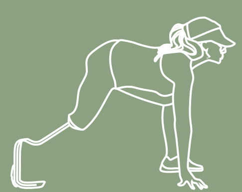
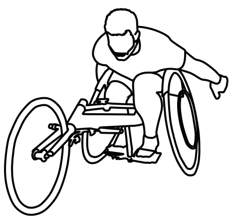
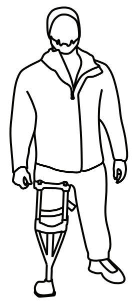
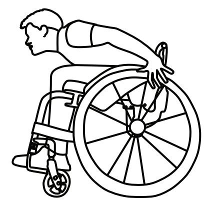
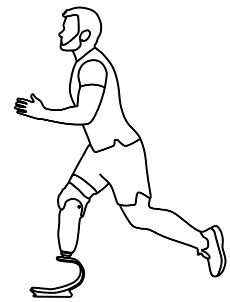
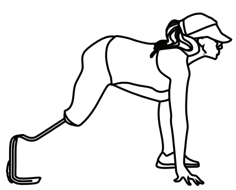


ENABLED BY DESIGN:

THE BUILT ENVIRONMENT AS A TOOL FOR HUMAN ENHANCEMENT

RESEARCH REPORT

by Alexia M. Lund

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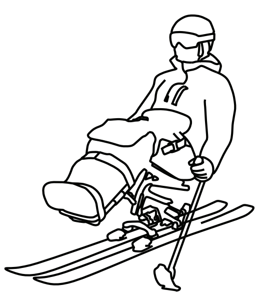
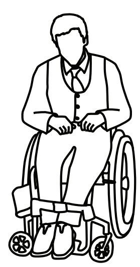

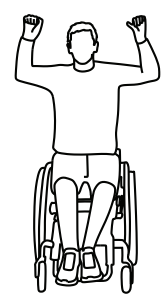

ALEXIA MARIE LUND
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INDEX

INTRODUCTION

research overview

PROBLEM STATEMENT

topical introduction and relevance

Historically, our society has demonstrated tendencies of exclusion towards those who misfit the norms. While there may be innumerable factors that come into play in these scenarios, such tendencies of marginalization seem to hold a strong connection to aspects of the built environment. As one of the many standardized systems in our world, design and architecture follow guidelines that commonly comply with a 'one size fits all' approach [1], catering to a mainstream majority while disregarding individuals who misfit such standards. Such scenario of design disablement is commonly true for users of assistive technology, whose scope of devices are rarely considered within traditional design practices [2]. Although such technologies may be partially accounted for through codes and regulations regarding wheelchair access, the usability of other forms of mobility assistance - such as walkers, crutches, canes, scooters and adaptive limbs - remain absent in such guidelines. This disregard of specific person-environment interactions indicates a gap within inclusive design practices, in which current approaches fail to carefully consider how "mobility challenges are not experienced in the same way across mobility device users"[3]. With architectural practices focusing on the needs of non-disabled bodies, the needs of mobility aid users seem to go unrecognized, leading to disadvantageous spatial conditions that restrict their capabilities. Taking that perspective into consideration, it's possible to say that the ambulation restraints of individuals who rely on mobility aids is less about their physical capabilities and more about architecture's lack of receptiveness towards their reliance on the use of assistive devices. Bringing to light the complexities between the built environment and the use of mobility devices, one may recognize that designing with consideration to assistive technology involves "considering not only an individual's physical capacity but also the demands created by the environment, as they jointly influence independent mobility" [4]. With that being said, it's possible to say that incapabilities associated with reduced mobility - whether from age or other factors - aren't as much of a concern as the built environment that aggravates them, and that is precisely what this research seeks to explore. Although other forms of impairments may also face barriers of flawed design, the primary concern to be addressed within this framework is the capability limitations imposed specifically on individuals who face reduced mobility and rely on assistive devices.

RESEARCH QUESTION

focus of investigation

-primary-

To what extent can the built environment serve as a tool for human enhancement?

While the current mainstream standards of the built environment may negatively contribute to the further impairment of incapabilities, one could question whether the built environment could also serve for the opposite effect. After all, "if people can be disabled and excluded by design, they can also be enabled and included by thoughtful, user-aware design" [5]. Through this perspective, in realizing that overlooked groups - such as mobility aid users - are being disadvantaged by their environments, the modification of their environment (rather than the modification of the individuals themselves) seems like an indisputable approach.

-secondary-

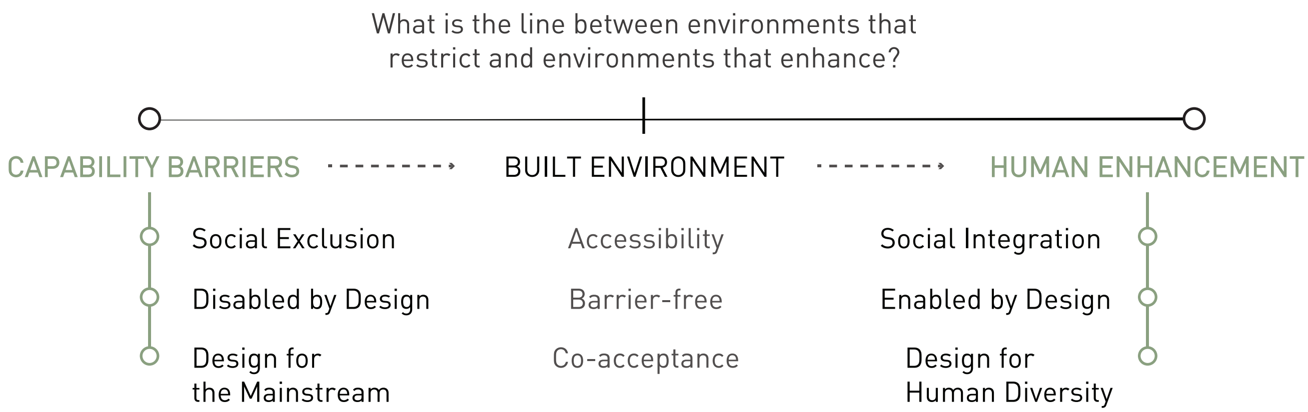
What factors of design may further restrict the capabilities of mobility aid users?

How can architecture be more receptive to the use of assistive technology?

The question which guides this research is strongly reflective of that very perspective, not only recognizing the role of the built environment as a factor of disablement, but also exploring its potential as a tool of enablement. To undergo such exploration of the potentials of architectural practices in the process of design inclusion, its role in processes of design exclusion must also be understood. The secondary research questions are precisely intended to bridge that gap, exploring the specifics of circumstances of spatial exclusion to procure comprehension of the external factors that shall be rerouted in objectives of inclusion.

RESEARCH STRUCTURE

stages of exploration



Throughout the research process, the mutual interest in the very distant themes of capability barriers and human enhancement prompted personal doubts in regards to the overall focus of the investigation. Was this exploration to focus on architecture's barriers or on its potential as an enabler? In recognizing how apart such concepts laid from each other, came the key realization that the research was not about each theme individually, but rather the relationship between them. Formatted into a scale, this mentality is visualized in the diagram above, which ranges from aspects of design exclusion to aspects of design enablement.

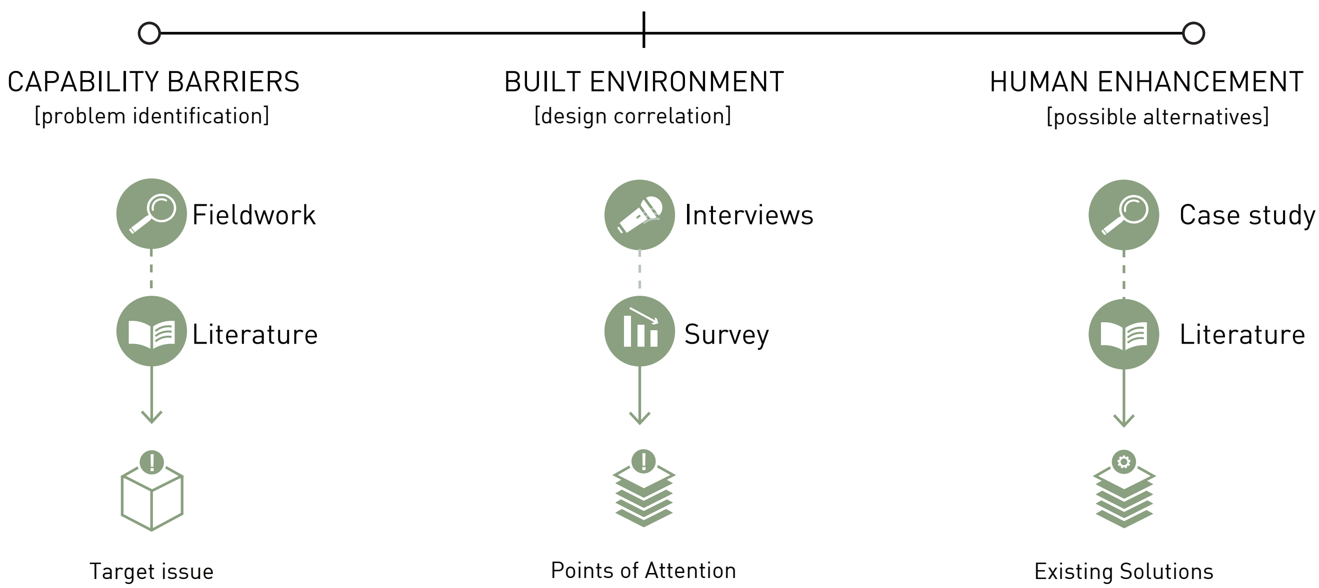
The scale travels through three topics:

(1) capability barriers
(2) the built environment
(3) human enhancement

Analyzed in parallel, these three themes unfold what lies between environments that restrict and environments that enhance, bringing to question the factors that establish such key distinction. What separates spaces that foster social exclusion and places that foster social integration? How do we go from disabling by design to enabling by design?

METHODOLOGY

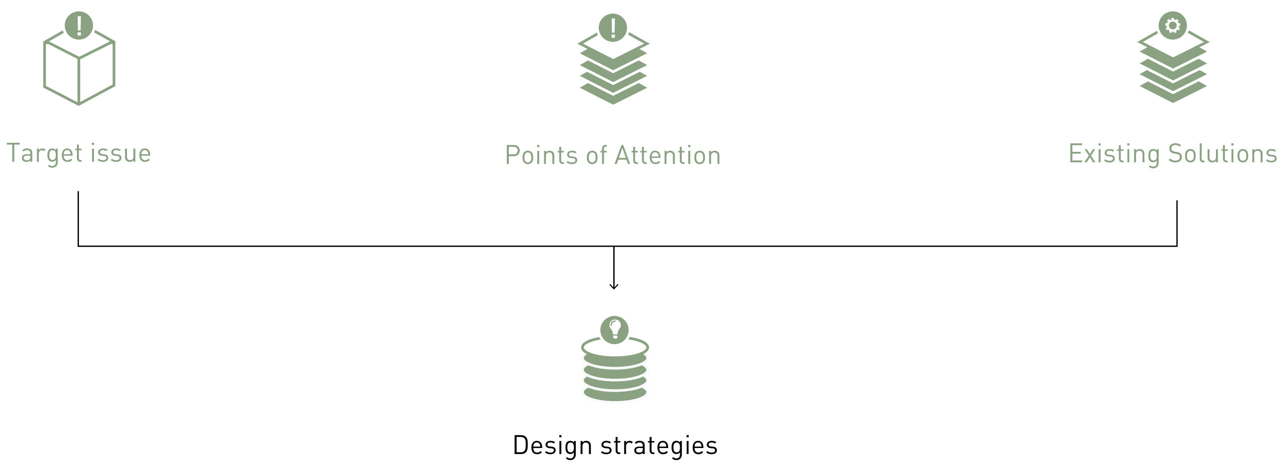
tools of investigation



As shown on the scale, these three themes are not only the primary topics of exploration, but also the three phases in which the research is divided. Each of the three phases holds an intended outcome, ensuring a topically-focused result for each phase. The theme of capability barriers focuses on the identification of the problem with the intention of determining the target issue. Meanwhile, the built environment subject analyzes the issue's design correlation, to establish points of attention to be considered in more inclusive design processes. At last, the human enhancement portion explores possible alternatives to understanding existing solutions to design disablement. This allows for multiple methodologies to take place, in which each topic uses tools that cater to their theme, such as interviews, surveys, or case studies.

GOAL

guiding theme and objectives



While the topic of architectural codes may be closely woven to the guiding theme of design disablement, it should be noted that they are not the primary focus of this research. In no way does this research seek to discard the importance of such guidelines, however, their analysis is certainly not a primary objective within the investigation. In fact, the goal of this investigation is precisely about what may lie in the gaps of such regulations, focusing not on accessibility per say, but rather on factors of inclusivity that remain understudied. Hence, **the goal of this research is to give rise to the voices of those who face design barriers, bringing to light the human-centered view of the more experiential factors of design disablement, with the hope of unearthing knowledge that supports architecture's potential as a tool for design enablement.** In other words, it seeks to gain a user-specific perspective of spatial barriers, to not only to emphasize the importance of accessible design, but also to unfold design strategies that may shape more inclusive processes. In one way or another, one more purpose nestled within these objectives is the opportunity to raise awareness on the need for improvement of inclusivity approaches in architectural practices. With that said, bringing attention to the responsibility that architects hold in the inclusion of people with disabilities and building up the influence for them to do so is also a guiding motivation.

The field of disability studies is explored through a wide range of academic perspectives, many of which have rather contrasting points of view. In fact, amongst the various lenses tackling this theme, even the definition of disability in itself varies between perspectives. Whilst there may be an array of viewpoints on the topic, the two most popular perspectives - and with the most distinct values - are the medical and social model of disability. In the medical model, disability is defined by specific biological impairments [6], within which the physiological variations of human-kind are somewhat perceived as unwanted characteristics. The medical model views disability as an attribute of the individual and not a result of affecting external factors that often relate to the environment. In adopting this rather pejorative association, the medical model "identifies disability with a physical or cognitive impairment that places one below species-typical functioning in some respect" [7]. Alternatively, the social model gives rise to the recognition that the process of disablement is dependent on external factors, and therefore something that can be strongly impacted by the qualities of one's immediate surroundings. With that being said, within the social model "disability is seen as a socially constructed phenomenon that results from barriers that are present in the environment" a perspective which acknowledges ranging influences on states of disablement and "locates it within the environment rather than within the person"[8].

The stance adopted by the social model is a more humanistic view that acknowledges how one's capabilities can be significantly affected by barriers imposed by the built environment. The growth of this concept was crucial to the development of disability rights in the past century, however "critics argue [that] the social model - or at least work advanced in its name - focuses too heavily on social and material barriers with little consideration of the experiential aspects of disability and the significance of physical impairment in people's lives" [9]. Such criticism may seem extreme, but it brings attention to how the process of disablement may be neither about one's physiological condition nor about one's environment exclusively, but in fact somewhere in between. This view is sometimes referred to as the social adapted model of disability, but also relates directly to the capability approach, which will be discussed in a later chapter. Overviewed, the point of this combined viewpoint is that "although a person's disability poses some limitations in an able-bodied society, oftentimes the surrounding society and environment are more limiting than the disability itself" [10]. This very description is significantly reflective of the perception adopted throughout this research, and is therefore the topical stance used in this thesis. With that being said, upcoming observations on design disablement are analyzed from this standpoint, considering factors of disability to be multifold,.

Prior to diving into the specifi cs of this research, it is important to identify the primary themes of exploration. Taking note of the research question, the terms 'built environment', 'tool', and 'human enhancement' are considerably important. Those terms are stems of other themes that are too very signifi cant to the research focus, including spatial qualities, assistive technology, and barriers and facilitators. Aside from providing a good idea of the topical direction of this investigation, the above mentioned terms and themes bring to light a rather overlooked gap in research and practices of design. Throughout this research it has been noted there are scarce amounts of literature that analyzes the topics of spatial qualities, assistive technology, and barriers and facilitators in a simultaneous manner. These topics are primarily addressed in architecture literature, medical journals, and guidebooks on universal design, however as depicted in the table below none of those formats include the overlapping relationship between all themes.

	Architectural Literature	Medical Journals	Universal Design Handbooks
assistive technology	○	●	●
spatial barriers and facilitators	●	●	○
design guidelines	●	○	●

Architectural Literature:
On one hand, spatial qualities of accessible design can be easily found in architectural literature, often focusing on functionalities and dimensions that are largely related to codes and regulations. While such guidelines may indeed be valuable, they are often a result from very broad conceptions of disability [15], and therefore tend to include little about other forms of assistive technology. A strong focus on wheelchair-users fails to take note of other mobility aid users whose needs should be also considered, failing to approach accessibility in a human-centered way and possibly lacking direct feedback from the very people who are impacted by this issue. This reiterates how in spite of its significant rise throughout the disability rights movement, accessibility regulations may be insufficient for an all-encompassed understanding of spatial disablement.

Universal Design Handbooks:
In parallel, content on universal design features signifi cant information on barriers and facilitators as well as assistive technology. However, as universal design covers different specialization scopes such as web, graphic, industrial and product design, there is no significant focus on the mutually important aspects of spatial qualities. Books such as "Breaking Down Barriers: Usability, Accessibility, and Inclusive Design" by Pat Langdon or "Inclusive Design: Design for the Whole Population" by Roger Colemann exemplify these characteristics, having a wide spectrum of design that leaves little room to understand specific relations between different assistive technology and architecture in specific. The field of universal design is the one closest to merging themes of design and mobility aid users, however, it seems as though in-depth research concerning specifically architectural qualities in relation to the use of assistive devices is lacking.

Medical Journals:

When it comes to medical journals, it's not hard to encounter occupational therapy or rehabilitation investigations that entail barriers and facilitators relating to the use of assistive technology. A few examples include Andrea Rosso's comprehensive review "The Urban Built Environment and Mobility in Older Adults" or even "The Role of the Built Environment and Assistive Devices for Outdoor Mobility" by Philippa Clarke. While such articles may include connections to the built environment, explorations related to spatial qualities are lacking. This emphasizes the absence of architectural perspectives on the subject, a concern that is even voiced within Clarke's work, which cites that:

> **"the complexity of interactions between different types of assistive technologies and the built environment (...) points to a relatively unexplored interplay between different environmental features in the disablement process."** [16]

With that said, while some occupational therapy investigations look into both design and mobility aid users, it seems as though in-depth research concerning specifically architectural qualities in relation to the use of assistive devices is lacking.

Indeed, when in combination all three realms offer significant information in regards to accessibility and design exclusion, but lacking overlap of such themes suggests a crucial gap in architectural practices, especially in terms of mobility aids specifically. Because each of the above mentioned realms perceive this topic through its own lens, the parallel connections that lie between them remain understudied, having little information regarding their mutual influences. Whilst the architectural field considers spatial qualities, it lacks analysis on how such qualities affect the experiences of different mobility aids. Alternatively, while the fi eld of occupational therapy dives into said experiences of mobility aid users, it only considers spatial qualities superficially. Taking that into consideration rises questions regarding the parallel influences between these themes, which is precisely what this investigation seeks to unfold. It is theorized that the exploration of such topical gaps will offer a new view on the mutual connections between the architectural field and occupational therapy. In gaining in-depth knowledge of accessibility barriers through an architectural perception while simultaneously looking into key themes regarding the use of mobility aids through views that are specific to occupational therapy, it is theorized that concepts of inclusive architecture may gain a whole new perception. Through the construction of this joint perception, one can hypothesize - and somewhat hope - that a new view of accessibility will not only pave the way for more accessible spaces, but also influence more inclusive design processes.

NOTES

[1] Clarkson, John. *Inclusive Design : Design for the Whole Population* (London: Springer, 2003), p. 220

[2] King, Emily, Tilak Dutta, Susan M. Gorski, Pamela J. Holliday & Geoff R. Fernie, "Design of Built Environments to Accommodate Mobility Scooter Users: Part II", *Disability and Rehabilitation: Assistive Technology*, p.432

[3] Prescott M, Miller WC, Routhier F, Mortenson WB, "Factors Affecting the Activity Spaces of People Who Use Mobility Devices to Get Around the Community",*Journal of Transport & Health 20* (Health Place, 2020), p.2

[4] Clarke, Philippa, "The Role of the Built Environment and Assistive Devices for Outdoor Mobility in Later Life", *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences* (J Gerontol B Psychol Sci Soc Sci, 2014), p.S9

[5] Clarkson, John. *Inclusive Design : Design for the Whole Population* (London: Springer, 2003), p.1

[10] Barbara E. Gibson et al., "Disability and Dignity-Enabling Home Environments," *Physiotherapy Theory and Practice 28*, Social Science & Medicine 74 2 (2012), p.476

[11] Jessica Flanigan and Terry L. 1966- Price, *The Ethics of Ability and Enhancement*, Jepson Studies in Leadership (New York, NY: Palgrave Macmillan, 2018), p.26

[12] Albert M. Cook and Janice M. Polgar, "Chapter 1 - Principles of Assistive Technology: Introducing the Human Activity Assistive Technology Model," in *Assistive Technologies (Fourth Edition)*, ed. Albert M. Cook and Janice M. Polgar, Fourth Edition (St. Louis (MO): Mosby, 2015), p.2

[13] Barbara Gibson and Gail Teachman, "Critical Approaches in Physical Therapy Research: Investigating the Symbolic Value of Walking," *Physiotherapy Theory and Practice* 28 (April 16, 2012), p.476

[14] Disabled World. (2010, September 10). Models of Disability: Types and Definitions. *Disabled World. Retrieved* May 9, 2022 from www.disabled-world.com/definitions/disability-models.php

CH. 1 OVERVIEW

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Aforementioned circumstances introduce concerns relating to design standardization and the resulting exclusion of people with disabilities. Whilst attention has been brought to the relevance of the issue, the specifics regarding its roots remains unexplored in the previous chapter. To procure understanding the spectrum that lies between design disablement and design enablement, there's an undeniable need to determine the factors which stem the precedents of mainstream design. Seeking to bring such factors to light, this section explores the different circumstances that may take part in shaping the continuous occasions of architectural practices that disregard the needs of individuals with a disability. While not yet diving into the specifics of design flaws, the following pages offer an equally relevant overview of a few different issues that may have paved the path to the flawed design qualities that will be later discussed. With that being said, this section focuses specifically on the identification of the problem of design exclusion and the factors which may influence it, including the topics of (2a) capability barriers (2b) accessibility norms, and (2c) assistive technology.

CHAPTER 1

problem identification

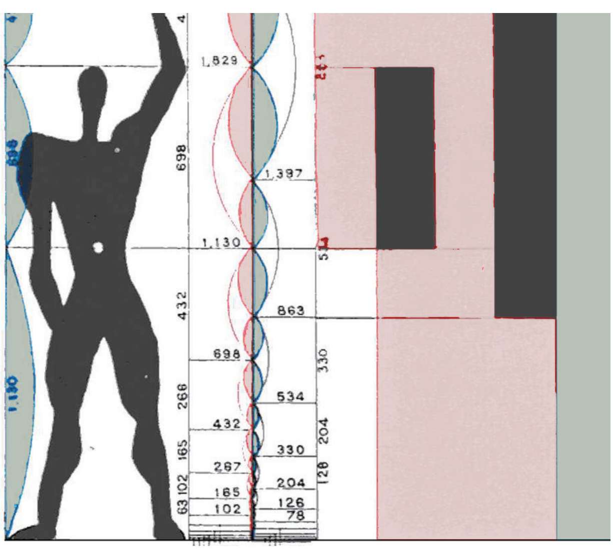
CAPABILITY BARRIERS

conceptual definition and primary realms of exclusion

As was introduced in the previous chapter, perceptions of 'normalcy' often shape patterns of exclusion within society. While the source of exclusion may come from something as simple as a spatial barrier, it's important to take into consideration that such deemed 'minor' restriction can still unravel into a multiplicity of other disadvantages. Unfortunately, these disadvantageous conditions remain true in resources that are rather essential for one's well-being. Be it in terms of employment, education, or even housing, the hierarchical division of bodies leading to unequal access to the built environment also inevitably leads to unequal distribution of resources [1]. In having structures of everyday life primarily available to non-disabled bodies, the hindered access to such facilities - be it schools, workplaces, shops, parks, transport or others - inevitably limits people with disabilities from fully participating in society [2]. Sub consequently, persons with a disability have a greater likelihood of being unemployed, with lower socioeconomic status, and with minimized chances of receiving proper education [3]. This means that standardized systems are in fact very much capable of either enhancing or hindering one's quality of life. Within this framework, such restrictive conditions are coined as 'capability barriers', which we define as the range of impositions that can limit an individual's opportunities. While the definitions of the word 'capability' may be associated with the possession of skill or competence [4], its definition in this research is representative of a more complex concept.

In line with the 'capability approach' developed by philosopher Amartya Sen, this investigation adopts the meaning of capability as what people are able to do or be as a result of what they're provided with [5]. This interpretation reclaims 'disability' as something that is situation-specific, resulting not strictly from individual attributions but from the interaction between the individual and their environment [6]. In other words, this reinstates that one's disability is not necessarily referent to their impairment, but instead to the external factors that make hardships of that impairment. Through the identification of such hardships, we uncover the realization that "if the barriers to full participation are not intrinsic to the individual but rather are social in nature, it is matter of social justice that these barriers should be dismantled" [7]. With so much being created with strict consideration to needs that are able-bodied specific "the social and physical world has been made in the image and likeness of non-disabled people", therefore creating a world that is "a home for their bodies"[8]. Hence, it is key to comprehend that the act of breaking such deeply ingrained values of ableism within the myriad of facilities and systems that exclude populations with disabilities is in fact a matter of civil right that can no longer be overlooked. Whether deprived of proper schooling, restricted from financial stability, or refrained from the possibility of building a home, the barred capabilities resulting from such systemic restrictions have indisputable life-changing consequences for those who face them.

As can be assumed, aforementioned 'external factors' of disablement are largely prevalent within the built environment and its recurring imposition of design exclusion. The continuous tendency of failing to design for a range of human variations is especially explicit in accessibility norms and regulations, which tend to address design for disabilities rather superficially. While these norms have drastically progressed throughout the last half century, the room for their improvement is sadly incalculable. Indeed, considering years of advocacy for the right to accessibility, it is undeniable that "the disability rights movement is one sign that our culture is growing more willing to include a more diverse definition of humanity" [9], and it's true that updates on accessibility codes are somewhat reflective of that reality. Specifically looking at architectural standards through a timeline - from Le Corbusier's Modular Man to Ron Mace's concept of universal design- it is clear that a lot has been achieved in regards to disability rights within architecture. Unfortunately, however, in spite of such progress, there is still much to achieve within the standardized guidelines of architectural inclusivity.



In many ways, this gap in the system is likely due to lack of direct knowledge on the spatial experiences of people with disabilities, as after all "terms of reference and the means of access have, as a rule, not been determined by disabled people but rather by non-disabled authorities" [10]. In other words, in the absence of proper user consultation, legislations on accessibility continue to be based on generalized views of the needs of people with disabilities. In fact, when looking into different guides and handbooks of access codes, this lack of human-centered views becomes quite clear.

Across a range of worldwide versions of accessibility regulations, there's one singular topic that always takes focus: wheelchairs. Rather consistently, wheelchair accessibility is the protagonist amongst many different access guidelines [11], and although wheelchair access is indeed very significant, such focus on a singular representation of disability suggests disappointedly broad perceptions. The extent of this single-faceted view is exemplified in the terminology of guidelines themselves, within which other forms of aids and devices are barely mentioned. In the context of the United States, for example, the most recent version of the Americans with Disabilities Act states the term "wheelchair" 222 times, whereas other terms such as "prosthetics", "crutches", or "walkers" are mentioned a maximum of 4 times [12]. This is a significant indicator of the common oversimplification of accessibility, as well as the misconception that designing inclusively is restricted to the removal of barriers. Whether speaking of crutches, canes, walkers, scooters, or even adaptive limbs, a whole group of devices has been left unaccounted for. In addressing a range of physiological variations within this single facet, knowledge of design inclusivity ends up being shaped by shallow associations that are restricted to 'wheelchair-friendly' approach. users only. This realization sadly reiterates how:

"accessibility regulations address specific dimensions and technical details rather than the more existential aspects of how human beings perceive and experience architecture" [13]

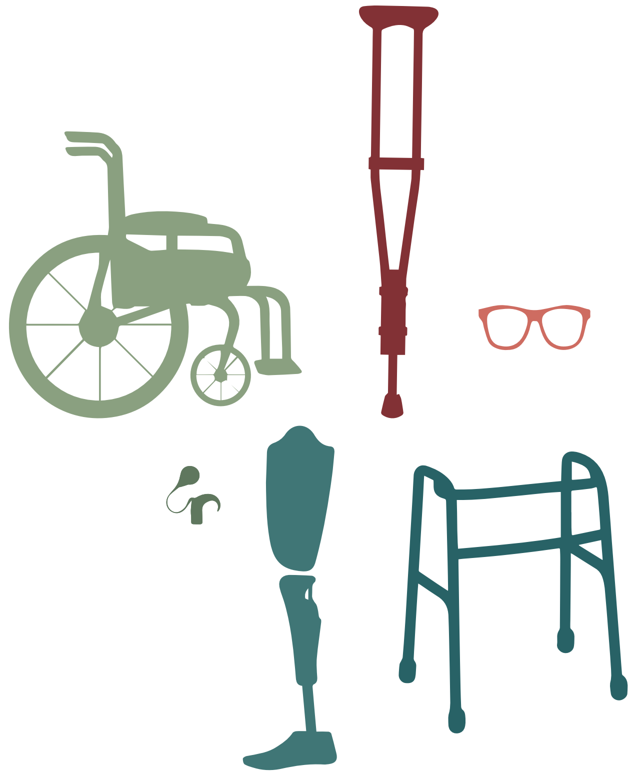
Hence, whether in the professional or educational field of architecture, it seems as though the multi-layered topic of disability is being oversimplified into the memorization of dimensions and the copy-pasting of ready-made CAD blocks. Bringing such factors to light, it becomes clear that "disability has somehow remained [a] seriously under-explored category in relationship to building design practices" [14]. This alarming concern may not have gained strong attention in the architectural realm, however, recent research within the field of rehabilitation therapy raises attention to how:

"[as] existing access standards are typically based on requirements of the manual wheelchair, there is increasing recognition that other mobility devices must be considered as standards are updated" [15].

With inadequate knowledge on different mobility aids, the lack of relevant data and appropriate tools leads designers to experience difficulties in implementing inclusivity values within the design process [16]. Acknowledging such concern, the following portion of the research aims to investigate different aspects of assistive technology and the possibilities of remedying its exclusion in design, looking into specific factors regarding their use within different spatial conditions and contexts.

In spite of generalized views on disability, it's rather evident that the variability of needs and conditions of people with disabilities fall onto an extensive scope. Whether speaking of cognitive, physical, or sensory impairments, the accessibility requirements for innumerable audiences continues to be disregarded in across various practices. Although accessibility barriers may be indeed experienced by ranging physiologies, the challenges related to design flaws manifest more clearly for people with restricted mobility. Ranging between a stroke, arthritis, amputation, cerebral palsy, muscular dystrophy, spina-bifida, visual impairments or others, mobility constraints can result from ranging predicaments [17]. Regardless of the multiple factors that make each person's mobility difficulties unique, one approach to regain or facilitate such loss of function is rather widespread: assistive devices. Assistive devices are products that are especially designed to maintain or improve a person's ability to perform certain tasks or functions [18], essentially serving as a tool or instrument that may enhance their capabilities and independence. The specific assistive tools that cater for issues with mobility, also known as mobility aids, "are designed to facilitate or enhance personal mobility" consequently maximizing and aiding "the ability to change and maintain body position and move from one place to another" [18]. As briefly discussed in the above topic of 'wheelchair-friendly', wheelchairs may automatically come to mind when thinking of mobility aids, especially due to common perceptions on disability. However, in spite of the popularity of wheelchairs the importance of other devices should not go unacknowledged, as many individuals may also rely on diverse devices such as canes, walkers, crutches, or others [19]. Whether used to provide wheeled mobility, to increase stability, or simply to minimize physical strain, these are instruments of enablement that facilitate the activities which users with restrained mobility would otherwise be challenged to fulfill. With that being said, "assistive devices are an essential component for people with disability to achieve functional independence and improved quality of life" [20]. Whilst the use of mobility aids is clearly common between most individuals with mobility difficulties, the many choices of device and their use is also individual to each person. With a palette of options that caters to so many different needs, mobility aids can therefore facilitate different functions in different ways, allowing many users to choose switching between varied technologies depending on what best fits a specific activity or location [21]. Aside from its everyday variability, an individual's use of such tools may also undergo periodic changes throughout different phases and ages, as more often than not users claim that "an assistive technology solution worked for them as an ongoing process as their impairments, their life stages, and their occupational roles changed over time" [22]. This emphasizes the importance of catering for a range of device-users, as a person who identifies as a wheelchair-user may also occasionally rely on the utilization of other mobility tools, and therefore their needs may vary. Such consideration is rather important when recognizing that through different devices users may have contrasting spatial experiences, which is precisely why understanding spatial-to-device relationships is so important.

The indispensable quality of such assistive devices is clear, however, there is still much to be learned regarding their relativity with specific contexts of use and the parallel environmental factors that shape their usability. These unexplored factors are of great importance, as "a number of barriers within a person's environment can limit personal mobility and the use of wheelchairs and other devices” [23]. It could be assumed that issues with mobility should rather be resolved through the redesign of mobility devices themselves, holding no specific responsibility to architecture or interior design. However, one should note that “those devices have limited value in making their users mobile without complementary environmental modification” [24], therefore the importance of architecture’s receptiveness to their use should certainly not be overlooked. The recurring absence of such considerations in traditional processes of design is related to lacking knowledge on the subject, having significantly limited information on the specific correlation between different mobility devices and spatial circumstances. Although occupational therapy journals may include studies that somewhat note these spatial barriers, “unfortunately, in the literature there is limited exploration of the nature of these barriers (e.g., specific barriers within the “physical environment”), and comparatively few enablers have been identified” [25]. Indeed, scientific literature concerning the topic may be widespread, but the architectural perspective of the subject seems to be uncharted. Whilst scarcely available, it’s noteworthy to remark that resources do indicate that users of mobility devices face ability constraints when negotiating with the built environment [26]. Findings as such suggest that overlooked device-to-space relations are indeed significant aspects of user experience, and should be given more attention in the processes of making building design more inclusive. As has already been acknowledged in the case of wheelchairs, the restraints to their use have an undeniable link to the spatial qualities that may either restrain or facilitate their efficacy. Sadly, the architectural receptiveness towards other forms of mobility aids seems to be largely understudied, because



“we know very little about which ones are the most important facilitators for mobility and how they interact with other built environment features.” [27]

While accessibility codes paved the way for a better understanding of design exclusion, there is still much to be understood about the inclusion of wider audiences. With that being said, there’s a undeniable need to learn more about the external factors that may affect their usability in different spaces. In order to tackle that challenge, the following pages look into different examples of mobility devices, their various design qualities, and the spatial factors that may affect their use.

CANES:

Alternatively named walking sticks, tripods, or quadripods, canes are walking aids primarily used as weight bearing support. With a hand-grip and single shaft, they are height-adjustable and come in different sizes [28]. A positive quality of canes is the one-hand use, which enables users to have more upper body freedom. Most importantly, they enhance balance and facilitate propulsion, redistributing the weight from lower limbs. In terms of disadvantages though, their use can be physically straining and may cause users to become easily fatigued. When it comes to the cane-usage in relation to space a few aspects should be taken into consideration, especially concerning the device's base and its various forms. Although traditionally in rubber tips, modern base designs have advanced shock absorption technologies, most of which cater to potential barriers and external factors that affect the use of the device. Some bring flooring conditions into consideration with spring-loaded tips, while more advanced designs have triangular tips that stabilize floor contact regardless of ranging angles in lower-limb movement [29]. Although such minor details may seem irrelevant, they also emphasize how the of canes design relies on a range of spatial considerations, which either facilitate or challenge its use. Flooring, for example, is certainly a factor in that equation, both in terms of materials and textures. An example of this are manifestations of floor openings like

perforated floors, which can lead cane tips to become stuck in openings of larger than 13mm, imposing challenges and requiring additional effort from the user. [30]

Even more surprising, weather exposure is equally relevant, leading latest technologies to include adaptations for different weather conditions, including "retractable metal tips or spikes [which] increase stability when the user walks on ice." [31] For this very reason, the aspects such as floor contact, textures, and weather, become too essential considerations when designing spaces for different cane-users.

Aside from being used for balance support, canes can also be utilized as a form of navigational tool for individuals with visual impairment. Technically known as 'white cane', this device "provides haptic information about the surface, elevation changes, and obstacles around the user" [32], avoiding collision, easing wayfinding, and consequently enhancing their mobility. This device is capable of easing the primary challenges of sightless navigation both indoor and outdoor, easing collision avoidance and localization of objects. It may be surprising to categorize white canes as mobility devices when their use is rather sensorial, however "white canes are also considered assistive devices because they assist people with visual impairments to move independently within their homes and communities" [33]. Therefore, as with any other mobility aid, spatial qualities are largely relevant in the use of white canes and its effectiveness as a wayfinding enabler. This correlation is rather significant when considering the likelihood of spatial barriers in unknown routes taken by blind individuals, because while "white cane techniques help find a clear path of travel, negotiate terrain, and move around obstacles" unfortunately they "cannot detect obstacles beyond the length of the cane." [34]

WALKERS:

Also known as rollators, walkers are gait supporting devices which can be moved by both pushing and pulling. Commonly used by the elderly population, they minimize poor balance and coordination, decrease weight-bearing in both lower extremities, can be used to train endurance, as well as avoiding fatigue in long-distance travels [35]. Aside from providing more stability than canes and crutches, walkers are more receptive to different types of terrain, including carpet, grass, and similar high-friction surfaces [36]. Their extensive advantages make them rather popular, being considered one of the most commonly used devices for people with restricted mobility However, these wheeled-mobility tools inevitably also come with some disadvantages. Aside from the improving of mobility, users may also experience unwanted effects like impaired arm swing, slowed gait patterns, and forward-flexing of the torso [37]. Due to this, some users claim getting tired and experiencing arm pain, while others voice issues with environmental conditions that challenged device use, including difficulties with sloping pavements and uneven surfaces. The voicing of these concerns about materials and surfaces raises attention to the correlation between the device in itself and the external factors which may make its use limited. A factor that furthers this connection is maneuverability, and the restraints that the built environment can bring to the movement of the device. Other than requiring large spaces due to lowered effect in crowds or cluttered settings, rollators also become tricky when it comes to changes in elevation, because they are certainly not appropriate for stair climbing [37]. While certainly very present and used for a long time, "the design and usability of rollators has been improved in recent years, and they have become very popular among people with mobility restrictions" offering bilateral support, they are simple to maneuver, and can come as either two-wheeled, three-wheeled or four-wheeled. [38]

Although such wheel quantity variation can come across as unimportant, it's significant to note that such model differences also affect the use of the device in relation to external conditions.

The use of four-wheeled walkers, for example, provides maximum stability but is severely limited on stairs due to its heavy weight and the need to lift the device with each step [39]. While three-wheeled walkers may be less stable, their compactness facilitates maneuvering in narrow spaces, and their fold-ability is significantly practical for transportation purposes. [40]. These slight differences in rollator models suggest that indeed spatial experiences can vary between rollator-users, and that their successful use is not only about person-to-device relations, but also device-to-space. Although previous studies deem rollators as a popular device that is highly effective for people with restricted mobility, research also suggests that their use is rather physically straining and hard to learn. There barriers of physical strain and maneuverability hold strong relation to spatial qualities, therefore the aid provided by walkers is inevitably shaped by the environmental conditions in which it is utilized, and its effectiveness is therefore largely reliant on the receptiveness of the built environment.

PROSTHETICS:

Although different devices such as walkers and canes may be used to assist with the mobility of lower limb amputees, the popularity of prosthetic devices is certainly prevalent as well. Also referred to in association with the term 'adaptable limb', a prosthetic is "an externally applied device used to replace wholly or partly an absent or deficient limb segment" [41], enabling functions of a lost arm or leg to be restored. When it comes to lower-limbs prosthetics the device allows prosthetic users to regain bodily movement that minimizes most of the functional limitations that may result from ankle, knee, above the knee, and at the hip amputations. Whilst the provided mobility enhancement is certainly worthwhile, it should be noted that these devices are too accompanied by certain challenges. Throughout an intense adaptation period "people with lower limb amputation may experience barriers to walking after discharge from prosthetic rehabilitation" [42], including barriers which are often related to the physical environment. Required to teach their bodies a whole new form of walking, the rehabilitation process inevitably brings prosthetic users an entire new experience of space. These new forms of spatial negotiation accompanied with the use of prosthetics may call for extensive changes in daily living and lifestyle, as "once basic walking is mastered, advanced training in a more complex environment - such as walking around obstacles, through narrow doorways, and on uneven terrain - has to be undertaken and mastered in a progressive manner" [43]. These key terms that make part of the rehabilitation process - "obstacles", "narrow doorways" and "uneven terrain" - indicate how the use of a prosthetic device can indeed be largely affected by the external factors imposed by its surrounding context. Beyond walking, the built environment may affect the effectiveness of lower-limb prosthetics in other forms of movement, such as abilities to step backwards, stepping sideways, or going up and down a set of stairs. In spite of being eased by different rehabilitation techniques - such as using the sound leg on the way up and the prosthesis on the way down - stairs can sometimes be a spatial hindrance for individuals using lower adaptive limb, because "negotiating stairs requires good balance and strength to use the standard step over technique" [44]. In spite of their physical strain, however, the use of prosthetics on stairs is surprisingly less challenging than on ramps, mostly because the inflexibility of artificial joints makes managing sloped surfaces very difficult. In fact, previous studies support this concern, in which "lack of flexibility in the prosthetic ankle was described as a barrier and this was reported as a major consideration when choosing a definitive prosthesis." [45] Again., these scenarios emphasize how the effectiveness of prosthetics is largely connected to provided spatial qualities, which can either hinder or facilitate the mobility of prosthetic users. While this link is rather evident, details of device-to-space relations remain under-explored, suggesting that

"more research is needed to develop a stronger understanding of the contextual factors as they pertain to a person's participation in meaningful activities following prosthetic rehabilitation."[46]

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CH. 2 OVERVIEW

After a stronger comprehension of the contrasting spatial needs of ranging mobility aids, one must seek understanding of the different design aspects that influence the relationship between mobility aid users and the spaces they interact with. To truly understand the imposition of the different barriers they may experience, there must be awareness of the array of scenarios in which they may arise. That is precisely what the following section explores, properly identifying accessibility barriers by exposing the multiple factors which may shape circumstances of design exclusion. In this context, those specific factors will be referred to as points of attention, which are divided amongst two categories: the building scale and the urban scale. While the building scale involves design aspects within the building and primarily its interiors, the urban scale zooms out into the neighborhood context, dealing with a wider geographical stance. For both categories, it should be noted that the primary content included in this chapter has basis on the user consultation process of this research, relying on information gathered through the user input surveying and interviews, which can be found in the annexed booklet which is entitled “User Consultation”.

CHAPTER 2

design correlation

BRIEF

topical divisions and structure

Having many points of attention sub-divided amongst both building and urban scales, this section covers a large amount of information. To ease comprehension and properly structure such extensive data, the content of this section can be further interpreted in the diagrams below.

Building Scale

barriers that mobility aid users within buildings and their vicinity

Circulation

routing maneuver

Refinement

aesthetics materiality

Movement

reachability balance aid

Urban Scale

barriers that mobility aid users face in the neighborhood context

Transport

transit parking

Navigation

access routes wayfinding

Nature

terrain climate

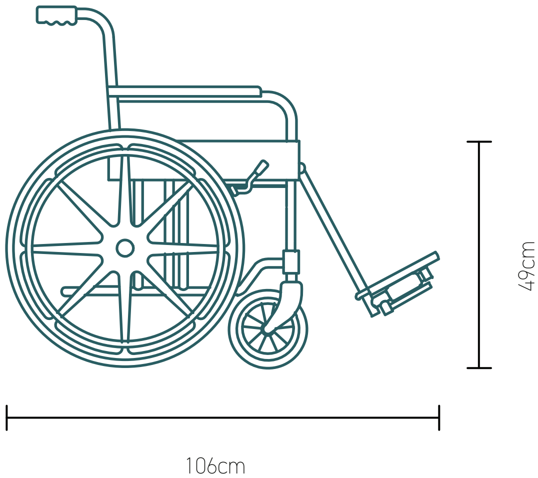
When listening to mobility aid users share their experiences with accessibility barriers, one thing becomes especially clear: the details matter. Whether speaking of a general aspect such as materiality or something as minimal as a doorknob, those particular design choices have a surprising relevant role in aspects of accessibility. In spite of their underwhelming scale, the significance of such details is rather evident when considering the different spatial relationships that mobility aid users may experience, especially in regards to the different devices they use. This is even more important when noting the different capacities or functions that devices provide, as one's response to environmental demands can vary significantly depending on their choice of assistive tool, and very commonly mobility aid users rely on switching between a combination of devices used for different occasions. [1]

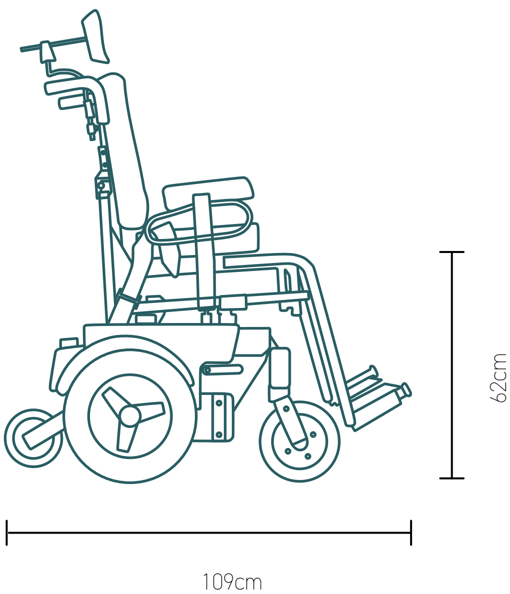
Given that, there's indeed great importance in "considering not only an individual's physical capacity but also the demands created by the environment, as they jointly influence independent mobility." [2]

With that said, in order to understand access barriers in interior spaces, it is necessary to understand not only the need of the person, but also the need for the use of a certain device. After all, "users of personal devices experience their use as the fusion of body and technology" in which "the person's sensing of the environment is thus a sensing through a diversity of technologies." [3] There are of course innumerable design factors that shape such spatial experiences, however, findings of this investigation indicate that the most prevalent lie within three categories: circulation, refinement and movement.

Circulation - *maneuverability and routing*

Circulation is of course a significant factor in any architectural design, yet it takes on a new layer of importance when it comes to mobility aid users, especially in terms of maneuverability, separated routing, and fire exits. The qualities provided by the built environment determine much of how one moves through a building, and if someone's mobility restraints aren't taken into consideration then the provided circulatory routes may become inaccessible. In the topic of maneuverability, a design barrier that mobility device users often encounter involves issues of navigating narrow indoor spaces [4], whether hallways, entries, or even doorways, most take on dimensions that are insufficiently wide for the use of certain devices. Modern accessibility codes may take into account specific proportions that ease this issue, requiring space for a 1.5m turning circle designed to accommodate wheelchairs [5]. While the enforcement of dimensions may certainly be a positive strategy, mobility aid users allege that the current requirements are outdated. Interviewee Daniel Toro, an architect himself, emphasized how bothersome these spatial limitations may be, claiming that in his opinion the 1.5m standard is barely sufficient for maneuvering of his manual wheelchair [6]. This issue of unmet spatial needs remains true for several other assistive tools, especially powered wheeled devices. Emphasizing the scale of the problem, a survey respondent also voiced concern for such dimensions, urging architects to "leave space for electric mobility aids, which often have a larger turning circle than manual wheelchairs." [7] While a wider turning circle may remedy these limitations, increase in space isn't always a sufficient strategy. As reflected in the example of mobility scooters, a spatial increase of such extent would be more costly than beneficial [8]. Taking this into consideration, it is crucial to recognize that accommodating





such devices is not only about spatial increase, but more about extensive comprehension of their use and its effectiveness within a space. In any case, academics in the field of occupational therapy assert that indeed

> **"small increases in dimensions would be necessary to allow for differences in driver skill levels, differing driver body sizes and capabilities, and the need to accomplish the maneuver in a reasonably short time."[9]**

Between exiting and entering rooms, navigating one-way corridors, or simply utilizing a restroom, such unconsidered factors of maneuverability inevitably complicate indoor circulation for users of wheeled devices. Although such complications may be majoritively prevalent for the use of wheeled devices in specific, similar spatial limitations remain applicable in other forms of assistive technology. As pointed out by interviewee Jamie Gane, certain circulation design strategies can also restrict or strain the mobility of lower limb amputees who wear prosthetics. He affirms that sharp turns can be physically straining due to additional weight on the adaptive limb, reflecting on his own experiences he explains "I can do a sharp left turn but I can't do a sharp right turn very easily."[10] With that being said, it's important to note that certain qualities of circulation design may too affect the use of prosthetic devices, including sharp turns, acute angles, or one-way corridors, for example. Either speaking of prosthetics or wheeled devices, aforementioned examples emphasize how certain needs of mobility aid users remain unmet in existing circulation design, suggesting that in order to design more inclusively some common circulation strategies - such as one-way corridors or narrow paths - need to be addressed differently.

While the above-mentioned movability factors may represent an important facet of circulation concerns for mobility aid users, such concerns are also very much present in other design choices. When it comes to indoor wayfinding and separated routing, the particular needs of individuals relying on mobility aids also seem to be overlooked. On so many occasions, a building's circulation system reflects the mobility needs of what is deemed as the 'standard human body', through which "a kind of 'walkism' is materialized in spatial structures that favor walkers over non-walkers." [11] These circumstances commonly result in separate paths that distinguish disabled and non-disabled bodies, leading to back-door entrances, awkwardly-located elevators, hidden paths, and isolated restrooms, which can undoubtedly challenge navigation for people using assistive devices. Aside from the emotional weight of this separation, the consequences stemming from this issue are multifold, augmenting travel distances, requiring additional effort, and most importantly resulting in significant physical strain. The negative repercussions of these design flaws were endorsed by one of the survey respondents, who asserted that:

"the wheelchair accessible routes are often hidden and quite complicated to navigate, which can be quite fatiguing when you have an energy-limiting condition." [12]

This tendency of disadvantageous spatial arrangements not only physically disconnects mobility aid users from other audiences, but also contributes to their invisibility in general society, an issue which is especially prevalent with separate entrances. An example, as recalled by interviewee Daniel, "in a beautiful museum you have to go through the back entrance and you don't get to see the artwork and stuff, because the only way to get in is through the back door." [13] In having participation limited to "backstage" experiences, mobility aid users then face a form of design exclusion that may deepen the negative perceptions and pejorative connotations that mainstream society has of the disability community, after all "the social organization of space is not merely a place in which social interaction occurs, it structures such interaction." [14] Indeed, one could argue that separate access is better than no access at all, however, such spatial separation may also promote perceptions of inferiority, because "even as some spaces may be physically accessible, individuals with impairments may nonetheless experience environments that codify their bodies as deviant and 'out of place.'" [15] Primarily, this indicates that while accessibility may be incredibly important, it is sadly insufficient in the promotion of social integration and design inclusivity. After all, if spaces and routes are provided exclusively for people with disabilities then they "turn out to be just a 'design for the disabled', with specific itineraries, segregated areas and facilities realized for those with disabilities." [16] Taking this into consideration, circulation becomes a key design factor in the creation of inclusive spaces - whether speaking of distinguished routing, limiting circulation, or separate entries - it is clear that the architectural choices that shape indoor movability also play a crucial role in the unification of different audiences, bodies, and capabilities.

Refinement - *aesthetics and materiality*

Small details play a crucial role in design inclusivity, and this is certainly applicable in terms of aesthetics and materiality. When it comes to the design of assistive devices such as grab bars, shower chairs, edge guards, or other forms of spatial adaptations, aesthetics certainly don't seem to be a priority. In fact, in terms of aesthetics those products seem to be strictly medical-looking, after all "assistive technology devices are designed to compensate for loss of functional ability and therefore tend to fall into the category of medical aids rather than desirable products." [17] Consequently, the immediate connection between assistive devices and medicine may lead to negative perceptions that deem aid users as sickly or dependent. With dependence often characterized as 'abnormal' [18] the use of assistive devices is then denormalized and considered as a 'special need', creating distorted views of assistance as a sign of inferiority and promoting unrealistic understanding of health and well-being. It goes without saying that negative connotations that stem from unfashionable appearance affect the overall presence and use of adaptive design, after all "social acceptability issues address the overall user motivation when selecting, buying, using and engaging with a certain product or service." [19] In other words, although lacking aesthetics may seem unimportant in current design processes of assistive technology, it is still a factor in their social acceptability and usability tendencies.

Lacking culturally valued traits, assistive tools have come to be widely unwanted, consequently "people with a choice will avoid such accessible installations due to their inherent stigma of disability." [20]

Given that, in spite of the undeniable functional importance of such tools, one could argue that their appearance should not be disregarded, after all it is what determines the associations that users may have of a space or product. The significance of the appearances of aid tools is reflected in one of the survey responses, in which 70% of respondents affirmed they wished that adaptable design solutions would be more aesthetically-pleasing [21]. An additional comment from one of the surveyees further supports that view, in which they claimed:

"To be frank, I don't really care about aesthetics if we're talking about bathrooms. If it is anything else other than a bathroom, then yes, design is important." [22]

While the aesthetics of restrooms may be considered less important than other aspects of design, they are also great examples of the constrasting aesthetical importance that designers may give to spaces for non-disabled versus spaces designed for di As mentioned by architect Marta Bordas Eddy - who is in fact a wheelchair user - it's not rare to experience buildings which have tremendously refined aesthetics everywhere except in the areas deemed accessible. As shown in the images above - which were taken by the architect herself - the generic bathrooms include very detailed aesthetics that are aligned with the rest of the building, while the accessible restroom distances from that style through a strictly medical-looking space, which seems to have no aesthtical considerations whatsoever. Instances as such are examples of the oversimplified perceptions of accessible design, in which sadly

“accessibility is considered under a merely functional conception, solely as tools and assistive devices but not as designed elements integrated within the built environment”. [23]

This delay in architectural practices shows how lacking aesthetics in adaptive design solutions may not only discourage mobility aid users from using them, but also possibly influences architects to avoid their implementation due to unfavorable design. As theorized by interviewee Erin Brown, if these adaptations were designed in a more agreeable style then perhaps architects would be more open to using them, “That’s really what it is, they want it to look good, they want it to give you a certain feel of modern and all that” [24]. With that said, while accessibility may not be dependent on aesthetics, in one way or another aesthetics are still an important factor in the scope of inclusive design. This importance - and its ability to shape perceptions - is reiterated in a recent movement within the online disability community. With newly designed mobility aids that are often personalized for the user, many mobility aid users have proudly broadcasted the use of their assistive devices across social media platforms. Through colorful patterns and materiality variations, these innovative designs strip away medical aesthetics and re-frame the use of mobility aids as something fashionable and prideful, as shown in the following images. This gradual build-up of more positive associations towards the use of mobility aids is a clear exemplification of the importance of aesthetics in the shaping of social norms. If medical connotations were to be stripped of assistive installations - such as grab bars, sanitary appliances, etc - then perhaps they could be socially normalized, properly designed, and widespread across architectural practices.

taraandwolfie Say hello to Ruby, my new rollator!

She’s a stunning lightweight @byacre carbon fibre walker, and straight out of the box I already love her. The design is sleek and intuitive and it’s the lightest outdoor rollator on the market. I can feel the difference and functionality already.

nina_tame Mobility aids are ruddy beautiful (especially when you match them with your dress).

Design appearances are certainly a factor to be considered in inclusive design processes, however, they are not the only aspect to be noted when it comes to refinement. As surprising as it may seem, materiality is a key component that may often be disabling to mobility aid users. Although it may not always be associated with accessibility, this commonly disregarded feature is in fact a crucial consideration for the safety and mobility of assistive device users. The importance of its consideration is primarily noticeable when it comes to types of flooring, which is a design choice that may unknowingly increase the risk of serious fall-related injuries [25]. Various different aspects of flooring materiality come into play when it comes to fall-risks for people with reduced mobility, limited gait, or simply reduced balance. Although evident qualities - such as leveled surfaces and minimum slope grade - may also be incredibly important, the primary factor to be considered when it comes to safe flooring is slip resistance. Obviously related to the perilous quality of smooth materials, "slip resistance is based on the frictional force necessary to keep a shoe or heel or crutch tip from slipping on a walking surface." [26] It is of course a key factor for all designs, but its importance in accessibility becomes ever alarming when considering that

"[people] who use crutches, canes, or walkers, and those with restricted gaits are particularly sensitive to tripping and slipping hazards." [27]

Shared experiences amongst the interviewees of this investigation exemplify the importance of slip resistance for the use of ranging devices. Interviewee Erin, for example, raised attention to the risk of using lower-limb prosthetics on slicker flooring, as a lack of proper grip in silky-smooth surfaces can often lead a prosthetic foot to slide. Beyond slippage, she also mentioned issues with harsh materials, claiming that "If the carpet is too thick or the texture is too coarse, sometimes your foot sticks. You find yourself falling again, because you're putting your weight trusting that the leg is going to go forward, but it's still behind now and you fall down."[28] Similar issues expand to the use of different mobility devices, as mentioned by interviewee Jamie Gane, who reiterated that

"When you're on crutches the thing you pay attention to most, more than on a prosthetic leg or wheelchair, is the texture of the floor"[29]

not only due to slippage, but also because of the trade-off of wearing down the device's rubber tips on harsher floorings. Asserting that overly harsh materials or overly smooth materials should be avoided altogether, these comments indicate that the options for risk-free materiality are evidently limited. Fortunately, different studies have assessed the advantages and disadvantages of ranges of flooring materials, providing different traits to be considered in their many choices. Within examples of such research, the distinction between flat and sloped surfaces is highlighted, emphasizing how the proper material choice is extensively circumstantial. Amongst different instances of such investigations, one specific included a lengthy list of materials recommended for sloped floors, claiming concrete wood float surfaces, asphalt, as well as some types of carpets and resilient tiles as appropriate materials for ramps. Alternatively, the study also remarked on the presence of "materials which might be expected to be satisfactory for level surfaces, but which might not be appropriate for ramps," which included concrete metal trowelled surfaces, ceramic tile, hardwood floor, and flagstone [30]. Amongst these materials, the mentioning of flagstone is especially interesting, because its characteristics fit Jamie's preference for bound gravel-like materials that provide porous surfaces [31]. Although flagstone certainly seems like a good option for inclusive design, it is also clear that the right material involves a variability that needs to be accounted for, and perhaps design practices have not yet determined the ideal solution for surfaces that can accommodate a range of mobility devices.

Movement - *balance and reachability*

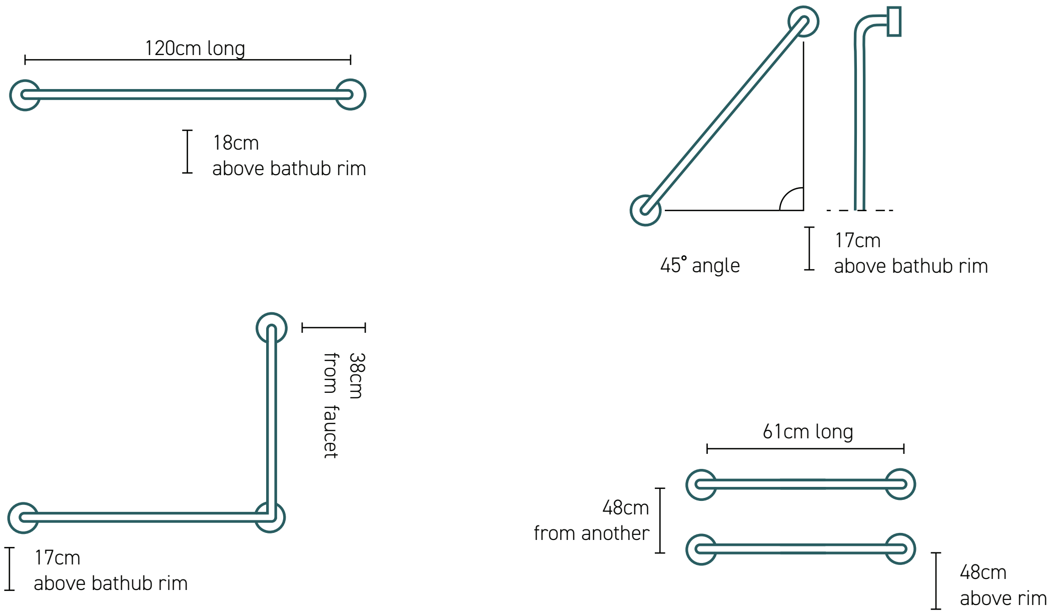
Whilst not easily categorized across the varying aspects that may shape a user's freedom of movement, spatial conditions involving the topic of balance and reachability are of undeniable significance. When it comes to balance support in specific, such scenarios often correlate with the lack of proper assistive technology such as grab bars, handrails, or proper seating, for example. Commonly referred to in association to home modifications, the implementation of grab bars "can compensate for the effects of [...] functional limitations such as impaired balance, poor coordination, limited range of motion, and reduced muscular strength." [32] In other words, they provide the necessary support for one's limited balance capabilities to be enhanced, maximizing the autonomy in performing the everyday tasks which users could otherwise not fulfill independently. Whether utilized to go up a set of stairs, to enter a bathtub, or simply to transfer into bed, alterations like grab bars, handrails or safety handles are capable of

"reducing the level of difficulty in everyday life tasks the client needs and wants to perform" [33] and can therefore consequently drastically change one's quality of life.

Of course, designs that lack such elements are not the cause of balance concerns per se, however, it can be sair that their lacking popularity in design practices certainly seems like a loss of opportunity. After all, disabling spaces are beyond the simple presence of spatial barriers, they are "also reflected in the absence of any means or mechanisms for disabled people to facilitate their mobility without some recourse to help." [34] Aside from their enabling role in enhancing abilities for everyday tasks, balance support devices also serve a key role as tools of injury prevention. As mentioned previously in the topic of materiality, one significant concern for individuals with reduced mobility is the risk of fall injuries, half of which not only occur in and around individual's residences, but also very commonly involve some form of spatial and environmental hazards [35]. Because of this,

even those who hold confidence in their balance skills can still benefit from the installation of grab bars, as their addition serves as a reassurance that in the unlikely event of loss of balance an extensive injury

This is the case for interviewee Jamie, who in spite of having very good balance has grab bars in his bathroom 'just in case'. Though he doesn't really need them, Jamie appreciates the presence of grab bars for fall prevention and comfort, especially because "a lot of the times with a prosthetic leg when you're going to plant your foot and the floor is wet, it just sweeps away, because it's more slippery than a normal foot." [36] When acknowledging these scenarios, it becomes evident that although many may associate the implementation of assistive technology strictly to medicine or occupational therapy, it holds a connection to circumstances that could be addressed via design practices.



With endless indications that spatial modifications can in fact be effective in reducing falls and preventing balance-related injuries [37], the role of architecture as part of the solution cannot be denied. With that being said, considering how barrier-free homes are "necessitated [for] the improvement of the home environment in relation to fall prevention" [38] there is relevance in having architects improve their understanding of the spatial circumstances relating to balance concerns. After all, while this issue cannot be remedied through architecture, it can still be avoided through improved design.

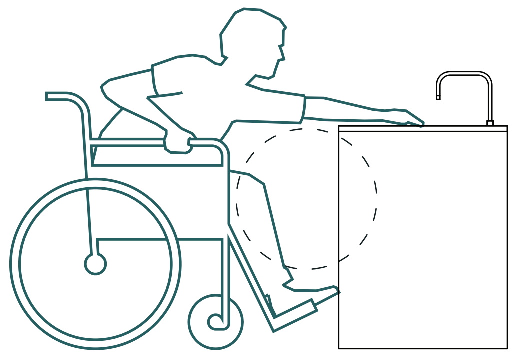
The topic of reachability is closely woven to aspects regarding balance, especially considering its mutual connection to the implementation of adaptive design and home alterations. Be it about the height of grab bars, window sills, doorknobs, countertops, cabinets, and so many other design elements, there's a rather common concern with standardized dimensions that don't account for the array of height varieties that different users may need.

Whether in bathrooms, kitchens, bedrooms, and even furniture, the inadaptability to ranging heights can impose capability barriers in everyday tasks for mobility aid users. The example of grab bars reflects this variation in reachability needs because preferences regarding their placement and configuration can vary tremendously [39]. For example, for someone with balance difficulties the presence of two grab bars on both sides of the toilet is very important, as it can provide the necessary arm support for him or her to sit up [40]. Alternatively, "somebody using a wheelchair only needs one grab bar, the one at the opposite side from where the wheelchair-toilet transfer is made" [41] which is precisely why grab bars must be hinged. Preference differences certainly come across when it comes to grab bar placement, however, it should be emphasized that this issue remains true for so many other design choices. Architect and interviewee Daniel Toro reiterated the importance of these arrangements, bringing attention to the different height needs for manual wheelchairs versus electric wheelchairs.

Using the example of a bathroom sink, he said:

"The thing is my chair is really low, but with an electric chair for a quadriplegic, there's just no way they can fit." [42]

While specific to wheelchairs, this is a good example of the unnecessary effort that such unfit dimensions can require of their users. Taking this into account, "it is important that a person's knees and thighs fit comfortably under a dining or work table" [43] because more often than not "heights may be too low for the wheelchair user." [43] Expanding on factors specific to wheelchairs, in being unable to access key spatial elements such as bathroom sinks, kitchen counters, or dining tables, a wheelchair user is not only impeded to perform an array of different activities, but also led to perform such activities with added strain. This added strain is resultant of excessive need for maneuverability - as is exemplified in the cases of unadjusted counter heights - in which the user is forced to approach the counter in parallel and twist sideways while seated in the wheelchair, rather than rolling up perpendicularly [44]. While these reachability needs seem clear for the case of wheelchairs, it's important to note that in most cases adjustments installed for wheelchairs specifically may not be compatible to other mobility aids. With so many preferences unaccounted for, it seems impossible to find design solutions that will fit such a wide array of mobility aid users. This unsuccessful "one size fits all" approach calls for innovative solutions that appeal to more adaptable and changeable methods. Based on this research, it's theorized that the right approach for this issue will be dependent on adaptability strategies. The value of such adaptable quality is reiterated when considering results from survey data, in which



50% of survey respondents predict the need for more future home alterations, in spite of prior modifications already in place. [45]

Whether it may be useful to different audiences or to an individual who switches between devices, the aspect of temporality - both in terms of balance and reachability - should be given more consideration. After all, when designing we are not simply designing for a specific group, but also for individuals and their future selves, whose needs and preferences will inevitably alter.

As reviewed above, access barriers are certainly prevalent on the interior building scale, and can indeed shape a lot of the experiences that mobility aid users have within the built environment. However, aside from the scale of indoor spaces, it's important to note that barriers to access can also be present within larger scales. When looking into the experiences of mobility aid users within outdoor settings, it becomes clear that design disablement is equally present on the urban scope, however, "despite the intuitive appeal of the importance of these surrounding contexts for mobility, research on the effects of the [urban] built environment on disability has been scarce" [46]. Many of the same barriers found on the building scale extend to wider contexts, in which issues of accessibility, mobility, and inclusivity continue to occur due to flawed and non-inclusive designs. Just as in the building scale, however, it should be noted that the elements of exclusion in the urban scale may also largely vary in shape, from straightforward aspects such as curb cuts and public transport, to more complex factors like signage, orientation, and natural elements. Regardless of their form, these factors are too capability barriers, all of which reiterate how

"the physical layout of neighborhoods [...] can limit access to the community and confine disabled people to particular zones of interaction" [47]

Whether via innovative sidewalks or simply adapted outdoor areas, neighborhood designs can certainly affect the inclusion of mobility aid users. While there are many ways in which these urban barriers may come into play, they are especially present in three categories: (1) transport, (2) navigation, and (3) nature, all of which will be discussed in this section.

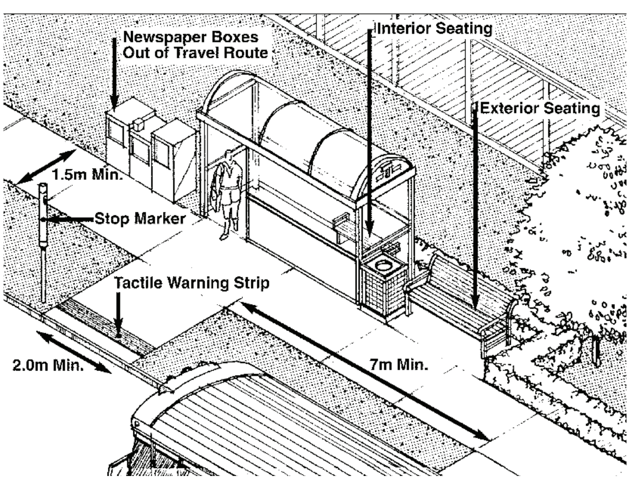
Transport - *vehicles and stations*

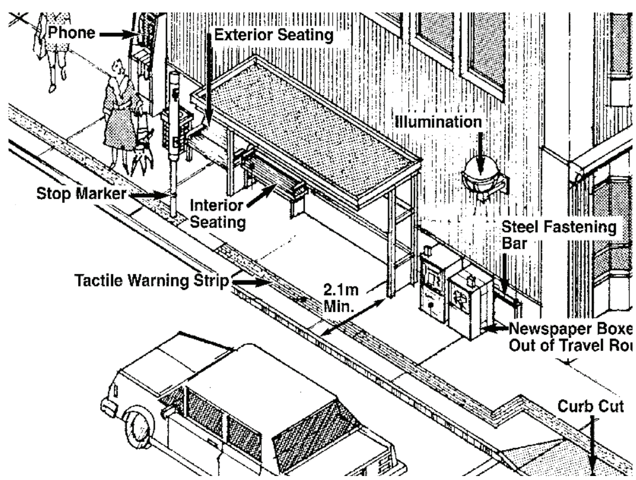
Amongst the incalculable urban barriers that mobility aid users face, the hardship of traveling between locations is one of the most significant issues. Not only mentioned repeatedly in literary sources but also voiced by interviewees, the concerns with lacking accessibility between neighborhood contexts is a crucial factor in terms of inclusivity. With urban contexts designed primarily for the non-disabled population, mobility aid users become "often hindered by the lack of appropriate infrastructure or mechanisms to enable them to move easily from one place to another." [48] Whether in terms of public transportation or discontinuous pedestrian networks, the absence of proper junctions bridging between areas continues to restrict many users from leaving their immediate surroundings. While there is of course an array of factors that comes into play in such spatial distancing, one of the primary concerns is the inaccessibility of public transportation. When it comes to public transport, while restrictions are widespread across various modalities of transportation, they are especially present in bus travel. In spite of advanced vehicular technologies that supposedly ease accessibility, existing solutions to accessible buses seem to be rather limited. Furthermore, while modern buses may be marketed as 'accessible', in so many occasions the singular way to access the vehicle is through a foldable ramp strictly available at the rear door, and normally used dependently with the help of the bus driver.[50]. While users can sometimes rely on the help of the bus driver, on many occasions they may feel like a burden to other passengers. Interviewee Daniel recalls an instance of this, in which he felt as though the lengthy process of lowering the bus access ramp led other passengers to become impatiently bothered with the wait, which was rather uncomfortable for him. [51]

This scenario brings attention how accessibility issues are not necessarily limited to the vehicle itself, but can also be present within the design of its boarding area. In fact, it is known that mobility aid users can not only be challenged in the entering and exiting of the vehicle, but also in the act of maneuvering within the securement area of bus stops [52]. Current approaches to accessible bus stops include elements that partially target this issue, - such as the curb cuts or clear travel routes shown in the images above - however, taking into account the topics discussed in the previous section, it can be theorized that other spatial alterations could have the potential to ease this further. The bus stops depicted in these images may be a good example of barrier-free design, as they clearly avoid having obstructions along the travel routes of users of wheeled devices. However, while the design may not necessarily impede users of wheeled devices to board the vehicle, it also doesn't enhance their ability to do so. Perhaps the addition of sloped platforms or continuous railings could not only ease maneuverability for wheeled devices, but also provide additional support for other passengers with balance limitations or gait difficulties. This room for improvement is supported by survey responses, in which when presented with outdoor-mobility design ideas

more than half of respondents claimed that bus stops with eased exiting and entering is something that they would find useful. [53]

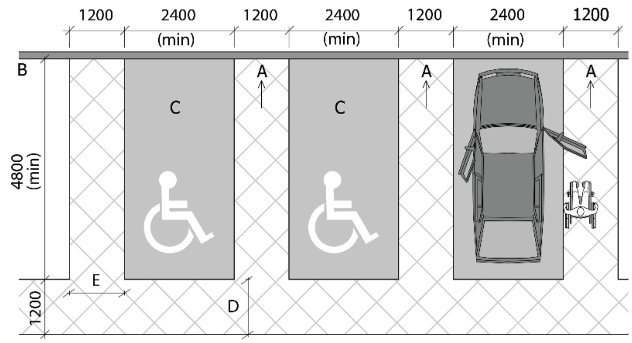
The survey further emphasizes the importance of accessible transportation through a question regarding taxis and cabs, in which 70% of respondents considered the implementation of more inclusive taxi stations to be a useful initiative [54]. This raises awareness of how facilities for other forms of transport, such as parking facilities, may too contain aspects that restrict the use of different mobility devices. With so many restrictions to utilizing such forms of transportation, many are robbed of geographically distant opportunities that they could otherwise attain. Under such circumstances, "their right to access and experience the city is compromised by transport networks[...] that privilege the movement of non-disabled bodies and additionally impede the mobility of disabled people." [55] With that being said, while minimized access to public transport may seem like a negotiable barrier, it is an undeniably significant obstacle to the capabilities of mobility aid users, and the alarming flawed design of both vehicles and stations needs to be addressed.





Moving from the topic of public transit onto a more private scale, issues with car parking are also a factor when it comes to instances of design disablement in the urban setting. A factor that immediately comes to mind when it comes to parking for drivers with reduced mobility is the topic of proximity. Having awareness of the strain that accompanies long distance travel for some mobility aid users, it is no surprise that when it comes to parking

"the distance between a car park and key facilities may present difficulties to some people due to actual distances involved."[56]



Key

A. Preferred access route with dropped kerb or level access avoiding travel behind parked cars
B. Dropped kerb or level access
C. Standard 2400 (min) x 4800 (min) designated parking space
D. 1200mm wide safety zone for boot access and cars with rear hoists, outside the trafic zone
E. 1200mm wide marked access zone between designated parking spaces

Note: All dimensions in millimetres

Interviewee Jamie Gane reiterates these circumstances, recalling that when enduring the physical effort of wearing his adaptive limb he is not hesitant to take advantage of the closest spots in disabled parking, because even the short walk from his car to the shopping center can be rather draining [57]. Hence, it is clear that the availability of designated parking spots can be impactful, however, whether the factor of proximity is sufficient to make these spots properly accessible remains questionable. The interview with Daniel brings attention to other potential factors of the design of inclusive parking lots [58]. Describing the many choices of car transfer tools, from transfer boards to chair lifts or even ramps built into the vehicle, he paves the way for the assumption that such a range of unique features may call for spatial needs that are different from the ones designed for standardized cars. Spacing, as shown in the image above, is a topic of importance, because with specific boarding and off-boarding methods it is necessary to "enable car doors to be fully opened for ease of access and also provide sufficient space for access to the car boot." [59]

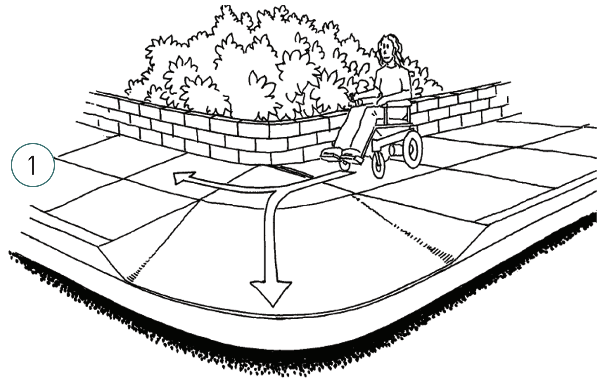
This is especially important when recognizing that many mobility aid users - like Jamie and Daniel - store their devices in their car boot, therefore requiring generous spacing to independently exit their vehicle and access their car trunk to retrieve their assistive tools. Although some may be able to undergo this transfer autonomously, the same may not apply to drivers of other abilities. Daniel, for example, requires assistance for transferring into and out of his car, he affirms "I usually just get in my car, and call on someone around to put my chair in my trunk. Most people are nice enough to do that." [60] Noting how the task of transferring may not always be fulfilled independently, one could question whether a more comprehensive parking design could ease this hardship. In spite of the importance of characteristics of proximity and spacing, could it be that parking design could also target barriers of dependence? Could the built environment provide tools that enable this task to be done easily and independently? With the knowledge acquired through this research, such potential of enablement seems feasible, however, that is to be answered through design.

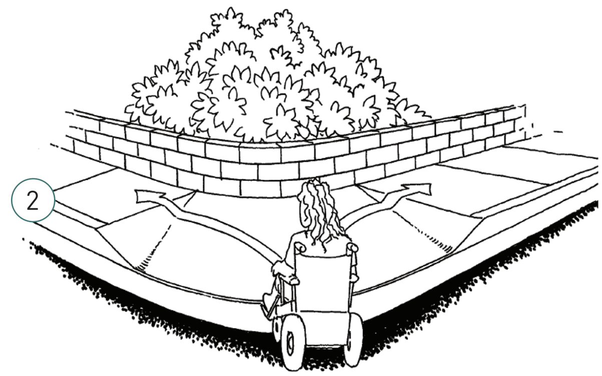
Navigation - *access routes and wayfinding*

When improperly designed, various urban elements can become obstructions in the line of travel of people using mobility devices, and those same urban elements most often go unnoticed to non-disabled people. The paths which such obstructions disrupt are known as access routes which "in the external environment include paths, pavements and other rights of way, such as pedestrian routes through a public space." [61] From small-scale factors such as misplaced lampposts and sidewalk cracks, to cross sloped curb cuts and dangerous crossings, mobility aid users have high chances of encountering barriers along their outdoor access routes. From the perception of an able-bodied person, instances of such path disruptions may seem like no issue at all, but as phrased by interviewee Erin Brown people are "used to stepping over stuff, not worrying and moving around, but when you're in a wheelchair you can't." [62] While Erin's anecdote may refer to wheelchairs exclusively, the same applies to a range of other mobility aids, including walkers, crutches, prosthetic limbs, and even long canes all of which may experience disruptions including

"issues such as changes in level in pedestrian network, path smoothness, material of the path, and obstructions on pathways". [63]

The first aforementioned factor of level changes represents one of the most crucial barriers that mobility aid users can face, especially within exterior built environments. Starting from the simplest of instances of unleveled routes, a curb step can already disrupt the path of many mobility aid users. While non-disabled audiences may simply step down from the sidewalk onto the street, the same would be very unlikely - if not also dangerous - to many mobility aid users.





As insignificant as it may seem, such small level change can already impede many mobility aid users from doing something as simple as crossing the street, which is why "pedestrian crossing points (...) should incorporate level or flush access to enable easy passage by all pedestrians" [64] which can be achieved through the implementation of dropped curbs or raised road crossing. Also known as curb cuts, these can be very efficient, however when designed improperly they can too become a path obstruction. As shown in the figures above, the specific placement of these elements is indeed a factor of great significance, for example

"perpendicular curb ramps are difficult for wheelchair users to negotiate if they do not have a level landing." [65]

The first illustration depicts a perpendicular curb cut that includes a landing, providing enough space - and level - for a wheelchair user to easily maneuver. The second illustration however, lacks the presence of a landing, in which case the ramp in itself disrupts the route of the sidewalk. In this scenario, a wheelchair user would not only struggle to enter the sidewalk - due to the strain of negotiating with a cross slope - but also have the excessive strain of going through two cross slopes when traveling through the sidewalk corner. Additionally, to ensure a direct line of travel between adjacent curbs

"the location of dropped curbs should match on both sides of the road" as this minimizes crossing distances and reduces the risk of conflict with motorized vehicles. [66]

Surprisingly, the texture and color of curb cuts are also of great importance, as they allow long-cane users and people with residual sight to distinguish between footway and carriageway. When misplaced, many other common elements in urban settings can disrupt the path of audiences relying on mobility devices, including street furniture - such as lampposts, benches, pay meters, etc. - or even temporary obstructions such as scaffolding, floor openings, and others. This is not to say that such elements should be avoided altogether, however, it's important to note that their placement should take into account the necessary space left for pedestrians, for which "a clear width of 2000mm is recommended to enable people to walk alongside each other and for two wheelchair users or parents with strollers to pass comfortably." [66] The above mentioned elements may not represent the full extent of barriers that may disrupt the outdoor access routes of mobility aid users, however, they do bring attention to how the design of inclusive urban settings is reliant on so many considerations that require a much greater understanding of different pedestrian needs. With that said it's important to note that, "to develop effective transportation networks, the people responsible for designing public sidewalks and trails must understand the needs of the full range of route users" [69], because one's ability to reach their destination is not only about their speed, coordination, or endurance, but also about the obstacles, grades, and cross-slopes that they may encounter along their way.

The impact of path disruptions certainly brings to light the need to design urban pedestrian routes that ease navigation for all users. Beyond the avoidance of hazardous disruptions, "the design of pedestrian environments should be easy to understand, logical and consistent" in order to "help people who use an environment regularly to memorize a route and to develop a mental map of the area." [70] Different features can help provide a level of predictability of such routes to ease one's orientation, and in the majority of cases such features relate to strategies of wayfinding. Indicative of how one is enabled to find their way within their immediate context,

"wayfinding is defined as the process that allows people to establish their location, determine their destination, and then develop and follow a plan that will help take them from their current location to their desired destination." [71]

Of course, wayfinding barriers or facilitators can be manifested in a range of ways, taking form in various design elements and qualities. However, when it comes to the urban scale specifically "wayfinding involves finding a route through the pedestrian network of sidewalks, crosswalks, and pathways." [72] It may be true that this orientation-related task can seem insignificant, but while its challenge may be imperceptible to non-disabled people, outdoor wayfinding can certainly be a hardship for individuals who use mobility aids. The difficulty stemmed from impassable paths delineated above is also related to aspects of design-to-user communication, given that ultimately "people with mobility devices may miss important cues because of obstacles and hazards in their path." [73] This lacking communication often takes shape in improper signage, which is a key guidance tool that should provide people with necessary information regarding their position, orientation, and proximity to nearby facilities. Whether given via visual information, auditory or tactile cues, "wayfinding information does not convey a warning, but rather provides orientation information to the user"[74], providing key information regarding available paths, directions, and destinations. Be it in the form of color orientation, landmarks, or simply standard street signs, to be achieved successfully

"a well-designed wayfinding information system displays information at strategic points to guide people in the direction of their destination." [75]

Given that signage can often be designed with non-disabled people in mind, standardized traits such as positioning, color contrast, and font size should be avoided, not only to ensure that the information depicted can be interpreted by ranging audiences but also to avoid possible hazards for different users. For example, "where eye-level signs, such as maps, are supported on two vertical posts, a tapping rail located between the posts (...) will help prevent an unsuspecting pedestrian colliding with the sign." [76] This example involves a barrier that physically impedes the user from a possible hazard, but other distinctive design choices regarding auditory and visual senses can also provide such indications. As briefly mentioned in the topic of access routes above, such sensorial cues serve a key purpose in aiding pedestrians to distinguish their paths and determine their routes, capable of helping them reaffirm their location. In fact, in some cases "wayfinding cues include raised tactile surfaces covered with bar patterns laid out in a path to indicate the appropriate walking direction, especially along routes where traditional cues such as property lines, curb edges, and building perimeters are unavailable." [77]

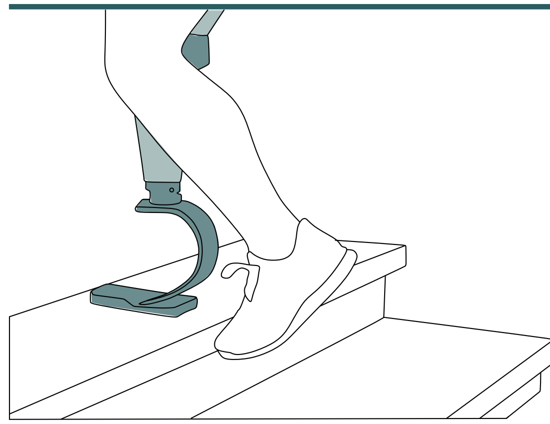
Nature - *terrain and climate*

As surprising as it may seem, natural factors - such as climate and terrain - play an important role in regards to the many spatial barriers that mobility aid users may encounter in the urban context. While not necessarily obvious to non-disabled people, there are rather many elements - both in natural and human made outdoors - that may restrain their access to outdoor exterior settings and activities. Terrain characteristics are perhaps one of the most challenging factors to be considered in the design of outdoor spaces, mainly because "designers have limited influence over the natural topography of an area and must seek to optimize accessibility and understanding through the creative placement of routes and features" [78] Indeed, when it comes to terrain a range of characteristics can become barriers for mobility aid users, most of which relate to surface types and level changes. Similarly to the topic of materiality, ranging qualities of outdoor surface types - like soil, gravel, grass, or others - can present a series of challenges for the use of mobility devices in outdoor access routes. Because of this, "the surfacing material on a trail significantly affects which user groups will be capable of negotiating the path", [79] Hence, due to tripping hazards, excessive physical strain, or simply limited efficiency of assistive devices, materials such as bare earth, cobbles, loose gravel, or sand, should be avoided as much as possible. [80] Additionally, a primary concern regarding the use of assistive devices on these natural surfaces is guaranteeing consistently firm paths, due to the risk of sinkage. With that said,

"surfaces that are not firm and stable make travel difficult for a person using crutches, a cane, wheelchair, or other assistive device"[81]

Hence, whether through the use of soil stabilizers, or if through the implementation of leveled man-made structures, outdoor recreational paths need to be sufficiently stable. Aside from stability, however, designers must also consider factors of level change, which can be particularly challenging depending on a site's topography. A path's slope is of major importance, especially when considering that "a gradient of 1:10 or steeper may be extremely difficult and dangerous for some people using wheelchairs or motorized scooters. [82] While such wheeled devices may be the first to come to mind when thinking of slopes and ramps, the parallel effect for users of other assistive devices should not be overlooked. In fact, this issue extends to the use of many other devices, for example "many cane and crutch users have difficulty lifting their feet high up off the ground, and abrupt changes in level can cause them to trip or fall. [83] Given such factors, the task of dealing with level changes may seem like an impossibility when it comes to inclusive design. Designers should seek to remember that

"when a terrace or steps or podium becomes a necessity for a designer, however, the result need not always be an obstruction for people with functional difficulties if the design is well considered."[84]



Taking that into consideration, in cases where the manipulation of the natural topography is less feasible designers may resort to the implementation of man-made stairs and ramps, in spite of the risks they may accompany. Regardless of the choice between ramps or stairs, it should be noted that either one can impose physical strain to mobility aid users. This brings to light the significance of the addition of resting points along access routes, which can either be achieved through generously spaced landings, or via the provision of a series of sheltered resting zones. In either case, "the steeper the incline, ramp or steps, and the greater the change in level, the more frequent the need for landings and resting places."[85] Beyond aspects of grade when it comes to the design of ramps, other factors such as visibility and length are equally important, even if often disregarded within architectural practices. Interviewee Jamie Gane reiterates how common it is to find ramps that are incomprehensibly designed. He affirms that based on his experiences seems as though

“a lot of times designers argue they have a ramp, but it’s tucked around the corner and you can’t see it, and there’s no signage, and it’s a really really long ramp that doesn’t make a lot of sense.” [86]

Considering the given context of inclusive design, many may assume that the ramps would be favorable when taking into account the use of mobility aids, however, while ramps may be an enabler for some it may also be a barrier for others. Another thing that was learned in the interview with Jamie, is that people who have lower-limb prosthetics and limited ankle movement typically find ramps far more challenging than stairs [87]. Looking into this discovery more closely, it has been found that indeed while ramps they may be beneficial for the use of wheelchairs, walkers, scooters, or even luggage and prams “some people find it difficult to walk on an inclined surface such as a ramp slope due to the angled position of the foot”. [88] All in all, this enhances awareness to how singular solutions may not always be the best approach to inclusivity, because the same tools that may enable an audience can be the barrier that disables another. This suggests that truly inclusive implementations of vertical circulation - whether in outdoor contexts responding to terrain or simply indoor level changes - should involve solutions that can be mutually to as many audiences as possible.

Aside from terrain, weather-related issues and climate conditions can also be factors of disablement within outdoor environments. [89] Truly, weather may seem like an equally-experienced challenge of nature, however, it’s important to note that “for people who report a mobility-related-disability, many of whom use a mobility device such as a cane, walker, or wheelchair, these challenges may be magnified.” [90] Although the perspective of non-disabled experiences may deem this comparison to be exaggerated, these weather-related impositions can be a significant barrier to participation in everyday outdoor activities, [91] which many certainly affect one’s quality of life. Inevitably, due to contrasting characteristics between climatic seasons certain elements of exposure that can lead to factors of disablements may only be experienced at specific times of the year. However, one important factor that is certainly not unique to a single season is rain, which can too impact spatial qualities capable of becoming access barriers. Through this rather unpredictable year-long factor the accumulation of water, for example, is a result of rain that may not only impose risks to one’s mobility but also restrict their wayfinding abilities. In fact,

“water at the base of curb ramps can obscure the transition from the ramp to the gutter and cause pedestrians to misjudge the terrain” [92]

also missing important wayfinding cues that are concealed by the water. Taking into consideration the previously discussed topic of materiality, another issue that can be easily associated with the factor of rain is slippage. Indeed, “slippery surfaces increase the risk of falls for those who use ambulation aids” [93] and is therefore a shared factor for the use of such devices. Whike certain types of flooring may offer characteristics that minimize this risk, it’s important to recognize that those same characteristics may change through time if directly exposed to outdoor conditions. For example, “polished surfaces cause glare and are not suitable in a damp climate, as they remain slippery in a moist atmosphere, even after rain has passed.” [94] The same applies to fine-grained stones with high calcium content, as they may erode with use and consequently form a polished layer that becomes dangerously slippery in wet weather. [95] Because of this, the choice of materiality for outdoor flooring becomes essential for the avoidance of fall-related injuries. While this may be a collective concern, it's important to know that the specific barriers resulting from flooring characteristics are in fact unique to each device and its capacity to withstand exposure to weather-related elements. For example, when it comes to wheelchairs and scooters the struggle with snow or ice is about difficulties in gaining traction, whereas in the case of walkers or rollators the challenge is mainly "due to the smaller wheels on their devices, which are typically unsuited for travel through snow." [96] In both cases users are not only posed with the high likelihood of becoming stranded outdoors, but also with the possibility of slipping and getting injured. As shown in the image aside, this may be remedied with supplementary tools that can adapt devices for snow use. However, people who are unfortunately unable to afford these are left with not choice but to either clear their access routes themselves, or request assistance from others. In both scenarios the chances of slippage are still high. A design element that is certainly useful for minimizing risk of slippage are implementations such as handrails and grab bars. Despite this, it should be noted that those can too be affected by weather exposure, especially when taking their materiality into account. Metal handrails, for example, can become incredibly cold winter conditions, so

"people who need to firmly grip handrails in order to safely negotiate a ramp will find a cold handrail extremely uncomfortable and possibly painful to use." [97]

Some could argue this could be easily avoided with the use of gloves, however, the solution may not be so simple. In fact, mobility aid users claim that "frostbite [is] an ongoing concern for them in winter because it [is] often difficult for them to wear gloves while navigating their wheelchair or walker." [98] These examples are only a few of the different ways in which climatic conditions may affect mobility aid users and their capability of performing activities on the urban scale. Although these winter-related scenarios may seem to hold no correlation to architecture whatsoever, it would be untrue to say that architectural design cannot be a part of the solution. Architecture after all entails the ability to shelter one from external elements, and a large portion of the afore-mentioned capability barriers resulting from climatic exposure could be avoided if users were given increased options of outdoor sheltered spaces.

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CH 3. OVERVIEW

With factors of design disablement identified in the previous chapter, the next step is to look into examples of design enablement. With the aim to unearth design strategies capable of more inclusive design practices, this section not only brings to light existing design solutions for inclusivity, but also a clear exemplification of architecture's capacity to enhance capabilities after all. The project that reflects such qualities is the one of a kind Hazelwood school in Glasgow, which carefully designed by GM + AD architects, with special attention to sensorial spaces.

CHAPTER 3

possible solutions

Although attributes of design inclusivity may often be limited to the simplicity of code compliance [1], it would be erroneous to assume that comprehensive design initiatives are non-existent. Indeed, approaches that carefully cater to unique user needs and accept aspects of human diversity may not be widespread, as after all the theme of disability inclusivity in relation to design continues to be significantly unexplored [2]. In spite of their rarity, however, architectural designs that are attentively tailored for unique users and their needs certainly exist, a scenario which is positively exemplified in the design of Hazelwood School in Glasgow. Designed by company GM + AD, the Hazelwood project highlights original approaches to inclusive design, reiterating the possibility that "designers (can) go far beyond the requirements of accessible school design and invent innovative solutions in partnership with students, teachers, and parents" [3]. Through observational research and extensive user participation, the architectural qualities of this facility reaffirm how design inclusivity can extend from the breaking of barriers to impactful solutions that truly focus on human capabilities. Amongst the many design qualities in the project, one of the most prevalent was the focus on sensorial cues, giving strong attention to the tactile, auditory, visual, and spatial awareness of the users.

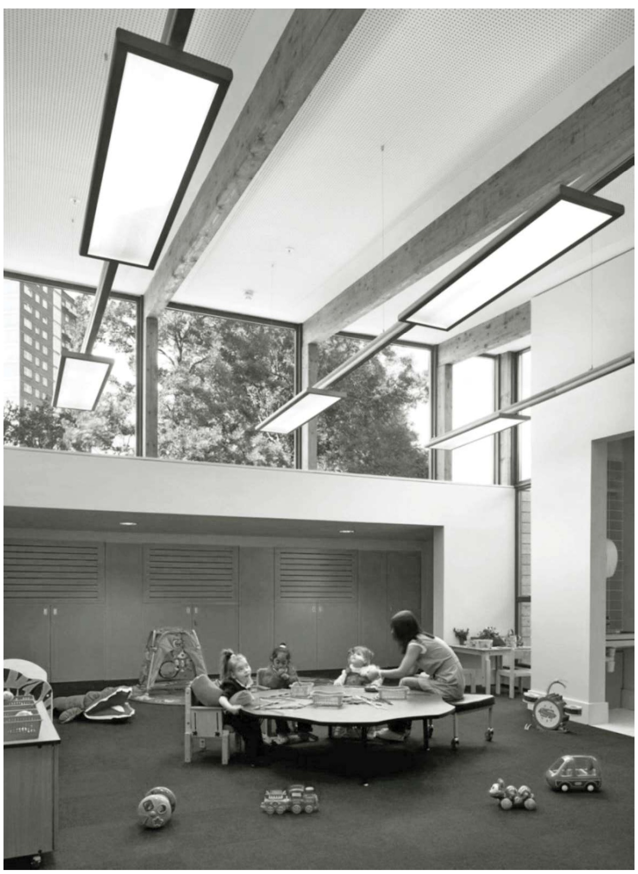
The renown Hazelwood project originated from a governmental search for alternative school building programs, an initiative through which the Glasgow City Council Education Services (GCC-ES) seeked for improved and innovative school design proposals [4]. Initially commissioned in 2003, the pilot project brief was rather unique, involving the relocation of special-needs students into a built-environment that would suitably cater to their needs. Departing from outdated inaccessible buildings housing contrasting teaching methodologies, all of the sixty students in question were multiple disabled, facing either dual sensory impairment and/or physical impairments as well [5]. The particular user group and range of complex needs made Hazelwood a challenging project, [6] the search for proposals was an essential process to finding the right architects to fulfill such design challenges. Within that phase, a prevalent quality of the GM + AD proposal was the choice to present design strategies rather than a refined architectural form, bringing awareness to their focus on sensorial experiences and reiterating design intentions that were more about methodologies and less about building-specific solutions [7]. In spite of presenting a much simpler design from fellow competitors, this decision demonstrated that

"they understood the complexity of the project [and] the sensitivities of the particular client group"[8]

confirming their compatibility with the challenges of the brief. The proposal by GM + AD turned out to be the winning proposition, amongst other five firms short-listed in the preliminary commission phase. As the characteristics of the user group sit outside the traditional standards of architecture, it is no surprise that the research process for the project was rather extensive. From the very start, the design team acknowledged the great significance of the investigative phase, holding onto the argument that the architectural form would only come into shape after a joint research development process [9]. While the architects may have led this investigation, the overall research was a collaborative process with a multiplicity of consultancies, "involving detailed pre-build analysis, development and discussion with client groups, teachers and children over a period of 18 months."[10] To fortify the client and architect relationship,

"GM + AD Architects approached the design by holding workshops, meetings, and seminars with the two client groups," [11]

including both the city council as well as the school community. Such collaboration was maintained throughout a large portion of the research process, extending into three key phases of the research process: data gathering, strategic briefing, and detailed briefing [12].



Data Gathering

The data gathering phase primarily involved observational work, utilizing methods of targeted insight through the eyes of the design team. One key step in this phase involved the visiting the student's previous schools, an occasion which not only provided an "extended observation of the activities in the existing schools" but also "paved the way for wider understanding of new design possibilities" [13]. Through observational work that exposed key design issues specific to the user group, building great knowledge of unique aspects of the target group. This portion of the research enabled the team to gain a base understanding of the students and their unique needs, consequently marking "a period [which] was crucial to the creation of an innovative and functional building." [14]

Strategic Briefing

In the strategic briefing phase a number of workshops were undertaken with the school's staff, which complimented findings of the first phase through a transdisciplinary partnership between the designers, head teachers, and faculty. This significant dialogue allowed for improved understanding of a range of key aspects of the specialized teaching methods and their strong connection to the school built environment, enabling a collaborative design consultation that went beyond the needs of the students and drew on the views and needs of the whole school community [15]. Other than establishing a significant network between the school community and the design team, "this interaction, which involved clinicians and other specialists, gave [...] the opportunity to fully understand and to challenge the requirements, potentials and restraints of the project." [16] This step paved the way for consultant relationships which were essential throughout the preliminary design phases.

Detailed Briefing

The detailed briefing involved an extension of the data gathering, through which information was acquired via consultation rather than observation. In this phase, the design team collected input directly from the users, conducting back and forth consultations through a series of meetings and interviews with school staff and parents, as well as medical experts. A key attribute of this briefing was the face-to-face collaboration with the school's head teacher, whose coordinator role enabled the possibility of having "a representative of the user group accompany and assist the brief and design development process." [17] A few of the tools utilized in this surveying process included questionnaires for staff's input on space use and functions, additional consultation of experts on disability, periodic presentation meetings of the design's evolution, as well as question and answer sessions with parents and staff.

The continuous consultation of teachers and parents brought to light a range of details that would otherwise have been unknown to the architects.

This in-depth process of acquaintance with the school community paved the way for essential decisions of the design process, and continuously guided the designers towards adjustments based on user preferences. In extending collaborations from the research phase into the design phase, the architects ensure the creation of "a supportive physical environment provided by sensitive architecture and careful design." [18] A key design decision which reflects the importance of this participative approach is the early recognition that design solutions could not be based on the needs of individual students. Although the architect's intention lied on ideals of inclusion, "it was realised that, while each child has unique problems which may be physical and/or behavioural in addition to multiple sensory impairment, the design could not be focused on the individual children" [19], as after all in many occasions a solution specified to a single child could also be the barrier for another. In other words, the designers acknowledged that the approach to inclusivity was not about the scale of the individual, but rather about the overlap of needs between all individuals, which shaped the decision that the design would have to accommodate visual, hearing, and physical impairments in a somewhat generic manner.

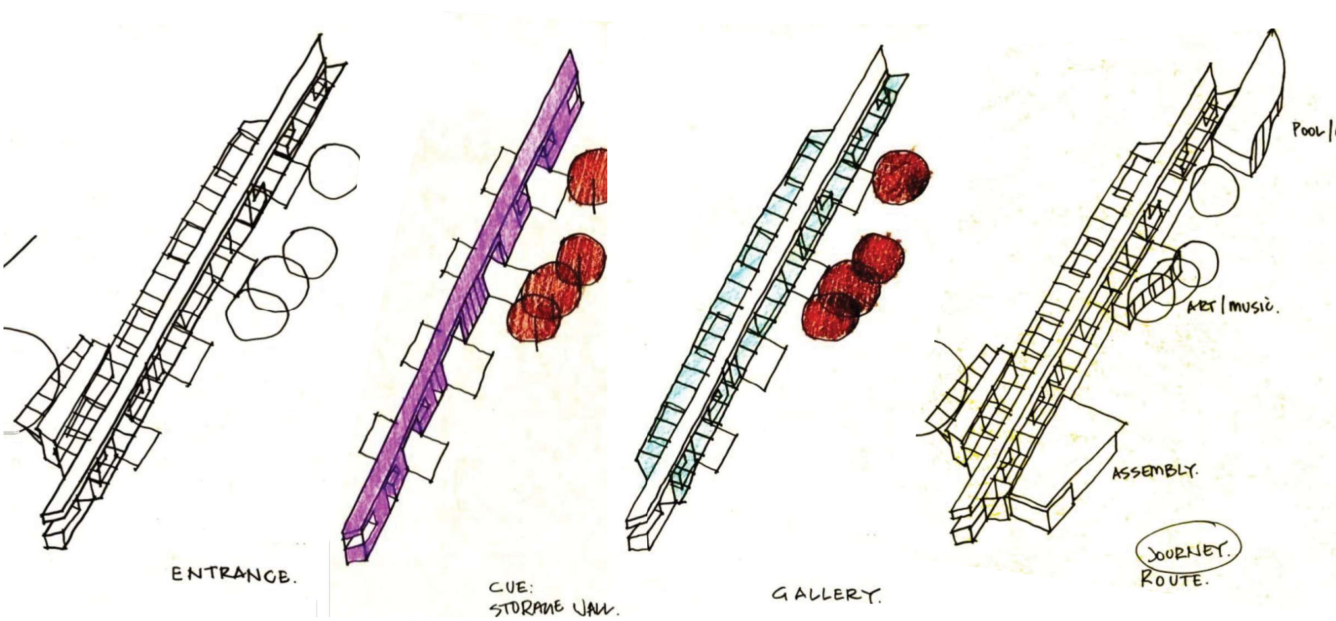
Considering these circumstances, it's clear that much of the decision-making was influenced by the research process, holding an especially strong basis on the findings identified in consultancy meetings and school visits.

Through this approach, some otherwise general design qualities were gradually shaped into unique and innovative tools for specialization.

Something as simple as the building's orientation is a great example of this, as the general considerations to orientation - such as sun exposure and noise pollution - gained a whole other layer of consideration to user needs. As shown in the diagrams in the next page, the evolution of the design stemmed from these initial considerations such as circulation, layout, and orientation, which set the foundation around which the design developed. The next pages will delineate the key considerations that shaped the design process and the early stages of some later-developed design qualities that concretize much of the building's identity.

Orientation: because of a great majority of students with hearing impairments, one could probably assume that noise pollution would not play an essential role in this project. However, to the designer's surprise "[a] significant factor that became apparent during the development was that children who are blind rely much more on their hearing." [20] Therefore, as expressed by the school's teachers, outside noise should be minimized to avoid visually impaired students from being impacted by auditory distractions. Due to a high-traffic road adjacent to the site, the southern side of the plot was prone to significant noise pollution, taking that into consideration the placement of classrooms along the northern part of the plot was purposely for the avoidance of noise distractions during class. As a result, transient spaces and transition areas were placed south of the classroom, immediately designating a north to south programmatic distribution that also characterized a lot of the design's acoustical considerations.

Layout: the design choices based on orientation set the foundation for the building's overall layout, delineating a defining distinction between the southern and northern volumes. Such distinction prompted the need for a connecting vessel that would not only unify both volumes, but also enable room for the expansion of other functions. The vessel in question unfolded in the form of a spacious corridor which was nicknamed by designers as 'the street', and set the primary axis and circulation of the building. Subsequently, the shape of northern and southern volumes as well as the volumetric interaction between them, derived from conditions provided by 'the street'. In many ways, the sreet is the backbone of the project. Such design decisions resulted in a "sinuous plan [that] not only creates strong internal circulation, [as] it also creates outdoor rooms" conditioning the unification of northern and southern realms "by cradling outdoor spaces via the plan's bends, [making] the adjacency of the two realms immediate." [21]



Circulation: when it comes to circulation, the building's navigational qualities were certainly influenced by attributes mentioned above. Naturally, the orientation influenced the rise of 'the street', and as the central axis 'the street' designated the building's primary circulation routes. While the initial conception of 'the street may' have been linear, it later gained an organic form that was primarily based on the site's vegetation. "The resultant curved form means that both internally and externally the building is broken down into manageable spaces" [22], creating routing conditions that simplify circulation as much as possible. As a result, "the curved form of the building reduces the visual scale of the main circulation spaces and helps remove the institutional feel that a single long corridor might create" [23], expanding the role of the corridor and its relationship with the surrounding volumes.

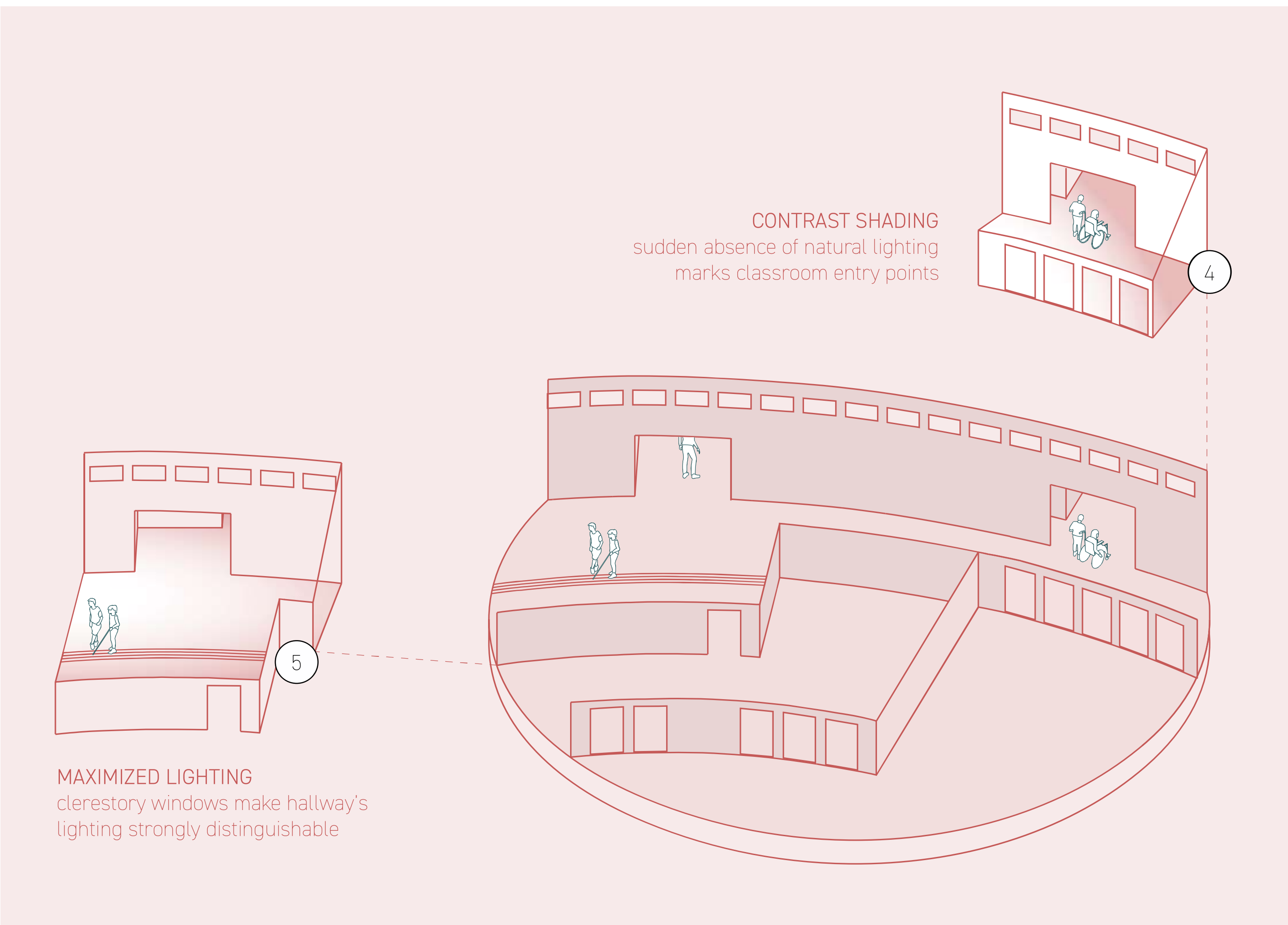
The design choices reviewed led to some very significant qualities of the design, reiterating that the children's needs were the backbone of the creative process [24]. Much of the finalized design led to spaces which went beyond programmatic functions and became in fact learning tools. Amongst several of the project's attributes, the ease of navigation fostered by the design is a clear quality of those circumstances, affirming the architect's belief "that even the smallest feature of the architecture could also be conceived as a learning aid." [25] Manifested through elements of texture, lighting as well as materiality, these wayfinding qualities not only bring an educational quality to spaces but also caters to the autonomy of students, "allow[ing] the children to move around the school with a greater level of freedom and independence." [26] These remarkable methodologies of design are carefully reviewed in the following section, which provides an analytical diagram of the building's extensive manifestations of navigational tools.

In order to understand the wayfinding qualities shown in the image above it is important to understand the concept of trailing, which is a primary orientation and mobility technique for people with sensory impairments.

Trailing is a tactile technique which visually impaired individuals use to determine their place in a space or to get a parallel line of travel, therefore relying on tactile cues as tools for orientation. [27]

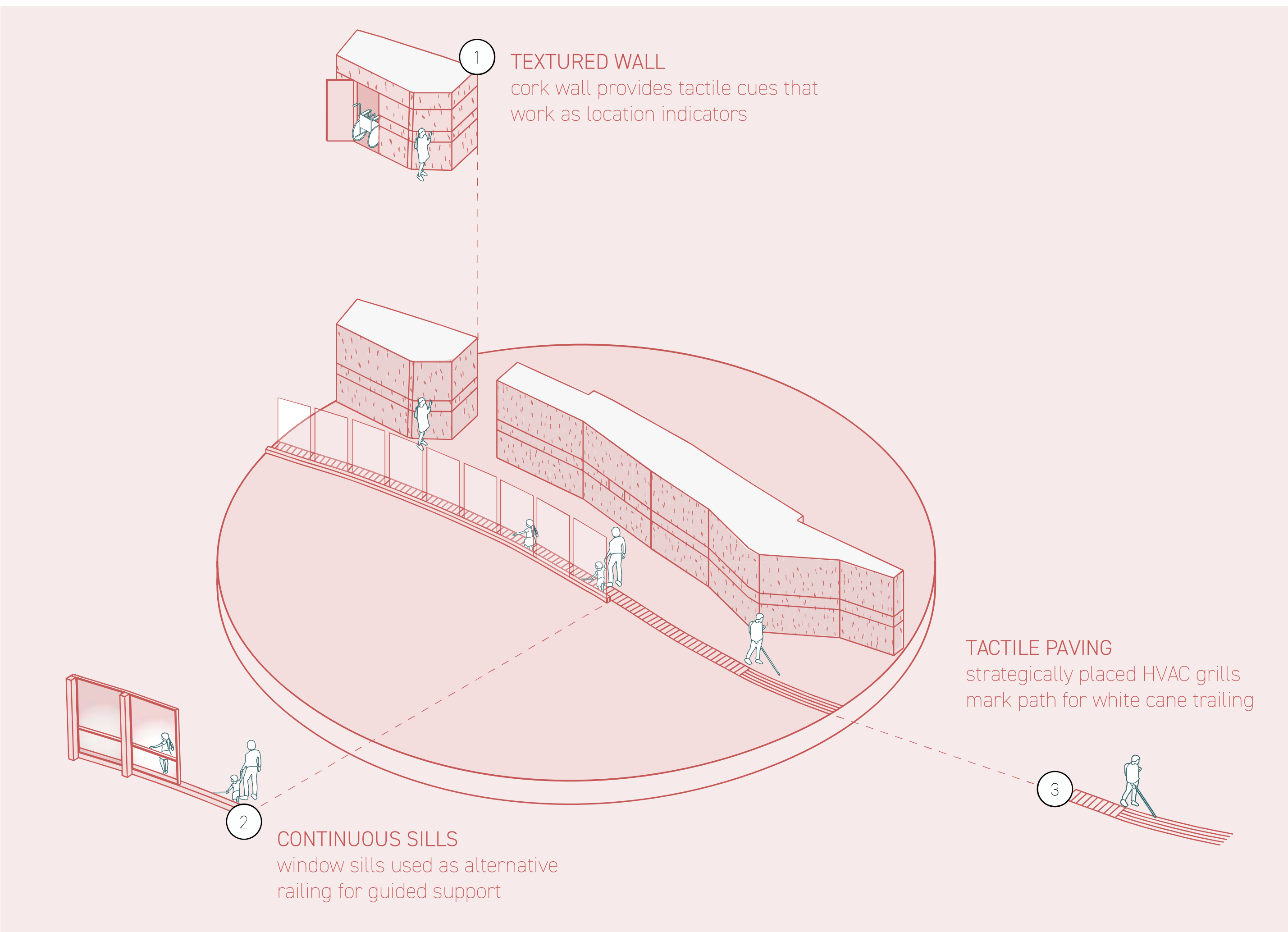
While the technique is most commonly used through "the act of using the back of the fingers to follow lightly over a straight surface", it may also be done through the use of canes. [28] With that being said, regardless of the element that indicates one's position - whether a wall, the floor, a window or others - trailing is about using tactile qualities as a means of identifying reference points that can help a visually impaired person determine their own location. and path. Given it is one of the most common wayfinding techniques for visually impaired people, the implementation of trailing tools in this project is certainly an indisputable design decision for the inclusion and enhanced autonomy of Hazelwood's sensorially impaired students. However, what is truly intriguing about the designer's implementation of such tools is the variation of ways and architectural elements through which these mechanisms were applied, extending from creatively-shaped wall surfaces, to windows sills, flooring, and even transoms. [29] Whether through texture, lighting, or materiality, the design team found a range of innovative ways to provide facilitated wayfinding for the students of Hazelwood, all of which are described in the following pages.

Lighting: as if the tactile cues weren't enough, the designers of Hazelwood school extended navigational tools onto the building's lighting design. While it's a very important factor to be considered in any design process, the reasons behind carefully designed lighting conditions in Hazelwood are somewhat unexpected. While this may come as a surprise to many, the design team was made aware that sensory impaired students can identify differences between naturally lit and artificially lit environments [33]. Taking that into consideration, the designers facilitated navigation by utilizing lighting contrast as a sensorial wayfinding tool, purposely making "threshold spaces [that] reduce in height as the roof steps and result in an entirely different volume, which is perceptible to a number of children." [34] The use of lighting contrast as a location indicator can be seen in different areas of the building, including access to classrooms - labeled below as [4] - as well as the entrance to the cafeteria, as shown in [5]. Becasue 'the street' is so well-lit, the sudden lack of light in the corridor indicates to students a point of transition, aiding them to find which points of the hallway lead to the attached rooms. This includes the senior classroom in which "the area is separated from the main spine of the school by an area of glazed roof that establishes a contrast in terms of lighting quality"[35].



Texture: tactile cues are many of the wayfinding tools found within the school, which "include the small-scale gestures of the zig-zagging wood walls, the waist-level contours in these walls, and the textures of the floors, including the placement of the HVAC grilles for additional aid in movement." [30] Out of the many tactile cues in the school, the most popular one is the cork wall in the primary corridor of the building. Labeled below as [1] and stretching beside the entirety of 'the street', "the wall runs the length of the school and is devised to incorporate messages and let the children know where they are" [31], utilizing different texture variations as important location indicators.

The zig-zagged shaped wall "is clad in cork, which has warmth and tactile qualities and provides signifiers or messages along the route to confirm the children's location within the school", [32] making independent circulation easier for visually impaired students. Another example are the window transoms, which are also specifically placed in varying heights to offer handrails that help student maintain their routes within 'the street', as is shown [2] in the figure below. Lastly, another example of tactile cues are the purposely placed HVAC grills that work like tactile pavements to reassure students of their routing. The grills mark paths along the entirety of the street, as shown in [3].



Materiality: Considerations to wayfinding and lighting sensitivities were also present in some of the project's choices of materiality. Aside from lighting contrasts, visual cues were made perceptible through carefully selected colors and textiles that also contributed to wayfinding qualities. The attention given to such decision was largely due to how the distinguishing between floor and wall surfaces - as well as easily identifying doors - can be a challenge for people with visual impairments. To facilitate such distinctions and avoid difficulties with orientation, the architects intentionally used both neutral as well as vibrant colors throughout the project. As a result, "colour changes or contrast to the neutral background act as signifiers to the children"[36], further nourishing spaces that stimulate their independence. The use of materiality as a complement to trailing can also be found through the building's facade in which

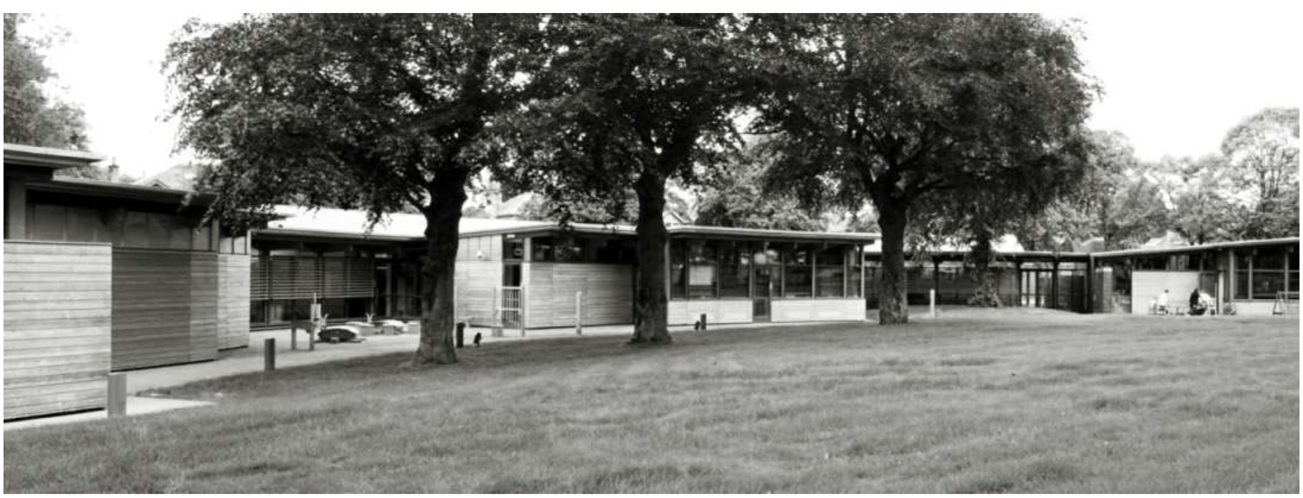
"cladding included textured materials such as naturally weathering larch boarding which offer tactile qualities for trailing but also stimulates the sense of smell." [37]

Reflection: Looking over the topics discussed in the previous pages, it becomes rather clear that while it could be assumed that the process of designing for disabled audiences would require an entirely different approach, the reality is that it simply requires a new perspective on well-known and somewhat generic design strategies. Whether orientation, layout, lighting, or even materiality, the difference between design that promotes disablement versus design that promotes enablement lies on understanding the need of the user. The main design considerations taken into account in the development process of the Hazelwood project are factors that are already ingrained in architectural practices, but which are often focused on an able-bodied perspective that leaves the needs of the disabled population overlooked. Through a research and design process that was extensively collaborative, the team designing Hazelwood school exemplifies how acquiring such understanding of an audience is precisely the approach needed for designing for enhancement. This becomes especially clear when comparing the well-being of students in the new school building versus their previous school building. While the spatial circumstances in the previous building created further difficulties in mobility, wayfinding, and autonomy in general, the new design embraces architecture's capacity to foster the exact opposite. A clear example of this is designer's approach to wayfinding, because not only did their design choices seek to avoid flaws that would challenge this task, but they also took the extra step of figuring out how the built environment could further ease navigation and enhance the student's abilities to move around autonomously. This is evidently shown in the textural elements implemented for trailing because the variety of sensorial tools offered for navigation not only allow the children to find their way more easily, but also fosters their autonomy in choosing the best tool for them.

Through the eyes of a designer, the success of the Hazelwood project seems indisputable. Not only do its design qualities go beyond the barrier-free values, as they also gear towards the concept of architecture as a tool for human enhancement. Moreover, it supports the idea that after all "accessibility [can] evolve from a simplistic view of barrier-free environments towards a more inclusive approach" [38] ,which is precisely the possibility that this investigation aims to explore. Whether speaking in terms of accessibility, wayfinding, or sensorial qualities, the school's design reaffirms that individuals can be enabled by architecture, rather than disabled by it. It therefore serves as an example to design practitioners, as after all "the design of Hazelwood confirms that young people with severe and complex needs (...) can be helped to manage these negative characteristics by a supportive physical environment provided by sensitive architecture and careful design." [39] Aside from its significant role within the evolution of architectural standards, the school's most significant impact is on its users, including students, teachers, staff, and parents. When it comes to the students, Hazelwood has been successful in providing proper spaces in which children with complex needs are enabled to develop their confidence and independence [40].

Official educational reports based on parental surveys indicate that not only do 83% of students like being in Hazelwood, but additionally 92% are making significant progress at the school. [41]

Such reports further claim that "the school and nursery has a welcoming and supportive culture where all learners feel safe and cared for" [42], a view which seems to be largely supported by the school's staff. This is a strong tribute to extent to which the school's new spatial qualities impacted the overall learning experiences of its students. As stated by Hazelwood's head teacher, Vincent Fergusen, "having the framework of such an excellent building makes all of our jobs so much easier. I still get a lift from walking through the doors each morning, with a recognition that I am extremely privileged to work in this fine structure and with these amazing people and children. [43]" All in all, there is no doubt in regards to the school's success, and such a positive view seems to be largely perceived as a result of the careful and inclusive design developed by Gordon Murray + Alan Dunlop, reiterating the extensive impact that comprehensive architecture can have in a community.



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CONCLUSION

SECONDARY QUESTION

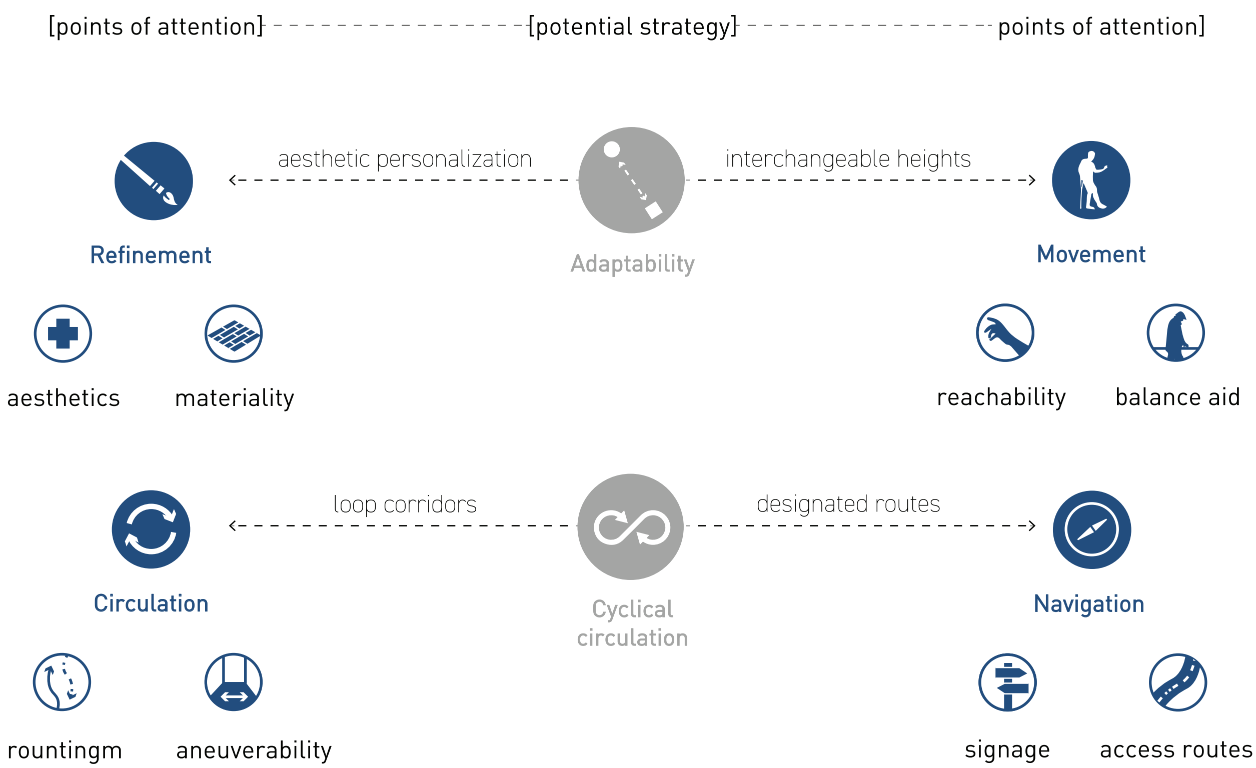
what factors of design may further restrict the capabilities of mobility aid users?

When looking over the themes discussed in chapter two, the link between architectural practices and specific circumstances of design disablement becomes undeniable. Through engagement with mobility aid users whose life experiences exemplify these circumstances, this research brought to light important - and somewhat surprising - design aspects that are resultant of in-comprehensive design processes that overlook their needs.

Both in the urban scale as well as the building scale, the examples given in the above-mentioned scenarios demonstrate how the spatial experiences of mobility aid users are in fact reliant on the architectural processes that designate such spatial conditions.

Whether speaking of circulation, refi nement, and movement, or transport, navigation, and nature, the correlation between design decisions and design disablement is unquestionable. Taking circulation as an example, scenarios regarding maneuverability really reiterate the extent to which current accessibility standards are limited to a 'wheelchair friendly' approach. Whether speaking of the insuffi cient space for electric wheeled devices or the circulation needs for walkers with a prosthetic leg, the topic of architecture remains a common factor. In the example of walkability for lower-limb prosthetics, it is true that one's diffi culty to make sharp turns isn't of course a result of fl awed design, however, if designers held more knowledge about the difficulties of walking with an adaptive limb, simple design decisions could already ease that experience. Through basic choices such as the avoidance of long one-way corridors or the just the implementation of curvilinear circulation routing options, the experiences of adaptive limb users could already be greatly impacted. The same applies to the case of the larger wheeled devices, an example that reflects how if designers seeked to grasp in-depth understanding of how one uses a scooter or an electric wheelchair, then it could be recognized that the solution to barriers imposed in their use can be much beyond spatial increases. Just as was the 1.5m turning circle was learned through codes and regulations and is now enforced as a design consideration, so could the three-point maneuvers of electric wheelchairs. Moving onto points of attention within the urban scale, similar examples remain applicable to this perception. The subject of public transport facilities is a reiteration of this, because while architecture may not remedy the flawed vehicular design of buses or trains, it does have the capacity to provide innovative bus stop design that will ease onboarding experiences for passengers who rely on mobility aids. Again, this is something that has to be reaffirmed through the design process, but in any case it raises attention to the potential that architectural innovations can have in the inclusion of users of assistive devices, as well as increase their partipation in collective activities. In bringing to light these points of attention, the preliminary considerations for more inclusive designs processes can already be known. However, while this chapter offers partial answers to the guiding questions of this research and scenarios that strengthen the theory that the built environment can serve as a tool for human enhancement, the extent of which that is true remains undiscovered. After all,

although the unreceptiveness of architecture was undoubtedly emphasized, the specifics of how it may improve its receptiveness doesn't lie within the above mentioned examples.



When it comes to the sought understanding of what factors of design may restrict the capabilities of mobility aid users, the answer is certainly clear: innumerable. The primary factors to be considered in the avoidance of those unwanted restrictions is delineated within the following categories: maneuverability and circulation, materiality and aesthetics, reachability and movement, mobility and navigation, and lastly climate and terrain. In a way, these terms may assimilate to a list of regular factors to be considered in any design process, and to an extent that may be true. What should be emphasized here is that in order to make architecture more receptive for mobility aid users, the above-mentioned terms need to be considered from the perception of mobility aid users themselves. While fully-construed solutions can't be developed without a research by design process, there are a few design strategies that come to mind when reflecting on these topics.

Most importantly, when looking at such array of points of attention simultaneously, it can be theorized that some of them could be mutually remedied through the same design strategies. For example, as is shown in the diagram above, using a strategy such as adaptability or modular design is something that could target both issues with refinement, as well as movement. In parallel, it can be assumed that similar conditions are applicable when it comes to circulation and navigation, both of which could be improved through different applications of cyclical routing. Of course, these are merely hypothetical tools as of now, but their potentials seem to be undeniable. Taking that into consideration, grasping the key aspects that make architecture unreceptive to assistive technology is inevitably a step towards understanding the ingredients required to make it more receptive, but the complete answer to that question most likely lies in this investigation's portion of research by design.

While aspects discussed in chapter two may provide a preliminary indication of possible design strategies for spatial enablement, it is the topic in chapter three that really concretizes and reaffirms the direction of that strategizing process. The design of Hazelwood school serves as the perfect example of the potential that the built environment has as a tool for human enhancement. By acquiring a proper understanding of the spatial challenges encountered by the school's students through an in-depth consultation process, the design team confirmed that the same design elements that are often construed as barriers can too be used as facilitators. In other words,

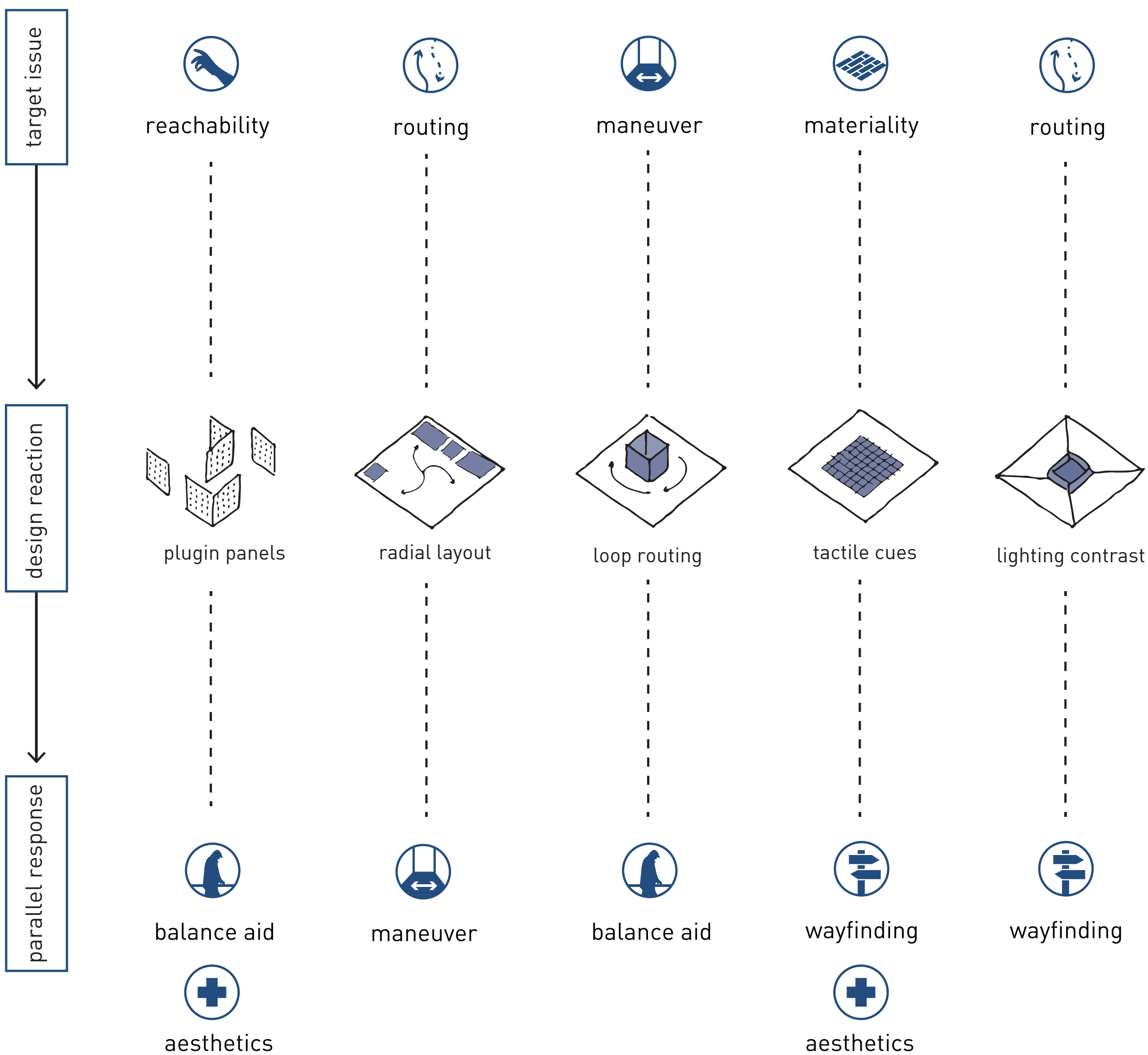
in many ways the school's design affirms that architecture's potential as an enabler lies precisely in the proper understanding of architecture's unwanted role as a disabler.

This suggests that a possible approach to pursue enhancement strategies in design is largely based on a problem-solving method that involves developing direct responses to each individual issue in order to come up with all-encompassing strategies that may target multiple issues at once. Some of the school's design qualities can be interpreted as a result of this method. For example, in learning about the light sensitivity challenges experienced by many students of Hazelwood, the design team explored different lighting design possibilities that would respond specifically to the issue of visual distractions tendencies in the classroom. Although design elements such as clerestory windows, ceiling height changes, and artificial versus natural lighting contrast were directly responding to that very problem, they later became responses to other barriers such as wayfinding and signage.

Now, while the case study of Hazelwood school may have paved the path for affi rming the enabling potential of architectural design, it doesn't offer suffi cient examples to measure the extent of such potential. Moreover, although the school's design offers outstanding examples of enhanced wayfi nding and the creative use of tactile cues, it doesn't provide specifi c design responses to many of the points of attention discussed in chapter 2. Rather, the potential solutions for those issues are targeted in the research by design portion of this project, which explores possible alternatives through the exploration of an inclusive residential complex in a highly forested area of Driebergen-Zeist. Hence, it is the approach of this project and its responses to specific design issues that truly seeks the answer to our primary question: to what extent can the built environment be used as a tool for human enhancement? Taking the the development of Hazelwood as an example, it is this author's assumption that analyzing each point of attention and seeking a design response for them individually is a possible path for developing strategies of inclusive design. Therefore, the starting point for the design process involves the investigation of individual design elements that may avoid, solve, or revert each of the previously discussed points of attention. The following section provides a brief overview of the research response that strongly shaped the design portion of this thesis, providing a post-production analysis and reflection of its methods. The next pages delineate the core of that process, depicting the outcome of a research by design process that aimed to explore enabling solutions to disabling issues. While somewhat theoretical, these ideas are still a sufficiently realistic example of how through innovative reactions to current issues of design disablement the role of the built environment as a tool for human enhancement can be affirmed.

Through out the design process, the design reaction to specific target issues later evolved to target other issues in parallel. For example, as can be seen in the diagram below, what was initially a response to issues with reachability became an element that could too target challenges with balance aid and aesthetics. Initially, the implementation of the plugin panels was merely an attempt to provide adaptability in the design of everyday-use elements such as counter tops, sinks, seating, etc, which could provide extensive potential for customization.

While exploring this possibility, came the realization that the interchangeability provided by the panels could also respond to height placement constraints with grab bars and rails, responding to the issue of limited balance aid. While those are typically medical-looking, having them designed in the same style as other everyday-use elements became too a solution for the problem of aesthetics. Having a similar fashion to the plugins that decorate the home, balance aids could then gain a destigmatization potential through a more decorative quality.



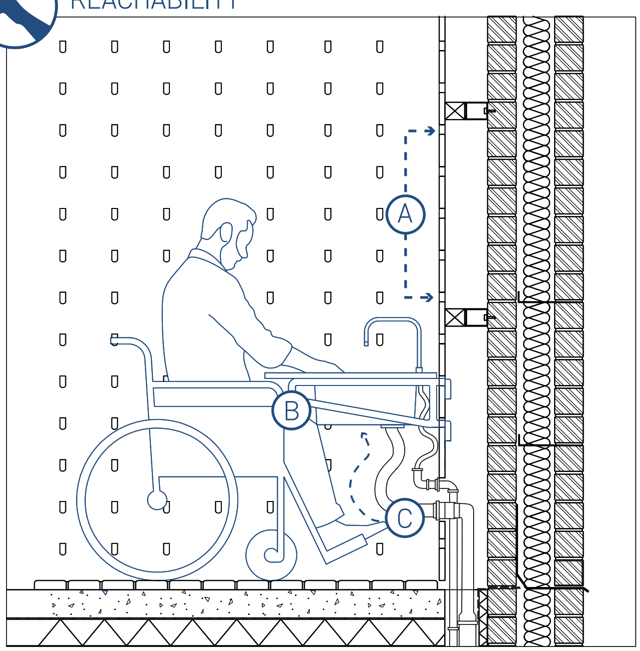
When looking closely at some of the solutions developed in the design process, one can begin to envision architecture's potential as an instrument for enhancement. Of course, at this stage of exploration these ideas are still somewhat hypothetical, after all the extent of their efficacy could only be affirmed if properly tested by mobility aid users themselves. In spite of the absence of that opportunity, confidence holds that the design elements responding to the points of attention unfolded in this research are still a plausible response. In fact, when considering the scope of knowledge gathered in the investigation, from interviews and surveys to journals and case studies, it can be positively assumed that the creative solutions from which they result are rather feasible. Now, while the extent of their feasibility may not be entirely measured, it's still possible to say that they are still a rather strong indication of possible methods that could make the built environment a better suited tool for enhancing the capabilities of mobility aid users.

This potential is reflected in the architectural drawings of the project, which depict ranging design qualities that not only emphasize the minimization of spatial disablement but also pave the way for enablement. Different examples may show this, but one in which it's quite evident is the implementation of plug-in panels, which respond to issues of reachability within the building scale.

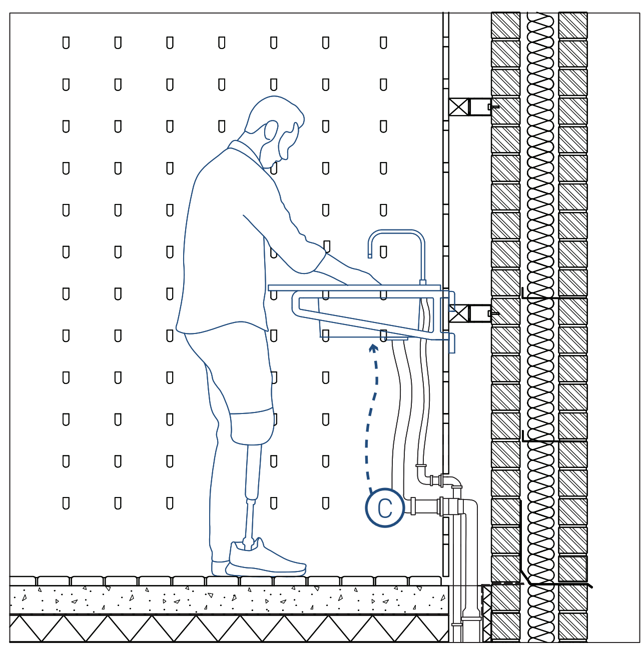
In half meter segments, these perforated plywood panels offer a unique vessel for the customization of elements that are typically ergonomically restraining to many mobility aid users.

Whether speaking of counters, sinks, table tops, and many others, it was recognized that a range of these standardized dimensions fail to cater to the varying use of different mobility aids.

REACHABILITY



[a] multiple height slots allow sink to be easily adjusted
[b] space under sink for enhanced wheelchair legroom



[c] flexible piping enables user to move sink autonomously

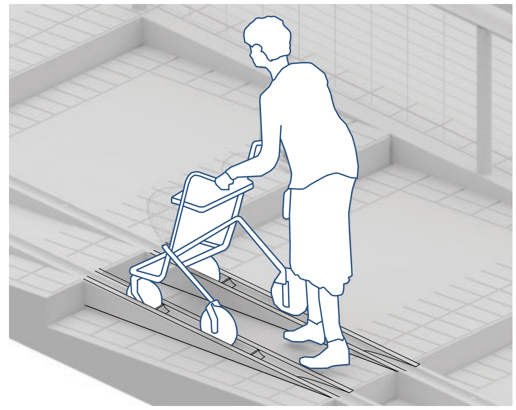
This brought attention to the importance of customization, hence the use of the perforated panels. Due to their perforation the panels offer different height levels for the installation of wall elements like kitchen tops, desks, cabinets, shelves, or anything that can often be designed in dimensions that are out of reach for someone in a wheelchair, scooter, or walker. This reaction to the issue of reachability brings affirmation in the built environment's role as an enabler. While standardized ergonomics may disable mobility aid users limiting their ease to perform everyday abilities, the implementation of a plugin system can enable them to do so. This method would not only enable customization between different users, but also provide eased changeability for each user to adapt their home over time. As can be seen in the image above, taking interviewee Jamie as an example, the laminated perforated panels in the restroom provide the necessary adaptability for Jamie to adjust his sink whether using his wheelchair or wearing his prosthetic leg. When considering content gathered in Jamie's interview, the application of this modular quality is emphasized, as according to him the need for changing between adaptive limbs and wheeled devices can vary greatly depending on the sensibility of his stump. Hence, depending on the assistive technology he needs the opportunity to alter his environment accordingly is rather valuable. With this approach, routine tasks that would otherwise be challenging are suddenly facilitated. When envisioning this approach in action, there is strong reason to believe that users would enabled to adapt to perform routine activities that would otherwise be restricted in less-adaptable spaces. Whether speaking of something as simple as cooking, using a desk, or even brushing their teeth, the enhanced opportunities for such simple routine tasks could be in fact quite impactfull, and should therefore not go unnoticed.

In spite of their simplicity, the enablement of these little everyday instances is still a significant indicator of the extensive potential that inclusive spaces can have in enhancing the opportunities of its users.

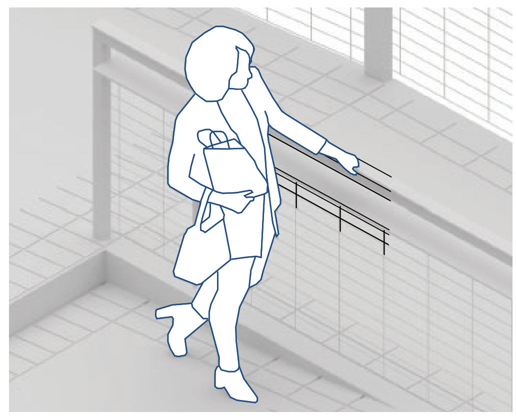
This is only one of the many methods that were explored in the design process. Other examples are also present in the urban scale and serve to prove this potential for enabling spaces. A great example is the proposed design of vertical circulation outdoors, which seeks to ease the negotiation of level changes to a range of mobility aid users. The research unearthed some important discoveries about level changes, one of which involves how their negotiation through the use of different devices can vary immensely. Taking that into consideration and seeking to better comprehend the different challenges that may come with utilizing stairs or ramps with a mobility device, a new proposition of eased level changes was developed. Although many may often assume that ramps are the key for vertical circulation in inclusive design, content within this investigation has proven otherwise. It's been affirmed that in fact when it comes to using stairs or ramps each mobility aid has its own set of usability factors to he considered.

Challenges relating to the use of prosthetic legs is reflective of this, as the sloping surface of a ramp has proven difficult to manage when walking with limiting ankle movement. Walkers are also an example, because while someone with a three-wheeled walker would easily push their device up or down a ramp, someone with a heavier four-wheeled walker would probably encounter challenges with controlling the weight of their device. These, and many other considerations enabled the creation of an innovative combination of ramps and stairs, that together are more accessible to all.

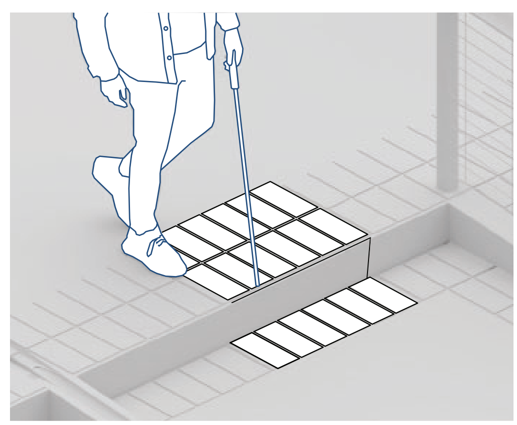
The figures aside demonstrate some of the features that hold potential to ease the negotiation of level changes when using mobility aids. As mentioned previously, an issue with the use of walkers, for example, can be the strain of controlling such a heavy device. Especially when it comes to four-wheeled walkers, the climbing of stairs is incredibly difficult. In parallel, their use in a ramp can also present its own set of challenges because of difficulties of controlling the weight of the device when it can so easily and unintentionally roll up and down the slope. To minimize the possibility of these physically straining barriers, one of the features included in the proposed vertical circulation is the roller tracks on the stairs. As shown in **[1]** these tracks assimilate to the ones used in bike stairs, making the use of wheeled devices possible over steps. Differently from bike stairs, however, these include 'back stoppers', which provide traction that impedes the device from rolling downwards. Another element here are the dual height railings, which provide balance support in two different placements, as can be seen in **[2]**. In addition to that, these rails also respond to issues with climate, having wooden rails to ensure tactile comfort during colder seasons. This is specifically a response to the climate category, through which it was discovered that metal or stone rails can often become painfully cold in winter, limiting the efficacy of its balance support. Lastly, both visual and tactile cues are implemented along the floor, as a response to mobility challenges for those who have limited vision. The purposeful placement of the bricks on edges of the steps provides tactile indication that can be perceived through the use of a white cane. Additionally, the color constrast between the concrete on the rise versus the brick on the run make it easier for people with reduced vision to distinguish the steps, avoiding any orientation difficulties with stair climbing, as shown in **[3].**



[1] tracks enable the use of wheeled devices on stairs with backstoppers that give traction to minimize the effort of pushing device



[2] rails are built at double heights to meet the needs of wider audience and made of wood for tactile comfort in colder seasons



[3] color and tactile contrast make steps more easily distiguished for users with limited vision or using a white cane

The aforementioned design elements are only a few of a myriad of features that responded directly to issues discovered in the research. In spite of being just a few, when looking at them closely the capacity of architectural design as an instrument of enablement seems much more feasible. Of course, without the possibility of developing prototypes and having them properly tested in different scenarios it is not possible to determine whether these elements of enablement would be realistic in practice. However, even in their theoretical form such design proposals are still quite promising, and certainly a good start for the development of more inclusive spaces. With that being said, between the example of Hazelwood school and the innovative design explorations that respond to issues that were researched rather extensively, it is possible to say that the built environment can in fact serve as a tool for human enhancement. Again, the extent of such potential may remain unmeasured, but the grand range of possibilities that can be concluded from this research do provide significant indication that spaces that enable are achievable after all.

Of course, the detailed application of such design ideas may remain unclear, however, the strategies that they encompass are sufficient proof of their attainability. Hence, to conclude,

while the design response developed in this framework may only scratch the surface of a myriad of other techniques of enablement, it does emphasize a crucial fact: inclusive architecture can be massively improved.

Therefore, the responsibility that architects hold in exploring such possibilities and aiming for their application should not go unnoticed. It is this author's hope that aside from providing sufficient content to affirms the built environment's capacity as a tool for human enhancement, this research will also serve as a n opportunity of enhancing the awareness of design professionals in their capability if being part of that change.

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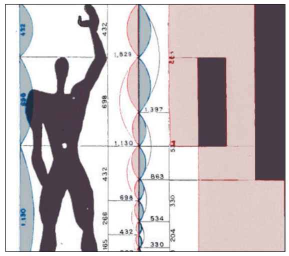

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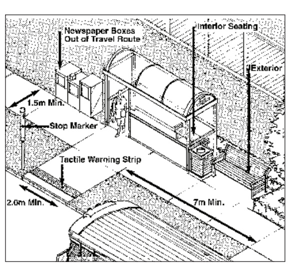

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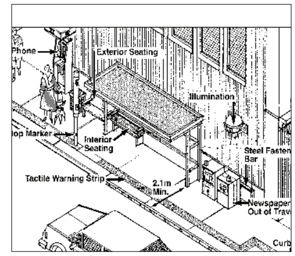

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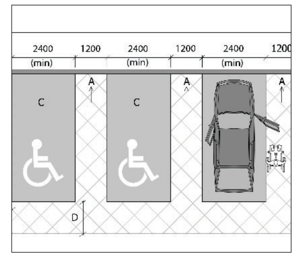

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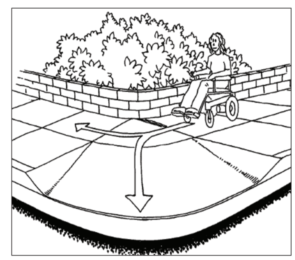

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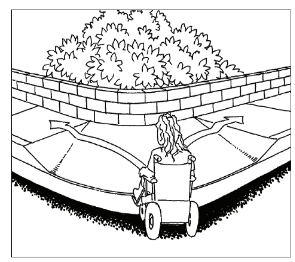

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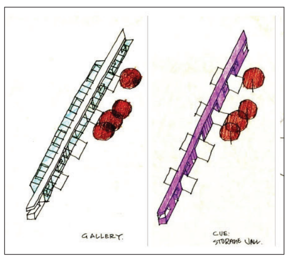

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REFLECTION

Alexia Marie Lund - 5317614 - AR3AD110 Graduation Thesis

Looking back onto the process behind this research, the benefit of hindsight certainly brings attention to the way things could've been done differently. Taking a closer look into the complete timeline of the project, the first concern that comes to mind is the imbalance between the progression of its different areas. It has now come to my attention, that rather than aiming to produce the project's whole base first and eventually develop its entirety simultaneously, I mistakenly spent disproportionate amounts of time and effort in individual tasks. Because of this, some themes advanced strongly while others were somewhat overlooked.

The distinction between the building and urban scales is perhaps an example of that, having the individual typologies undergo a lengthy and thoughtful design, leaving little time (and energy for that matter) to apply the same approach to elements of the urban scale. This is partially explained by the personal objective of a career direction that focuses on smaller scales, therefore wanting to spend more time to learn about the topics I hope to further specialize in. When taking that into consideration, having a more superficial vision of the urban scale while producing a distinctively refined proposal for the building scale doesn't seem so negative. However, when looking at their overall result comparatively as a designer there is a disappointingly evident quality difference between the two scales. This issue of disproportionate division of time and themes was also a challenge in the development of the building scale itself. When designing the typologies, for example, too much time was given to perfect the floor plans before even considering their relationship to sections and elevations. In focusing so much on the plans I lost sight of the other equally relevant viewpoints from which my design could've benefited. Being able to analyses this now brings the realization that when finally addressing the design in section, a lot of what had already been developed in plan had to be altered anyway. Hence, this brings to light how there is no point in perfecting preliminary versions before understanding how other portions of the design may affect it. Additionally, this recognition is especially relevant in the topic of building technology, because a more well-rounded perspective of the simultaneous design in section and plan could've certainly eased the understanding of the building's technical aspects. Instead, having focused so much on plans to then later review their construction in section left room for a disconnect between my own understanding of the relationship between building technology choices. In other words, in seeking perfection on preliminary versions of single tasks, the different project areas developed unequally, having certain portions be quite refined, while others somewhat rushed. Although reflecting upon these aspects may feel partially negative, it also brings the realization that mistakes themselves were a big part of the process. Without all of the preliminary versions that seemed insufficient and had to be altered I would've never arrived to the final version that in fact feels positively reflective of my research, With that said, although thinking of alternative approaches that could've eased the project's development is certainly a key exercise, I certainly hold no regrets on the many mistakes along the way. This is because the making of such mistakes is what paved the way to reflect on possible improvements, and is after all what will enable me to do better on the next project. Hence, while I hold awareness that my thesis as a whole could've significantly benefited from alternative paths, I still hold pride in the path taken. After all, the wrong paths can sometime lead us to the right places, and it is my hope that this bumpy journey has brought me to a position that will shape me into a better architect.