Inclusion: access & interaction of people with disabilities with the physical & digital environment

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Abstract
It is crucial to ensure that people with disabilities have equal access and interaction opportunities with both physical and digital environments. This includes providing accessible facilities, technologies and platforms that accommodate different types of disabilities, such as visual, hearing, mobility, or cognitive impairments. The issue of making it easier for people with disabilities to access and interact with their environment: living spaces, working spaces and public spaces has been a major priority for designers, architects, engineers and even society in general for many years. Disability is the experience of any condition that makes it more difficult for a person to do certain activities or have equitable access within a given society. Disabilities may be cognitive, developmental, intellectual, mental, physical, sensory, or a combination of multiple factors. For every single type of disability we will see that there is a different set of measures that need to be taken into consideration when designing accessible tools, furniture, transportation, communication means, spaces, a.s.o. We have created ways to communicate with people that are unable to speak or hear, we are enabling individuals with impaired mobility to access all types of structures and pathways, to drive cars and manipulate complex machinery. In this context, the access to the digital world becomes more and more a necessity for any individual in our society in order to be able to communicate, to work, to get access to information, private and public services, a.s.o. By creating inclusive environments, we can promote independence, empower individuals, and enhance their overall quality of life.

Keywords: social inclusion, disabilities, accessibility, handicap, digital service access, digital skills.

1. Introduction
The issue of making it easier for people with disabilities to access and interact with their environment: living spaces, working spaces and public spaces has been a major priority for designers, architects, engineers and even society in general for many years.

To a certain degree, physical impairments and changing mental states are almost ubiquitously experienced by people as they age. Aging populations are often stigmatized for having a high prevalence of disability.

To the number of persons with disabilities from birth or acquired during a person's lifetime we will have to continously add a big procentage of the aging population as well, as it is for certain that getting older, we will all be disabled eventually.

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2. Basic physical mobility

In 1936 the German architect Ernst Neufert published the well-known work *Architects' data*, which contains standardisation rules for all elements of the built space, rules that are taught in all schools of architecture in the world, are respected, applied and constantly optimised.

First published in 1936, its 39 German editions and translations into 18 languages have sold over 500,000 copies worldwide [1].

This manual is an essential reference for the initial design and planning of a building project. It provides, in one single volume, the core information needed to form the framework for the more detailed design and planning of any building project. Organised largely by building and space type, it covers the full range of preliminary considerations, and with over 6200 diagrams it provides a mass of data on spatial requirements.

Architects all over the world are able to design the same way spaces, pathways and furnished environment in order to be easy accessable to people with mobility difficulties.

To improve accessibility for mobility disabled people in the city, a comprehensive approach can be taken. This includes installing ramps and elevators in public buildings, pedestrian crossings, and transportation hubs, as well as providing accessible parking spaces. Additionally, cities can implement audio signals at pedestrian crossings, tactile markings on sidewalks, and audible announcements at train stations to help visually impaired individuals navigate. Furthermore, cities can also promote the use of assistive technologies such as wheelchairs, scooters, and mobility aids, and provide training for emergency responders and healthcare professionals to ensure they can effectively respond to the needs of mobility disabled individuals.

Assistive technology is a generic term for devices and modifications (for a person or within a society) that help overcome or remove a disability. The first recorded example of the use of a prosthesis dates to at least 1800 BC. The wheelchair dates from the XVII-th century [2].

Fig. 1. Concept of futuristic mechanical exoskeletons for mobility-disabled persons created with A.I. assisted software
Source: Monica-Mihaela Frangulea

But mobility difficulty is just one type of disability.

Disabilities may be cognitive, developmental, intellectual, mental, physical, sensory, or a combination of multiple factors [3].

3. Visual impairments

Impaired vision can range from poor vision to blindness. Visual disability requires a totally different set of measures in order to facilitate access to the physical environment than in the case of other sensory or physical impairments.

A brilliant inventor, Louis Braille have developed a system of tactile code that could allow blind people to read and write quickly and efficiently. He presented his work to his peers for the first time in 1824, when he was fifteen years old, opening the possibility of reading to blind people and set the fundamentals visual impaired people access systems in our society.

Louis Braille's system of embossed type is now used by blind and partially sighted people for reading and writing all over the world and it has been adapted to almost every known language [4].

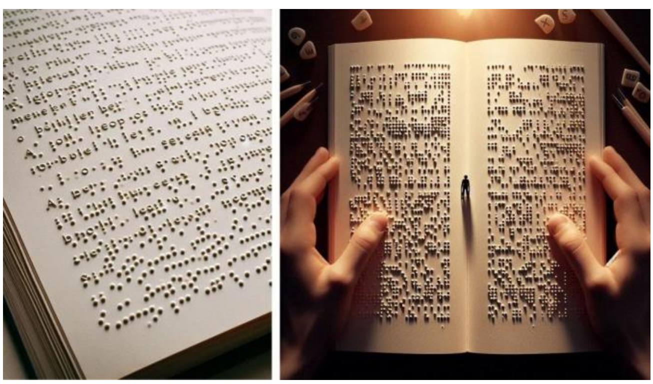

Fig. 2. Books printed with Braille tactile reading system. Image created with A.I. assisted software
Source: Alexandru Linca

Today we are developing much more advanced technology to assist people with this type of condition, such as screen readers and print reading devices, which convert text into spoken words.

To address the challenges faced visual impaired individuals in urban spaces, various access systems have been developed and implemented. One such system is the installation of tactile paving on sidewalks and public spaces, providing tactile cues to guide visually impaired individuals safely. Additionally, audible signals at pedestrian crossings have been introduced to assist blind people in safely navigating busy intersections. Moreover, the development of mobile applications specifically designed for visual impaired people has revolutionized the way they access information and navigate urban environments. These applications provide real-time navigation assistance, information on nearby points of interest, and even indoor navigation support in complex buildings such as shopping malls or airports.

Enhancing access systems for blind individuals in urban areas has a profound impact on their independence, safety, and overall quality of life. By improving accessibility features such as tactile paving and audible signals, blind individuals can navigate urban spaces with greater ease and confidence, leading to increased independence and mobility. Furthermore, enhancing access systems contributes to the safety and security of blind individuals in urban environments, reducing the risk of accidents and improving their overall well-being. Ultimately, promoting inclusivity and equal opportunities for all individuals in urban spaces, including those with visual impairments, is essential for creating a more accessible and welcoming environment for everyone.

In conclusion, the challenges faced by blind individuals in urban spaces necessitate the development and enhancement of access systems tailored to their specific needs. By incorporating tactile paving, audible signals, and mobile applications, urban environments can become more inclusive and accessible for individuals with visual impairments. The impact of these enhanced access systems extends far beyond the individual level, contributing to the safety, independence, and inclusivity of urban communities as a whole. It is imperative that urban planners, policymakers, and communities work together to ensure that access systems in urban spaces are designed with the needs of all individuals in mind, fostering a more inclusive and equitable urban environment for everyone.

Fig. 3. Concept of automatic stairs access to buildings from the street for mobility-disabled persons created with A.I. assisted software
Source: Monica-Mihaela Frangulea

In April this year the students at the University of Architecture and Urban Planning „Ion Mincu" in Bucharest were given the task of testing in real life action the accessibility of interior public spaces by trying to access the university lobby and the other surrounding areas wearing blindfolds. Such an exercise brings awareness to the future architects of how difficult such a condition is (visual impairment) and what they have to take into consideration when designing interior and exterior structures and spaces.

Fig. 4. Students wearing blindfolds in order to test the accessibility of the lobby space of the University of Architecture and Urban Planning „Ion Mincu" in Bucharest
Source: Monica-Mihaela Frangulea

We also have to mention the major role the urban public lighting is playing in our society. During night time, without artificial lighting to highlight the environment, everybody is blind!

Without artificial light we would not be able to move around at night, to find our way around and to navigate urban routes - streets, pavements, alleys, paths, parks, squares, a.s.o.

A proper amount and distribution of artificial light in the urban areas as well as in the interior spaces insures the safety and security for everybody at the level of urban circulation and functionality, because in addition to the street lighting strictly necessary for this safety, there is also a need for visible urban landmarks on a larger scale (buildings, monuments, landmarks), in order to facilitate the correct perception of the position the observer is having in the urban environment, can calculate the correct path and distance to its destination or just be aware of the location the observer is at all times.

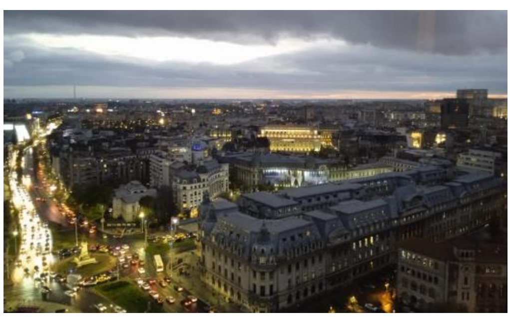

Fig. 5. University Square at dawn, photographed from the last floor of Intercontinental Hotel, Bucharest
Source: Monica-Mihaela Frangulea

4. Hearing impairment

By 2050, nearly 2.5 billion people are projected to have some degree of hearing loss, and at least 700 million will require hearing rehabilitation.

Over 1 billion young adults are at risk of permanent, avoidable hearing loss due to unsafe listening practices [5].

Along with the efforts to promoting safe listening to reduce the risk of recreational noise-induced hearing loss, innovation is taking also steps in creating new technologies to help people with hearing disabilities.

Hearing impaired individuals in urban areas grapple with limited access to auditory information and communication, which are essential components of daily life. The absence of sound cues can hinder their ability to perceive important announcements, warnings, or instructions in public spaces. Additionally, navigating public transportation systems poses a significant challenge for deaf persons due to the reliance on auditory cues for boarding announcements and route information. This can lead to feelings of isolation, frustration, and even safety concerns. Furthermore, accessing public services and facilities, such as government offices, healthcare facilities, and educational institutions, can be daunting for those persons without adequate support or accommodations in place. To enhance accessibility for hearing impaired individuals in urban spaces, cities can implement various systems and technologies. For instance, public transportation systems can be equipped with visual indicators, such as LED displays or audio-to-text systems, to provide real-time information to passengers. Additionally, auditory signals can be replaced with visual alerts, such as flashing lights or vibrating seats, to notify individuals of arrivals, departures, and stops. Furthermore, city squares and public spaces can be designed with visual cues, such as Braille signage and audio loops, to facilitate navigation and communication.

5. Invisible disability

Invisible disabilities, also known as Hidden Disabilities or Non-visible Disabilities (NVD), are disabilities that are not immediately apparent, or can be noticed. They are often chronic illnesses and conditions that significantly impair normal activities of daily living. Invisible disabilities can hinder a person's efforts to go to school, work, socialize, and more. Some examples of invisible disabilities include intellectual disabilities, autism spectrum disorder, attention deficit hyperactivity disorder, fibromyalgia, mental disorders, asthma, epilepsy, allergies, migraines, arthritis, and chronic fatigue syndrome.

6. Digital access for persons with disabilities

Many of these community members face communication challenges and while technology has become more ubiquitous in people's lives, those with such challenges face a digital divide that is present due to a lack of accessibility considerations within the digital ecosystem. Affordability and accessibility of technology products as well as digital literacy are the main barriers affecting their digital access and inclusion [6].

In this context, access to the digital world is becoming more and more a necessity for any individual in our society in order to be able to communicate, to work, to get access to information, private and public services, a.s.o.

Accessibility systems to digital platforms are crucial for people with disabilities, enabling them to fully participate in the digital world. These systems include features such as text-to-speech, screen reader software, and closed captions, which provide equal access to information and opportunities for individuals with visual, hearing, motor, or cognitive impairments. Additionally, accessibility features like keyboard-only navigation, high contrast modes, font size adjustments, screen readers, speech recognition software, alternative input devices, and captioning tools are just a few examples of the innovative technologies that have been developed to improve accessibility and can help individuals with mobility or visual impairments navigate and interact with digital platforms with ease.

Companies like Apple and Microsoft have also integrated built-in accessibility features into their operating systems, making it easier for users to customize their digital experience according to their needs.

For example, Apple has recently launched the “Eye Tracking” system powered by artificial intelligence, that gives users a built-in option for navigating iPad and iPhone with just their eyes. Designed for users with physical disabilities, Eye Tracking uses the front-facing camera to set up and calibrate in seconds, and with on-device machine learning, all data used to set up and control this feature is kept securely on device, and isn’t shared with Apple.

The same company has developed the “Music Haptics” system as a new way for users with hearing disability to experience music on iPhone. With this tactile accessibility feature turned on, the Taptic Engine in iPhone plays taps, textures, and refined vibrations to the audio of the music.

A range of “Vocal Shortcuts" was also developed, giving users an option for enhancing speech recognition for a wider range of speech. Designed for users with acquired or progressive conditions that affect speech, such as cerebral palsy, amyotrophic lateral sclerosis (ALS), or stroke, these features provide a new level of access, customization and control, building on features introduced in iOS 17 for users who are non speaking or at risk of losing their ability to speak [7].

The work on accessibility at MSR India has spanned the range of new access systems from spatial audio with HoloLens to the use of feature phones to reach children with vision impairments and a spectrum of tangible toys to enhance numeracy for them, to a quiz platform for the Deaf or Hard of Hearing community, with an overarching new methodology called “Ludic Design for Accessibility”.

Microsoft Ludic Design for Accessibility is a novel methodology that puts playfulness at the center of any design for accessibility. The key idea was that a solution for accessibility designed with this methodology will be in the form of an engaging and inclusive game. By extended and joyful play with the game the players can acquire the designed in skills purely as a side effect [8].

The same company has developed SEEDS (Scalable educational experiences with digital scaffolding), a project that builds on top of the work over the past four years with Vision Empower Trust, a DPO that has now reached about one hundred schools for the blind across a dozen states of India, codesigning the solutions with Microsoft and taking them to the end users. The goal of the project is to introduce digital technologies to children in schools for the blind from the primary stage onwards but the long-term vision is to reach every one of the estimated 1–2 million children with vision impairments in India [9].

By incorporating these accessibility features, digital platforms can promote inclusivity, diversity, and social equality, ensuring that everyone has equal access to education, employment, and social opportunities.

7. Impact of Accessibility on Security for People with Disabilities

The integration of accessibility measures for individuals with disabilities into both physical and digital environments significantly impacts security, fostering a safer and more inclusive society. Ensuring accessibility not only enhances the independence and quality of life for people with disabilities but also contributes to overall societal security in various ways:

Physical Security: Technologies such as advanced driver-assistance systems (ADAS) in cars, which include features like lane departure warnings and adaptive cruise control, support drivers with disabilities and improve overall road safety. By assisting drivers in maintaining control and awareness, these systems reduce the risk of accidents, contributing to safer road conditions for all users.

Cybersecurity: The increasing reliance on digital assistive technologies, such as smart home devices and wearables for health monitoring, necessitates robust cybersecurity measures. Protecting these devices from cyber threats ensures that people with disabilities can rely on them without compromising their personal safety and privacy.

Fig. 6. Abstract images of Multi-Factor Authentication for people with disabilities.
Image created with A.I. assisted software
Source: Alexandru Linca

Ensuring that Multi-Factor Authentication (MFA) options are accessible to all users, including those who may have motor or cognitive difficulties, is crucial. For example, using mobile authentication apps or physical tokens can be adapted to meet diverse needs.

In conclusion, the integration of accessibility measures for people with disabilities profoundly enhances security across physical, digital, and social dimensions. By fostering an inclusive environment, society not only supports the independence and well-being of individuals with disabilities but also enhances overall safety and resilience, benefiting all members of the community.

References

[1] „Ernst Neufert," [Interactiv]. Available: https://architectuul.com/architect/ernst-neufert. [Accesat 15 May 2024].

[2] R. A. Cooper, Hisaichi Ohnabe și Douglas A. Hobson, în *An Introduction to Rehabilitation Engineering,* CRC Press, 2006, p. 131.

[3] L. Francis și A. Silvers, „Perspectives on the Meaning of "Disability"," *AMA Journal of Ethics,* vol. 18, nr. 10, pp. 1025-1033, 2016.

[4] Royal National Institute of Blind People (RNIB), *Invention of Braille,* 2017.

[5] Worlds Health Organisation, „Deafness and hearing loss," Available: https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss#:~:text=A%20person%20who%20is%20not,conversational%20speech%20or%20loud%20sounds. [Accesat 18 May 2024].

[6] The UN RefugeeAgency (UNHCR), „Digital Access and Inclusion of People with Disabilities," [Interactiv]. Available: https://www.unhcr.org/innovation/wp-content/uploads/2021/03/Digital-Access-and-Inclusion-of-People-with-Disabilities.pdf. [Accesat 19 May 2024].

[7] Newsroom, Press Release, „Apple announces new accessibility features, including Eye Tracking, Music Haptics, and Vocal Shortcuts," Available: https://www.apple.com/cm/newsroom/2024/05/apple-announces-new-accessibility-features-including-eye-tracking/. [Accesat 2 June 2024].

[8] Microsoft, „Accessibility and Assistive Technology," Available: https://www.microsoft.com/en-us/research/project/accessibility-and-assistive-technology/. [Accesat 2 June 2024].

[9] Microsoft, „Scalable Early Education with Digital Scaffolding (SEEDS)," Available: https://www.microsoft.com/en-us/research/project/scalable-early-education-with-digital-scaffolding-seeds/. [Accesat 3 June 2024].