. When the spatial frequency of the target is either very high or very low, people often need the target to be of high contrast to accurately perceive it. When the target's spatial frequency is in the medium range, the viewer should be able to perceive the target even with lower luminance contrast, which means a higher contrast sensitivity in the medium spatial frequency range (Campbell & Robson, 1968).

2.2) Setting Standard for Contrast in Low-vision Inclusive Design

In the current design guidelines for low-vision inclusive architectural design, the standards for contrast are either unclear or lack research basis. The HEAVI questionnaire (Swenor et al.., 2016) which evaluates fall-related hazards in the homes of visually impaired residents includes multiple items concerning contrast. The evaluation battery identifies staircases, doors, and fixtures that have no contrast to their backgrounds as safety hazards. However, there isn't an objective standard for "no contrast," leaving the judgment to human raters who are using the battery. The NIBS guideline set minimal value contrast between an object and adjacent or background surfaces to be 30 (NIBS, 2015; Bright, Cook, & Harris, 1997). Yet it is not clear what research and data are the basis of such a cutoff line.

Research on how various types of visual impairment can influence contrast sensitivity may serve as references for setting standards to luminance contrast in low-vision inclusive architecture design. Chung and Legge (2016) found in 30 subjects with various vision diagnoses that the Contrast Sensitivity Function (CSF) in low-vision subjects had the same shape and curvature as the CSF of normal-sighted people. The low-vision CSF only differed in the optimal contrast sensitivity achieved, and the spatial frequency where the maximum contrast sensitivity presents. The optimal contrast sensitivity of low-vision subjects is often lower than the normal-sighted subjects, and the optimal contrast sensitivity is often achieved with targets of lower spatial frequencies, compared to normal-sighted subjects. Thurman et al.., (2016) have reached the same conclusion in their study involving 43 low-vision subjects.

The two aforementioned studies provide a basis for inferring the minimum luminance contrast needed for a specific low-vision person to detect a target of known spatial frequency. However, the contrast sensitivity of low-vision observers can have high individual variance. It would be difficult to draw one universal cutoff line to suit the needs of all. As mentioned, visual acuity, rather than contrast sensitivity, was mostly used as the definition standard of visual impairment severity.

The severity breakdown of visual impaired population can be drawn as an inference for the contrast sensitivity distribution, though it should be borne in mind that contrast sensitivity can vary with visual acuity in different rates for different types of vision conditions (Xiong et al.., 2020). From the survey data obtained from UK Biobank, among the 65,033 participants aged between 40-69 and had fundus image recorded, 2.6% had binocular visual impairment (McKibbin et al.., 2018). Among those with binocular visual impairments, 62.7% had mild impairment (0.3-0.45 logMAR), 35.4% had moderate impairment (0.45-1.0 logMAR), and 1.2% had severe impairment (1.0-1.3 logMAR). Worldwide, by the year 2015, 2.57% of 7.33 billion total population had mild visual impairment, whereas 2.95% had moderate to severe visual impairment (Bourne et al.., 2017).

Box 2: Design Principles from Studies of Contrast

- Not all contrast textures are helpful – a checkerboard pattern can impair step recognition relative to a solid monochromatic texture
- Sensitivity to contrast varies with the complexity (i.e. spatial frequency) of objects being observed, so contrast that works for a simple sign or target may not work for others
- It is possible to predict the necessary contrast for target detection with low vision, it is necessary to know the severity of contrast sensitivity loss, which is not widely available yet

Currently, we cannot find a similar severity breakdown of prevalence for the low vision prevalence in the United States. In the two available datasets, the majority of the visually impaired population fall into mild severity range. However, the proportion of the population with moderate and severe visual impairment is also impossible to ignore. It would be an important decision where to set a cutoff line for the minimal luminance or value contrast required in low-vision inclusive workplace designs. It might be reasonable to set different standards based on the specific purposes and anticipated user groups of the space being designed.

3) Studies of Layout

Determining where objects will be placed is an important consideration for designers of visually accessible spaces. For instance, support pillars, seating, or tables can either function as intended if placed properly, or act as hazards if they are placed in such a way that they are not visible to people with low vision. In addition to hazard detection, object layout can also influence the likelihood that a person with vision impairment is able to easily recognize a given object. Academic research has investigated this issue in three primary ways: focusing on hazard detection, object recognition, and where gaze is directed while navigating with low vision.

3.1) Hazard Detection

One common method used to assess hazard detection is the mobility course, wherein subjects with low vision are asked to walk through a space with obstacles placed in their path (as described for Kuyk et al., 1998, in Section 1.1). A powerful example of this type of study was conducted by Turano et al. in 2004, in which 1504 subjects with low vision completed both eye examinations (assessing visual acuity, contrast sensitivity, and extent of visual field) and a mobility course.

The course consisted of a 16.4 m path through an indoor space, seeded with baskets, hanging plants, and wooden mannequins, and was completed using any visual aids (e.g. white cane) they typically used. They found that loss in the extent of visual field was the primary predictor of decreased walking speed and increased number of collisions with obstacles, while contrast sensitivity was associated only with the number of collisions, and visual acuity predicted neither. This finding is complemented by another study in 2003, which found that subjects with AMD (a disease which reduces the extent of the visual field) were unlikely to detect hazards with enough space to safely stop while walking (Goodrich et al.., 2003).

Another study by Timmins et al. in 2012 provided a potential explanation for why this may have been occurring. In this experiment, subjects with normal vision and subjects with field of vision loss were asked to walk through an indoor space that was either totally unobstructed or included a single obstacle present on the ground, which was either 5 or 10 cm tall. Subjects were instructed to step over the obstacle and continue walking to the end of the room.

Throughout their walks, the height of subjects' feet and orientation of their heads was captured using 3-D motion capture system. The system showed that in comparison to the normally sighted subjects, those with field loss were looking downward toward the ground, at their immediate surroundings near their feet, significantly longer throughout their walks. This downward gaze may reflect the process of *mobility monitoring*, or the reallocation of attentional resources away from examining the environment in favor of safe travel.

This process was observed in a series of experiments by Rand et al. in 2015, wherein subjects walked through buildings with no obstacles, and were asked to tell experimenters what they observed after their walk. Their findings showed that while walking with degraded vision, subjects remembered landmarks and other environmental features more poorly than those with normal vision. However, this effect was observed to a lesser degree when the subjects walked with a sighted guide, who led them through the walk. Thus, when walking unguided with impaired vision, people are less able to examine their environment, even without obstacles, and must look down toward the ground when there is the potential for ground-level hazards. However, if a guide is available, either in the form of a sighted person or a guide rail, this functional impairment is not as detrimental.

With regards to design, these studies suggest that while walking through areas that potentially have obstacles in the walking path, people with field loss tend not to look far ahead, but instead focus on their immediate surroundings. Therefore, if a warning or indicator of upcoming obstacles is to be effective, it ought to be visible to someone with that viewpoint. However, the Timmins study also showed that while walking in the unobstructed condition, there was no difference between where subjects with field loss and those with normal vision in regard to where they were directing their head.

This is a key point for those seeking to implement Inclusive/Universal Design – when people with field loss feel secure in their walking path, without the presence of hazards, they will look towards the similar locations as those without field loss. In this case, signs or other information can be communicated in the same way to both groups. On the other hand, if hazards are present, additional signals may be necessary to inform those with field loss. Further emphasizing the importance of information close to the ground was a study conducted by Rand et al. found that judgments of people with low vision about the distance to objects was affected by the point at which it appeared to touch the ground.

People judge the distance to objects assuming that they are on the ground. Therefore, an object that is higher up in space (or if the contact point is not visible, in the case of the glass legs of a table, for instance) will be judged as being farther away than one that appears to be directly touching the ground. This suggests that making the point at which an object contacts the ground could be critical for ensuring those objects do not become hazardous.

3.2) Gaze Behavior

Another emerging methodology are mobile eye trackers, which can provide information about where people direct their gaze (more specifically, where they point their eyes) while navigating through an environment. These devices usually take the form of a set of glasses equipped with both a front facing camera and a camera directed at the subject's eye. The pupil is tracked using the camera directed at the eye, and this position is displayed as an overlay on the video recorded by the front facing camera. A study in 2001 by Turano et al. used an eye tracker to examine where people with retinitis pigmentosa (a disease that reduces peripheral field extent, leading to "tunnel vision") directed their gaze while walking through a novel indoor environment, as compared to people with normal vision. Subjects walked along a 33 m route through the inside of a university building, consisting of straight hallways and four right angle turns.

Upon reviewing the resulting video data, the experimenters quantified the footage by constructing a gaze-categorization scheme. Each frame of footage was classified into one of 5 categories (depending on where the gaze was directed), including goal (where they were headed), layout (walls and boundaries between the walls and floor/ceiling), ahead (the wall directly in front of them), object (items on walls such as posters), and down (the floor). They found that people with retinitis pigmentosa distributed their gaze more broadly throughout the environment than people with normal vision, focusing most of the time on floor-wall boundaries, walls, and the floor.

This finding suggests that rather than looking directly ahead while exploring novel spaces, individuals with retinitis pigmentosa will instead use the boundary between the wall and floor as a navigational cue. These boundaries are typically high contrast, reliable cues that inform the viewer of their distance to walls, and their position within rooms. With regards to design, this experiment confirmed that these are useful cues, and should be maintained for visually accessible spaces.

Another study in 2019 used an eye tracker to assess where people looked while actively visually searching for targets during a walking task (Freedman, 2019). In this experiment, low vision subjects (with a heterogeneous group of vision disorders, all of which impaired visual acuity) and normally sighted subjects with artificially restricted visual acuity were both equipped with eye trackers. Both groups of subjects walked through an indoor space along an unobstructed path while verbally describing objects placed adjacent to the path.

As in the 2001 Turano et al. study, gaze position was classified into categories, which were set up along horizontal and vertical axes relative to the path they walked along. Along the horizontal axis, gaze categories included left of the path, on the path, or to the right of the path. Along the vertical axis, gaze categories included floor, floor-wall boundary, and wall. The final type of category was object, for when subjects were looking directly at a target.

The results of the study replicated what was found in 2001, namely that subjects with low vision looked toward the floor-wall boundary significantly longer than normally sighted subjects. Importantly, even when normally sighted subjects had lowered acuity, this difference was still observed, with the artificially impaired group spending most of their time looking toward the floor instead. This suggests that it is not lowered acuity itself that causes this behavior, but rather a behavior that people with low vision learn to do with experience in navigating.

These boundaries are typically high contrast, reliable cues that inform the viewer of their distance to walls and their position within rooms, making them a valuable tool for low vision navigators. With regards to design, these experiments confirmed that these are useful cues, and should be maintained for visually accessible spaces.

3.3) Recognition Studies

The final category for review is studies which investigate the ability of people with low vision to visually inspect objects in the environment. Using residual vision to determine the characteristics of an object can be key to moving through a space carefully. For instance, the ability to determine whether an upcoming step is a step up or a step down could be the difference between a fall and a successful walk.

Bochsler et al... examined this ability in their 2013 study in which low vision subjects were asked to visually identify whether an upcoming surface was a step up, step down, or a ramp. This was accomplished by having subjects stand on a raised platform and using a mechanical platform which could be adjusted to create a step or ramp, depending on how it was situated relative to the platform. Subjects completed the task under a variety of different conditions, including high vs low background contrast, various lighting arrangements, and after walking.

The study showed that identification was significantly improved after walking toward the surface, and that step-ups were more visible than step-downs. In the context of accessible design, this could suggest that including space for people to approach a set of stairs may be helpful for improving safety. Furthermore, this methodology clearly demonstrated improvements in step recognition, meaning it could be a fruitful avenue for future research of proposed step-visibility interventions. Additionally, a study in 2012 by Kallie et al…, found that objects with curved surfaces were identified more easily than those with flat surfaces.

Ishiwata et al. proposed a step detection system to support the mobility of the visually impaired. The system is made up of a sensor unit that will be attached to the user’s chest and a PC with a battery to be installed in a backpack (Ishiwata, Sekiguchi, Fuchida, & Nakamura, 2013). The device uses a small laser range sensor to obtain the distance information in the vertical cross-sectional plane in front of the user. The laser range sensor measures the distance to different points in front.

Sensor data has a threshold value to classify it into different segments. The segment is then analyzed to identify the pattern of stairs. After the detection, the system provides information on the existence of a step via voice or a beep sound. In experiment trials, the device performed well, with over 95% accuracy for both upstairs and downstairs. The system is yet to be tested in an outdoor environment.

Bouhamed et al. discussed an approach to detect staircases by using an ultrasonic sensor attached to a white cane (Bouhamed, Frikha Eleuch, Kallel, & Sellami Masmoudi, 2012). Their electronic cane is made up of two ultrasonic sensors (for staircase and ground obstacle detection respectively) and a monocular camera for obstacle detection. The researchers selected the “LV-EZ0” ultrasonic sensor for their application. The sensor is able to provide range information of 6–254 inches with 1-inch resolution. The monocular camera selected is “LinkSprite JPEG Color Camera TTL Interface” with a capture range from 10 to 15m.

For the staircase detection, the researchers keep track of the changing reading from the ultrasonic sensor to the ground and use the data to identify the terrain in front such as a floor and ascending or descending staircases. The experimental results showed that the detection rate of the staircase is estimated to be 89.8%. Shahrabadi et al. developed a simple algorithm for detecting stairs by using a camera at a distance of 5 meters from the stairs.

The algorithm starts with capturing of the image and followed by processing the image to identify the edges within a preset region of interest (ROI). The candidate step is selected if the edges found within the ROI match with the specific criteria determined by the researchers (Shahrabadi, Rodrigues, & du Buf, 2013). Munoz et al. developed an effective indoor staircase detection algorithm by using an RGB-D camera. The researchers use a Google Project Tango, which includes an RGB-D camera mounted within a tablet (Munoz, Rong, & Tian, 2016). Harms et al. proposed a stair detection algorithm to aid people with vision impairment in real time. The prototype is a helmet mounted with a stereo camera rig and Inertia measurement unit (IMU) (Harms, Rehder, Schwarze, & Lauer, 2015) Cloix et al.. developed an assistive system to improve the performance of existing smart assistive devices. In 2015, Cloix et al.. suggested that the existing mobility aid devices such as rollator is unable to prevent users from descending stair hazard (Cloix, Bologna, Weiss, Pun, & Hasler, 2015). Thus, the researchers proposed a method to detect descending staircases in real time using a passive stereo camera. The experimental setup consists of the Bumblebee2 stereo camera mounted at a height of 76 cm, on top of a standard three-wheel rollator.

Box 3: Design Principles from Studies of Layout

- When walking alone, people with low vision look downwards frequently, so information may be more visible there than locations with higher elevation (Note: less significant without any potential hazards)
- Guide rails or sighted guides can improve low-vision peoples' ability to remember landmarks by removing the attentional cost of monitoring their safety
- High contrast boundaries between floors and walls are useful orientation cues
- The point at which an object appears to contact the floor can affect judgements of its distance. High contrast between the point of contact of furniture (e.g. legs of a table) and the floor can help ensure they do not become hazards
- Step-ups are easier to identify than step-downs for people with reduced visual acuity
- Walking toward a step can improve detection of it
- Round surfaces are more easily visually identified than flat surfaces for people with low vision

Discussion

As shown in the current review, there has been consistent input of academic research that can serve as facilitation to Inclusive Design of the workplace for the low-vision population. Boxes 1, 2, and 3 in this review contain suggestions for how academic findings can be used to create principles for designing visually accessible spaces. For all the major considerations in visually accessible workplace design, namely lighting, luminance and value contrast, and object arrangement, the research body has examined how the variations in each factor would influence task performance of subjects with natural or simulated visual impairment, or aged vision.

The tasks used in these research studies include both daily activity tasks, such as reading, sorting pills, identifying architectural features, and walking, as well as psycho-physical tasks, which measures low-level perception abilities under different external conditions. Both kinds of task performance data can help us understand the relationship between the aspects of design and the user experience of a low-vision or aged population. Such an understanding can not only guide design practices but can also serve as a reference for setting standards for inclusive design, as attempted by the NIBS (2015) and IES RP 28-16 (2016) guidelines.

However, the existing design guidelines for inclusive visual environment design have not taken full advantage from the related research studies. As we reviewed, many standards set in the guidelines (NIBS, 2015; ANSI/IES, 2016; Swenor et al.., 2016) did not base their standard for illumination or value contrast on the behavioral data obtained by research. There seems to be a gap between the academia and design industry.

Two issues might be the reason for such a gap. The first issue is that the research findings can be overly abstract to guide actual design practice. For example, contrast is a major cue for object recognition. Contrast sensitivity of the viewer determines the minimum contrast required on an object so that it can be accurately perceived by the viewer. Currently, there are many studies committed to testing contrast sensitivity in subjects with various visual conditions. However, the results are often quantified and expressed in Pelli-Robson scores or Contrast Sensitivity Functions, which can be communicated in the ophthalmology field, but is not extended to the design industry. Further work needs to be done to translate these results into useful information for designers.

One attempt to mend the bench to practice gap is the project of Designing Visually Accessible Space (DeVAS), which developed a software to estimate the visibility of architectural features to observers with known visual acuity and contrast sensitivity (Thompson et al., under review). The software takes as input the 3D model of an architecture design, a physically accurate image rendered from the 3D model and a given viewpoint, and the visual parameters of the viewer. The viewer’s visual parameter can be virtually set to assess the visual inclusivity of the proposed design.

Based on the visual parameters of the given viewer, the software uses a nonlinear filter to simulate the perceived image of the viewer at the given viewpoint in the designed space (Peli, 1990). By comparing the filtered image with the 3D model, the software will capture and visualize the architectural features that cannot be accurately perceived by the viewer (Thompson et al., 2017). The DeVAS software, with further validation and promotion, has the potential to help assess design plans of a visually inclusive workplace.

The second issue lies in the sample size of academic research. For a finding to be a reliable basis of design guidelines or standards, the practitioners and policy makers would expect the study to have a large sample size. However, in the academic world, the sample size of perceptual studies is often no larger than 50. What is considered a strong case in academia might not be as persuasive in the policy maker’s eyes. To mend this gap, meta-analysis can be conducted to accumulate a larger sample size from lines of studies on similar topics.

Assistive Technologies for Orientation and Mobility

Blind and partially sighted individuals (BPSI) frequently rely on assistive technologies for orientation and mobility. In work environments a variety of assistive technologies and strategies are used such as aids added to the white cane, indoor GPS systems and mobile assistive technology apps, etc. Researchers have explored a variety of indoor assistive technologies in various environments which may be beneficial for orientation and mobility for

BPSI. These technologies can be beneficial in transitioning to new work environments during job training and help in obstacle detection and avoidance and assist in navigating everyday work environments as well as unfamiliar indoor environments.

Bhowmick and Hazarika, 2017 identified in their review that the field of assistive technologies for blind and partially sighted individuals is complex, wide and evolving constantly. Since the inception of the field, one of the key areas of focus has been the design and development of Electronic Travel Aids (ETAs). ETAs assist BLV in known and unknown indoor and outdoor environments by providing rich environmental information, obstacle avoidance, object recognition and navigation through the use of ultrasonic systems, GPS, cameras, infrared, laser and mobile assistive technologies. Sonar based mobility such as Russell Pathsounder (1965) and Mowat Sensory (1977) functioned as obstacle detectors.

A string of similar prototypes followed later, however the user acceptance for these technologies was low. Computerized ETAs were developed such as NavBelt, a wearable sonar system that enabled blind users to safely walk through unknown obstacle cluttered environments. One such ETA which has been a success story is the mobility aid Ultracane, which combined the long cane with ultrasonic sensors. Further innovation has led to the development of wearable ETAs such as those with a system on a chip (Soc) and sensors mounted on a shirt pocket. The advent of depth sensing technologies has led to modern indoor navigation systems such as the Roshni project and ARIANNA for both indoor and outdoor navigation systems.

Plikynas et al., 2019 presented an evaluation and comparison of indoor navigation systems and provided insights for directions for further development in this area. The authors found that wearable devices for navigation systems are often complex and combine three types of modules: an input module, computational module, and feedback module. The input module provides environmental information to the computational module which is responsible for processing the data then presented to the user through the feedback module.

Input module - depending on the types of sensors being used for navigation the input modules can be further categorized into camera-based, non-camera-based and hybrid. Non-camera-based systems use various sensors to sense the environment and represent it to the user, examples of these input modules are systems such as Radio-Frequency Identification (RFID), Near Field Communication (NFC), Bluetooth Low Energy (BLE) and Ultra-Wideband (UWB).

Wi-Fi and magnetic field-based methods are often suggested for localization indoors. It has been proposed that these technologies be used for indoor navigation for BLV. To be trackable the users must carry dedicated equipment (tag or tag reader, smartphone, or other receiver/transmitter device) while navigating their surroundings. Non-camera-based technologies used to build indoor navigation tools for blind have their advantages and limitations, the authors suggest that UWB may be a preferred choice as it maximizes accuracy, infrared (IR) is rarely used for indoor navigation systems as it struggles to detect transparent objects such as glass or windows.

Wi-Fi technology being widely available in most indoor environments is an attractive option as well. Limitations such as the accuracy of the Wi-Fi is impacted by a variety of factors such as devices, temporal changes in surroundings and building materials interacting with radio signals and magnetic field-based technology. Wi-Fi may be impacted by the changes in the value of the magnetic field vector depending on the position of the device, walking speed and the level at which the device is being held. Camera-based systems use a live stream or images as their main source of information. These systems are capable of object detection in addition to navigation. Camera based systems can be further categorized depending on the type of cameras being used such as single camera (Charged Coupled Devices (CCD) or complementary Metal-Oxide-Semiconductor (CMOS) image sensory and 3D camera.

Single-camera sensors lack the depth component and use fiducial markers such as Aruco and QR codes as an alternative. Idrees et al. (2015) tested the recognition of QR codes under varying light conditions and markers of different sizes and blurriness levels. QR codes were found to be easily detected under low light conditions at a blurriness ratio of up to 60%. 3D camera systems can be categorized as being ToF (time of flight) camera based or depth sensor (RGB-D) camera-based. In ToF cameras an IR ToF sensor is used which illuminates the environment with modulated infrared light and measures distances up to 5m within an accuracy of +/- 0.01 meter while in RGB-D cameras a color sensor is used that measures range of up to 10 meters but may vary depending on performance accuracy, scene and lighting conditions.

Computational Module-Hardwares in navigation systems can be categorized as off-the-shelf communication devices such as smartphones, computational devices such as Arduino and Raspberry Pi and mixed.

Feedback module transmits the information to the user in one of three channels such as tactile (e.g., vibration feedback or force feedback), auditory or visual (e.g. magnifiers, VR/AR). The information collected from the semi-structured interviews from users in this study indicated that 16/25 experts mentioned not using ETAs for indoor navigation due to lack of commercially available and suitable indoor ETA solutions despite advances in technology. The authors indicate that the differences between indoor and outdoor usage of smartphone apps may be due to absence of GPS signals indoors which restricts the usage of positioning and navigation apps. There is ongoing research being conducted in this area of using Wi-Fi, visual data recognition algorithms, beacons, RFID tags and other systems.

Current Challenges and Barriers to the Use of AT in Workplace Environments

Despite an increasing number of individuals with vision impairment working there remains a large proportion of individuals who are BLV continue to remain unemployed. Accommodations involve the provision of assistive technology (AT) or the adaptation of existing workplace technologies to render them accessible and usable. DeJonge and Rodger, in their 2006 study, identified barriers to the use of AT in the workplace in which they noted the importance of optimization and strategies to improve optimization. Optimization refers to the process of improving the use of technology by adjusting or customizing it to accommodate the specific requirements of the individual, the tasks being undertaken and the environment, as well as learning to use it to effectively carry out the required work tasks.

Optimization is an important issue for people with disabilities who rely on technology as it can decrease fatigue and strain, ensure comfort and enhance work performance. Technology abandonment (or non-use) can result when changes occur in the user's abilities, activities, when device performance is ineffective or when there are environmental obstacles. Lack of training was also identified as a barrier. The authors noted that users need to be proficient in the use of AT, training should not only provide the user with an understanding of the basic functions of the technology but should also equip him or her to fit and adjust it for continued efficiency as their requirements change. Other key barriers identified were limited knowledge, complexity of technology, cost of support, difficulties in meeting the training needs, and time required to develop proficiency.

Challenges for inclusive user centered design for assistive technologies

Despite major advances in technologies, orientation and mobility continues to be challenging for blind and partially sighted individuals in work environments. It is important to consider the approaches being used towards designing indoor navigation systems and the involvement of participatory research in the design elements. Real Valdés, Santiago & Araujo, Alvaro. (2019) highlighted a major flaw in the design of navigation systems for BLV users which is a set of reiterated deficiencies concerning the knowledge of the users' needs, capabilities, and limitations despite the great amount of work that has accumulated over the last few decades. They noted that one of the first problems faced in the development of assistive technology is the heterogeneity of the targeted public.

The assistance required is related to the users' residual vision, among other circumstances, such as physical or sensory disabilities deriving from the ageing process that should be noted (81% of the BLV are aged above 49 years). They focused on blindness as the most severe case of disability, so as to provide the reader with enough data to infer the needs of specific users. Several user requirements concerning navigation systems for the blind have often been addressed.

First, regarding communication of environmental information, some typical features are:

1. "The presence, location, and preferably the nature of obstacles immediately ahead of the traveler." This relates to obstacle avoidance support.
2. Data on the "path or surface on which the traveler is walking, such as texture, gradient, and upcoming steps."
3. "The position and nature of objects to the sides of the travel path," such as hedges, fences, and doorways.
4. Information that helps users to "maintain a straight course, notably the presence of some type of an aiming point in the distance," such as distant sounds.
5. "Landmark location and identification," including those previously seen, particularly in (3).
6. Information that "allows the traveler to build up a mental map, image, or schema for the chosen route to be followed." This point involves the study of what is frequently termed "cognitive mapping" in blind individuals.

While the first ETAs were oriented to the first category of information, solutions that placed virtual sound sources over POIs easily covered points (4) and (5), and solutions based on artificial vision could provide data in any category. One key factor to be aware of in this context is the theory behind the development of sensory substitution devices, when describing the "cognitive load" or "intuitiveness" of some user interfaces.

The authors identified that multiple devices have been developed to guide and assist BLV individuals along indoor/outdoor routes. However, they have not completely met the technical requirements and user needs. Most such unmet aspects are currently being answered separately in several research fields, ranging from indoor positioning, computation offloading, or distributed sensing, to the analysis of spatial-related perceptual and cognitive processes of BLV people. On the other hand, smartphones and similar tools are rapidly making their way into their daily routines. This presented an architectural system for design and development of navigational assistance devices as identified in the figure below.

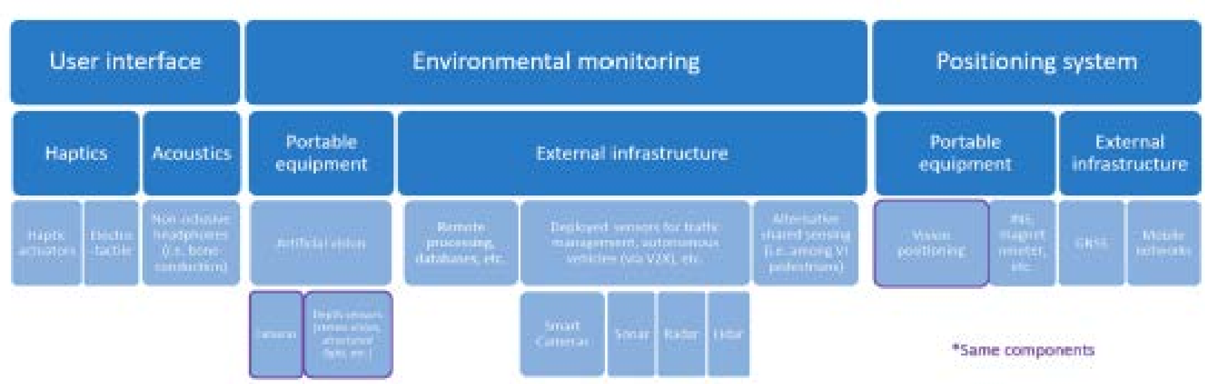

Figure 9. Architecture proposal for navigation assistance devices (examples included).

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Inclusive Design of Workplaces for People who are Low Vision or Blind

September 2020

Institute for Human Centered Design

Table of Contents

Introduction

There are very limited requirements in the Americans with Disabilities Act (ADA) pertinent to people with vision limitations, especially for people with low vision. This analysis took a global snapshot of current standards (legally mandated requirements) and guidelines (recommended and often set as policy but not mandated) in order to identify promised practices for accessibility and inclusive design to consider to inform best practice and policy.

It is not exhaustive but includes a number of the most recent standards and guidelines. Those are from the Middle East and they incorporate a very expansive set of both common requirements that were first in place in the US and Europe and best practice from across the world as well as from their own research.

The material is organized by elements in sequence from the outside of a building. All pertinent material to that element is below it. In sequence you will find:

ADA requirements are first in all cases assuming that there is a pertinent ADA reference.

Massachusetts Architectural Access Board (MAAB) requirements are included only if they exceed the requirements of the ADA.

International Standards Organization (ISO) is next. ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. ISO is considered the gold standard for accessibility and inclusive design in much of the world though not so familiar in the US. One of the advantages of ISO standards is the rigorous revision process that occurs on a five-year schedule.

Specific standards or guidelines in use in other nations that go beyond either ADA or ISO relevant to people with visual limitations. These offer a snapshot of ideas that could be adopted as best practice or formalized as policy.

Approach and Entrance

Exterior Accessible Route

Required - ADA (206)

> An accessible route to an accessible entrance should be provided from all points of arrival including streets, sidewalks and parking areas. The Accessible routes should coincide with or be in the same area as the general circulation path and should be constructed to allowed a person to approach, enter and exit the building safely.

Accessible routes should be leveled and have a firm, stable and slip resistant surface. Exterior accessible routes should be designed to prevent accumulation of water.

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

- Provide wayfinding, guided path and other physical support of information.
- Use tactile walking surface indicators to indicate the directional orientation especially where no other clues indicate the path to the building. Across large or open areas, people who are blind need a tactile route or guiding line to follow.

Provide additional illumination or visual contrast and tactile information, such as a change in material or tactile walking surface indicators at key decision points to assist orientation and wayfinding.

- Ensure routes to be followed have at least a minimum luminance contrast to the surroundings to assist people with vision impairment.

Inclusive Design Standards (England) 2019:

- Be installed with any necessary joints closed and flush to prevent white canes, for instance, from becoming trapped.
- Have consistent use of color and surface material if used as a wayfinding tool.
- Have level changes indicated by visually contrasting surfaces that do not create confusion.
- Avoid the use of any busy patterns, including stripes, that may cause confusion or be disorienting.
- Avoid the use of highly reflective materials. They can appear to be wet and therefore slippery even when they are not. They may also be a source of reflective glare which can be disorienting for many people with a visual impairment.
- Drainage covers and gratings within walking areas should not be provided within tactile surfaces at controlled crossing points.
- Accessible paths of travel leading to pedestrian entrances should be marked with color and texture contrast to the surroundings.

Entrances

Required - ADA (206.4)

At least 60 percent of entrances should be accessible.

Note: Massachusetts requires all public entrances to be accessible.

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

- Ensure the main entrance to the building is identifiable from the boundary of the site and from any designated accessible parking spaces on the site. If the entrance cannot be easily identified, suitable means of visual and tactile wayfinding shall be provided.
- Ensure the entrance(s) to a building, including final fire exits, are easy to locate, safe and easy to use, and are protected from exposure to rain and snow. Entrance and final fire exit doors shall be sufficiently high and wide, and easy and intuitive to operate.

[NOTE: Guidance from the Middle East is the most recent and it incorporates much of what has been developed before in Europe so it is organized as their first resources. Please note that only unique guidance above and beyond US guidance is included.]

Built Environment Guidelines for the Kingdom of Saudi Arabia 2010:

- Accessible pedestrian entrances should be protected from the weather. The use of canopies or recessed entrances should be considered.
- If door entry intercom systems is provided, consider incorporating both visual and audible signals to indicate when the door has been released. Telephone intercoms provided at entrances should include visual and audible information to indicate when the other party has received the intercom call.
- Entrance area walls and ceilings should be finished in a plain light matt color to help diffuse light and increase visibility.
- Accessible paths of travel leading to pedestrian entrances should be marked with color and texture contrast to the surroundings.

Ireland: Technical Guidance Document M 2010 and Building for Everyone: A Universal Design Approach 2012:

- Any entrance used exclusively by employees should be accessible.
- Audio clues, such as a small fountain or rustling plants, and olfactory features such as fragrant plants can also assist.
- Artificial lighting can highlight the entrance to a building and make it more obvious at night.
- Glare and reflection from lighting or materials should be avoided as it is confusing for those with visual impairment.
- A recommended clear area for a landing immediately outside an entrance is 2400mmx2400mm (Approx. 95 inches by 95 inches) for guide dogs.

Signage

See Orientation and Information section.

Means of Egress

Required - ADA (207)

An unobstructed path to exit a building and/or a space should be provided. The means of egress includes an exit access which is the path leading to an exit, an exit which is door either leading to an enclosed stairway or to the outside, and an exit discharge which is the path leading to a street or public way.

Areas of Refuge

Required - ADA (207)

An area of refuge is a protected area where someone unable to use stairs can wait for evacuation assistance. Areas of refuge are not required in facilities that are equipped throughout with an automated sprinkler system in compliance with the applicable code.

Areas of refuge must be equipped with a two-way emergency communication system.

Two-way communication in areas of rescue assistance require the following printed information:

- Instructions on how to use the communication system under emergency conditions.
- Directions to other means of egress.
- Indication that persons able to use the exit stairway are to do so as soon as possible, unless they are assisting others.
- Information on the planned availability of assistance in the use of the stairs or supervised operation of elevators and how to summon such assistance.
- These signs must meet ADA standards for visual and tactile characters.

Stairways that are part of a means of egress are addressed by the applicable code. In addition, interior and exterior stairs that are part of a means of egress must comply with requirements in the ADA Standards (504).

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

- Conveniently locate information concerning fire safety and fire evacuation procedures at all entrances and final fire exits. Information on evacuation plans should be available to all building users in a format they can understand. This can include large print, audio, Braille, and easy-to-read text.

Approved Document B (England) 2019 and Inclusive Design Standards (England) 2019:

- Final exit location should be clearly visible and recognizable.
- All escape routes should have adequate artificial lighting.
- Escape routes should be designed to take into account the needs of people who are neuro-divergent, including the provision of appropriate orientation information.

Interior Circulation

Protruding Objects

Required - ADA (307)

Objects mounted along circulation paths can pose hazards unless their projection is limited. Circulation paths include interior and exterior walks, hallways, elevators, ramps, and stairways. Objects mounted with leading edges that are 27 inches high maximum (within cane sweep) or that provide minimum headroom clearance 80 inches minimum do not pose hazards and can protrude any amount.

Headroom clearance of at least 80 inches high is required along all circulation paths. Fixed barriers, such as guardrails, fixed planters, benches, and other elements are required where the vertical clearance is less than 80 inches such as at open stairways and along sloped or curved walls.

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

- Minimum 2100 mm (83 inches) clear height guard detectable with cane, max 300 mm (12 inches) above the floor level.

Dubai Universal Design Code 2017:

- All open spaces lower than 2400 mm (95 inches) under a stair shall be protected with a handrail or fixed equivalent element to protect people from the overhead hazard.

Built Environment Guidelines for the Kingdom of Saudi Arabia 2010:

- A tactile and color contrasted warning surface should be provided where overhead or protruding hazards exist. The detectable surface should be located flush with the surrounding walking surface and extend at least 300 mm (12 inches) outward around the entire overhead or protruding hazard.
- The leading edge of a protruding or overhanging object should be color contrasted to its background and surroundings to enhance the visibility of the hazard.

Interior Accessible Routes

Required - ADA (401)

Accessible routes are comprised of walking surfaces, doorways, ramps, elevators and platform lifts. The floor or ground surface of accessible routes should be stable, firm and slip-resistant. The minimum width of an accessible route must be 36 inches however, the minimum width can be reduced to 32 inches for a length of 24 inches maximum.

Additional clearance is required at 180 degree turns around an element that is less than 48 inches wide. The clear width must be at least 48 inches at the turn and 42 inches minimum approaching the turn (unless the clear width at the turn is 60 inches minimum).

The minimum clear, unobstructed width of an accessible route must be free of handrails and any other projections such as fire extinguishers, notice boards, coat hooks, etc.

Passing Spaces

Required - ADA (403.5.3)

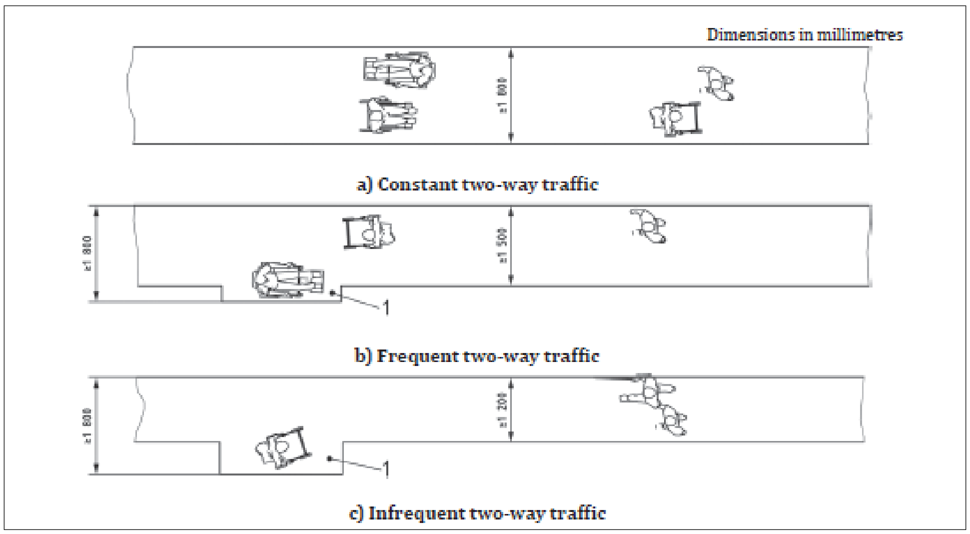
Passing space of at least 60 inches should be provided at intervals of 200 feet maximum.

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

The projected volume of people in a corridor shall be a criterion when establishing the minimum width and length of the corridor. Different corridor widths are determined by intensity of use:

- at least 1800 mm for constant two-way traffic; (70 inches)
- at least 1500 mm for frequent two-way traffic; (60 inches)
- at least 1200 mm for infrequent two-way traffic. (48 inches)



Two-way Traffic Corridors

Dubai Universal Design Code 2017:

- Where the floor elevation of an interior accessible route, corridor or access aisle is higher that an adjacent surface by 200-600 mm (8 inches to 24 inches), the edge(s) of the accessible route should be protected by a color contrasting curb that is at a minimum of 75 mm (3 inches) high. If the difference of floor elevation is greater than 600 mm (24 inches), a guard must be provided.

Edge Protection

Vertical Circulation

Stairs

Required – (ADA 504)

Stairs that are part of an accessible means of egress must comply with the applicable standards.

Components of Stairs:

- Uniform riser heights and uniform tread depths. Open risers are not permitted;
- ½ inch maximum radius of curvature at the leading edge of the tread;
- Handrails on both sides of stairs, continuous within the full length of each stair flight and extensions at the top and bottom.

Exterior stairways should be designed to prevent accumulation of water.

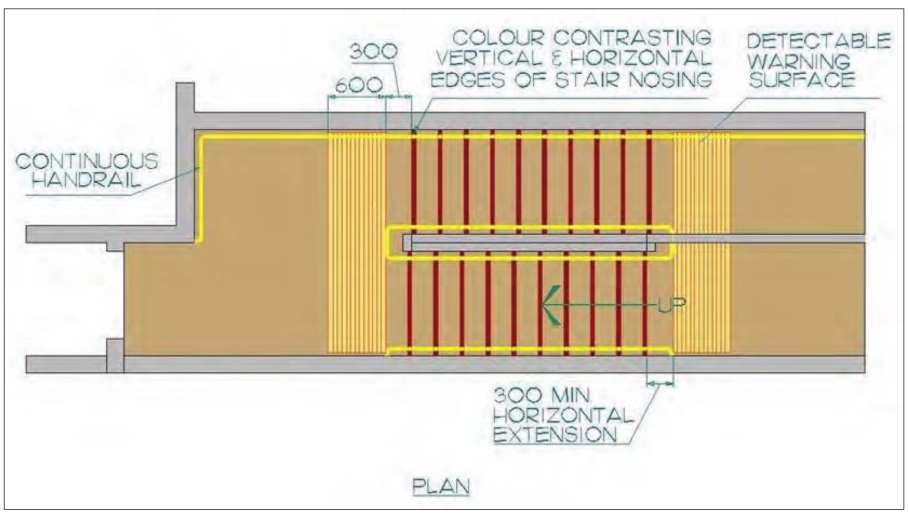
Visual contrast on the leading edges of treads is helpful for people with low vision.

Note: Massachusetts requires all stairs to comply.

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

- Provide a minimum illumination at the top and bottom of the flight of 200 lx and 150 lx in between.
- Ensure there is a visual contrast between landings and the top and bottom step of a flight of stairs. Preferably, a visual warning line with a single strip of 40 mm (1.5 inches) to 50 mm (2 inches) without a break should be provided on the front edge of the going of each step with a minimum luminance contrast.
- Where a flight of stairs is in an open area, provide a tactile walking surface indicator (TWSI) at the top landing. Where different materials are used for the flights and landings of a stair, care should be taken to ensure that their frictional characteristics are similar in order to minimize the risk of stumbling tripping.
- Where tactile attention patterns are used, they should be provided on the landings at the top and bottom of every flight of stairs across the whole width of the stair.
- Where attention patterns are used at the top and bottom of stairs, the tactile walking surface indicator shall not cause visual confusion of the first and the last step of the flight.



Stair design criteria (Built Environment Guidelines for the Kingdom of Saudi Arabia 2010)

Approved Document M (England) 2015, Approved Document K (England) 2013 and Inclusive Design Standards (England) 2019:

- For general access stairs, flights between landings should have maximum 12 risers.
- If stairs have more than 36 risers in consecutive flights, make a minimum of one change of direction between flights.

- Do not have single steps.
- Guarding should be provided at the sides of flights and landings when there are two or more risers.

Technical Guidance Document M (Ireland) 2010 and *Building for Everyone: A Universal Design Approach* 2012:

- Where it is not appropriate to use tactile hazard warning surfaces, floor finishes that contrast both visually and audibly (when walked on, i.e. timber to stone) should be used to highlight the top and bottom of the stair flight.

Ramps

Required – ADA (405)

Ramps can provide an accessible route between changes of level. In many instances, ramps can be a practical solution for people who have difficulty using stairs, while other people can have difficulty using ramps.

Components of ramps:

- Minimum clear width of 36 inches.
- 1:12 (8.33%) maximum running slope and 1:48 (2.08%) maximum cross slope.
- A level landing for every 30 feet maximum of rise.
- Handrails with horizontal extensions on both sides.
- A firm, stable and slip-resistant surface.

Providing the least possible slope below the 1:12 (8.33%) maximum offers better usability for a wider range of users. Exterior ramps should be designed to prevent accumulation of water.

Note: Massachusetts requires a minimum width of 48 inches and a maximum 1:50 (2.00%) cross slope.

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

- In addition to a ramp, provide a flight of steps if the ramp is steeper than 1:20 (5 %) and the change in level is more than 300 mm (12 inches).

Technical Guidance Document M (Ireland) 2010 and *Building for Everyone: A Universal Design Approach* (Ireland) 2012:

- Where provided by artificial light, it should achieve a minimum luminance of 20 lux on level and gently sloped access; with a minimum luminance of 100 lux on ramps or steps measured at ramp, tread and landing level.
- The ramp slope should contrast visually with landing surfaces to highlight the change in place to people with visual difficulties.
- Tactile hazard warning surfaces should not be used on ramps as they are not designed for this purpose.

Approved Document M (England) 2015, Approved Document K (England) 2013:

- Ramps are to be avoided where possible and not used on principle routes. Where used, gradients should not be steeper than 1:15 (0.66%).
- The ramp surface should be of a color that contrasts visually with that of the landings.

Handrails

Required - ADA (505)

A handrail provides a means of support and guidance for building users. Handrail will help most people going up or down a flight of steps or a ramp. Handrails shall be provided on both sides of stairs and ramps.

As a minimum, handrails must provide:

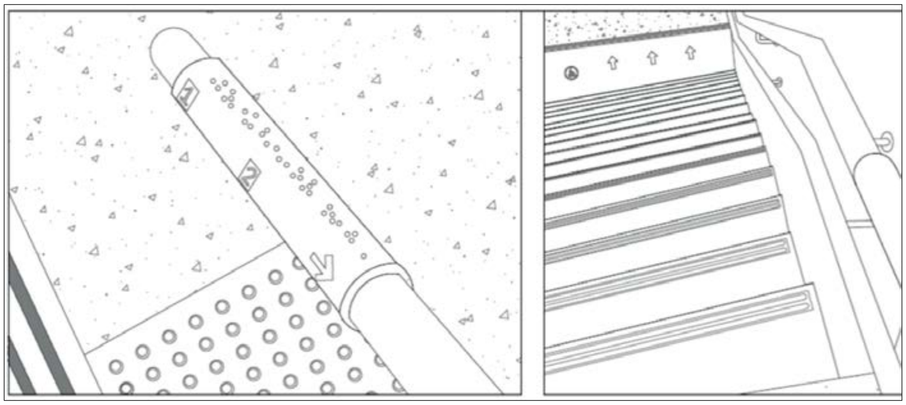
- A continuous gripping surface;
- Be located at least 1½ inches from adjacent wall;
- Compliant cross sections;
- Have a smooth surface that provides adequate resistance to hand slippage.

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

Visual and tactile information

- Provide visual contrast of a handrail to the adjacent background, e.g. a wall.
- If raised text or tactile symbols are provided, it should be unobtrusively and permanently fitted or fixed to handrails as an important source of information for people who have a vision impairment, e.g. indication of floor number, direction of fire evacuation, etc.
- The tactile information shall be short and easy to understand. Directional information can include arrows.



Examples of visual and tactile information on handrails

Technical Guidance Document M (Ireland) 2010 and *Building for Everyone: A Universal Design Approach* (Ireland) 2012:

- Where the surface of the adjacent wall is rough, the clearance should be 75mm (3 inches); where it is smooth, the clearance may be 60mm (2.5 inches).
- If a central handrail is used (stairs with width greater than 2000mm), care should be taken, perhaps using floor color or textures as a warning, to make them obvious both visually and audibly (when walked on) to prevent collision with the center handrail.

Elevators, LULA's and Lifts

Required - ADA (407 & 408)

Passenger elevators that are part of an accessible route should comply with the requirements for elevators stated in the accessibility standards.

The minimum elevator car dimension and the minimum clear width at elevators doors vary depending on the use of the building and shall at least provide space for a person using a wheelchair and a companion.

Note: Massachusetts requires a handrail on at least one wall of the elevator.

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

- Ensure the color and tone of the lift entrance contrasts with the surrounding wall finishes.

- Consider providing a distinguishable floor surface of approximately 1500 mm (60 inches) × 1500 mm (60 inches) outside the elevator or lift doors.
- In complex buildings or wide halls, provide a tactile walking surface indicator to facilitate the location of an elevator or lift entrance and guide to the call button.
- In case of a car size where a wheelchair user cannot turn around, install a mirror to enable the user to observe obstacles behind when moving backwards out of the car. If a glass mirror is used it shall be made of safety glass.
- If any wall of the car is substantially mirrored or covered with a reflective surface, measures shall be taken to avoid creating optical confusion e.g., by means of decorated glass, or a minimum vertical distance of 300 mm (12 inches) between the floor and the bottom edge of the mirror.

Dubai Universal Design Code 2017:

- Lights should be installed only on the ceiling to provide a uniform illumination of a minimum of 100 lux.

Accessible Elevator Dubai Universal Design Code

Approved Document M (England) 2015 and *Inclusive Design Standards* (England) 2019:

- Elevators and lifts are to be located directly adjacent to the principle circulation stairs or escalators
- Elevators and lifts should be easy to find and have lift or elevator doors that contrast visually with the adjoining wall in all light conditions
- People using or waiting for a lift need audible and visual information to tell them that a lift or elevator has arrived, which floor it has reached, what lift has arrived and where in a bank of lifts or elevators it is located.
- The use of visually and acoustically reflective wall surfaces can cause discomfort for people with vision impairment.
- On glass doors and walls there should be permanent contrasting manifestations at two levels, within 850mm (35 inches) to 1000mm (40 inches) from the floor and within 1400mm (55 inches) to 1600mm (63 inches) from the floor.

Doors and Doorways

Required - ADA (404)

When doors and doorways are part of the accessible routes they should provide a minimum clear width of 32 inches. Projections into the required clear opening width between 34 inches and 80 inches above the finished floor shall not exceed 4 inches. The minimum opening force to pushing or pulling open an interior door should not exceed 5 pounds of force to operate.

Doors that are part of an accessible route are required to have minimum maneuvering clearances on both sides of the door. Maneuvering clearances are specified accord to the direction of approach, swing of doors and in some cases the presence of a latch or a closer. Ensure the maneuvering clearance is free of protrusion the full height of the door.

Handles, pull, latches, locks and other operable parts on doors should not require tight grasping, pinching or twisting of the wrist.

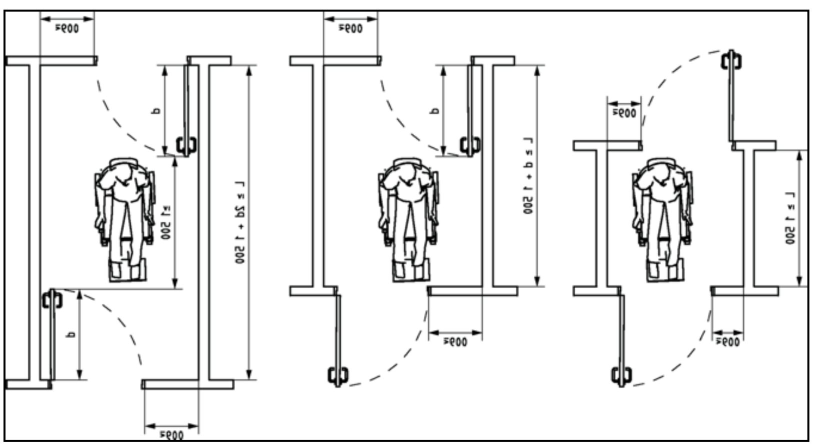
Thresholds on doors should be ½ inch height. ¾ inches is permitted for existing buildings if they are beveled on each side with a slope not steeper than 1:2.

Note: Massachusetts requires exterior doors to have a maximum opening force of 15 pounds.

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO):

- Doors forming part of an accessible path of travel shall have a luminance contrast to doorframe and the surrounding wall.
- The minimum width of the area of visual contrast shall be 50 mm (inches). If this is not possible to achieve, provide a marking of at least 50 mm (2 inches) width (e.g. around the frame of the door), with a different visual contrast from the wall surrounding all the perimeter of the door;
- Provide a visual contrast between the door leaf and the handle with their background.
- Door locks, door handles, bells and other devices for gaining entry to a place shall be easy to locate, identify, reach and use, and shall be operable with only one hand. D-lever handles are preferred.
- The minimum unobstructed maneuvering space between doors in an entrance lobby shall not be less than 1500 mm (60 inches) free of the door swing.



Maneuvering Clearance at Doors in series

Approved Document M (England) 2015 and Inclusive Design Standards (England) 2019:

- Bi-fold and manual sliding doors are not to be used.

Technical Guidance Document M (Ireland) 2010 and *Building for Everyone: A Universal Design Approach* (Ireland) 2012:

- Doors consist of a frameless glass should be clearly defined with permanent manifestation on the glass, within two zones, from 850mm (34 inches) to 1000mm (40 inches) and from 1400mm (55 inches) to 1600mm (63 inches) above the floor, contrasting visually with the background seen through the glass (from inside and outside) in all lighting conditions.

- The edges of a glass door should be apparent when the door is open.
- If a glass door is adjacent to, or is incorporated within, a fully glazed wall or glazed screen, the door and wall or screen should be clearly differentiated from one another, with the door being more prominent (e.g. framed with a high contrast).
- The direction of opening doors into rooms should, wherever possible, be consistent throughout a building.
- Where doors have a lock, the lock should be positioned above the handle and a recommended 72mm vertical distance from the level handle to keyhole so that the latter is clearly visible and unobstructed.
- Highly reflective finger plates (on push doors) should be avoided as they may appear to be a vision panel and thereby cause confusion.

Viewing Lights

Required - ADA (404.2.11)

When side lights adjacent to doors or gates, containing one or more glazing panels that permit viewing through the panels it shall have the bottom of at least one glazed panel located 43 inches maximum above the finished floor.

Additional Accessible and/or Inclusive Design Recommendations to Consider

<u>International Standards Organization (ISO) 2020:</u>

Viewing panels in door leaves:

If viewing panels are provided, they shall comply with the following:

- Locate the lower edge of the glazed panel 600 mm (24 inches) maximum above floor level.
- Locate the upper edge of the glazed panel 1600 mm (63 inches) maximum above floor level.
- In width, the glazed panel shall start no more than 200 mm (8 inches) from the latch edge of the door, and the glazing shall not be less than 150 mm wide (6 inches).

<u>Approved Document K (England) 2013 and Inclusive Design Standards (England) 2019:</u>

In critical locations, glazing should comply with one of the following:

- Ensure that glazing, if it breaks, will break safely.
- Choose glazing that is one of the following: robust or in small panes.
- Permanently protect glazing.

Manifestation of Glazing.

- Critical Locations include large uninterrupted areas of transparent glazing which form, or are part of, the internal or external walls and doors of offices, showrooms, etc.
- The risk of collision is greatest when two parts of a building, or the building and its immediate surroundings, are at the same level but separated by transparent glazing and people may think they can walk from one part to the other.

Provide glass doors and glazed screens with all of the following:

- Manifestation at two levels.
- Manifestation that contrasts visually with the background seen through the glass, from inside and outside, in all lighting conditions.
- Manifestation in the form of a logo or sign, a min of 150 mm (6 inches) high, or a decorative feature such as broken lines or continuous bands, a min of 50mm (2 inches) high.
- Where glazed doors are beside or part of a glazed screen, they are clearly marked with a high-contrast strip at the top and both sides.
- Where glass doors may be held open, they are protected with guarding to prevent people colliding with the leading edge.
- It is important that designs and glazing types recognize the need to avoid glare from the sun and reflections from artificial lighting.

<u>Technical Guidance Document M (Ireland) 2010 and *Building for Everyone: A Universal Design Approach* (Ireland) 2012:</u>

- If a door has multiple viewing panels, the min zone of visibility should not be interrupted by opaque areas that obstruct more than 350mm (14 inches) of the vertical height of the zone. Rationale: this allows people to see another person approaching the door in the other direction to avoid collision.
- Where a door or fixed panel is mostly glazed or comprises a single pane of glass, it should incorporate permanent markings.
- The markings should contrast visually with the background surfaces viewed through the door in both directions and in all lighting conditions.
- The use of two-tone markings often improves visibility.
- Where doors comprise a glazed or other panel that is of a similar material to the adjacent wall, they should be highlighted with a contrasting color frame, decorative feature or other means.

Windows

Required – ADA (229)

Where windows are provided for operation by occupants they should have hardware that is operable with one hand and do not require tight grasping, pinching, or twisting of the wrist. The force required to activate the operable part at a window should be 5 pounds maximum.

Interior Rooms

Reception Areas

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

- Locate reception desks in areas that are clearly identified to be easily recognizable from a building entrance.
- Provide carpets or entrance flooring systems or tactile walking surface indicators that can help in locating reception counters for people who have a vision impairment.
- Consider design requirements for color and visual contrast.

Employee Work Areas

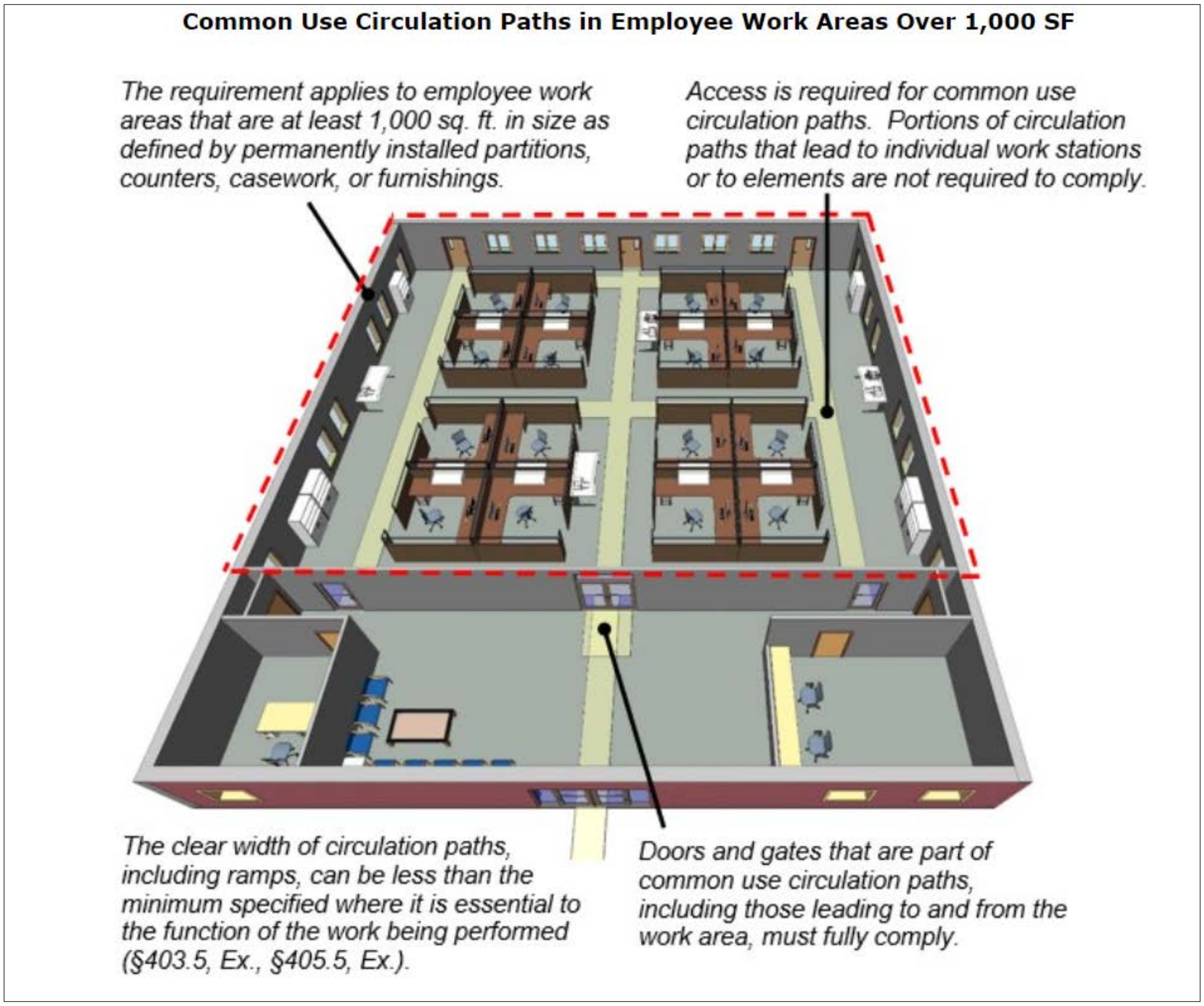
Required - ADA (203.9)

Areas used by employees for work are not required to be fully accessible but it is recommended such areas include accessible elements when possible. Employees with disabilities are entitled to reasonable accommodations in the workplace. Accommodations can include alterations to spaces within the facility. Designing employee work areas to be more accessible at the outset will eliminate or reduce the need for more costly retrofits in providing reasonable accommodations for employees with disabilities.

Designing employee work areas to be more accessible will eliminate or reduce the need for more costly retrofits in providing reasonable accommodations for employees with disabilities.

As a minimum, employee work areas must be designed to provide:

- Access for approach, entry and exit;
- Door maneuvering clearance outside the work area;
- Clear floor space 30 inches min. by 48 inches min. inside;
- Compliant door (clear width, hardware, etc.);
- Accessible circulation paths (see interior circulation route).



Additional Accessible and/or Inclusive Design Recommendations to Consider

Built Environment Guidelines for the Kingdom of Saudi Arabia 2010:

- Fans, lights and other devices should not, or should not be located so that they do not, create background or ambient noise that can interfere with hearing and communication.

Building for Everyone: A Universal Design Approach (Ireland) 2012:

- Individual areas within an office that require or would benefit from a quiet environment, such as a meeting room or an interview area, should be located away from external sources of noise.
- The internal layout of an office can also be used to advantage to separate quiet work areas from potentially noisy facilities, such as refreshment areas.
- The size and shape of individual rooms and the acoustic performance of the building fabric and its furnishings can all influence the acoustic environment and should be tailored to suit the requirements of the particular workplace or room.

Work Surfaces

Required - ADA (226)

Work surfaces used only by employees for work are not covered by the Standards. Consider work surfaces that are flexible and permit installation at variable heights and clearances. As a minimum, ensure work surfaces are between 28 inches and 34 inches.

Toilet Rooms

Required - ADA (213)

Where toilet rooms are provided they should be accessible and comply with the applicable standards.

Additional Accessible and/or Inclusive Design Recommendations to Consider

Built Environment Guidelines for the Kingdom of Saudi Arabia 2010:

- A toilet facility should incorporate even illumination throughout of at least 200 lux.
- Door handles and locking mechanisms should incorporate pronounced color contrast, to differentiate them form the stall door. Grab bars should incorporate pronounced color contrast, to differentiate them from the surface they are mounted on. Toilet fixtures should incorporate pronounced color contrast, to differentiate

them from the background environment. The emergency call button or pull cord, flush controls, toilet paper dispensers and ablution hoses, should incorporate color contrast, to differentiate them from the background environment.
- There should be color contrast between wall, lavatory, grab bars, faucet and wall, soap-dispenser, towel-dispenser, towel-disposal, hand-dryer units.
- Accessible toilets should be equipped with an emergency call button or pull cord. A waterproof emergency call button or pull cord should be provided adjacent to the accessible toilet fixture. The emergency call button or pull cord should activate a bell or other signaling device, that is monitored from a location within the facility.

Technical Guidance Document M (Ireland) 2010 and *Building for Everyone: A Universal Design Approach* (Ireland) 2012:

- Mirrors should be positioned where they will not cause confusion by seeming to distort the size or configuration of a room.
- Full-height mirrors should be avoided as they may be perceived as a wall opening.
- In an accessible toilet, if the soap and paper towel dispensers are positioned correctly directly above the washbasin, a mirror is recommended to be positioned on the wall opposite the washbasin.
- Bins with lids should be easy to operate and bins should contrast visually with the surrounding surfaces.
- Hand dryers should be provided in close association with lavatories.
- Mirrors should be positioned where they will not cause confusion by seeming to distort the size or configuration of a room.
- Full-height mirrors should be avoided as they may be perceived as a wall opening.
- Trash cans with lids should be easy to operate and should contrast visually with the surrounding surfaces.

Approved Document M (England) 2015 Inclusive Design Standards (England) 2019:

- Timed lighting systems should not be used.

Electrical and Environmental Elements

Required - ADA (205)

Compliance is required for operable parts located in accessible spaces and along accessible routes. Operable parts include light switches, electrical and communication receptacles, thermostats, alarm pulls, automatic door controls, and other elements used by facility occupants.

Operable parts should not require tight grasping, pinching or twisting of the wrist. Operable parts should be mounted between 15 inches and 48 inches above the finished floor or ground.

Additional Accessible and/or Inclusive Design Recommendations to Consider

Dubai Universal Design Code 2017:

- Light switch controls and electric outlets shall be installed between 900 mm (36 inches) and 1200 mm (47 inches) Height and be located a minimum of 600 mm (24 inches) from any corner.
- The switch plate shall present at least a contrast of 30 points Light Reflectance Value (LRV) in relation with the surrounding wall.

Approved Document M (England) 2015:

- A consistent relationship with doorways and corners will further reinforce the ease with which people manipulate switches and controls.
- All users should be able to locate a control, know which setting it is on and use it without inadvertently changing its setting.

Technical Guidance Document M (Ireland) 2010 and *Building for Everyone: A Universal Design Approach* (Ireland) 2012:

- People should never have to move through an unlit area in order to locate a light switch. In many cases this will require use of two- or three-way switching.
- Where a switch is not available in a color that contrasts with its surroundings, colored margins, which are capable of providing the necessary contrast, are available for some of the more common switch types, such as lights or sockets.
- Multi-gang switches should be avoided wherever possible as the plethora of switches can be confusing.
- Any visual information associated with a switch or control, such as instructions or a reference, should be provided in the form of a pictogram and should be embossed to enable tactile reading.
- Switches on inclined surfaces are generally easier to operate than those on vertical surfaces. Inclined surfaces should be tilted up by 15 degrees.

Orientation and Information

Signs

Required - ADA (703)

Signs should be legible for people with vision or cognitive impairments. Exterior and interior signs identifying permanent rooms shall provide the information with raised characters duplicated in braille. Signs should be located on the latch side of the door; a clear floor space should be provided outside the swing of the door.

Also, see Wayfinding Report.

Lighting

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

Due to the increase of optical scatter in the eye, the effects of glare are exacerbated for elderly people and for individuals with some types of vision impairments (e.g. cataracts, corneal edema, and vitreous opacities). Glare can cause discomfort and interfere with task performance by decreasing the perceived contrast in visual displays (i.e. disability glare).

- The routes to and around a building shall have sufficient artificial lighting to facilitate awareness of changes of level or gradient. The positioning of lights should not cause glare, reflection or shadows. Ramps, entrances, steps, signage, etc., should be well lit artificially, with an illuminance of at least 100 lx.
- Lighting should not produce glare. Glare and shadows can be avoided by shielding or shading light sources; by use of indirect lighting, by avoiding placing of windows at the end of corridors.
- Ensure interior lighting provides visual conditions consistent with the visual task, e.g. the perception of hazards, signs, elements for orientation, interpretation of sign language, etc.
- Ensure artificial lighting gives good color rendering. Light sources with a color rendering index Ra > 80 are recommended.
- Good artificial lighting is crucial for everyone, ensuring that people with limited vision can use buildings safely and conveniently, and that people with hearing impairments can lip read.

Built Environment Guidelines for the Kingdom of Saudi Arabia 2010:

- Illumination: Pedestrian entrances should be evenly illuminated to a minimum 150 lux at its exterior.
- Illumination Transition: Immediately inside the entrance door there should be an illumination transition zone where people with visual impairments are able to adjust from a bright outdoors to a more dimly lit interior. The transition zone should have a level of illumination that averages the general exterior and interior levels at the entrance.
- Illumination: Offices, work areas and meeting rooms should incorporate even illumination throughout the space of at least 100 lux. Where reading is required, or may occur, task lighting with a minimum of 200 lux should be provided.
- Interior Lighting Fixtures: Light sources and fixtures should be selected to minimize direct glare or indirect glare on nearby reflective surfaces.
- Interior Illumination Properties: Light sources should provide as full a spectrum of light as possible, as an aid to edge and color definition. Lighting should be configured to create an even distribution at floor level and to minimize pools of light and areas of shadow.
- Offices: No less than 200 lux, measured at table height. Lighting in meeting rooms should be capable of being adjusted (e.g., dimmers).
- Meeting Rooms: Lighting in assembly areas should be capable of being adjusted (e.g., dimmers).

Dubai Universal Design Code 2017:

- Corridors: The average minimum illumination is 100 lux calculated at floor level, with a minimum value of 60 lux.

Approved Document M (England) 2015 and Inclusive Design Standards (England) 2019:

- In main circulation routes, entrance/exit points and places where people may be expected to interact with others, light will be important at both low level to indicate pathways/routes and at higher level to allow people's faces to be clearly lit and identified.
- Natural and artificial lighting in a corridor should be even, diffused and without glare, reflections or shadows.
- Transitional lighting should be provided between areas of lighting level changes to allow people's eyes to adapt to the different levels.

Technical Guidance Document M (Ireland) 2010 and *Building for Everyone: A Universal Design Approach* (Ireland) 2012:

- Light should not cast shadows on steps or across ramps as this may mask change sin level and present a hazard.

Acoustics

Additional Accessible and/or Inclusive Design Recommendations to Consider

International Standards Organization (ISO) 2020:

- The acoustic environment in a building should be suitable for all its users, particularly persons with vision impairments who rely on acoustic information for orientation.

Dubai Universal Design Code 2017:

- Rooms shall be designed with sound absorbing surfaces to reduce the transference of noise.
- Floor finishes, wall surfaces and ceilings should be selected so that occasional noise is not unduly amplified. (e.g., Hard surfaces such as marble or terrazzo will allow each foot step to be heard by people who are visually impaired, but add another level of confusion for people who are hearing impaired).
- At accessible routes in large facilities where way-finding is problematic, the sound transmission/reflection characteristics of finish materials should aurally differentiate major and secondary paths of travel.
- Ceiling shapes should be designed so that echoes do not occur, unless an alternate acoustical treatment is incorporated. (Note: domed shapes tend to distort sound).
- In meeting rooms and assembly areas where the spoken word is key to comprehending the proceedings, all unnecessary background noise (e.g., from fans or other mechanical equipment, air diffusers, etc.) should be dampened and/or the room should include adequate sound insulation.

Approved Document M (England) 2015 and Inclusive Design Standards (England) 2019:

- Good acoustic design should be employed to achieve an acoustic environment that is neither too reverberant nor too absorbent so that announcements and conversations can be heard clearly.
- The design of the acoustic system should ensure that audible information can be heard clearly.
- Poor acoustics cause confusion and make it difficult to use sound as a navigational aid.

- Provide noise reduction where communication will be important.
- Provide adequate sound insulation to minimize intrusive noise, both from outside and within the building.
- Separate noisy and quiet areas of buildings with a buffer zone.
- Room materials should contribute to a desirable acoustic environment.

Building for Everyone: A Universal Design Approach (Ireland) 2012:

- Rooms in a building that benefit from a quiet location, such as individual offices should be located away from external noise sources.
- Within a building, quieter areas can be buffered from potentially noisier areas with the use of lobbies, screens, or other rooms.
- Within each room, good acoustic design can be achieved by ensuring a low level of background noise coupled with an optimum reverberation time for sound generated within the room.
- In general, larger spaces have longer reverberation times than smaller spaces. Therefore, a large space will require more absorption to achieve the same reverberation time as a smaller space.
- Hard surfaces, such as concrete, brick, plaster, and timber, all reflect sound and will contribute to the creation of reverberant, potentially noisy, and echoing internal environment.
- Softer surfaces, such as carpets, curtains, mineral fiber suspending ceiling tiles, and upholstery, will tend to absorb sound and therefore contribute to a quieter internal environment from floor surfaces.
- For people with visual difficulties, audible clues within an environment can aid navigation and wayfinding, but they need to be clear and not masked by excessive reverberation or echo.
- A good acoustic environment is one in which the level of background noise is low and the reverberation time is suitable for the size and purpose of the space.

Surface Materials

Additional Accessible and/or Inclusive Design Recommendations to Consider General

Approved Document M (England) 2015 and Inclusive Design Standards (England) 2019:

Appropriate choice of floor, wall and ceiling surface materials and finishes can help people with vision impairment appreciate the boundaries of rooms or spaces, identify access routes, and receive information. (i.e. glare and reflection from shiny surfaces and large repeated patterns should be avoided).

Floor Finishes

- Floor surface finishes with patterns that could be mistaken for steps or changes of level are avoided.
- Glossy or highly polished materials are not to be used as they can appear wet and therefore slippery, they can also cause reflective glare that can confuse people.
- Matting and carpets to have a shallow, dense and non-directional pile.
- Large or repeating patterns should not be used if they involve bold and contrasting colors, including step prints.
- Attention should be given to flooring details at changes in level.

<u>Inclusive Design Standards (England) 2019:</u>

Visual Contrast

- In order to facilitate orientation and ensure the safe use of the built environment visual contrast is to be provided between adjacent surfaces to highlight potential hazards and to promote the legibility of graphical information.
- The perception of visual contrast is improved with better lighting conditions; note that reflection and glare from shiny surfaces may reduce visual contrast and create visual confusion for some groups of people.
- For large surface areas where lux level is greater than 200 lux, then at least 20 points difference in Light Reflectance Value (LRV) between building elements is acceptable. For all other lighting conditions at least 30 points difference is required.
- The minimum difference in the LRV should be achieved and maintained throughout the life of the building elements and in all conditions (e.g., wet and dry). Deterioration and maintenance shall be considered at specification.

Other Accommodations

Relief facilities for guide and assistance dogs

Additional Accessible and/or Inclusive Design Recommendations to Consider

<u>International Standards Organization (ISO) 2020:</u>

A relief facility for guide and assistance dogs should be provided near any building where a guide or assistance dog owner is employed.

A secure area should be provided close to the building for use as a dog relief facility. The dog relief area should be at least 3000 mm (10 feet) × 4000 mm (14 feet) with a 1200 mm (47 inches) high secure fence. The entrance gate to the enclosed area should have an easy to operate and secure catch. It is recommended to provide a waste bin and a supply of plastic bags, close to the entrance. An accessible sign in braille and large print saying “For service dogs only” should be displayed. The area should be cleaned regularly and well maintained.

Refreshment Facilities

Additional Accessible and/or Inclusive Design Recommendations to Consider

Inclusive Design Standards (England) 2019:

- Furniture should have rounded corners to prevent injury from sharp corners.
- Furniture should contrast visually with the surrounding.

References

2010 ADA Standards for Accessible Design.

Massachusetts Architectural Access Board 521 CMR.

2019 California Building Code.

International Standards Organization (ISO) 2020 — Accessibility and usability of the built environment.

ISO -Assistive products for blind and vision-impaired persons — Tactile walking surface indicators 2019.

Dubai Universal Design Code 2017.

Universal Accessibility Built Environment Guidelines for the Kingdom of Saudi Arabia 2010.

Approved Document M: Access to and use of buildings Volume 2 – Buildings Other Than Dwellings 2015 Edition, England (The Building Regulations 2010).

Approved Document B: Fire Safety Volume 2: Buildings other than dwellings 2019 Edition The Building Regulations (England) 2010.

Approved Document K: Protection from falling, collision and impact 2013 Edition The Building Regulations (England) 2010.

Inclusive Design Standards Global Disability Innovation Hub, Queen Elizabeth Olympic Park, London Legacy Development Corporation (England) May 2019.

Ireland Technical Guidance Document M: Access and Use (The Building Regulations 2010).

Building for Everyone: A Universal Design Approach. National Disability Authority and Center for Excellence in Universal Design (Ireland) 2012.

Glossary

Access

Approach, entry or exit.

Accessible

Describes programs and physical spaces that are accessible to and usable by people with disabilities and complying with the accessibility requirements of federal accessibility standards and state accessibility codes.

Access Aisle

A parking access aisle must be on an accessible route and be five feet wide minimum for cars and eight feet wide minimum. Two accessible parking spaces may share an access aisle. Access aisles must be level with surface slopes and not exceeding 1:50 (2%) in all directions. The access aisles must be clearly striped. A passenger loading zone requires a 60 inch wide access aisle to be the full length of the vehicle and clearly marked. There can be no changes in level between the access aisle and the pull-up space.

Accessible Means of Egress

A continuous and unobstructed way of exiting from any point in a building or facility that provides an accessible route to an area of refuge, a horizontal exit, or a public way.

Accessible Route

A continuous, unobstructed path connecting all accessible elements and spaces of a building or facility. Interior accessible routes may include corridors, floors, ramps, elevators, lifts, and clear floor space at fixtures. Exterior accessible routes may include parking-access aisles, curb ramps, crosswalks at vehicular ways, walks, ramps, and lifts. The width of an accessible route must be 36 inches min. Accessible routes shall coincide with or be located in the same area as general circulation paths. Where circulation paths are interior, required accessible routes shall also be interior.

(ADA) Americans with Disabilities Act of 1990, as Amended

This federal law, based on the 1964 Civil Rights Act, prohibits discrimination and stipulates equal participation for people with disabilities in employment, state and local government, public accommodations, commercial facilities, transportation, and telecommunications.

ADA Coordinator

This is the designated employee responsible for coordinating the efforts of the government entity to comply with ADA title II, and investigating any complaints that the entity has violated Title II. Also called “Accessibility Coordinator” or “504 Coordinator” (for entities receiving federal funds who must comply with Section 504 of the Rehabilitation Act).

ADA Notice

The obligation of a state and local government and recipients of federal funds to publicly communicate to the public their commitment to comply with the American with Disabilities Act (ADA).

Adaptability

The ability of certain building spaces and elements, such as vending machine, counters, restrooms, gates, and grab bars, to be added or altered to accommodate the needs of people with or without functional limitations or to accommodate the needs of persons with different types or degrees of disability.

Administrative Authority

A governmental agency that adopts or enforces regulations for the design, construction, or alteration of buildings, facilities, vehicles.

Alteration

A change to a building or facility that affects or could affect the usability of the building or facility or portion thereof. Alterations include, but are not limited to, remodeling, renovation, rehabilitation, reconstruction, historic restoration, resurfacing of circulation paths or vehicular ways, changes or rearrangement of the structural parts or elements, and changes or rearrangement in the plan configuration of walls and full-height partitions. Normal maintenance, reroofing, painting or wallpapering, or changes to mechanical and electrical systems are not alterations unless they affect the usability of the building or facility.

Ambient Light

The light that is already present in a space, before any additional lighting is added. It usually refers to natural light, either outdoors or coming through windows as well as light reflected from all surfaces in that space. It can also mean artificial lights such as normal room lights.

Area of Rescue Assistance/Areas of Refuge

An area, which has direct access to an exit or an area adjacent to an exit discharge, where people who are unable to use stairs or are unable to travel more than 100 feet to a public way may remain temporarily in safety to await further instructions or assistance during emergency evacuation.

Assistive Listening

A technology in which a transmitter broadcasts the wanted sound and minimizes background noise and reverberation to the user's receiver and improves the volume and clarity of speech and other sound relative to noise.

Assistive Listening Device (ALD)

An audio enhancement system that brings sound directly into the ear of someone with hearing limitations (people with or without hearing aid(s)/cochlear implant(s)). It helps to overcome the problems of distance and surrounding noise. Refer to ADA 2010 Standards to determine the number of ALDs that must be hearing-aid compatible:

http://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm#pgfId-1010597

Assistive Listening Systems (ALS)

An amplification system utilizing transmitters, receivers, and coupling devices to bypass the acoustical space between a sound source and a listener by means of audio loop, radio frequency, infrared, or direct-wired equipment.

Assistive Technology

Devices used by people with disabilities - including physical, sensory, or cognitive limitations -- in order to perform functions that might otherwise be difficult or impossible. Assistive technology can include mobility devices such as walkers, scooters, and wheelchairs, as well as hardware, software, and peripherals that assist people in increasing, maintaining, or improving functional capacities.

Audio Loop (Induction Loop)

Device that uses electromagnetic waves for transmission of sound. The sound from an amplifier is fed into a wire loop at customer information kiosks or ticketing windows, which broadcasts to a telecoil that serves as a receiver. Those with a telecoil can hear automatically. Those using hearing aids without a telecoil can use a special induction receiver to pick up the sound.

Automatic Door

A door equipped with a power operated mechanism and controls, which open and close the door automatically. The switch that begins the automatic cycle may be a photoelectric device, floor mat, or manual switch (see power assisted door).

Auxiliary Aids and Services

Services and equipment that provide persons with sensory or speech disabilities equal opportunity to participate in and enjoy the benefits of programs or activities. The following examples are not exhaustive.

- assistance filling out forms
- assistive listening system
- audio recordings
- Braille materials
- open or closed captioning
- communication boards
- computer-aided real-time transcription
- description of visually presented materials
- large print materials
- note takers
- qualified interpreters
- remote video interpreting
- screen readers
- Skype or other web-enabled video
- speech synthesizers
- telephone handset amplifiers
- text messaging
- text telephones (TTYs)

Addition

An expansion, extension, or increase in the gross floor area or height of a building or facility.

Area of sports activity

That portion of a room or space where the play or practice of a sport occurs.

Assembly area

A building or facility, or portion thereof, used for the purpose of entertainment, educational or civic gatherings, or similar purposes. Assembly areas include, but are not limited to, classrooms, lecture halls, public meeting rooms, public hearing rooms, auditoria, or stadiums.

Blended Transitions

Blended transitions are raised pedestrian street crossings, depressed corners, or similar connections between the pedestrian access route at the level of the sidewalk and the level of the pedestrian street crossing that have a grade of 5 percent or less. Blended transitions have a slope of less than 5%; because they are not ramps, they needn't have a perpendicular relationship with the street.

Braille

A system of touch reading and writing for blind persons, in which raised dots represent the letters of the alphabet. Braille also contains equivalents for punctuation marks and provides symbols to show letter groupings.

Building

Any structure used or intended for supporting or sheltering any use or occupancy.

Cane-detectable Barrier

A barrier used to warn blind or low-vision people of a hazard. The barrier is equal to or less than 27 inches detectable by cane users before they reach the obstruction or hazard with their bodies.

Captioning (Open)

Open captioning translates the audio portion of a video or film program into visible subtitles in real time. Viewing does not require special equipment; captions are present on the screen at all times.

CART - Computer Assisted Real-Time Transcription

A service in which an operator transcribes verbal communication into a computer that displays the typed words on a screen (either a computer screen for one person or a large screen for a group).

Catch Pool

A pool or designated section of a pool used as a terminus for water slide flumes.

Characters

Letters, numbers, punctuation marks and typographic symbols.

Clear Floor Space

The minimum unobstructed floor or ground space required to accommodate a single, stationary wheelchair. The dimensions of the clear floor space must be 30 inches min. by 48 inches min.

Closed-Circuit Telephone

A telephone with a dedicated line such as a house phone, courtesy phone or phone that must be used to gain entry to a facility.

Circulation Path

An exterior or interior way of passage provided for pedestrian travel, including but not limited to walks, hallways, courtyards, elevators, platform lifts, ramps, stairways, and landings.

Common Use

Interior or exterior circulation paths, rooms, spaces, or elements that are not for public use and are made available for the shared use of two or more people.

Color Contrast

A significant contrast in color between the foreground and the background of an element, i.e.., light on a dark background or dark on a light background (70% contrast between characters and the background is considered an appropriate contrast for people with low vision).

Cross Slope

The slope that is perpendicular to the direction of pedestrian travel (running slope). For the cross slope of an accessible route, the maximum cross slope allowed is 1:50.

Curb Ramp

A short ramp cutting through a curb.

Detectable Warning

A standardized textured surface with a pattern of truncated domes built in or applied to walking surfaces or other elements that warn of hazards on a circulation path, such as track crossings, platforms, and curb cuts.

Detention Facilities and Correction Facilities

Buildings, facilities, or portions thereof, in which people are detained for penal or correction purposes. Detention facilities include, but are not limited to, jails, detention centers, and holding cells in police stations. Correctional facilities include, but are not limited to, prisons, reformatories, and correctional centers.

Disability/Individual with a Disability

The ADA defines a person with a disability as physical, sensory or mental impairment that substantially limits one or more major life activities, has a record of such a condition, or is regarded as having such a condition. The ADA also makes it unlawful to discriminate against a person based on that person's association with a person with a disability.
https://adata.org/faq/what-definition-disability-under-ada

Effective Communication

A practice in which written, spoken, and visual information is clear and understandable to people with disabilities as it is for people who do not have a disability. This applies to private and public entities. Public entities have an additional obligation to give primary consideration to the individual's choice when determining what is "effective."

Egress, Means of

A continuous and unobstructed path of travel from any point in a building or structure to a public way and consisting of three separate and distinct parts: (a) the exit access, (b) the exit, and (c) the exit discharge. A means of egress comprises the vertical and horizontal means of travel and shall include intervening room spaces, doorways, hallways, corridors, passageways, balconies, ramps, stairs, enclosures, lobbies, horizontal exits, courts and yards.

Element

An architectural or mechanical component of a building, facility, space, or site.

Elevated Play Component

A play component that is approached above or below grade and that is part of a composite play structure consisting of two or more play components attached or functionally linked to create an integrated unit providing more than one play activity.

Employee Work Area

Areas within any kind of employment setting used exclusively by employees. All or any portion of a space used by employees and used only for work. Corridors, toilet rooms, kitchenettes and break rooms are not employee work areas.

Entrance

Any access point to a building or portion of a building or facility used for the purpose of entering. An entrance includes the approach walk, the vertical access leading to the entrance platform, the entrance platform itself, vestibule if provided, the entry door or gate, and the hardware of the entry door or gate.

Equivalent Facilitation

Use of designs, products, or technologies as alternatives to those prescribed, provided they result in substantially equivalent or greater accessibility and usability.

Existing Facility

A physical structure in existence on any given date, regardless of whether the building has been in place for a period of time, is newly constructed, or has been altered.

Facility

Any or all portion(s) of buildings, structures, sites, complexes, equipment, rolling stock or other conveyances, roads, walks, passageways, parking lots, or other real or personal property, including the site where the building, property, structure, or equipment is located.

Fundamental Alteration

A change that is so significant that it alters the essential nature of the goods, services, facilities, privileges, advantages, or accommodations offered.

Grievance Procedures

A formal system for making and resolving complaints of disability discrimination (by employees or anyone who uses an organization's programs, services, or activities) in a prompt and fair manner, required by those with responsibilities under Section 504 of the Rehabilitation Act and the Americans with Disabilities Act.

Ground Level Play Component

A play component that is approached and exited at the ground level.

Handrails

A rail serving as a support or guard along walking surfaces, stairs, ramp, platforms. They are required to be on both sides of stairs or ramps. For stairs, they must be 34 to 38 inches above stair nosings. For ramps, handrails must be provided in pairs with one 34 to 38 inches measured vertically from the surface of the ramp to the handrail. The lower one is between 18 and 20 inches. They should be continuous within the full length of each stair flight or ramp run. Inside handrails on switchback or dogleg stairs or ramps must be continuous between flights or runs.

Handrail Extensions

Handrail gripping surfaces are required to extend beyond and in the same direction of stair flights and ramp runs a distance of 12 inches long minimum.

Impracticable/Impracticability

(a) Compliance with codes and requirements would be technologically infeasible; or

(b) Compliance with codes and requirements would result in excessive and unreasonable costs without any substantial benefit to persons with disabilities.

Inclusive Design

A framework for the design of places, things, information, communication, and policy to be usable by the widest range of people operating in the widest range of situations, without special or separate design.

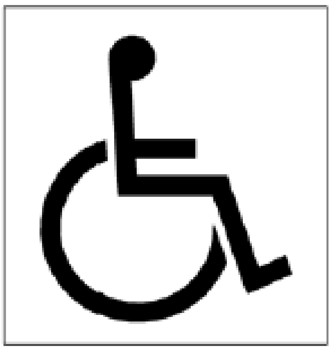
Integrated Setting

An integrated setting enables people with disabilities to interact with nondisabled persons to the fullest extent possible. Separate programs are permitted where necessary to ensure equal opportunity. A separate program must be appropriate to the particular individual.

International Symbol of Accessibility (ISA)

Icon indicating building features that is suitable for people with disabilities. The ADA Standards of 2010 require that a standard icon only be used where it is required. Standards issued under the ADA require that the ISA label certain accessible elements, spaces, including parking spaces, entrances, and toilet rooms.

The symbol and its background must have a non-glare finish. The symbol shall contrast with its background with either a light symbol on a dark background or a dark symbol on a light background.



International Symbol of Accessibility (ISA)

International Symbol of Access for Hearing Loss

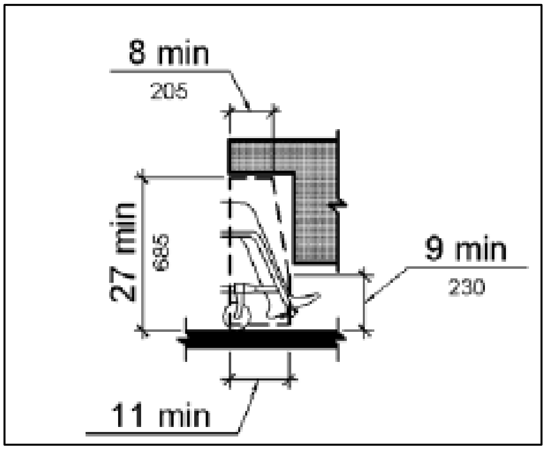
Icon indicating the availability of an assistive listening system in the building. The ADA Standards of 2010 require that a standard icon only be used where it is required.

The symbol and its background must have a non-glare finish. The symbol shall contrast with its background with either a light symbol on a dark background or a dark symbol on a light background.

International Symbol of Access for Hearing Loss

Knee Clearance

Minimum required height under an element (e.g. work surface, lavatory, dining surface) that allows a person in a wheelchair to sit at the element. The height must be 27 inches min.



Large Print

A sans serif font (e.g., Arial, Helvetica) and type size (minimum 18 - 20 points) commonly used by people with visual impairments or who are legally blind.

Level Landing

Level landings are required at the top and bottom of each ramp run. Changes in level greater than 1:50 are not permitted at landings. Landings must be designed to prevent the accumulation of water.

Light Reflectance Value (LRV)

The proportion of visible light reflected by a surface at all wavelengths and directions when illuminated by a light source. LRV is also known as the luminance reflectance factor. The LRV is expressed on a scale of 0 to 100, with a value of 0 for pure black and a value of 100 for pure white.

Mail Boxes

Receptacles for the receipt of documents, packages, or other deliverable matter. Mail boxes include, but are not limited to, post office boxes and receptacles provided by commercial mail-receiving agencies, apartment facilities, or schools.

Maintenance of Accessible Features

The requirement that certain features of facilities and equipment be readily accessible to and usable by persons with disabilities and be kept in operable working condition. Accessible features cannot be reversed. This does not prohibit isolated or temporary interruptions in service or access due to maintenance of accessible features and/or repairs.

Major Life Activity

Activities that an average person can perform with little or no difficulty, including functions such as caring for oneself, performing manual tasks, walking, seeing, hearing, speaking, breathing, learning, working, and bodily functions. The ADA Amendments Act of 2008 clarified that major life activities also include major bodily functions.

Maneuvering Clearance

Minimum clear floor area that must be provided on both sides of doors and gates.

Marked Crossing

A crosswalk or other identified path intended for pedestrian use in crossing a vehicular way.

Maximum Extent Feasible

When a public entity undertakes an alteration to an existing facility that could affect the usability of the facility, the alteration must be made accessible to the maximum extent feasible.

Mezzanine

An intermediate level or levels between the floor and ceiling of any story with an aggregate floor area of not more than one-third of the area of the room or space in which the level or levels are located. Mezzanines have sufficient elevation that space for human occupancy can be provided on the floor below.

Modification of Policies and Procedures

Changes to existing policies and procedures to accommodate the needs of people with disabilities and ensure equal access to all goods, services, and activities offered to others.

Multiple Chemical Sensitivity

A condition in which people have extreme sensitivity to low-level everyday chemicals (e.g., solvents, cleaning products, and volatile organic compounds [VOCs). Individual tolerances vary, but the condition can be disabling.

Occupant Load

The number of persons for which the means of egress of a building or portion of a building is designed.

Operable Part

A component of an element used to insert or withdraw objects, or to activate, deactivate, or adjust the element. Any maintenance which does not affect structure, egress, fire protection systems, fire ratings, energy conservation provisions, plumbing, sanitary, gas, electrical or other utilities.

Other Power-Driven Mobility Devices (OPDMD)

"A mobility device powered by batteries, fuel, or other engines… that is used by individuals with mobility disabilities for the purpose of locomotion, including golf carts, electronic personal assistance mobility devices… such as the Segway® Personal Transporter, or any mobility device designed to operate in areas without defined pedestrian routes, but that is not a wheelchair."

Path of Travel

A continuous, unobstructed pedestrian route for reaching, entering, or exiting a destination within a building that connects to the external path of travel including sidewalks, streets, and parking areas.

Pictogram

A pictorial symbol that represents activities, facilities, or concepts.

Power-assisted Door

A door with a mechanism that helps to open the door or that reduces the opening resistance of a door, upon the activation of a switch or a continued force applied to the door itself.

Primary Function Area

A major activity for which the facility is intended. Areas that contain a primary function include, but are not limited to: the customer services lobby, ticketing, platforms or boarding areas.

Program Accessibility

The extent to which programs and activities as well as services and benefits are readily accessible to and usable by persons with disabilities when each type is viewed in its entirety.

Protruding Objects

Objects that extend into circulation path from the side or from posts, or objects that overhang circulation paths and do not provide clear headroom. Objects with a leading edge more than 27” above the finished floor and not more than 80” above the finished floor or ground should not extend more than 4” horizontally into the circulation path. An unprotected area underneath stairways is also a protruding object.

Public Entrance

An entrance that is not a service entrance or a restricted entrance.

Public Right of Way

Public land or property, usually in interconnected corridors, that is acquired for or dedicated to transportation purposes.

Public Use

Interior or exterior rooms, spaces, or elements that are made available to the public. Public use may be provided at a building or facility that is privately or publicly owned.

Qualified Historic Building or Facility

A building or facility that is listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law.

Qualified Interpreters

Sign Language Interpreter

> A person who is trained in American Sign Language (ASL) or other visually interactive language that uses a combination of hand motions, body gestures, and facial expressions. Specially trained people perform sign language interpretation. There are several different types of sign language including American Sign Language and Signed English.

Oral Interpreter

> Interpreters specially trained to articulate speech silently and clearly, sometimes rephrasing words or phrases to give higher visibility on the lips. Natural body language and gestures are also used. Not all people who are deaf or hard of hearing are trained in

sign language. Some are trained in speech reading (lip reading) and can understand spoken words more clearly with assistance from an oral interpreter.

Cued Speech Interpreter

A cued speech interpreter functions in the same manner as an oral interpreter except that he or she also uses a hand code, or cue, to represent each speech sound.

Qualified Reader

A person who is able to read effectively, accurately, and impartially for a person with a disability using any necessary specialized vocabulary.

Ramp

A walking surface that has a running slope greater than 1:20 (5%) but no greater than or equal to 1:12 (8.33%).

Reach Range

Maximum and minimum allowed height to reach an element.

Restricted Entrance

An entrance that is made available for common use on a controlled basis but not public use and that is not a service entrance.

Running Slope

The slope that is parallel to the direction of travel.

Safe Harbor

A provision within ADA 2010 Standards that clarifies that an entity that has met previous federal design standards for accessible design does not need to update to the ADA 2010 Standards unless there is an alteration to the facility.

Screen Reader

A computer program that speaks written text and allows a person to listen to the written text on a webpage or in a computer program. Screen readers read only text; they cannot describe pictures or other images, including images that are pictures of text.

Self-Service Storage

Building or facility designed and used for the purpose of renting or leasing individual storage spaces to customers for the purpose of storing and removing personal property on a self-service basis.

Service Animal

Any dog that is individually trained to do work or perform tasks for the benefit of an individual with physical, sensory, or brain-based functional limitations (disabilities). Other species of animals, whether wild or domestic, trained or untrained, are not service animals under the ADA. Note that miniature horses are not considered service animals, but an individual may request a reasonable modification to use a miniature horse in some circumstances.

Service Entrance

An entrance intended primarily for delivery of goods or services.

Shared Use Path

The term “shared use path" means a multi-use trail or other path, physically separated from motorized vehicular traffic by an open space or barrier, either within a highway right-of-way or within an independent right-of-way, and usable for transportation purposes. Shared use paths may be used by pedestrians, bicyclists, skaters, equestrians, and other nonmotorized users including motorized and manual wheelchairs.

Sidewalk

A paved walk within a street right of way.

Signage

Displayed audio, symbolic, tactile, and/or pictorial information.

Designation

Interior and exterior signs identifying permanent rooms and spaces. (E.g. restrooms, room numbers and room names)

Directional and Informational

Signs that provide direction to or information about interior spaces and facilities of the site

Egress

See Designation, and Directional, and Informational.

Site

A parcel of land bounded by a property line, or a designated portion of a public right of way.

Space

A definable area, such as a room, toilet room, hall, assembly area, entrance, storage room, alcove, courtyard, or lobby.

Story

That portion of a building or facility designed for human occupancy included between the upper surface of a floor and upper surface of the floor or roof next above. A story containing one or more mezzanines has more than one floor level.

Structural Change

Structural change includes major reconstruction of walls or partitions or relocation of load bearing walls or partitions. Minor alterations including the opening of sections of walls and/or the relocation of equipment or fixtures may not be considered a structural change.

Tactile

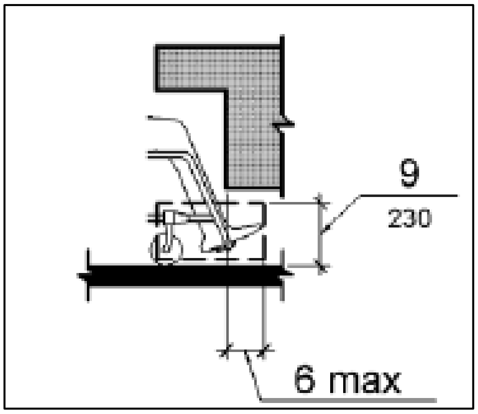
An object or sign that can be perceived using the sense of touch.

Technical Infeasibility

With respect to an alteration of a building or a facility, something that has little likelihood of being accomplished because existing structural conditions would require removing or altering a load-bearing member that is an essential part of the structural frame; or because other existing physical or site constraints prohibit modification or addition of elements, spaces, or features that are in full and strict compliance with the minimum requirements.

Toe Clearance

Space under an element between the finished floor or ground and 9 inches above the finished floor or ground.



TTY

An abbreviation for teletypewriter. Machinery that employs interactive text-based communication through the transmission of coded signals across the telephone network. TTYs may include, for example, devices known as TDDs (telecommunication display devices or telecommunication devices for deaf persons) or computers with special modems. TTYs are also called text telephones.

Transfer System

Platforms, steps and supports that allow a person who uses a wheelchair or a mobility device to access an elevated play component.

Transfer Device

Equipment designed to facilitate the transfer of a person from a wheelchair or other mobility aid to and from an amusement ride seat.

Unassisted Access

Unassisted access enables a person with a disability to obtain information about and to maneuver a path of travel independently and without the assistance of another person, except at those points and under those conditions under which individuals without disabilities would be in need of assistance from another person.

Undue Burden

This term applies to a potential limitation to the obligation of program accessibility and means significant difficulty or expense.

Universal Design

See Inclusive Design.

User/Expert

Anyone with lived experience of functional limitation who has developed natural experience in dealing with the challenges of our physical, information, communication, policy, and attitudinal/social environments.

Use Zone

The ground level area beneath and immediately adjacent to a play structure or play equipment that is designated for unrestricted circulation around the play equipment and where it is predicted that a user would land when falling from or exiting the play equipment.

Variance

Formal request for a modification of or substitution for compliance with a code, standard, regulation, or policy.

Vehicular Way

A route intended for vehicular traffic, such as a streets and driveways. Accessible routes must not overlap the vehicular way.

Vertical Clearance

Vertical clearance must be 80 inches high minimum. Guardrails or other barriers shall be provided where the vertical clearance is less than 80 inches high. The leading edge of such guardrail or barrier shall be located 27 inches maximum above the finish floor or ground. Door closers and door stops may be permitted to be 78 inches (1980 mm) minimum above the finish floor or ground.

Video Remote Interpreting (VRI)

An interpreting service that uses video conference technology over dedicated lines or wireless technology offering high-speed, wide-bandwidth video connection that delivers high-quality video images. This is an efficient option for short conversations with people who use American Sign Language when the content and length of the exchange doesn't warrant hiring an interpreter or when an interpreter cannot be procured.

Walk (Walkway)

An interior or exterior path of travel with a paved surface intended for pedestrian use, including but not limited to general pedestrian areas such as sidewalks, plazas, courts and crosswalks.

Wayfinding

What people consider, understand, and do in order to find their way from one place to another. It is the result of a complex process involving vision, hearing, cognition, sensory perception, experience, expectations, decision-making, and other factors.

Wayfinding means:

- Knowing where you are
- Knowing your destination
- Knowing and following an effective route
- Recognizing your destination
- Finding your way to your next destination or back to your starting point

Wayfinding System

People are able to find their way through complex facilities as a result of environmental design features, operational policies and practices, and their own behavior. These three components – design, operations, and behavior – comprise a wayfinding system.

Wheelchair

A manually operated or power-driven mobility aid designed primarily for use by a person with a mobility limitation for the main purpose of indoor, or both indoor and outdoor use.

Wheelchair Space

Space for a single wheelchair and its occupant.

Work Area Equipment

Any machine, instrument, engine, motor, pump, conveyor, or other apparatus used to perform work. As used in this document, this term shall apply only to equipment that is permanently installed or built-in in employee work areas. Work area equipment does not include passenger elevators and other accessible means of vertical transportation.

Acronyms

MAAB – Massachusetts Architectural Access Board

A regulatory agency within the Massachusetts Office of Public Safety. The nine-person board was established under state law, M.G.L. Chapter 22, Section 13A. Its legislative mandate states that it shall develop and enforce regulations designed to make public buildings accessible to, functional for, and safe for use by persons with disabilities. It enforces regulations governing building accessibility, reviews complaints and requests for waivers, and provides training and technical assistance on accessibility issues.

ADA - Americans with Disabilities Act of 1990, as Amended

This federal law, based on the 1964 Civil Rights Act, prohibits discrimination and stipulates equal participation for people with disabilities in employment, state and local government, public accommodations, commercial facilities, transportation, and telecommunications.

ALD - Assistive Listening Device

An audio enhancement system that brings sound directly into the ear of someone with hearing limitations (people with or without hearing aid(s)/cochlear implant(s)). It helps to overcome the problems of distance and surrounding noise.

ALS - Assistive Listening Systems

An amplification system utilizing transmitters, receivers, and coupling devices to bypass the acoustical space between a sound source and a listener by means of audio loop, radio frequency, infrared, or direct-wired equipment.

ASL – American Sign Language

A visually interactive language that uses a combination of hand motions, body gestures, and facial expressions. Specially trained people perform sign language interpretation. There are several different types of sign language, including American Sign Language and Signed English.

ASTMF

American Society for Testing and Materials.

ASTM F 1292-99 Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment (see 1008.2.6.2).

ASTM F 1292-04 Standard Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment (see 1008.2.6.2).

ASTM F 1487-01 Standard Consumer Safety Performance Specification for Playground Equipment for Public Use (see 106.5).

ASTM F 1951-99 Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment (see 1008.2.6.1).

(PAR) – Pedestrian Access Route

A pedestrian access route is a continuous and unobstructed path of travel provided for pedestrians with disabilities within or coinciding with a pedestrian circulation path in the public right-of-way.

PROW – Public Rights of Way and Shared Use Paths (from US Access Board)

New design guidelines developed by the US Access Board will cover access to public rights -of -way, including sidewalks, intersections, street crossings, and on-street parking. The Board is also addressing access to shared-use paths providing off-road means of transportation and recreation.

Inclusive Design of Workplaces for People who are Low Vision or Blind

September 2020

Institute for Human Centered Design

IHCD is in the process of making all footnotes accessible please contact us for a revised copy.

Table of Contents

Introduction

Huge numbers of people globally (1.3 billion) and nationally (7.6 million) live with a vision disability.[1] The ability to navigate safely and independently is an essential component of their lives.[2] Thus, design-related wayfinding issues and features for people with low vision cannot necessarily be separated from other inclusive design issues and features that affect this population, but it can frame them usefully.

There is a great deal of global source material about wayfinding in general and wayfinding for people with vision disabilities, including research and guidance. Much of this information focuses on micro-level details, such as font sizes and sign locations, rather than on macro-level information, such as how elements of a wayfinding system fit together. In this report, we have done our best to strike a balance between the macro and the micro.[3]

Much as we would have liked to include or address every detail and every source, this was not possible given the project's time and budget parameters. Additional examinations of this material would be a potentially fruitful next step.

Context

- Low vision
- Vision loss increases with age; the world's population is aging at a rapid rate
- Vision limitations vary – one size does not fit all
- ADA signage standards do not address the needs of the low-vision population
- Accessibility is not the same as inclusive design
- Orientation & Mobility (O & M) training
- The physical environment can enable or impede independent navigation
- Wayfinding
- A wayfinding system

[1] We will use various terms, intended to be synonymous, to refer to people with "vision limitations," including "vision disabilities," "low vision," "blind and low vision," "blind and partially sighted individuals," and others.
[2] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[3] We viewed guidance from the International Standards Organization, Saudi Arabia, Dubai, the United Kingdom, and Ireland. Some of this material reiterated what we already knew or found in other sources, and some contributed to this report. However, we neither spent time reconciling disparities among these international guidelines nor making a case for why we did not agree with some of it (such as some recommendations for color coding).

Low vision

- Low vision is characterized by vision that is no longer correctable by glasses, contact lens, surgery, or medication.
- Low vision is severe enough to cause difficulty with the ability to complete daily living tasks.
- Vision impairment occurs from age; injury, such as traumatic brain injuries experienced by war veterans; or disease.
- Different diseases affect different parts of the visual system and cause different patterns of vision loss, which result in different functional deficits and accommodative needs.[4]
- Making spaces navigable by people with vision loss makes them more navigable by everyone.

Vision loss increases with age; the world's population is aging at a rapid rate

- The need to address accommodation of people with low vision in all building types increases as the population ages.[5] According to the website Design for Sight, by interior designer Erin Schambureck[6]:

  3.4% of the population has a vision disability (United States Census Bureau 2010). This includes as many as 6.9% of people over age 65. This roughly equates to 2.5 million people over 65 with low vision. By 2030 there will be more people over age 65 than under age 17. As our population ages there will be larger numbers of people with low vision who have difficulty navigating public transportation, healthcare facilities, and public buildings unless designers can take a more sensitive approach to low vision issues in the visual environment.

Vision limitations vary – one size does not fit all

- "Low vision" is a designation that includes people with diverse abilities and needs. Thus, not every person with low vision will find every wayfinding recommendation in this report useful or relevant to him or her.
- While blindness may be apparent to others, on account of accompany service animals and the use of white canes, low vision may be a non-apparent functional limitation.
- Most people who are legally blind have some degree of sight. Thus, they can partially rely on sight to navigate. People with vision loss also use textures and sound to navigate.[7] Three (of the many) types of vision limitations to be aware of:

[4] National Institute for Building Sciences (2015) Design Guidelines for the Visual Environment, Version 6, p.6.
[5] National Institute for Building Sciences (2015) Design Guidelines for the Visual Environment, Version 6.
[6] https://www.designforsight.com

Colorblindness[8]

Colorblindness involves an individual's inability to see colors or contrasts properly. This problem affects around 4.5% of the population. When designing spaces that apply to colorblind people, understand the different types of colorblindness. The most common type of colorblindness is red/green colorblindness, which involves the inability to differentiate between different hues of red and green. Some people suffer from blue/yellow colorblindness, which makes blues and yellows indistinguishable, while a minority of people with colorblindness will be unable to distinguish colors at all.

Compromised depth perception[9]

Because they find it difficult to judge distances, people with compromised depth perception have trouble perceiving where surfaces change levels, whether on walkway floors or at countertop levels. This condition happens most frequently when one eye is damaged or lost. The brain can adjust to improve depth perception through one eye, but these individuals may still find level changes challenging to negotiate.

Reduced visual field[10]

A reduced visual field means that a person has trouble seeing at the periphery, or outer edges, of their field of vision. It can also mean that the person's two eyes don't function as a team, sending conflicting images to the brain and resulting in blurry, overlapping, or indistinct images. This can make it difficult for someone with reduced peripheral vision to anticipate obstacles or moving hazards.

Other vision limitations

Other vision limitations include diabetic retinopathy, glaucoma, cataracts, macular degeneration, and hemianopsia[11]

Deafblind

Some people are both deaf and blind.[12]

ADA signage standards do not address the needs of the low-vision population

- According to the National Institute for Building Sciences, and Aries Arditi, PhD of Visibility Metrics, LLC, "While accommodating some needs of people who are blind, the

[7] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[8] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[9] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[10] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[11] https://www.sciencedirect.com/science/article/abs/pii/S0169814111000631
[12] https://www.economist.com/christmas-specials/2018/12/18/the-rise-of-buildings-for-the-deaf-and-blind

current ADA (Americans with Disabilities Act) and ICC (International Code Council) Standards fall far short of addressing the needs of people with low vision.”[13] [14]

- According to Dr. Arditi, “The requirements that address low vision, however, are inconsistent and lack rationale and empirical support. Moreover, they fail to ensure accessibility, as standards should, since sign illumination, contrast, and finish are incompletely or poorly specified. For signs that are critical for wayfinding, such as directional signs, the requirements eithr fail to enhance low-vision accessibility at all or do so only insignificantly.[15]
- According to Marsha Mazz, Director of Accessibility Codes & Standards, of the United Spinal Association, “Most people who have low vision or blindness aren’t helped by tactile signs required by the ADA.” She knows no one who reads braille signs, “They only tell you where you are, not where you’re going.” [16]

Figure 1. This ADA-compliant men's toilet room sign has good contrast, universal symbols for men, and the International Symbol of Accessibility, as well as braille and raised lettering. A person with some vision may be able to stand close enough to read it. Experts argue that the braille and raised lettering are not widely used by people with vision disabilities.

Accessibility is not the same as inclusive design

- We use the term “accessibility” to refer to compliance with codes and standards, including the Americans with Disabilities Act.
- Inclusive design is design that works for the widest spectrum of users without the need for specialized adaptation. It centers around the user experience with a focus on social sustainability. IHCD uses the World Health Organization’s Definition of Disability

[13] National Institute for Building Sciences (2015) Design Guidelines for the Visual Environment, Version 6.
[14] Arditi, A. (2017). Rethinking ADA signage standards for low-vision accessibility. Journal of Vision, 17(5), 8-8.
[15] Arditi, A. (2017). Rethinking ADA signage standards for low-vision accessibility. Journal of Vision, 17(5), 8-8.
[16] Interview with IHCD, Aug. 4, 2020.

as the foundation for our consulting and research work in the field and in our user/expert lab. We believe that good design must work not only for as many users as possible, but also enhance everyone's experience. [17] [18]

Orientation & Mobility (O & M) training

- O & M helps people who are blind or visually impaired recognize where they are and know how they are going to get to their intended location. Combined with good wayfinding abilities, O & M involves sensory awareness, the space between objects, finding items/places and using canes to navigate/detect obstacles.[19]

The physical environment can enable or impede independent navigation

- While treatment of low vision and other visual disorders are medical issues, assuring optimal access to the built environment for persons with visual impairments is a design issue.[20]

Wayfinding[21]

- Wayfinding means knowing where you are, knowing the name of your destination, finding an effective route, recognizing your destination, and finding your way to your next destination or back to your starting point.
- Wayfinding involves both brain and body. Depending on the individual's own abilities and limitations, it may involve seeing, hearing, thinking, remembering, moving on foot or in a wheeled mobility aid, moving in a vehicle, etc.
- Wayfinding is influenced by past experience and expectations.
- Wayfinding is not the same as signage, although the two terms are often (incorrectly) used synonymously.

A wayfinding system[22] [23]

- The abilities of customers to find their way to, around, and out of all types of exterior and interior environments is influenced by a wayfinding system comprising design elements, operational elements, and user behavior:

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[17] https://www.humancentereddesign.org
[18] https://www.designforsight.com
[19] https://www.right-hear.com/wayfinding-and-technology-helping-the-blind-and-visually-impaired-navigate-the-world/
[20] National Institute for Building Sciences (2015) Design Guidelines for the Visual Environment, Version 6.
[21] Carpman, J. R., & Grant, M. A. (2016). *Design that cares: Planning health facilities for patients and visitors*. John Wiley & Sons.
[22] Carpman, J. R. Working Paper: Inclusive Wayfinding: System Elements, Guidelines, Best Practices, IHCD 2020.
[23] Carpman, J. R., & Grant, M. A. (2016). *Design that cares: Planning health facilities for patients and visitors*. John Wiley & Sons.

- **Wayfinding design elements** include architecture; interior design; horizontal and vertical circulation; landmarks; views; lighting; features for people with functional limitations, such as tactile maps; exterior and interior, static and digital signs and maps; environmental graphics, etc.
- **Wayfinding operational elements**[24] include terminology, spoken directions, written directions, staff training, wayfinding element updating and maintenance, etc.
- **Wayfinding design and operational elements**[25] include technology (website wayfinding content, apps, etc.); marketing collateral; attention to the needs and preferences of people with functional limitations, such as making websites accessible; etc.
- **User wayfinding behavior**[26] includes deciphering wayfinding words and numbers, comprehending spatial layouts, reading maps, following signs, recognizing landmarks, asking and remembering directions, using wayfinding technology, and following particular (but not always clearly communicated) expectations for wayfinding behavior.

[24] It is easy to underestimate the importance of wayfinding operational elements, but they are an essential component of an effective wayfinding system.
[25] See Wayfinding-related Elements that Contribute to Interior Wayfinding Ease for People with Vision Limitations: Design and Operations, later in this report, for a list of apps that can be used for wayfinding by people with vision disabilities.
[26] Carpman, J. R., & Grant, M. A. (2012). Directional Sense: How to find your way around. Institute for Human Centered Design.

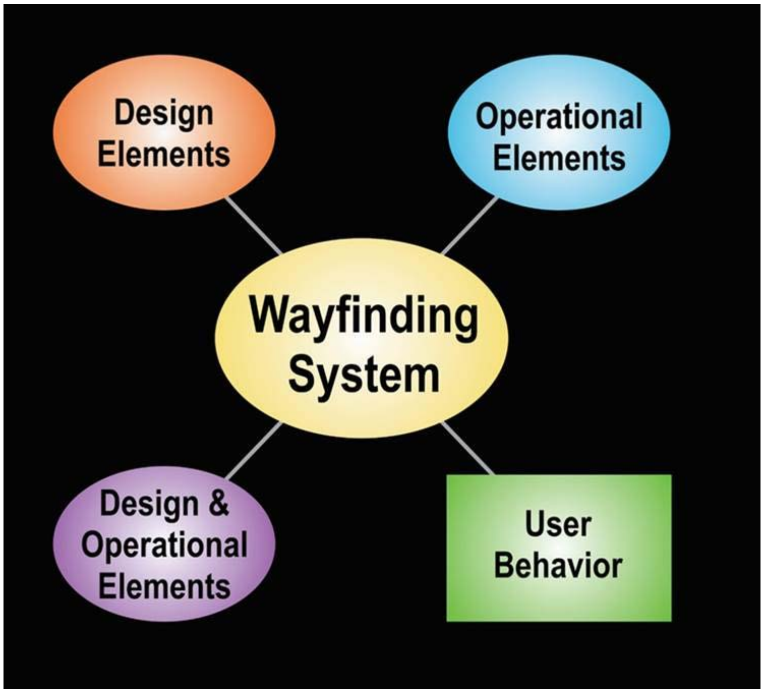

Figure 2. Elements of a wayfinding system. Source: Carpman Grant Associates, Wayfinding Consultants.

- When these wayfinding elements work together to provide all users (regardless of familiarity; directional challenges; age; culture; or functional limitations) with the accurate, legible, audible, consistent wayfinding information they need; where and when they need it; using wording and messages they can understand and follow; the likelihood is that they will be able to find their way with relative ease. This is what we call a "successful" wayfinding system.
- Although it is often said that a wayfinding system should be *intuitive*,[27] this is almost never the case. Users need to learn their way around places and facilities and be guided by a wayfinding system of design, operational, and design + operational elements.[28]
- Once someone has learned their way around a complex environment, wayfinding becomes internalized and second nature to them. As a result, they often find it difficult to understand how first time or unfamiliar users can *not* know their way around or why they become disoriented. This failure of wayfinding empathy on the part of decision-makers may also extend to people with low vision, who need certain types of wayfinding cues, including high contrast, large font sizes, and the like.
- *Predictability* is critical to wayfinding ease for everyone, and especially for people with low vision.[29] An environment can become predictable as a result of the user's own

[27] For example, see Inclusive Design Standards UK 2019.
[28] See more about how people come to "know" their way around in Carpman, J. R., & Grant, M. A. (2012). *Directional Sense: How to find your way around*. Institute for Human Centered Design.

effort and experience. He or she may have experienced it before and learned to navigate it over time. He or she may have experienced other similar facilities and can generalize from those.

- People who plan, design, and manage wayfinding systems also play a part in creating places where people can get from here to there with some degree of ease. They must juggle user needs, preferences, and behavior, along with myriad planning and design issues and details. Aesthetics, internal politics, budget requirements, and as well as ongoing management and maintenance are additional concerns, as are applicable standards, regulations, and codes.
- An inclusive wayfinding system goes beyond accessibility mandates and works for all users, regardless of age, ability, or culture.

Best Practices in Inclusive Wayfinding Planning & Design[30]

- Focus on customers
- Develop a comprehensive wayfinding system
- Include essential wayfinding elements
- Follow principles of effective wayfinding system planning
- Use environmental design to support wayfinding ease
- Attend to wayfinding design details

Focus on customers

Design for inclusion

- Make sure fixed and digital wayfinding elements are considered, planned, designed, coordinated, implemented, updated, and maintained with diverse customers in mind, including people of all ages, abilities, and cultures.[31]
- Follow the most recent, applicable standards, codes, regulations, research literature, articles, websites, and best practices with regard to wayfinding for all.

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[29] Marsha Mazz, Director of Accessibility Codes & Standards, of the United Spinal Association, interviewed by IHCD Aug. 4, 2020.
[30] Carpman, J. R. Working Paper: Inclusive Wayfinding: System Elements, Guidelines, Best Practices, IHCD 2020.
[31] These may include elements beyond those required for compliance with ADA Standards, MAAB Rules & Regulations, and local codes, such as apps, wayfinding information on accessible websites, tactile maps, tactile models, large-print maps, specialized maps (e.g. Showing noisy areas), detectable warnings, large- font signs, audible information that is slower and clearer than usual, interpreters, human guides, etc.

- Understand that functional limitations may be non-apparent.
- Make accessible routes legible to all customers.

Consider unfamiliar users

- Design the wayfinding system for unfamiliar users. Some people will be first-timers, some will not have used the system for a period of time and have forgotten how to navigate it, and some will still feel unfamiliar, even though they have used the system multiple times. Renovations and changes tend to make users feel unfamiliar, even if they once knew an area or facility well.

Recognize that wayfinding behaviors are often imperfect

- Users, including those with vision disabilities, do not necessarily understand layouts, make sense of numbering systems, follow signs perfectly, remember landmarks or directions, or use wayfinding technology as intended. Thus, wayfinding elements need to be planned, designed, and maintained with imperfect wayfinding behaviors in mind. The wayfinding system needs to accommodate people who follow the wrong route or who end up in the wrong place on the wrong floor in the wrong building.
- Wayfinding cues, including signage need to anticipate that there may be more than one route to a given destination. Some users may choose the quickest route, others may choose a route that passes by a meaningful place, while others may choose a scenic route.

Seek evidence-based wayfinding guidelines

- Wayfinding guidelines that grow out of a body of objective, empirical research that is well designed and carried out are more likely to be widely applicable and useful over time, than are those based only on personal experience or intuition.

Encourage effective wayfinding behavior

- Plan and design a wayfinding system that lets users know where they are, enables them to follow an effective route to their destination, makes their destinations recognizable, and allows them to recover from navigation mistakes, reverse the route, or continue on to another destination.[32]
- Unfamiliar users will not know about certain behaviors that are expected of them. For instance, when visiting an outpatient clinic, they may be expected to register first, online, by phone, or in person. When traveling by train, passengers may be expected to purchase and validate their ticket before boarding. It is important to provide

[32] Our working definition of "wayfinding." See Carpman, J. R., & Grant, M. A. (2016). *Design that cares: Planning health facilities for patients and visitors*. John Wiley & Sons.

unfamiliar users with clear information, in multiple formats, about what they need to do (and how they need to do it) in order to use a given facility.

Engage with User/Experts

- Systematically engage with user/experts (people with lived experience of functional limitations) to review the wayfinding system in existing sites and facilities and give feedback on facility design and wayfinding system planning throughout the design process.

Develop a comprehensive wayfinding system

Make use of inclusive planning & design expertise

- Consult with inclusive wayfinding experts to plan, design, review, and oversee implementation of wayfinding system elements.

Customize wayfinding planning for each unique project

- Use the particulars of a given project, such as climate, location, site, building type and design, users (ages, cultures, abilities, tasks), project goals, corporate history and culture, standards, regulations, and codes, budget, and other factors, to influence wayfinding system planning and design.

Make the wayfinding system accurate, consistent, predictable, and clear

- Make sure wayfinding information is accurate and consistent.
- Make every aspect of the wayfinding system consistent in wording, numbering, logic, appearance, etc. throughout the site and facilities.
- Locate wayfinding information at exterior and interior decision-points and design it consistently, so unfamiliar users know what information to expect and where to expect it.
- Use widely understandable numbering, wording, and icons. Keep wayfinding messages as short as possible. Spell and punctuate correctly.

Integrate wayfinding system elements

- Integrate all fixed and digital, visual, and audible wayfinding design, operational, and design + operational elements.

Plan for ongoing, wayfinding system management & maintenance

- Plan for ongoing, proactive evaluation, management, and maintenance of the wayfinding system.
- Plan for inclusive wayfinding along temporary pathways, as needed during maintenance or construction projects.

Include essential wayfinding system elements

Know how to communicate with fixed signage

- Use the best, most effective sign type (fixed or digital; directional, identification, information, etc.) for a given purpose.
- Provide complete directional signage trails all the way from each point of origin to each corresponding destination.[33] Identify destinations. Users who follow directional signs expect them to lead to the destinations listed. Make sure that no destinations are dropped along the way.

Use digital signage and audio to reinforce wayfinding messaging

- Fixed signage, digital signage, and audio announcements (if used) should be accurate, clear, and consistent. (Make sure audio announcements easily audible to a majority of users.)

Understand the utility of maps

- Maps are important wayfinding elements that show the user's location in relation to the surrounding environment. Whether fixed (You-Are-Here maps, Emergency Egress maps), paper (handout maps), digital (website maps, app maps), tactile, or in other formats; when well designed, located, and correctly oriented, maps are an effective tool to help users know where they are and find their way to their destinations.

Make use of landmarks

- Landmarks help distinguish one place from another or make one particular spot stand out.
- Unique, memorable, thoughtfully located landmarks are an inclusive wayfinding element - appreciated and used by everyone, including children, people who don't speak English as a first language, people with vision limitations, and people who self-identify as directionally challenged.
- Exterior and interior landmarks are useful wayfinding elements that offer opportunities to incorporate artwork, greenery and plants, and other unusual visual features into a wayfinding system.

[33] The number and placement of signs and other wayfinding elements along a path/trail will vary with features of the site and facility. Wayfinding information is needed at "decision-points" and periodically along long pathways. These are known as "reinforcement" signs.

Recognize the importance of staff direction-giving

- Some unfamiliar customers prefer to ask and receive directions from human beings rather than using fixed or digital wayfinding aids. And for other people, circumstances may necessitate asking directions.
- Staff need their own orientation and training in how best to offer directions to users (and fellow staff).

Incorporate (ever-changing) wayfinding technology

- Wayfinding technology from apps to websites, AI (artificial intelligence) to AV (autonomous vehicles), and more that are in development or remain to be developed, will continue to play a role in how people navigate.
- Consider building in charging stations and additional electrical outlets for personal devices (containing wayfinding apps).
- Consider what future technology might look like and how it can be accommodated.

Follow principles of effective wayfinding system planning

Use widely understandable logic

- The logic of entrances, horizontal and vertical circulation, location of key destinations (including restrooms), floor numbering, room numbering, etc. must be made clear to unfamiliar users through wayfinding signs, maps, spoken directions, apps, etc.
- Use a hierarchy of wayfinding information from general to specific.

Make wayfinding elements legible

- Make sure wayfinding elements and the information they contain are visible, unambiguous, readable, and understandable up close and from a distance.
- Select fonts clear enough and large enough for everyone to read.
- Use icons that are widely understood. Make them large enough for everyone to read.[34]
- Use sufficient contrast (at least 70%) between messages and backgrounds, and between signs (or other wayfinding elements) and backgrounds.
- For most messages, use mixed case, which is more legible than all uppercase or all lowercase letters.
- Avoid blocking or obstructing views to wayfinding information.
- If there are elevators, make sure call buttons and cab buttons are easy to see and understand.

[34] Make thoughtful use of the ISA – International Symbol of Accessibility. Avoid using it to indicate elevators (there are separate icons for those).

Attend to wording and symbols on signs, maps, and other wayfinding system elements[35]

- Use wording that is accurate, short, easy to understand by most users, easy to pronounce, and unique.
- Avoid wording that uses acronyms or abbreviations, is misleading or confusing, uses jargon, uses euphemisms, has double meaning, or includes donor names (unless necessary).
- Use wording consistently.
- Consider creating messaging in languages other than English, as needed
- If symbols or icons are used on wayfinding elements, they should be "evident, culturally universal, not counterintuitive."[36]

Provide the right information, in the right place, at the right time

- Horizontal circulation: Locate wayfinding information at decision-points. Provide reassurance signs along lengthy pathways.
- Vertical circulation: Locate wayfinding information before and after changes in level, including at ramps, stairs, elevator lobbies, and elevator cabs. Carefully determine the type of needed information for particular points in the user's journey, such as floor number, directory, directional sign, and/or You-Are-Here maps.
- Locate wayfinding information perpendicular to the flow of foot (and vehicular) traffic. Wayfinding information is most useful when it faces the person navigating.
- Whenever possible, locate information in "consistent and approachable locations so that those with reduced acuity may view them at close distance."[37]
- Locate wayfinding information within the accepted "cone of vision:" not too high and not too low. Avoid locating wayfinding information on the floor or ground.

Build in some intentional redundancy

- Make wayfinding information available in multiple, integrated formats. User preferences vary with regard to the formats of signs, maps, apps, websites, landmarks, spoken directions, etc. Functional limitations may play a role in determining which formats are most useful. Preferences may also vary depending on personal circumstances and situations, time of day, season, etc.

Minimize wayfinding distractions

- Since wayfinding takes a great deal of attention, anything that compromises that attention will be detrimental. Numerous factors can distract from wayfinding, but

[35] Carpman Grant Associates, Wayfinding Consultants, Wayfinding Masterplan for Indiana University Health, 2012.
[36] Saudi 2010 Destinations-Guidelines, p. 130.
[37] Arditi, A. (2017) Rethinking ADA signage standards for low-vision accessibility. *Journal of Vision*, 17(5):8-1-20.

three are especially common: noise, crowds, and advertising. Reflective surfaces and materials can also be distracting, especially for people with brain-based sensitivities.

Use environmental design to support wayfinding ease

Make key destinations identifiable from a distance and up close

- Every aspect of environmental design, from site planning to architecture, landscape architecture, interior design, and graphic design can help make destinations identifiable whether users are a distance away or up close.

Keep architectural layouts & circulation patterns simple

- Avoid circular, triangular, or other layouts with angles other than 90-degrees, as these layouts often cause confusion for users.

Do not obstruct views to wayfinding elements or information

- Since it is essential that users are able to wayfinding information, be sure views to it are not blocked by vegetation, solid objects, seating, advertising, or anything else.

Attend to wayfinding design details

Provide effective contrast

- Provide sufficient contrast (at least 70%) between wayfinding messages and backgrounds, on signage, maps, directories, etc.

Avoid reflectivity

- Refrain from using reflective surfaces or materials for wayfinding information.

Attend to wayfinding-related lighting

- Thoughtfully use ambient and/or focused, external and/or internal lighting to make wayfinding elements stand out and be legible. Avoid glare.

Use color-coding carefully, if at all

- While it is tempting to rely on color to communicate wayfinding information, color is limited in what it can do.[38]
- Limit the number of colors to a few, distinctly different hues, and if a color is used to have meaning, never use it "just for decoration."

[38] And some people are colorblind.

Be aware that details can make or break wayfinding elements (and wayfinding systems)

- Message wording, font type, font size, color contrast, lighting, reflectivity, map orientation, icon clarity, and a host of other details, used in combination, can render wayfinding elements (and wayfinding systems) useful or confusing.

Architecture & Interior Design Inclusive Wayfinding Planning Guidelines[39]

- Provide accessible pathways
- Make facility layouts predictable
- Provide unobstructed views to information, pathways, and destinations
- Ensure wayfinding-related legibility
- Plan locations for wayfinding signs and maps
- Plan for wayfinding lighting
- Use landmarks and other design details to create unique, memorable places
- As needed, create places for advertising that do not block views to key features and wayfinding information
- Mock up all wayfinding elements in advance

Provide accessible pathways

- Exterior and interior pedestrian pathways must be accessible. These are covered in the ADA Standards.[40]

Make facility layouts predictable

- Unfamiliar users; seniors; people with physical, sensory, and brain-based functional limitations; directionally challenged users, and others will benefit from and appreciate consistent, predictable site and facility layouts. This will reduce stress, save time, and make their experience more pleasant.
- Keep layouts and circulation patterns simple and avoid circular, triangular, or other layouts with non-90-degree angles, as these layouts often cause confusion.

[39] Carpman, J. R. Working Paper: Inclusive Wayfinding: System Elements, Guidelines, Best Practices, IHCD 2020.
[40] Regulations of MAAB and/or local codes may also apply.

Provide unobstructed views to information, pathways, and destinations

- Users need to be able to see[41] where they are heading. For instance, with regard to public transit stations, when users are in nearby parking areas, they need to see pathways to the stations. They also need to see the stations themselves, station entrances and exits, the various lines served by the stations, ticketing machines (if any), turnstiles (if any), tracks, platforms, vertical transportation (ramps, stairs, elevators, escalators, if any), static signage, digital signage, and maps (area maps, system maps).
- Make sure these essential views are unobstructed. For instance, avoid placing seating in front of maps.

Ensure wayfinding-related legibility

- Legibility and clear views are related, but not necessarily synonymous, since they depend on where the user is standing. For instance, in transit stations, the stations themselves (and their line identification) need to be legible from afar. Key features that should be legible (obvious) rather than hidden, include: ramps, elevators, escalators, and stairs (if any), as well as station exits. These should not be located in alcoves or visually blocked by walls.
- Legibility is a function of materials, contrast, reflectivity, lighting, and other factors. For instance, when elevator doors and frames blend in with their surroundings, they may be hard to distinguish, especially for people with low vision and/or brain-based limitations. Whenever possible, use materials and colors to help key features, including identification signage, contrast with and stand out from the surrounding environment. Avoid using reflective surfaces or materials for walls, ceilings, floors, and features, such as elevators.
- Legibility also relates to design details, such as elevator call-button panels, where it is sometimes hard to tell the call button from other round indicators.

[41] This assumes that users have vision. New apps for people with low vision (like Aira) use smart phone cameras and trained professionals, who interpret views for the user.

Plan locations for wayfinding signs[42] and maps[43]

- Users will seek wayfinding signs and maps to provide information and reinforce their knowledge about how to proceed.

Principles for locating signs and maps:

- Locate signs and maps at "decision-points," places where users make decisions about whether to go straight, turn right, turn left, reverse course, go up, or go down. (For instance, directional signs are needed in view of people exiting elevators.)
- Sometimes, "reassurance signs" are needed along lengthy pathways.
- Wayfinding information should face users, not be located off to one side.
- The longer the viewing distance, the larger the sign messages should be.
- Signage in multiple languages will be larger and take up more room than signage in a single language.
- Avoid locating wayfinding information on glass windows or doors. (It is not legible.)

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[42] Carpman Grant Associates, Wayfinding Consultants. Indiana University Health Interior Wayfinding Masterplan, 2012.

Types of wayfinding signs include:

Exterior

- Trailblazer signs, as needed and appropriate
- Advance notification signs, as needed and appropriate (e.g. for upcoming turns)
- Parking area identification signs, entrance & exit signs
- Parking garage directional and identification signs
- Accessible parking spaces
- Site/institutional identification signs
- Exterior directional signs (vehicular and pedestrian)
- Accessible pathway signs (if all pathways are not accessible)
- Accessible entrance signs (if all entrances are not accessible)
- Building/facility identification signs

Interior

- Major and minor destination identification signs
- Vertical transportation (elevators, escalators, stairs) identification signs
- Elevator directories (identifying floors on which the elevator stops)
- Interior directional signs
- Emergency egress signs
- Static wayfinding information signs
- Digital wayfinding information signs

[43] Types of wayfinding maps include:

- Area/neighborhood maps
- Exterior You-Are-Here maps and handheld maps (of large or small areas)
- Interior You-Are-Here maps and handheld maps (of large or small areas)
- Emergency Egress maps
- Tactile maps (encompassing different sizes and types of areas)

When designing facilities, consider places where wayfinding signs are needed and provide:

- Ample wall areas that will support the size and weight of wayfinding signs and maps.
- Floor and ground areas for freestanding signs and maps with sufficient surrounding space for wheelchair users and others to view the information from their preferred viewing angles and distances. Different sizes and heights will be required, depending on content and viewing distances.
- Ceiling areas from which wayfinding signs can be suspended. (Note: These will not be legible to most people with vision disabilities.)

Plan for wayfinding-related lighting

- It is essential that exterior areas be legible at night and during inclement weather. All users need lighting that is even (without shadows or dark spots) and sufficiently – but not overly – bright for viewing circulation areas, wayfinding signs and maps, and other exterior and interior features. Avoid backlighting and glare, which can make wayfinding information hard or impossible to see, especially for people with low vision.
- Consider consulting with lighting experts about wayfinding-related lighting.

Use landmarks and other design details to create unique, memorable places

- Using landmarks is a key behavioral strategy for navigation. Wayfinding landmarks need to be noticeable, memorable, and unique.
- Landmarks provide word-free wayfinding cues, useful to people who have low vision, non-English-speakers, non-literate people, directionally challenged people, and others.
- Landmarks provide a way to give local flavor to facilities and reinforce institutional and/or community identity.
- Landmarks offer an element of fun and visual or tactile interest.
- Avoid landmarks that provide false wayfinding information, such as historic identifiers that are no longer accurate.

As needed, create places for advertising, or other non-wayfinding information, that do not block views to key features and wayfinding information

- In many institutions, advertising appears on walls, floors, suspended from ceilings, etc. Advertising sometimes appears such volume and in so many locations that it seriously detracts from the legibility of wayfinding information.
- People with low vision and those with brain-based functional limitations may have an especially difficult time distinguishing between advertising displays and wayfinding displays. Advertising is sometimes designed to mimic wayfinding information. It can

block views to wayfinding information, and/or may be located in places where one would expect to see wayfinding information.
- Designers can help with this problem by designing areas, frames, and other locations specifically designed for advertising, but not blocking or interfering with views to key environmental features and wayfinding information (including signs and maps).

Mock up all wayfinding elements in advance

- All wayfinding elements, including wording, sign design, map design, color contrasts on interior design features, and others should be mocked up before they are finalized. This will enable designers and decision-makers to view them in the given environment (or a surrogate environment) and be sure they meet performance criteria.
- It is essential that there also be an opportunity for user/experts, including people with vision disabilities, to review wayfinding element mockups for legibility, contrast, font size, placement, and the like.
- Mockup testing findings should inform subsequent phases of wayfinding element design.

Wayfinding-related Elements that Contribute to Interior Wayfinding Ease for People with Vision Limitations: *Design*[44]

- Workplace entries and exits
- Horizontal circulation: layouts
- Vertical circulation: stairs, elevators, escalators
- Hazards and obstacles in the path of travel
- Interior design features: patterns, visual clutter
- Interior design features: themes
- Lighting
- Windows and window coverings
- Doorways
- Reflective surroundings
- Contrast
- Floor materials
- Toilet rooms
- Detectable warnings
- Signage
- Landmarks

[44] There is some intentional redundancy in this section.

- Color coding
- Tactile maps
- Non-tactile You-Are-Here maps
- Sounds (acoustic wayfinding)

Workplace entries and exits[45]

- Provide color contrasts around entry and exit doorways, stairways, and along circulation pathways. Provide high contrast door handles.
- Avoid specifying glass doors (including revolving doors), if possible. These may be confusing and challenging to navigate for people with vision disabilities.[46] Automatic doors can be helpful, as long as it is clear to users with low vision and others where to enter.
- Make entries and exits wide enough to accommodate foot traffic.
- Consider adding auditory and tactile feedback elements.
- Make the entry/exit layout consistent and simple so that it is easy to memorize for people with vision limitations. For example, the threshold should be well marked; steps should be a standard height.
- Use materials with care, to promote safety and legibility for people with vision limitations.
- Clearly demarcate stair edges.
- Specify stair railings that contrast with their surroundings.
- Light entries/exits evenly and sufficiently.
- Use signage to clarify the desired user behavior at entries and exits.

[45] Institute for Human Centered Design: Interview Summary Report User/Experts, 2020.
[46] Institute for Human Centered Design: Interview Summary Report VR Counselors, 2020.

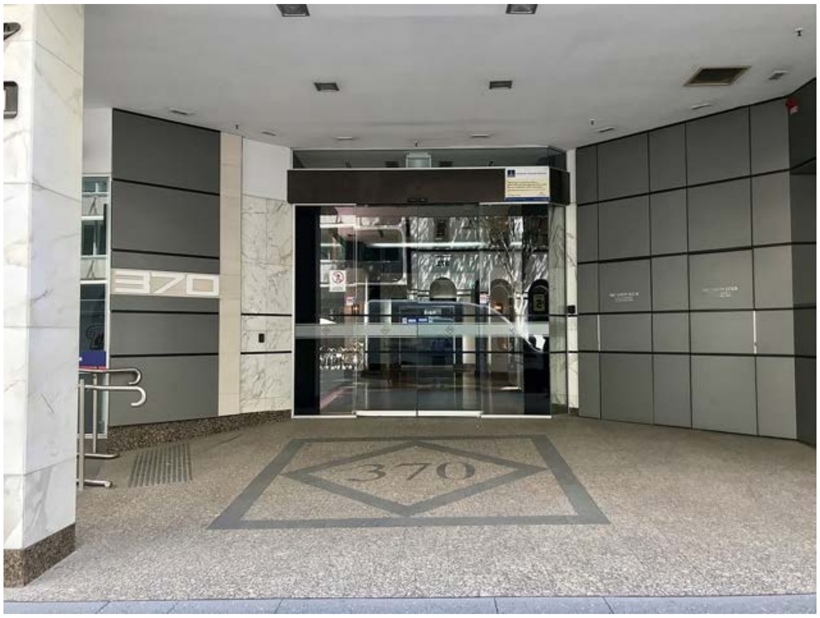

Figure 3. This photo shows an exterior view of a building entrance that is likely confusing and difficult to navigate for a person with low vision. The address is located in two places that are difficult to see: on a wall, with stretched numbers that do not contrast well with their background, and on the floor, which would be easy to miss. Glass entry doors are so reflective that it is almost impossible to see where to enter, despite some glass manifestation.[47]

Figure 4. Helpful features include detectable floor strips leading to/from the entry/exit doors. However, there is a stanchion blocking access to the exit door from the inside and to the inside from the entry door. There are some variations in floor materials that may be useful, including a walk-off mat near the entrance/exit and both smooth and matte tiles. Potentially problematic features include reflective column materials that provide glare, large expanses of glass, and a reflective ceiling.

[47] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment

Horizontal circulation: layouts

- Avoid circular layouts.
- Use layouts that have simple, image-able shapes: such as geometric shapes, linear layouts, letters or familiar objects that can help people with vision disabilities create a mental map and predict the circulation path ahead of them.[48]
- Avoid layouts with irregular shapes, as these will be difficult or impossible to memorize and predict for users with vision disabilities.
- Arrange areas by function in easily identifiable sections.[49]
- When possible, standardize layouts of repeated spaces, such as toilet rooms and conference rooms.[50]
- Use right angles between and among corridors, rather than acute or obtuse angles.
- Make circulation paths clear. Avoid big, mostly empty spaces, where people with vision limitations have to cross an undifferentiated area.[51]
- Make building layout as consistent as possible from floor to floor.[52]

Vertical circulation: stairs, elevators, escalators

Stairs

- Stairs are potentially dangerous for everyone, particularly for people with low vision. Since stairs are also a healthy alternative to using elevators or escalators, organizations may wish to encourage their employees' use of stairs. To make stairways easier to find and safer for people with low vision, consider the following:[53]
- Consider using contrasting textures and colors, and prominent boundaries and signage to make stairways noticeable. Mark the edges of steps using contrasting colors.
- Consider using e raised stripes, running parallel to the step, at the top and bottom of a staircase, as a warning.
- As required by ADA, use railings on <u>both</u> sides of stairways and make these a color that contrasts with the wall color.
- As required by ADA, use stair identification signs near stairways.
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- Consider making doors or doorframes leading to stairways a contrasting color.
- Consider using large, clear signage to identify each floor accessed by a stairway. Include information about exiting, if users cannot exit on a given floor.

[48] Institute for Human Centered Design: Interview Summary Report User/Experts, 2020.
[49] Institute for Human Centered Design: Interview Summary Report User/Experts, 2020.
[50] Institute for Human Centered Design: Interview Summary Report User/Experts, 2020.
[51] https://visionaware.org/everyday-living/home-modification/meet-erin-schambureck-registered-interior-designer/
[52] https://visionaware.org/everyday-living/home-modification/meet-erin-schambureck-registered-interior-designer/
[53] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment

- Provide even illumination in stairways.[54]

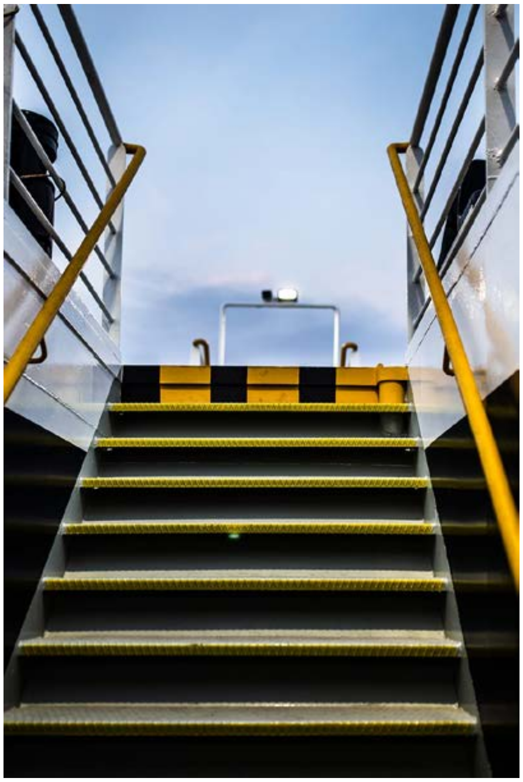

Figure 5. This view of a stairway shows contrasting railings on both sides and contrasting strips along the treads.[55]

Elevators

- Think carefully about locating elevators within a building, so that they are easy to find – for people with vision disabilities and others.
  - If they are located along a main circulation path, use a perpendicular wayfinding cue to indicate the presence of the elevator. A redundant cue would be contrasting colors used for the elevator doors or doorframes.
  - If elevators are located in a recessed area, wayfinding cues need to be even more obvious, since users often complain about not being able to find “hidden” elevators.

- Consider using perpendicular identification signage to point out the location of elevator banks.

[54] Institute for Human Centered Design: Interview Summary Report User/Experts, 2020.
[55] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment

- If there is more than one elevator bank in a building, use legible signage to clarify which floors are accessed by which elevators.
- Consider using contrasting colors and/or materials to differentiate elevator banks from circulation space.
- Consider using contrasting colors and/or materials to highlight elevators, so they are easily distinguishable from walls.
- If there are multiple elevators, consider ways to indicate with sound which elevator is arriving.
- Provide large size, high contrast elevator directories, indicating the floors reached by each elevator and the destinations located on each floor.
- Consider using aural messaging to indicate the direction of the elevator.
- Consider using aural messaging to indicate the floor number on which the elevator is stopping.
- In elevator lobbies, as users face the elevators, consider enhancing legibility of elevator buttons with contrasting-color lighting.[56]
- In elevator lobbies, as users face the elevators, avoid having maintenance controls look similar to elevator buttons.
- In elevator cabs, in addition to meeting ADA guidelines for braille and raised lettering, consider using contrasting colors for floor-number buttons.
- In elevator cabs, consider using raised lettering in contrasting colors to identify potentially confusing icons (such as the door-closing icon or ambiguous abbreviations, such as "M.")[57]
- In elevator cabs, make the Emergency Call button legible to users with vision disabilities, using texture, raised lettering, high contrast color, and the like.
- Make the inside of elevator cabs brightly lit.[58]
- In elevator lobbies, as users exit, consider having essential, legible wayfinding information within view: a floor number, a directional sign, a correctly oriented You-are-Here map, a landmark.[59]
- Include information about elevators in an app focusing on a particular building: the location of elevator banks, the number of elevators in each bank, which floors the elevators access, how to know when an elevator arrives, how to know the direction of the elevator, etc.

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[56] Designforsight.com
[57] Carpman, J. R., & Grant, M. A. (2012). *Directional Sense: How to find your way around*. Institute for Human Centered Design; Carpman, J. R., & Grant, M. A. (2016). *Design that cares: Planning health facilities for patients and visitors*. John Wiley & Sons.
[58] Institute for Human Centered Design: Interview Summary Report VR Counselors, 2020.
[59] Landmarks are often only visual, but can also have texture to make them usable by people with low vision.

Escalators

- Escalators are potential hazards for people with low vision, who can stumble or fall if they miss a step or ride in the wrong direction.[60]
- O & M training and various apps can assist people with low vision to recognize and safely use escalators.[61]

Hazards and obstacles in the path of travel

- People with low vision will not have to worry about their safety as they navigate, if circulation paths are free of hazards and obstacles.
- One such hazard can be glass, in the form of glass walls and glass doors. Glass “manifestation” (a feature, such as decorative decals, that prevents users from trying to walk through large glass areas) can help reduce the danger for people with vision disabilities and others.

Interior design features: patterns, visual clutter

- Avoid excessive use of patterns on surface materials (visual clutter) that can lower the user’s ability to detect contrast between objects and their surroundings and make it difficult for them to know where they are in space.[62] [63]
- Examples: patterned carpets on stairs and ramps; a combination of highly patterned furniture, workstations, and flooring materials.

Interior design features: themes

Design various areas, within an office building or other workspace, to look different. This can be done with color, lighting, furnishings, landmarks, etc. The best way for someone to know where they are in space is for it to look unique.

Lighting[64]

- Bright lighting is considered beneficial by some low vision users, especially in hallways, entryways, and exits.[65]
- Some low vision users prefer diffused lighting in workspaces.[66]

[60] Nakamura, D., Takizawa, H., Aoyagi, M., Ezaki, N., & Mizuno, S. (2017). Smartphone-Based Escalator Recognition for the Visually Impaired. *Sensors (Basel, Switzerland)*, *17*(5), 1057. https://doi.org/10.3390/s17051057
[61] https://youtu.be/nvDp80wQaJc
[62] Designforsight.com
[63] Dubai Universal Design Code Final Feb 2017.
[64] See NIBS, p. 13-14 for a technical discussion of luminance, illuminance, and light source spectral distribution
[65] Institute for Human Centered Design: Interview Summary Report User/Experts, 2020.
[66] Institute for Human Centered Design: Interview Summary Report User/Experts, 2020.

- Be vigilant about avoiding shadows, resulting from a combination of design features and lighting. These can be confusing (shadows may look like water or holes, or steps, etc.) and hazardous to people with low vision.[67]
- Avoid lighting placement that shines directly into pedestrians' eyes.[68]
- Use light levels that allow older users and users with low vision to discern environmental details.[69]
- Consider lighting quality as well as lighting quantity.
- Avoid combinations of natural and artificial lighting and reflective materials that cause glare at various times of day.[70]
- Create lighting transition zones, so seniors and others have time to adapt from bright outdoor lighting to dimmer interior lighting.[71]
- Consider using lighting locations as a wayfinding cue for people with vision disabilities.[72] Lighting can be located to follow the intended circulation path. For instance, in some areas, people would walk parallel to lighting along north/south corridors and in other areas, they would walk perpendicular to lighting along east/west corridors.

Windows and window coverings

- Consider using glass "manifestation: (applied or built in designs that break up large expanses of glass that may not be obvious to people with limited vision.)[73]
- Provide window coverings that can be used, as needed, to prevent glare and reflections. Consider the operational implications of such window coverings.[74]

Doorways

- Consider using contrasting colors and/or textures on flooring near doorways.[75]
- Consider using contrasting colors around doorframes.[76]
- Consider installing automatic doors. If possible opt for sliding doors. Use design features (color, materials, signage, etc.) to indicate where the automatic door is opening.[77]

[67] Designforsight.com
[68] This is written for exterior lighting, but applies to interior lighting too.
[69] Designforsight.com
[70] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[71] https://visionaware.org/everyday-living/home-modification/meet-erin-schambureck-registered-interior-designer/
[72] Thanks to architect Chris Downey for this suggestion.
[73] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[74] Devices may be helpful that cover windows when automatic sensors indicate too much light.
[75] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[76] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[77] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment

Reflective surroundings

- Avoid reflective surfaces, like glass, which can be disorienting.[78]
- Reflective surfaces can confuse visually impaired people, who can't distinguish real obstacles from reflected ones.
- Examples: large glass walls, water, glass doors (see section on "Hazards and obstacles in the path of travel" above)

Contrast

- Maximum contrast – in color, texture, materials, lighting – is probably the single most important environmental feature that can help everyone, especially people with low vision, understand where they are in space and how to make their way. Contrast can also provide important safety warnings.
- Use sufficient color contrast, along with even, ambient lighting to help low-vision users detect edges and differences among design features.[79] [80]
- This can help users figure out where they are in space, which is part of wayfinding.
- Examples: stair treads, risers, stringers; toilet room walls and fixtures; door frames, handles, switches, handrails, counters; contrasting floor materials, wall materials, and seating. Signage that contrasts with walls; text that contrasts with background.
- Color contrast is especially important to make obstacles stand out.

Floor materials

- Avoid shiny flooring, which when combined with artificial or natural lighting, can lead to confusion about floor features.[81] Reflections on shiny can cause too much light in some areas, making it hard to follow visual wayfinding cues.
- Consider using textures, such as rubberized surfaces or epoxy paint mixed with sand, to distinguish one area from another for people with vision disabilities. [82]
- Avoid any type of flooring, such as a rug, that creates a tripping hazard.[83]
- Area rugs or "walk-off mats" can mark destination entrances, reduce echo, indicate direction, and increase the ability of people with vision limitations to attend to audio cues.[84]
- Consider specifying hard flooring materials, so white canes won't get stuck.[85]

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[78] Designforsight.com
[79] Designforsight.com
[80] This is for exterior stairs and steps, but applies to interior ones too.
[81] Designforsight.com
[82] Institute for Human Centered Design: Interview Summary Report User/Experts, 2020.
[83] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[84] Institute for Human Centered Design: Interview Summary Report User/Experts, 2020.
[85] Institute for Human Centered Design: Interview Summary Report VR Counselors, 2020.

- Use anti-slip materials.[86]
- Be aware that flooring can be a useful cue for people with low vision. Use it intentionally to indicate building entrances, seating areas, boundary markers, and other functions.[87]
- Tile patterns can help make routes more obvious, but also can appear as confusing or frightening – such as patterns of dark and light floor tiles that can simulate changes in the height of the floor.[88]
- Avoid specifying complex floor patterns.[89]

Toilet rooms

- Use contrasting colors to make toilets, urinals, sinks, soap dispensers, dryers, towel dispensers stand out.[90]

Detectable warnings

- Use material color and texture to signal changes in the environment, such as at ramps, handrails, stairs, signage, and controls.[91]

Signage[92] [93]

Suggested changes to ADA signage standards, by Aries Arditi, PhD[94]

- Requirements for visual characteristics of signs intended to improve access for those with low vision should be expressed not in terms of physical features, such as character height and contrast, but rather in terms of the distance at which a sign can be read by someone with nominally normal (20/20) visual acuity under expected lighting conditions for the installed environment. This would give sign designers greater choice in design parameters but place on them the burden of ensuring legibility.

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[86] Institute for Human Centered Design: Interview Summary Report VR Counselors, 2020.
[87] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment. Ideally, involve user/experts in your decision-making.
[88] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[89] Institute for Human Centered Design: Interview Summary Report VR Counselors, 2020.
[90] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment, IHCD User/Expert interview.
[91] Designforsight.com
[92] We include fixed maps, such as You-Are-Here maps and Emergency Egress maps, in the signage category.
[93] International Standards Organization (2020). Building construction – accessibility and usability of the built environment, Section 10.5 Signage and 10.6 Graphical symbols. This document contains signage-related text and guidelines, some, but not all, of which are useful for understanding wayfinding and improving wayfinding ease for people with low vision. It is beyond the scope of this project to provide a detailed analysis of Sections 10.5 and 10.6.
[94] Arditi, A. (2017). Rethinking ADA signage standards for low-vision accessibility. Journal of Vision, 17(5), 8-8

- Mounting of directional signs, which are critical for effective and efficient wayfinding, should be required to be in consistent and approachable locations so that those with reduced acuity may view them at close distance.

Sign locations

- Sign locations need to be predictable and consistent. For instance, place signs at corridor intersections and at other decision-points. Additional “reinforcement” directional signage may be needed along long corridors. [95]
- Consider 7 ft (2m) a typical viewing distance to wayfinding signs.[96]
- Mount wall signs 55-67 in high (1,400 – 1,700 mm) standing persons and 40-43” high (1000 -1100 mm) for wheelchair users.[97]
- Locate interior (and exterior) wayfinding signs perpendicular to the flow of traffic.
- Avoid using wayfinding signage mounted on posts or protruding into the path of travel.[98]
- Ceiling-hung wayfinding signage may be difficult or impossible for low-vision users to see. However, if used, mount it at least 84 in. (2100 mm) above the path of travel.[99]
- Locate signage at eye-level.[100] Allow enough space around it, so it can be read at close range.[101] According to the ISO (International Standards Organization)[102]:
  - Directional and functional signs should be located between 1,200 and 1,600 mm where they are easy to approach, to touch and read the raised signs with fingers.
  - Signs should be located where they are clearly visible to people who are seated, standing, or walking.
  - Where a sign can be obstructed, as in a crowded situation, the signs shall be placed at a height of at least 2,100 mm above finished floor level. The same requirement applies to signs fixed to the ceiling or projecting from walls. There should be two signs; one that can be seen from a distance above other people's heads, one as a complement at the height recommended above.

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[95] Carpman, J. R., & Grant, M. A. (2016). *Design that cares: Planning health facilities for patients and visitors*. John Wiley & Sons.
[96] National Institute for Building Sciences (2015) Design Guidelines for the Visual Environment, Version 6. Where areas at signs are congested or where information needs to be conveyed at greater distances to allow appropriate reaction and response, greater viewing distances may be needed.
[97] National Institute for Building Sciences (2015) Design Guidelines for the Visual Environment, Version 6.
[98] National Institute for Building Sciences (2015) Design Guidelines for the Visual Environment, Version 6.
[99] National Institute for Building Sciences (2015) Design Guidelines for the Visual Environment, Version 6.
[100] Designforsight.com
[101] International Standards Organization (2020). Building construction – accessibility and usability of the built environment, Section 10.5 Signage
[102] International Standards Organization (2020). Building construction – accessibility and usability of the built environment, Section 10.5 Signage

  - Where there is sufficient space, door signs shall be located on the latch side of the door within 50 mm to 100 mm of the architrave (doorframe).

- If there must be overhead signage, repeat the text on wall-mounted signage.
- Avoid putting signage lettering on glass.

Sign contrast

- Make sure signage contrasts with its background; text contrasts with sign background.

Sign fonts

- Use ADA sign font sizes as a baseline, but be open to the need for larger font sizes on wayfinding signs. Involve User/Experts – people with low vision – to review optimum sizes.[103]
- Make sure font sizes are easy to read. According to the ISO (International Standards Organization)[104]:
  - The fonts shall be easy to read. The font style should be a sans serif font similar to Helvetica or Arial medium.
  - The letter height depends on the reading distance. A letter height between 20 mm and 30 mm for each meter of viewing distance is preferred. The letter height shall not be less than 15 mm.
  - It is recommended that messages of a single words or groups of words begin with an upper-case letter and continue with lower case letters (sentence case).
  - The words should not be placed too close together. Adequate height spacing should separate the lines. Lines of text should be ranged from a vertical line (unjustified).

Sign-related lighting[105]

- Use lighting to illuminate signs. “Brighter illumination on signage can improve the ability to see contrasts and discern characters even further for people with low vision.”[106] Sign lighting can be external or internal.
- Signs should be well illuminated, with no glare.[107]

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[103] Institute for Human Centered Design: Interview Summary Report VR Counselors, 2020.
[104] International Standards Organization (2020). Building construction – accessibility and usability of the built environment, Section 10.5 Signage
[105] See http://www.DesignforSight.com for detailed guidance about lighting and lighting-related issues for people with low vision.
[106] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[107] International Standards Organization (2020). Building construction – accessibility and usability of the built environment, Section 10.5 Signage

- Existence of glare depends on how the sign is placed, the material and the illumination. The background, graphical symbols, logos and other features shall be of a matte or low sheen finish.[108]

Technical considerations for signage

Tactile wayfinding aids (braille) are generally not familiar to older adults and persons with low vision, but all wayfinding aids should comply with the following, according to the National Institute for Building Sciences, Design Guidelines for the Visual Environment, Version 6[109]:

- Information displays, lettering styles, spacing and other features should comply with ADA Standards 703.2 (30), and as follows:
- Signs are more legible for people with low vision when characters contrast with their background with a Light Reflectance Value (LRV) as recommended in Table 4D-2.
- Lettering and other graphics should be monochromatic white information on black field because many persons with low vision have some degree of color blindness and difficulty with low contrast.
- Raised or incised lettering not contrasting in color or value with the surrounding field is not recommended for use by persons with low vision. Shadows may confuse rather than enhance visibility.
- Wayfinding surface illumination should be uniform and as recommended in Table 5C-1, Ref. 4, in daylight and after dark and the sign surfaces should be shielded from the light source to avoid reflected glare.
- Internally illuminated or backlit signs may be difficult for persons with low vision due to glare.
- Variable message signs may be suitable with the following recommendations:
  - Use left-justified text a minimum of 22 mm (7/8 in.) high but not less than 1 percent of the distance at which the sign is to be read.
  - Use sans-serif fonts with upper and lower-case in simple sentences without abbreviations.
  - Space characters about ¼ of the font width, and space words more than characters.
  - Space lines apart 50 percent of text height where multiple lines are needed, but avoid fewer than 3 lines.
  - Do not use multiple colors or flashing messages.
  - Liquid crystal displays may be difficult for persons with low vision, especially where they may be subject to direct sunlight or strong shadows. LED and other internally illuminated displays are preferable.

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[108] International Standards Organization (2020). Building construction – accessibility and usability of the built environment, Section 10.5 Signage

[109] National Institute for Building Sciences (2015) Design Guidelines for the Visual Environment, Version 6.

See also International Standards Organization (2020). Building construction – accessibility and usability of the built environment, section 10.6 Graphical Symbols.

Landmarks[110]

- Landmarks are environmental features that can provide wayfinding information over and above signage and maps.[111] They act as reference points, let users know they are on the right (or wrong) track, cue actions, and serve as meeting places.
- Typical landmarks in public buildings are paintings, sculpture, plants, plaques, dramatic interior design treatments, and other predominantly visual features, which are not necessarily helpful to people with vision disabilities.
- However, landmarks do not only need to be visual. Artwork and sculpture can provide varied textures – identifiable by touch. Landmarks may also have auditory features, such as an indoor fountain with bubbling water. Landmarks may even have olfactory features, such as an indoor garden or massing of fragrant plantings. These types of landmarks that rely on other senses can provide useful wayfinding cues to people with vision disabilities.

Color coding

- Avoid the use of color coding as a wayfinding cue. Colors may be hard to distinguish for people with low vision and people with colorblindness. Color coding is rarely used with consistency and users may be understandably confused when color is used to have meaning at some times and some places, and at other times and places used for decoration.[112]

Tactile maps

- Consider using tactile maps, either fixed or portable.[113] (See below for talking maps and models.) Tactile maps come in many formats, including audio-tactile and strip maps. Tactile maps created by The Lighthouse, in San Francisco, involve blind

[110] Carpman, J. R., & Grant, M. A. (2012). *Directional Sense: How to find your way around*. Institute for Human Centered Design., Chapter 8 Recognizing Landmarks.
[111] Saudi guidelines call this "orientation cuing." (Saudi) The Built Environment Guidelines, p. 73
[112] Carpman, J. R., & Grant, M. A. (2016). *Design that cares: Planning health facilities for patients and visitors*. John Wiley & Sons.
[113] Users might borrow them while they are in the building and return them when no longer needed.

designers and collaborators. Their maps incorporate braille and large print.[114] [115] [116] [117]

- Some global guidance, such as that from Dubai, focuses on tactile maps. Some guidelines include[118]:

  – Tactile maps shall include only essential information: location of services and paths and position of elements such as information, main services, toilets, etc.
  – Concepts used should be easy to understand.
  – Graphic plane representation (lines, surfaces) should be defined through embossment, textures and color contrasts.
  – The signs and lettering of the map shall be represented taking into account contrast between fonts and background colors. The font size shall be at least 20 mm in a sans serif type font. Furthermore, the information shall be represented in Braille.
  – The maximum dimensions of horizontal fixed tactile maps will be of 800 mm x 450 mm.
  – The symbols should be clearly differentiated (form, color and texture) and shall be easily associated with their representation.
  – For complex maps buttons providing oral information shall be provided.
  – When a tactile map is provided, it will be located within the accessible path and its location shall be indicated with a tactile orientation and warning surface. It should be in a well-lit area. Obstacles in front shall be avoided such as glass protections.
  – When they are mounted in busy public places, they shall include sound information.
  – In large buildings and open spaces for public use (parks, beaches), they shall be located at the main entrance area, near the door, on the right side, within 1000 mm. In a building with more than one floor, it shall be located near the stairs or the elevator.
  – When fixed to a vertical surface, it shall be centered between 1250 mm and 1750 mm above the floor. On horizontal or inclined surfaces, the height shall be between 900 mm and 1200 mm from the floor and the inclination will be between 30º and 45º from the horizontal level.

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[114] https://lighthouse-sf.org/design/tactile-maps-wayfinding/
[115] https://www.visibilitymetrics.com/navigation-and-wayfinding#580
[116] https://lighthouse-sf.org/tag/wayfinding/
[117] http://axisarch.com/2018/06/design-for-the-blind-architecture-for-the-visually-impaired/
[118] Dubai Universal Design Code Final Feb 2017, p. 239.

Figure 6. Tactile maps can be useful to blind users, as a redundant cue, to let them know where they are and how to continue on to their destination.[119]

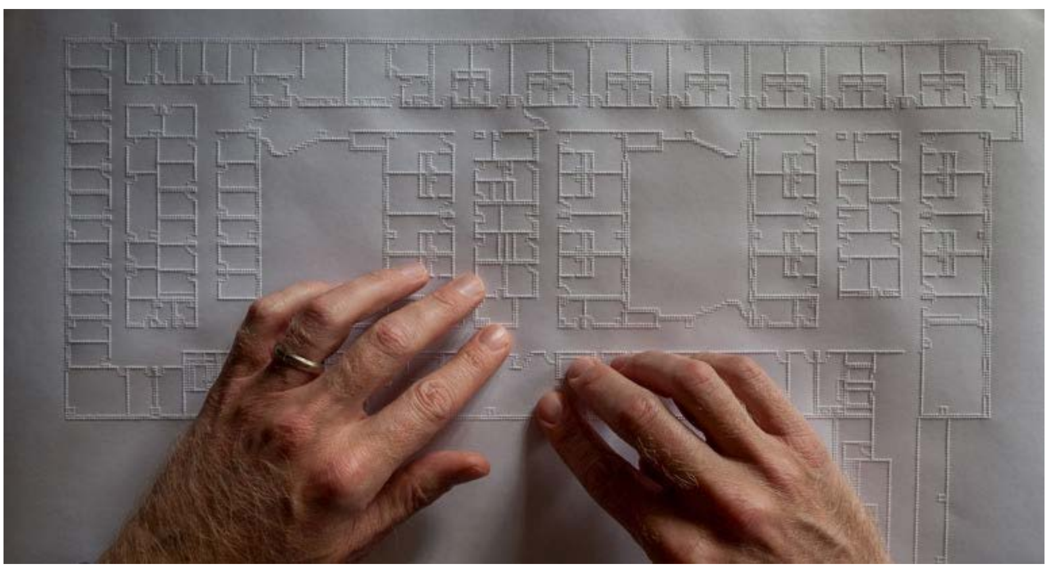

Figure 7. A close-up of a tactile map as read by architect Chris Downey, who is blind. The map does not use contrast to indicate architectural features: everyone is white on white.[120]

[119] https://lighthouse-sf.org/design/tactile-maps-wayfinding/
[120] http://axisarch.com/2018/06/design-for-the-blind-architecture-for-the-visually-impaired/

Non-tactile You-Are-Here maps

- People with some vision may be able to use stationary You-Are-Here maps to understand where they are within a facility or an outdoor space, and find a route to their destination.
- It is essential that You-Are-Here maps use large, sans serif fonts that contrast with their background, have a "You-Are-Here" symbol to show the user's position in relation to the surrounding environment, and be oriented so that forward in space is up on the map.[121]

Sounds (also known as Acoustic Wayfinding)[122]

- Acoustic wayfinding involves using a variety of auditory cues to create a mental map of the surrounding environment. This can include a number of techniques: navigating by sounds from the natural environment, such as pedestrian crossing signals; echolocation, or creating sound waves (by tapping a cane or making clicking noises) to determine the location and size of surrounding objects; and memorizing the unique sounds in a given space to recognize it again later. For the visually impaired, these auditory cues become the primary substitute for visual information about the direction and distance of people and objects in their environment.[123]
- However, there are a number of common obstacles to acoustic wayfinding techniques: noisy outdoor environments can challenge an individual's ability to identify useful sounds, while indoors, the architecture may not provide an acoustic response which is useful for orientation and destination. Among the most difficult environments to navigate for individuals who rely on acoustic wayfinding are crowded places like department stores, transit stations, and hotel lobbies, or open spaces like parking lots and parks, where distinct sound cues are lacking. This means that, in practice, individuals who navigate primarily by acoustic wayfinding must also rely on a number of other senses – including touch, smell, and residual sight – to supplement auditory cues.
- These different methods can be used in tandem. For example, visually impaired individuals often use a white cane, not only to physically locate obstacles in front of them, but also to acoustically get a sense of what those obstacles may be. By tapping the cane, they also create sound waves that help them to gauge the location and size of nearby objects.

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[121] Carpman, J. R., & Grant, M. A. (2016). *Design that cares: Planning health facilities for patients and visitors*. John Wiley & Sons.
[122] https://en.wikipedia.org/wiki/Acoustic_wayfinding
[123] Reginald G. Golledge; Robert John Stimson (1997). *Spatial behavior: a geographic perspective*. Guilford Press. p. 508. ISBN 978-1-57230-050-7.

Some design considerations:

- Create spaces that minimize echoes, which can be confusing to people with low vision.[124]
- Use auditory cues at important areas, such as elevators.[125]
- Consider sounds emanating from different textures, such as hard-surface flooring, which can offer useful wayfinding cues.[126]

Wayfinding-related Elements that Contribute to Interior Wayfinding Ease for People with Vision Limitations: *Operations*

- Floor numbering
- Zones and room numbering
- Wayfinding staff training
- Wayfinding system maintenance and management

Floor numbering[127]

If floor numbers were always just consecutive numerals, everyone – including people with vision disabilities – would be able to use them to navigate. Unfortunately, reality throws in numerous exceptions, which can impede wayfinding ease for all users. For instance:

- Since elevator cab buttons offer limited space, abbreviations – such as *M* - are often used, but these may be unintelligible to unfamiliar users.
- Floors may be at grade, above grade, or below grade. An entry floor at grade might be labeled *G* for Ground, *M* for Main, *L* for Lobby, *S* for Street, or *1* for first level. Floors below grade may be labeled *B* for basement, *LL* for Lower Level, *G* for Garage, etc.
- Some *floors* may be called *levels*.
- Unless the floor numbering system is simple and logical, users with vision disabilities may wish to ask about its logic before they use a building for the first time.

[124] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[125] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[126] https://www.bigrentz.com/blog/ultimate-guide-designing-navigating-spaces-people-vision-impairment
[127] Carpman, J. R., & Grant, M. A. (2012). *Directional Sense: How to find your way around*. Institute for Human Centered Design., Chapter 4 Deciphering Wayfinding Words and Numbers.

Zones and room numbering[128]

Some people with vision disabilities may find it helpful when a large building is divided into discrete areas or zones.[129] These may be labeled for cardinal directions (North, South, etc.) or by other terms.

Room numbering seems as if it should be an easy task to accomplish, but is surprisingly tricky, both to do and to understand. People with vision disabilities rely on room numbering as part of a wayfinding system and thus they want room numbers that are logical to and predictable by unfamiliar users.

The biggest confounding issue is the layout of a facility. Anything layout other than double-sided corridors will become complicated to number and navigate. Facilities may have unique layouts, room uses that are atypical, and other qualities that – despite the best intentions of all involved - may result in a confusing room numbering system for all users, especially users with vision disabilities.

If room numbers can be in the same locations on various floors of a building, it will enable people with vision disabilities to predict where to go.

Ideally, room numbers should meet the following criteria:

- Make each room number unique.
- Build in logic that is easy to understand by unfamiliar users, including users with vision disabilities:
- The meaning of letters and numerals comprising room numbers
- Sequencing (where room numbering begins and ends on each floor) should be clear to unfamiliar users, but it will probably need to be explained.
- Patterns, for instance, odd numbers on the “left, “and even numbers on the “right.”[130]
- To make things even more complex, there are often “skips” in room numbering to allow for future changes.

Wayfinding staff training[131]

No wayfinding system is complete without recognizing the role of building staff and volunteers in assisting unfamiliar visitors – including people with vision disabilities – to find their way around. Unfamiliar staff may also need wayfinding assistance.

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[128] Carpman Grant Associates, Wayfinding Consultants, report to Francis Tuttle Technology Center, 2010.
[129] Thanks to Chris Downey for describing this in the Lighthouse in San Francisco.
[130] “Left” and “right” are relative terms, depending on which cardinal direction one is facing. See Carpman, J. R., & Grant, M. A. (2012). *Directional Sense: How to find your way around*. Institute for Human Centered Design.
[131] Carpman Grant Associates, Wayfinding Consultants, Wayfinding Masterplan for Canadian Museum for Human Rights, 2013.

Detailed planning for wayfinding staff training is beyond the scope of this report, but there are some basic issues to consider:

- Staff need their own orientation to the physical plant when they begin work at a new job site.
- All staff need to understand and be able to navigate the entire facility, outside and inside
- All staff need to understand components of the facility's wayfinding system, including floor numbering, room numbering, signs, maps, apps (including those for people with vision disabilities).
- All staff need to understand wayfinding needs of diverse users, including, but not limited to, people with vision disabilities. [132] Staff need to be aware that users have a choice about how to receive wayfinding assistance: for example, they may prefer to ask for directions, be guided, be directed to the nearest elevator, or something else.
- All staff need to know how to give accurate and effective directions to unfamiliar users.
- All staff need to know how to find answers to wayfinding questions they, themselves, can't answer.
- The content of wayfinding training may vary with the job responsibilities.

Wayfinding system maintenance and management[133]

Wayfinding systems and the facilities within which they operate often experience change. Re-locations, renovations, name changes, and the like, mean that a wayfinding system (and its components) is a dynamic, rather than static, entity. If wayfinding elements, such as signage and spoken directions, do not keep up with facility changes, users – including people with vision disabilities - may become confused or lost.

A Wayfinding System Maintenance Program, overseen by a Wayfinding Manager, is a proactive strategy for ensuring attention to wayfinding details, large and small.

It is important to conduct periodic reviews of the effectiveness of the wayfinding system for all users, including people with vision disabilities. These are known as Wayfinding Analyses, Post-Occupancy Evaluations, and Building Performance Evaluations.[134]

[132] Saudi 2010 Destinations-Guidelines, p. 306
[133] Carpman Grant Associates, Wayfinding Consultants, Indiana University Health Interior Wayfinding Masterplan, 2012.
[134] See Preiser, W. F. (2001). The evolution of post-occupancy evaluation: Toward building performance and universal design evaluation. *Learning from our buildings a state-of-the practice summary of post-occupancy evaluation.*

Enumerating the details of this type of program is beyond the scope of this report, for people who rely on the accuracy and predictability of wayfinding elements – including people with vision disabilities – it is critical that someone attend to them.

Some wayfinding-related issues that can be the purview of a Wayfinding Manager, and relevant to people with vision disabilities:

- Sign messages on directories, directional signs, identification signs
- Terminology on tactile maps
- Potential hazards in corridors (when people temporarily store items they don't have space for)
- Ongoing staff wayfinding training, so they can give accurate directions
- Attending to window coverings that can reduce or eliminate glare
- Seeing that water on floors around entrances is cleaned up
- Attending to burned out bulbs in lighting fixtures

Wayfinding-related Elements that Contribute to Interior Wayfinding Ease for People with Vision Limitations: *Design and Operations*

- Wayfinding Apps for people with vision limitations[135] [136] [137]
- Talking maps and models

Wayfinding apps for people with vision limitations

AIRA[138]
The blind person gets a very small device that sits on the side of a pair of glasses. They tap the device and connect with a trained assistant, who sits at a computer screen able to geo locate them on the map, see through their camera, and answer any questions making full use of internet searching.

Alexa Blueprint[139]
A feature of Amazon's Alexa personal assistant that will allow hotels to provide an audio blueprint of a room so that it can be navigated by a guest who is visually impaired.

[135] https://travelabilitysummit.com/accessible-products-a-quick-inventory/
[136] https://gowithfloat.com/2016/11/10-apps-indoor-navigation/
[137] http://www.coolblindtech.com
[138] https://aira.io/
[139] www.amazon.com

Aware[140]
The Aware app from Sensible Innovations is a new way for people who are visually impaired and print challenged to thrive in mainstream daily activities negating the need for memorizing routes and landmarks because of inaccessible labels and signs.

BBeeps[141]
A rolling suitcase that warns users of obstacles and helps blind people navigate through crowds and airports.

Be My Eyes[142]
This app allows a sighted person to "be the eyes" for a blind person in need of help moving through an unfamiliar environment. The app will work indoors or outdoors using a live video connection. Blind users can request help from a sighted person, and the sighted users will then be called for help. As soon as the first sighted volunteer accepts the request for help, a live audio-video connection is set up between the two, and the sighted user can tell the blind person what they see when the user points their phone at something using the rear-facing camera. This app has been reviewed by the American Federation for the Blind.

Blavigator
Blavigator is a prototype vision system for persons with very low vision. An ordinary webcam connected to a portable computer or smartphone is worn at chest height. The computer analyzes the video frames to identify valid walking paths and obstacles just beyond the reach of a person's white cane.

Blindsquare[143]
BlindSquare is the world's most widely used accessible GPS-app developed for the blind, deafblind and partially sighted. Paired with third-party navigation apps, BlindSquare's self-voicing app delivers detailed points of interest and intersections for safe, reliable travel both outside and inside. (see videos) Available in many languages.[144]

BrailleNote GPS
This wearable GPS receiver provides auditory location information and mapping tools to augment independent travel for people who are blind or visually impaired. To prepare for a journey, a user can choose a location almost anywhere in the world and virtually navigate to that place as though

[140] https://www.sensible-innovations.com/
[141] https://triblive.com/local/pittsburgh-allegheny/cmu-researcher-designs-suitcase-app-to-help-the-blind-at-airports/
[142] http://bemyeyes.com
[143] http://www.blindsquare.com
[144] Described in Nelson Rego, "University Installs New Wayfinding System for Visually Impaired Students," 6/3/18 https://coolblindtech.com/university-installs-new-wayfinding-system-for-visually-impaired-students/

they were doing it in person. The device has a “look around” capability that automatically announces nearby streets, intersections, and businesses in dozens of categories.

BrainPort Vision Pro[145]
Translates digital information from a wearable video camera into gentle electrical stimulation patterns on the surface of the tongue. Users feel moving bubble-like patterns on their tongue which they learn to interpret as the shape, size, location and motion of objects in their environment. Some users have described it as being able to “see with your tongue.”

Buzzclip[146]
This small and discreet wearable device is for people who are blind or partially sighted. Buzzclip uses ultrasound to detect obstacles that may lie directly in one’s path. It then notifies the user of these obstacles through intuitive vibrations, allowing the user to safely navigate around any objects that they may encounter, including essential head level obstacle.

ClickAndGo Wayfinding[147]
Lots of useful info and features, including Tactile maps and low vision maps, as well as virtual kiosks.

Cydalion
Float’s newest app, called Cydalion, works in indoor environments. It scans the surrounding area and gives augmented reality audio feedback to a person with a visual impairment who is wearing it. For a detailed discussion of the technology behind Cydalion, see the article by Pamela Hogle in Learning Solutions Magazine.

EyeMusic
This app is the successor to an earlier navigation aid called The vOICe that was developed a few years ago. The EyeMusic app captures shapes and colors and translates them into “soundscapes” – auditory representations of pictures. Colors are represented using different musical instruments, higher pixels of the image are converted into higher notes on a given musical instrument (i.e., higher pitches on the piano, trumpet or the violin) while lower pixels of the image are translated into smaller notes on the same musical instruments.

Horus
With some of the same capabilities as Cydalion, this device from a Swiss company is currently being tested in Europe. The expected price is $2000, but that includes the pocket computer that runs the device, and the price will come down as this market becomes more competitive. If you are interested in this device, you need to get your name on their waiting list.

[145] http://www.wicab.com
[146] https://www.imerciv.com/
[147] https://www.clickandgomaps.com

Indoor Explorer[148]
An app that uses beacons and indoor location information stored in the OpenStreetMap® to allow people who are blind or visually impaired to independently navigate through a venue and easily locate entrances, elevators, restrooms and other points of interest.

Jaws Talking Kiosk
A device that attaches to existing kiosks found in Visitor Centers, hotels and attractions that make information available for those who are blind.

Low Viz Guide
This indoor navigation app enables users to find their way around large meeting spaces and always to take the shortest route between two places. The user is guided by a combination of positioning algorithms, Bluetooth low-energy beacons, and a free mobile app on an iOS phone or tablet.

PERCEPT System
The PERCEPT system uses electronic tags mounted at specific landmarks determined by Orientation and Mobility instructors. PERCEPT includes real-time interactivity, a gesture-based user interface, and detailed navigation instructions.

Right-Hear[149]
An app that turns public spaces into accessible environments for blind and visually impaired people.

Seeing AI[150]
“A free app that narrates the world around you” – available in English, Dutch, Geman, French, Japanese, Spanish

The vOICe
This app uses augmented reality headphones to convert images and colors taken by a live camera into binaural sound. With training and practice, a user who is blind can learn to navigate an indoor environment by listening to the AR feedback.

Wayfindr.net
Nonprofit developing accessible audio navigation – London-based, benchmarking standards for digital wayfinding on mobile devices.

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[148] https://www.accessexplorer.net
[149] https://www.right-hear.com/
[150] https://www.microsoft.com/en-us/ai/seeing-ai

WeWALK[151]
A revolutionary smart cane developed for people with a visual impairment. The cane detects obstacles above the waist and can also be paired with your phone for navigation.

Figure 8 Blind and low vision users have many navigation apps available to them. (Source: https://segd.org/interactive-wayfinding-visually-impaired)

Talking maps and models[152]

- Investigate the latest talking maps and models to see if these make sense for your building.
- Prototype models and maps represent spaces as 3D buildings in a landscape (for a campus), or as a raised-line and textured surface (for a building interior). In each case, forms were generalized to focus on only those features that are relevant to wayfinding and orientation, with all superfluous information omitted for tactile clarity and legibility.
- The models are touch responsive; that is, as you explore them with your hands and fingers, they announce the names of the thing you are touching, followed by a description of activities occurring at each place and, finally, spoken directions for walking to that place. By explaining the configuration of the building or campus, the

[151] https://wewalk.io/
[152] https://segd.org/interactive-wayfinding-visually-impaired. Refers to prototypes developed by the Center for Inclusive Design and Environmental Access at the University of Buffalo and Touch Graphics, Inc.

systems are intended to make it possible for a determined independent blind traveler to identify and travel to any location. The models strive to be appealing and user-friendly for everyone, including those with other disabilities, or no disability, without compromising accessibility.

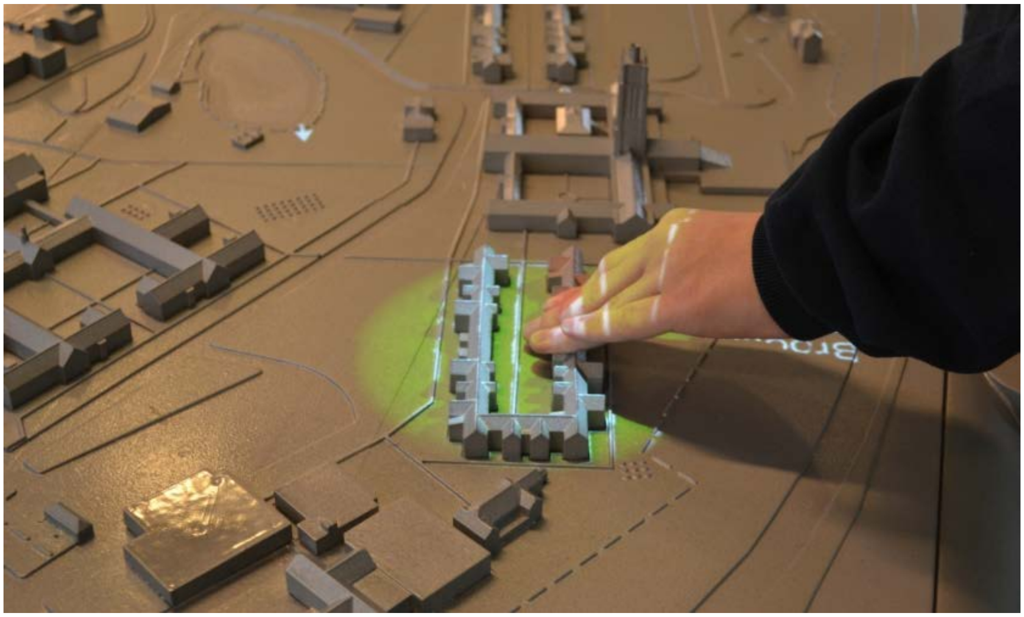

Figure 9. This is a 3-D, talking model prototype of an exterior environment, developed by the Center for Inclusive Design and Environmental Access at the University of Buffalo and Touch Graphics, Inc.[153]

Next Steps

- Expand the focus to exterior as well as interior environments (including toilet rooms), journey to work, etc.
- Speak with more User/Experts
- Involve more VR staff
- Involve more O & M staff
- Conduct Post Occupancy Evaluations of work environments that include people with vision limitations
- Examine available navigation apps in depth
- Examine more literature

[153] https://segd.org/interactive-wayfinding-visually-impaired

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MASSACHUSETTS COMMISSION FOR THE BLIND

Inclusive Design of Workplaces for People who are Low Vision or Blind

September 2020

Institute for Human Centered Design

Table of Contents

National Industries for the Blind (NIB) Headquarters, Alexandria, Virginia

Introduction

The National Industries for the Blind (NIB) project is all new construction for an eight-story office building above ground with another three levels of parking below grade. This project has the distinction of being the first building to be built within the rapidly developing new mixed-use Potomac Yard Town Center (PYTC) area of Alexandria, Virginia. The project site is a corner parcel located at the intersection of Potomac Avenue and Glebe Road and is directly across Potomac Avenue from the site of a new Metro light rail facility projected to open in 2022. Other projects of similar scale in the area are commercial office buildings with street level retail, a hotel and a new Virginia Tech innovation campus are already under construction with more development anticipated to be built in the coming years.

As an organization whose mission is to “enhance the opportunities for economic and personal independence of people who are blind, primarily through creating, sustaining, and improving employment,” it was critical for the new NIB headquarters, conference and training facility to not only meet all accessibility regulations but also provide a respectful and empowering environment for its staff and visitors that are blind and visually impaired and/or have other disabilities. It was also important that they provide a state-of-the-art example of Inclusive Design for the people, associated agencies, venders and suppliers with whom they regularly engage. Consequently, the building and interiors were designed through the lens of the principles of Inclusive Design and with a deep knowledge of the blind and visually impaired user experience.

Description

This new development area is created out of the abandoned Potomac Railroad Yard that is strategically located within five (5) miles of the Capital Mall in Washington, D.C. and only 1.7

miles from Ronald Reagan National Airport both of which will be easily and quickly accessible via the adjacent Potomac Yard Metro light rail station.

In addition to the advantages of the location proximate to the City of Washington and National Airport, the NIBS Board of Directors developed an interest in the benefits of ownership over continued lease arrangements for their headquarters. This specific site also offered the opportunity to be an early investment in the region's most significant new area of centrally located development.

The building includes 110,000 GSF with 10,000 GSF of street level retail along with two independent street level lobbies one serving the NIB and the other serving its primary tenant, Kaiser Permanente. The NIB's conference and training center, fitness and locker rooms along with an outdoor terrace is located on the second floor. Levels 3 and 4 along with half of level 5 are occupied by Kaiser Permanente as a medical office and clinic facility while NIB occupies the balance of level 5 and all of levels 6 and 7 as well as the level 8 penthouse Boardroom, roof terrace and separate service animal relief area (SARA).

Design and User Experience

The workforce located at this headquarters facility is comprised of a typical professional workforce yet with a higher proportion of blind and visually impaired employees. The headquarters is frequently visited by its business and partner interests that also include a high proportion of people with disabilities and most specifically, persons who are blind or visually impaired.

People arrive to this facility by all typical means including car, bike, taxi, ride-share as well as scooter but also via foot as well as bus, and eventually, Metro Rail. Structured below grade parking is available under the building with access directly up into the offices above through the core elevators. Bicycle parking storage is also available with shower facilities on the second floor. A passenger loading zone is located on Potomac Avenue adjacent to the building.

The goals for this project were to provide a new headquarters building uniquely serving National Industries for the Blind (NIB) and their diverse employees creating a space tailored to their important mission through the use of an inclusive and collaborative design process while also establishing NIB's presence as a gateway building within the quickly redeveloping Potomac Yard Town Center (PYTC). More specifically a primary design goal was to create an inclusive work environment for their blind and visually impaired employees and visitors while also serving as a state-of-the-art demonstration of Universal Design principles for the NIB's allied agencies and vendors. It was essential that this project provide and demonstrate a workplace environment where BVI employees could thrive and where BVI visitors could be seamlessly welcomed, empowered and included.

Virtually all NIB staff that are blind and visually impaired were engaged individually and in groups in the planning and design of the facility – especially its workplace environment. Both general and individual needs and concerns were solicited through surveys and interviews as well as directly within specific design aspects of the building. Multiple user group meetings were convened to meet with the design team and the organization's leadership culminating in a post-occupancy discussion for punch-list items and potential follow-up adjustments to various needs and opportunities.

Evaluation

The most successful responses to the project design goals and intentions address the care for visual accessibility, orientation and wayfinding as well as the multi-sensory materials pallet. Regarding visual accessibility, this has to do with the nature of the visual environment to maximize the visual acuity of low vision users within the space. The consistent use of effective color contrast for all primary architectural elements including doors and frames, baseboards, accent walls, flooring changes, as well as the gradated frosted film on interior glass partitions and doors as well as signage and lighting, all work to naturally maximize the visual accessibility of the environment. The approach to orientation and wayfinding within the building by virtue of its simple rectangular and repeatable plan further augmented through its logical room numbering system and further enhanced through its wholistic signage system results in an easily understandable, memorable and easily navigated environment. An essential aspect of the orientation and wayfinding strategy for the building is also built off its material choices that offers both effective color contrast as well as effective tactile contrast for haptic feedback for cane users and under foot for others including dog users. The material pallet with regards to the flooring finishes provide an effective hierarchy to the circulation system in and around the offices and the associated support and ancillary areas.

Universal Design Features

This project for the National Industries for the Blind (NIB) was designed in compliance with governing state and local accessibility regulations including the American with Disabilities Act (A.D.A.). The client further directed that the design be guided by the principles of Universal Design and more specifically for the needs and opportunities of the blind and visually impaired (BVI)as this is a natural expression of the work they do and the people and mission they serve.

Chris Downey, AIA, an architect with 20 years of sighted architectural experience that continued within the profession after losing all sight in 2008, was added to the project team within the Design Development phase of the project to provide consulting design services pertaining to BVI User Experience design as well as Universal Design.

A fundamental position by the client with regards to Universal Design was to insist on it as the core value commitment that would ensure the inclusion of the BVI and not a separate or adaptive strategy. This commitment to Equitable Use as part of Universal Design is demonstrated by the seven (7) principles of Universal Design:

- The controls for the dispatch elevator system, a challenging yet essential technology for this project, would set the non-visual audible interface to be the default modality simultaneously along with the standard visual user interface.
- Furthermore, the decision was made for the control units to be tactile keypads rather than the more common touch-screen control units which provide a legally accessible interface yet as a woefully sub-optimal user experience.
- All rooms, spaces but also work-stations are identified with accessible signage clearly displaying visual, raised characters and braille.
- All designation signage for rooms was built off a numbering system that aids in wayfinding and orientation within the building for the benefit of all and critical for the BVI.
- Beyond the extensive use of accessible signage, the principle of Perceptible Information was explored and expressed through the provision of hard flooring surfaces in all primary circulation areas so as to better enable echo location for BVI cane travelers and to reinforce a hierarchical structure for the circulation areas.
- Additionally, a gradated frosted film was used on all areas of glass walls for increased visibility for those with low vision conditions with contrasting colors of floor finishes at either side of the glass.
- Provisions were also made for effective color contrast for all doors, door frames, baseboards, signs and other critical elements to provide clearly perceptible critical information for the benefit of low vision users.
- Within the fitness room, a hard surface flooring establishes the primary circulation area in contrast to an easily detectable softer cushioned rubber flooring area for workout equipment and stations. This simple but clear demarcation sets and reinforces where the BVI user should anticipate equipment, much of which includes stationary and moving parts that would otherwise be considered protruding objects or non-compliant elements within standard head clearance requirements.
- The primary approach to the principle of Flexibility in Use was to allow for individualized adjustments of window treatments (blinds) at exterior glazing as well as dimmable controls for lighting as well as task lighting at individual work stations.
- The principle of Simple and Intuitive Use is most critically demonstrated through the provision of a very orthogonal linear plan with a very straight forward circulation system that repeats within the primary office levels (levels 6 and 7) with an elevator, bathroom and

stair core that repeats throughout the building. The building is rectangular in plan extending in length from east to west with the core at the center of the length and width with the plan generally mirrored along the center longitudinal east west axis.

- Private offices are located along the length of the north and south perimeter walls with a few open work-stations interspersed amidst the offices. The east and west ends of the plan at either side of the building have open work-stations oriented toward the glazed walls at either end of the building.
- Most critically, A room numbering system was developed in collaboration with BVI employees that offered a logical flow and orientation to the space that would both assist in finding particular rooms, spaces and workstations in a predictable manner while also providing for a sense of orientation by being able to determine the current positioning within the building by virtue of reading any particular room, work-station ore area number.
- Most generally described, room numbers begin at each floor at the center of the east end of the building at 00 and then continue from the southeast corner of the building at 01 toward the Southwest corner with odd numbers along the south exterior wall with even numbers along the center of the south side of the building then resuming at 41 from the northeast corner and repeating the same logic west toward the northwest corner again with the odd numbers along the exterior wall and the even numbers within the central area.

▪ Another example of Simple and Intuitive Use was the use of a tactile keypad for the dispatch elevator system as opposed to the typical touch screen models that have a less intuitive and less optimal and obviously non-visual interface. A traditional elevator would have offered a simpler and intuitive operation for the elevator but would not have provided the flexibility and control necessary for the bifurcated elevator service split between NIB and its tenant. This was especially true with regard to the need for immediate re-configuration in the event that any one elevator might go out of service.
▪ Beyond the typical thoughts regarding the principle of Size and Space for Approach and Use, an additional feature with regards to the dispatch elevator system was the use of a tilted or canted keypad for operation. As the keypads are mounted within reach ranges for people who are short of stature or use wheelchairs, the units end up a bit low for many to use comfortably. Having the keypads mounted so that the bottom edge is projected out from the wall and tilted back with the top of the keypad unit tight to the wall, this angle provides a more comfortable ergonomic position for using the unit than if it had been mounted flat against the wall. This angle also aides the visual reading of the information directing the sighted user to the correct elevator for use.
▪ The principle of Low Physical Effort in this context can be challenging to identify especially within the experience of a BVI user or employee. That said, the straightforward orthogonal and simple planning supported by a predictable, expansive and logical room and work-station numbering system can significantly reduce the stress that can be experienced by BVI employees in workplace environments absent this kind of simple and intuitive use strategy. Failure to provide this fundamental design approach can result in tremendous stress, frustration and wasted time that can ultimately decrease independence and a sense of

inclusion for the BVI employee if not others while also requiring them to unnecessarily waste energy toward what should require less mental effort for menial tasks that result in wasted physical effort.

- Additionally, toward the principle of Low Physical Effort, appropriate lighting levels combined with additional task lighting, dimmable controls and window treatments provide a flexible and tunable quality to the workplace that ultimately reduces the physical and mental stress along with the effort for low vision employees to function well within the space.
- One final design feature of the project that addresses this concern is the client's investment in enhanced sound insulated glazing assemblies within the exterior curtainwall to mitigate the disruptions that would otherwise result from the general street traffic as well as the nearby light-rail station and especially the noise created by virtue of being within near proximity of Reagan National Airport.
- The acoustic environment is essential for effective concentration for the BVI employee, if not everyone. In addition to the noise mitigation, other acoustical attributes of the material pallet including carpet, acoustic ceiling tiles and sound attenuating workplace modular partitions, a suitable acoustic environment is achieved that is intended to reduce stress within the workplace environment.
- More specific to BVI User Experience Design, all reception desks and counters are provided with cane notches that enable a cane to be snuggly leaned against in a stable position to enable a BVI cane user to set it aside when needing to use both hands for a particular task or simply to set it aside for a more casual conversation.
- Additionally, all reception desks are designed to be orthogonal and well oriented within the space contrary to early designs that had a reception desk for the level 2 conference area that was on a radius that fit the space well but which would have been predictably disorientating for BVI users when leaving the desk.
- Otherwise all products and elements within the café self-service area are labelled visually and in braille while the self-service checkout station is set to the default visual operation along with the non-visual interface.
- The materiality of the café break area also organizes the space in simple ways leveraging contrasting colors and floor finishes to visually and non-visually break down the space in service areas, circulation zones and seating areas.
- The carpet used in the seating (dining) areas was selected to signify the area (Perceptible Information) while providing some "calming" and acoustic dampening and absorption for what would otherwise be a very loud and reverberant area yet also address the client's concerns for maintenance and cleanability.
- Finally, a service animal relief area (SERA) is located on the top roof terrace providing ample areas of concrete paving as well as equal areas of AstroTurf for the animals to walk and explore as necessary in advance of taking care of their business on the material of their (trained) preference. The enclosed SERA is also provided with an exterior hand washing sink, hose bib for spraying down the area after use, appropriate area drains, baggie dispenser and a trash receptacle as well as a bench to sit and rest/wait.

Environmentally Sustainable Features

The NIB project achieved LEED Gold Certification with a strategy using Variable Refrigerant Flow (VRF) technology HVAC, eco-friendly building management practices, reflective roof surfaces and locally sourced materials whenever possible.

Project Details

There are a number of products, details and finishes used in the NIB project that enhance the user and specifically the BVI user experience. Foremost among these is the use of accessible signs for every room, space and work-station well in excess of the code required minimum. The signs provide tactile and visual information with high visible contrast for the characters with regards to the sign field but also from the field to the surface that it is on.

Additionally,

- Visually and tactile contrasting flooring products are used to assist in orientation and wayfinding while also supporting suitable acoustic environments.
- To enhance visual clarity and accessibility, a gradated frosted glazing film was specified for and applied to all interior glass partitions.
- Working with the elevator vender and manufacturer, Otis Elevator Corporation, tactile keypads were specified and provided for the dispatch elevator system providing far superior interface for all users.
- Acoustic insulated glazing was provided to mitigate exterior noise so as to ensure an appropriate acoustic interior environment for all building users.
- For the stair linking the street level lobby to the second level conference area, an illuminated handrail directs light down upon the stair treads and risers for increased visual accessibility while providing an unexpected treat of a nicely warmed handrail for the cold winter months.
- Additionally, each of the stair nosing's incorporate high visible contrasting strips to increase safety and visual accessibility for low vision users.
- Finally, the introduction of cane notch details at all reception and counter tops throughout the NIB space were integrated as an integrated design feature for all cane using BVI employees and visitors.

Otherwise, it's important to note that many of the products specified for use in the building are products manufactured by the NIB's partner non-profit blind agencies through the contracts administered by NIB.

Lessons Learned

There are a few aspects and elements within the project design that are less successful. One challenge has to do with finding the front door at the corner of Potomac Avenue and Glebe and specifically the card key reader and intercom unit at the front door. Generally speaking, the front door is well articulated as a recessed alcove with canopies extending out above off the face of the building which all add to the acoustic and visual identity of the entry. The challenge emerges out of the situation wherein the address, 3000 Potomac Avenue, as preferred by the client, has front doors in the alcove recessed back off the corner in a nice covered area but with doors that face Glebe Street. It can be a little confusing but easily anticipated and explained. The challenge emerges in finding the actual door, or more specifically the card reader and intercom that must be found and engaged to enter the building. Ultimately, the unit, integrally mounted on the storefront glazing assembly to the right of the front door is perfectly logical and is visually accessible but is ultimately only marginally cane detectable and easily missed.

As a retrofit solution, a rubber walk-off matt that was placed on the ground in front of the unit making it easily cane detectable and more visually evident. Other more architectural solutions were considered that could have provided an integrated tactile guide or demarcation at the unit that could also have been cane and more visually detectable but was not feasible as a fix after construction. An alternative for consideration for other situations would be to use a pedestal mounted card key reader and intercom unit that could be located slightly in front of the storefront glazing immediately adjacent to the right of the (sliding) doors. This can be a little trickier when used in conjunction with out swinging doors due to maneuverability around the swinging doors but is more manageable and straight-forward when used with sliding doors. Part of the challenge that led to this condition was that it was initially assumed that the card reader and intercom would be at the second (interior) doors within the vestibule such that the exterior doors would have automatically slid open so that the sliding operation could have been heard on approach and effectively given an audible beacon to spatialize the doors location and an open door that would be easily cane detectable.

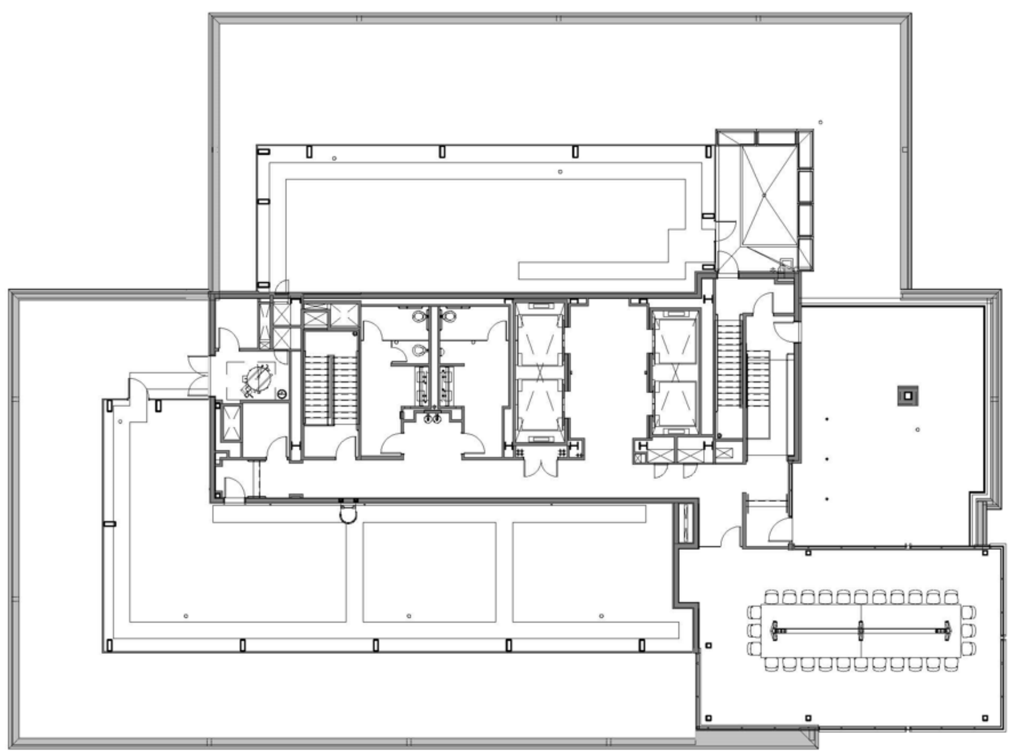
Another less successful aspect of the design is the challenge of orientation when stepping out of the elevators, especially on floors 7 and 8 for the NIB offices. This is a challenge because the elevator lobby has a pair of elevators on either side of a simple rectangular lobby with openings out to the work areas off the north and south sides. As it is possible to take elevators at either the east or west elevator banks, it is easy to lose orientation and fail to remember which side you are on when exiting. There are sufficient visual elements to immediately provide the orientation but there is insufficient non-visual multi-sensory bias built into the elevator lobby to provide immediate orientation.

The most accessible quick queue to resolve the orientation is to reach for a flat screen monitor mounted at typical eye level between the elevator doors on the west wall, whereas there is no monitor on the east wall. Another option is to turn up the volume on the display monitor so that it could be heard. But as there are work-stations nearby, that would likely be too disruptive. In retrospect, it would have been preferable to create some other multi-sensory bias to the elevator lobby by having contrasting threshold finishes at the openings to the north and south sides, to have contrasting tactile finishes on the east and west walls and/or some other multi-sensory difference to embed a more obvious bias to the space.

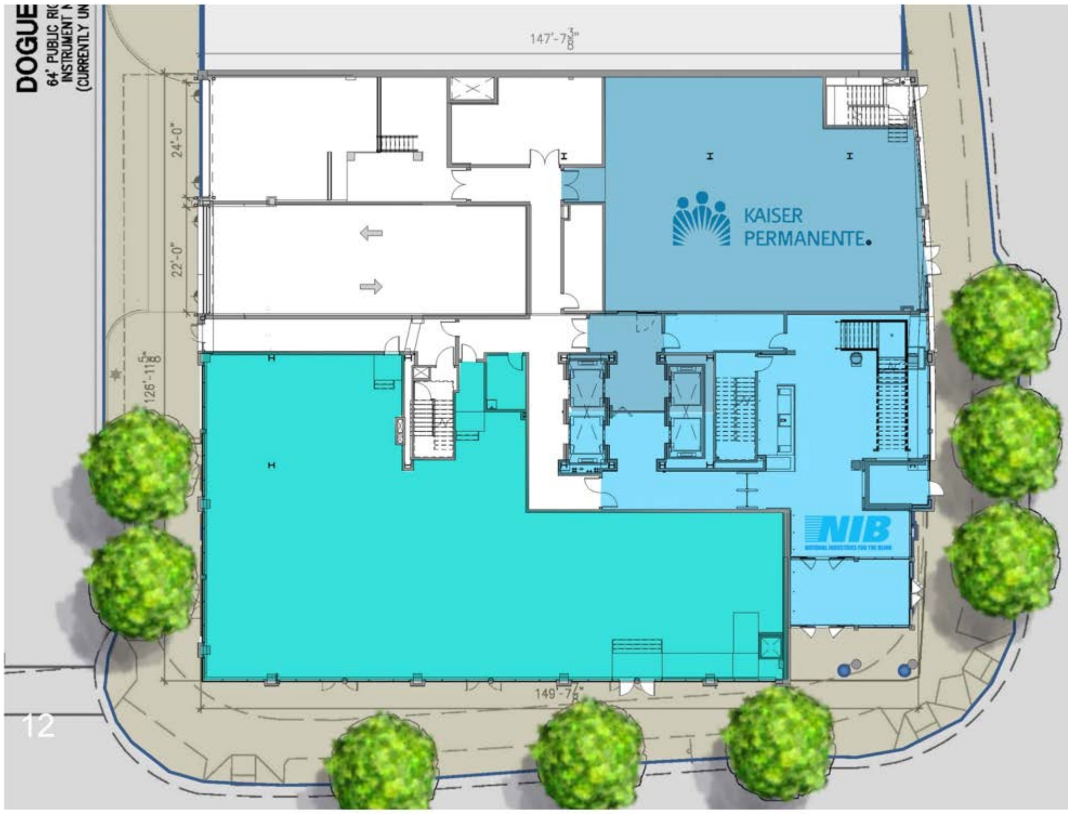
Another challenge that emerged after occupancy was that the lighting design anticipated light levels appropriate for the most common forms of low vision conditions. One employee, however, had a visual impairment that results in tremendous sensitivity to light requiring that her workstation have very low light levels. Although the initial solution was to simply leave the overhead lights off in that immediate area, the light tied to the lighting circuit that was always required to be “on” by code was directly in front of her desk. Rather than having to relocate her workstation, the overhead lighting was re-circuited so that the required illumination could be out of her line of sight and as remote as possible from her immediate work area.




NIB 8th Floor Plan



NIB First Floor Plan



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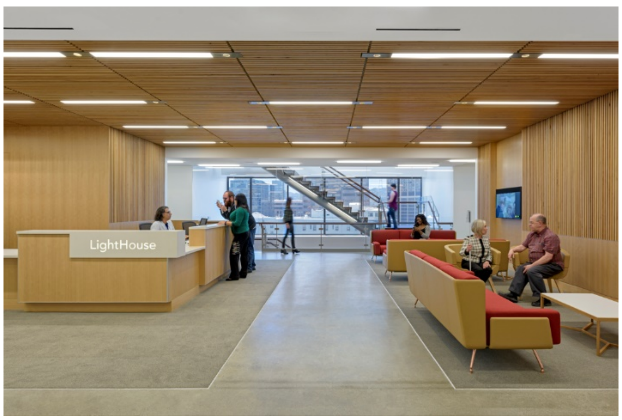
LightHouse for the Blind and Visually Impaired, San Francisco, California

Introduction

The project for the San Francisco LightHouse for the Blind and Visually Impaired (LightHouse) was a tenant improvement of the top 3 floors of an 11-story building, floors 9, 10 and 11, located at 1155 Market Street in San Francisco. The building is a modern commercial office building originally constructed in the mid-1980's directly across Market Street from UN Plaza. In 2014 -15, Prior to the work by the LightHouse, the building underwent a major renovation at the street level lobby, and elevator core as well as some of the building services and core restroom facilities including the core restrooms on level 9 but not on levels 10 and 11.



Description

The Lighthouse's criteria for the location of its new headquarters included the intent to stay within the City of San Francisco and be located at or in very convenient proximity to BART (Bay Area Rapid Transit) and other municipal bus and rail service. The majority of the Lighthouse's employees, approximately half of whom are blind, and their entire client and community base are blind and visually impaired (BVI), making them dependent on mass transit. Otherwise, as their intent was to team with a known developer to jointly purchase an entire building, the property needed to be jointly viable within each organization's economic interests. This building's floors 1 – 8 are leased and occupied by City offices including the San Francisco Mayor's Office on Disability at street level and that the City as tenant sharing the building offered significant financial security. This location also had the benefit of being within a long-neglected stretch of Market Street that was undergoing significant investment and boasting major global technology companies. City Hall is also nearby.

The LightHouse is located at 1155 Market Street on the south side of Market between Seventh and Eighth streets and across from UN Plaza, Hastings Law School and one block east of the

Twitter Headquarters. It is located within 20 feet of the nearest BART and MUNI (underground) Civic Center Station. San Francisco's new Federal Building, opened in 2008, is in near proximity behind the building. The LightHouse project is located within a slowly emerging but still gritty stretch of Market Street at the edge of the Civic Center district of San Francisco. That said, Trinity Place, a new four-tower residential project is under construction on the adjacent site to the west with its fourth and final tower scheduled for completion in 2021. When complete, it will transform the area offering a total of 1,900 units of housing, a major Whole Foods Market and additional street level retail.

The LightHouse occupies the top three floors of the eleven-story building at 1155 Market Street while the City of San Francisco has long-term leases in place for the remainder of the building including the San Francisco Mayors Office on Disability at the street level. Level ten, the mid-level of the three floors for the LightHouse headquarters serves as the main reception and most public interfacing floor of the project. North of the main reception, includes large multi-purpose rooms along the north (Market Street) side, a large training kitchen, a video-conference room and a pre-function space with a coffee and (event) wine bar central to these program areas.

People typically arrive at this location via BART and MUNI at the underground station directly in front of the building. For those that can use the stairs, the exit from the underground station comes within about 15 steps of the front door of the LightHouse building. For those that cannot use the stairs, an elevator servicing the station is directly across Market Street where there is a signalized mid-block crosswalk with audible pedestrian signals that lead directly to the front door of the building. Other accessible bus and light rail service is available along Market Street near the building. A small garage under the building accessed off Stevenson Street along the back of the building offers limited parking for agency vehicles and occasional employee use with availability by special arrangements for events after hours. Parking is generally available in nearby public garages. Taxi service is available along Market Street whereas ride share services are limited to service at the nearby cross streets or at the back door to the building. Some employees cycle to work storing them in the dedicated bike storage within the building.

Design and User Experience

The challenge put forward by the LightHouse Executive Director was to create an empowering experience for a person experiencing sight loss and stepping into the LightHouse for rehabilitation services for their first time. This first impression was to be the antithesis of the negative experience he had in his first visit to a similar agency decades prior which left him pessimistic and dreading his future prospects in blindness. The charge for the LightHouse was to immediately welcome this first-time client to a community alive with optimism, positivity, activity and energy within an environment that was rich, delightful and respectful and connected within the blind experience.

The design challenge was to create an environment that was especially resonant to the multi-sensory, non-visual and low vision experience of the users while presenting an environment that was not overtly adaptive or “special” but rather, surprisingly normal. The challenge was to address those concerns and opportunities in a manner that was subtle, well-integrated and all organic within the overall design aesthetic. Despite this, it was also to be visually appealing and positive for the sighted Lighthouse family members, loved ones and friends of the people they serve and the community at large. It was also to be a rich and delightful place to work that would attract and retain high quality employees. The design goal was also to engender a sense of community providing places and opportunity for chance encounters and spontaneous conversation for the staff and community all within the normal day-to-day routine of the agency.

The LightHouse provides rehabilitation services for people with or experiencing sight loss. By definition and mission, the demographic they serve are blind and visually impaired. Beyond that, the LightHouse is unique in that, at any given time, their workforce is more than fifty percent BVI including a majority of their senior leadership and by decades-long tradition, their Executive Director. By policy, their governing Board of Directors is required to be at least fifty percent BVI. Another demographic served is the deaf-blind community for whom they offer training and community. The Lighthouse also has a Federal Communications Commission (FCC) grant to provide adaptive technologies specific to this group across the state of California.

The south side of level 10 includes the Adaptations Store, a Demo Lab, the CA Phone Access Service, Community Service offices, Adaptive Technology Training and office space as well as exam rooms for the Berkeley Low-Vision Clinic. The reception area at the center of level ten is located immediately west of the elevator and core bathroom lobby at the east side of the building and includes typical reception services as well as a comfortable sitting area. Two new single-occupant gender-neutral accessible restrooms were added at either side of the west end of the reception area as permitted by city ordinance. These single-user toilet rooms were necessary since it was not possible to achieve the required plumbing fixture count resulting from the new large assembly areas on this floor and the current dimensional requirements for toilet room accessibility within the limits of the existing core restrooms that are land-locked between the existing elevators and the egress stairs. A new open stair along the east side of the reception area was cut into the tenth and eleventh floor slabs to connect and unify all three floors together for the organization.

Down one level to the ninth floor, the elevator lobby and open grand stair both land at either side of the Volunteer Lounge with a comfortable seating area and the Volunteer Coordinator’s office flanked by three small “reading rooms” at either side. The Executive Offices, Board Room, Development offices and Psychological Service offices along with a conference room. A more casual “living room” and a coffee room are located to the north end of level 9. The south side has yet more administrative offices, I.T. services, HIPPA storage, the MAD Lab (Media and

Accessible Design Laboratory) and braille/tactile graphic production room as well as a staff break room and kitchenette.

The top floor, level eleven, has a lounge space at the center that connects directly with the core elevator and restroom lobby to the east and the grand open stair to the west. Rehabilitation Service offices are located on the north end of this floor along with some training rooms, a fitness room, craft room, a STEM Lab/hacker space and a HAM radio station. The south side of the eleventh floor includes a short-stay dormitory facility with 21 beds (1,2 and 3 bed room configurations), separate men's and women's shower facilities, laundry room and a shared kitchen that opens out back into the employment "Immersion Lounge" at the center of level eleven.

The design process for the LightHouse leveraged tremendous levels of user engagement throughout all phases of the project. As the Executive Director and the Senior Director of Programs were both blind, the concept of user engagement started at the top and ran through the organization prompting numerous user group studies throughout the project. The primary resource for the user group. Studies came largely through the diverse pool of BVI employees and members of the Board of Directors as well as from within the community of people they serve. While the client engagement was extensive within the senior executive leadership, it drew more heavily upon BVI staff and community members for user group studies related to signage, effective color contrast all sorts of miscellaneous relevant details, and what the lighting designer regarded as the most extensive and most engaged lighting mock-up testing they had ever done.

The BVI executive leadership and select BVI members of the board of directors with relevant expertise were also deeply engaged in quasi-user/client group testing within the acoustic modelling and design process. A larger but overlapping group was directly engaged with the consultant team in the design of a from scratch custom accessible Audio/video control panel.

Evaluation

Designing a rich, lively and empowering first impression for a person experiencing sight loss coming to the LightHouse for the first time leveraged a multi-sensory design strategy built upon strategic programming and planning. Locating the reception area on the tenth floor immediately adjacent to the existing elevator core together with the decision to create a new internal communicating stair connecting all three levels formed the essential back-bone to design response. This put the reception a maximum of one floor away from any function at the LightHouse and enabled a visual and acoustic connectivity between all floors. Having the new stair open within this space created a sense of community and cohesion that could not have existed without it as each floor would have been floors unto themselves with connectivity only possible through the existing core elevator lobbies.

By encouraging staff to come and go through the tenth floor, the reception area is the effective heart and the most animated and lively focal point of the headquarters through which most people pass. The design of the stair to have one flight of stairs stacked upon the other extending across the entire west end of the reception area rather than switchback stairs meant that people walk the width of the reception area to continue on to the next floor. It effectively increases the opportunities for chance encounters and conversation as well as animating the space. The use of wood as the stair treads and risers give a nice audible quality and timbre to footfalls, cane taps, conversation and rattles of dog collars as people use the stairs giving presence of the stairs within the reception area whether it is seen or not.

Having a regular schedule of events and activities organized around the pre-function space to the north of the reception area lends a buzz and vibe heard outside of the activities within the pre-function or Multi-Purpose rooms. Some days the sounds and smells of a class in the Training Kitchen enliven the space. At other times, from the reception area you may hear chatter from the Adaptations Store down to the southeast of the reception area where all products can be picked up, explored and discussed with a very lively and knowledgeable staff – most of whom are blind themselves.

At other times, staff may come out to welcome a student waiting for a tech training session down the hall on the southwest side or perhaps overhear conversation or laughter from the Immersion Lounge above or from the administrative staff on the level below. Taken together, this all creates a framework in which the reception area serves as the heart of the headquarters with the most energy and traffic coming to and through it at all times.

Fundamental to the success of achieving this lively yet pleasant environment, though, was the acoustics. Acoustical design modelling and design listening sessions were held in Arup's Sound Lab with the project team and LightHouse leadership. This process was essential to achieve project goals while preserving a comfortable acoustic resonance and ambient noise level balanced with effective speech intelligibility for the receptionist. It was reported by one of the receptionists after about two weeks in the new space, that he loved how he could hear so much activity around yet had simple and easy conversation with people across the desk or on the phone.

Another success rooted in the acoustic design and performance is the open training spaces off the circulation loop. These spaces, thought of as "acoustic mitts," were in response to the Executive Director's desire to not have all training and conversation lost behind doors in a way that would lose the energy of the place. The degree of acoustic absorption and treatment within these spaces provide a very comfortable intimate setting for one-on-one sessions but also allow a sense of community connection for those inside and those walking past.

Staying with the acoustic performance, the “Voice Lift” system installed within the Boardroom is a tremendous success that effortlessly reinforces the location of the person speaking. The BVI listener at the opposite end of the large table knows exactly where to look for the person that is speaking.

The design of the visual environment, beyond being a rich, well-designed visual experience, is also successfully visually accessible through the use of effective color contrast within the architectural finishes at doors and frames, baseboards, stair nosing strips, and key feature elements as well as the room identification signage. The three-inch-high room numbers at each door (larger than permitted by code for accessible signage) combined with effective color contrast has been particularly successful with regards to visual accessibility and effectively supports the room numbering as part of a wayfinding system.

Although a post-occupancy evaluation has not been performed, the anecdotal feedback is that the high levels of illumination have been successful and effective for low-vision users although some sighted staff without visual impairments have reported the light levels to be a little high.

But. . .

Although the strategy of having the new stair at the opposite side of the reception area from the elevator lobby provides for equitable use regardless of how people change floors, the subjective or qualitative experience is not quite equitable. As access from those lobbies back into the LightHouse space requires use of a keypad, using the elevator has an almost has a “back door” quality to it that suffers in comparison to the experience when using the stairs. Regardless, the new open stair and the sense of community created for the entire organization is dependent on this strategy and it would be cost prohibitive to have a receptionist at every floor located immediately off the elevator lobby that would be required to establish the necessary level of security and control if these lobbies were left open.

As successful as the acoustics are and as effective as the lively reception experience is, when major events are underway at the Multi-Purpose rooms, the noise can be a little too loud and disruptive back into the offices and training areas at the south end of that floor. At such times, the doors between the reception area and the offices to the southwest corner typically get shut which solves the problem even at the sense of openness for the organization.

Otherwise, there were two oversights within the acoustic modelling efforts that have had negative impacts – one that has been resolved with the other still unmitigated.

The first acoustic problem emerged upon occupancy. It occurs within the corridors of the dormitories as they were found to be too loud and reverberant. The system had been the same as other parts of the headquarters but changed from acoustic ceiling tile to a fire-rated sheetrock over the corridor in that area to comply with fire code. The solution, after construction, was to add commercial grade carpet tiles through the corridors and some intermittent acoustic baffles.

The other “noise” problem doesn’t have an easy solution as it is related to the condenser for the commercial grade refrigerator in the training kitchen on the tenth floor. Unfortunately, the noise level of this fixture was not anticipated or modelled for the space and even if it had been, there does not appear to be commercial refrigerators that operate within an acceptable noise levels for this space.

One last aspect that could be thought to detract from the low-vision user experience is the decision to not have “manifestations” on the areas of large glass walls. Manifestations are decals or some form of visual marking on a glass wall at eye level to make the invisible glass sheet visible and evident. This had been considered and cleared with a limited sampling of low vision users with the determination that the glass is sufficiently evident through reflections on the glass as well as the phenomenological presence of the glass as you get near to it. Additionally, there is a reasonable argument to be made that proper cane use resolves the risk of collision with the glass and the perimeter mullions and the effective color contrast at either side of the (sill) mullion on the floor provides some additional evidence of the glass wall. Ultimately, a less “adaptive” and more integrated strategy than the use of manifestations could have been used such as the use of intermittent vertical and/or horizontal mullions within the glazed wall to better define the plane of glass. That said, I’ve yet to hear of any anecdotal stories or complaints that the glass walls have been a problem in this particular application.

Universal Design Features

Mark Cavagnero Architects Associates was selected as the prime architect in part for the firm’s inventive and creative Universal Design solution for the renovation of the historic Durant Hall on the UC Berkeley campus. Consulting architect Chris Downey, blind since 2008, a former client of the agency and a board member, was engaged as a design consultant for this project with regards to BVI user experience as well as universal design.

The applicable accessibility codes and regulations for this project included the 2012 CBC (California Building Code) Chapter 11b and the 2010 ADA Design Standards. Consideration of Universal Design emerged from the client’s interest to exceed the minimum requirements of ADA and the CA accessibility regulations with an interest and commitment to a more equitable blind-centric environment that was rich yet subtle in nature that could provide a uniquely wholistic and integrated environment. The goal was a surprisingly accessible environment for the users yet remarkably "normal" by not appearing to be adaptive or "special."

This project meets and exceeds known accessibility requirements in many regards responsive to the explicit needs of the BVI but more generally within the greater disability experience.

Critical to the visually impaired and specifically within the consideration of the low vision experience, the LightHouse sought to provide the level of lighting established at its prior location and as consistent with recommended lighting levels for similar facilities. These lighting goals are not addressed in ADA Design Standards nor in the California accessibility regulations.

More significantly, the recommended level of illumination by virtue of limits regarding light density was not attainable within the limits of the California energy regulations. Using state-of-the-art efficient lighting and control systems, the lighting designers were only able to deliver a quarter to a half of the lighting levels advisable for the majority of the circulation and program areas of the project. Supported by industry guidance and the significant BVI demographic for workers and service recipients with BVI, the project team sought and was granted an ADA workplace accommodation agreement that exceeds the state lighting restrictions and delivers the light levels (density of light) needed.

Additionally, the LightHouse low vision user group studies revealed that the character height requirements for tactile signage required by the ADA as well as the CA accessibility regulations were too small to be seen. A sign strategy was developed that met the code requirements yet augmented them with additional room numbers above the required signage at the desired/preferred size. Additionally, all rooms were provided with accessible designation signs.

For the new open grand stairs linking the three levels together at its central (10th floor) reception area, high contrast nosing strips were integrated at each stair tread providing 70% lumens contrast at the first and last nosing of each run of stairs with 50% contrast at all intervening tread nosing's. By CA regulations, only the first and last stair nosing's for each run of interior stairs were required.

For egress, a (now discontinued) audible and highly visible exit hardware was used at each of the 2 emergency doors off of each level. This product, tied to the building's alarm system, would speak out "Emergency Exit here," in English and Spanish, whenever the emergency alarm system was triggered. Additionally, a laser light arrow sign would be directed at the floor and would move to lead toward the exit door. In situations where the exit door is off the primary circulation system accessed through an exit corridor, a series of high intensity light dots low on the wall would provide a moving string of lights toward the exit.

The LightHouse also integrated an infra-red hearing loop system within all of its multi-purpose, "living rooms" and conference room areas for the benefit of those with hearing impairments.

Finally, the design process was led by the Principles of Universal Design with a strong focus on responding to the BVI experience. There were many strategies deployed with regards to effective color contrast, multi-sensory design related to perceptible information, extreme concern for equitable use with regards to avoiding bias of any one group over another.

Environmentally Sustainable Features

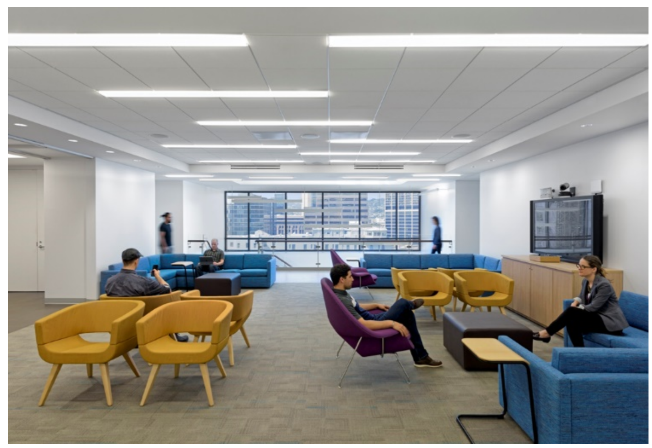
Environmental sustainability is always a key concern especially within the San Francisco Bay Area. However, it was not a key driver for this project. That said, the project did comply with the San Francisco Green Building Ordinance for interior tenant improvements and the HVAC system complies with the strict California Title 24 Energy Use requirements. Additionally, all new plumbing fixtures were specified to be low-flow to conserve water.

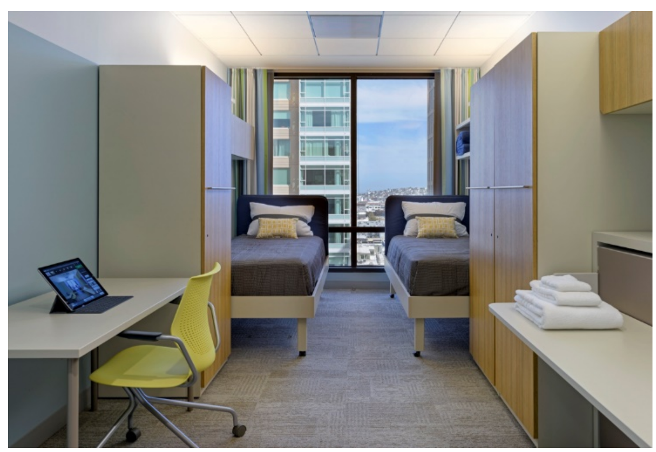
Not explicitly an energy sustainability tactic, the addition of the new interior open communicating stair linking all three levels of the LightHouse effectively limits the reliance upon and use of the elevator system and the energy required therein. The options of stairs encourages general health and wellness for the occupants and users. Above the opening cut into the existing floors for the new stair, a new linear skylight was cut into the roof slab to introduce more natural light into the space while the Sono-Tube skylight system was used to provide natural light at specific places within the corridors for the eleventh-floor dormitories where existing rooftop mechanical equipment would not permit the necessary alignment where needed.

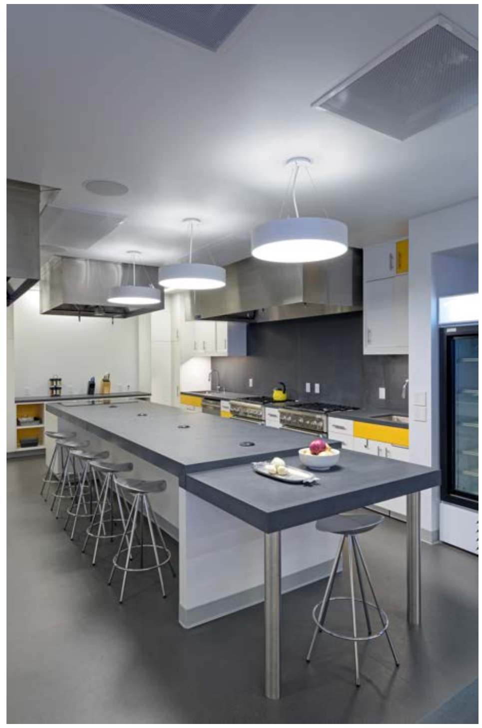
Additionally, low-VOC (low volatile chemical) paints, flooring (carpets and resilient flooring) and finishes were used throughout the facility while the main circulation corridors and paths took advantage of the existing concrete slab polished and treated with a low sheen, (low glare for low vision users), and a low-VOC sealer.

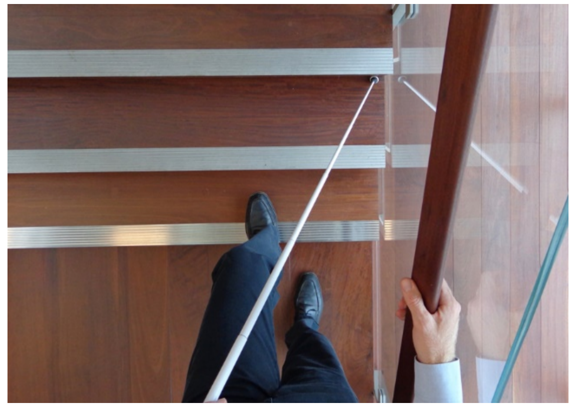

930

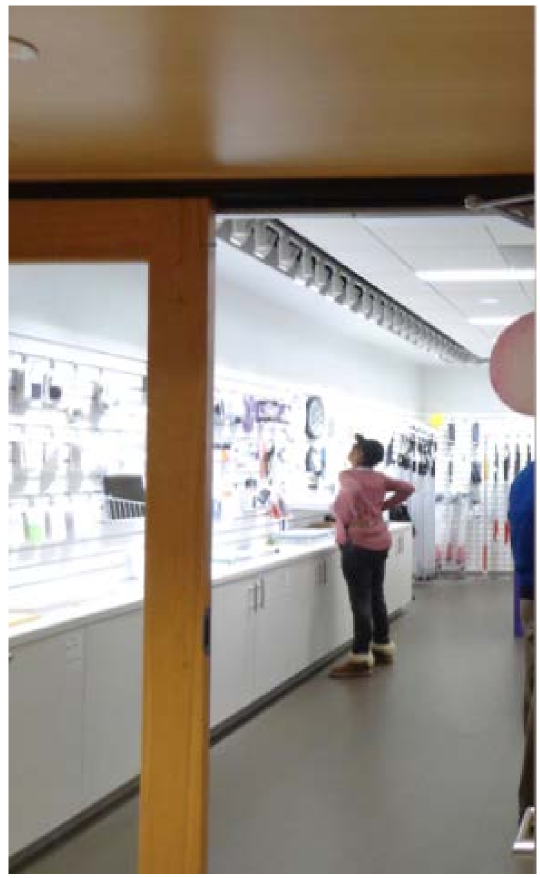

A

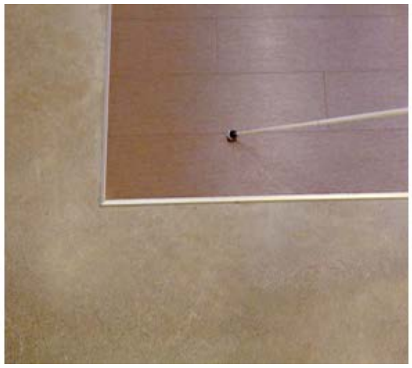


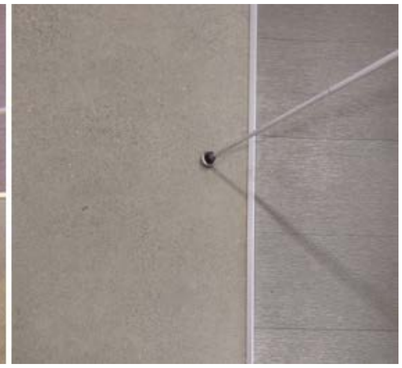


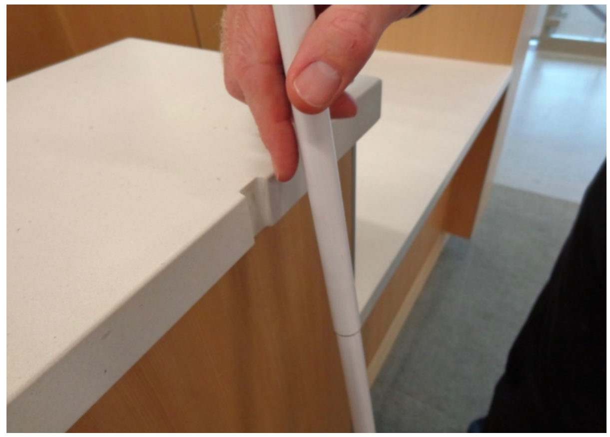










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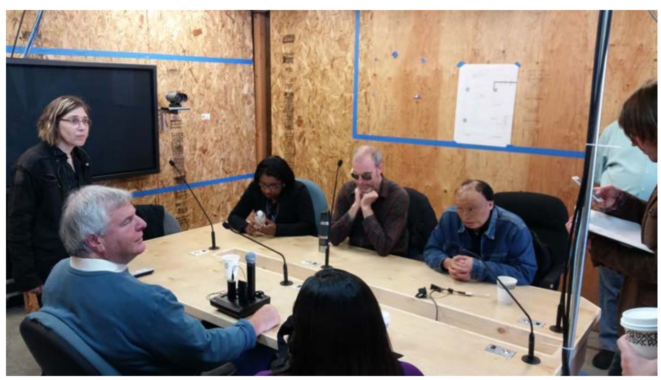
CONFERENCE
ROOM




POSITION
RM A
RM B
RM C
ROOM PRESET
LAPTOP 2
BLURAY
LAPTOP 1
SAT TV
AUD CONF
APPLE TV
OFF
VID CONF
TALK
DIAL
1
2
3
DIAL
4
5
6
HOOK
7
8
9
FLASH
#
0
*/.
BACK
CLEAR
TALK
ROOM COMBINE
AB
BC
NONE
ABC
TALK
AUDIO
VIDEO
AUD CONF
VID CONF
MIC 1
MIC 2
PRIVACY
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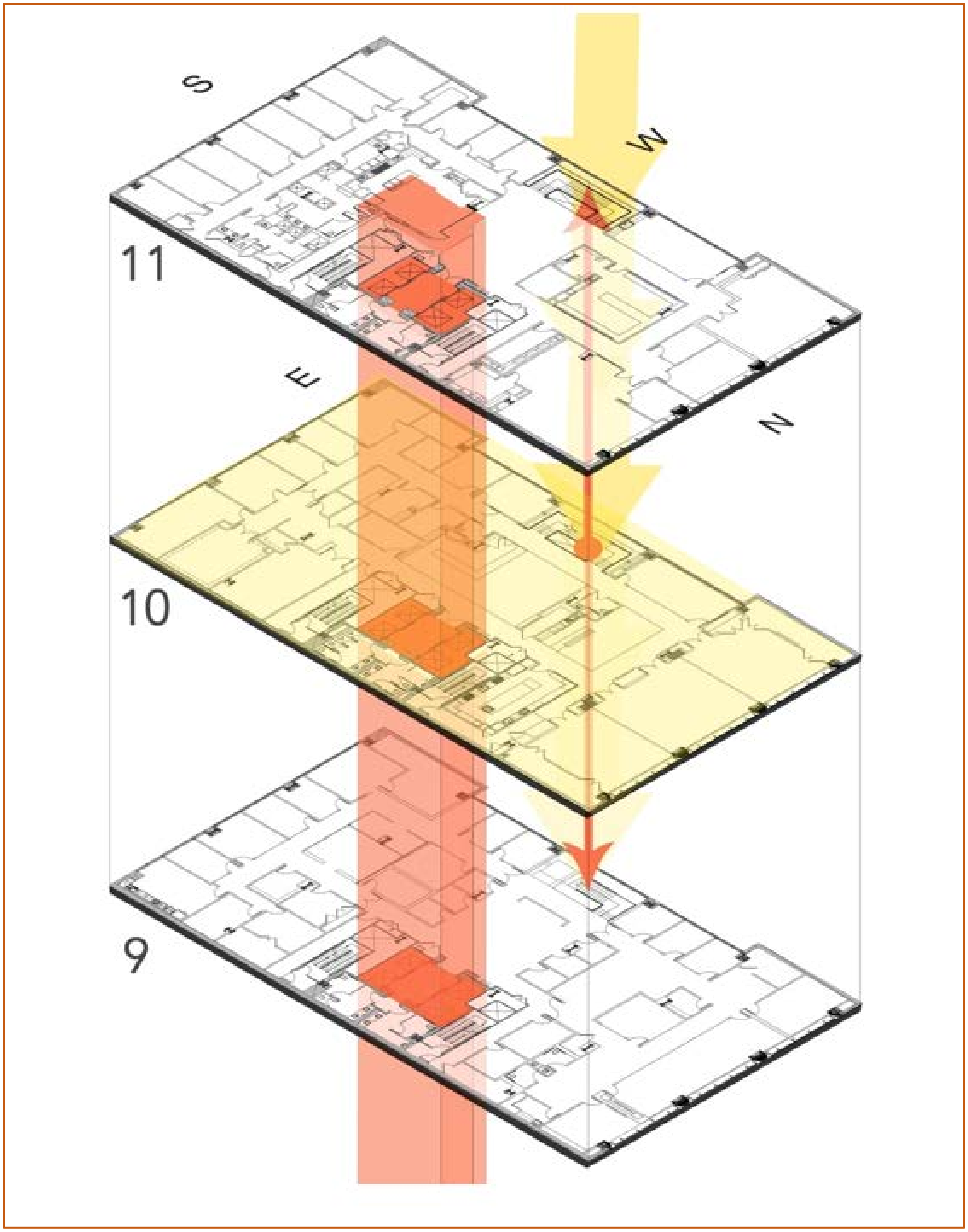

Architectural rendering of LightHouse's floorplates floor nine through eleven.

Project Team

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Institute for Human Centered Design Headquarters, Boston, Massachusetts

Introduction

The Institute for Human Centered Design (IHCD) is an international education and design non-profit organization committed to advancing the role of design in expanding opportunity and enhancing experience for people of all ages, abilities, race/cultures and socio-economic status. IHCD was founded in Boston in 1978 as Adaptive Environments and changed its name on its 30th anniversary to have a name more reflective of current work. IHCD's headquarters have always been in Boston though some of the team work remotely in other parts of the US.

IHCD meets its mission through an unusual mix of education, technical assistance, consulting, research and interdisciplinary design services. Each activity informs the others for a dynamic interplay of learning and exploration. As deep content experts in both accessibility and Inclusive Design, IHCD does mission-driven consulting and design services so makes most of its budget through earned income.

For many years, the organization was based in Boston's Fort Point Channel in a building that is the border building of Boston's Innovation District. When the Boston Wharf Company, the London-based owner of the historic building sold it in 2003, rents tripled. Given that neither IHCD's own space nor the building reflected the mission of inclusive design, IHCD went searching for alternation space for a new headquarters that could be reflective of its values and allow more space for programs and research.

Description

IHCD leased a new headquarters in Boston's West End, a downtown neighborhood between City Hall and North Station, one of Boston's two transportation hubs. North Station is home to two subway lines, a portion of the commuter rail system, and Amtrak's last East Coast link heading to Portland, Maine. It is also Boston's premier sports and conference space. IHCD leased the whole first floor of the historic building that has 100 hundred running feet of very large windows and about 8,600 square feet of space. Some of the space had 14-foot high ceilings. It also had not been renovated since the early '80s and had not been leased for 6 ½ years. There were also three slight level changes in the rectangular space. It needed significant renovation.

This project is a good example of a renovation driven by Universal Design that had scant resources to undertake the project. The allocation from the owner for renovation covered demising the space, the replacement floor, creating three low ramps between levels, walls and plumbing pipes for two new toilet rooms.

Despite an extremely limited budget, IHCD wanted to create a space that would not only house the Boston IHCD staff but also provide an environment that reflected its organizational values. The space needed to seamlessly welcome and accommodate the widest possible spectrum of staff, interns, board members, visitors, and User/Experts. The goal was to design a space that also communicated that Inclusive Design could be attractive and cool, and that would read as a good design.

IHCD was fortunate to have two key assets that made big goals possible. First, IHCD had a set of relationships with manufacturers who generously provided furniture, appliances, fixtures and also friends who donated the 'grace notes' of the space (a set of distinguished mid-century modern furniture and two large tactile sculpture installations [see list in Project Team]). Second, the Executive Director's husband is a sculptor and furniture designer and maker (Slot-B-Design) willing to commit over a year of pro-bono labor plus the cost of materials and a contribution to studio rent.

Design and User Experience

IHCD engaged the staff early to seek ideas about needs and preferences. There were programming sessions about the programs and activities that would take place in the new space, substantially larger and offering many more opportunities that the previous space. An expectation of a much more public space was discussed and how to best separate public and staff areas. Visual privacy was a concern that needed to be balanced with access to natural light. Work spaces would be designed that kept solid surfaces low and semi-opaque above.

As the design evolved, it was possible to solicit much more specific ideas in response to detail. Flexible height of working surfaces was important and people needed more or less storage.

The majority of staff had lived experience with functional limitation so that breadth of specific needs informed the inclusive design solutions.

The organization of space evolved around fixed structural elements that would be kept with a priority on keeping the retail space, the conference room, and the library separated from staff work space.

One of the new challenges of the space was the visibility of the space to the street. Staff were uneasy about the idea of being so visible to passersby. The resolution came in the final design by Coco Raynes of the window coverings. Only the retail area keeps the windows largely clear at the bottom. The balance of windows had solid acrylic film or dense film graphics that significantly obscured direct observation. Night lighting was also a condition of occupancy. The neighborhood was in transition and there were large crowds at night for the Boston Celtics and Boston Bruins games at TD Garden at North Station as well as concerts all year round when there were not games. The owner and neighborhood association wanted a lively streetscape. The final window design satisfied the community and the staff.

Inclusive/Universal Design Features

The Principles of Universal Design were first promulgated in 1997 and created by five US organizations including Adaptive Environment, IHCD's original name. They were copyrighted to the Center for Universal Design at North Carolina State University at Raleigh. IHCD incorporated these principles into all of our work but will use them as a convenient way to illustrate features in this case study.

Equitable Use The work space was designed to anticipate both known and unknown users with a certainty that diversity of ability would be a constant. Entries, toilet rooms, kitchen and any shared work spaces are designed for everyone. Individual work stations are the same materials and vary slightly in size based on functional needs and location.

Flexibility in Use Nearly all of the furniture is designed with wheels and locking casters to maximize flexibility for individuals and for the space itself. In addition to the IHCD Boston-based staff, IHCD also commonly welcomes twenty (20) interns, co-op students, and fellows over the course of each year. Many have lived experience with a functional limitation. Flexibility in the physical environment includes being able to tailor a space for your needs, being able to move about the space over the course of the day to find somewhere that works best, flexible policies to allow remote work if needed and/or desired.

Simple, Intuitive Use Humanscale's Liberty chairs are dominant throughout the office and have simple adjustments that can be figured out without a manual or a tutorial. Toilet rooms all have automatic sinks and hand dryers.

Perceptible Information All furniture contrasts with the flooring. Braille labels have been added to controls on the microwave and Washlet controls. Each workspace has a framed photo of the employee who uses it along with a name in print and braille. The cooktop was chosen because it has three dimensional, easy to reach knobs.

Tolerance for Error Toto Washlets are toilets with built-in bidets and are in two of the single user toilet rooms. The alarm system uses a simple fob that can be passed in front of the security box mounted on the wall to lock or unlock the office. All flooring surfaces are matte finish (wood, carpet, rubber flooring to prevent glare.

Low Physical Effort Examples include a coffee pot that is plumbed into the space and needs only a click of a switch. The microwave is installed below the counter in the kitchen and has partially open sides for ease of use even with little strength.

Size and Space for Approach and Use The kitchen area is designed with open space under most of the counter including the cooktop. There are easy turning radii throughout the space. There are no areas of the space that require backing and filling for wheelchair users.

Environmentally Sustainable Features

IHCD committed to maximum integration of environmental sustainability and inclusive design in the renovation of the space.

- Demolition was the first opportunity to act on that commitment. What interior elements could be incorporated into the new space were kept. That included two existing accessible single user toilet rooms. As much of the old build-out as possible was recycled including wood and glass.
- Water efficient Toto toilets and sinks replaced the original plumbing fixtures in the original toilet rooms and were used in the two new accessible single user toilet rooms.
- A new policy of not having a water cooler in the space and discouraging staff use of disposable plastic containers included double filtered water from the sink.
- Nearby Suffolk University's dated library was slated for replacement in a new building. The building was slated to be imploded with all of the fixtures in place. With the help of an IHCD board member on the Suffolk faculty, IHCD was able to recycle hundreds of running feet of library shelving that became a design feature forming one wall of every work station.

- When the new library was ready, there was an excess of needed new shelving. The University made a gift to IHCD rather than ship the excess shelving to the
- The entire original floor had to be replaced. Maple "shorts," lengths of flooring leftover from longer boards, was used for the floor.
- IHCD purchased flatware, glasses, cups, dishes and serving bowls and plates that are washed after every use even for events rather that disposable products.
- All wood for work stations, kitchen, sliding doors was Forest Stewardship Council (FSC) certified.

Project Details

Design development evolved to include an overall concept of public space along the front long side of the rectangular floor plan. The three shallow levels worked to add a sense of transition and defined the functions of the spaces subtly. These grade changes were slight but the ramps with double height railings and a two-inch wooded edge evolved as quasi-porch areas with staff often gathering there, leaning and sitting on the railings, for a quick chat.

There is a sequence of program from the entry door to IHCD directly from the building lobby after passing through a vestibule from the street entry.

- Retail occupied the first full level on both sides with a screen looping videos or presentations toward the street. A shallow ramp with stainless steel railings made the transition to the next level.
- Exhibits were on the next level with a mix of graphics and free-standing rolling displays and integrated lighting. The conference room was opposite with a 10-foot set of sliding wood and glass doors with Hafele hardware that could telescope to open fully to the exhibit area, allowing that space to double conference room capacity if needed.
- With a very large free-standing cabinet forming a wall on the exterior side and a salvaged original wall on the other, the next space had the library on the interior side and a library reading/working area on the window side with displays of recent books and magazines.
- Transitioning to the next level via a shallow ramp, this is the largest area with two aisles of work stations on both sides for a total of 16 opposite the window wall. A small meeting room is at the back with an office equipment (large capacity multi-function printer +) area in between along with storage.
- On the window side of this area is the open plan kitchen on the left and an open area with chairs and eight tables. These are all on wheels and can be configured into different size tables or used as clover-shaped individual tables. The tables can be flipped up to be stored in a three-foot square area.
- The final bay is the last change in level and has three work stations toward the rear with an additional work area with more extensive surfaces for drawing and plan review. The window wide of this space includes hung bicycle store adjacent a half wall with a ramp

around it to the rear exit. A large storage room is behind this area that has since been converted for use as the User/Expert Lab.

- There are four toilet rooms, all along the back wall of the space, two renovated but original and two behind the library

There were two opportunities to demonstrate the benefits of sliding doors in the space. One was to a new accessible single-user toilet room with a simple sliding door with easy to use hardware and a contrasting vertical grab bar pull. The second is the sequence of eight sliding wooden doors with large central glass lights suspended with a Hafele hardware system. These are attached to a structural beam in order to forego the need for a bottom channel and make it easier for anyone to open and close. They have never failed to work and can be moved by people of low stature, people with limited strength, people using wheeled mobility.

Evaluation/Lessons Learned

The renovation worked to meet organizational goals. After almost 30 years since its founding, IHCD had a space that didn't just meet organizational space needs but became a popular hub for events. Over 200 people were easily accommodated in an opening celebration. It became a popular site for other non-profits to hold trainings and events. A downtown place that was fully accessible and in ready access to a range of transit was rare. A hundred feet of great graphics about design for everyone became a signature identity and remains hard to miss.

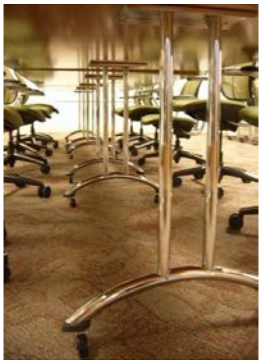
One lesson that burdened staff the most from the start have been the acoustical conditions. There are almost all hard surfaces and very high ceilings. Many of the staff took to wearing head phones to control noise intrusion. Acoustical clouds made a large difference in one public space but it's too limited to solve the problem. The Lab, Conference Room, and Library have lowered acoustical ceilings which make them work.

Lighting was another important lesson. Given the tight budget and dependence on donated products, the lighting design was ad hoc and not the product of a concerted commitment to inclusively designed lighting. As a mitigation effort to improve personal comfort, each staff person had task lighting in their own space. The inability to dim lights in the conference room remains a frustration.

In 2009, a comprehensive analysis of IHCD headquarters' lighting was undertaken as a Master's Thesis in the Lighting Resource Center at Rensselaer Polytechnic Institute (RPI). Christopher Hardwick Lighting for Inclusive Design, The Guidebook. He provided not only a critique but also a substantive rationale for making a priority investment on lighting for user comfort and performance. The program has not been undertaken only because of the cost. Should it be possible to extend the lease, these changes would be a priority.

The goal has been to design a space that worked across the spectrum of physical, sensory or brain-based functional limitations. And it's a continuous process of paying attention to what works and what fails for different people with different needs and preferences. The space works quite well for people who are low vision. But navigability of the space can be difficult for people who are blind. A tactile map of the space has been created twice but has not been sufficiently robust for long-term use. A verbal orientation on arrival about the organization of the space helps but most people will need human assistance to get where they are going.

In the last year, a new problem arose in response to security concerns for WeWork who leases all of the upper floors. They now lock the entrance doors from the street. One must either have a pass card or be buzzed into the space in a poorly designed intercom. For IHCD, it means a large number of User/Experts with visual limitations are no longer easily able to get into the building and depend on staff cell phones to coordinate entry.



Library


Library




IHCD's floor plan from 2010.

Project Team

Collaborators: Architect, Timothy Mulavey, RA Mulavey Studios (with collaboration from staff designers: Barbara Knecht, RA, Stephen Demos, RA, Emmanuel Andrade, Associate AIA)

Contractor: Eoin Barry, CPAC, Inc.

Furniture design and custom build-out: Slot-B Design In-kind design and fabrication for all of the work stations, conference room tables, cabinet and cork boards, four corporate partner kiosks, the retail build out, library detailing and kitchen.

Gift from the Kaye Family:
Six mid-century modern pieces of furniture: square table, four chairs, two Mies Van Der Rohe armchairs
Gift of two tactile sculptures - Rosalind Driscoll

Environmental graphics & glass exhibit tables:
Coco Raynes Associates
In-kind design of 100-foot window graphic in frosted acrylic,
quotes about inclusive design in seven (7) languages
Cyr Sign - fabrication & installation of window graphics as well as all signage

Corporate product contributors:
Humanscale - all seating, some lighting
Itoki, 8 tables and 16 chairs from their Eco/UD line
Toto - all plumbing fixtures for four (4) toilet rooms, 2
renovated, 2 new
Lightolier
Ostrom Glass and Metal Works

Access Living, Chicago, Illinois

Introduction

This project is an office building that models the intersection of Universal Design and environmental sustainability on an infill site in the River North neighborhood of Chicago. Founded in 1980, Access Living brought the Independent Living Movement to Illinois and the City of Chicago. Working with their extensive membership and staff, LCM architects and Access Living developed Universal Design goals for the building, then methodically worked through each decision, testing them against the Universal Design goals and the criteria for a silver LEED rating. The result is an "ordinary" looking building that exemplifies social, economic and environmental sustainability.

Description

Access Living is a not-for-profit service and advocacy organization founded in 1980 to improve the lives of people with disabilities. In keeping with its mission to serve a diverse community from all over "Chicagoland," Access Living selected a centrally located urban site, well served by public transportation. The new headquarters is a model of social and environmental sustainability, with a gold LEED rating, that demonstrates the intersection of green and Universal Design.

The building is a 35,000 square foot four-story office building, on an 80 by 140-foot site, that also serves as a community resource and educational center. The neighborhood is a mix of residential and commercial uses in easy walking distance to restaurants and retail. Nearby are two lines of the Chicago "El" as well as bus service. There is staff and visitor parking on site, under the building and on grade at the rear of the ground floor.

One enters into a reception lobby-lounge and consumer resource center, both of which are visible and accessible from the street. The building core of elevators, stairs, restrooms, and support spaces occurs along the east wall of the building. This zone borders a "Main Street" corridor that runs from the front to the back of the building and benefits from daylighting at each end. The balance of each floor is available for all other functions: open plan office for each or the organizational teams, private offices for the senior management, one large meeting room and two smaller ones, employee lounge, reception and exhibition hall, roof terrace, and assorted support spaces.

Design and the User Experience

To initiate the design process, Access Living and LCM Architects organized a design symposium that brought together experts in Universal Design, including the Institute for Human Centered Design (IHCD), and a representative group of users. The session was organized to learn about barriers and brainstorm solutions for a typical office environment. The session provided the architects with a wealth of information as well as guidance for further investigation.

From this exercise, the architects developed a set of goals for Universal Design and for an advanced LEED rating. They embarked on a process of examining every aspect of the building and its furnishings to meet those goals. Although the intent was to create an office environment that would resemble any typical office environment, the expectation was that it would be superior in usability and human comfort because no decision would be taken without deliberation of its impact on a wide range of users, many of whom have disabilities.

The features of the building that capitalize on the intersection of green and Universal Design are those that save energy and enhance user experience often because they include some aspect or mode of operation that is tailored to individual needs.

Automatic sensors to open the front doors, turn off lights in unoccupied spaces, raise and lower shades and operate faucets and toilets are energy saving and work well for people with limited strength, dexterity or fine motor skills. Abundant daylighting, flexible task lighting and zoned ambient lighting allow individuals to have the best lighting for vision, and the electrical energy use to be minimized. Local overrides for HVAC and light and shade controls allow for more responsive energy use and a higher degree of human variation in comfort. Non-emitting paint, fabrics and carpets affixed with water-based glues reduce the need for air filtration in the HVAC system and increases the comfort and productivity of users with allergies and chemical sensitivities.

At least two innovative design aspects were incorporated to accommodate the large number of staff persons who use wheelchairs and other mobility devices. There are two elevators that are large enough for four wheelchair users at any one time. To allow someone to enter and exit the elevator without taking time and space to turn 180 degrees, there are doors and controls at either end of the cab. There is no need for standing occupants to step out to make room for a chair user to exit or for a person using a chair to maneuver out backwards.

An equally innovative solution is the design of the restroom entrances without doors that are cumbersome for many users. The layout is typically seen in airports with a U turn around a privacy screen wall. Care has been taken to provide acoustical treatments including high NRC ceiling tiles and more sound absorbing materials to reduce the effects here, and throughout the building, of ambient noise that can be distracting to some and a barrier to hearing for others.

Evaluation

Access Living documented the design intent of the project starting shortly after the design symposium in 2004. The original list created by LCM Architects was augmented and analyzed to maintain a record of the project. The building opened in 2007. In 2008, approximately 18 months after the building was occupied, a Post Occupancy Evaluation was performed.

From the evaluation, users are highly satisfied with the way the building looks and the way the building works. The clarity and simplicity of its spatial organization makes it easy for first time users to navigate. The elevator is visible from the front entrance; the 1st - 2nd floor atrium, and the glass walled conference rooms on the 3rd and 4th floors provide ready landmarks on the main street corridor and when exiting the elevator. Finer grain wayfinding to specific workstations in the open plan offices, especially for those with vision impairments, is more difficult.

Particular details called out positively include the quantity and flexibility of light (natural and artificial), quality of the air, and the use of color and art. Most people appreciate the flexibility of the workstations. The work surfaces, cabinets and drawers, as well as the chairs, can be adjusted for people of different heights and preferences. The green roof and terrace are considered a tremendous asset.

The unusual entry sequence to the toilet rooms received a generally favorable reaction, while the details of the stalls and the automatic sensors received a much more mixed review. The stall doors and latches are cumbersome according to some; the sensors too erratic and stingy according to others.

The large elevators with dual controls are appreciated by chair users and non-users alike. One person even remarked that they roominess allowed for spontaneous social interaction. In the same vein, people who may not benefit directly from some features - such as the wheelchair user friendly elevator or the resting room - take pride in working in a place that considers the need of a wide range of users.

The post occupancy evaluation revealed that some fine grain adjustments are needed, the overall design intent and its realization are extremely sound. The quality of the environment for a large number of users with very particular environmental requirements is extremely good. Access Living reached the goal of creating a beautiful and inviting office building that works for a wide range of users.

Universal Design Features

- Participatory design process with user experts.
- Heat coils in the sidewalk reduce the slippery conditions of snow and ice at the entrance
- Bi-level (street or sidewalk) curbside drop off
- A contrasting strip integrated into the sidewalk provides a visual guide to the front door
- Sensor activated sliding entry doors with an air curtain to balance heat loss
- Seating in the entry vestibule to wait for a ride pick up
- Bi-level reception desk convenient for seated receptionist and standing or seated visitors
- A variety of chair styles in waiting area to fit different preferences and abilities
- Public computer on adjustable height table in lobby
- Steelcase office furniture with adjustable height work surfaces, overhead storage, and under mounted file cabinets for people of different heights, reaching ability, and strength
- Office and conference room chairs seats move up and down, backward and forward, or tilt; arms can be raised or dropped, suiting a variety of body types and sitting positions
- Task lighting at desks mounted on movable arms
- Color (walls and furniture) and artwork are used to identify different floors and provide wayshowing landmarks
- Zoned HVAC and lighting, occupancy sensors and automatic shade controls, all with manual overrides
- Doorless toilet room entrances; automatic sensors on fixtures and fittings.

Environmentally Sustainable Features

- Urban site, reused foundation, near public transit
- Sensors activate flushers, faucets, soap and towel dispensers in the toilet rooms for energy saving and sanitary reasons.
- Occupancy sensors for lights
- Light sensors control shading devices; with manual overrides
- Harvested and direct day lighting
- Carpet of recycled content attached with water-based glue
- Green roof
- High quality indoor air (IAQ) through material selection and systems specification
- Modular furniture and demountable partitions reduces waste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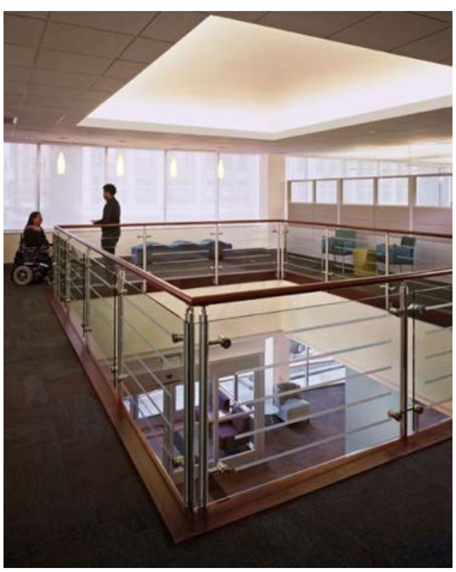


Project Team

Architect: LCM Architects
Project Manager: Illinois Facilities Fund/Cotter Consulting Incl
General contractor: Michuda Construction
MEP Engineer: 20/10 Engineering
LEED Consultant: Seiben Energy Associates
Structural Engineer: Thorton Tomisetti

Project Facts:
Location: Chicago Illinois
Completed: 2007
Client: Access Living
Design Team: LCM Architects
Planning Authority: City of Chicago

Sections of the Washington Talking Book and Braille Library, Seattle, Washington

Introduction

The Washington Talking Book & Braille Library (WTBBL) has an amazing history beginning in 1906. It is a program of the Washington State Library, formerly a part of the Seattle Public Libraries. The demand for the programs and services evolved, which required reassessing the feasibility of the facility to support growth. A State grant was awarded to a Seattle architectural team in 1996 to renovate the home of the WTBBL Lenora Street building with project completion in 1997.

The primary goal was to make this highly recognized facility a state-of-the-art, accessible environment for both staff and patrons who are low vision and blind. The extensive expansion and renovation of an existing 1948 Art Deco-Streamline Modern two-story concrete building, with second floor parking, included an interior remodel of 40,000 SF of new management and librarian offices, public library areas with bookshelves and reading areas, conference room, radio reading rooms, children’s reading room, and installation of a high-density mobile shelving storage system. Exterior improvements established a new accessible entrance with an address change, new roof membrane, and new paint at all facades.

Description

A site and facility feasibility study were completed in 1996 to determine a possible relocation of the City of Seattle owned WTBBL. The study identified the existing home of the library since 1983, a two-story building and former automobile dealership built in 1948, met the robust criteria. The expansion criteria involved the second-floor acquisition of the original parking garage and dock area needed to support the mobile book services program. The facility meets the criteria of the National Register of Historic Places and the Seattle Landmarks Preservation Ordinance.

The State of Washington Chapter 11 accessibility building codes were more stringent in some areas, than the federal Americans with Disabilities Act (ADA) Standards for Accessible Design. Therefore, the most rigorous of the applicable requirement was incorporated. The Accessibility Consultant, a sub to the Prime architect, provided specialized design expertise and knowledge to support the library staff and patrons who are low vision and blind. The principles of Universal Design (UD) were woven into the project decision-making processes to provide inclusive user experiences.

The WTBBL is in the Denny Triangle neighborhood, one of the fastest growing urban neighborhoods in Seattle and stretches north of the Seattle business district to the grounds of the Seattle Center, famous for the Seattle Space Needle. It is close to the iconic Pike Place Market and South Lake Union. The terrain is generally flat. There are no houses in the Denny Triangle. Condominium towers and high-rise apartment complexes serve an active cosmopolitan family and professional lifestyle. Countless businesses reside and flourish in the community including three blocks for the Seattle Amazon headquarters campus.

The location of the WTBBL is in a prime Seattle area, originally a steep hill, now generally a flat terrain, and has a Walk Score of 100, considered a “Walker’s Paradise.” The library is served by a world-class public transportation system which includes the Sound Transit Link light rail and First Hill Streetcar both within less than a mile, and bus stops are just a few minutes’ walk away. On-street and garage parking, car sharing from Zipcar and Relay Rides provides additional options for the community to visit the library.

The major spatial areas of the library are the interior foyer with stairs and elevator access to the second-floor parking garage, the Children’s Reading Room adjacent to the lobby with a welcome reception desk, direct access to the large meeting room, accessible restrooms, and the readers advisory and circulation workstations. A quiet seating area is available adjacent to the large windows to enjoy the multiple format reading materials on bookshelves. The primary staff and volunteer areas include eleven recording studios, radio broadcast reading service rooms, breakroom, and management offices. The second floor provides leased office spaces, the parking garage, and supported the Mobile Book Services program until 2018.

Design & User Experience

The WTBBL is a specialized public library that builds community and provides equal access to information and reading materials for Washington residences who are unable to read standard print. The primary user group are staff, volunteers, and patrons who have low vision or are blind. Staff tasks range from librarians as readers’ advisers, transcribing braille to producing books and much more. The large and dedicated corps of volunteers support multiple needs including mailing books and equipment and returning them on the shelves. Patrons of the library include older adults, local families bringing children to the Friday multisensory children's reading time, the active youth program providing engagement and learning, and children of all ages, from toddlers to teens enjoying the books and materials provided in multiple formats.

Libraries are known for being tranquil and comfortable settings. Acoustics and lighting are key design aspects in maintaining these attributes and were identified as important project goals. Additional goals included:

- Create a workplace and public library environment that is responsive and instills confidence in wayfinding, independence, and mobility.
- Accommodate and increase efficiencies in staff and patron tasks.
- Provide a welcoming accessible main entrance.
- Design the layout with clear delineation of public and private spaces.
- Provide strong color contrast in materials and surfaces.
- Provide non-glare lighting in all spaces with additional light levels in corridors.
- Provide a convenient exterior dog relief area near the main entry.

The ADA*ptations*® Inc. firm (currently The ABCs of Accessibility® Inc.) was selected to provide proactive Universal design (UD) solutions that would support the needs of the user group. The intent was to go beyond prescriptive accessibility building codes that do not address wayfinding or lighting.

A successful project requires a responsibility to understand the experience of the users. The design team engaged staff in virtually every design phase including the functional and space program to ascertain their multifaceted program goals aligned with spatial needs. Presentations of floor plans and materials were provided in visual and tactile formats to ensure the plans could be understood by all of the constituents for the project.

Evaluation

Accessible design standards and related building codes, for all intents and purposes, do not address the environmental needs of users who are low vision and blind. Tactile and braille signage is one of the few areas referenced. Planning and designing a project specifically for this user group sorely miss the mark if current standards were applied in the absence of universal design (UD). The WTBBL project was successful, in large part, based on the design teams' holistic approach to ensure user participation and engagement.

Universal Design Features

Multiple inclusive design details contribute to a positive user experience:

- The existing main library entry impeded access to people who were unable to navigate stairs. The entry relocation around the side of building required a change of address and an accessible inclusive entry. Automatic door openers were installed for ease of use.
- Providing an exterior location for a guide dog relief area was an important design consideration. For convenience and orientation an area was identified across from the new accessible entry.
- The functional and space program identified a staff procedure to support first time patrons and volunteers with navigation and orientation. The receptionist greets, orients, and provides a tour for users to become acclimated to the library areas and services. Personal sighted guides also aid the patron to the desired area(s) of interest.
- Multisensory wayfinding was not identified specifically as a design goal. However, the spatial configuration of public and private spaces lends itself to confident independent wayfinding.
- Strong color contrast between doors/door frames and walls, and between walls and floor coverings supports orientation and mobility.
- Matte finishes on horizontal and vertical surfaces diminishes glare and reflections.
- Good maneuvering space around bookshelves for ease of access
- Abundant daylighting provided by three exterior walls of large glass windows.
- The layered lighting approach created a visually and functionally balanced library and workplace environment.

Environmentally Sustainable Features

Environmentally sustainable features include retaining the original 1948 structure with the large plate glass enclosed windows, which canted outwards on one side behind a concrete planter lining the sidewalk on the ground floor level, proximity to public transit, low-VOC interior paint. Flexible and adaptable modular workstations with acoustical panels support the diverse user needs, manage changes in the workplace, and reduce waste.

Project Details

A variety of products were specified in this extensive renovation project with the primary objective to enhance the experience of staff, volunteers, and patrons with low vision or blind. Appreciating that the users have multifaceted needs, the design team approached the selection process to encompass the most inclusive feasible outcomes. Products included:

- Automatic door openers installed to facilitate an inclusive access on the exterior main entry and foyer library doors.
- Interior doors with lever door hardware to support ease of operation.

- Tight low height pile glue down carpet with minimal pattern to reduce disorientation, and strong color contrast with seating and table surfaces were installed in many of the spaces. Flush transitions between floor coverings were provided.
- Layered lighting includes ambient recessed ceiling lighting, adjustable task lighting, soffit lighting above the reception desk, and ample daylighting provided by three exterior large glass panel window walls.
- Acoustical ceiling tiles installed throughout results in an acoustically comfortable environment.
- Cane detectable custom workstations with radiused corners and accessible transaction counters.
- Easy access bookshelves.
- Furnishings such as tables and seating specified with intentional surface color contrast with the floor covering to differentiate between the two surfaces.
- Modular workstations with adjustable height work surfaces and acoustical panels to flexibly meet user needs and preferences.
- High density mobile storage system for cassette books on tape for ease of access and orientation.
- Tactile and braille interior signage for room identification and orientation designed with reverse contrast of dark background and light letters and installed on light colored walls.

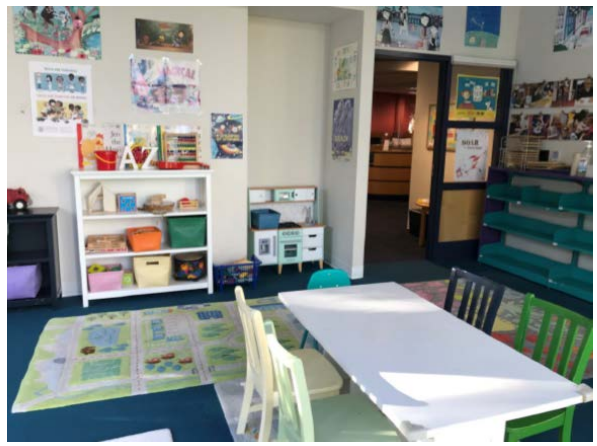
Lessons Learned

The Children’s Reading room glass panel door opens to the lobby reception area. The room is often filled with joyful noise coming from the children playing with toys, story time, and other engaging activities. The space reverberates with noise off the large single pane glass windows and the door. The wall-to-wall carpet and acoustical ceiling tiles provide some acoustical benefit. A lesson learned design consideration could have been to install additional sound absorption materials, understanding the quite different functional uses and their proximity within the library. One interim solution staff have found helpful is closing the door during high activity times.

A 2020 capital budget request has been submitted to replace the original 1948 exterior single pane windows, which will significantly enhance the spatial acoustical ambience.

A recent conversation with a keenly knowledgeable WTBBL staff person, not involved in the initial project, shone a light on the awareness level of Universal/Inclusive Design and the benefit of surface color contrast. For example, the carpet has been replaced and new Mid-Century Modern seating has been added in a reading area with some surface color contrast between the seating and flooring. While the solution may be satisfactory, a long-term client benefit would be to prepare a document that shares perspectives and insights of applying

Universal/Inclusive Design to support the evolution of environmental change for years to come and enhance the user experiences.



Washington State Department of Services for the Blind, Orientation and Training Center, Seattle, Washington

Introduction

The application of Universal Design (UD) was not a project specific policy or requirement. The accessibility and Universal Design consultant recommended the integration of UD to support an interactive and engaging student learning environment and enhance workplace performance. The State of Washington building codes were more stringent than the Federal ADA in some areas. The applicable accessibility codes and design standards were incorporated as a baseline for UD.

Description

The Seattle office of the Washington State Department of Services for the Blind (DSB) and the Orientation and Training Center (OTC), a program within DSB, is collectively referred to as the DSB/OTC. Services have been provided for nearly forty years in this 22,000 SF, two-story brick building.

The DSB/OTC facility is in the vibrant Rainier Vista/Columbia City suburban residential neighborhood located approximately 5 miles south of downtown Seattle. The neighborhood has greatly evolved and matured around the DSB/OTC the past 40 years. There are multiple options within walking distance to experience shopping, dining, parks, movie theaters, and access to transit systems. A notable bonus is the one-mile proximity to stroll along the beloved Lake Washington.

The major spatial areas of the two-story facility with on-site parking include administrative offices, conference rooms, training classrooms, restrooms, and breakrooms. Exterior stairs served as the main building entry to the DSB upper level. Interior stairs connected the two levels. A rear entrance on the upper level and a front entrance on the lower level provided access to the building for individuals who required an accessible route of travel. An exterior main entry ramp and an elevator were included in the project scope.

The upper level is the Seattle office for the DSB administration and the Vocational Rehabilitation (VR) program offices. The lower level supports the OTC program. The OTC is a dynamic training center with alternative skills training classrooms, including braille and computer. An Orientation and Mobility (O&M) classroom, Home Economics classroom, student center, shop room, small conference room, restroom, and independent staff offices round out the lower level space utilization.

The primary scope for this renovation project required multiple system upgrades including a seismic retrofit, asbestos removal, fire codes, and a new boiler. In conjunction to the primary project scope, accessibility and ADA upgrades required an accessible route of travel to the main entry and elevator. The OTC program, located on the lower level, had the most significant fire code violations with a citation for an inner hallway within a hallway. Reconfiguration of the alternative skills training classroom spaces were included in the overall scope.

The identified scope of work for this 2000-2001 renovation project was primarily for system upgrades. The scope expansion, commonly referred to as "scope creep," occurred during the famous February 2001 Nisqually earthquake that rocked Seattle. The earthquake energized the OTC staff to secure additional accessibility. It is ironic that the building was undergoing seismic upgrades at the time of this major earthquake.

Prior to the commencement of the project, the Seattle office staff were relocated to a temporary location and the OTC program was housed in an adjacent property facility to minimize program disruption. The additional OTC accessibility modifications added an approximate $40k to the $2.1M budget.

A primary project goal was to meet and exceed required ADA and related accessibility requirements. We recognized the minimum codes and design standards would not meet the needs of the OTC training center program and would require an additional design approach. The approach chosen was to apply the principles of Universal Design (UD) and incorporate them in virtually every design detail to enhance the independence, confidence, user experience, and inclusive wayfinding of staff and students who are low-vision or blind.

Design and User Experience

The DSB provides "one front door" for people of all ages who are low-vision or blind to receive the vocational rehabilitation (VR) services necessary to build or continue their careers.

The (VR) employment program enables people age 14 and older who are low-vision or blind to maintain or return to employment or occupation. The Youth Services program serves children and youth who are blind or have low vision "from birth through high school graduation" including the transition to college or employment. The Independent Living program empowers individuals to choose their lifestyle and level of independence. The Business Support program supports businesses, non-profits, and government organizations to improve diversity, equity, and inclusion in their workplace cultures.

The demographics demonstrates the need for these supportive services and ranges from people who are centenarians, people who are culturally diverse, homeless clients 60 years old or younger, people with diabetes, depression, arthritis, and Parkinson's disease just to name a few.

The existing layout lacked a supportive functional environment for the OTC program goals and teaching methodologies for students and staff who are low-vision or blind. For example, the small conference room did not provide adequate space to hold liaison meetings, classrooms lacked capacity for user flexibility. For the students who are learning a new way to navigate environments, it was a challenge.

The primary goal was to enhance the accessibility of the training center to promote student confidence and independence as well as to reflect the current and future curriculum goals.

The goal setting process for students was accomplished through a dynamic staff and student interview process. A combined list of needs and desires included:

- Separate classrooms independent of staff offices to provide privacy and a quiet working space.
- Classroom flexibility to create multi-purpose spaces.
- A quiet study area for students, which included computer access and storage space for personal belongings.
- Internet access in all areas, including classrooms and common areas.
- A "gathering" space for students with a sink, refrigerator, coffee maker, microwave, and drinking water with flexible seating to meet as a large group or in small clusters.
- A private space for staff and student small-group meetings.
- An accessible Home Economics classroom expanding from two to three separate training kitchen workstations, a computer station, sewing area, a dining area to accommodate eight individuals for sit-down meals, and the ability to host larger group buffet-style luncheons.
- Laundry and storage areas for kitchen supplies and other related items.

OTC students and staff were actively involved from the initial meeting with the accessibility and Universal Design consultant team. To gain a better understanding and insight into the daily activities of the program and its functions, each of the design and consultant team members used vision occlusion goggles while participating in meetings and design activities. This intent of this equalizer exercise was to ensure the consultants would have first-hand experiences with simulations of being a person without vision in order to better understand the wayfinding and orientation needs of students as well as to appreciate their insights and perspectives of the proposed design needs and solutions. The design approach was highly effective and is ingrained in planning processes to this day.

The inclusive design approach to integrate Universal Design (UD) was led by Susan M. Duncan (formerly ADA*ptations*® Inc.). Her experience and knowledge in working with people with low-vision or who are blind, set the framework to go beyond accessibility building codes and integrate design solutions responsive to user needs and preferences.

Evaluation

The renovation met and, in some cases, exceeded the DSB/OTC goals and serves as a catalyst to move toward implementation of program visions. The original character of the building has been retained with the inclusion of the spatial reconfigurations and addition of the elevator and accessible entry features. The revitalization of the system upgrades has also positively influenced user environmental comfort and safety.

The informal Post-Occupancy Evaluation revealed the OTC spaces reflected the functional and wayfinding needs for the students and staff who are low-vision or blind. The intentional inclusion of applying Universal Design principles with the experience and insights of the consultant team, shined a light on the maximization of visual accessibility. It is important for planners to understand the design layout and related elements can have a profound effect on the safety and independence of the users.

Should the minimum accessibility building codes been solely applied, the user experience outcomes would not have been as successful. For example, the primary goal for the Home Economics training classroom was to provide kitchen workstations that would be flexible and provide teaching consistency. In addition, they would support the teaching curriculum by reflecting the reality of living environments, such as apartments. Student accomplishments are an important outcome of the program, hence the functional customization of the classroom to empower students to be successful. This has translated into tangible employment opportunities and provided a big a boost to the students. The Business Enterprise program has opened the door for students to be an owner/operator of a restaurant at the end of the program. Currently, there are 21 restaurants that support the program statewide.

Evaluation of User Experience

Lighting influences and impacts user well-being, independence, and safety in environments, and this project demonstrated the important role lighting serves for users who are low vision or blind. New students are tested in the orientation and mobility (O & M) program for preferred light levels. Some students are photophobic and prefer it dark, while others need maximum lighting for successful wayfinding.

Lighting in the OTC hallway, with no intersecting hallway connections, does not fully meet user experience with its new lighting. Individual wall-mounted semi-indirect fluorescent lights were installed on one side of the corridor, as specified by a lighting specialist. The light levels are not evenly diffused and create shadows and glare off the wall and floor.

Coupled with the somewhat ineffective lighting is the newly installed vinyl composition tiles (VCT). The VCT were specified in a matte finish to provide minimal reflection, glare, acoustical value, and ease of maintenance. The VCT routine maintenance procedures include periodic buffing which has slightly increased the floor glare. It is important to note all lessons, including the O & M training, are conducted with students wearing sleep shades. However, this does not negate the need for enhanced balanced lighting and minimal or no surface reflectance for all users of the environment.

Universal Design Features

- The new accessible entries connecting to the public right-of-way and elevator provide an inclusive and welcoming feeling for all users.
- The OTC floor plan reconfiguration includes 90-degree turns for ease of user navigation.
- The OTC main hallway has proven to be a good, acoustically-sound, travel teaching tool to discern distance. The O & M instructor noted she would ask the student "how far away do you think the voice of so and so is from here?" Additional wayfinding teaching elements in the hallway include the dark brown 6" high wall base and contrast with the neutral matte finish wall color, the wall color contrast with the door and door frames, and the cane detection and acoustical benefit of the VCT flooring.
- Flush flooring transitions were designed to be void of potential trip hazards.
- Door hardware is lever style and meets the closed-fist principle for ease of use.
- Color contrast has been provided with horizontal surfaces such as table and chair seating colors with the flooring.

The Home Economics training classroom renovations received the most significant intentional accessible and Universal Design enhancements. The open space classroom incorporated three instructional kitchen areas, a dining table for eight, a sewing area, computer station, and an adjacent laundry room. The primary user benefits included:

- Three students can work at the same time in the individual kitchen workstations. Each area is designed with different elements to provide flexibility in learning and support diverse abilities, including students who may use mobility equipment such as a wheelchair.
- A large island with base storage is designed in the center of the classroom to provide students easy access to the common items. The island also serves as a convenient area for potlucks and celebrations. The graduation celebrations are more efficiently held in this training classroom.
- The sewing area expanded to be a more flexible space with improved task lighting.
- The classroom lighting provides an option to dim a portion of the room as desired and overall, is more conducive to students with light sensitivity issues.
- The addition of a convenient student computer station to perform tasks such as researching recipes, creating a shopping list, or applying for a food handler permit rounded out the classroom features.

The new Student Center is referenced as the *heartbeat of the training center*:

- The classroom reconfigurations include the addition of this multi-purpose room centrally located in relation to classrooms and in the heart of the OTC.
- The spatial relationship to the braille and computer classrooms and teacher offices enhance wayfinding and provide an opportunity for socialization, which is an important aspect of the training program.
- Engagement activities include seminar and guest speaker presentations as well as weekly staff and student meetings.
- Modular tables provide flexibility to reconfigure from small break out needs to larger table gatherings.
- Student lockers provide convenient access for personal belongings.
- The kitchenette area provides an area for storing and preparing lunches and is a training environment. For example, the student who takes the last cup of coffee makes a fresh pot. All students take turns maintaining a clean microwave and cleaning out the refrigerator at the end of every term.
- To reflect the heartbeat symbolism and synergy, the space has reddish orange accent walls.

The Student Study Area:

A smaller computer area near the Home Economics classroom, provides students an additional area to study, gather, practice computer and braille skills, and have student meetings around the centrally located table. The space offers flexibility with five accessible individual computer stations and coat rack.

Project Details

- The modular tables provide flexibility to reconfigure from small break out needs to larger table gatherings.
- The lighting, including task and daylighting, are beneficial in classroom and staff rooms.
- The acoustical ceiling tiles combined with the tight woven low pile carpet (included in the original bid) support users' abilities to focus and concentrate.
- The vinyl floor covering was selected for durability and effective cane detection.

Lessons Learned

This case study has been developed nearly twenty years after project completion and has provided an opportunity to connect with former and current OTC staff to glean information on the strengths and weaknesses of the renovation. We are grateful for their shared insights and perspectives on the quality of the user experiences.

A key take-away from the staff discussions is a *gap* in the "whys" communication. Specifically, it goes without saying the staff and students that served on the frontlines of the project, know first-hand "why" changes were made and the identified benefits. Over time, procedures, teaching programs, elements or areas change, as well as the users evolve, which is the value added of incorporating inclusive design. When worn materials, such as countertops or flooring, need replacement will the Universal Design principles be met? Will the horizontal surfaces be in a matte finish and have color contrast between the materials? When access is designed in a cabinet base for wheelchair accessibility using a T-Turn layout, will future staff know the "whys" behind the design? It is important to ensure that the communication torch be passed on at project end, with the "whys" and education in a format that best supports the staff to maintain the goals of usability, safety and to enhance, not impede, positive user experiences.

The architectural and construction teams were selected through a government bid process, with an identified scope of work, in 2000. The accessibility and Universal Design consultant team were not included in the initial project scope. The consultant team joined the OTC aspect of the project about halfway thru the scope, around the time of the earthquake. The OTC Program Manager served as the liaison to the Prime, to ensure minimal expense would be incurred by expanding the scope to incorporate recommended modifications to the training center.

The lighting consultant was a sub to the Prime and did not interface with the accessibility and Universal Design consultant. In hindsight, a lesson learned is there should have been a priority for professional subconsultant collaboration on the lighting specifications, specifically for the main hallway. There are inherent challenges of not being a subconsultant to the Prime for a project scope of this size. However, in this case, a successful outcome was achieved.

MASSACHUSETTS COMMISSION FOR THE BLIND

Inclusive Design of Workplaces for People who are Low Vision or Blind

September 2020

Institute for Human Centered Design

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Overview – Report of User/Expert Interviews

As part of its work with the Massachusetts Commission for the Blind (MCB), the Institute for Human Centered Design (IHCD) conducted a pilot study examining workplace interior design features for clients with vision disabilities. During August 2020, IHCD spoke by phone with ten User/Experts who are blind or who have low vision, and six vocational rehabilitation counselors and Orientation & Mobility (O+M) specialists. Each phone interviews lasted 20-30 minutes.

The User/Expert pilot study focused mostly on physical features of work environments in relation to orientation and mobility: how each features functions well and what the respondent would change about the feature if they could.

Specific topics included:

- Assistive technology
- Color contrasts
- Elevator lobbies
- Floor materials
- Glare and reflections
- Layout
- Lighting
- Room numbering
- Sounds (ambient noise level, sounds that assist O +M, acoustics)
- Stairways
- Wayfinding signage
- Workplace accommodations
- Workplace entries
- Workplace exits
- Workplace features that make them feel more included, productive, and independent at work

The following User/Experts were interviewed:

- Sheryl Erwin, Research Assistant III, Low Vision Rehab Lab, Mass Eye and Ear https://www.mass.gov/news/in-the-lab-again-the-sheryl-erwin-story
- Jini Fairley, ADA Coordinator, City of Newton, MA https://newton.wickedlocal.com/article/20160401/NEWS/160409439
- Sunish Gupta, Founder of Easy Alliance, Visiting Lecturer, Northeastern University
- https://www.slideshare.net/marklittlewood/business-of-software-conference-usa-2019-sunish-gupta-accessibility-is-not-rocket-science
- Natalie Jung, Senior Account Manager, Higher Education, EVERFI

- Ryck Lent, Retired Partner, Leader Networks; board member and volunteer for vision, sailing, photography and education non-profits
- Paul Parravano, Co-director of Government and Community Relations, MIT https://www.justastart.org/paul-parravano/
- Carl Richardson - State House ADA Coordinator, Mass State House https://www.wickedlocal.com/article/20120621/NEWS/306219665
- Jennifer Ross, Customer Engagement Coordinator for the Department of Systemwide Accessibility, MBTA
- Gina Russo, Outreach Specialist, Perkins Braille Library
- Cindy Wentz, Program Supervisor for Independent Living (retired), Mass Rehabilitation Commission https://mabvi.wordpress.com/tag/mass-rehab-commission/

Findings from the User/Expert Interviews

Design Considerations for Workplace Entries and Exits

Typical Challenges:

- Crowding
- Ineffective lighting
- Materials that create challenges for mobility (e.g. shiny stone for floors, glass doors)
- Multiple ways to enter (push and pull entries may be hard to figure out easily)
- Ineffective numbering systems for multiple exit/entry points (hard for pick-up and drop-off vehicles for multiple entry/exit point that aren't labelled)

Suggested improvements:

- More color contrasts around entry and exit doorways and stairways and along circulation pathways, high contrast handles
- Increased width of entry and exit points to accommodate traffic
- Addition of auditory and tactile feedback elements
- Consistency and simplification of layout (e.g., level thresholds that is well marked, standard height and number of stairs, making it easy to memorize)
- Material considerations (e.g., carpet, surfaces with surface texture, stair markers and railings) to prevent stumbles and falls, variation in textures generally noted to be useful)
- Lighting & signage (clear instructions for what you are supposed to do to enter and exit the building)

Design Considerations for Color Contrasts

Typical Challenges:

- Lighting affecting contrasts
- Inadequate contrasts along doorways and turning points
- Inadequate contrasts for obstacles
- Ineffective color considerations (e.g., shades of grey)

Suggested Improvements:

- Higher contrast for entrances and turning points or intersections
- Higher contrast for handles, switches, signage & stairways
- Higher contrast to detect obstacles, pathways which have objects jutting out.
- Material considerations (carpet vs non-carpeted, adding sidelights to solid doors)
- Color considerations (different colored walls, light-colored walls against solid-color carpeting)

Design Considerations for Lighting

Typical Challenges:

- Standard illumination along all office areas
- Automatic timers for lighting in places not heavily trafficked
- Inconsistent patterns in switch positions

Suggested Improvements:

- Higher Illumination (i.e., brighter lighting was considered beneficial by some low vision users especially in entryways and exits for spotting contrasts)
- Functional Illumination (preference for bright lighting in hallways, and diffused even lighting in workspace
- Automatic timers tailored to the worker (beneficial for participants who are photophobic and preferred dark spaces)

Design Considerations for Managing Glare and Reflections

Typical challenges were not identified by most participants.

Suggested Improvements:

- Consideration for changes (glare changes throughout the day depending on sun position)

- Manage potential glare problems with manipulation of window blinds, ideally blinds that offer a range of open/closed position as well as raising and lowering in response to changing light conditions

Design Considerations for Functional Floor Materials:

Typical Challenges:

- Difficulties with materials such as linoleum, tile and shiny polished stone, hard surfaces made more problematic with high polish applied by maintenance
- Ineffective Contrasts

Suggested Improvements:

- Materials that provided texture were generally considered better for navigation such as
  - Rubberized surfaces
  - Epoxy paint with a bit of sand (may provide grit to the flooring around corners of the building and right before stairs begin)
  - Area rugs/Carpeting (identified as being beneficial to mark entrance areas, to prevent falls, reduce echo and pick up on audio clues) but firmly secured along all edges if not recessed into the floor

- Contrast considerations and floor markings for navigation (e.g., dark insets or tape on light color floors, raised edges for indicating direction)

Design Considerations for Functional Layouts

Typical Challenges:

- Circular Layouts
- Open Space - no ‘shoreline’
- Lack of predictable system of signage and numbering
- Disorganized spaces, particularly furniture and storage in the path of travel

Suggested Improvements:

- Simplified layouts (easy to memorize/imagine such as linear layouts, squares and rectangles)
- Organized layouts (areas arranged by function in easily identifiable sections)
- Standardization of common space layouts (bathrooms, lunchrooms, conference rooms)
- Standardization of signage placement and language for information and directional signage and room designation signage that follows a logical numerical or letter system)

Design Considerations for Functional Room Numbering

Typical Challenges:

- Lack of required room designation signage
- Inconsistent signage of all types
- Small sizing
- Illogical numbering, lack of system

Suggested Improvements:

- Logical and understandable (easy to follow and memorize- e.g., numbers oriented according to compass directions (east, west, north, south), easy to navigate to using a built-in compass on smart phones)
- Consistent across all rooms
- Directional and information signage with high contrast and large format
- Tactile information such as maps and models

Design Considerations for Stairways:

Typical Challenges:

- Ineffective lighting especially at top of stairs
- Lack of contrast at nosing
- Inconsistent riser height of stairs
- Ineffective Numbering
- Lack of delineation between treads and risers
- Missing feedback elements (tactile strips)

Suggested Improvements:

- Even illumination
- Functional numbering (large size)
- Functional Delineating Elements (color contrast strips can be easily visible, tactile warning strips)
- Standard riser size (comfortable to navigate, not too deep or steep)
- Safety considerations (compliant railings noted to be important to prevent falls and confusion; beneficial on both sides, extensions at top and bottom; contrast color for railings)
- Advanced warning for stairs going down)

Design Considerations for Elevators and Lobbies

Typical Challenges:

- Crowding
- Ineffective feedback elements (Difficult to know which one was coming up/down, touch screen interactives without mechanical or sensory feedback)
- Placement (difficult to know which elevator to enter for multiple elevators and direction of elevator)
- Ineffective signage for buttons
- Materials causing challenges with delineation (mirrored or polished surfaces with no contrast)

Suggested Improvements:

- Clear delineation (beneficial for navigation through a crowd
- Feedback elements (auditory feedback to state the floor you on arrival, speaking elevators-may also be beneficial for no contact scenarios such as COVID, e.g., "Hey Alexa, which elevator will take me to the 13th floor?")
- Effective buttons (easy to find, high contrast, tactile, emergency call buttons always in a standard location with high contrast to their surrounding)

Design Considerations for Acoustics

Typical Challenges

- Ambient noise impacting concentration
- Background noise affecting screen reader focus
- Lack of control on sound level of equipment of all kinds
- Elements which prevent use of audio cues or echoes for navigation (hard surfaces such as wooden floors, crowded areas, open spaces cause sound to travel and bounce)
- Excessive acoustical control without any audible cues can be unnatural and disorienting.

Suggested Improvements:

- Control on unwanted sounds while working (Doors that can be closed in office space, noise cancelling headphones)
- Materials that provide optimal echoes for navigation (optimal spacing, walls, carpeted surfaces, materials that will provide different feedback when the cane is tapped to provide orientation)
- Use of auditory feedback elements (key fobs that beeps, elevator dinging, masking music in bathrooms, talking buttons)

Service Animal Considerations in the Work Environment

Only one out of the 10 participants used a service animal.

Considerations mentioned:

- Proximity to a service animal relief area
- Proximity to an exit point
- Proximity to a grassy area with a dog waste container
- Space consideration in the workspace area for the dog

Inclusion Features in Workplace Environments

- Trained Staff (aware of challenges, mentioned what they were doing, inform individual if something was in the way)
- Familiarization of Environment beforehand
- Personalized Individual Workspace per needs (lighting needs, technology needs, space needs)
- Availability of Information Center for guidance
- Considerations in Common Spaces (Lunch rooms with organized food sections for access)
- Anticipation and Accommodation for Assistive Technology Usage

Typically Requested Accommodations for Workspace Environments

- Safety considerations (keeping corridors clear, railing on stairways, repair of outside ramp, low vision markers to avoid bumping into people)
- Navigation considerations (functional signage, accessible elevator buttons, tactile maps)
- Soundproof cubicles
- Technologies (magnification, iPads, iPhones, software, CCTVs)

Overview – Report of VR Counselor Interviews

The VR counselors' and O+M specialists' pilot study focused on workplace design features that these experts think are useful to their clients with vision disabilities.

In order to understand the process of job placement, participants were asked if they inspect/visit the worksite prior to placement of an MCB client. Three out of six participants commented that they do not and three participants indicated that they do complete a site inspection and a workplace assessment. One participant suggested that that would be preferred however they typically do not get the opportunity to do so.

Specific topics included:

- Accommodations at the workplace
- Assistive technology
- Color contrast
- Company websites
- Elevator lobbies
- Floor materials
- Glare or reflections
- Layouts
- Lighting
- Room numbering logic
- Service animals
- Sound
- Stairways
- Wayfinding signage
- Workplace entries
- Workplace exits

The following Vocational Rehabilitation counselors and O+M specialists were interviewed:

- Keri Davidson-Bravman, Vocational Rehabilitation and Children Supervisor, Massachusetts Commission for the Blind
- Sengil Inkiala, Vocational Rehabilitation and Children's Service Provider for Greater Boston, Massachusetts Commission for the Blind
- Priscilla Ngome, Vocational Rehabilitation Counselor, Massachusetts Commission for the Blind https://www.mass.gov/news/sharing-her-vision-the-priscilla-ngome-story
- Mayanne Mc Donald-Briggs, Transition Counselor, Massachusetts Commission for the Blind
- Meg Robertson, Director of Orientation & Mobility, Massachusetts Commission for the Blind https://www.linkedin.com/in/meg-robertson-66567712#:~:text=As%20the%20Director%20of%20the,and%20around%20in%20their%20communities.
- Alan White, Massachusetts Commission for the Blind, Regional Director, Metro West

Design Considerations for Workplace Entries/Exits

- Well defined entry and exit points (high color contrast, texture contrast, width and lighting)
- Material Consideration (glass doors typically considered challenging)
- Clear accessible signage (large print, high contrast)

- Type of Entry (automatic doors preferable, bars on doors preferable vs handles, rotating doors not recommended)
- Placement (consider distance from a busy street, placement near fire exits preferred)

Design Considerations for Color Contrasts

- Contrasts help reduce cognitive load
- Color contrasts were noted to be beneficial throughout the workplace (especially for entry/exit points, bathrooms, cubicles, stairways (top and bottom), common areas, security information desk)
- Need to be extreme (dark on light or light on dark, subtle contrasts might be aesthetic but not functional for BPSI)
- Color coding (beneficial to have a few and simple colors like red and blue)

Design Considerations for Lighting

- Lighting preferences may be unique for each individual
- Adjustable lighting in work areas (special filters, glasses if needed)
- Standardized lighting throughout workspace (typically not functional) vs. Uniform lighting to avoid blind spots and adjustment from light to dark areas (as close to natural light as possible)
- Overhead and dispersed lighting
- Entry/exit points, hallways, stairways (high focus on lighting)
- LED better than fluorescent lighting
- Natural Lighting

Design Considerations for Glare and Reflection

- Material considerations (avoid shiny surfaces, tile flooring causes light to bounce, walkways that are all glass can be challenging to navigate)
- Controllable window coverings (conditions vary throughout the day, especially important for spaces where most time is spent)
- Placement considerations (glare from lighting placed in the ceiling (from top) causes floor reflections.

Design Considerations for Flooring Materials

- Material considerations (even and hard flooring (materials that are too soft may cause cane to get stuck), industrial carpets, combination of materials to distinguish areas, materials which provide optimal echo)

- Safety Considerations (anti slip materials, addition of warning strips or trims on ramps, stairs and entry/exit areas)
- Keep patterns on flooring simple, high contrast with background

Design Considerations for Workspace Layouts

- Consistency in layout (standard layout on all floors in the building, restrooms, sinks etc. placed in the same location, floor numbering & elevators designed with consistency)
- Linear and numbered layouts
- Fixed individual workstations
- Open space layout with well-defined spaces (avoid clutter or barriers)

Design Considerations for Functional Room Numbering

- Organized and Predictable Logic [content (floor number, room number), consistent (first floor 1xx, second floor 2xx), odd & even numbers on opposite sides, sequenced (up on one side of the corridor, down the other.
- Tactile Feedback elements (raised numbers, braille numbers)
- High Contrast

Design Considerations for Wayfinding Signage

- Consistent Signage (placement, large print, high contrast)
- Directional and Reinforcement signage (along stretches of corridor and at decision points, large print labels and arrows)
- Contrast (with wall and text)
- Placement (at eye level, angle that is accessible to touch)
- Tactile feedback elements (braille, raised)
- Illuminated Signage

Design Considerations for Stairways

- Illumination (well-lit and overhead lighting)
- High Contrast (against wall, railings and top and bottom of stairs)
- Numbering (Large print numbering with high contrast, braille)
- Markings (yellow strips on each stair, first and last stair -well marked with high contrast, textures for identification)
- Railings (both sides, high contrast)

Design Considerations for Elevator Lobbies

- Audio Feedback (announcing arrival, direction, floor number)
- Identification (Signage to indicate which one to use and direction for multiple elevators)
- Signage (perpendicular to wall, high contrast, raised and braille, high contrast)
- Elevator buttons (high contrast, braille, raised)
- Illumination (well-lit elevator cab)

Acoustic Design Considerations

- Auditory feedback elements (beneficial in elevators, can be used for wayfinding, fire exits- can provide direction to exit)
- Control of noise (partitions, materials which provide optimal echo)
- Training and Education to Employees for sound management and sensitivities

Assistive Technologies

- 4 out of 6 participants indicated assistive technology usage by their clients with percentages ranging from 25% to 80%, one participant indicated high usage in clients.
- Technologies mentioned: AIRA, Be My Eyes, Clue, Indoor GPS in smartphones, Percept (RFID reader)
- 2 out of 6 participants indicated that they haven’t seen their client use AT or that they were not aware of any good GPS technology that is available.

Design Considerations for Service Animals

- Space Considerations (Larger cubicle or workspace to accommodate dog)
- Placement (placed near an exit door and waste receptacle)
- Education and law requirements (training and education to employers and co-employees for service animal requirements, law requirements explained to prevent social issues)

Other Design Considerations

- Considerations for how employees are reaching work
- Providing information about workplace environment prior to starting
- Allowing training with mobility specialist prior to work
- Education and training for staff for best practices and emergency exits, training for co-workers on how to accommodate and support a worker with vision disabilities
- Functional Restroom design (lighting, signage, contrast, predictable design for usability)

- Operational Features (co-workers or staff may need to control shades and lighting to support workers with vision disabilities, keeping the hallways decluttered)

Recommended Accommodations

- Individualize recommendation per needs and worksite
- Training and education among co-workers and supervisors
- Marking telephones and fax machines with tactile feedback
- Locations of office workspaces (close to bathrooms, the cafeteria, an outside door – if they have a service dog, and their supervisor).
- Personalized lighting
- Communication between HR, client and AT staff and IT support
- Individualized navigation training to client

The pilot study was led by Janet R. Carpman, PhD MCP, IHCD Director of Wayfinding. Interviews were conducted by Dr. Carpman; Andrew Freedman, Graduate Student, University of Minnesota Laboratory for Low Vision Research, Department of Psychology; Tzesika Iliovits, IHCD Project Manager, Inclusive Design Projects; Stacey Langton Toohey, OTR/L; and Mitali Kamat , MA OTR/L ATP. This report contains a summary of the interview findings.