

An analysis of station infrastructure design to improve accessibility between the platform and suburban train carriages.

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Abstract

This paper presents research supported by the CRC for Rail Innovation to establish guidelines for best practice in station design and infrastructure within Australia. One key consideration in this process is the Disability Standards for Accessible Public Transport 2002 (DSAPT) which seeks to eliminate discrimination in public transport access around infrastructure by 2022.

Within railway station design it is accepted by operators and governing bodies that the interface between train and platform, 'the gap' is a major impediment to accessibility compliance. It remains problematic in achieving 'unassisted' access in 'boarding from, or alighting to' the platform surface particularly for passengers with impaired mobility.

Using Melbourne's Metropolitan rail network as a case study it is revealed that there are several contributing factors which do not enable independent access from the platform to the train. This is evident in current industry practice of driver assisted boarding, multiple rolling stock designs and the impact of a station design legacy throughout Melbourne's rail network.

In this paper ensuing operational constraints in and around infrastructure are analysed in order to redefine 'the gap' issue from a design perspective towards enabling user independence. The aim of this research is to scope the extent of infrastructure issues and operator response to inform the approach of a new design solution around 'cross-gap' accessibility.

1. Introduction

The station as public architecture is fundamental to the commuter experience and individual response to the built environment (Burns 2000). It provides shelter, amenities, provides directional cues, and is perceived as a local identity or reference point. It is integral to facilitating the movement of passengers between trains and alternate destinations. Often the public perception of its performance becomes closely linked with, yet overshadowed by the punctuality of the train (Weinstein 2000). However, as an essential part of rail infrastructure the station and its functional attributes are subject to specific criticism especially when safety and accessibility is concerned.

In Melbourne, commuter rail operators are faced with the challenging task of providing an appealing travel proposition to passengers. A perceived 'value for money' service and timely travel experience is expected, that offers a clean, comfortable and safe environment (Cheng 2010) for passengers. At the very least a service that elicits a neutrality in opinion from customers regarding their travel experience.

It is suggested that achieving positive customer experiences involves affirmative interactions. These can be with the immediate built environment, rail employees and the provision of a reliable and punctual service (Iseki & Taylor 2010). One key aspect of an individual's positive travel experience should be the enabling of unassisted access. Having

personal choice of when and where to participate throughout the intended trip is also integral to customer satisfaction (Weinstein 2000). In contrast, negative experiences can present when the environment or service provision affects travel choice, this can be heightened for users with mobility impairment (Seyers 2011).

This current research is driven by the DSAPT (2002) objectives for the provision of one hundred percent accessibility in public transport for all users. It involves looking at the train and station as a connected system (Fujiyama, T, Nowers, J. & Tyler, N. n.d.) from an independent perspective on the Melbourne metropolitan network. It should be acknowledged from within the DSAPT that target dates for compliance differ across infrastructure which is 2022 - for conveyances this concludes in 2032.

1.1.A problem of access

The successful and timely interactions of 'cross-gap' accessibility, negotiating the gap between platform and train will be discussed from three operational perspectives towards train carriage occupancy.

- Firstly, an analysis of the current environment of stations across Melbourne is presented from a user's perspective.
- Secondly, direct and indirect implications any service interactions have on the 'dwell time', the train's stationary period adjacent to the platform over the length of the trip.
- Thirdly, the procedural task of train drivers to facilitate the cross gap accessibility of mobility impaired passengers to satisfy interim DSAPT milestones.

The method of qualitative and quantitative analysis intends to establish a local framework to pursue opportunities within the current system. To direct a potential design solution aligned with the requirements of the DSAPT 2002.

2. Station design environment

An applied design approach is taken to cross gap accessibility. This requires an understanding of the current operating environment and the motivating policy, the DSAPT. At the conclusion of the 2022 DSAPT milestone for infrastructure, it is anticipated that Melbourne will be operating Siemens and Xtrapolis rolling stock - still within their operational lifespan of 40 and 30 years respectively (Mr V So 2012, pers.comm., 24 Jan). Currently Melbourne also operates another two metropolitan trains, the Comeng and Hitachi. The 2022 compliance date should see only 10% of the Comeng still within its intended design life - the Hitachi rolling stock will be obsolete (Mr V So 2012, pers.comm., 24 Jan). Alongside these are non-metropolitan carriage designs operating on regional network lines. Improved station design access will need to address the present-day condition in anticipation of future user experiences. The design life of rolling stock should also be considered towards achieving a DSAPT compliant rail network in advance of 2022.

2.1.DSAPT and accessibility

The DSAPT document provides measurable guidelines such as ramp gradients, handrail positions and suitability of materials, a 'fit for purpose' approach. This technical focus forms the basis or minimum considerations in the pursuit of a compliant and inclusive operating environment. An inclusive solution is one that accommodates a greater diversity of users and individual needs, the basis for the DSAPT legislation. The value of such an approach is clearly supported by the *2009 Disability, Ageing and Carers, Australia: Summary of Findings* with whom 18.5% of the Australian population identify with having a disability. Of these 18.5% with disability; 87% had a specific impairment restricting their ability to perform routine communication, self-care activities and mobility tasks.

Understandably, mobility and communication are of particular importance when negotiating the public transport setting. In public transport the industry recognised term 'persons with reduced mobility' (PRM) is applied. Physical and sensory impairments of varying degree as well as users with temporary impairments such as sport injuries and dependants are included within this term of reference.

An inherent relationship between DSAPT and accessibility exists. Accessibility extending to an 'accessible journey' for those with disabilities is forwarded by the Victorian Council of Social Service (Reynders 2011). VCOSS advocates the continual need for progressive solutions to public transport accessibility. In addressing this specific issue the DSAPT (*Section 8.2*) introduced a 'limit of size' for an acceptable entrance gap in relation to Australian public transport services. Internationally the concept of universal design acknowledged as 'design for all' strengthens the intent of solving access problems for those with disabilities. UD being beneficial to all users is also suggested as a positive initiative from an economic standpoint (Odeck, Hagen & Fearnley 2010).

A pivotal requirement disclosed in DSAPT (*Section 8.2*) is for an assistive device to be made available when a vertical rise or gap exceeds 15mm or a horizontal gap exceeds 40mm. It might appear an inconsequential dimension however substantial research has been conducted in this cross-gap area (Daniel & Rotter 2009; DeJeammes 2000; Hashizume et al. 2009) to determine the limits of acceptable 'unaided' access. Once such study conducted research to evaluate a 50mm x 50mm gap currently perceived as acceptable within Europe. What was revealed was that upper limits of 50mm x 50mm cannot be safely negotiated by a significant proportion of PRM's, particularly wheelchair users (de Kloe, de Boer & Daamen 2008).

Taking this into consideration the DSAPT policy standard of 15mm x 40mm when applied in context across Melbourne stations it becomes self-evident that this gap allowance is unattainable. Consequently, rail operator's current response is to deploy a ramp manually by the train driver as a solution albeit temporary (Reynders 2011) to overcome the issue. DSAPT (*Section 8.2*) also states that operators and providers may assume that passengers will board at a point that has a firm and level surface to which a boarding device can be deployed. In Melbourne this area assumes close proximity to the drivers cab and therefore located in the majority at the ends of the platform.

DSAPT provides further specifications for design consideration of an assistance device with minimum gradient ratios applied to three contexts.

- a ratio of 1:12 for unassisted access which applies to external ramps
- a ratio of 1:8 for unassisted access where ramp length is less than 1520mm
- a ratio of 1:4 for assisted access which applies to external ramps

Drawing upon these DSAPT cross-gap standards and supporting specifications from the Australian Standards AS1428.2 the following diagram offers up three iterations of a fixed platform solution. Applying the DSAPT ratio of 1:8 for 'unassisted' access this layout determines the breadth of platform intrusion from a vertical rise of 200mm.

Allocating space for a compliant ramp gradient on the platform as determined from Fig. 1 reveals that when the vertical rise to the vestibule landing exceeds 112.5mm in height, the slightest fixed ramp length will terminate 900mm in distance from the platform edge. Having already exceeded the maximum 15mm in vertical distance of the DSAPT. A yellow line acting as a warning line delineates this distance mark. In further integrating a flat surface landing using Fruin Levels of Service (VRIOGS 2011) or the minimum wheelchair turning circle (AS1428.2) both iterations noticeably infringe the level platform area designated for waiting passenger occupancy.

Figure 1: Illustration of DSAPT ‘unassisted access’ ramp overlay (Moug 2012)



Other solutions in use by international rail operators comprise wayside foot platforms extending from the carriage to the platform edge and vice versa - these only address the horizontal gap. Wheelchair lifts and ramps to be operated by a station attendant are personnel based solutions however these do not facilitate individuals 'unassisted access' for disabled users.

2.2. Station design – a rail legacy

The negative impact of station design on accessibility for PRM's in observing the DSAPT can be attributed to pre-existing parameters of the built station design. It is typical of rail infrastructure and public architecture to be designed for a functional life of 100 years (VRIOGS 2011). This is in stark contrast to the mean design life of 32.5 years of current Melbourne rolling stock. As a result station infrastructure finds itself misaligned with modern policy requirements. Melbourne's rail network infrastructure like many networks has been subject to periodic capacity growth in line with an increase in population and patronage (PTV 2012).

Not inconsequential is Melbourne city's early stations built circa 1900-1920s also form the majority of stations within Zone 1, the fare zone closest to the city centre. A number of these stations are of historical significance and subsequently heritage listed. This prohibits or restricts remedial intervention and expansion to accommodate growth.

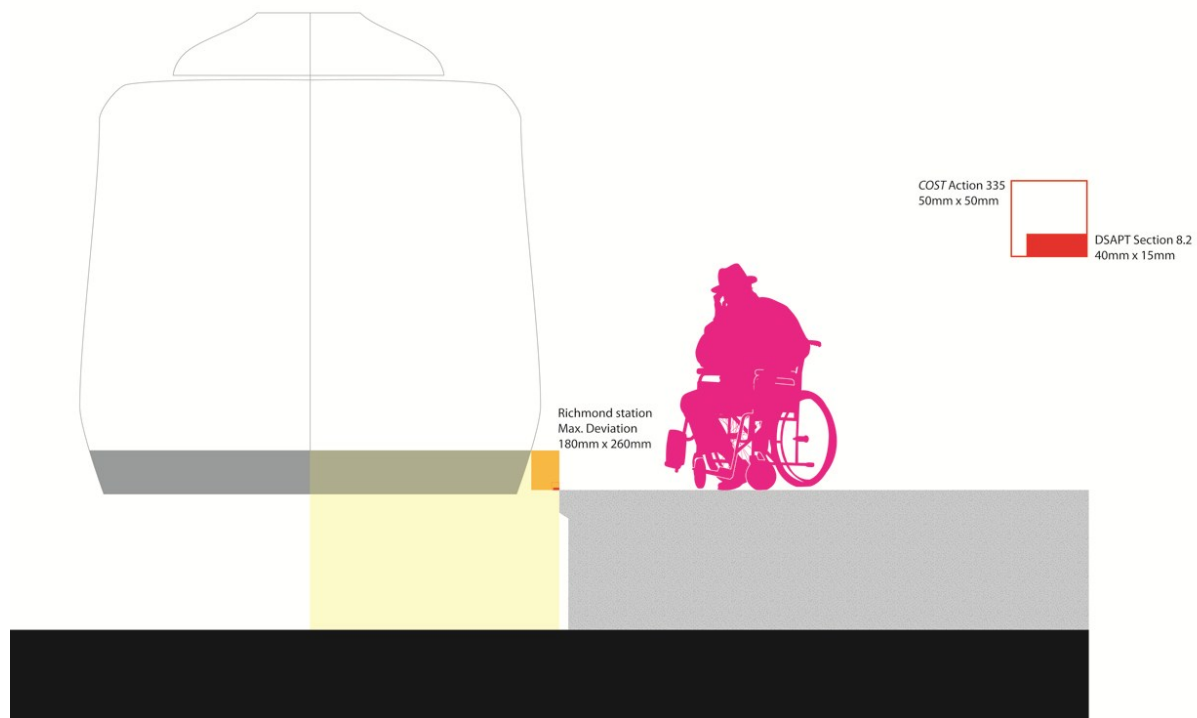
Existing station design (to include heritage stations) therefore requires a rethink to overcome barriers to compliancy under the DSAPT. A major component is the platform surface and how it can enable accessibility for PRM's.

Research undertaken by Daamen et.al (2008) into the European *COST Action 335* report challenging the acceptable gap of 50mm x 50mm suggests that the DSAPT gap standard in Australia is directed towards a realistic gap measurement in principle. In applying these two standards in context reveal the inherent challenge faced by operators. Richmond station which is situated on the South East corridor in the Melbourne network is a cordon station between Lilydale, Glen Waverley, Alamein, Sandringham, Frankston, Pakenham and Cranbourne lines. Applying both the *COST 335* and DSAPT cross gap measurements against survey data from Public Transport Victoria (PTV) there is a considerable difference between the current conditions of the operating environment and DSAPT policy.

At Richmond a maximum deviation of 180mm horizontal and 260mm vertical eclipses the *COST Action 335* reported standards for PRM's of 50mm x 50mm, already disproved as attainable (de Kloe, de Boer & Daamen 2008). The problems of legacy station design on access become vividly apparent.

A standardised step height becomes increasingly important. Melbourne's population is projected to increase in number and age with persons over 65 representing 17.5 per cent of Victoria's population by 2031 (Victoria in Future 2012 April 2012). Using Richmond station as an example and observing ISO 22411:2008 the comfortable ascending step height for an elderly female of age 60 – 69 years is 180mm decreasing to 170mm from age 70 onwards. The descending height is 170mm decreasing to 160mm from 80 years onwards. These limits are obtained in relation to the step threshold on a stair incline. The impact of a gap taking into considerations the stride height and depth or the gait cycle would prove a greater issue. These comfortable step heights do not satisfy the upper limits of 260mm at Richmond station. Coupled with a dynamic environment, wet weather conditions and presence of other passenger's this can impact on both physical and psychological response to cross-gap accessibility.

Figure 2: Illustration of Richmond platform deviation with DSAPT and European *Cost Action 335* overlay (Moug 2012)



Controlling the vertical deviation is problematic. The height range varies across the longitudinal length of the platform surface. Likewise it differs across similarly adjacent platforms locations at this station; this is not isolated to Richmond station. Contributing factors to surface deviation stem from multiple infrastructure conditions; from station foundation settlement, ballast settlement of the track, degradation of platform surface materials, and ongoing maintenance of track levelling and alignment to reduce the cant (sideways tilt) of the train carriage.

2.2.1. The archetypal station

Station design layouts across the Melbourne Metropolitan network consist of a number of archetypal arrangements of either an island platform or single faced platform or a combination of both. A topographical survey was undertaken to gather quantitative data – a combination of satellite images and site visits. Of these, 189 stations are at-grade, 17 are sub-grade, 11 are designated aerial, and the remaining 3 are located underground.

Logic considers the most advantageous station design elements for improved accessibility for PRM's is a straight platform edge and the location of the entrance and exit in closest proximity to the assisted boarding platform zone.

The topographical survey of Melbourne's station reveals that nearly 25 per cent of platforms have a non-linear profile as exhibited in the island platform layout as shown in Fig.3 and in both single faced platforms (shown adjacent to an centre island platform) as shown in Fig. 4. An important observation allowing for clear sightlines for train drivers safely departing stations (MTM 2012, pers.comm., 18 March). Research also reveals that almost two thirds of station platforms have an entry point in a central location in the context of the entire length of platform. Of the remaining third of station platforms almost 60 per cent of these are accessed via the outward bound (up direction) end and 40 per cent from the city (down direction) end of the platform.

Figure 3: Greensborough station (Image retrieved from Google Earth on 6th March 2013)



The result being that the configuration of station layouts is intrinsically linked with enabling efficient access to mobility impaired users. Mobility impaired passengers requiring assistance on arrival or departure are enabled by the unique asymmetrical station design such as exhibited at Greensborough station in Fig.3. Greensborough has an advantage over typical station configurations such as Toorak shown in Fig.4. PRM's arriving at Greensborough are located towards the centre of the platform under shelter, assisted boarding zones at the respective end of each platform are located in close proximity to the opposing direction. This is not similarly exemplified at Toorak Station. Toorak station requires PRM's to travel along the length of the platform, exposed to weather conditions to arrive at the allocated boarding position nearest the train drivers cab. A centrally located, accessible design solution will allow 60 per cent of platforms (relative to the station entrance/exit) to offer a comparable service to Greensborough.

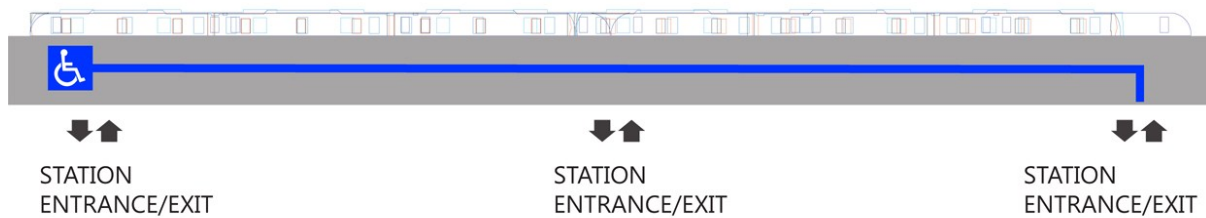
Figure 4: Toorak Station (Image retrieved from Google Earth on 6th March 2013)



2.2.2. Boarding distributions

Difficulties facing PRM's in the current network is the position of the assisted boarding point in relation to the entrance point to the station. The current default length of Melbourne's platforms at 160 metres includes a supplementary 10 metres for operational purposes (VRIOGS 2011). Metropolitan Trains Melbourne (MTM) uses a single person operated train (SPOTS) policy. Assisted boarding by the driver is performed at the end of the platform nearest the drivers cab and logically in the direction of travel. For PRM's to get boarding assistance added effort is expected to reach the designated zone. Increased effort is demanded should the station entrance be located longitudinally opposite the desired boarding zone, as indicated in the diagram below.

Figure 5: Illustration in *plan view* of boarding and alighting designations (Moug 2012)



2.2.3. Accessible functional space

Location is important in negotiating the station layout. The demands of functional space within the paid zone of stations can be divided simply into two areas; the occupancy space of the platform surface and an egress or entrance space proximal to the platform surface. The platform arrangement is governed through the Victorian Rail Industry Operators Group Standards (VRIOGS 2011). It is informed by Australian Standards AS 1428.1-2009 with respect to space allocated for manoeuvring of wheeled mobility aids.

Figure 6: Illustration (plan view) of station platform specification VRIOGS 002.1 (Moug 2012)

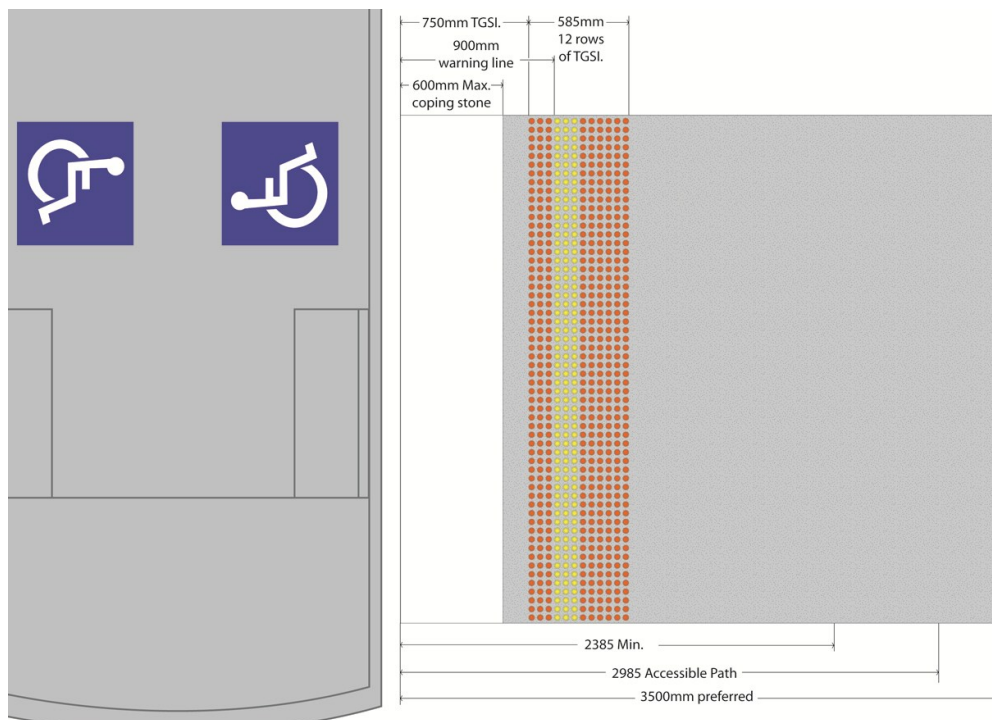
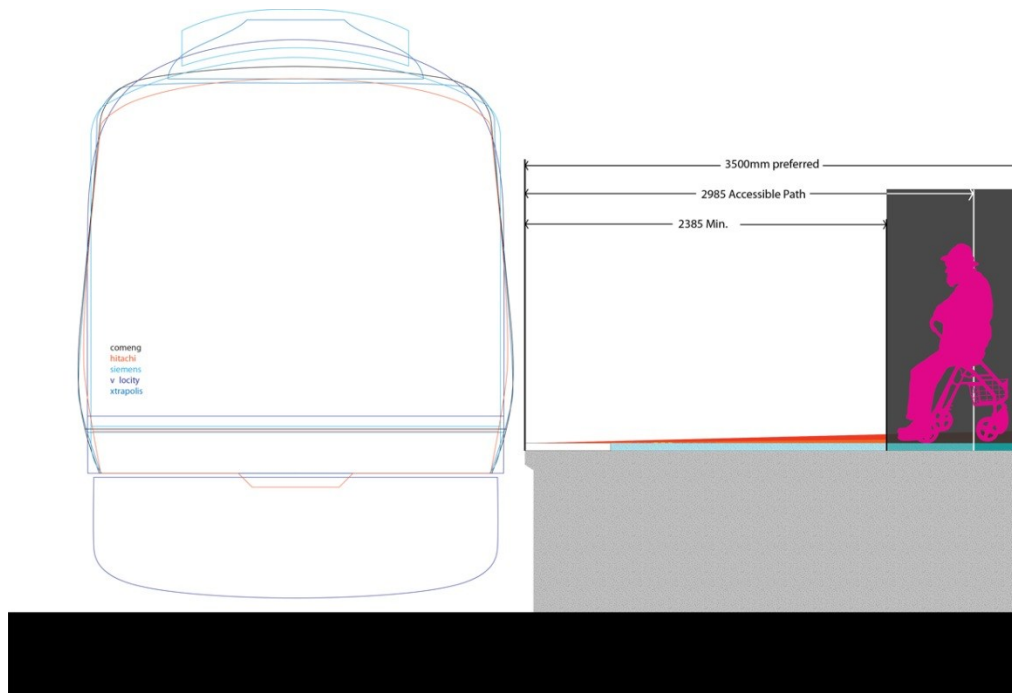


Figure 7: Illustration (elevation view) of station platform specification VRIOGS 002.1 (Moug 2012)



Towards the edge of the platform are markings delineating space visually and tactilely. The demarcation of a yellow warning line at 900mm provides a recommended safe wait position for boarding passengers. The use of tactile ground surface indicators or TGSI's allows for vision impaired users to obtain direction and distance information at the platform edge. Consistent application of this DSAPT requirement is ongoing. The platform edge itself can be constructed from a variety of fixed, non-conductive materials; bluestone, concrete and timber with an anticipated lifecycle of 50 years. From an operational perspective it remains for the most part void of any physical obstruction; this is governed by the structural gauge envelope (VRIOGS 001) ensuring trains do not impact the station or platform surface infrastructure, refer to Fig. 8.

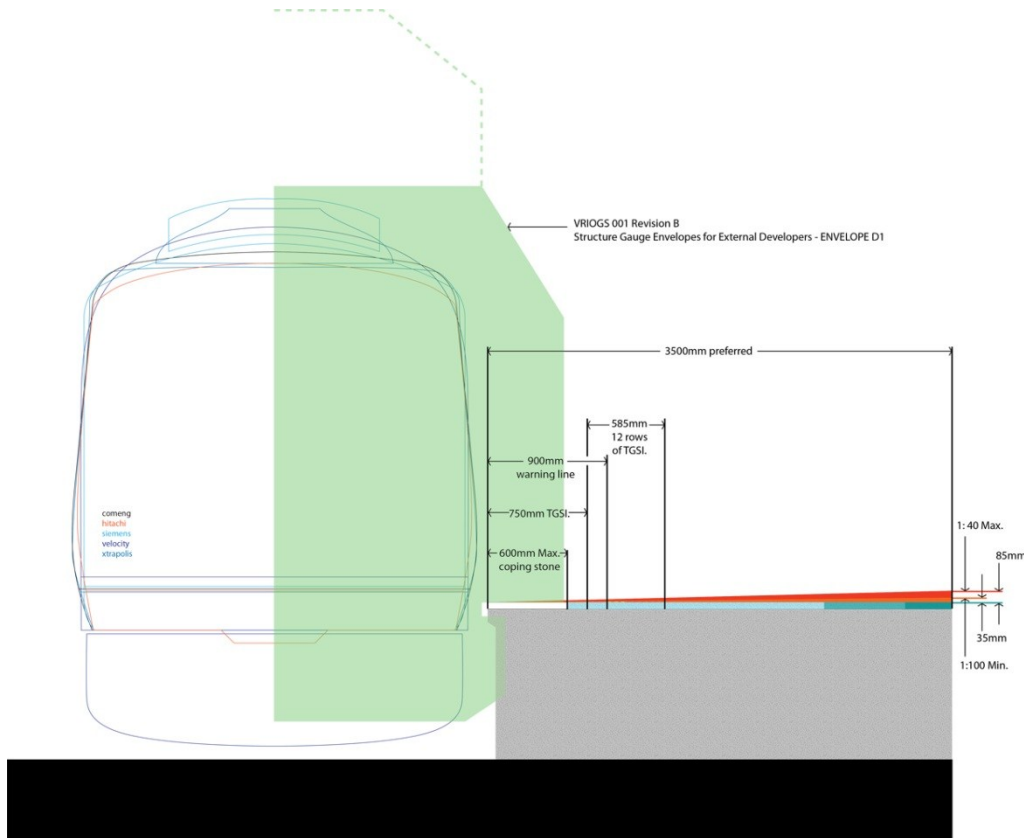
As a result, from the platform edge and 900mm inwards this section becomes a transitional space. Intended vacant when a train approaches, to be engaged whilst boarding and carefully negotiated in moving along the platform. Melbourne's stations as High Level Platforms (HLP) attempt to provide passengers with a level boarding access. It is unsuccessful for a number of reasons. A major factor is the four types of operating rolling stock, each with a variation in the cross-sectional profile and floor height above the top rail of the track. Secondly, station platform design has employed the use of a cross-fall and camber for island platforms as per Section 9.7.2 (VRIOGS 2011).

'Gradients and cross falls for floor surfaces in platform pedestrian areas shall comply with the DSAPT and DOT policy as outlined below.

The cross fall on platforms is to lead away from the platform edge with the gradient having a minimum of 1:100 and a maximum of 1:40. This gradient shall be consistent to prevent water collecting on the platform surface.' Section 9.7.2 (VRIOGS 2011)

Creating a platform trajectory that is sloping in the opposite direction not conducive to level boarding. The train floor level in most instances exceeding the standard platform height of 1060mm from top of rail (VRIOGS 2011).

Figure 8: Illustration in section view of station platform specification VRIOGS 002.1 and overlay of structural gauge envelope D1 specification VRIOGS 001 (Moug 2012)



2.3. Station assistive devices

For a number of PRM's a train journey is assisted by the use of a mobility aid. The foremost focus group of mobility impaired patrons in cross-gap access research are users of wheelchairs (Rueger 2011). In this perspective often the difficulty in negotiating the gap is not an attribute of the wheelchair user but the aid itself. Consideration should be given to the functional design limits of the wheeled device and its role in preventing self-assisted boarding and alighting of the train to the station platform (Hashizume et al. 2009). Accordingly rail operators across Australia communicate the 'limits of size' for accommodating and supporting the use of mobility aids.

- Fit within an allocated space of 1300mm by 800mm;
- Be no more than 750mm wide at a height 300mm above the ground;
- Weigh less than 300kg including the aid, occupant and assistant (if applicable) when using a ramp or other boarding devices
- Be able to move in the direction determined by the transport operator; and
- Have effective braking systems to maintain stability.
- Turn 180 degrees within an area 2070mm by 1540mm;
- Cross a horizontal gap up to 50mm wide;
- Mount a vertical rise (bump) up to 15mm;
- Cross grating gaps up to 13mm wide and 150mm long;
- Negotiate a 1:14 grade ramp unassisted;
- Negotiate up to a 1:8 grade where the ramp is less than 1520mm; and

- Negotiate a 1:4 grade ramp with assistance

These standardisations are integral to position the built environment in formulating inclusive design solutions. Australian Standards does not specify a standard diameter requirement for castors/ wheels suitable for use in the rail environment. Reference instead is given to ISO22883:2004/ISO22884:2004 sizing which ranges from 50mm Ø through to a 300mm Ø for applications up to 16km/h. In Western Australia operators require passengers accessing pedestrian level crossings i.e. over railway tracks, to use a mobility aid capable of crossing a gap up to 75mm wide (Burgess 2012) more than the DSAPT 40mm gap requirement.

3. Network dwell time

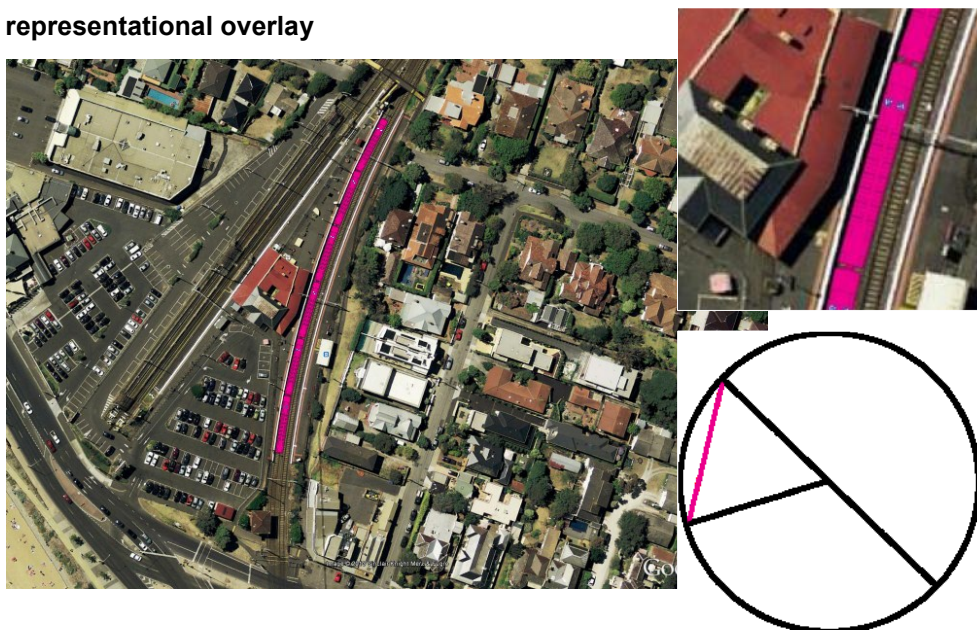
Irregularities in cross gap accessibility on the network service timetable have a cumulative effect on the scheduled delivery of services. The 'dwell time' identifies the at-rest position of the train whilst engaging passengers boarding and alighting at the station platform. Dwell time usually includes an anticipated period of time to allow the exchange of passengers but is susceptible to elongated periods when involving PRM's and accounting for unpredictable passenger behaviour (Coxon, Burns & de Bono 2010). Aside from improving passenger mobility and network efficiency recent research indicates a cost benefit to operators of a universal design (UD) approach to public transport (Karekla, Fujiyama & Tyler 2011). A reduction in dwell time as highlighted (Karekla, Fujiyama & Tyler 2011) allows operators to provide a service to all passengers whilst reducing the operational requirement by one train providing immediate cost savings.

How does station design which currently performs a passive role facilitate improvements in the exchange of passenger? Firstly the identified issue in platform edge height and linear distance from the train vestibule requires the provision of an additional loading service (DSAPT Section 8.2). In addition Melbourne's network platforms exhibiting a curved longitudinal edge also increase the likelihood of a boarding service use. It is suggested also for able bodied passengers that a large gap created by the curve of the platform is of heightened safety and mobility concern (Daniel & Rotter 2009). The gap is created as a result of the linear carriage positioning itself against the curved platform edge - described as a chord within geometry. The horizontal gap increases towards the centre of the carriage, refer to Fig. 9a which incorporates 9b & 9c. Increased anxiety is attributed to an increase in the gap distance (Cheng 2010) affecting the passengers station experience.

Figure 9a: Brighton Beach Station (Image retrieved from Google Earth on 6th March 2013)

Figure 9b: Detail view of train overlay

Figure 9c: Chord representational overlay



4. Driver as facilitator

Australia's metropolitan rail industry does not engage the use of an Automatic Train Operation (ATO) metro system. Such systems are in operation in varying levels of automation across Europe, Asia and the United States of America. A single person train operator train policy (SPOTS) employs a human train driver responsible for conveying passengers in Melbourne. As a result, variable levels of staffing at stations and platforms across the Melbourne network require the driver to take on sole responsibility for mobility access. This standard procedure will also see the driver facilitating boarding access at premium stations. This is also indicative of the 65 per cent of stations which remain unstaffed outside peak hours as collated here.

- Premium - 79 in total and staffed during all operational hours
- Host - 26 in total and staffed at morning peak of the working week
- Unattended – remaining stations totalling 115 have no staff present

For drivers in Melbourne the SPOTS approach exposes a number of safety issues and pressure constraints in performing timely cross-gap procedures safely. In contrast, NSW and Queensland operate a two person policy with an on-board guard to present to assist PRM's.

4.1. Driver ramp relationship

Ramp deployment may appear an innocuous task to the untrained person however, in the context of an operational rail network the simplest task is prone to unpredictable conditions. A train driver must perform this task for passengers who exhibit varying levels of disability - ranging to the severe. Passengers with communication impediments also impair punctuality of the current method. This process must also be undertaken in all weather conditions and may involve one or multiple users in need of assistance.

4.1.1. Ramp design

The current design specification of a boarding ramp must comply with Australian Standards AS/NZS3856.1 (1998) Clause 2.1.8 (b), (c), (f) and (g). The boarding ramp design in use is a bi-fold aluminium ramp hinged along the centre and placed perpendicular to the train. It has a vertical edge profile along the longitudinal edge no less than 75mm in profile height to prevent wheel roll off. A locating flange is provided for on the interior facing edge to locate within a corresponding channel of the vestibule tread plate. The planar surface of the ramp is coated with a slip resistant surface to comply with AS 3696.13. Ramp measurements for width are 800mm (deployed) and are able to accommodate a weight of 300kg inclusive. The dead weight of current designs is around twelve kilograms. Iterations of the ramp have been developed by the Melbourne operator to include lighter weight materials and a mechanically fastened and leveraged solution on the train carriage. The collapsible stowed ramp remains the product in use in Victoria.

Figure 10: Illustration of operator method for access ramp deployment by train driver in Melbourne (Moug 2013)

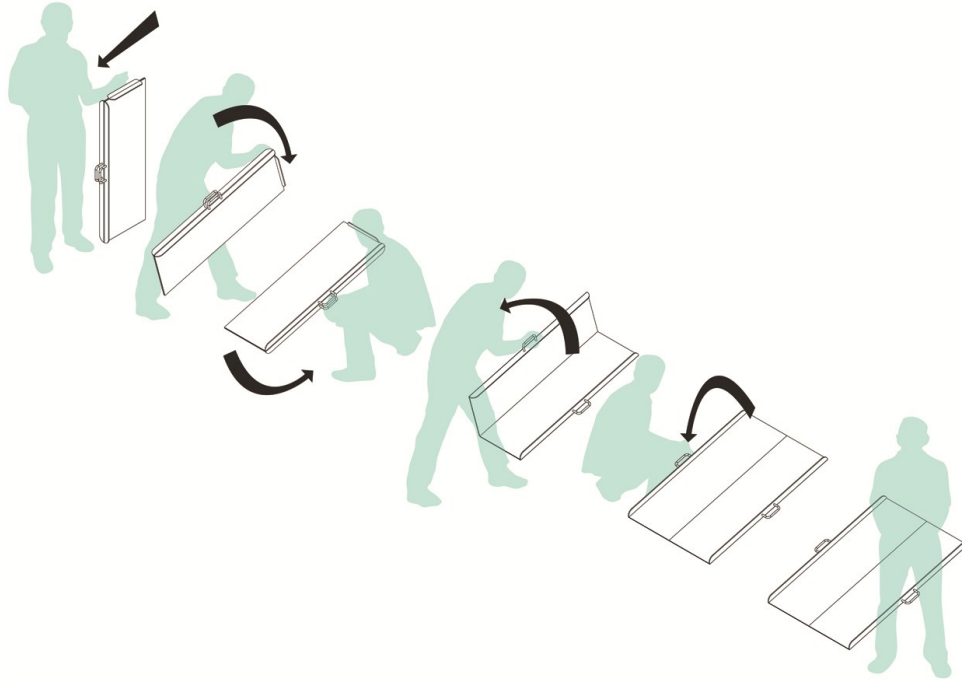


Figure 10a: Illustration of operator method for access ramp stowing to be used by train driver in Melbourne (Moug 2013)

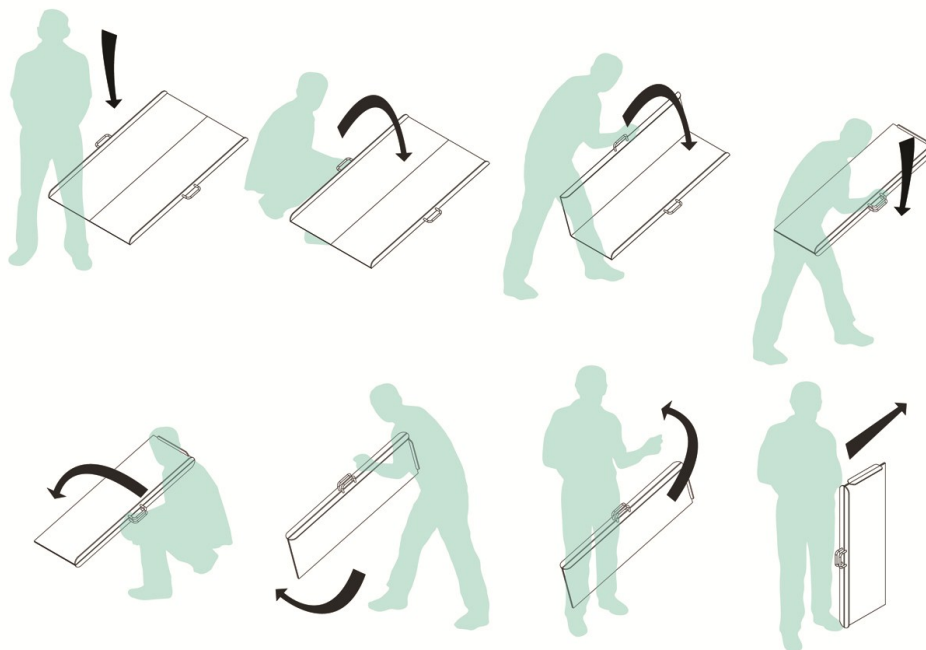
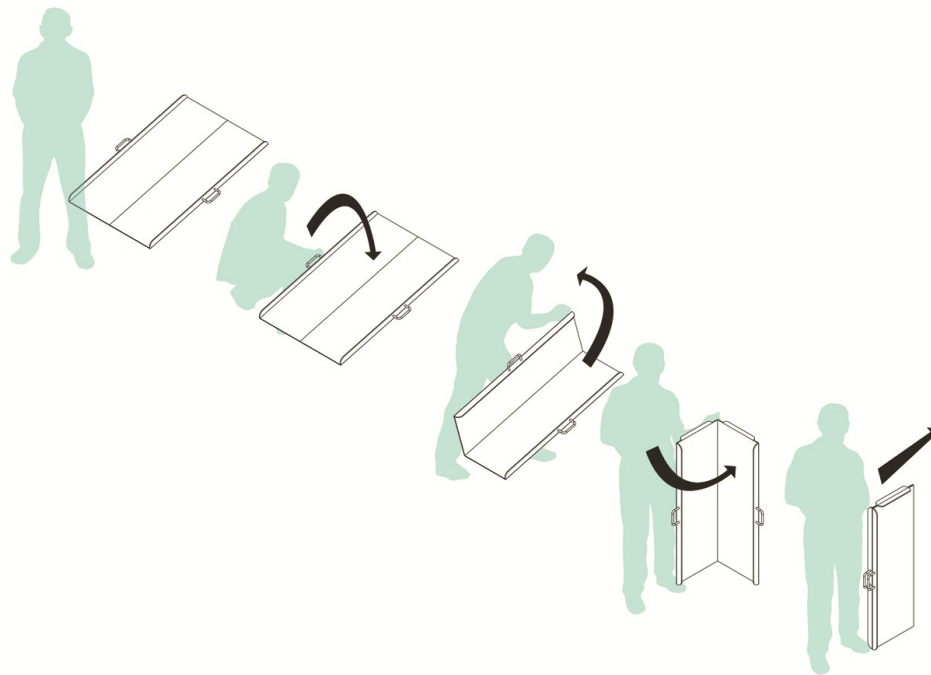


Figure 10b: Illustration of driver initiated method for access ramp stowing in Melbourne (Moug 2013)



4.1.2. Ergonomics

A manual operation, the deployment of the ramp in first instance requires a physically capable operator. The ramp must first be removed from its stored position. The ramp is stowed edge facing in perpendicular position to the carriage door. A security key is used to unlock the cabinet door to then remove the ramp in a lateral direction (Fig. 10). The current system employs rollers to assist in ease of extraction; external damage to the housing through general use aggravates this process causing unnecessary strain and delay to the driver. Once fully removed the ramp is then deployed from the platform towards the train and located in a receiving channel on the aluminium tread plate. Policy requires that the driver proceed to lower the ramp in a correct postural position with bending at the knees to maintain a neutral spine. Once the first side is in place the driver using the handle to pivot the top leaf is then required to unfold the ramp and likewise position using the bended knee procedure. Once the passenger has negotiated their way the procedure is reversed (Fig. 10a). 20 seconds from ramp deployment to stowed position is the expected timeframe.

As a result of the time schedule need for a timely execution of the task drivers have developed a safe way to speed up this process (Fig. 10b). By raising the first ramp leaf to a 90° position and then pivoting the ramp to a vertical position using the station side lower edge closing of the bi-fold readies the ramp to be stowed. This is not official practice but employed as a conscious improvement to better current practice.

4.1.3. Safety – limiting risk

Observing the ramp deployment process reveals a number of instances where driver service is disrupted and potentially hazardous. A driver is required to first ensure the brake is applied to the train and an immobilising procedure via a switch and/or key removal is initiated. The driver is required to safely exit the carriage via the driver side cab entrance as per protocol onto the platform. In particular circumstances the need to lock the cab is done with a security key on the drivers' person. At this point if the key set is dropped the likelihood is the keys will fall between carriage and platform onto the tracks.

Track occupational protocol requires the incident be reported to the train controller prior to attempting to recover keys - the result is significant delays. Once exited from the cab the driver follows an 'unattended cab' policy whereas the cab is required to be secured should the driver leave a three metre radially distance from the cab. Any delay in excess of 3 minutes will affect the network train schedule timetable.

Occupation health and safety risks and personal injury in deploying the ramp occurs through incorrect lifting, uncontrolled collapsing of the ramp resulting in crush injuries and lacerations from damaged aluminium surfaces. Potential falls from uncontrolled footing can occur via external elements particularly gusts of wind and slippages due to wet conditions. Design development utilising perforations or alternative ramp surfaces could be investigated to alleviate some of the surface pressure acting on the ramp from gusts.

4.1.4. Passenger interactions

Driver assisted boarding allows for direct communication with the passenger and is an opportune moment to establish destination information. The passenger is expected to present a 'reminder sticker' with destination and other pertinent information; this is to be carried on their person. Once received by the driver it is used as a visual reminder through the duration of the trip. Indicators such as a boarding assistance wallet are available free in Sydney, NSW likewise a reflective ticket wallet in Adelaide, SA. These also visually identify passengers in need of assistance when presented to an approaching train driver. Melbourne uses a sticker with variable success (MTM 2012, pers.comm., 18 March).

Figure 11 (left): Image of boarding assistance wallet (retrieved from http://www.cityrail.info/travelling_with/accessible_services/boarding_on 15th April 2013)

Figure 12 (right): Image of reminder sticker in use in Melbourne (Moug 2013)



Passenger interactions can be less genial. Interviews conducted with drivers at MTM revealed that assisted boarding can expose the driver to potential verbal abuse and threats or physical altercations with discourteous passengers. Disorderly engagement or use of an assistance device by unintended passengers throughout the deployment and stowing process could cause further driver discomfort particularly throughout the lifting process (MTM 2012, pers.comm., 18 March).

4.1.5. Planning for independent access in stations

Provision of independent access services in the current rail environment across Australia is of similar standard. Areas for assisted boarding are commonly communicated through the marking out of the International Symbol for Access.

As in Victoria, rail operators in Queensland, New South Wales, and South Australia and Western Australia offer ramp assisted boarding at a prescribed location. The exception to driver assisted boarding in Queensland and New South Wales as previously described where assistance is facilitated by the guard. In Melbourne where wheelchair passengers are routinely using public transport as is the case at Ringwood and Box Hill on Melbourne's Belgrave line station side assistance is delivered.

Initiatives around accessible services are underpinned by Disability Action plans encouraged in part by the Disability Discrimination Act (DDA 1992) and the DSAPT (2002). Such documents align cities and operators to improve the performance around access and user experience. Integrating or improving on the following standards into the current station design environment offers opportunity for improved mobility.

- high level platforms
- portable ramp
- guard assistance (NSW as indicated by a blue outside guard compartment and Queensland)
- station attendants (Adelaide SA)
- assisted boarding point (typically front carriage or the sixth carriage in NSW)
- spaces are usually located in the carriage in-front or behind the guard's cabin
- planning ahead web/phone
- disability access guide i.e. station meeting requirements
- companion card
- boarding assistance wallet

5. Conclusion

Melbourne rail stations continue to cause cross gap accessibility issues preventing independent access for mobility impaired public transport users. Operators in order to comply with the DSAPT (2002) are obligated to provide one hundred percent accessibility across rail infrastructure by 2022.

This research highlights the extent of discord between the DSAPT policy and the tangible operating environment.

- Using international research into cross-gap accessibility to assess the DSAPT maximum gap limit of 40mm x 15mm is has shown in the Melbourne rail context this is currently impractical.
- A quantitative analysis of Melbourne's station designs revealed how legacy issues of curved platforms present a problem to level boarding and cross gap variation.
- How the configuration of station entrance, boarding and platform layouts could be re-evaluated to incrementally support an accessible design solution at each entrance/exit to station and remaining two platform positions to service 100% of arriving or departing passengers.
- Multiple rolling stock designs will continue to compound Melbourne's access issues and should be examined prior to future purchase.
- Applying the standards of the DSAPT and VRIOGS with data from operational stations reveals functional limitations of a fixed ramp solution at legacy stations.
- Review of operator policy of single person operated train (SPOTS) demonstrated the usefulness of an integrated design solution removing occupational risks for the driver.

Current station design and driver tasks support further design exploration of alternative solutions for cross-gap accessibility at the platform edge within Melbourne. This research will inform further studio based design practice.

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