Designing the Home to Stay: 
A Comparison of Visitable, Adaptable and Universal Housing Design Approaches 
for Older Home Owners

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Designing the Home to Stay:  
A Comparison of Visitable, Adaptable and Universal Housing Design Approaches for Older Home Owners  

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Australia’s ageing home-owner population has a preference to remain living at home; but to do so, their housing needs to be designed to be safe, usable and accessible. Though making custom modifications to the home can make it safer and more accessible for a resident with reduced abilities; perceived disadvantages include high cost, unattractive appearance, reduced dwelling value, and difficulty of implementation. Addressing this are alternative design approaches applied during initial dwelling construction, such as Visitable Design, Adaptable Design and Universal Design. These design approaches are increasingly being promoted, and in some cases regulated, around the world; including in Australia. Prior analyses of the costs and benefits of these design approaches suggest their inclusion in the initial dwelling design adds minimal cost and is far more cost-effective than modifying conventional housing. However, publicly available information on the impact of these design changes and their costs on the development process, is limited.  

A cost-benefit analysis comparing Visitable, Adaptable and Universal housing design approaches with the traditional approach of modifying conventional housing, was undertaken as part of a research project on dwelling, land and neighbourhood use by older home owners funded by the Australian Housing and Urban Research Institute and the Commonwealth Department of Health and Ageing. Application of these design approaches to three dwelling types: a separate house, an attached house and an apartment in a current Australian residential development enabled an examination of the types of access features that are currently being included in leading residential developers’ dwelling designs; and the ease (or difficulty) of meeting Visitable, Adaptable and Universal criteria, while continuing to address market trends, consumer preferences and amenity in housing design. A detailed comparative costing of these approaches was also provided. This paper reports on the findings of this study, focusing on the design issues and their implications for wider implementation in Australia.
Introduction
The preference of Australia’s population of older home-owners is to remain living at home in their later years. Whether their choice of future home is the home they live in, either in its current form or changing it to better suit their household; or moving to another home, be this a smaller home, in another location, a senior’s residence in the general community or a retirement village; this environment needs to be usable, accessible and safe.

To provide a suitably designed home, both the dwelling itself and the surrounding neighbourhood, a range of design approaches have emerged. Custom modifications have been the traditional approach to providing a safer and more accessible home environment for a resident with reduced abilities; however, increasing demand and cost of modifications, combined with perceived disadvantages regarding their appearance, effect on property values and difficulty of implementation have led to alternative design approaches. These design approaches: Visitable, Adaptable and Universal Design consider the future needs of residents during the initial design process. Visitable housing designs provide the minimum critical features so a wheelchair user can enter the home, fit through the doorway and use the bathroom. Adaptable housing is designed to be Visitable at the time of construction, and then be easily and inexpensively modifiable in future to provide additional accessibility if required. Universal housing designs are also Visitable, but avoid the need for future modification by providing an accessible environment for people of all ages and the widest range of abilities from the start.

The national multi-disciplinary research project: ‘ Dwelling, Land and Neighbourhood Use by Older Homeowners’ (Judd, Olsberg, Quinn and Demirbilek, 2010), funded by the Australian Housing and Urban Research Institute [AHURI] and the Commonwealth Department of Health and Ageing [DoHA] examined these housing design approaches as part of its investigation of older Australian home owners’ experiences and expectations regarding their use of their home and neighbourhood as they age. A national survey of 1782 older residents, primarily homeowners, and in-depth interviews with 70 older homeowners in their homes (including 20 interviews with people from Culturally and Linguistically Diverse [CALD] backgrounds) revealed the majority of respondents considered it important that their own home and the home of their friends and family would meet their needs if they developed a disability or their need for assistance increased in the future. Having the home they are living in able to be modified easily and at low cost to meet needs was important to 85% of respondents; having a home that would meet needs without requiring any modifications was important to 78.4%; and more than two-thirds of the older home owners (67.9%) considered it important that they could move to a home that could better meet their needs. It was not just in their own home that it was important to provide access; 64.5 % of respondents considered it important that the homes of friends and family they like to visit had some critical wheelchair access features including no steps to the entrance, a toilet on the entry level of two-storey housing, a kitchen and living room on the entry level of two-storey housing, and/or a bedroom on the entry level of two-storey housing.

Though there is apparent consumer support for these design approaches, and previous analyses of the costs and benefits of these approaches indicates that consideration of accessibility in the original design of dwellings adds minimal cost; there remains concern within the housing industry regarding their implementation, marketability and cost. This research project included a cost-benefit analysis that sought to take a detailed, comparative examination of the effect on cost and the design and development process of including the features of each of these design approaches in a range of housing types. This paper reports on the findings to date, of the detailed design analysis of these design approaches when applied to these current housing designs, and discusses the implications for future implementation of these approaches in new Australian housing.

Design approaches
The ageing of the population and corresponding increase in disability, combined with the preference to remain living at home, is increasing the demand for modifications to older residents’ homes. Though limited statistical data is available regarding the overall number and cost of home modifications for older Australians, the Home and Community Care [HACC] Minimum Data Sets (Table 1) show that over the last 4 years, the number of HACC-funded home modification clients increased by more than
half, and total expenditure nearly doubled. It is expected that home modifications funded privately by residents would far exceed this amount.

Table 1 HACC-Funded Home Modifications in Australia#, Clients aged 65+

Source: Adapted from data in DoHA (2009), DoHA (2005).

<table>
<thead>
<tr>
<th>HACC Clients</th>
<th>Average cost of home modification</th>
<th>Total expenditure on home modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003-2004</td>
<td>18,457</td>
<td>$252</td>
</tr>
<tr>
<td>2007-2008</td>
<td>27,813</td>
<td>$328</td>
</tr>
<tr>
<td>% increase</td>
<td>50.7%</td>
<td>30.2%</td>
</tr>
</tbody>
</table>

Certainly, home modifications have been shown to assist in reducing the risk of falls (Kochera, 2002; Todd & Skelton, 2004) and promote independence (Kutty (2000) cited in Kochera, 2002, p5), but this approach has some apparent disadvantages. Modifications are perceived by some as costly, devaluing the property, unattractive in appearance, and being too much trouble to implement, which can lead to resistance to implementing them (Ohta & Ohta, 1997). Combined with the increasing cost and demand for modifications, these factors have contributed to the pursuit of alternative options to provide safe and accessible housing.

Adaptable Design, Universal Design and Visitable Design are three such alternative design approaches with a common objective: making housing accessible (Building Commission Victoria [BCV], 2002, p4), and considering this accessibility during the initial housing design and construction. Despite their shared goal, some common design features, and a tendency in the housing industry to use these terms interchangeably; their approaches are quite different.

**Visitable Design**

The objective of Visitable Design is twofold: to assist people in a wheelchair to visit the homes of their friends and families; and to provide the most critical access features in a person’s own home, avoiding difficult and costly changes if they are required in the future (Maisel, Smith and Steinfeld, 2008).

A Visitable home is marked by three core architectural conditions:
- One zero-step entrance at the front, back or side of the house, depending on site conditions
- Doorways that provide thirty-two inches of clearance
- At least a half bath on the main floor (Maisel et al, 2008, p1)

(Note: 32” is equal to 813mm and a half bath is a toilet and basin)

In the USA, Visitability has been implemented in several states through regulation and incentive methods, and national regulation is also being considered through “the Inclusive Home Design Act” (Maisel et al, 2008, p7).

The UK’s regulated basic access features in Part M of the building code specifies a similar list of requirements:

…a level or ramped approach to the dwelling, a level threshold and floor on the entry level, a toilet on the entry level (or main level if there are no habitable rooms on the entry level), hallways and doorways wide enough for a wheelchair, and power outlets, light switches and communication sockets at a specified height that can be reached by wheelchair users. Where the gradient of the site makes the level floor and the level or ramped approach to the dwelling unfeasible, the design of staircases with handrails for ease of access by ambulant users is specified (Office of the Deputy Prime Minister, 2004, cited in Quinn et al, 2008).
In Australia the requirement for Visitable housing is specified in Australian Standard ‘AS 4299-1995 Adaptable Housing’ [AS 4299]: at least one wheelchair accessible entry, a Visitable or Accessible toilet, and the circulation space at doors (minimum 800mm clear width) and on the path of travel (minimum 1000mm clear width in corridors) between the entry, living area and toilet to comply with AS 1428.1 (Standards Australia, 1995). Though not regulated, these access provisions are incorporated into some local government development controls, and further provisions have been considered for the Australian Building Code, including basic Visitability, a living space, food preparation space and bedroom space on the entry level, and potential for future installation of a lift or stair lift in multi-storey housing (Australian Network for Universal Housing Design [ANUHD], 2005).

Adaptable Design

In its simplest terms, Adaptable Design in housing refers to a dwelling that has been designed and constructed so that it can be easily and inexpensively modified in the future if required. The (non-mandatory) Australian Standard AS 4299 provides three schedules of design requirements, from Class C: the essential housing features, through to Class A: the essential housing features and all desirable features (Standards Australia, 1995). All Adaptable homes must be Visitable from the time of construction.

In the UK, a similar approach, ‘Lifetime Homes’ consists of 16 housing design features developed by the Joseph Rowntree Foundation [JRF]. Like Adaptable housing, Lifetime Homes are intended to provide an environment that will suit people with disabilities currently and in the future (JRF, 2007).

Universal Design

Universal Design in housing considers people of all ages and all abilities in design. It is “the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design” (Center for Universal Design [CUD], 1997). Unlike Adaptable Design, Universal Design should have all access features included right from the time of construction so that the need for future changes is avoided. The CUD’s original Principles of Universal Design (CUD, 1997) were followed by a list of design examples for housing. These are not (nor were they intended as) the definitive features of Universal Design. To design a dwelling that caters for people of all ages and the widest range of abilities would require all design aspects of the dwelling, from the site and location through to the fixtures and fittings. Recent doctoral research identified more than 200 individual performance criteria that would be relevant (Quinn, 2010). However, an industry preference for just a small set of the most critical Universal features; has led to a number of 10-feature housing guides being developed (ANUHD, 2008; DoHA, 2007, Nissim, 2008).

Cost-benefit analyses of these design approaches

Advocates for these design approaches claim that the cost of inclusion is minimal and far less than attempting to modify a conventional dwelling in the future. A cost-benefit analysis of implementing Class C requirements of AS 4299 Adaptable Housing (Hill, 1999) in a range of housing types confirmed the initial cost of incorporating AS 4299 Class C was minimal: less than 1% of total cost, and less than 6% if a lift was to be added in a small apartment block. The cost of modifying the Adaptable dwelling in the future was far lower than a regular dwelling. In a more recent cost analysis by Landcom (2008) the result was similar: the cost of including twelve ‘critical’ design elements of AS 4299 in typical project homes added only 1-2% to the initial construction cost (Landcom, 2008, p7). The findings of the Australian studies correspond to similar costing analyses of Lifetime Homes in the UK (JRF, 1997) and Visitable Design in the USA (Concrete Change, 2003; Maisel et al, 2008).

Despite evidence that the cost is minimal, there remains concern in industry that application of these design approaches remains too costly and lacks market support. In the USA, Visitability advocates’ cost analyses indicated that Visitable features added minimally to construction costs, yet housing industry groups’ analyses suggested that small dwellings would need a considerable increase in size and resulting cost. Examination of the design and costing methods used by the groups showed that they were using very different approaches to meeting the design criteria and calculating their cost (Maisel et al, 2008). Similarly in the UK, the industry perception that Lifetime Homes Standards
would greatly increase costs was found to be due to misinterpretation of the standards “or insufficient
time to think through how the standards can be incorporated without increasing the floor area of each
dwelling” (Sangster, 1997:5).

This suggests part of the problem with industry acceptance of these approaches could be due to a lack
of understanding between advocates and industry, regarding the design features that would meet
criteria, methods of implementing these features, how the implementation affects the design and
construction time and process, and the resulting costs. Certainly, recent Australian publications have
sought to provide information on design and construction methods (Building Commission Victoria,
2002; Landcom, 2008), though detail on costing of design features has been limited to theoretical
costs, if provided at all (Hill PDA, 1998; Landcom, 2008). This study aimed to provide additional
detail on the design and cost of housing features, and the effect of their implementation; to provide
further information for advocates and industry alike.

Method of housing design analysis
The study took a case-study approach, analysing the degree to which three current dwelling designs
complied with each design approach, then altering the designs so they did comply. The design
features and differences in cost were then recorded and analysed, and compared with the design and
cost of modifying these standard dwellings in the future.

Dwelling Designs
Three types of dwelling structures were chosen as the case studies for the analysis:
- a compact, two-storey, four-bedroom separate house with attached single garage;
- a two-storey, three-bedroom attached house with attached single garage;
- a two-bedroom apartment in a multi-storey block, with lift access and basement parking.

These dwellings were located in two recent master-planned estates in Sydney, developed by leading
Australian residential developer Delfin LendLease.

Each of the dwelling designs was initially examined to determine the degree to which it met each of
the three design approaches: Visitable, Adaptable and Universal. The design and construction
documentation, including where available: floor plans, elevations, schedule of finishes, electrical
specification and prime cost items [PC] schedule were the primary information sources; supplemented
by photographs and brochures. Each dwelling’s floorplan and relevant elevations were transferred into
a CAD software program, then altered to comply with each of the design approaches. In the redesign
of the dwellings, changes were minimised to preserve the assumed amenity and marketability of the
dwelling, and retain the high level of finish. Rooms and features were kept in or close to their current
positions, any reduction of room (particularly bedroom) sizes was avoided, and the floor area and
dwelling footprint was not altered.

Design criteria
A set of design criteria were selected for each of the design approaches, based on their perceived
applicability to the current Australian situation.

Adaptable Design
The features for Class C of Australian Standard AS 4299 were the source of Adaptable Design criteria.
There were two design scenarios for two storey dwellings: providing Class C access on the ground
floor only; and providing an accessible means of vertical travel to the first floor, then applying Class C
access to both floors. Following the responses in the earlier survey regarding the importance of the
dwelling being modified easily and at low cost to meet needs, the future adaptations were more
restricted than what is allowed for in AS 4299: no removal or replacement of fixed walls, no
construction or relocation of bathroom fixtures, and all adaptations being possible while the residents
remained living in the home.
**Visitable Design**

The Visitability design criteria were adopted directly from the definition in AS4299: a step-free entry, a Visitable toilet, and the circulation space at doors and on the path of travel between the entry, living area and toilet to comply with AS1428.1.

**Universal Design**

The three existing Australian guidelines for Universal Design, each specifying a slightly different set of 10 most critical housing features, were the source of the Universal Design criteria. The primary source was ‘Top 10 Features for All Stages of Life’ (DoHA, 2007), as well as ‘Top 10 Housing Features’ (ANUHD, 2008) and ‘Universal Housing Standard’ (Nissim, 2008). Some of the criteria in these sources consisted of measurable requirements, such as a minimum dimension for the clearance width of doors and corridors. However, the criteria were mostly expressed as design principles which were un-measurable. In these cases, corresponding performance requirements in Quinn’s ‘Universal and Flexible Housing Design Criteria’ (Quinn, 2010) were adopted.

**Home Modifications**

As home modifications are generally custom-made for the individual resident, a method of standardising the modification for comparison with the other design approaches was required. For the analysis, it was assumed that the modified dwelling would meet the criteria of Class C features in AS4299. In this scenario it was considered that the modification would be government-funded and would be required within the lifespan of the existing fitout (that is, renovation would not otherwise be needed). Thus, building changes and cost would need to be minimised.

**Costing method**

The costs of making the design alterations to each of the dwellings was calculated using ‘Cordell Housing Building Cost Guide – New South Wales December 2008’ [Cordell] (Reed Construction Data, 2008) and entered into a spreadsheet for each dwelling. Where the costs in Cordell were too general (eg. multiple door widths being assigned the same cost, or limited sizes provided for shower screens), or too detailed (eg. individual costs for each piece of plumbing pipe), industry quotes were obtained, or estimates were made. For the modification costing, a profit margin and GST needed to be added to material and labour costs. A nominal figure (allowing for factors such as economic climate, the size and complexity of modification work, supplier competition in the market and the builders’ and contractors’ costs) of 50% was selected as the margin.

The potential variation and impact of the margin for modification is a recognised limitation of this costing method, in addition to the limitations of Cordell data, variation in base costs due to the fluctuating cost of building, and discounts available for increased sales volume and supplier relationships. However, though these costs could differ from housing industry cases; this method of providing the full details in costing spreadsheets allows developers and builders to apply it to their own situation, using the spreadsheets with costing data from their own developments.

**Housing Designs and Costs**

In the design process for each dwelling design there was no attempt to use the same design solutions for the different design approaches: Visitable, Adaptable and Universal Design; and although home modifications were being designed to comply with post-adaptation AS 4299 requirements, the resulting Adaptable Design and home modification were quite different. The focus in each re-design was to provide the most cost-effective change while maintaining the quality of finish, marketability and amenity of the original design.

It was not the intent, and would be quite limiting, to consider only the differences in the overall design and cost between the design approaches. The following analysis takes an in-depth view, comparing a selection of individual criteria and their costs across the different design specifications. It is based on the designs and cost of the largest and smallest dwellings in the study: the two-bedroom apartment (Figure 1) and the four-bedroom separate house (Figure 2).
Figure 1 Apartment floorplan

Figure 2 House floorplan

Ground floor

First floor

Author: Joanne Quinn, Bruce Judd
Housing features

Accessible path to enter

The Visitable Design and Adaptable Design criteria required access to a (any) dwelling entry, while the Universal Design requirement was to have access to the main entry (Table 2). The implication of this variation was shown in the separate house design. For Visitable and Adaptable Design the accessible entry could be provided through the front living room doorway, and resulted in very little change. For Adaptability and Visitability, the only change to the path was lowering the existing door frame, and raising the fill and paving in the front courtyard. For Universal Design, the living room doorway could not be used as access was required through the main entry. The requirement for a 920mm wide door clearance (970mm door leaf) and 1525mm wide circulation was problematic in the narrow inset entry design; if the dwelling width cannot be increased, either the width of the living room or garage would need to be reduced by close to 200mm.

Table 2 Accessible path to entry in criteria for each design approach

<table>
<thead>
<tr>
<th>Design Approach</th>
<th>Accessible path to enter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visitable</td>
<td>A continuous accessible path of travel from street frontage and vehicle parking to entry complying with AS 1428.1</td>
</tr>
<tr>
<td>Adaptable</td>
<td>A continuous accessible path of travel from street frontage and vehicle parking to entry complying with AS 1428.1</td>
</tr>
<tr>
<td>Universal</td>
<td>A step-free pathway, 1200mm minimum width, connecting the parking space or the street to the main dwelling entrance.</td>
</tr>
<tr>
<td>Modification</td>
<td>A continuous accessible path of travel from street frontage and vehicle parking to entry complying with AS 1428.1</td>
</tr>
</tbody>
</table>

The apartment block had a local council requirement for lift access and an accessible path within common areas of the dwelling, so no costs were incurred in changing the design. Had this not been the case, the cost increase would have been substantial: potentially removing steps and regrading land between the street and foyer, widening common corridors, and providing a lift between the basement carpark, street and apartment. As a future modification, such a change could be impossible. The Visitable and Adaptable criteria allowed for the accessible entry to be any entry (Table 2). In this scenario, the accessible path could be through a service entrance or rear entrance, which might be appropriate for a house as in the case above, but would most likely be unsatisfactory for an apartment building. The Visitable and Adaptable criteria required the accessible path be provided from both the street and parking space, but the Universal criteria allowed the accessible path from either. Again, this could be unsatisfactory for an apartment building.

Doors

The criteria for clearance width of doorways differed between design approaches (Table 3). For the Visitable house entrance, the existing door set in the living room could be used. However, the Adaptable requirement for the clearance to be provided in a single independently operated door required a bi-fold door of the same dimension; a change costed at close to $400 at construction, or more than $2000 for later modification. The 970mm wide timber door leaf required for the Universal criteria needed to be custom made, at an increased cost near double the cost-increase of a ‘semi-standard’ 920mm wide door leaf.

Table 3 Clear door widths for entry/internal doors in criteria for each design approach

<table>
<thead>
<tr>
<th>Design Approach</th>
<th>Entry door</th>
<th>Internal doors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visitable</td>
<td>800mm</td>
<td>800mm</td>
</tr>
<tr>
<td>Adaptable</td>
<td>850mm</td>
<td>at least one entry door 820mm</td>
</tr>
<tr>
<td>Universal</td>
<td>920mm</td>
<td>main entry door 920mm</td>
</tr>
<tr>
<td>Modification</td>
<td>850mm</td>
<td>820mm</td>
</tr>
</tbody>
</table>

In the apartment the dwelling entrance door was already larger than standard: an 870mm wide, 45mm thick, steel fire-door. The Visitable 800mm clearance was provided with this door (and the supply cost of an 870mm wide door was identical to a ‘standard’ 820mm width door). For the 850mm...
Adaptable clearance, a 920mm wide door leaf was required; with an increase in door supply price of just over $60 at construction or more than $2600 for later modification of the doorway. For the Universal 920mm door clearance, the thicker door and fire-rated frame required a 1020mm door leaf, at an additional supply cost of close to $140. The effect of thicker doors and frames supports the specification of doorway clearance rather than door leaf size in design specifications.

In both the house and apartment most current internal doors were 820mm leaf. In the apartment, the increase in cost to an 870mm leaf to provide 800mm or 820mm clearance was minimal. However, to modify the doorways for 820mm clearance cost more than $700 per doorway. Though offset hinges could be used to increase the door openings, an 820mm door clearance could not be achieved on an 820mm leaf door.

Corridors and circulation at doors
The 1000mm corridor width required in the Visitable and Adaptable Design criteria could be achieved easily at construction. The wider 1200mm corridor for the Universal criteria had a major effect on design of surrounding areas, particularly adjacent room sizes; but was achievable at construction (Table 4).

Table 4 Minimum corridor width and circulation space at doorways

<table>
<thead>
<tr>
<th></th>
<th>Corridor minimum width</th>
<th>Circulation at doors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visitable</td>
<td>1000mm</td>
<td>Refer to measurements in AS 1428.1</td>
</tr>
<tr>
<td>Adaptable</td>
<td>1000mm</td>
<td>Refer to measurements in AS 1428.1</td>
</tr>
<tr>
<td>Universal</td>
<td>1200mm</td>
<td>1525mm turning circle</td>
</tr>
<tr>
<td>Modification</td>
<td>1000mm</td>
<td>Refer to measurements in AS 1428.1</td>
</tr>
</tbody>
</table>

However, more of an impact was made by the circulation requirements at doors (Table 4). The door circulation requirements in AS 4299 required that a series of door configuration tables be consulted in another standard: AS 1428.1, and the space requirements for each size of door be individually calculated (Figure 3). It did not consider rooms that have the approach from an angle, and did not provide dimensions for larger doors, open doorways, or automatic doors. The spaces required had major implications for bedrooms and bathrooms. Access to the first floor master and 4th bedroom could not be achieved without replacing the fixed wall with a temporary wall to which full length sliding doors could be added. An option for modification of the first floor was not provided in this analysis – to provide the required circulation space at doors as a modification would require removal of several walls and the re-finishing of flooring and ceilings.

Figure 3 Circulation spaces at doorways on a continuous accessible path of travel

Source: AS 1428.1-2001 (Standards Australia, 2001, Appendix C Figure C1)
In contrast, the Universal requirement of a 1525mm diameter turning circle at each doorway still had an impact on the space required but was far simpler to implement.

**Parking**
Of the three sets of design criteria, only Adaptable Design (and hence home modifications) had requirements for the size of the parking space. The two-bedroom apartment had two car spaces in the basement parking area, so a single vehicle could be easily accommodated in the adjacent spaces. In the house, the garage was 2.9-3.3 x 5.7 m, well short of the 3.8 x 6 m required by AS 4299. Due to the path adjacent to the driveway, adequate parking space could be provided outside the garage. However, this reduces amenity, and local council would be unlikely to allow an overhead cover to be constructed at the front of the property. Removing the dividing wall between the house and garage would be another possibility at construction, but full-length (more than 4m long) sliding doors with adequate fume sealing would be costly and are not widely available in the residential market.

**Bathrooms**
Neither the house nor apartment had a Visitable toilet in the initial design, yet in both cases it was straightforward to implement by relocating a wall. The inclusion of the accessible bathroom was far more problematic, due to the circulation space requirements for the toilet and shower, but was still readily achieved at the time of construction. However, when modifying the bathroom in the future, there was no choice other than demolishing the entire bathroom.

**Kitchen**
The apartment kitchen was an L-shape with island, needing to be moved to provide adequate circulation space for the design approaches, whereas the house kitchen was a U-style with more than 1700mm between opposite benches, and did not require enlargement. Both kitchens required changes to the pantry adjacent to the fridge, relocation of the under-bench oven to an in-wall position, and a variety of cabinet changes for both the Universal and Adaptable approach. In these scenarios, the design changes were very time consuming (particularly due to ambiguity in the AS 4299 specification) but readily achieved at minimal cost.

The modifications could be made without replacing the same benchtop and with minimal cabinet changes. However, the possibility of the current finishes such as cabinet door laminates, and floor and splashback tiles, being unavailable at the time of modification, could require otherwise unnecessary replacement to avoid a mismatched finish. Likewise the replacement of an otherwise suitable sink and appliances was costly. In the apartment the cost of the kitchen modification exceeded $12,000, more than ten-times the cost of the other design approaches.

**Bedroom**
The existing master bedrooms met the space requirements for the Adaptable and Universal Design criteria, so there was also no need for modification. In both the apartment and house, the master bedroom was provided with a walk-through wardrobe. Some design alteration was required to maintain usable space in this area when increasing the size of the adjacent ensuite. Though both bedrooms had space to accommodate a built-in robe instead, the loss of walk-through robe would potentially affect amenity and marketability.

Providing a bedroom space on the entry level of the house required a quite straightforward conversion of the front living room, with the addition of a doorway. This maintained the north-facing open plan living area adjoining the kitchen at the rear, and made use of the adjacent toilet facilities. As well as a living room or bedroom, the addition of a doorway made this space suitable as a home office.

**Implications for future housing**
In this analysis, virtually all of the design features to comply with the criteria in each housing design approach could be achieved within the existing floor area of the dwelling. Effort was made to minimise changes; keeping key features and functions in their existing locations and preserving the high level of finish so that the amenity and marketability of the original design would be maintained.
Nonetheless, some compromises were required and developers, builders and designers need to determine whether the new designs would be acceptable to the market.

Developing the dwelling designs to comply with the criteria for each of the new design approaches took a far greater design time than would be feasible in the commercial design process, even if the designer had specialist knowledge in this field. The most complex criteria to implement were the Adaptable features from Class C, AS 4299. This could partly be attributed to this list of criteria being the longest, but was also the result of ambiguity in the requirements, the need to constantly consult other Standards, particularly AS1428.1 and 1428.2, and the very large circulation space requirements at doors and within the bathroom. Also, two sets of designs and documentation were needed for the design at construction and at adaptation. Design time is generally not factored into cost analyses (including this one), yet is an important issue for designers, developers and builders. If new design criteria are to be more widely implemented (whether through regulation or incentives) they need to be communicated in a self-contained document and have only the critical requirements so they are flexible for the widest range of dwelling configurations.

When comparing the Adaptable and Universal Design approaches, Universal Design: designing all of the accessible features in prior to construction; was preferable in terms of the cost and the design time. This study took a more restrictive approach towards adaptation than the current AS 4299, avoiding any changes to plumbing and replacement of walls at the time of adaptation; yet even the relatively minor adaptations could be resisted by residents. For example, replacing a wardrobe to provide additional circulation space at a bedroom door or discarding the undersized glass shower screen, could be perceived as wasteful if the original items are still in good condition. This perception of waste could well be magnified when modifying the conventional dwelling. Also, some changes such as making the first floor accessible would be near impossible without demolishing virtually the entire interior space, primarily due to the circulation space requirements.

Whether to provide access to the first floor of a two-storey dwelling or the ground level only would depend on the dwelling design and the household. In this analysis it was far simpler to focus solely on the ground floor of the house for access, not least because there was a suitably sized and located living room available, with an adjacent laundry-toilet ready for conversion to a bathroom. However, the ground floor was less than half of the total dwelling floor space, so a person who could not use stairs would be restricted to a small area and would be a considerable distance away from the other bedrooms if overnight care was required. A lift would be required to make use of the first floor, and even a basic model installed in the existing house void exceeded $60,000. Lift suppliers contacted for quotes during the project claimed that lift costs have come down in recent years, but the feasibility of lifts in project homes is dependent on future demand and resulting lowering of costs.

A comparison of the same design criteria in the apartment and the separate house showed that access requirements could differ between dwelling types. This was particularly the case for the method of entry to the dwelling. In a house it could be quite acceptable to provide the accessible entry via an entrance other than the main entrance, e.g. through the alternate living room entry, through the adjacent internal garage or even a rear door, depending on lot size and layout. However, in an apartment block, providing access only via a carpark or an entry door without an equal presence (eg, through a utility area or fire escape) would most likely be unacceptable. This suggests that when developing design criteria in future, the needs of all dwelling types need to be investigated and included.

The availability of products had a direct bearing on implementation of the design approaches. For example:

- a sink which met the maximum 150mm bowl depth in the AS 4299 criteria could not be identified in the Australian market;
- a suitable sliding door system with an acoustic seal (a basic requirements for use in a bathroom) could not be sourced;
the narrow garage attached to the house could be opened up with sliding doors to provided adjacent interior circulation space, but well-sealed sliding doors were needed and not readily available

- to fit a dishwasher under a lowered kitchen bench, the only dishwasher option was one brand of drawer-style washer (other than a miniature bench top model).

This suggests that product availability needs to be considered in the development and the updating of design criteria, and highlights many opportunities for new products in the Australian market.

The requirement for non-slip flooring in the dwellings highlighted specific problems in measuring slip resistance, as well as a need for measurable performance requirements and differences in implementation between contract and project housing. Relatively few ranges of tiles are currently tested for slip resistance (commercial tiles) and even so, there is no current clear requirement of slip resistance in Australian Standards, only a recommendation in HB 197 of slip resistance for different commercial applications. R10 was taken as the measure for slip resistance in the project, and R10 tiles were quoted at a similar price for regular porcelain floor tiles. Whereas an architect could specify this tiling to be used in an apartment, project home customers generally select their own tiling within a set price range or pay for alternative tiling. In the absence of regulation it suggests a need for educating both designers and consumers regarding the importance of appropriate tiling selection.

**Conclusion**

The cost-benefit analysis comparing Visitable Design, Adaptable Design and Universal Design with the home modifications undertaken as part of the Dwelling, Land and Neighbourhood Use by Older Home Owners project involved detailed design and costing of dwelling features in these approaches, an a range of housing types. The housing design cost results to date are confirming the results of previous Australian and international cost analyses: that allowing for access in the initial construction of a dwelling is more cost-effective than making changes in the future.

By taking a more detailed view of the design and cost effects of applying these design approaches to actual case study dwelling designs, several issues regarding their feasibility were raised. Most important among these were:

- Increasing access features in the initial construction of the dwelling reduced initial design time and cost compared to planning for these features in future adaptations, as well as reducing future cost and otherwise unnecessary replacement of fixtures and fittings. Limiting the amount and cost of future adaptation also fits the preferred approach of older home owners, revealed in the survey.
- There was a lack of consistency between the same design criteria in the different design approaches, and these different requirements had a considerable effect on whether the existing dwellings were already suitable, and the degree of changes required. It highlighted the need for reliable anthropometric data for dwelling residents of all ages and abilities to be incorporated into design criteria for the each of the design approaches in future.
- Complexity and ambiguity in design criteria had a considerable effect on design time; particularly when there was a need to consult additional Australian Standards and make individual calculations of measurements for design features. To ensure that implementing new design approaches is feasible within the time constraints of commercial housing development, design criteria need to be provided in a clear, self-contained format.

In addition, the development of detailed design and costing documentation for all design changes required to meet the different design criteria, adds to the current Australian information on design and construction processes for providing more accessible housing. It is a method that could give builders and developers the opportunity to assess the suitability of these design approaches for their own market, housing, and costing conditions.
References


Author: Joanne Quinn, Bruce Judd


