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Designing a “Think-Along Dwelling” for People With Dementia: A Co-Creation Project Between Health Care and the Building Services Sector

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Designing a “Think-Along Dwelling” for People With Dementia: A Co-Creation Project Between Health Care and the Building Services Sector

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Ageing-in-place is the preferred way of living for older individuals in an ageing society. It can be facilitated through architectural and technological solutions in the home environment. Dementia poses additional challenges when designing, constructing, or retrofitting housing facilities that support ageing-in-place. Older adults with dementia and their partners ask for living environments that support independence, compensate for declining and vitality, and lower the burden of family care. This study reports the design process of a demonstration home for people with dementia through performing a literature review and focus group sessions. This design incorporates modifications in terms of architecture, interior design, the indoor environment, and technological solutions. Current design guidelines are frequently based on small-scale studies, and, therefore, more systematic field research should be performed to provide further evidence for the efficacy of solutions. The dwellings of people with dementia are used to investigate the many aspects of supportive living environments for older adults with dementia

The members of the focus groups are acknowledged for their contribution. The authors wish to thank OTIB (*Opleidings- en ontwikkelingsfonds voor het Technisch InstallatieBedrijf*) in Woerden, The Netherlands; and the Dutch Alzheimer Society (*Stichting Alzheimer Nederland*) in Bunnik, The Netherlands for their contributions during the course of the project, and Hugo van den Beld for guiding the focus group sessions.

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and as educational and training settings for professionals from the fields of nursing, construction, and building services engineering.

KEYWORDS *architecture, Alzheimer, home modification, independence, ageing in place, adaptation*

The majority of older people want to remain living in the community. Ageing-in-place can be defined as the ability to live in the private home for as long as confidently and comfortably possible. To enable older adults to age-in-place, individuals may receive support for instrumental activities of daily living and physical activity. In addition, homes are being modified and individuals are receiving technological solutions (Stefanov, Bien, & Bang, 2004). All of these interventions may, to a certain extent, facilitate ageing-in-place, depending on one's health status.

A special group of older adults deal with dementia. Alzheimer Europe (2006b) reported that the number of citizens with dementia in the EU-28 ranges from 5.5 to 6.15 million. These figures are based on studies by Ferri et al. (2005) and Hofman et al. (1991). Wimo et al. (2007) estimated that the total societal cost¹ of dementia care in the EU was €54.3 billion, or approximately €14,200 per person. Contrary to popular belief and despite the enormous costs associated with dementia care, the majority of Europeans with dementia reside in the community (van Hoof, Kort, & van Waarde, 2009). Additional support is given through family care, which represents a great societal and economic value (€26.8 billion for the EU, or €4,700 per person with dementia) (Wimo et al., 2007).

Ageing-in-place is a strategy that is prioritized by national and municipal policies in The Netherlands. Ageing-in-place is actively stimulated as the capacity of institutional settings as nursing homes is under pressure. Contrary to popular belief, about two-thirds of the people with dementia in The Netherlands live at home. To a large extent, they are dependent on family care, which is supplemented by professional care (Health Council of The Netherlands, 2002). Charness and Holley (2001) concluded that "[t]he majority of persons with Alzheimer's disease dwell at home. . . . So, when considering design issues, the first stop is going to be at the home" (p. S69). In short, older adults with dementia need homes that support ageing-in-place and the provision of care at home.

There are numerous behavioral and psychological symptoms in dementia (Mace & Rabins, 2006). These symptoms may have implications for daily living and the use of the home. Some of the most prominent symptoms include impaired wayfinding and wandering, difficulties with understanding,

¹ All cost figures by Wimo, Winblad, and Jönsson (2007) have been recalculated from US\$ figures at a rate of €1 = US\$1.27.

TABLE 1 Overview of Symptoms Among People With Dementia and the Percentages of Carers for Whom These Symptoms Cause Problems (Alzheimer Europe, 2006b)

Current Symptoms		Most Problematic Symptoms for Carers to Cope With	
Activities of daily living (96%)	Finding belongings (77%); financial activities (74%); shopping (73%); showering/bathing (71%); cooking (70%); using telephone (69%)	Activities of daily living (68%)	Showering/bathing (25%); being left alone (20%); incontinence (19%); finding belongings (16%); moving in general (14%); sleeping (12%)
Cognition (93%)	Memory/confusion (87%); concentration/attention (78%); orientation/getting lost (63%); recognizing people (54%)	Behavior (50%)	Agitation/aggression (16%); personality changes (16%); irritability (11%); wandering/restlessness (10%); depression (8%)
Behavior (89%)	Social withdrawal (50%); personality changes (47%); wandering (44%); lack of energy (43%); irritability (40%)	Cognition (45%)	Memory/confusion (32%); concentration/attention (12%); orientation (12%); recognizing people (7%)
Communication (88%)	Following conversation (74%); writing/reading (70%); comprehension of language (49%); speaking (47%)	Communication (36%)	Following conversation (16%); comprehension of language (14%); speaking (12%); writing/reading (3%)

poor judgment, the inability to recognize, disorientation, loneliness, restlessness, misplacing items, hiding things and hoarding, shadowing, declining social skills, and eating inappropriate items (Table 1). These symptoms are not seen in all individuals with dementia, and not all problems are equally difficult to cope with by carers (Alzheimer Europe, 2006a). However, the symptoms can be a source of concern for relatives and influence ageing-in-place in a challenging way. Some of these problems can be addressed by the design of the home environment and appropriate environmental interventions.

Traditional modifications and technologies primarily provide a solution for individuals with impaired mobility. This means that the homes that have undergone modifications or have been designed according to the needs of

older adults, such as single-level homes, are not fully supportive to individuals with dementia and their family carers. To add to this challenge, there is a shortage in the number of homes with basic modifications. According to de Klerk (2004), one of three older individuals with severe physical limitations in The Netherlands (100,000 individuals) does not live in a suitable dwelling. De Klerk (2004) further concluded that approximately 25% of nursing home residents might be able to age-in-place in the community if adapted homes are provided. Silverstein, Hyde, and Ohta (1993) studied the implementation of recommended adaptations ($n = 501$) for dementia in practice. It was concluded that target problems addressed were cognitive and behavioral impairments, safety, carer ease, and impairments in activities of daily living. On average, 25 recommendations were made per household, with a range of 1 to 53 recommendations. Thus, providing home modifications for impaired mobility is not sufficient. Given these figures, which represent demand and supply, it is important to consider adapting dwellings of older adults with dementia more than ever before.

Being able to age-in-place is largely dependent on the availability of family carers. Because many of the family carers of individuals with dementia are aged 65 years and older, they may cope with health problems that stem from biological ageing or a chronic disease themselves. The home has a profound influence on the care for individuals with dementia; therefore, family carers may ask for environmental interventions that support care (Duijnste, 1992). Warner (2000) stated:

We must be realistic. Alzheimer's is a disease of the mind, not of the home. The environment is not a treatment, and it offers no cure. But many problems related to the disease can be lessened for the person with [Alzheimer's disease] and especially for the caregiver by making changes in the home environment. (pp. 2–3)

The fewer barriers in the home, the easier and less burdensome family care can be. Family carers also play a crucial role in having home modifications performed. To fulfill this task, they need adequate information. A small number of publications provide family carers with practical information on how to implement environmental interventions at home (Blom, Tjadens, & Withagen, 2000; Kort, van Hoof, Bronsveld, & Blom, 2010; the Ministry of Community and Social Services, 1990; Rommel, Declerq, De Clerq, Van Audenhove, & Lammertyn, 1998). Ideally, these changes to the home environment should be supported by scientific evidence through evidence-based building. According to Zimring and Bosch (2008), evidence-based design is derived from evidence-based medicine. Evidence-based medicine makes use of clinical protocols resulting from systematic reviews of research literature evaluating the quality and quantity of research supporting the efficacy of specific clinical decisions, project evaluations, and evidence collected by

operations of the client. Practice-based evidence and experiences are other sources of knowledge. The role of the built environment in relation to the well-being of patients and support of health care is a growing concern among health care providers, environmental psychologists, consultants, and architects (Devlin & Arneill, 2003; Huisman, Morales, van Hoof, & Kort, 2012).

The increasing number of older people with dementia and their family carers poses challenges in terms of creating suitable living environments and appropriate housing facilities. Supportive housing facilities are not only practically nonexistent, but there are few studies and documents focusing on how such housing facilities should be designed and built for individuals with dementia (Blom et al., 2000; Ministry of Community and Social Services, 1990; Rommel et al., 1998; van Hoof, Kort, van Waarde, & Blom, 2010). There are publications on the design of institutional facilities (Cohen & Weisman, 1991; Stroobants & Verhaest, 2012), but these are not always useful when designing homes. In addition, demonstration homes are few in number and often linked to university research programs. There is a need to develop homes for community-dwelling older adults with dementia, which accounts for the decline of one's health and cognitive functioning. The importance is that the home's design and technological solutions support activities of daily living, reduce the incidence of problem behaviors, reduce the burden of care on family carers, and delay the demand for professional care for individuals with dementia (Meiland et al., 2012; van Hoof, Kort, van Waarde, et al., 2010).

Therefore, the aim of this study was to design a home for people with dementia that aims to support ageing-in-place that could be used as a demonstration dwelling for training and education. The study deals with the development and design process of this conceptual home and addresses and integrates the following aspects of the home environment: architectural and interior design; the physical indoor environment; and technological solutions connected to the dwelling.

METHODOLOGY

Within the innovation program Technology@Home (*Technologie Thuis Nu!*), a collaboration of *Hogeschool Utrecht*, *OTIB*, *Uneto-Vni*, *Stichting Innovatie Alliantie*, and *Taskforce Innovatie Regio Utrecht*, an indoor miniature neighborhood was constructed in the Dutch town of Woerden. This neighborhood serves as a test ground for the building services sector to explore existing technological solutions for health care challenges, which enables people to age-in-place. This program shows the importance of the building services sector for the domain of health care and provides a valuable resource for housing corporations, education, and future occupants. One of the projects within the program was the design and development of a home for an older

couple wherein one of the partners has dementia. This dwelling should integrate existing technologies and evidence-based solutions to create a safe, secure, and comfortable home. The goals of the dwelling are to inspire professionals with a background in health care, housing, construction, and building services engineering about the possibilities of the built environment and to translate findings from science into a tangible home that people can experience in a three-dimensional fashion. By visiting the demonstration dwelling, identified solutions can then find their way into practice. This dwelling was officially opened April 26, 2012.

The dwelling had to meet several conditions. First, the design needed to be suitable for habitation by a couple with one spouses with early-stage dementia. The design for the dwelling for people with dementia should demonstrate that the integration of architectural and technological solutions can be achieved within a single design. The home had to be designed in such a way that it complied with the regulations stated in the Dutch Building Code and it fit within the limits for qualification for rent allowance. If one resides in a rented accommodation and his or her personal income is below a certain level, it may be possible to qualify for rent allowance in The Netherlands. Two other building-related application conditions are that the home concerns an independent accommodation with its own entrance, bathroom, and kitchen and that the rental price must be within a certain range, which depends on the size and features of the home. The dwelling in this project has a surface area of approximately 60 square meters (size of final design 57 m²), which is a normal-sized home for older people. Another condition was that the home could also be used with other target groups, such as parents with a disabled child or first-time buyers just getting into the housing market, although claims of efficacy would then need to be researched in more depth. The home should not be designed as a dementia dwelling, but rather more like a think-along dwelling to minimize stigmatization and increase its applicability range. For example, the design needed to be such that the home could be located along a corridor in a larger apartment block. Moreover, the design features should be an added value to family carers so that a spouse with dementia is more independent and is being monitored and supported by technology and feels more comfortable and expresses fewer behavioral problems.

The design of the dwelling was based on literature research, and focus group sessions with experts in the field of dementia and housing for older adults. The literature study was conducted as part of the doctoral work of one of the authors (van Hoof, 2010). This work identified a large number of environmental interventions that originated in design goals and principles for dementia and conventional home modification practice (van Hoof, Kort, van Waarde, et al., 2010). Based on the literature study, a preliminary concept of a dwelling was designed and presented by van Hoof and Kort (2009). Based on the experiences of the Technology@Home program, this preliminary design

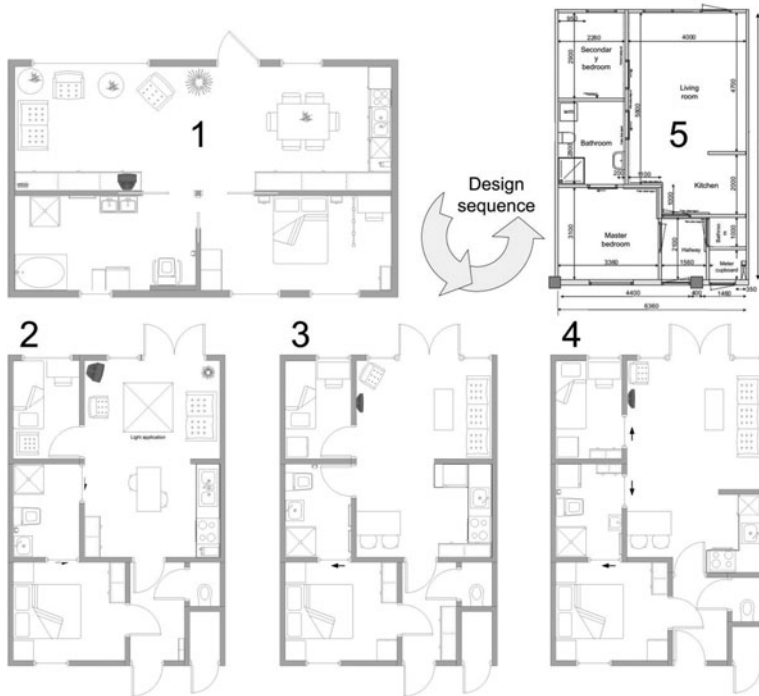


FIGURE 1 Design sequence of the dementia demonstration dwelling. The starting point was the design by Van Hoof and Kort (2009) (1). This design was adapted to fit the dimensions of the site it was going to be built on (2). A small table is introduced in the kitchen area (3). There was still a discussion on the use of sliding doors, the layout of the bathroom and the size and layout of the kitchen area (4). The final design is shown (5).

was altered (Figure 1). For example, an entrance hall was added to the design, as well as a separate bedroom and a different layout of the kitchen (Figures 2 and 3). The features and rationale behind these design solutions were described on an A4-sized leaflet. The improved design was the basis of the focus group sessions, which consisted of two workshop rounds.

The first focus group was held on June 29, 2011, with 12 participants, and the second on September 14, 2011, with 6 participants. These participants have a background in design of buildings for older individuals or care for people with dementia. Both sessions lasted for 3.5 hours and resulted into amendments to the home's design (Figure 1). The sessions were supervised by a session coordinator, and minutes were recorded by a secretary. The focus group members consisted of representatives of various patient organizations and organizations for the aged with expertise from the field of care and home modifications. The members of the focus groups had extensive knowledge of home modifications and user needs and had long-standing experience with dementia and the ageing process. The members were invited to provide feedback on the presented designs and their programs (design

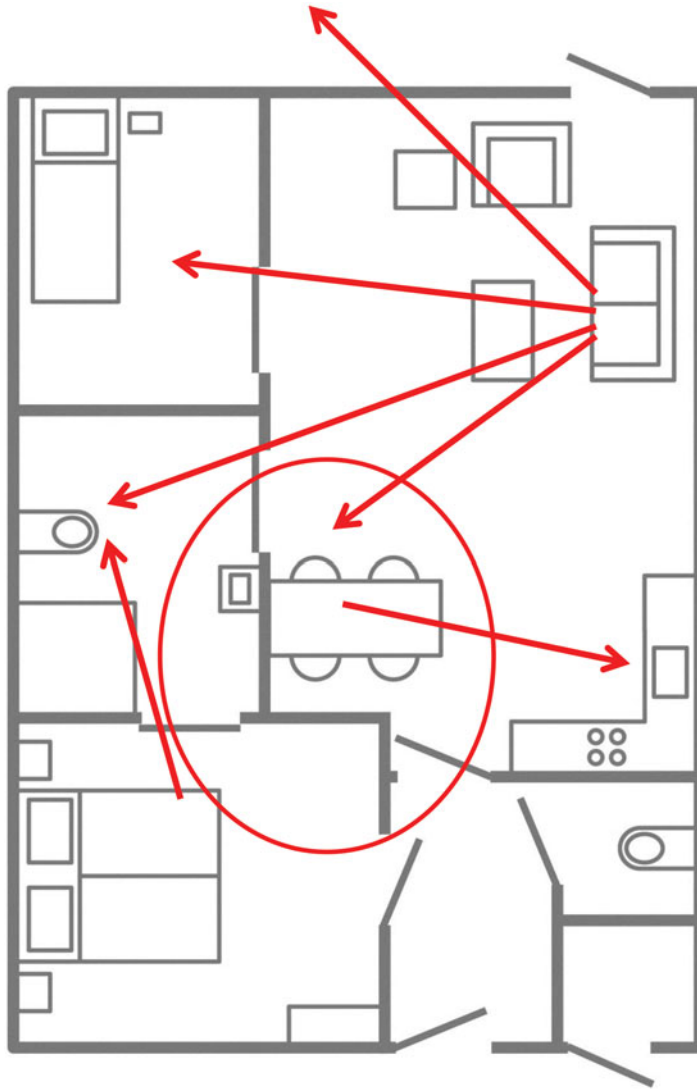


FIGURE 2 Schematic representation of sightlines and circular pacing route in the dwelling (color figure available online).

features) and to bring various notions concerning the home environment and related design solutions together. Apart from providing feedback on the design proposals, the members proposed additional design principles they knew from daily practice. Problems indicated by the focus group were studied and new design solutions were sought to address these problems.

During the first session, the focus group members went to visit the other demonstration dwellings with the Technology@Home program and the location where the new home had to be built. Thereafter, the main investigator

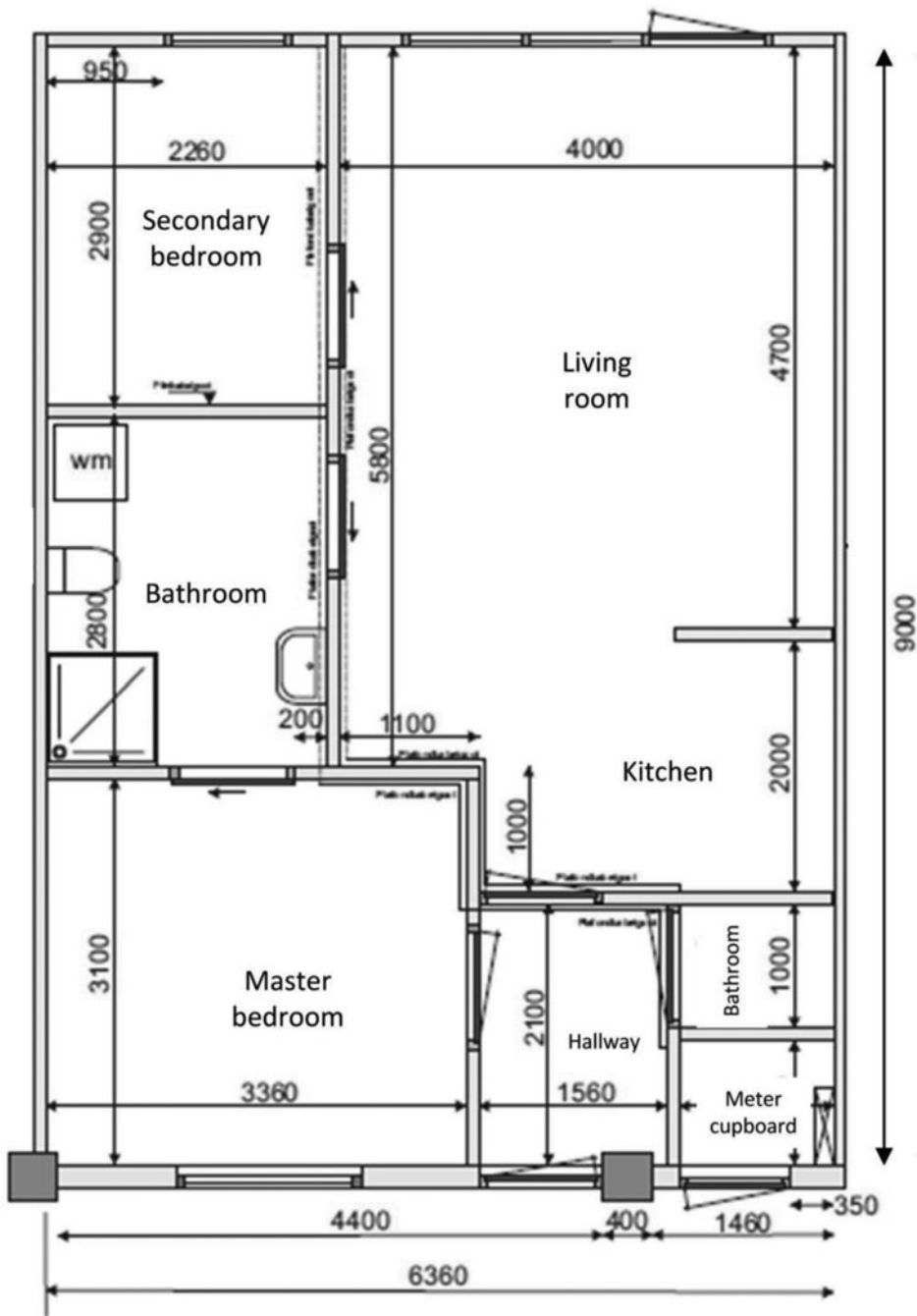


FIGURE 3 Layout of the dwelling. Adapted with permission from Bouwbedrijf Vendrig, Montfoort, The Netherlands.

presented the initial design of the dwelling for individuals with dementia to the focus group members. The aforementioned leaflet was handed out to all members. The presentation was followed by two half-hour sessions in which couples commented on the architectural features of the rooms in the dwelling in six configurations, namely: living room and kitchen; living room and bedroom; living room and hall; living room and secondary bedroom; kitchen and sanitary rooms; and bedroom and sanitary rooms. Each of the two sessions thus dealt with two rooms at a time, so that every member discussed at least 4 spaces. Feedback was written down on a paper template. The outcomes of these one-to-one discussions were later shared in a plenary session. Based on the results of this session, the preliminary design was altered. The main points of feedback concerned the lighting in the living room, the use of sliding doors, the positioning of plug sockets, the type of doors leading to the garden, the location of the television, the type of heating system, the size of the storage space, the kitchen and its use by older adults, the secondary room and its functions (such as withdrawing), downsizing the hall, the floor covering of the bedroom, the type of walls (metal stud partitions), the positioning of the washbasin and shower in the bathroom, the exhaust systems, and the infrastructure needed for sensor-based networks and cameras. Most of the features had already been included in the preliminary design and thus were a mere elicitation of the design's description.

During the second focus group session, the updated design was again presented. The main points of feedback were shared with the group. The focus of the second session was on the interior design, such as color schemes, use of materials, lighting, technology and home automation, and the layout of the furniture. Again, two rounds for collecting feedback were held, bearing in mind that the main criteria for choosing design options were related to improving comfort and safety and security. Templates for providing feedback were handed out for the various rooms of the dwelling. Thereafter, results were discussed in a plenary session.

RESULTS

The home's design is described as a sequence of spaces, in which each space is used for specific activities by the residents. The layout of the dwelling is shown in Figures 2 and 3. The home can be accessed via a small hallway, providing access to a toilet space, the main living room, and the master bedroom. The meter cupboard is placed externally. An important feature is the open plan living room. Occupants can observe all parts of the dwelling from almost all positions in the home and thus can watch each other. The wide sliding doors in the center of the home can be easily operated and allow a view of the toilet from the living room. The bathroom is wheelchair-accessible and is equipped with modified sanitary equipment. There is a

shortcut between the master bedroom and the bathroom in the form of a sliding door. The kitchen is positioned in the living room and includes design features to improve safety and security. The partner with dementia can sit and participate in easy food preparation tasks. A second bedroom offers a room for the caring partner to retreat to or can function as a timeout room for the person with dementia. The main design solutions are summarized in Table 2. The majority of design solutions are taken from van Hoof, Kort, van Waarde, et al. (2010). That document provides extensive lists of environmental solutions for individuals with dementia and a full list of references. These environmental interventions are related to toileting, bathing and personal care, dressing and doing laundry, sleeping, cooking, dining, general safety and security-related interventions at home, and assistance with perception, orientation, and memory.

Front Door

There are three visible ways of opening the front door. Apart from the regular doorbell, there is a numerical lock that can be used by care professionals during work shift or in cases of emergency (Figure 4). The door handle is a senior lock, wherein the keyhole is located above the actual handle, which improves its visibility. By using electronic systems for opening doors, homeowners can decide who they want to grant access. The camera, which is located next to the door, allows you to see who is at the door and to open the door from a distance. Inside the dwelling, the front door can be opened via an app (for a tablet computer) in cases of emergency, including a fire. At the same time, doors can remain shut when unknown individuals or salesmen are standing in front of the door. This was an explicit desire of the focus group. These ambient intelligence technologies can contribute to an increase in safety and security among individuals with dementia and their family carers (van Hoof, Kort, Rutten, & Duijnste, 2011; van Hoof, Wouters, Marston, Vanrumste, & Overdiep, 2011). People with dementia may have difficulty understanding the technology though. Privacy-related issues and ethical dilemmas are not found to be a concern in practice as long as the home owners are in control.

External Meter Cupboard

The entrance to the home's meter cupboard is placed externally (Figure 5), mainly for safety and thoughts expressed by Adlam et al. (2004). This design is also a way to minimize unrest when building services workers need to be inside the meter cupboard. Workers do not need to come inside the home, and external placement allows for easy access. The external meter cupboard is the central point for amenities as electricity, water, and gas. There is a special valve in the gas pipe that can be switched off with a key switch

TABLE 2 Main Technological Focus Points of the Dwelling

Front door	Camera Doorbell Numeric lock Door can be opened and locked with an app for a tablet computer (family carers)
External meter cupboard	Automated shut-off valve for gas Storage space for wheeled walked Home automation systems Fire alarm
Hallway	Front door, coat rack (wandering) and ‘home-switch’ camouflaged by curtain Turning directions of the doors are such that they prevent individuals from leaving the home during wandering
Toilet space	Separate toilet for guest, and for person with dementia at night Lock can be opened from outside Electricity available for shower toilet
Kitchen	Open lay-out kitchen Tap with blue and red markers for hot and cold Valve to limit water temperature (up to 40°C) Hob (gas) with barrier for pans Shut-off valve for gas (key) Electrical connection present for electrical hob in the future Protective covers inside plug sockets Magnetic locks on cupboards Waste container inside cupboard Sieve placed in the drainage
Living room	Ceiling-mounted luminaires for light therapy Large (lifter)chair placed near windows Curtains, blocking daylight Infrastructure along the ceiling for data and electrical wiring Small dining table with memory board Telephone with large touch buttons Analogue clock Imitation hearth
Second bedroom	Door frames painted in contrasting colors Wide sliding door for sight lines with second bedroom or time-out room
Bathroom	Wide sliding door for optional sight lines during daytime with toilet Short walking distance to toilet and bathroom appliances Design radiator for towels Container for incontinence material Raised washing machine Height adjustable toilet with flush buttons Colour contrasts applied to toilet bowl, seat, and tiles, for better orientation Roll-in shower with robust shower curtain and rails, no threshold Hand-held shower, turning handles on tap Anti-slip tiles
Master bedroom	Sight line and short walking distance to bathroom Door frames painted in contrasting colors Darkening curtains
Miscellaneous	Absence of thresholds Rough floor covering Turning direction of doors is such that people can walk in circles during pacing Radiant floor heating instead of radiators Thermostats for separate rooms Fire alarms in every room Data access points in every room Use of color contrast and pictograms

in the home's hallway. By turning this key, the home is switched to its safe mode. This happens automatically in cases of a fire or emergency. The central appliances for home automation and the home's fire alarm system are located inside this meter cupboard. The space can also be used as a storage space for dangerous items, such as cleaning agents, or for storing valuable items in a vault. Many older adults cope with diminishing mobility and begin using assistive devices. There is sufficient storage space for mobility aids, such as wheeled walkers, in this room. These practical solutions were incorporated in the design based on the opinions of the focus group members.

Hallway

To limit the chances for wandering behavior, the coat rack and the front door are placed out of sight via a curtain (Figure 6) (Blom et al., 2000; Ministry of Community and Social Services, 1990; Zgola, 1990). Having a curtain takes away stimuli to leave the home. However, this solution is subject to debate. In a review on the effects of subjective exit modifications to prevent wandering, Price, Hermans, and Grimley Evans (2007) concluded that studies on this matter were unsatisfactory and vulnerable to bias. There



FIGURE 4 Numerical lock next to the regular doorbell (color figure available online).

was not sufficient evidence that camouflaging doors was effective in reducing wandering behavior. The study also states that subjective barriers may cause fear and anxiety in some individuals with dementia. Locking people into their home also has ethical dilemmas, but the risks of accidents happening on the street are taken away. In compliance with Blom et al. (2000) and Gitlin (2007), keys are not left on the door but rather are stored out of sight behind a curtain. Behind this curtain there is the safe mode switch of the dwelling that a carer can use when leaving the house in order to increase safety and security (Table 2). Of course, there is the possibility to observe the individual with dementia remotely via an app. Apart from manipulating the gas valve, one also control the home's cameras. Furthermore, there is an option that the carer can receive a phone call when the door bell is being rung.

There are no thresholds in the hallway or in the rest of the dwelling to limit the chance of tripping and falling. The flooring is rough but easy to clean. No dark mats have been placed on the floor because the color difference could be perceived as a hole in the floor (Blom et al., 2000). All doors in the hallway and the dwelling have been placed in such a way that, when opened, they create a circular walkway. This configuration results in a safe indoor space without any dead ends that can be used for pacing (Blom et al., 2000; Gitlin, 2007; Ministry of Community and Social Services, 1990; Pynoos, Cohen, & Lucas, 1989). Seen from the hallway, one enters the living room without seeing the kitchen. When leaving the master bedroom, one enters the hallway without a direct view of the front door.

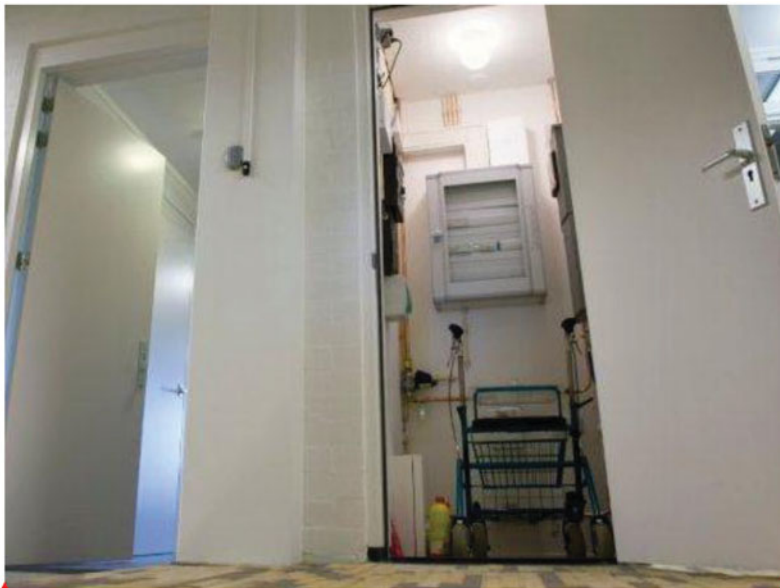


FIGURE 5 View of the external meter cupboard (color figure available online).



FIGURE 6 View of the front door and the curtain camouflaging the coat rack (color figure available online).

Separate Toilet

There are two toilets in the dwelling: one in the bathroom and the second in the hallway near the front door. Having a separate toilet serves two purposes: having a main toilet for guests and having one for use by the individual with dementia during the night. The height of this toilet cannot be adjusted. The space and the bowl have a white color scheme. The lock of the door can be

opened from the outside as well, in cases individuals lock themselves into the room and cannot figure out how to unlock the door. One could also choose to have the lock removed (Gitlin & Kyung Chee, 2006), but this is not desirable when considering the privacy needs of guests.

There is an additional plug socket in case residents choose to have a shower toilet installed (a toilet with automated bidet function) (Ministry of Community and Social Services, 1990; Warner, 2000). During the night, individuals with dementia may start looking for a toilet in a corridor and can then use this toilet. Tilly and Reed (2008) stated that providing cues to help find the restroom quickly may reduce the risk of wandering. The light can be turned on with a regular switch. To minimize confusion, there are no automated lights or flush function. These design solutions are chosen based on the practical experiences of the focus group members.

Kitchen

The kitchen is the space where domestic and homemaking activities, such as cooking, cleaning, and doing the dishes, are performed. Modern kitchens, which are often equipped with various kitchen appliances, often have a high-tech character and make no sense to someone with dementia. One of the goals of a modified kitchen is to have people with dementia participate in various kitchen activities with minimum risk (van Hoof, Kort, van Waarde, et al., 2010).

The kitchen area has an open layout, which enables residents to have contact with one another person in this room or any of the adjacent areas. Odors can contribute to olfactory sense activation (van Hoof, Kort, Duijnste, Rutten, & Hensen, 2010). Because of a gradual diminution of the olfactory sense, gas and malodorous foods may no longer be detected (van Hoof, Kort, Duijnste, et al., 2010). The kitchen equipment and utensils are selected based on familiarity. Modern thermostatic taps may lead to confusion (Blom et al., 2000). Therefore, a traditional tap with turning handles with red and blue color elements that represent hot and cold is optimal. There is a thermostatic valve underneath the sink that acts as an anti-scalding device (van Hoof, Kort, van Waarde, et al., 2010) because the warm water can never exceed 40°C in temperature. Below the sink, there is a small tap for getting a bucket of hot water. The valve can also be reset to allow for higher water temperatures.

The hob (or stovetop) uses gas. This is in accordance to the expectations of Dutch homeowners. Unlike an electric hob, a burning gas flame automatically shows that it is on. A possible disadvantage is that a gas-lit stove may stay hot for longer than an induction hob, which loses its heat relatively fast. An additional socket for an electrical hob has been put in place below the counter. A special rail is put in place (Figure 7) around the hob to prevent pans from falling or accidentally being pulled off (Blom et al., 2000). Such



FIGURE 7 Hob with barrier for pans (color figure available online).

systems can also be found in many sailing boat galleys and mobile homes. As mentioned before, the gas can be switched off in the hallway. Zgola (1990) stated that when the gas is turned off, individuals with dementia may call a service worker, which is a situation that may be encountered in real life. There is an oven in the kitchen. This appliance can be a dangerous when used for storage. Therefore, the plug has been pulled out of the socket as an additional way to create awareness (Gitlin, 2007; Warner, 2000).

Other safety measures that have been taken are child-proof plug sockets (plastic inserts) and using a non-visible magnetic lock on one of the cupboards (Figures 8 and 9). These measures can be stigmatizing. In the initial stages of dementia, all closets and drawers should be accessible to preserve dignity (van Hoof, Kort, van Waarde, et al., 2010). The cupboard contains hazardous and potentially dangerous goods, as well as the anti-scalding valve. The waste container has been placed out of sight, in the cabinet underneath the sink. In case of hoarding behavior, wherein some individuals with dementia are known to hide valuables in the bin, these items cannot be stored in this bin and thrown away. A small sieve is placed in the kitchen sink to prevent things from being flushed (Warner, 2000).

Living Room

A homelike and familiar design of the living room is important to individuals with dementia (van Hoof et al., 2010a) (Figure 10). Personal items such as picture frames, figurines, and paintings have a positive effect on mood and cognitive abilities and can be used for reminiscing activities. To maintain



FIGURE 8 Child-proof sockets: safety or stigma? (color figure available online).

safety at home, the amount of clutter is kept at a minimum (van Hoof, Kort, van Waarde, et al., 2010). The floor is covered with tarkett, a flooring material that looks like wood and is easy to clean. To minimize confusion and increase safety at home, floral decorations in the home should always be nonpoisonous plants and flowers (Blom et al., 2000; Bowlby Sifton, 2007; Gitlin, 2007; Gitlin & Corcoran, 2000). Plastic plants and fruits get dusty over



FIGURE 9 Magnetic lock on cupboard, with removable plastic key (color figure available online).



FIGURE 10 Overview of the living room. A comfortable chair is placed near the window, which increases the exposure to daylight of the individuals seated. An analogue clock provides information about the time of day. To further reduce the risk of falling, the number of loose cables in the home should be minimized. This also prevents the dust collection and lessens the need for intensive cleaning (color figure available online).

time and are difficult to clean; therefore, these should not be used as a substitute. Possibly hazardous potpourri (eating) is not to be used in the dwelling (Warner, 2000).

To deal with clinging behavior and the fear of being abandoned, both residents and carers should have an overview of spaces to keep in contact with one another. Therefore, the dementia dwelling has an open floor plan, which is enlarged by the wide sliding doors. These doors can be opened and shut in compliance with openness and privacy wishes. This is particularly true for the sanitary rooms, which are visible from the kitchen and from the sofa area when the sliding doors are fully opened (Figure 11).

The physical indoor environment (e.g., odors, the thermal climate, lighting and sound) plays an important role in creating a fitting domestic environment for people with dementia because this group loses mental and physical capabilities faster than their senses, both at home and in institutional settings (Garre-Olmo et al., 2012; van Hoof, Kort, Duijnste, et al., 2010; van Hoof, Kort, Hensen, Duijnste, & Rutten, 2010). The two most important aspects of the indoor environment dealt with in the home are lighting and thermal comfort. Radiant floor heating, as opposed to radiator panels, reduce the risk of injuries due to burning or falling and limit the circulation of suspended dust. An imitation hearth contributes to a homelike atmosphere and is a



FIGURE 11 A table in the kitchen area, decorative hearth, and sight line of the toilet are available from the sofa (color figure available online).

familiar item to most individuals. In the dwelling, four separate thermostats are installed that have a turning switch as means of control. To improve mood, alertness, and behavioral symptoms, two ceiling-mounted luminaires are put in place (van Hoof et al., 2012) that have a remote control for intensity and correlated color temperature (Figure 12). The open character of the home is further enhanced by the large windows that allow people to look outside and provide additional daylight access. Bowlby Sifton (2007) stated that windows could help offer reality reassurance by providing outdoors views that help with orientation to the season and time of day. A chair is placed next to the window to maximize exposure to daylight (Sinoo, van Hoof, & Kort, 2011). There are darkening curtains in front of the windows to limit the amount of external light during the evening hours. This should simulate a natural evening and get your body into the sleeping mode.

Unused infrastructure has been put into the walls and ceiling of the home for future wired solutions (e.g., data, electricity), as was suggested by the focus group members. By introducing these infrastructural solutions, there is more flexibility for future adaptations. For example, it is hypothesized that reflections and repetitive patterns wall paper prints can be experienced as depth, which can cause fear, restlessness, and confusion (Cohen-Mansfield, Werner, & Marx, 1990). Based on this hypothesis, the home is decorated with neutral colors without patterns and prints.

A small table is placed near the kitchen for performing small kitchen activities (Figure 11), and individuals with dementia can sit down here and feel connected to everyday life (Blom et al., 2000; Bowlby Sifton, 2007;



FIGURE 12 Ceiling-mounted luminaire for administering light therapy (color figure available online).

Mace & Rabins, 2006; Warner, 2000). This is also a place for the person to watch the carer for clinging behavior. This table can serve as a center for unobtrusive observation of the household (Cohen & Weisman, 1991). Hypothetically, the person with dementia can sit in the corner, which should contribute to an increased sense of security. The table and chairs in the kitchen section are robust but light-weight to be able to move them when needed. The table should be high enough for use by individuals in a wheelchair. There is a memory board on the table with various pictograms to provide a structure for the day. A large analogue clock provides an additional tool for temporal orientation (Ministry of Community and Social Services, 1990;

Pynoos et al., 1989). A large-button telephone helps individuals with dementia make phone calls. The television is positioned opposite of the chair from an ergonomic perspective, as was indicated by the focus group members. It can be digitally locked against adult content and violence to prevent unwanted negative feelings (Blom et al., 2000; Warner, 2000).

Second Bedroom

The second bedroom is a multifunctional room that can also be used as a room for participating in hobbies, as well as a quiet room or a timeout room. Spouses and relatives may feel the need for privacy. Warner (2000) proposed the need for a respite zone or quiet room with comfortable furniture for carers. Such a room could be off-limits to the individual with dementia, which is reserved for the carer. In the second bedroom, there is a special section for the partner or carer to withdraw to or participate in hobbies or activities in privacy. Gitlin (2007) also mentioned the need for setting up a so-called quiet room with comfortable furniture for rest breaks in case of extreme agitation. In instances wherein couples no longer sleep together (because of nocturnal unrest or incontinence), the second bedroom can contribute to good night's rest and serve as a second bedroom. This room can also be used for additional storage of books and other items or as an office.

Bathroom and Second Toilet

Figure 11 also shows a wide sliding door leading to the bathroom. It is one of the sight lines in the dwelling (Figure 2). Residents can thus choose whether they want to have a toilet bowl placed in sight. Some individuals with dementia may face difficulty in locating the toilet when needing to visit this facility. It is assumed that toilets are easier found (and thus used) during daytime when clearly marked or visible from the living room (Coulson, 1993; Namazi & DiNatale Johnson, 1991; Pynoos et al., 1989; Zeisel, Hyde, & Levkoff, 1994). In some countries, national legislation may not permit a bathroom to be directly accessible from a kitchen area or living room without taking additional measures, such as increased ventilation rates.

The toilet bowl itself can be adjusted in height via a mechanism hidden behind the flush button panel (Figure 13). This was a feature that was installed based on recommendations by the focus group members. The toilet does not have an automated flushing system; this would be confusing and people with dementia may start looking for the flush button or cord. The toilet seat is black, which contrasts with the white ceramic bowl. This additional contrast helps with orientation. The lid of the toilet seat has been removed (Zgola, 1990) so that people will not sit on top of it when they rush



FIGURE 13 View of the bathroom. The height adjustable toilet seat has contrasting colours. The raised washing machine and container are visible in the center and the right. The radiator panel can be used for heating towels, which improves comfort during drying off (color figure available online).

to use the toilet. A special container for waste incontinence materials is part of the equipment in the bathroom. A small radiator panel has been installed in the bathroom for heating towels. This provides additional comfort after showering (van Hoof, Kort, Hensen, et al., 2010).

To allow for wheelchair accessibility, the bathroom is equipped with a roll-in shower that allows maximum freedom of movement for a carer when assisting the other. A hand-held showerhead is put in place for showering. It makes showering easier for carers, and it can be a better option for individuals who are afraid of water falling on top of them from a height (van Hoof & Kort, 2009). There are two rills in the floor, which make sure that flooding cannot occur into the bathroom itself and the adjacent bedroom (Figure 14). According to the focus group members, some individuals with dementia may not recognize the rill system and wonder how the water can be drained. The shower curtain is robust, in case individuals panic or fall and want to grab it (Warner, 2000). The floor tiles are anti-slip tiles, which is a safety measure. The walls have been constructed to allow for the placement of additional bars and handles. Despite discussions in the literature (Blom et al., 2000; Warner, 2000), mirrors are not removed, reduced in size, or covered.

A raised laundry machine prevents individuals from having to bend over when filling or emptying the machine. Detergents and cleaning chemicals are stored away safely (Warner, 2000). Moreover, there is no laundry basket



FIGURE 14 Rills in the floor near the roll-in shower prevent flooding (color figure available online).

in the bathroom, which may resemble toilets and be used as such (Warner, 2000; Zgola, 1990).

Master Bedroom

The bedroom door opens in such a way that it provides a logical routing toward the living room. This design feature limits the risk of individuals leaving the home when displaying wandering behavior. To make going to the bathroom easier during the night, there is a sliding door between the bedroom and the bathroom that serves as a shortcut (Figure 15). Another problem facing older people with dementia is the risk of falling, which is even larger at night when they have to walk long distances to reach the toilet. Therefore, the shortcut may also limit the risks of night-time accidents, including falls. At the same time, the visual sight line may not be effective at night, and the partner with dementia may actually venture out into the hallway to look for a toilet. This is normal location for a toilet space in The Netherlands. Both exit doors of the bedroom lead to a toilet. The short walking distance to the bathroom also positively contributes to the tasks of a carer. When needing water, it can easily be got from the bathroom washbasin.

A carer may move out of the bedroom he or she shared with the person if this arrangement interferes with sleep patterns. Therefore, a second bedroom is available. There is double bed in the bedroom instead of twin beds. When dealing with the consequences of incontinence, twin beds provide an



FIGURE 15 View on the bathroom from the master bedroom (color figure available online).

advantage over a single bed. To account for impaired mobility, the amount of furniture is kept at a minimum (Warner, 2000).

DISCUSSION

To the building services sector in The Netherlands, taking care for safety and comfort in future care dwellings is more than just applying the latest information and communication technologies in and around the home. The sector should also focus on other solutions, including home modifications. The dwelling presented in this study is a three-dimensional showcase that can be experienced by visitors and potential end-users. In a co-creation project, best practices and evidence-based solutions have been included in a single design, but the home is more than just a showcase. The building services sector can show what the sector can contribute to the care for older individuals and ageing in place. Social housing organizations, care organizations, educational organizations, and future care consumers can visit the dwelling and be inspired or have discussions about the feasibility of the solutions presented. Another goal of the dwelling is to create awareness about the role of national building codes and the interests of real estate developers in relation to new construction plans.

Policies and legislation dealing with dementia and housing facilities should widen their scope to include ageing-in-place in one's own home. The dwelling itself shows how demand and supply can be brought closer to one another. To improve the current situation, it is essential that all people

involved have access to relevant information. Family carers and people with dementia should have easy access to usable and understandable information about architectural and technological solutions, which can support ageing-in-place. Therefore, Kort et al. (2010) created an information Web site for home modifications for use in The Netherlands (www.thuiswonenmetdementie.nl, information in Dutch only). The dissemination of knowledge should also address professional carers, professionals from the domain of building and technology, and policymakers and civil servants. This knowledge can help bridge the gap between demand and supply. Moreover, working with individuals with dementia calls for a paradigm shift in the way designers and contractors operate. Civil servants at the municipal level should increase their skills and knowledge to adequately support people with dementia and their family carers in implementing architectural and technological solutions as people with dementia wish to age-in-place.

Preconditions for the Implementation of Design Solutions

The actual implementation of the design solutions found in the dwelling is a complex matter involving a large number of stakeholders. The preconditions for the implementation are influenced by the dwelling people live in, the urgency to have interventions performed, the stage of dementia and comorbidities, the needs of informal carers, and the capabilities of formal carers and occupational therapists in particular, as well as financial aspects.

As Mace and Rabins (2006) reported, it is important to remember that no single design suggestion will work in all situations. Different people need different approaches and solutions that work as facilitators, which in turn are influenced by the client system. One should look for solutions that make sense to the carer and are low in cost (Mace & Rabins, 2006). Personal abilities of individuals with dementia play a role as well (Ministry of Community and Social Services, 1990). Solutions that are facilitators to one individual may turn out to be a barrier to another.

According to Olsen, Ehrenkrantz, and Hutchings (1996), a successful modification strategy follows a three-stage movement-access continuum. Approaching home modifications along this continuum encourages independence and movement when appropriate, and at the same time provides safety and control. Olsen et al. (1996) stated that “[w]ith a sensitive and ongoing modification strategy, the home environment can become an asset rather than a liability for caregiving” (p. 1).

Particularly in the early stages of dementia, when environmental interventions may have a maximum effect, the same measures may be confronting and perceived to be stigmatizing. Modifications performed in the early stages of dementia may support performance, whereas in moderate dementia, the disablement process continues and more assistance is required from carers (Gitlin & Corcoran, 1996). Additional modifications may be needed with

progressive memory loss and require periodic reevaluation. A person with dementia can decline without carers realizing the increased risks (Mace & Rabins, 2006).

Environmental interventions constitute only a fraction of what is needed for people with dementia to remain independent (Zgola, 1990). Spouses should receive support from the full array of options, including domestic care and counseling. According to Silverstein et al. (1993), the role of carers should not be underestimated in the process of implementing home modifications. Too often, informal carers are unfamiliar with specific modifications that can be made and how these modifications are paid for and by whom they are installed at home.

Charness and Holley (2001) reported the challenges that lie in updating existing housing because retrofitting is more expensive than designing properly in the first place. Design solutions can be considered more easily during the design phase of a building than during retrofitting. Going through numerous official procedures related to retrofitting can be a stressful event for both the person with dementia and the informal carer. Fortunately, most design solutions are simple and do not require getting permits. In addition, some of the work that needs to be performed may require workers to be in the home for some time. Getting work done as early as possible allows for better management of less stress (Warner, 2000). When big modifications are being made, one can later modify gradually (Warner, 2000).

Evidence Base Versus Evidence Chase

According to Codinhoto et al. (2009), there is a considerable amount of evidence linking health care environments to health outcomes, despite the lack of clarity in relation to cause-effect relationships:

There is poor clarity in the area, as research findings have been presented using different theoretical frameworks and a multitude of methods have been used to investigate the effects of the built environment on health outcomes. (p. 139)

Also within the domain of dementia and design, the effects of design solutions are greatly disputed, and are still subject of numerous studies. Day, Carreon, & Stump (2000) reported that current "[d]esign guides typically offer 'hypotheses' for how the spatial organisation and appointment of the physical environment may promote well-being Frequently, design guidance is based on the practical experience of designers or facility administrators; other times, design guidance is research based, applying findings from clinical research on dementia in the form of design 'solutions'" (p. 397). According

to Weisman (2003), the review by Day et al. (2000) “provides substantial support for many of the broad recommendations presented in the various design-for-dementia guidebooks” (p. 169). Cohen and Day (1993) stated that guidelines for the planning and design of environments for people with dementia “are best viewed not as inflexible directives, but as an attempt to expand and stimulate thinking on the relationships between dementia and design” (pp. 8–9). Guidelines, in their view, “are hypotheses amenable to, and requiring, implementation and validation” (Cohen & Day, 1993, p. 9). Weisman (2003) stated that the guidelines by Cohen and Weisman (1991):

might best be viewed as broad hypotheses or notions of best practice . . . regarding what ought to make a difference in environments for people with dementia, at the same time, these guidelines were never viewed as universally applicable, in the way that traditional models of positivist science were directed toward the formulation of ultimately generalizable principles. The guidelines were meant to be precisely that—broad principles the application of which must be tempered by circumstances specific to individual dementia-care settings. (p. 168)

The aforementioned conclusions are also shared by Dobrohotoff and Llewellyn-Jones (2011) for the architecture of psychogeriatric inpatient units. Earlier work by van Hoof (2010) summarized the broad range of design solutions and the rationale behind them. Gitlin, Liebman, and Winter (2003) systematically evaluated a range of environmental strategies. Approximately 90% of the 63 studies reviewed reported positive outcomes, although most studies were methodologically flawed, involved small samples, and were conducted in nursing home settings (Gitlin et al., 2003).

Weisman (2003) also stated that there is “a growing number of model facilities, with care providers increasingly willing to develop environments which purposefully implement and evaluate innovative approaches to dementia care” (p. 171). Previous work by van Hoof and Kort (2009) and the current study can also be seen in that light. Weisman (2003) stated that:

[t]he findings and lessons to be derived from the body of work on dementia care environments seem to be substantial. They should not, however, be limited to those derived solely from the empirical research on environments for people with cognitive impairments. It's equally important that we keep in mind the innovative ways in which these model facilities were planned, programmed, and designed; the systemic way in which they were conceptualized; and the innovative ways in which they have been publicized. (pp. 171–172)

When conducting a literature study, it is important that sources included are of a high standard. The evidence base regarding environmental

interventions has been subject to numerous discussions in terms of quality. O'Carroll (1999) concluded that the evidence base in the domain of housing facilities for dementia is not sufficient to allow us to meaningfully guide policy and practice:

What is surprising is the relative dearth of large, adequately controlled treatment evaluations in this area. . . . The sample sizes are small and therefore generalizations to the population at large must be made with extreme caution. Given that research in this area has been going on for many years, it is extremely surprising not to find a more substantial body of evidence. (p. 105)

On the other hand, Mitchell (1999) stated that, as a practitioner in the field, one has an instinctive feeling that something is working:

You can see it on the faces of the group members, you can feel it in the atmosphere, you can capture it in people's comments. However, when projects are small and struggling, it is difficult to envisage being part of a large intervention trial, for example, despite the belief one has in the quality of care. Schemes can fail and falter for a variety of reasons. Yet, as is stated in the paper, the single case study is a valid methodology. (p. 107)

Although gathering evidence is important, there seems to be a gap between the medical and technological/design approaches. In healthcare-related studies, evidence is always based on a wide range of substantial research outcomes. In design studies, a small number of subjects may be a broad enough basis to judge whether a design will work. A gap in understanding between the two scientific domains may lie in this fundamental difference. Although compelling arguments are made for the therapeutic efficacy of an appropriate living environment, little research has been performed to date to determine whether the special design features are effective in reducing symptoms and to quantify to what extent they contribute to self-care, well-being, and vitality (Desai & Grossberg, 2001; Zeisel et al., 2003). Systematic and large-scale studies should be conducted on the efficacy of environmental interventions included in the dwelling because evidence is often based on small-scale and noncontrolled studies. Additional research is needed for the study of optimal indoor environmental conditions and related building systems. For example, the application of ceiling-mounted lighting systems calls for more research on the details of the lighting equipment, specifically threshold illuminance levels and spectral composition of the light (van Hoof et al., 2012). Future evaluation studies of technologies that are used to support ageing-in-place should focus on the integration of such systems within the context of family and professional care and a person's home environment.

The solutions that are integrated into the dwelling's design will be subjected to further testing within the Technology@Home program. Main themes in future study will be its feasibility, the user acceptance, and efficacy. Also, the dementia dwelling will be used as a model to analyze the current housing of individuals and the daily problems individuals with dementia encounter. The majority of individuals with dementia live in existing homes. Therefore, it should be determined how to implement the design solutions into the existing housing stock.

Calkins (2001) is somewhat cautious about the potential successfulness of the environmentally deterministic approach, in either research or design. She states that the approach basically assumes that a finite, relatively small number of variables can account for a significant proportion of the variance (Calkins, 2001). However, the number of variables and the relationship between them are complicated. Calkins (2001) is supported by Lawton (2001), who concluded that there are far too many possible design variations to hope that any great proportion of them might ever be tested experimentally. Also, Lawton (2001) stated that the interface of person and environment in real situations may be too complex to capture in a linear experimentally controlled test.

CONCLUSION

The design process of the dementia demonstration dwelling has shown that it is possible to integrate evidence-based architectural and technological solutions, which support both individuals with dementia and their carers in daily life situations. These solutions could also be used in the private home of older adults with dementia, which should facilitate ageing-in-place and delay the need for expensive institutional care. Whether a modified dwelling is supportive in relation to ageing-in-place, and, if so, for how long, depends on the specific needs of people with dementia. As the dementia progresses or when family care comes under pressure, there may come a time when architectural and technological solutions no longer offer sufficient support and institutionalization becomes inevitable. The dementia demonstration dwelling is one of the steps taken in The Netherlands to make the public aware of housing-related solutions for dementia care.

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