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PROJECT REPORT

O14: Critical review of design and development practices that relate to access for people with disability (universal access): Part 2 Performance-based concepts and training requirements - Year 1 (2019/20)

ARRB Project No.: 014966

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SUMMARY

This report aimed to identify and review current performance-based concepts/strategies used in the design and planning of universal access (access for all users including people with disability) and to determine whether these may assist in ensuring dignified and defensible accessibility for all users, with a particular focus on people with disability. Training courses available to industry professionals and professional competency requirements were reviewed where possible and any gaps or improvements were identified.

Across Australia, current practice often involves designing to meet minimum compliance levels of Australian design standards; a practice which results in restricted access and inappropriate availability, usability, utility or desirability of services and products (PwC Australia 2019). Fortunately, there has been an increased use and awareness of performance-based concepts, aimed towards improving universal design and accessibility.

Human-centred design is an approach to design and development that encompasses the performance-based concepts identified in this report. The human-centred design method aims to create more usable systems through the involvement of intended and potential users.

Performance-based concepts that were identified and investigated within this report include:

- cooperative design
- living laboratories
- usability of design
- universal design.

From the review of these performance-based concepts (see Table 3.4 for comparison) it was found that the performance of each was situationally dependent; succeeding in some situations while failing in others. The investigation also identified that there was only a small pool of case studies undertaken on these concepts when applied to a project, and no projects were in transport design. Each concept has positive and negative aspects that should be weighed on a project-by-project basis to determine which concept is most suitable.

As part of this report, the Queensland Department of Transport and Main Roads (TMR) *RPD308 Pedestrian Crossing Facilities and Tactile Ground Surface Indicators Design (2016)* and several external training courses were reviewed. Due to scheduling and logistical constraints, it was not possible to attend these courses at the time of writing. Therefore, the review was conducted on available material. TMR was able to provide training material for their training course, while it was not possible to obtain training materials for external courses.

The TMR *RPD308 Pedestrian Crossing Facilities and Tactile Ground Surface Indicators Design* training course was reviewed against the following criteria (see Table 5.2 for review):

- if they align with the latest standards, guidelines, and legislation
- if there is any guidance identified from this project's research that should be provided in this document
- if the language used is dignified and/or politically correct

- if recommendations from this project's research should be applied to course material.

This report also identifies and briefly describes 16 other training courses (see Table 5.3) that are available in Australia relating to universal access design.

From the review of performance-based concepts and training courses the following recommendations have been made:

- TMR should develop a policy document requiring the use of a performance-based concept throughout the life of any development projects to ensure the needs of users have been considered to the greatest extent possible. ARRB cannot conclusively declare that one of these concepts is superior as the potential benefits and disadvantages are situationally dependent and should be determined at the project leader's discretion. However, ARRB does recommend the use of cooperative design and universal design as they both demonstrated benefits in the case studies investigated.
- Updates should be made to TMR's *RPD308 Pedestrian Crossing Facilities and Tactile Ground Surface Indicators Design* training course as per Table 5.2. These updates are to ensure the training course uses politically correct language, demonstrates the latest standards and guidelines, focuses on universal and dignified access, and reinforces the legal ramifications of inadequate designs.

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1 INTRODUCTION

1.1 BACKGROUND

The Department of Transport and Main Roads (TMR) has committed to improving the provision of accessible transport infrastructure for all users with a significant focus being placed on access for people with disabilities. TMR has refocused its efforts by publishing the revised *Disability Service Plan 2017–2020* and the *Disability Action Plan 2018–2022*, outlining actions to be taken to enhance accessibility.

The Australian Bureau of Statistics' (2020) *Survey of Disability, Ageing and Carers* estimates there are currently 906 100 people with a disability in Queensland, representing approximately 17.9% of the Queensland population (ABS 2019)[1]. This means that around 1 in every 5 people in Queensland have a disability, which may affect their mobility.

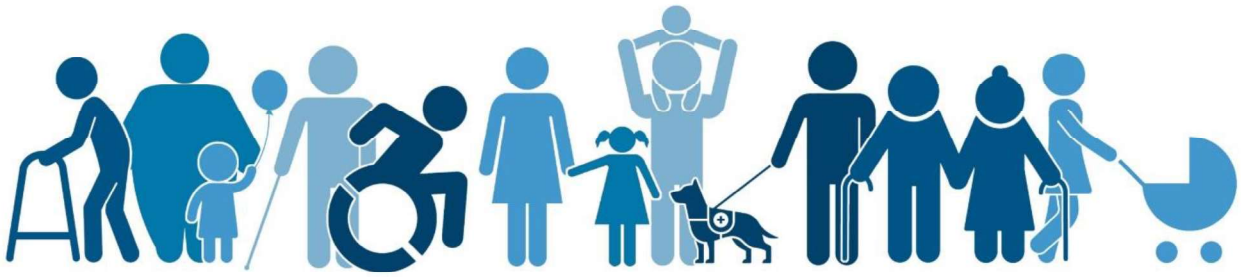
Accessibility defines the relationship between the capacity of an individual and the demands of the environment. Inaccessibility results from the demands of an environment being too high to match the capability of the individual.

The definition of accessibility can be described in two ways:

1. the possibility of a user to reach different destinations
2. the creation of an environment that is usable.

An accessibility solution is achieved by either increasing the capability of the individuals to match the demands of the environment or by reducing the demands of the environment to match the user's capacity. The latter is the most appropriate choice as the environment is easier to manipulate (Lundebye et al. 2011).

Figure 1.1 Illustrative sample of people with disabilities



Source: Williams (2020).

Built environments that are inaccessible for a person with disability or one which limits their ability, disadvantages them and lowers their quality of life. This disadvantage puts them at a higher risk of social exclusion and negative states of health and well-being (Haning, Gazy and Woolmer 2012). In 2019, over five

[1] Total QLD population = 5 076 500 (ABS 2019). Population with disability = 906 100 (ABS 2020)

million elderly or people living with disability in Australia were vulnerable to being excluded from activities and opportunities, limiting their social, educational, economic and other opportunities (ABS 2020).

Those who are unable to transport themselves by personal or assisted means face the disadvantages of mobility limitations, due to improper measures being taken or considered in the design process (Rosenbloom 2007; Whitson 2017). In some cases, designers have directly or indirectly failed to exercise anti-discrimination laws, such as the *Disability Discrimination Act 1992* (Sections 23, 24, and 31).

Ideally, planners, designers and engineers should consider the needs of all users (children, elderly people with a disability etc.); this has not been the case historically or even in some recent developments. Court discrimination cases are currently being heard where developers have satisfied minimum design requirements but have been accused of failing to provide reasonable access or socially accepted access when considering factors such as steep path gradients and weather conditions (Jarvie 2019; Mercury 2017; Whitson 2017).

It is difficult to discern why roadblocks to achieving universal access have been overlooked which has led to non-optimal accessibility outcomes. It may be the result of a lack of understanding, training or experience from planners, developers, or engineers. It may be that time, cost, scope, legacy infrastructure, or other considerations influenced non-optimal accessibility.

In past or traditional practices, it is not uncommon for designers to depend solely on their own perception of user needs in connection with standards and codes to ensure a design is safe to serve its purpose or be cost-effective. Designers who translate this into universal access design may depend on standards as a compliance tool to meet the want and needs of people with impairments. Without a framework to follow, designers are vulnerable to forming decisions based on their own experiences and assumptions of intended user needs and desires.

Designers in the transport industry often create designs that are appropriate for the ‘average’ or ‘optimum’ user who generally does not experience mobility or sensory limitations. Consideration is given at the end stages of the design process as to how and where (if necessary) the design can incorporate accessible features that are compliant with standards (PWC Australia 2019). However, implementing changes at the end restricts the ability for seamless integration and the possibility to achieve the highest result for the lowest cost. This leads to the needs of vulnerable users being excluded, overlooked, or misunderstood.

Theoretically, if a designer creates an environment that is accessible by those with mobility or sensory disadvantage, then it is almost guaranteed that those without mobility issues will be able to easily use the same environment (PWC Australia 2019).

Some organisations focus on improving tertiary education surrounding universal access design, while others focus on improving or developing methodologies and ways of thinking in the design approach (Italian Ministry of Foreign Affairs 2015). It is difficult to cater a solution to meet the needs of all people with disability, as disabilities are unique to the persons who experience them. Solutions should at the very least as best they can address the most common issues surrounding transportation problems and patterns for people with disabilities (Ajuria 2005) such as:

- Accessibility devices are poorly maintained and not in working order.
- When making several connections (inter-modal), frequent discontinuity in accessibility ruins the entire trip.
- Specific accessibility measures have usually been designed with a reduced group of users in mind (people with severe mobility problems).
- Due to extra deployment time of current accessibility systems and because of their failures the use of these systems often causes anger for drivers and travellers without mobility problems and frustration and embarrassment for people with disability.
- Large groups of people with mild mobility problems often avoid using public transport because it is unsatisfactory for their needs.

- Public transport congestion and discomfort is increased in many cases by narrow, difficult or intricate access devices and routes.
- Improvements in accessibility for people with a disability are often rejected based on their lack of technical/economic viability.
- Design for all is gaining more importance in fields (house building) while transport seems to stick to differing access systems.

Many people with disability find that access to transportation or the use of transportation is a major problem for them (Rosenbloom 2007). The biggest struggles/barriers arise when walking or equivalent is required, which is a critical mode of transport for personal mobility. For this reason, many choose to venture out less than other people without disability, especially if private modes of transport (e.g. car and taxi) are not available to them (Rosenbloom 2007).

This report focuses on discussing performance-based concepts for design that designers can actively apply when developing a tool, product or design that is universally accessible. The term 'universal access' applies not only to civil design but to other industries such as technology and communication services (Soegaard 2019; Stanley 2018). Hence, strategies that are regarded in other industries or fields outside of construction and transportation design have not been discounted.

A brief overview of each of these concepts is provided in this report, followed by case studies to demonstrate the types of projects where these concepts have been applied as well as the benefits and disadvantages recognised. This was done to evaluate which of these strategies, if any, is most suitable to recommend for adoption by TMR to address transportation patterns and problems for people with disability.

1.2 PROJECT AIM AND OBJECTIVES

This project aimed to review road industry practices and competencies with a view of achieving the TMR vision of creating a single integrated transport network capable of providing universal access for all users.

People with disability may experience risks and difficulties that other people without disability are unaware of or do not experience. This project is intended to investigate if and where systematic transport network access failures may be occurring for people with disability.

This project was broken down into three key parts, with a separate report being produced for each part. The final stage of the project was to develop a summary report to summarise the contents of the three key parts. The aims for each part of this project are described below.

Part 1: Review of design and development practices that relate to access for people with a disability

This report aimed to identify access issues and recommend key areas of improvement in planning and design policies, training, and guidance. This is intended to adequately inform and lead designers, planners, engineers, and decision-makers to provide a transport network that to the greatest extent possible delivers safe and dignified universal access.

Part 2: Performance-based concepts and training requirements

The second report aimed to identify and review current performance-based concepts/strategies used in the design and planning of universal access and determine whether these may assist in ensuring dignified and defensible accessibility for all users. Training courses available to industry professionals and professional competency requirements were also reviewed, gaps were identified, and improvements were recommended.

Part 3: Investigation of accessibility for people with a disability and NDIS

The third report aimed to identify what provisions need to be put in place when topography results in undignified accessibility for people with disability and to investigate if electric assistance technology and NDIS is changing design user capabilities.

Part 4: Summary report of findings

The final summary report aimed to summarise the findings and recommendations of the entire project into one document.

This report only focuses on Part 2 of the project which was to identify performance-based concepts and how these may assist to ensure dignified and defensible access, and review available training courses and competency requirements.

1.3 OBJECTIVE

The objective of this project was to identify ways to investigate existing practices and provide recommendations to improve practices in the provision of universal access for all users, including people with disability or movement impairment, and the elderly.

1.4 PROJECT SCOPE

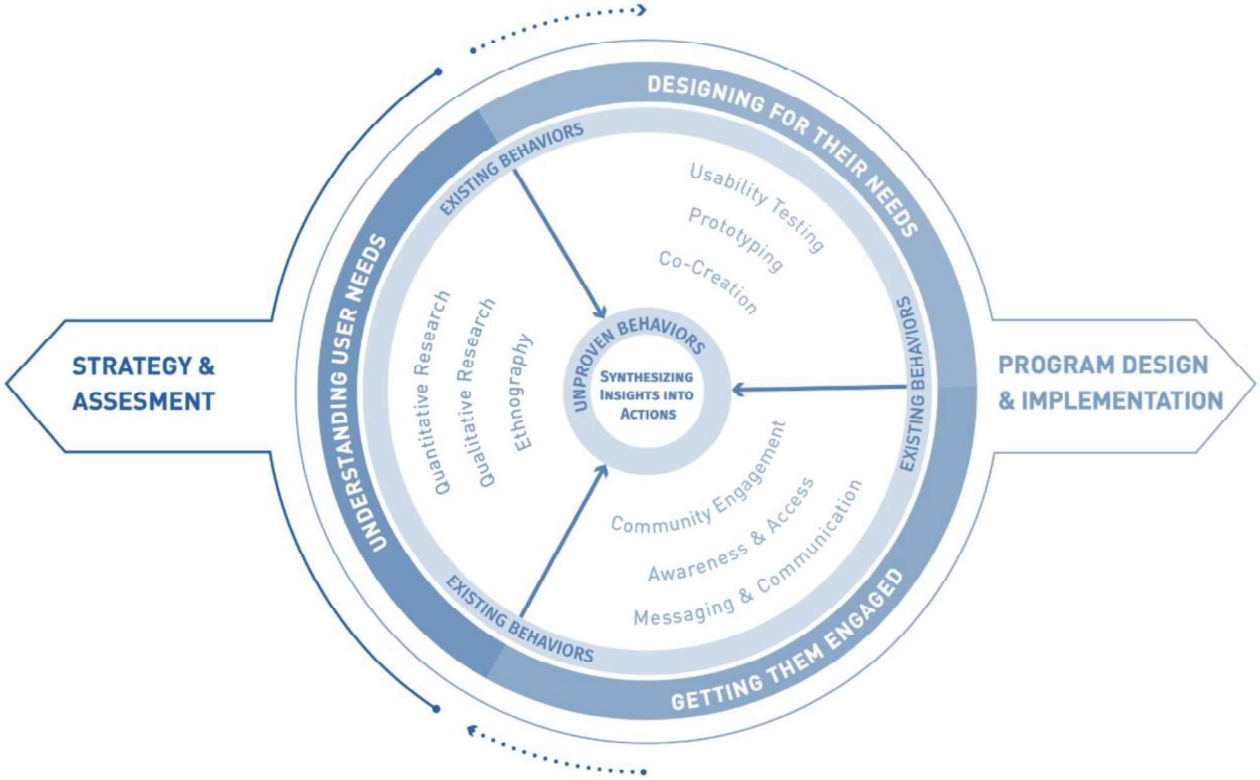
The scope of this project included the following:

- review of existing policies and guidance published by TMR, Austroads and Australian Standards that impact the accessibility of people with a disability within the road network. Identification of gaps or barriers to access for people with a disability and recommend improvements
- identification of performance-based concepts (such as 8 to 80, human-centric design, or universal design) and how these may assist to ensure dignified and defensible accessibility
- review TMR's existing training courses available to industry professionals and professional competency requirements
- identification of what accessibility for people with disability means in the road network
- identification of barriers to access due to topography and provisions needed to ensure dignified and defensible accessibility
- identification of whether electrical assistance technology and the NDIS is changing the capabilities of people with disability.

2 HUMAN-CENTRED DESIGN

Human-centred design is an approach to systems design and development that aims to create more usable systems through the application of human factors, behaviour and usability knowledge and techniques (Giacomin 2014). This design process was first created for the ergonomics, computer science and artificial intelligence fields, but has since been applied to many other fields including civil infrastructure design. The design process is intended to focus on the needs, contexts, behaviours and emotions of the people that the solutions or systems will serve (Giacomin 2014). The overarching framework for human-centred design is shown in Figure 2.1.

Figure 2.1 Framework of human-centred design



Source: Braga (2019).

Universal accessibility is successful if it is socially accepted and usable within a reasonable level of effort by the greatest number of people possible. TMR expressed that there is a need for improvement in the current practice in designing for universal access (design system). The current standard practice for designing a facility or space is often to design for the 'average' or 'optimum' users (people without disability) as the primary focus. In the Austroads *Guide to Road Design* (AGRD) and the Austroads *Guide to Traffic Management* (AGTM) the structure of information is generally presented with the following order of emphasis:

1. Present relevant legal compliance – legislation, Australian Standards etc.
2. Provide additional guidance and recommendations – 'average' pedestrian and vehicle safety measures.
3. Consider people with disabilities (where deemed necessary) – little information and often just refers to other documents.

Typically, consideration for people with disability is given towards the end of the design process as to how and where (if necessary) the design can incorporate features that are compliant with Australian design standards and are accessible for people with mobility and sensory impairments (PWC Australia 2019). Standard practice for accessibility is typically found to be about meeting compliance and does not dictate the focus of the design, it only applies standard or traditional design methodology and tools to problem solving

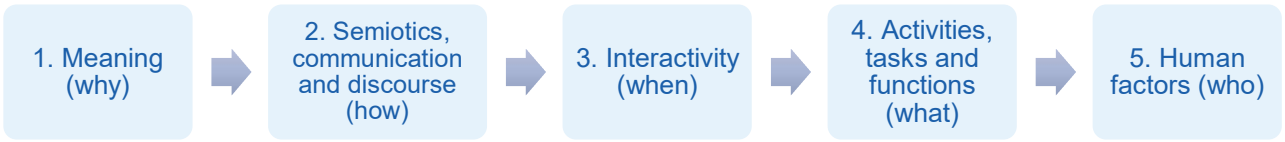
(Queensland Government 2018). Human-centred design is the approach of prioritising the needs of people first and foremost to which the system serves and therefore makes it a suitable approach for the design of universal access.

This design approach is already being used in practice to create higher quality accessible cities (Doig 2014). SmartCitiesWorld (2019) acknowledged human-centric mobility as the key to 'quality of life in cities'. New Zealand is encouraging this shift in thinking to 'people first' as described in their *Urban Street and Road Design Guide* (Auckland Transport n.d.).

Human-centred design is based on the use of techniques that communicate, interact, empathise and stimulate the people involved. It informs an understanding of people's needs, desires and experiences (Giacomin 2014). This leads to systems and services that are physically, perceptually, cognitively and emotionally intuitive (Giacomin 2014).

Austraffic (2020) identified that a human-centred design approach enhances the effectiveness and efficiency of the system and improves user satisfaction and accessibility. Based on Giacomin's (2014) report, the hierarchy of human-centred design considerations are as depicted in Figure 2.2.

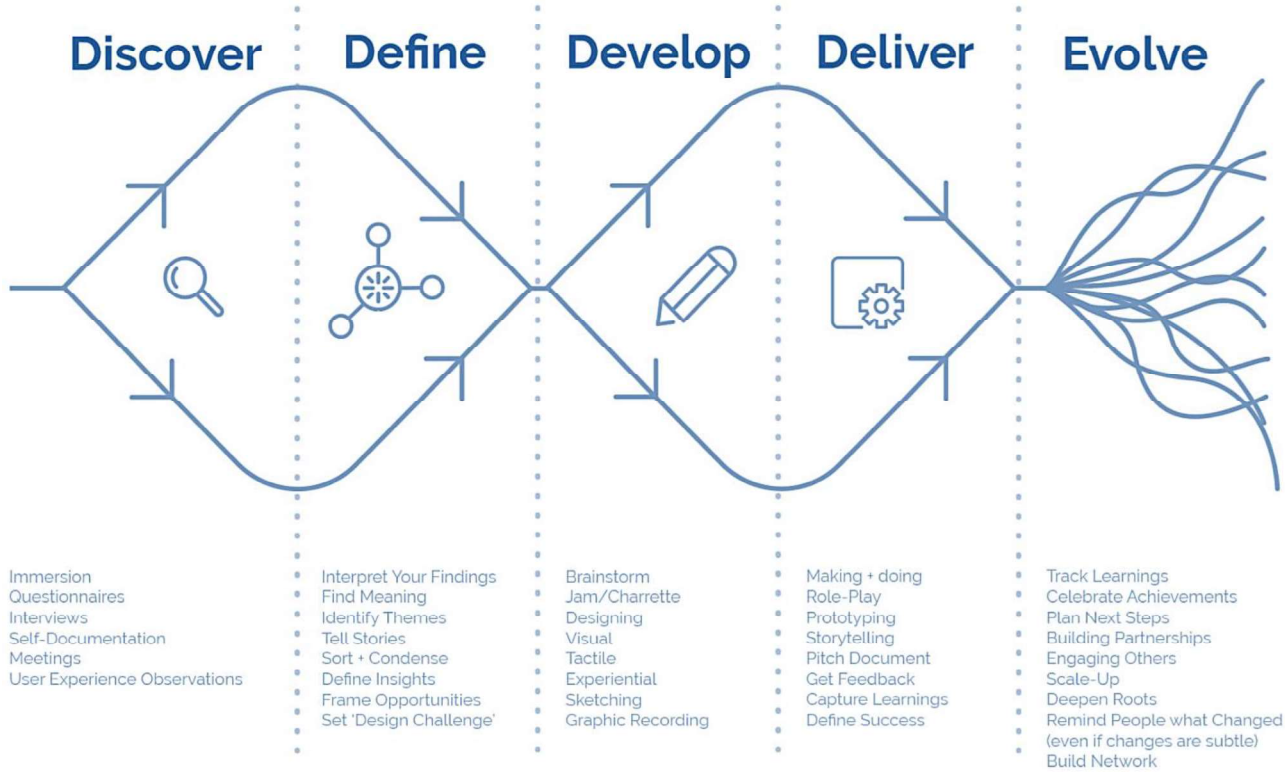
Figure 2.2 Hierarchy of human design considerations



Source: Based on Queensland Government (2018).

Human-centred design encourages user involvement in all stages of the project life to garner insights and explore ideas through testing and refining possible solutions (Queensland Government 2018). Ung (2020) outlines the phases through which human-centred design is approached (see Figure 2.3). The key activities involved in each phase are outlined in Table 2.1.

Figure 2.3 Phases of the human-centred design process



Source: Ung (2020).

Table 2.1: Key activities involved in each phase of the human-centred design process

Discover	Define	Develop and refine	Deliver, evaluate and evolve
1. **Identify the design challenge –** Broadly define the problem space 2. **Define the people you are designing for** 3. **Undertake research –** Understand the problem space by listening to and observing people 4. **Processing of data synthesis and interpretation** 5. **Articulate research findings**	1. **Identify and prioritise opportunities –** Clear expression of a problem from the customer's perspective 2. **Define the problem to be solved** 3. **Consider success measures –** Identify how you will measure the impact of the solution from a customer and business perspective 4. **Create design criteria –** Consider customer needs when designing a solution	1. **Generate concepts** to solve the problem 2. **Prioritise concepts** to be tested 3. **Iteratively prototype, test and refine the concepts** to identify an appropriate solution	1. **Communicate the vision** 2. **Plan and implement the solution** 3. **Continually evaluate the impact and iterate** based on observation and user feedback

Source: Based on Queensland Government (2018).

Mitchell et al. (2016) discuss applying a 'human approach' to transport, which would enable engineers to find more effective and efficient ways to move people across cities and countries. Human-centred mobility is said to require engineers to put the user at the centre of design and decision making, which would create more efficient and resilient transport solutions that are beneficial for both passengers and operators (Mitchell et al. 2016). The most important element of a city-wide integrated transport system is the individual passenger and their desire for a simple, seamless journey; followed by recognition of accessibility and mobility, instead of modes of transport in isolation (Mitchell et al. 2016). To enable human-centred mobility, the transport system needs to be designed to be user-centric so that all elements from ticketing to wayfinding are highly intuitive.

Mitchell et al. (2016) state that to accomplish the aim of supporting a growing and vibrant city, the transport system needs to be efficient, cost-effective and accessible to the widest population possible. Mitchell et al. (2016) identified the tool MassMotion, which enables a focus on human mobility by predicting how people's journeys will intersect. Through simulating decisions and movements of pedestrians to make 3D models using detailed operational data, information is provided on efficiency and comfort for people connecting between different modes of transportation on their journeys (Mitchell et al. 2016). MassMotion allows multiple scenarios to be explored, optimising thousands of user experiences, for positive decisions to be made early in the design process (Mitchell et al. 2016).

IDEO (2015) states that human-centred design assists to arrive at solutions that are desirable, feasible and viable by adopting an iterative approach to solving problems. This allows for the incorporation of feedback from the people being designed for, making them a critical part of how the solution evolves (IDEO 2015). The benefits of adopting a human-centred design approach include enabling the creation of government services that more closely align with people's needs and desires, which ultimately promotes engagement and growth as shown in

Table 2.2 (Queensland Government 2018).

Table 2.2: Benefits of a human-centred design approach

Benefits for the people of Queensland	Benefits for government
• Services that meet the real underlying needs of customers • An improved customer experience of products or services • Less stress and frustration when using a product or service • Removal of cognitive load when determining how to use services • Increased popularity and use of services by customers	• Creates an image of government to its public as being people-centred • Provides an external, customer perspective of the problem at hand • Helps paint a picture of the wider context in which the problem lies • Systems and services that meet the needs of the people tend to cost less in support – they don't need additional assistance (or training) • Can increase productivity and improve operational efficiency • Reduce project risks of a 'failed' service • Builds organisational resilience • Helps staff understand and build empathy for customers

Source: Queensland Government (2018).

Josias (2017) from the American Institutes for Research outlines that human-centred design is a framework for building changes and systems around people's capabilities, limitations and needs. Such systems should be designed so that people are at the centre of design decisions and that technology, processes and organisations support how people perform activities (Josias 2017). Key principles Josias (2017) proposes as necessary for human-centred design are:

1. Gathering information about perspectives, capabilities, needs and expectations of different users.
2. Applying an iterative process.
3. Involving multidisciplinary and diverse design teams.

To inform transit organisations on applying human-centred design processes, data is suggested to be collected from the following sources (Josias 2017):

- People – surveys, interviews, focus groups, observations, ridership data etc.
- Technology – data analytics, human factor evaluation, usability studies etc.
- Processes – safety data, customer service data, workflow processing time etc.
- Organisation – staffing patterns, training costs, implementation costs etc.

Josias (2017) identified stakeholder benefits of using human-centred design, see Table 2.3.

Table 2.3: Benefits of using human-centred design

Organisation	System developers	Customers
• Reduce the risk of errors • Improve system safety • Increase efficiency • Improve return on investment • Enhance workforce productivity and satisfaction • Reduce training costs • Improve customer loyalty	• Identify and address usability issues through redesign • Reduce the risk of late and costly fixes • Improve user acceptance • Reduce costs and time for fixing issues after implementation	• Experience greater customer satisfaction • Complete activities more efficiently • Perform activities more safely • Spend less time and effort learning to use the system • Experience less frustration • Be more loyal

Source: Josias (2017).

Additionally, using a human-centred design approach has been identified to create a significant return on investment, both during design and implementation as well as after implementation (Josias 2017). Developing complete or near-complete solutions during design and implementation can result in reduced risk of time and cost overruns, reduced cost of addressing late fixes and improvement in user acceptance rates. After implementation, there can be an increase in the revenue generated by the improved system, reduction of costs by improving efficiency, and increased volume of repeat customers.

Central to human-centred design in the transportation context is the concept of mobility management. Mobility management is an approach to the design and delivery of transportation services that starts and ends with the customer (Josias 2017). Ideally, the entire transportation network would work together and deliver the transport options that best meet the community's needs, where mobility creates more choices.

Implications for using human factor data in designing and delivering transport services include customer/rider implications and system/service implications, see Table 2.4 (Josias 2017).

Table 2.4: Implications for using human factor data

Customer/rider implications	System/service implications
• Enhanced engagement of customers • Improved rider satisfaction • Increased ridership and use of mobility options	• Improved alignment between mobility services and rider conditions – Reduced inefficiencies in services that are incompatible – Better use of scarce resources – Improved perception by the public due to improved efficiencies of service delivery • Enhanced rationale for creating a network with increased service options to fill gaps • Diverse mobility service providers may join networks

Source: Josias (2017).

3 PERFORMANCE-BASED CONCEPTS

Ahman and Gulliksen (2014) suggested that there are several different approaches when designing for accessibility, but after much development on each concept over many years it has now become challenging to distinguish concepts, strategies and approaches from one another, as much of them have merged a combination of their aims, principles and strategies.

Terms are now sometimes used interchangeably, such as universal design and inclusive design (Ahman & Gulliksen 2014; IHCD n.d.; Queensland Government 2013). An example from Ahman and Gulliksen (2014), in a note from a European Union (EU) Minister in 2009 saw the concept terms 'integral accessibility', 'accessible design', 'design for all', 'inclusive design', 'barrier free design' and 'transgenerational design' as converging terms and is canopied under the concept term 'universal access'. Therefore, the performance-based concepts outlined in this section that contain concepts considered as converging have been canopied under alike concepts where relevant. The concepts discussed and real-life examples of application provided here are all human-centred design:

- Cooperative Design (Ahman & Gulliksen 2014), Section 3.1.
- Living Laboratories (Van Geenhuizen 2018), Section 3.2.
- Usability of Design (Bevan 2009), Section 3.3.
- Universal Design (Ahman & Gulliksen 2014), Section 3.4.

3.1 COOPERATIVE DESIGN

Cooperative design, also known as 'participatory design' or 'co-design', is often a part of design research and/or product development (Smith et al. 2017). Ahman and Gulliksen (2014) suggest that this strategy is particularly useful when it comes to users with special requirements as it entails full cooperation between development teams and the intended users throughout the development life. While standards specify the minimum defensible values of design components, cooperative design ensures the assembly of components results in a functional and dignified product.

The community of people living with disability is not homogenous, as people experiencing the same disability do not experience that disability at the same levels as each other. For people who have the most extreme levels of a disability, it does not mean that they experience the most difficulty or disadvantage. How people with the same or different levels of a disability choose to or can handle their disability determines the extent and nature of their disadvantages. This is why it is important to involve people with varying experiences, circumstances and abilities. The greatest number of perspectives one can attain, the more valuable information there is to educate planners, developers and engineers about suitability and social acceptance of designs.

This approach is meant for developers and intended users to share knowledge and experiences, ultimately providing developers with new insights into the development of processes (Ahman & Gulliksen 2014; Steen et al. 2011). With user involvement, accessibility issues are thought to automatically be included and addressed (Ahman & Gulliksen 2014). Many of the performance-based concepts encourage user involvement already, but cooperative design pushes for users to be completely involved in planning and designing.

For those involved in the cooperative design process, they can commonly experience consultation fatigue (disengagement). It is necessary to maintain their interest in the consultation; there is also the need to sometimes re-engage people and keep them in a database long term as contacts for future endeavours. Reasons why people may disengage include (Butteris 2012):

- failure to deliver on projects that have been consulted on previously
- failure to explain why projects could not be delivered
- failure to acknowledge previous contributions

- failure to report back a summary of the consultation outcomes
- failure to report back on the impact of the consultation process
- too many emails in general or too many about irrelevant subjects.

Ways in which to reduce fatigue include (Butteris 2012):

- acknowledge particularly thoughtful contributions
- follow up personally with valuable contributors to have a deeper conversation about their views and suggestions
- share thoughtful contributions via social media
- share thoughtful contributions at face-to-face events (using panels, slideshows etc.)
- let contributors know when the consultation process hits major milestones
- invite contributors to participate in deeper decision-making processes
- distribute a summary email of recent consultation activity.

Options to re-engage participants include (Butteris 2012):

- consulting on interesting subjects that are easy to understand, have concrete impacts and some emotional content
- asking interesting and engaging questions
- providing a good reason to come back. How will the consultation affect the outcomes? How will the issue under discussion directly affect them?
- providing incentives including prizes or preferred access to processes (e.g. by invitation to Council meetings)
- personally, inviting people who have participated in the past to join discussions about new issues
- honouring the commitment required to participate in the consultation process by closing the loop.

Effort that can be made to keep people coming back for future endeavours includes (Butteris 2012):

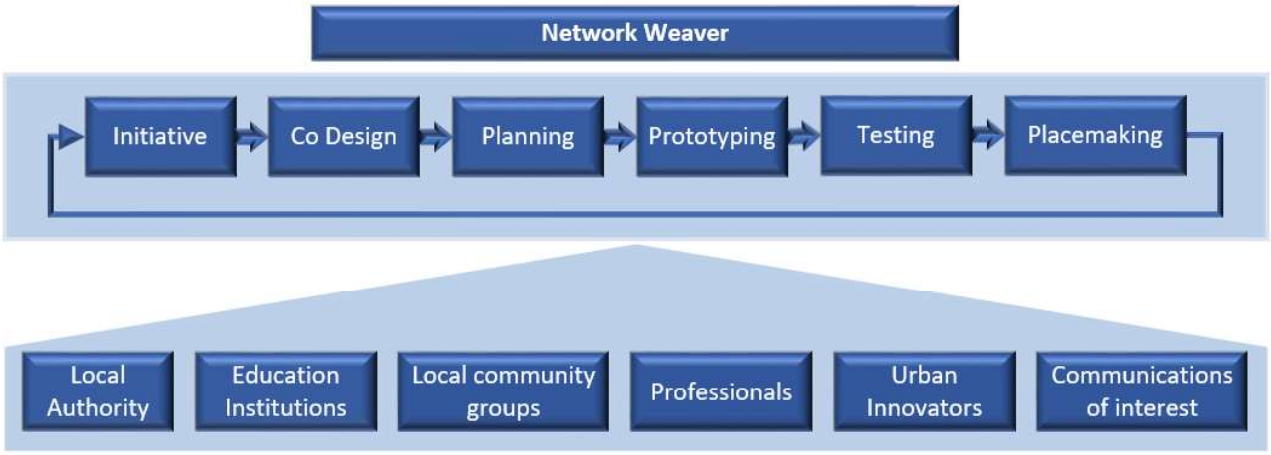
- keeping emailed information to a minimum
- keeping emailed information highly relevant to the individual (potentially by asking them to nominate subjects of interest in the registration form)
- keeping emailed information local by targeting information to people from specific suburbs that are more likely to be interested in projects
- always closing the loop.

3.1.1 INFRASTRUCTURE AND COMMUNITY CASE STUDY

Webb et al. (2018) wrote about the School of Architecture at the University of Limerick's collaboration with local government officials and local community participants in co-designing neighbourhoods, villages, and cities in Ireland. Since 2010 this initiative has been known as the Adaptive Governance Lab (AGL). The outcomes of these co-designing projects were expected to be improvements in liveability for the participants' respective areas through collaborative designing and adaption of solutions. The approach is considered adaptive, via the integration of a process that aligns local creativity and experimentation with government process, under iterative feedback loops.

These projects were developed using the AGL overarching framework (see Figure 3.1). Community engagement/consultation sessions were held four to six times a year, each session being three to five days long (Webb et al. 2018). Early consultations were organised to explore opinions and positions of community members who were likely to be affected by rulings made concerning the built environment, transport and local resources (Webb et al. 2018). Consultations allowed a platform for open community critiques and changes in design to be discussed with community inputs.

Figure 3.1 AGL designing with communities' framework



Source: Webb et al. (2018).

Many governing bodies involved in the AGL adopted innovative perspectives and started collecting data to solve complex urban problems and justify decisions. Within the planning process, there was a rise in interest and trust between residents and planners, who recognised the value of the platform (Webb et al. 2018). Co-creating sessions also saw an increase in interest, which is where brainstorming of prototypes of what could exist for future development is undertaken (Webb et al. 2018).

Yet, in some instances, there were issues encountered where authorities became increasingly concerned that project works would become temporarily stagnant due to fears that a consensus between community and planners would not be obtained under the platform (Webb et al. 2018). Another risk recognised was that the co-design process could lead to poor quality as a result of design decisions being made through majority consensus (Webb et al. 2018). Webb et al. (2018) reported that sound design leadership was required to mitigate against these risks.

3.1.2 BENEFITS OF COOPERATIVE DESIGN

Steen et al. (2011) evaluated cooperative design from several other works and determined that this approach can see benefits of:

- higher quality system requirements
- higher system quality
- a better fit between the system and user needs
- improved user satisfaction
- development of differential new services
- services of better value and/or reduced costs
- reduced development time
- mutual learning and understanding about users
- enhancing communication and cooperation skills among development team members.

Overall, the belief is that users do generate ideas and share information or experiences that are useful inputs, sometimes generating extremely innovative outcomes that better match user needs and are socially accepted. Steen et al. (2011) also mention professional developers' ideas are generally more technologically feasible as they have a greater understanding of regulations and design quality. Documents from Civica International (n.d.) support these potential benefits.

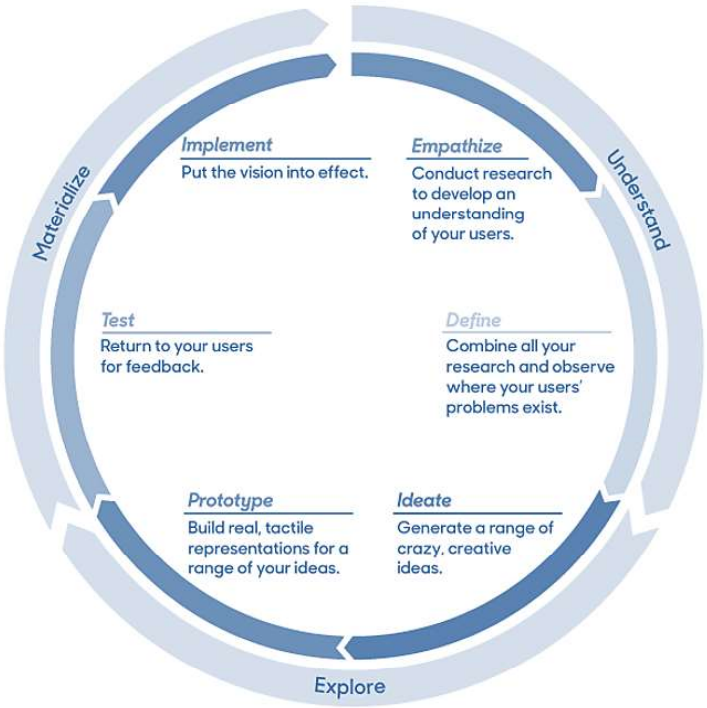
However, it is noted in the case study provided, there are disadvantages to involving users. The first was the risk of interruption to project life and the second was poor quality, likely the result of the development team

choosing the desire to please the public and intended users and overlooking the quality of products and that good leadership is required to avoid this.

3.2 LIVING LABORATORIES

The Living Laboratories (Living Labs) is a relatively new concept, gaining ongoing popularity since 2005 (Lucassen et al. 2014). The main idea of the Living Labs concept is that the user of the product acts as the guarantor for successful development and innovation of the end product through real-life rather than lab-like environments, which should theoretically produce a close to near-perfect product. 'Perfect' means that the product meets the users' actual needs (Thiesan et al. 2009). The greatest challenges in using Living Labs is the ability to identify useful information to support real-life innovation as it requires those involved to have an open and supportive mindset (Niitamo et al. 2012; Van Geenhuizen 2018). An example framework for the use of Living Labs is shown in Figure 3.2.

Figure 3.2 Living Labs framework



Source: Kostuch (2019).

The interaction design approach is a term used interchangeably with Living Labs. It is defined as being concerned with the structure and behaviours of interactive systems, which has evolved to include interaction between people and their environment (Queensland Government 2018). Living Labs does not mandate direct input from the intended user, it only suggests that some form of real-life research (often behaviour/interaction observation) is included in the pre-development stage.

An article by Van Geenhuizen (2018) claims that using Living Labs as a methodology to enhance user-centric innovation, has great potential in bringing inventions to the marketplace, but the performance of this methodology requires further evaluation to be of greater benefit. Van Geenhuizen (2018) created a novel framework for the evaluation of Living Labs which is as follows:

1. a system approach providing an analytical view on living labs' performance and results
2. a focus on actor-complexity and boundary-spanning needs
3. a set of questions concerning, e.g. absorption of user-feedback, satisfaction among actors, and openness and connecting with larger networks
4. a list of key performance factors

5. a focus on participatory evaluation.

Co-created Living Labs is the intended learning process and contains joint problem defining and problem-solving through iterative experimentation and improvisation between the user and development team. Co-created Living Labs bears much resemblance to cooperative design. The user values (e.g. medical, socio-cognitive and socio-economic) are central while interacting and co-constructing, in many cases, creators are trying to test improvements, design for future scenarios, act in focus groups or observe user behaviour. This human-centric design approach can support boundary spanning to create a common language, trust, common ground and interests and community between those involved whether they be the users or organisations (Van Geenhuizen 2018).

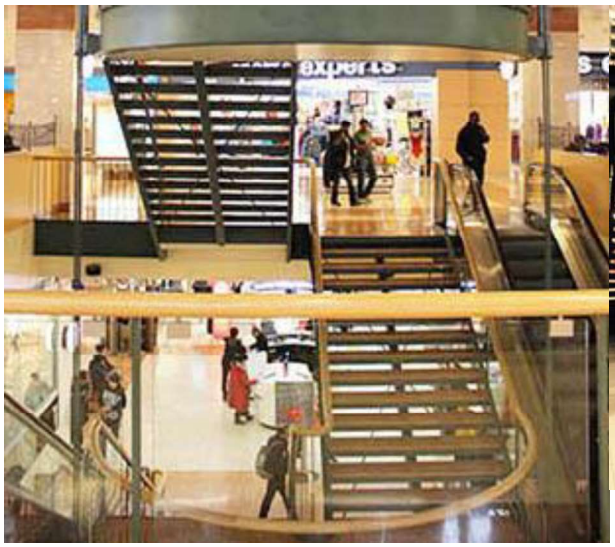
3.2.1 PEOPLE-ORIENTATED CASE STUDY

Living Labs conducted a people-orientated case study that discusses a long-term case at an Amsterdam elderly home in the Netherlands. The venture aimed to provide a combination of information communication and technology support services and systems to boost user independence (Van Geenhuizen 2018). The co-creation approach used a mix of user interviews on tested applications, acting in focus groups and doing collaborative experiments of specific applications. There was also an observational approach to the users' daily life activities. Issues that arose were keeping users involved and gaining trust from them to allow for boundary spanning, such as privacy (Van Geenhuizen 2018). The outcomes of this Living Lab saw the users have an increase in acceptance of information communication and technology tools for assisted living and for the development team they adopted a better understanding of the desires and ideals of the users. Business partners were not engaged in the process, but educational institutions were strongly involved in the learning process (Van Geenhuizen 2018).

3.2.2 ORGANISATIONAL-ORIENTATED CASE STUDY

A Living Lab case that was organisation orientated was the reconstruction of a shopping centre in Montreal, Canada. The aim was to implement better wayfinding and navigation technology for wheelchair users under the refurbishment of the shopping centre. Those who chose to be involved resumed their life and social integration experiences while shopping. The first phase of this was identifying obstacles and facilitators of participation for people with disabilities. Next was the performance of technology and interventions, then the evaluation of impacts and factors on these (Van Geenhuizen 2018). Two main user groups were involved, one being the people with disabilities and the other being the rehabilitation service provider, some commercial partners were involved in the pilot stage and broader network activities (e.g. business-related). One of the key outcomes from the refurbishment was the change from a central staircase (Figure 3.3) to a new panoramic elevator (Figure 3.4).

Figure 3.3 Before refurbishment. West end central staircase



Source: Arbour (n.d.).

Figure 3.4 After refurbishment. Panoramic lift at west end that fits three wheelchairs

Source: Arbour (n.d.).

The main user groups adopted different roles in mutual learning in joint experiments, focus groups etc. The inclusion of commercial partners enhanced commitment and partnership among core actors (Van Geenhuizen 2018). Inputs related to boundary spanning were multi-disciplinary and multi-sector approaches such as construction technology and transport behaviour (Van Geenhuizen 2018). Overall, the outcomes were co-created innovations that improved understanding of the multi-disciplinary and multi-sector aspects. Two years following the refurbishment completion, satisfaction measuring among participating actors and their perceived importance of the outcomes and their involvement were compared to anticipated results. This final evaluation supported the process of Living Lab activities (Van Geenhuizen 2018). There has also been an increase in the number of people with disability that are visiting the establishment (Arbour 2020).

3.2.3 MULTI-ACTIVITY ORIENTATED CASE STUDY

The Manchester Ferranti building at the University of Manchester in the United Kingdom was undergoing refurbishment. For this work, participants were involved in planning the refurbishment activities. The project was expected to provide a systematic framework where staff and students could engage with estate staff and their environmental consultants, creating a multi-activity Living Lab framework (Van Geenhuizen 2018). In terms of scope, boundary-spanning for the project focused on maintaining subject focus, research requirements, legal requirements and deadlines of specific programmes. During the process, a successful result involved students' belief that the experience added valuable learning and networking experience for their future (Van Geenhuizen 2018). However, a limitation found was that this type of university Living Lab is not easily transferable or re-creatable to other settings. Living Labs typically involve a more closed environment as the campus involved often had independent facilities which required the development of real-time solutions such as energy suitability, transport, food and production (Evans et al. 2015). A benefit of Living Labs is that they offer the opportunity for co-creators (students and staff) to learn in a realistic daily life setting (Evans et al. 2015).

3.2.4 BENEFITS OF LIVING LABORATORIES

Living Labs can be used across a wide range of contexts. Used effectively, this approach has the potential to educate the development team members and benefit users by creating or co-creating based on the users' real-life experiences. Co-creating has made users more comfortable using the product/system and promoted openness, inclusion, innovation and collaboration in creating solutions for people.

Decisions made are not based on assumptions but reflections of real-life and therefore any issues are deemed to be automatically addressed. This is likely to be effective if a co-creation Living Labs approach is

used and less effective without the input of intended users. It is assumed that co-creation Living Labs would have the same risk of design delays and poor quality as those occurring in cooperative design.

It is difficult to determine whether this concept could be applied effectively in a transportation context. Civil infrastructure design often cannot be tested as costs for prototypes or use of environment imitating technology (e.g. virtual reality) would be expensive (Vanfossen 2019). Searching for existing infrastructure that is similar to the proposed development for user testing purposes would be time-consuming and result in additional costs. The approach surrounding the organisational orientated case study of refurbishing existing civil infrastructure would likely be the most appropriate, where life experiences collected from the target audience and target audience support workers would be the main source of real-life innovation. This approach proved successful in a civil infrastructure access context and had a measure of social acceptance.

3.3 USABILITY OF DESIGN

The term 'usability' here refers to the ease of access and use of a product or design. This is different to the term 'user-friendly', which focuses solely on the ease of use of a product (Bevan et al. 1991). Overall, usability is the extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency and satisfaction (Horold et al. 2014). It is sometimes termed as 'user experience design' (Queensland Government 2018).

A design that is considered useable will meet the following criteria (Soegaard 2019):

- It should be easy for users to become acquainted with and competent in using the design at first contact.
- The goal of the design should be easy to achieve by users.
- Users should be able to easily recall the design on future visits.

These criteria serve as the minimum requirements and designers should try to produce designs that are above minimal standards (Soegaard 2019). For example, a small flight of stairs that only requires handrails to comply with minimal design safety regulations and does serve its purpose could be improved with high-friction stair tread to lower the risk of users slipping. A design that is not considered to be useable can more easily be determined with user input, by assessing user requirements from the product and the environment provided to use the product (Soegaard 2019).

It is recommended that users provide feedback on the user experience for design (or similar design where appropriate) based on the look, feel and usability. However, it is key that designers also understand the common core areas of the overall user experience too, such as those listed in Table 3.1 (Soegaard 2019).

Table 3.1: User experience factors and examples in a civil infrastructure design context

Criteria	Example
The information provided (if required) for users to easily use a service or tool	Perhaps a site offers the choice of a long ramp incline through a park and there is also a lift intended to help those who are likely to struggle up a long ramp. However, the ramp is clearly noticeable as the human traffic is generally heading to the ramp to use it and the lift is around a corner and has no indication of its location. Users who are unaware that a lift is available, and no information is provided that a lift is available nearby, may attempt to use the ramp and experience hardship in doing so if they have physical limitations or issues.
Physical design (appearance)	In the case where a small set of stairs and ramp alternative are provided at a park, there is well-maintained grass surrounding the stairs, but the ramp is surrounded by unmaintained vegetation. The user may have an unpleasant experience if the ramp path is covered with overlapping vegetation. This can not only make it difficult to move through but also unpleasant to the eye, adding to the negative experience.
Accessibility	Say there is only a set of toilets on the second floor of a long slender rectangular shopping centre and the only way users can access those toilets is to use a set of lifts located at one of the far ends of the shopping centre. This provides difficult access for people of all ages and mobility as human traffic would likely create a bottle-neck effect.
Credibility	People with sensory impairments may have a preconceived notion that an organisation, industry or type of facility has a poor reputation for consistency and reliability of use. This preconception can act as a deterrent for those living with sensory impairments. For instance, a person suffering from a back injury has a choice between attending two local chiropractors. The first is located in a medical centre and the other is located in a private commercial building. This patient chooses

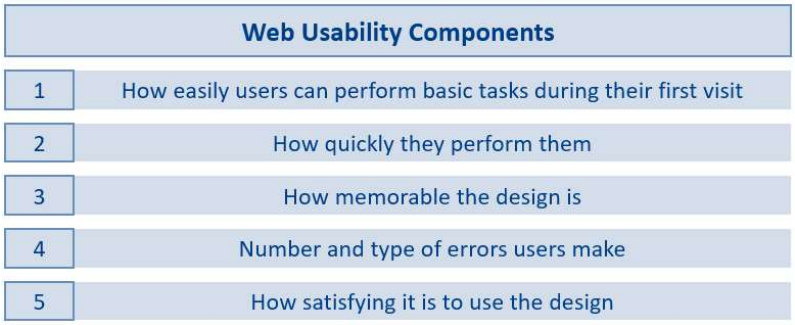
Criteria	Example
	the medical centre with the preconceived notion that due to his injuries the medical centre is better equipped to have facilities to support him reaching the chiropractor office.

Source: Soegaard (2019).

The key factor is accessibility, as the design or service cannot be utilised if it is not accessible by those whom it is intended for regardless of its degree of user-friendliness. This usability approach is commonly used in the development of Information Communications and Technology (ICT) services for persons living with sensory and mobility impairment, see Figure 3.5 (Soegaard 2019; Stanley 2018).

The fundamental principles acknowledged here are transferable in some aspects of design for universal access infrastructure, as exemplified in Table 3.1. It is suggested that beyond this, appointed accessibility auditors can be used as another assurance measure (Stanley 2018).

Figure 3.5 Components of website usability



Source: Based on WebAlive (2016).

This is typically a reiterative process where user requirements are set as the highest priority. There is a great deal of focus on overall user experience in comparison to other approaches mentioned earlier which are more focused on creating a user-friendly product. However, the application of this method in an ICT design environment usually allows for usability testing.

Evaluating the ease of access and user experience with a product or service can be conducted by testing it with intended users to identify usability issues, constructive criticism and levels of satisfaction with the product against its intended purpose (Queensland Government 2018).

3.3.1 USABILITY DESIGN CASE STUDY

Usability has been a common practice in the development of digital technology since 2000 and the benefits have been recognised during this period of technological advancement (Karreman et al. 2007).

In 2002 the Tec-Ed conducted their own evaluation performed by usability experts of two projects that were completed by the same team who implemented a usability design approach and documented their findings and experiences during the project life. The evaluation was to assess the overall user experience with the products and identify any critical issues before the company finalised the projects (Keirnan et al. 2002).

The first case was from 2001 which was an evaluation of the usability of a beta web application to aid in creating a user guide for a client. The application was intended to assist financial advisors and assistants to buy, sell, trade, and manage mutual fund accounts for their clients, also it monitored the advisor performance (Keirnan et al. 2002).

The usability experts performed several tasks that users would expect to do. The general questions for performance evaluation allowed for the identification of usability flaws that were not critical (see Table 3.2). Designers used the findings to improve the web application that had a high user satisfaction and successfully put together a user manual which was achieved more quickly than expected due to the improvements (Keirnan 2002).

Table 3.2: Questions and findings for design usability evaluation for Case 1

Usability evaluation questions
How easy is the interface to use?
How organised is the interface?
Are supportive navigational aids effective?
Is language direct and simple?
Are there any unnecessary on-screen elements encountered?
How well does the interface assist in avoiding problems?
Are there any unnecessary on-screen elements encountered?
Findings
Certain tasks required more than the necessary numbers of steps or clicks. This made the application slow to use.
The trading services menu included items for both trading and non-trading tasks, making it confusing to learn to use. Thereafter, it continued to be awkward to use.
Within an application, a user could not easily tell where they were.
Comparing funds was not easy as generated reports were missing important labels.
Instructions were given inconsistently and sometimes were non-existent.

Source: Keirnan (2002).

The second case was from an internal project in 2000 which saw the same team tasked with creating a custom database application to monitor time and expenses on client projects and internal projects. The application was supposed to allow users to import budget and time data which would allow managers to customise reports (Keirnan 2002).

The application was intended to be a standalone application to have users only use the application's embedded instructions and not having to refer to the user guide. Evaluation questions were set up for the testing to identify certain criteria. In this case, the questions were surrounding when would users refer to the manual for help? What did they find difficult? Or when would embedded instructions be ignored or overlooked? The evaluation was conducted by multiple user groups in sessions where they were instructed to complete set tasks. Their feedback allowed the evaluators (also developers) (Keirnan 2002):

- to concentrate on areas where user problems were expected
- target behaviour of specific user groups
- collect meaningful data about aspects of product use
- recommend product changes based on data, not opinion
- confirm or challenge the usability assumptions of product developers.

3.3.2 BENEFITS OF USABILITY OF DESIGN

The United States Department of Health & Human Services (2017) expressed that the greatest benefits of the usability design approach in an Information Communication and Technology (ICT) application is that designers can learn if users can use the product successfully and identify the length of time required for a user to complete their required tasks (civil equivalent being, for example, time to cross a road). This was seen in the case study as the collection of meaningful data. There is also the benefit of measuring the satisfaction levels and analysing user performance of the entire experience (US Department of Health & Human Services 2017) as witnessed in the case study.

Usability is known to address certain user groups (e.g. persons with disability) and document where the user experience is problematic or unenjoyable. Effective product changes can be recommended to challenge usability development team assumptions. This is already a strategy in the creation of human-computer interaction interfaces and systems for people with disabilities (Karreman et al. 2007) as a solution to greater societal dependence on technology that has seen people with disabilities become disadvantaged (Huang 2003).

In addition to these benefits, it was revealed from the reviewed case studies that there were improvements in efficiency in the overall process and quality in execution. It was also noted that this approach was not only a technical path of product development but a complementary skill-enhancing professional development.

Testing usability has been performed for new travel technologies. Technologies similar to the Queensland Go-Card used for fare payments have already adopted usability testing as well as journey planning technology (Inglesant & Sasse 2007). Inglesant and Sasse (2007) claim that usability should not be seen as an upgrade to products or systems but should be seen as a part of the policy, and that policy objectives can fail if they are based on rationalist assumptions.

Usability of design is not a well-established approach in the design and construction of civil infrastructure and there is scarce literature to evaluate the effectiveness of this approach in a civil infrastructure design context. However, the application of this in a civil design context would likely see the benefits in the expanded scope of looking at the user experience as the main priority which is inclusive of the user-friendliness of the design and compliance of design standards.

3.4 UNIVERSAL DESIGN

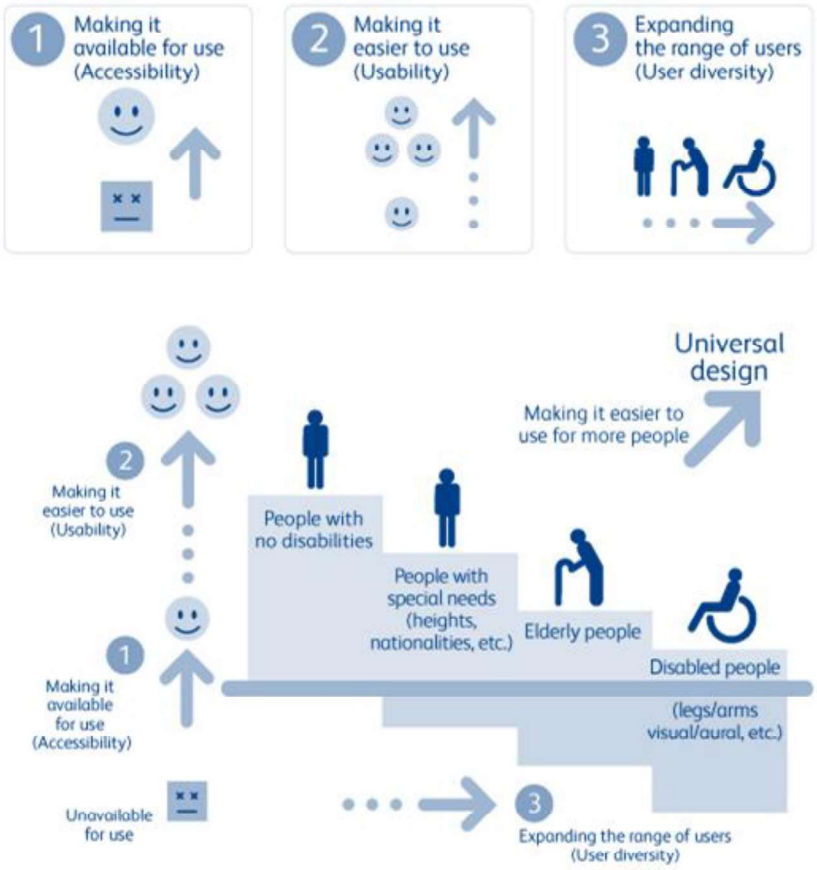
Universal design refers to the design of products and environments that are usable to the greatest extent possible by everyone, regardless of their age, ability or status in life, without the need for adaptation or specialised design (Agarwal & Steele 2016; Hallgrimsson 2019). Universal design is considered a proactive approach for design professionals as it regards end-users as comprising of a range of abilities, rather than focusing on accommodating people with disability individually (Hallgrimsson 2019). Universal design seeks to enable people with disability to live independently and participate fully in all aspects of life (Babinard et al. 2012).

As discussed earlier, the term ‘universal design’ is often used interchangeably with the term ‘design for all’, both of which aim at designing for the entire customer base and having a product that is usable by the greatest amount of people (Ahman & Gulliksen 2014). This is similar to the term ‘inclusive design’ as it bears similarities to universal design and design for all, but it includes the concept of ‘reasonable’ in the definition. In this context, reasonable means that the design is optimal with the resources available. This means that designers may not have to develop a severely segregated or excessive number of solutions as this would be unsustainable in some cases as it would require an extensive amount of resources. A system that is flexible and/or adaptable is encouraged instead (PWC Australia 2019). This also means that some people will be excluded from some services, products and participation in some circumstances, but the overall aim is to minimise the number of those who are excluded and benefit the majority (PWC Australia 2019).

Hallgrimsson (2019) states that by training architects, engineers, and industrial designers to incorporate universal design principles into their work, the long-term effects and expectations of people with disability can be addressed without much oversight and advocacy. Universal design also represents a ‘design with’ rather than ‘design for’ mentality that proposes people with disability participate in part of the planning and design stages of new projects (Hallgrimsson 2019).

Universal design is considered as a key concept in addressing exclusion from infrastructure and requires an engineering approach, developing a comprehensive understanding of the challenges to be addressed, establishing clear objectives and taking a systematic approach to address these objectives (Agarwal & Steele 2016). Morsey (2015) suggests that to make cities more liveable for people with disability strategies such as those depicted in Figure 3.6 are needed.

Figure 3.6 Mechanics of universal design for equal access cities



Source: Morsey (2015).

A commitment to universal access at every level of project planning, design, implementation and operation, is required (Agarwal & Steele 2016). While legislation and guidelines have been developed to mandate accessibility standards, these have often been undermined by poor compliance enforcement (Agarwal & Steele 2016).

Seven principles of universal design as reported by the Institute for Human Centered Design (IHCD) are (IHCD n.d.):

1. Equitable use – Design does not disadvantage or stigmatise any group of users.
2. Flexibility in use – Design accommodates a wide range of individual preferences and abilities.
3. Simple, intuitive to use – Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills or current concentration level.
4. Perceptible information – Design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
5. Tolerance for error – Design minimises hazards and the adverse consequences of accidental or unintended actions.
6. Low physical effort – Design can be used efficiently and comfortably and with minimum fatigue.
7. Size and space for approach and use – Appropriate size and space is provided for approach, reach, manipulation and use regardless of the user's body size, posture or mobility.

This concept is recognised as an approach to identify and eliminate barriers to accessibility and ensure that people with disability have equal access in a transportation context (Babinard et al. 2012). In a public transport context, universal accessibility is the idea that people with different levels of mobility should be granted the same dignity, comfort, safety, speed and capacity when using public transport (Ajuria 2005). It was identified that accessibility needs to be a systematic concern in the planning and implementation of urban transport infrastructure.

The universal design approach is increasingly being adopted in bus and rail transit operations to address transport infrastructure barriers (Agarwal & Steele 2016). Innovations include the low-floor transit vehicle (adopted for buses, trams, heavy and light rail) to provide almost-level access from curbs and short-ramp access from street level (Agarwal & Steele 2016). Other examples of universal design include:

- portable lifts or manually folding ramps on all transit vehicles
- automated lifts and ramps to address platform-level issues
- raised pads at bus stops with ramp access, allowing for:
  - easier access for someone with mobility impairment to enter the bus
  - people with visual and cognitive impairments to find the stop
  - improved safety for all users waiting for the bus
- real-time information on waiting times, allowing planning of journeys
- smart cards for fare collection, gates and ticketing (facilitates access and reduces journey activities and time)
- visual and tactile warning systems at the edge of platforms
- railings and posts painted in bright, contrasting colours
- audible signs to help people with visual impairments find gates and identify buses.

3.4.1 UNIVERSAL DESIGN CASE STUDY

The Universal Design case study was conducted by a group of researchers from the Umea Institute of Design from 2006 to 2008 in Sweden (Bogren et al. 2009). The project's inception came about in light of the Swedish bill that stipulates that from 2010 all public spaces had to be accessible. The group was commissioned by the Swedish Railroad Administration which was struggling to meet the requirements of the bill. The project aimed to develop a prototype of a train information terminal that provided accessible information to the widest amount of people possible. The scope of the project stated that the output needed to meet the following requirements:

- have the ability to be mass-produced
- be maintainable
- be able to withstand wear and tear from frequent use.

The project was separated into four stages (Bogren et al. 2009):

1. Conduct contextual studies at locations where existing information systems already existed and were in use.
2. Begin the design phase using low-fidelity prototypes with some participatory elements.
3. Design and implement a fully functional prototype system.
4. Test and evaluate users in situ and in real-time to make improvements for final design based on feedback.

The Bogren et al. (2009) contextual study was performed by observing already existing information systems at train stations, airports, bus stations, and subways (Figure 3.7). The group also engaged in questioning travellers about their experience using the systems and documented the findings. The group's choice to engage with users in the beginning and throughout the project life was found to be of use in finding ways to bridge experimental gaps. The experience and information that users provided guided ideas, needs, requirements and opinions surrounding the design process. Participants consisted mostly of people with intellectual disabilities, mobility impairments, hearing impairments, short stature and people with motor controls and perception deficits.

Multiple interactive low fidelity prototypes were created which were then tested by participants in an iterative process that allowed the developers to make minor fixes/adjustments as necessary (Figure 3.8). User participation helped identify design implications, some of which challenged the design team's expectations and pre-understandings. An example of this was in the early prototypes of a large interactive horizontal

widescreen (100 cm) which is popular in Sweden. This layout caused users with perceptual challenges confusion and disorder, and for many participants with visual challenges they were unable to read over distances of 20 cm. An eventual prototype was created that was as close to the final product as possible so that users would not have to visualise certain features of the system (Figure 3.9). The final design with features that were requested by the users and was flexible for users to cater to their own needs. Overall, the project achieved success as the product was able to better cater to the needs of a larger variety of people with disability than the previous system that was in place at Swedish rail terminals (Bogren et al. 2009).

Figure 3.7 Existing information systems

Source: Bogren et al. (2009).

Figure 3.8 Intended users and design researchers discussing early prototypes

Source: Bogren et al. (2009).

Figure 3.9 Prototype in use (left and middle); finalised design proposed (right)

Source: Bogren et al. (2009).

3.4.2 ATTEMPTED UNIVERSAL DESIGN TRANSPORT CASE STUDY

Babinard et al. (2012) reviewed 12 projects that took place in China and Vietnam from 1998 to 2010 with a focus on the accessibility of urban transport for people with disabilities. All projects were large scale (USD 43m to USD 113m) and were focused around pedestrian mobility developments of road infrastructure, traffic management schemes, and improvements of public transport facilities This project was to assess issues surrounding accessibility for people with disabilities, and explore how these issues were being addressed by (Lundebye, Svensson, & Dotson 2011):

- reviewing World Bank project documents regarding how accessibility issues were addressed
- interviewing team Task Leaders from the World Bank
- assessing accessibility at each of the sites
- highlighting best practices used on sites
- making recommendations for the World Bank about how to address accessibility issues in future.

There were few benefits identified among the 12 projects, which was in large part related to the fact that none of the regions had guidelines, regulations or documents about the rights of humans with disabilities; whilst consultation with stakeholders were minimal (Lundebye, Svensson, & Dotson 2011). Babinard et al. (2012) identified that principles of universal design were unable to be applied in some situations due to the following factors:

- lack of knowledge amongst professionals about the existence of standards and their applicability
- lack of consistent implementation and enforcement of standards
- lack of input from the community and from consultation with people with disabilities about the barriers to transport they face and priorities for access features
- lack of awareness and coordination among government agencies to apply universal design principles to all elements of a travel chain, so that it was fully accessible
- a perception that making urban transport accessible will be costly.

Additionally, in applying universal design concepts for accessibility, key issues were identified in two stages (Babinard et al. 2012):

- Planning stage
  - accessibility for people with disabilities not the main focus of the project
  - A perception that by improving the pedestrian environment, accessibility would automatically improve (adequate attention to designing a fully accessible environment by explicitly discussing incorporating accessibility principles is often needed)
  - lack of a consistent level of attention to provisions for persons with disabilities.
- Implementation stage
  - inconsistent application of access guidelines
  - lack of resources for supervising contractors to implement accessibility features.

3.4.3 UNIVERSAL DESIGN IN TRANSPORT STRATEGIES

In the European Union (EU), the UNIACCESS project aims to achieve quality and equality of access to public transport by promoting and supporting the networking and coordination of research and innovation activities (between stakeholders) in the field of universal design of accessibility systems for public transport (Ajuria 2005). Ajuria (2005) identified that accessibility design is a multidisciplinary issue that demands a highly coordinated approach where:

- end-users validate new designs and communicate their needs and assessment of the situation
- designers and manufacturers find cost-effective and viable solutions
- operators ensure that what works in a laboratory setting also works in real-life

- authorities legislate and regulate.

The Victoria Transport Policy Institute (VTPI) (2019) discusses ways to design transportation systems to meet the widest possible range of needs, including those of people with disability. This is through universal design principles that address the needs of people with disability but also benefit all other users. VTPI (2019) stated that universal design should be comprehensive, resulting in seamless mobility options from origin to destination and should consider all possible obstacles that may exist in transportation terminals, sidewalks, paths, roads and vehicles. As people's mobility and accessibility are determined by the built environment, design standards and practices based on the average person fail to accommodate many potential users. A universal design approach assumes that the built environment should accommodate all users as much as feasible. Universal design planning includes the following (Victoria Transport Policy Institute 2019):

1. standards for pedestrian facilities, transit vehicles and other transportation services adopted by local, state or federal governments
2. programs to educate planners and designers on incorporating universal design into planning and transportation facility design
3. special projects and funding to reduce barriers and upgrade facilities to meet new accessibility standards
4. public transit vehicle and station design to accommodate wheelchair users, parents with strollers, hand carts, wheeled luggage and other baggage
5. Complete Streets policies: ensure that roads are designed to serve diverse users and uses including people with disabilities and other special needs
6. pedestrian road safety audits to identify potential problems and barriers, and opportunities for improving pedestrian safety
7. multi-modal level of service ratings: indicate the quality of convenience, comfort and security experienced by pedestrians, cyclists and transit users including universal design factors
8. parking facility design standards that dedicate spaces for vehicles used by people with disabilities (include extra-large spaces for vans with lifts)
9. development of multi-modal access guides: includes maps and other information on access by people with disabilities to a particular destination
    a. including the availability of transit and taxi services and quality of walking options
10. provide travel training, which helps people with disabilities learn to use public transportation services.

The AusAID's (2013) *Accessibility Design Guide* provides guidance on enabling people with disability to participate equally in social and economic life through the design and implementation of development initiatives. Costs of incorporating or not incorporating universal design principles were outlined (see Table 3.3).

Table 3.3: Costs of incorporating or not incorporating universal design principles

Costs of incorporating universal design	Costs of NOT incorporating universal design
Universal design not as costly when accessibility is addressed during planning and construction	Significant costs as inaccessible environments limit economic education, health, social and other opportunities for people with disabilities and make them more dependent on others
Costs for accommodating accessibility regulations are small in relation to the gross domestic product (0.01%)	Consider three components when working with universal design: • Direct costs for people with disability (including access to services) • Indirect costs to support people/family members of people with disability • Opportunity costs of foregone income for people with disability
Providing fully accessible facilities increases building costs by as little as 0.5% to 1% if planned, designed and implemented from the outset	
The cost of retrofitting for accessibility after building completion is great	

Quantity of extra physical space required is a misconception with many cases only requiring rearranging and planning within the existing space	Access to public and private transport is a key factor in breaking down barriers Providing access from home to roads, transport stops and between buildings is crucial to ensuring increased access to a wide range of services
	Additional costs from the retrofitting of existing infrastructure to ensure accessibility
	Potential legal costs stemming from discrimination claims

Source: AusAID (2013).

AusAID (2013) identifies that to succeed, universal design must start with planning and proceed through implementation, monitoring and evaluation and it was considered important that universal design was incorporated through:

- being participative, sensitive, and inclusive – consulting government, people with disability, non-government organisations, and stakeholders throughout the process
- being realistic – constructing an accessible environment was considered to be best achieved when approached incrementally, prioritising interventions and investments
- considering regulatory, structural, human behaviour and operational practices.

AusAID (2013) proposed guidelines for consideration when applying universal design principles in transport systems and infrastructure, these are:

1. Encourage appropriate access and integration so people can move between different forms of transport with ease and safety.
2. Build so infrastructure can withstand external environment elements to protect infrastructure and those who use it.
3. Enable efficient running of facilities to provide better service for users.
4. Build in a sustainable manner to ensure long-term use.
5. Build so the infrastructure is environmentally friendly for users by using appropriate materials, distinguishing between various uses, ensuring the safety of users and maintaining infrastructure.

An extension to number five is to consider common health concerns or sensitivities around chemicals and specific plants in landscaping.

Additionally, the following strategies were identified to make transport more inclusive (AusAID 2013):

1. learning from and working with people with disability organisations
2. working with municipalities and road authorities
3. mainstreaming mobility and access for the whole community, including people with disability during the early transport planning stage.

If effective measures can be taken to create a universally accessible environment that is socially accepted by the greatest number of people it will reduce the risk of discrimination claims and will reduce the burden of legal costs for parties associated with discrimination claims and higher costs of retrofitting access infrastructure compared to delivering accessible infrastructure embedded into the projects.

3.4.4 AGE INCLUSIVE STRATEGY (8 TO 80 CONCEPT)

One example of a universal design strategy is the 8 to 80 concept. It refines the scope so that the target users are based on age to demonstrate that universal design can be discussed in focus groups. The 8 to 80 'litmus test' involves imagining a public space and asking whether it is suitable for both young and old users. It involves determining how cities can be created in which both 8-year-olds and 80-year-olds can move about safely and enjoyably (Lorinc 2012).

Farrelly (2014) states that cities should accommodate changing generational needs and lifestyles, where communities need to be designed to be interdependent; providing environments that are adaptive over a

person's lifetime. This involves cities being inclusive, accommodating people with disabilities and those with limited mobility.

Gil Penalosa, the executive director of Toronto-based 8 80 cities, advises cities around the world on the importance of more accessible surface transit, improved cycling and pedestrian infrastructure and more programmable park space (Figure 3.10). 8 80 cities aim to enhance mobility and public space to create more vibrant, healthy and equitable communities. They believe that if everything done in cities is great for an 8-year-old and an 80-year-old, then it will be great for all people (8 80 cities n.d.).

However, from a universal access design perspective, people outside the age of 8 to 80 also exist in the community and should not be ignored. The focus of 8 to 80 is anticipated to be more about safe and independent mobility, with the expectation that people outside those ages have assisted mobility.

Figure 3.10 The 8 to 80 concept applied in Toronto, Canada. Location: Woodbine Ave to Woodmount Ave

Source: 8 80 cities (n.d.).

3.4.5 BENEFITS OF UNIVERSAL DESIGN

Universal design is a highly established way of thinking to approach design and planning for universal access with the intent to eliminate barriers in a transport context for people living with a disability. The Australian Government encourages the implementation of dignified universal design. The Australian government already sets out proposed guidelines for consideration when applying universal design principles in transport systems and infrastructure.

Like other concepts, it is strongly orientated around making an outcome that is user-friendly for as many people as reasonably possible. In addition, different strategies can be group targeted (e.g. age inclusive).

Implementation of this strategy by other authoritative bodies has already resulted in increased access, such as the Swedish Rail Administration's success in creating flexible information systems for travellers that cater to a larger group of people who experience a disability.

When engaging in universal design, it is highly recommended that developers engage with the intended users (e.g. through consultations, focus groups, etc.) however, this is not a mandatory element of universal design. Including people with disabilities in development, challenges designers' expectations and pre-understanding of the users' needs and capabilities. This then directly influences major design choices to ensure better levels of accessibility for those users. Developers that choose not to engage with intended users could find themselves making decisions based on poor levels of research and knowledge of requirements for whom they are designing and lead to directly or indirectly overlooking critical details or problem areas.

Universal design is primarily a mindset or framework; it is the idea that people involved in developments will continuously have the needs of all community members in mind so that overlooking details and problem areas are less likely. Overlooking critical details or problem areas can result in high costs typically stemming from the need to rectify design issues or incurring legal fees due to legal action taken against the designer.

Finally, this strategy can easily be benefitted by incorporating other already discussed strategies such as cooperative design, Living Labs and usability of design. The Swedish Rail Administration case study looked at having participants provide information about their experiences and test interactive prototypes which are both part of cooperative design methods. The latter also looked at evaluating usability and improving usability. The designers also looked at natural interactions with existing systems for inspiration and learning which is also a feature of the Living Labs approach. The adoption of any of the additional strategies would potentially provide their respective benefits.

3.5 COMPARISON OF PERFORMANCE-BASED CONCEPTS

The explored performance-based concepts follow the human-centred design approach and are all applicable in the development of services or products that assist or are suitable to use for people living with a disability.

However, not all of them are widely established in the context of design and construction of civil infrastructure. Notably, usability of design is predominantly used in the development of technology-related fields. Living Laboratory is a concept that is quite new and growing in popularity when creating new interactive technology. Cooperative design and universal design are already established as approaches to creating universal or user accepted designs. Cooperative design was found to be applicable in combination with the three already mentioned concepts, therefore increasing the potential number of benefits to each of these concepts.

From the research conducted the facets of each strategy were categorised to be either 'state of mind' or 'design step' strategies. Here 'state of mind' is defined as a way of thinking or an additional consideration through the design planning and construction; 'Design step' is the implementation of additional planning or design steps, usually used to gather information or feedback; they are both used to guide developer assessments and choices. The strategies have been broken down in Figure 3.11 and Figure 3.12 for the performance-based concepts.

Figure 3.11 State of mind strategies of the performance-based concepts

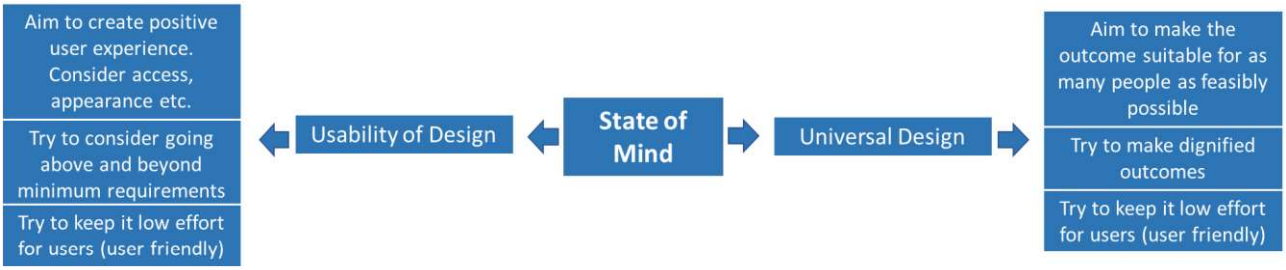
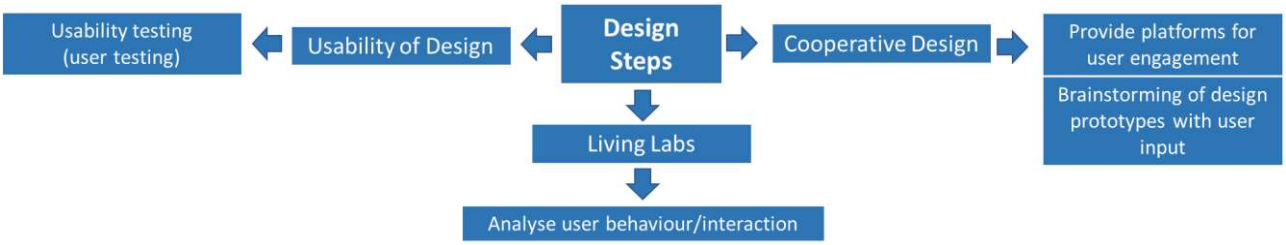


Figure 3.12 Design step strategies of the performance-based concepts



The application of these performance-based concepts in the appropriate circumstances has the potential to see the advantages and disadvantages listed in Table 3.4. There are common advantages and

disadvantages among the concepts and each of them can be applied to the design and planning of universal access under the right circumstances.

Under other circumstances, only some, or none, of the aspects of these concepts may be applicable. Cooperative design was seen in a majority of the performance-based case studies, and is therefore recommended but may not always be a possible option. For performance-based concepts, ARRB cannot conclusively declare that one of these concepts is superior to the others in a transportation context as the potential number of benefits and disadvantages are situationally dependent. Knowledge and value of these types of human-centred design concepts are not widely recognised for transport design of infrastructure and systems. Concepts should be chosen on a case-by-case basis to select the concept which provides the most advantages. Cooperative design and universal design provide the most adaptability and may be beneficial to all project types. However, further awareness surrounding the use and significance of universal access and approaches to universal access is recommended to select the best concept for projects.

Table 3.4: Identified advantages and disadvantages of explored performance-based concepts

Performance-based concept	Advantage	Disadvantages
Cooperative Design	• Decisions are based on the developer's expertise and user input • Challenges expectations and pre-understandings • Known to be applicable in civil infrastructure development • Reduced in costs of delivery • Builds stronger relationships between users and developers • Reduction of risk in failure • Raised quality product requirements • Higher system quality • Improved/higher intended user satisfaction • Promotion of innovative thinking • Reduction in development time • Improvement of team collaboration skills • Improvement of team understanding of intended users • Collection of informative data for future endeavours	• Potential for conflicts between users and developers • Project completion may be delayed • Lower product quality • Interest for users and planners rises and falls • Adds time to project
Living Laboratories	• Known to be applicable in civil infrastructure development • Can incorporate co-operative design methods • Co-operative methods are flexible (e.g. consultations, surveys), but is not limited to user participation. • Boundary spanning • Greater user acceptance of products and innovations • Improved team understanding of users' requirements and desires	• Decisions are based on developers' findings from the chosen method of research • Confidence in decisions are based on the level of research performed • Incorporation of co-operative design requires the developer to keep participants interested • Incorporation of co-operative design can have the same disadvantages as cooperative design • Trying to test designs physically through any prototypes or other similar existing designs (highly recommended) is costly and time-consuming

Performance-based concept	Advantage	Disadvantages
	• Possibility to include commercial and education partners (strengthening networks) • Incorporation of co-operative design can have the same advantages as co-operative design	
Usability of Design	• Focused on user experience as a whole, inclusive of accessibility, user needs, user-friendliness, appearance, information and credibility of developers • Designs that are above minimum standard are encouraged • Incorporates cooperative design methods in usability design testing. • Recognises the need for predictability of a product • Usability testing is known to be used to test transport technologies (e.g. journey planners) • Suggested by one source that appointed accessibility auditors to be used as an additional assurance measure • Encourages measuring of satisfaction levels and user performance of overall experience • Easier identification of problem areas • Recommended product changes based on the collection of meaningful data, not opinions. Confirming/challenging usability assumptions. • Usability testing linked to efficiency • Incorporation of co-operative design can have the same advantages as co-operative design	• Currently not recognised in a civil infrastructure design approach (recognised in ICT) • Unsure of level of effectiveness in the design of civil infrastructure • Usability testing requires testing of prototypes or designs physically, alternatively, developers could try to test through similar existing designs. Either option is likely to be costly and/or time-consuming. • Improvements usually based on practical usability testing
Universal Design	• Focused on creating products that can be used by the widest range of people feasibly possible (user-friendly) • Well established as an approach to designing civil infrastructure which eliminates barriers for people with disabilities • Recognised by the Australian Government • Incorporation of co-operative design methods is highly encouraged • Incorporation of co-operative design can have the same advantages as co-operative design • Encourages dignified designs	• Decisions are based on developers' findings from the chosen method of research or level of knowledge of the target audience • Incorporation of co-operative design can have the same disadvantages as cooperative design

Performance-based concept	Advantage	Disadvantages
	• Living Labs and usability of design can be incorporated into universal design. Therefore, adding to their respective potential benefits	

3.6 USER PARTICIPATION METHODS AND FINDINGS

Many resources on human-centric design encourage the intended users to be involved in one or a combination of planning, designing and testing phases of design development in a way to provide insightful information that can lead to products and solutions that meet the needs of the users (see Section 3). Fundamentally, this is a fair and representative form of decision making. However, some non-users were also used as knowledgeable resources. From the observation of cases and practices explored in this report, it was found that the participation of users can be classified into four categories: user, non-user, observational and no participation. The order of discussion in this section is reflective of what is believed to be the most effective to least effective methods applicable to the design of civil infrastructure.

3.6.1 USER PARTICIPATION

This is where the intended users participate in some part of the development. Developers co-operate with the intended users, who will likely play a role as a guarantor, informant or product tester. Developers are likely to depend on the feedback they are provided with from the intended user to continue development or for redevelopment. This form of participation was used in most case studies discussed in Section 3.

This method of participation would directly bring developers and intended users (people living with a disability and their carers) together to engage in some form of discussion or transfer of information or recommendations for development. This is thought to be the most effective since their needs and desires are best understood by the intended users themselves. Therefore, their contribution of knowledge is reliable and can be informative in the process of making decisions. Their handover of knowledge can be exchanged in a range of ways; one way could be through the process of surveys of life experiences, another could be an open platform for feedback on proposed ideas. The appropriate method of engaging the intended users should be chosen in a suitable manner. Overall, this is suggested to be a desired measure as almost all case studies were linked to cooperative design.

In some of the discussed cases, keeping intended users engaged proved challenging and conflicts of interest arose. This was seen to sometimes pressure developer teams' decisions that could consequently lead to drops in quality of outcomes. Leadership should be exercised to ensure that developers are balancing quality, constraints, cost-effectiveness, usability and relations between developers and users in the co-design of products.

Intended users engaged in the process should be from a variety of levels and types of impairments to provide a diverse range of insights and perspectives. As mentioned earlier, people who experience limitations in access come in a variety of forms such as hearing, seeing, mental, mobility impairment or natural bodily function deterioration and their needs and wants are different. However, disabilities come in numerous levels and limitations and it is best to choose the number and variety of representatives that appropriately capture their requirements. Furthermore, their direct involvement and feedback can provide a basis as to what is likely to be socially acceptable among people who are experiencing a disability.

3.6.2 NON-USER PARTICIPATION

Non-user participation means the person engaging in consultations is not the intended user (people with disabilities). The organisational orientated Living Laboratories case (Section 3.2.2) used this method as a measure to gain information surrounding the needs of the intended users. Information about obstacles was

sourced and participation of intended users was facilitated by consulting with a group of people that have an assumed level of understanding of the intended users' wants and needs (rehabilitation service providers). Generally, the non-user participant is someone who has a great deal of understanding or experience with intended users or is specialised in that area of development. Designers in some cases could also act as the user themselves and try creating the experience of persons with disability by respectfully imitating the intended users' ability to better identify potential weaknesses in their design.

This method of participation can be advantageous if non-users are extremely familiar with the needs and capabilities of people with a certain type of disability or even multiple types of disabilities. They act in the same way users do in the user-participation method. They are there to provide knowledge, information and recommendations on the needs and desires of intended users. The exchange of information can come in a range of ways. It is still recommended that multiple non-users be involved.

The advantage of this method is that if developers can access a group of non-users who have a high level of understanding of the needs and capabilities of a variety of levels and range of disabilities then the number of engagers can be less than gathering the number of actual users using the user participation method. Although, as non-users, they are unlikely to be experiencing disabilities and they have a second-hand understanding (e.g. assisting, observing etc.) which may not be as reliable as the first-hand experiences of actual users.

3.6.3 OBSERVATIONAL PARTICIPATION

Observational participation was described as part of the people-orientated Living Laboratories case study discussed earlier. The development team in this case used observational participation as part of their human-centric strategy to observe users in their environments, which their products would be used in. Based on this real-world research, the developer can make judgements, assumptions and define real-world solutions.

This method in its purest form would not see any direct communication between developers and intended users. As decisions related to design and planning would be based on observational assumptions, they are more likely to overlook the needs, wants and concerns of intended users. It is recommended that the use of this method should be in conjunction with user participation and/or non-user participation to see the greatest benefits.

Using this method may be difficult as it would require gathering a variety of people with disabilities to a space to observe them doing tasks, attempting to move around or navigate obstacles. This would require a private or public space and activities to be prepared which would be time consuming and expensive.

3.6.4 NO PARTICIPATION

This is a 'design for' approach rather than a 'design with' approach. This form of participation was described in Section 1.1 as a part of the traditional method of designing and incorporating universal access. Non-user participation means that the user does not engage in any part of planning, designing or testing nor do they provide any assistive information. This means designers do not consult with the intended users but use their best judgment to design and create. Designers will sometimes attempt to research the needs of intended users without directly cooperating or engaging with them.

This method is least likely to be effective as the level and focus of research that is done is up to the developers. The level of research may not be adequate and well-focussed. Attempting to do extensive research outside of guides and standards to understand users' needs may be highly time-consuming in comparison to direct engagement with users or non-users. Designing based on developer perceptions and assumptions could easily see developers overlook potential needs and desires of the intended users.

4 REASONABLE NON-COMPLIANCE

Planners, developers, designers and engineers should continually make the effort to create a process that is defensible and effective in producing environments and networks that are universally accessible. However, developing universally accessible environments that are suitable for independent use by every pedestrian regardless of their ability is challenging. It is difficult to be certain that an environment is suitable for every person, but designers should aim to cater for the needs of the greatest number of people as possible.

Typically, road design guidelines provide values of parameters that are appropriate for the design of roads in greenfield sites. In Austroads *Guide to Road Design: Design Considerations*, these are referred to as Normal Design Domain (NDD) values (Austroads 2016; Austroads 2019); the concept of design domains has been adopted by TMR. Much work on roads nowadays is concentrated on brownfield developments where a range of constraints exist, and NDD values cannot always be applied if an economical outcome is to be achieved (Austroads 2016; TMR 2013a). TMR has offered additional guidance over the last 17 years for designing in brownfield sites which have been progressively introduced into the *Road Planning and Design Manual*, for example (TMR 2005; TMR 2013a):

- additional material on design philosophy, including the concept of Design Domain
- introduction of the concept of Extended Design Domain (EDD) – EDD extends below the NDD value for a parameter where an increase in its value produces a higher benefit
- introduction of the concept of Design Exceptions (DE) – values that fall below the EDD because they are not likely to be supported on the grounds of reasonable design capability (e.g. cannot provide reasonable stopping capability).

In certain circumstances, time, cost, scope, legacy infrastructure or other considerations or constraints can 'force' non-optimal accessibility. Rightfully there can be a concern that an environment or facility can be universally accessible but would require using values of parameters that are non-compliant (existing outside of the NDD). The legal ramifications, if someone is injured from using designs that use EDD or DE, can be a deterrent or be used as a reason to not provide any additional facilities at all.

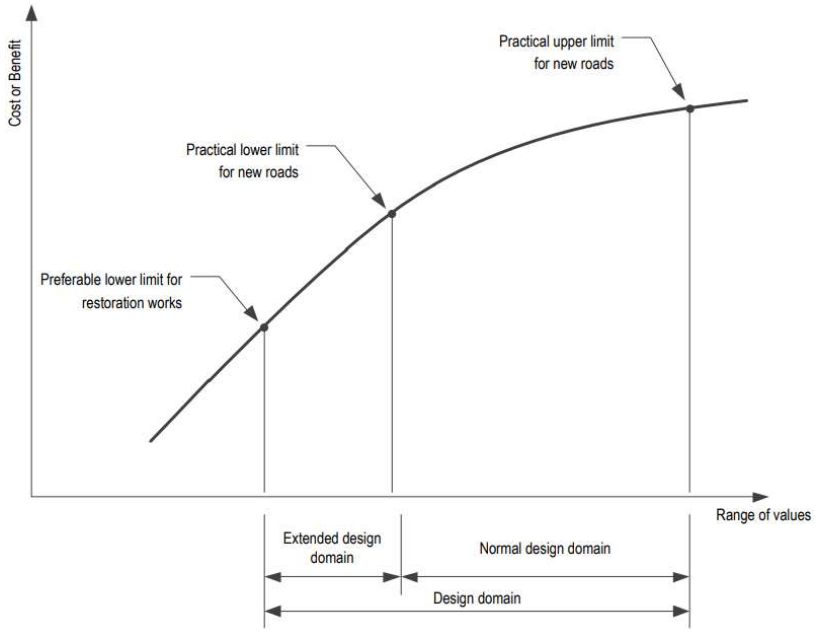
EDD and DE should be considered if a decrease in parameter value produces a higher benefit and only if the safety of pedestrians and other critical considerations are not compromised. These engineering decisions call for knowledge, experience, insight and a good appreciation of community values.

The relationship between design domains is illustrated in Figure 4.1; the design domain encompasses an NDD and an EDD. The lower sections of the design domain signify values that would generally be considered less safe or less efficient, but usually less expensive than those in the upper regions of the domain. The decision on the values to adopt should be made using objective data on the changes in cost, safety and levels of service caused by changes in the design, together with benefit-cost analysis.

Data is not always available, especially data that relates changes in the values associated with specific design elements and parameters to safety performance. Designers are then told to refer to relevant documents, including Austroads Guides and other research reports, to evaluate the potential effects of changes in values for the various design elements involved. The data chosen should also consider the importance of incorporating Safe System principles in the design (Austroads 2019).

According to Austroads (2019) values below the design domain cannot be justified on engineering grounds. Using such values constitutes a design exception and must be formally approved by the relevant road agency after due consideration and documentation of all constraints, criteria and risks.

Figure 4.1 Design Domain concept



Source: Austroads (2019).

5 TRAINING COURSES

Currently, accessibility benchmarks are set out in Australian Standard AS 1428. Under the guidance and regulations of this standard and other documents discussed in previous sections, designers are still producing or choosing designs that are not accessible, user-friendly nor socially accepted for people who live with or experience a disability or impairment. People with disability continue to experience difficulties accessing public facilities through the current transport network infrastructure. It is not to suggest that designers of the infrastructure are intentionally producing designs that are not functional or dignified for use by people with disabilities. The current levels of guidance, training and awareness of the importance of universal access may be unsatisfactory or be overlooked.

For guidance on universal access designers can refer to AS 1428, which consists of four sections:

- AS 1428.1-2009 *Design for access and mobility – General requirements for access – New building work*
- AS 1428.2-1992 *Design for access and mobility – Enhanced and additional requirements – Buildings and facilities*
- AS 1428.4.1:2009 *Design for access and mobility – Means to assist the orientation of people with vision impairment – Tactile ground surface indicators*
- AS 1428.5-2010 *Design for access and mobility – Communication for people who are deaf or hearing impaired*.

The majority of information that relates to universal accessibility in AS 1428 is focussed on the interior of buildings and exterior access to buildings, and not outdoor pedestrian transport networks. Designers with little experience could assume the requirements of the AS 1428.1 and AS 1428.2 as best practice when designing pedestrian network infrastructure, including outdoor pedestrian networks. There is some guidance on the topic 'people with disability' contained in the Austroads Guides to Road Design and Traffic Management, which is associated with elements of the outdoor pedestrian network infrastructure, but it is not emphasised. This lack of focus and obscurity of requirements for outdoor pedestrian movement and network requirements for those with disabilities likely contributes to the designer's conception of non-optimal, non-functional and undignified designs.

5.1 TMR TRAINING COURSE

TMR has expressed concern that designs are not always functional and dignified for people with disability and that this may not be recognised until the final product has been constructed. At the time of writing, TMR has provided only one course, the *RPD308 Pedestrian Crossing Facilities and Tactile Ground Surface Indicators Design* that provides working knowledge and development skills in the selection of pedestrian crossing facilities and facility design for pedestrians with vision/mobility impairment. However, attendance at the course in person was not possible. Course materials, provided by TMR were reviewed however, this may not provide all levels of knowledge transfer that may be achieved by attending in person.

Based on the training material received, the focus of this training package is primarily on roadway crossings and considerations that should be given for people with disability. TMR has advised that the purpose of the course is not to recite readily available information (legislation, standards etc.), it is to explain the rationale for them to designers so they understand why they exist and how to apply them.

At the end of the program, participants are expected to have the capacity to (TMR 2016):

1. integrate the fundamentals of AS 1428.4.1:2009, to provide equitable access to road infrastructure for vision/mobility impaired pedestrians
2. incorporate the TMR *Pedestrian Crossing Facilities Guidelines and Prioritisation System User Guide* when selecting pedestrian crossing treatments

3. select and apply appropriate kerb ramps and tactile ground surface indicators (TGSI) principles to pedestrian crossing facilities
4. demonstrate enhanced knowledge of the consequences of non-compliance with equitable access requirements
5. implement the Pedestrian Level of Service prioritisation points system.

A review of the course material was undertaken with consideration given to the following criteria:

- if they align with the latest standards, guidelines, and legislation
- if there is any guidance identified from this project's research that should be provided in this document
- if the language used is dignified and/or politically correct
- if recommendations from this project's research should be applied to course material.

The training course resources for RPD308 provided by TMR are outlined in Table 5.1.

Table 5.1: RPD308 course materials

Item	Document	Description
1	Course outline.pdf	This one-page document provides an overview of the course RPD308, which includes brief details about the: • target audience • prerequisites • business benefits • course duration • program outcomes program content
2	1_Accessible pedestrian facilities.ppt	Course content presentation part 1 *Document overview*: • target users • standards regarding accessibility for pedestrians at facilities • legislative obligations • TMR practices • consequences of non-compliance
3	2_Pedestrian crossing facilities Harmonised.ppt	Course content presentation part 2 *Document overview:* • road rules quiz • standards and guidelines • understand and use the facility selection tool • pedestrian crossing facilities do's and don'ts
4	Pedestrian Facilities Workshop	Course exercise
5	RPD308 Indicative Program.doc	Course itinerary
6	TGSI Walk Instructions Updated.pdf	Course exercise

The content of the course looks at specific standards, legislation, guidance and other documents. Content materials numbered 1 to 3 were evaluated as they contained the information presented to course participants. The course material was reviewed against the criteria discussed previously and the results are recorded in Table 5.2. The course provides guidance on who can experience access limitations and provides general guidance on how to consider people with disability when designing, which is universal access teaching. However, it is focused on pedestrian crossings only and not focused on universal access as a concept that applies to the design of all transport infrastructure.

Resources referred to in the course content include:

Standards:

- *AS 1428.1 (2009) – Design for Access and Mobility – New Building Work*
  - Grades for accessible walkways and ramps, and profile.

- *AS 1428.2-1992 (R2015) - Design for access and mobility - enhanced and additional requirements: buildings and facilities*
  - referred to for push-button on post-placement on a level surface
- *AS/NZS 1428.4.1 (2009) – Design for Access and Mobility – Tactile Ground Surface Indicators*
  - Various TGSI treatments for different sites.
- *AS 1742.10 – Manual of Uniform Traffic Control Devices – Part 10: Pedestrian control and protection*
  - Harmonised with TRUM.

Legislative:

- *Disability Discrimination Act* (DDA)
- *Disability Standards for Accessible Public Transport* (DSAPT)
- *Disability (Access to Premises – Buildings) Standards* (Premises Standards)
- *Anti-Discrimination Act*
- *Transport Operations (Road Use Management) Regulation* (TORUM).

Other:

- Queensland Manual of Uniform Traffic Control Devices (MUTCD)
- *Traffic and Roads Use Management (TRUM) Manual* –Volume1 Part 6 Section 3.4-1
- Standard drawings and interim drawings:
  - 1446 (10/09) – Kerb ramp and TGSI placement
  - 1447 (10/09) Median and island crossing – Ramped and cut through treatments for pedestrian facilities and TGSI placement
  - KRG1 and KRG2 (10/09) – Guidelines for the installation and application examples of TGSI on ramped kerb crossings.
- *Road Planning and Design Manual* (RPDM)
- TransLink Transit Authority – *Public Transport Infrastructure Manual*
- Guidelines for facilities for blind and vision-impaired pedestrians (under development)
- Austroads Crossing facility web tool.

Table 5.2: Investigation of course content items 1 to 3

	Criteria			
Document	**Aligns with the latest standards and legislation?**	**Guidance identified that should be provided in this document**	**Is the language used is dignified and/ or politically correct?**	**Recommendations from this project that should apply to course material**
Course outline.pdf	AS 1428.4.1:2009 is referred to as aiming to 'provide equitable access to road infrastructure for vision/mobility-impaired pedestrians. The Pedestrian Crossing Facilities Guidelines and Prioritisation System User Guide, no longer exists.	AS 1428.4.1 is claimed 'to provide equitable access to road infrastructure for vision/mobility impaired pedestrians'. Guidance should also be provided on facilities for pedestrians with mobility impairments, the elderly, people with prams etc. The course only provides guidance on the safe use and implementation of tactile indicators for those who may be blind or have vision impairments.	'vision/mobility impaired pedestrians' under 'program outcomes' is politically incorrect as it refers to the disability before the individuals. Action required: rephrase to 'pedestrians with vision/mobility impairments'.	The stated focus of this course is said to be on specific types ('vision/mobility') of disability, which excludes other forms of disability such as hearing impaired even though they are mentioned in other course materials. Action required: inclusive terms such as 'Universal access' or 'persons with disability' should be considered as an alternative to being inclusive of all user groups (including hearing impaired, elderly, etc.). Update referenced guideline to more current Guidelines (Pedestrian Crossing Facilities Guidelines and Prioritisation System User Guide)
1_Accessible pedestrian facilities.ppt **2_Pedestrian crossing facilities_ Harmonised.ppt**	The legislation listed here is relevant, with some exceptions. 1_Slide 20: AS 1428.4.1 states that discrete TGSIs should be greater than 45%, not 40% as slide claims. Reinforce requirements of the *Human Rights Act* 2019 (QLD). 1_Slide 16: The Traffic and Roads Use Management (TRUM) Manual –Volume1 Part 6 Section 3.4-1, was removed in 2017.	Guidance and brief mention to other documents should be provided. AS 1428.1 and AS 1428.4.1 are referred to frequently, but other relevant standards are not or are scarcely mentioned. Mention should be made to other AS 1428 documents as they provide wayfinding information (can be relevant for people with intellectual disabilities at crossings), parking facilities (crossing facilities exist here) and enhanced additional requirements. Lack of emphasis on creating universally accessible pedestrian crossing facilities as opposed to accessible for people with disability. Include recommendation of consultation with people with disability groups	Slide 16: 'blind and vision-impaired pedestrians' is politically incorrect as it refers to the disability before the individuals. Action required: rephrase to 'pedestrians with vision/mobility impairments'.	Compliance and minimal requirements are highly promoted. The presentation should provide awareness to the fact compliance does not mean dignified design. To some degree, it should encourage going beyond minimum requirements. Referenced Guideline need to be updated (*Traffic and Roads Use Management (TRUM) Manual – Volume1 Part 6 Section 3.4-1*). 1_*Guidelines for facilities for blind and vision impaired pedestrians* is said to be under development. Update if development is finalised.

Overall, the material provided does, in most cases refer to the most recent standards and legislation. However, legislation such as the *Human Rights Act* 2019 (QLD) should be included to emphasise the legal requirements applicable to pedestrian crossings that include:

- A human right may be subject under law only to reasonable limits that can be demonstrably justified in a free and democratic society based on human dignity, equality and freedom.
- In deciding whether a limit on a human right is reasonable and justifiable as mentioned in subsection (1), the following factors may be relevant:
    a) the nature of the human right
    b) the nature of the purpose of the limitation, including whether it is consistent with a free and democratic society based on human dignity, equality and freedom
    c) the relationship between the limitation and its purpose, including whether the limitation helps to achieve the purpose
    d) whether there are any less restrictive and reasonably available ways to achieve the purpose; [s 14] *Human Rights Act* 2019 Part 2 Human rights in Queensland v43 2019 Act No. 5 Page 17 Authorised by the Parliamentary Counsel
    e) the importance of the purpose of the limitation
    f) the importance of preserving the human right, taking into account the nature and extent of the limitation on the human right
    g) the balance between the matters mentioned in paragraphs (e) and (f).

There were a few occurrences where people with disability are referred to in politically incorrect terms, these have been identified in Table 5.2. The course material (not the course outline) states that designers should aim to design for everyone, therefore inclusive language (e.g. universal access) when referring to pedestrians is recommended.

Guidance has been consolidated into a PowerPoint presentation but as the course is provided in a presentation format the information provided is vague. Nowhere in the course content has it been recommended that consultation with people with disability should be undertaken as a measure to ensure universal access. There is a reinforcement of legal obligations throughout the course content including minimal design values, but there is no encouragement of participants to go above and beyond the minimum design requirements which reinforces the current design-for-compliance mentality.

This is not part of the aim of the course but, it is recommended that designers be encouraged to take measures to ensure dignified and defensible design, as well as socially accepted designs. For example, designers should consult with focus groups, or integrate or develop universal/disability access assessments or audit frameworks.

5.2 AVAILABLE EXTERNAL COURSES

There are courses available from other providers which potentially offer participants an overview of relevant disability design principles, legislation, standards and concerns. A compilation of available courses is shown in Table 5.3, identifying the course name, advertised description and link for additional information. As mentioned previously, due to scheduling and logistical constraints it was not possible to attend these courses in person. The courses have been reviewed based on available material however, in all cases the providers were reluctant to provide course materials.

A significant part of these courses appears to focus on the creation, review and audit of universal access designs to ensure suitability for people with disability. It is difficult to state with certainty whether the courses provide designers with the appropriate guidance and knowledge or discuss development strategies to cater for the needs of all users.

A large number of the courses identified in Table 5.3 are from the Australian Access Institute (AAI). The first two courses are said to be related to transport infrastructure and conveyances. All courses are self-

described as setting the benchmarks for universal design education and training. The AAI also provides consultation services and a series of handbooks that aim to improve access to businesses, services and premises.

Table 5.3: Courses identified as being potentially relevant to universal access

Course	Description and link
Australian Access Institute	
Addressing access in transport infrastructure & conveyances – 1 day	This one-day course provides participants with an understanding of the wide range of access requirements related to transport infrastructure and conveyances that must be considered in the planning, design, development, maintenance and upgrade of these spaces and facilities. Utilising a variety of learning techniques, the course focuses on the wide range of challenges that are experienced by people with various access issues in utilising transport infrastructure and conveyances. This includes mobility, vision, hearing, intellectual and cognitive issues. The course importantly provides a practical framework for understanding relevant legislative requirements including the *Disability Discrimination Act* 1992, the *Disability Standards for Accessible Public Transport* 2002, the *Disability (Access to Premises – Buildings) Standards* 2010 and the Australian Standards for access and mobility, as well as non-mandatory 'best practice' guidelines. The course identifies the key access elements to consider in transport infrastructure and conveyances with an emphasis on access solutions. All of the important access considerations relating to these key elements are explored. URL: https://accessinstitute.com.au/event/addressing-access-in-transport-infrastructure-conveyances-1-day/
Conduct a transport premises, conveyance and boarding device access audit – 2 days	This nationally recognised course incorporates CPPACC4008A – Conduct a Transport Conveyance and Boarding Device Access Audit, and CPPACC4009A – Conduct a Transport Premises Access Audit. It is ideal for people who have responsibility for reviewing, planning, designing, managing or maintaining transport infrastructure and conveyances, as well as those who are required to provide advice to others regarding legislative and practical access compliance. URL: https://accessinstitute.com.au/event/conduct-a-transport-infrastructure-and-conveyance-access-audit-2-days/
Understanding access and universal design in parks and outdoor spaces – 1 day	This course provides participants with an understanding of the wide range of universal access requirements related to parks and outdoor spaces, that must be considered in planning, design, development, maintenance and upgrade of these spaces and facilities. The course includes: • an overview of universal access and design principles • an overview of relevant legislation, Australian Standards and relevant guidelines • an overview of universal access issues – what's and why's • practical perspectives relating to universal access barriers and solutions • Universal Access Guidelines for Parks and Outdoor Spaces Utilising a variety of learning techniques, the course focuses on the wide range of challenges that are experienced by people with various access issues in utilising parks and outdoor spaces. This includes mobility, vision, hearing, intellectual and cognitive issues. In addition, the challenges faced by all users of parks and outdoor spaces are discussed and solutions identified. The course also provides a practical framework for understanding relevant legislative requirements including the *Disability Discrimination Act* 1992, the *Disability (Access to Premises – Buildings) Standards* 2010 and the Australian Standards for access and mobility, as well as 'best practice' universal access guidelines. The course identifies the key universal access elements to consider in parks and outdoor spaces with an emphasis on universal access solutions. All of the important universal access considerations relating to these key elements are explored. URL: https://accessinstitute.com.au/event/understanding-access-and-universal-design-in-playgrounds-and-outdoor-recreation-areas/

Course	Description and link
CPPACC4005A Conduct a building access audit – 2 days	This course is for people who have responsibility for reviewing, planning, designing, managing or maintaining buildings, as well as those who are required to provide advice to others regarding access issues in the built environment. The key elements of access to buildings, including relevant legislation and *Disability (Access to Premises – Buildings) Standards* 2010 are incorporated. The nationally recognised course provides participants with a practical framework and tools for undertaking an access audit of a building. URL: https://accessinstitute.com.au/event/cppacc4005a-conduct-a-building-access-audit/
Understanding access legislation and universal design in buildings – 1 day	This course provides participants with an understanding of the wide range of disability access and universal design considerations that must be addressed in the planning, design, development, maintenance and upgrade of buildings. The course incorporates an overview of universal access and design principles, relevant legislation and Australian Standards, universal access issues – what's and why's. Participants also receive Access Guidelines for Buildings. URL: https://accessinstitute.com.au/event/understanding-access-legislation-and-universal-design-in-buildings/
CPPACC4006A Conduct a playground access audit – 2 days	This course is for people who have responsibility for reviewing, planning, designing, managing or maintaining buildings, as well as those who are required to provide advice to others regarding access issues in the built environment. The key elements of access to buildings, including the relevant legislation and 2010 are incorporated. The nationally recognised course provides participants with a practical framework and tools for undertaking an access audit of a building. URL: https://accessinstitute.com.au/event/cppacc4006a-conduct-a-playground-access-audit-2-days/
CPP50711 Diploma of access consulting – 11 days	This course provides students with a premium, nationally recognised qualification as an access consultant. This course provides students with the skills required to provide advice on access to the built environment, as well as services and programs for people with a range of access challenges, including people with disabilities, older adults, emerging baby boomers, parents with prams and families. Importantly the course also provides the basis for a comprehensive understanding of the reasons behind the legislation and standards – the 'why's' of access – relating to the function and use of buildings, facilities and services. URL: https://accessinstitute.com.au/event/cpp50711-diploma-of-access-consulting-11-days/
CPP50711 Diploma of access consulting course for building surveyors – 8 days	This course will provide building surveyors with a significant 'point of difference' to their peers and competitors when it comes to understanding and assessing access compliance in buildings. It provides essential knowledge and skills related to the 'why's' of access' and provides an understanding of the rationale behind the access requirements of the Building Code and the Australian Standards for access and mobility. It includes all of the units of competency of the Certificate IV in Access Consulting as well as others to support a higher-level understanding and application in the 'real world' environment. This course has been adapted for building surveyors and candidates must be able to demonstrate recognised prior learning or credit transfer for some units of competency. URL: https://accessinstitute.com.au/event/cpp50711-diploma-of-access-consulting-for-building-surveyors/2017-06-02/
CPP40811 Certificate IV in access consulting – 8 days	Aimed at people and organisations with the responsibility to improve access to buildings, facilities, parks, streetscapes, playgrounds and open spaces. This includes government staff, building certifiers, architects, building designers, asset managers, occupational therapists, educational institutions, hospitals and other organisations.

Course	Description and link
	URL: https://accessinstitute.com.au/event/cpp40811-certificate-iv-in-access-consulting/2017-06-04/
CPP40811 Certificate IV in access consulting for building surveyors – 5 days	This course is for people who have responsibility for reviewing, planning, designing, managing or maintaining buildings, as well as those who are required to provide advice to others regarding access issues in the built environment. The key elements of access to buildings, including the relevant legislation and access to premises standards are incorporated. The nationally recognised course provides participants with a practical framework and tools for undertaking an access audit of a building. This course has been adapted for building surveyors and candidates must be able to demonstrate recognised prior learning or credit transfer for some units of competency. URL: https://accessinstitute.com.au/event/cpp40811-certificate-iv-in-access-consulting-for-building-surveyors/2017-06-04/
Bridging course for CPP50711 Diploma of access consulting – 3 days	This 'Bridging' course provides students, who have completed the 'face to face' training sessions for the Certificate IV in Access Consulting, the opportunity to gain the Diploma of Access Consulting by completing additional required units of competency. These additional units relate to the provision of advice on access to the built environment including additional access auditing elements, anthropometrics and ergonomics. URL: https://accessinstitute.com.au/event/bridging-course-for-cpp50711-diploma-of-access-consulting/2017-06-06/
Department of Transport	
RPD308 Pedestrian crossing facilities and tactile ground surface indicators design	This program is designed to provide sound working knowledge and develop skills in the selection of pedestrian crossing facilities and facility design for pedestrians with vision/mobility impairment. URL: https://www.tmr.qld.gov.au/-/media/busind/Commercial-services/Technical-training-solutions/Technical-Training-Program.pdf?la=en
RPD309 Pedestrian and cycling provision for planners and managers	This condensed program is designed to provide knowledge and develop skills in the application of current best practice pedestrian and cycling provision as part of the road transport system, based on an understanding of the key issues and operating requirements for pedestrians and bicycle riders. Fieldwork, tutorials and real-life team-based workshop exercises form the basis of this program. URL: https://www.tmr.qld.gov.au/-/media/busind/Commercial-services/Technical-training-solutions/Technical-Training-Program.pdf?la=en
Safe System Solutions	
8 to 80 Training	This interactive course explores the complexities of a growing and ageing population and how the road network needs to adapt to account for this changing demographic. The course explores the characteristics of older pedestrians, including users of motorised mobility scooters and electric wheelchairs; younger pedestrians; and older drivers, and relates them to road design elements. This workshop covers: • definition of pedestrians, and risks for young and older pedestrians • pedestrians on motorised mobility devices, including illegal devices • road rules for pedestrians • older drivers, changes to vision that can affect driving, and the visual impairment game • older drivers, and how physical, perceptual, and cognitive declines can affect driving URL: https://safesystemsolutions.com.au/wpcontent/uploads/2019/09/8to80interest.pdf
Equal access	
Disability access & awareness training courses, including DDA	Equal Access Pty Ltd provides training sessions that cover a variety of disability-related topics. There are several training modules but training sessions can be

Course	Description and link
(3 workshops)	tailored to suit each organisation thereby ensuring that the content has direct relevance to attendees. URL: https://www.disabilityaccessconsultants.com.au/training/
Australia Government Training	
PPACC4001A – Apply disability awareness to assessing access situations *(Seems to be a unit within a TAFE level course. Details unknown at the moment, requires further investigation.)*	This unit specifies the competency required to apply the knowledge of disability to the implementation of the *Disability Discrimination Act* (DDA) and relevant state and territory anti-discrimination legislation. Access consultants must understand the impact of the environment on disability and the impact of disability on the environment. Access consultants must implement these skills and knowledge in all aspects of their work. The unit requires the ability to work sensitively in relation to disability issues and to display appropriate attitudes when planning and implementing work that impacts people with disabilities. URL: https://training.gov.au/Training/Details/CPPACC4001A

5.3 LIMITATIONS IN TRAINING COURSE REVIEW

Attendance of the TMR and external courses was not possible due to logistical constraints. Therefore, it was difficult to determine if the courses adequately addressed the topic of universal access with appropriate attention to people experiencing disability. Based on the lack of materials from the unreviewed courses it was not possible to conclusively determine if the external courses are enhanced versions or duplicates of the TMR course - *RPD308 Pedestrian Crossing Facilities and Tactile Ground Surface Indicators Design.*

Additional changes to those recommended above may be required as the course was not attended in person and a major part of learning in these types of training courses typically comes from the presenter.

6 RECOMMENDATIONS

From the review of performance-based concepts and training courses the following recommendations have been made:

- TMR should develop a policy document requiring the use of a performance-based concept throughout the life of any development projects to ensure the needs of users have been considered to the greatest extent possible. ARRB cannot conclusively declare that one of these concepts is superior as the potential benefits and disadvantages are situationally dependent should be determined at the project leader's discretion. However, ARRB does recommend the use of cooperative design and universal design as they both demonstrated benefits in the case studies investigated.
- Updates should be made to TMR's *RPD308 Pedestrian Crossing Facilities and Tactile Ground Surface Indicators Design* training course as per Table 5.2. These updates are to ensure the training course uses politically correct language, demonstrates the latest standards and guidelines, focuses on universal and dignified access, and reinforces the legal ramifications of inadequate designs.

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