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Session 6A
Inclusion and Engagement
Inclusive retailers: Visually impaired shoppers’ perceptions and preferences

Hong Yu
Ryerson University

Sandra Tullio-Pow
Ryerson University

Abstract
This project investigates visually impaired shoppers’ apparel shopping experiences, preferred store features, and perceptions of inclusive retail store quality. The exploratory study uses a telephone survey method for data collection, with a sample of 62 low vision respondents residing in rural and urban areas in Canada. The questionnaire measures: (a) shopping experiences including frequency, types of stores frequented, past shopping experiences, and overall satisfaction; (b) perceived importance of store features; and (c) demographics. An open-ended question concludes the questionnaire and findings from the qualitative data are presented. Exploratory factor analysis was performed on the scale measuring perceptions of retail store features. Three factors were identified: store ambience, store accessibility, and service quality. In addition, t-tests were conducted to compare the importance of retail store features as perceived by male versus female and by urban versus rural respondents. Based on the findings, the researchers discuss implications for academics, policy makers, and practitioners in the related fields.

Keywords
Inclusive retail design, shopping experience, visually impaired

Visual impairment
Vision loss is a detrimental effect of aging that impacts physical, social, and psychological aspects of people’s lives [30, 35]. Approximately 3.6 million Canadians are diagnosed with disabilities, including 648,000 people with visual impairment or blindness, many of whom are elderly [21]. In the U.S., more than 3 million Americans over age 40 live with blindness and low vision [32, 33]. Without a doubt, the prevalence of eye disease increases with age; the American cohort with blindness or low vision may reach 5.5 million by 2020 [32].

Using North American criteria, blindness is defined as the maximal visual acuity in the better eye being equal or less than 20/200, while low vision is classified as maximal visual acuity in one eye equal or less than 20/40 [27]. It is important to note that only a small fraction of the Canadian population is blind; the majority of visually impaired persons live with low vision [27]. As a rule, most people adjust reluctantly to predictable changes in vision as they enter middle age: they purchase reading glasses to compensate for the inability to focus on small print, need increased light levels for improved contrast perception, and find it more difficult to drive at night.
due to hindered glare recovery from oncoming headlights [9]. However, with advancing age, other serious forms of eye disease and vision loss may occur, including macular degeneration, which typically impacts central vision; cataracts, which manifest as reduced glare recovery and decreased visual acuity; glaucoma, which initially presents as a loss in peripheral vision; and diabetic retinopathy, whose symptoms include overall decreases in visual acuity, colour perception, and the ability to adapt from dark to light [10, 16, 36]. Some of these symptoms may be improved with surgery or medication [35] and resulting vision loss may be offset by using handheld magnifiers, specialized glasses with tinted filters to reduce glare, large print computer software, voice synthesizers, and audio books or other talking devices [10].

Loss of vision correlates to reduced quality of life [1, 23, 29, 30, 35]. Persons with visual impairment have an increased risk of falls and associated injuries (e.g., hip fractures), medication mistakes, social isolation, and depression [9, 23, 35]. These issues have critical significance now that our society includes more than 4.6 million Canadians over the age of 65 [39].

**Inclusive retail design**

Traditional design processes for products and the retail environment focus primarily on the mainstream market, with little attention to the needs of aging baby boomers and the disabled community [13, 25]. As people are living longer [38] and more people are living with some type of disability [20], incorporating universal design principles into design practice has become increasingly necessary. Inclusive Design (sometimes referred to as Universal or Accessible Design) is defined as “the design of all products and environments to be usable by people of all ages and abilities to the greatest extent possible” [40]. Market accessibility is one of the key principles of Inclusive Design [11] and forms the core justification of this study.

Over the last 25 years, society has become more aware of the barriers facing people with special needs. For example, since the Canadian federal government published its Obstacles: Report of the Special Committee on the Disabled and the Handicapped, municipal building codes now require ramps and elevators for improved accessibility to public buildings [20]. More recently, Ontario introduced the Accessibility for Ontarians with Disabilities Act, 2005, which promotes barrier-free living [22]. Nevertheless, persons with visual impairment are significantly limited in their abilities to travel alone and unaided [19]. Moreover, as Kaufman-Scarborough pointed out, truly inclusive shopping access requires more than merely widening the doors; it is only “achievable through a balancing of legally required architectural attributes, moderated by adjustments in terms of actual merchandise, displays, and specific store environment created by each retailer” [25]. In this sense, retail design should be looked at from a “servicescape” perspective [6] that considers the store’s physical surroundings as a holistic element underpinning both the customers’ and the store employees’ experience. Inclusive design sends positive messages to disabled people, messages which tell them “you are important,” “we want you here,” and “welcome” [31].

**Retail environment**

Environmental psychology theories recognize the retail environment’s impact on shoppers. Two paradigms may be applied to explain and organize shoppers’ emotional, cognitive, and behavioural responses to the retail surroundings they encounter. Mehrabian and Russell’s [28] emotion-cognition-behaviour paradigm is considered a classic but has been challenged in recent years. The theory posits that emotions are antecedents of cognition, which in turn lead to two contrasting forms of behaviour: approach and avoidance [15]. Approach involves a desire to stay, explore, and affiliate, while avoidance comprises the opposite behaviours. An alternate theory states that cognition elicits emotion [26]. In other words, upon entering a given
environment, a person first evaluates the external and internal cues in terms of his or her own experience and goals; such an appraisal then results in an emotion [26]. The cognition-emotion theory has received empirical support in retail atmospherics [2, 12] and serves as an overarching conceptual framework for the current study.

The retail environment is an important factor in consumers’ evaluation of the products and services offered, because shoppers may assign aesthetic and instrumental values to the formal, expressive, and symbolic qualities of store environments [17]. Therefore, a retail environment may influence consumers’ inferences about merchandise, service quality, and store image [2]. A number of studies suggest that ambient and social cues are significant atmospheric elements that influence consumers’ affective states in store environments and impact their shopping and purchasing behaviour [3, 5]. Ambient cues refer to physical and auditory aspects of store environments, such as lighting, music, colour, and display, whereas social cues correspond to factors such as the number and friendliness of employees.

**Objectives of the study**

The selection and purchase of clothing by visually impaired shoppers has been the subject of research studies in Hong Kong, the United Kingdom, and the United States [8, 18, 24]. Difficulties reported include inadequate sales service, poorly communicated clothing details and pricing information, as well as awkward store navigation, all differing from sighted shoppers’ experiences. There clearly is a dearth of information related to the visually impaired experience within the Canadian apparel market. Consequently, this study represents an early attempt to investigate the perception and preferences for universal retail design in Canada.

Specifically, the research sought to expand understanding of the shopping experience of visually impaired shoppers and to investigate preferred store features and perceptions of inclusive retail store quality in order to better serve the visually impaired community by making recommendations to policy makers and industry practitioners alike.

**Research method**

**Data collection**

Our exploratory study employed a telephone survey method for data collection. The sample includes 62 low vision respondents residing in rural and urban areas in Canada. The target population represents Canadian men and women between 40 to 70 years of age who live in either rural or urban areas and who are defined as having low vision (i.e., maximal visual acuity in one eye equal or less than 20/40). We chose this target population because the study focuses primarily on baby boomers with low vision and we intend to compare the shopping experiences, perceptions, and preferred retail store design features between urban and rural residents. Due to the low incident rate of the target population and our intention to avoid relying on self-report as a way of determining respondents’ eligibility for participation in the study, we recruited the respondents through low vision clinics and an email LISTSERV mailing list of users of low vision aids.

Sixty-two identified respondents agreed to participate and are included in the current study. Written consent was obtained prior to the 15-minute telephone survey. A $10.00 gift card to a popular Canadian franchise coffee shop was mailed to the respondents after completion of the telephone survey. The sample consisted of 21 male and 41 female respondents between 40 to 70 years of age. About 27.4% completed high school; 24.2% obtained a 1- to 3-year college diploma; 32.3% earned a Bachelor’s degree; and the rest (16.2%) were identified as Others. About 41.9% were employed, while 40.3% were retired and 17.7% were unemployed. In terms
of annual household income, 9.6% reported an income less than $25,000, 38.8% reported between $25,001 and $75,000, and 45.2% reported income of $75,001 and over (see Table 1).

Table 1: Demographic characteristics of the sample (N=62)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Respondents (№)</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21</td>
<td>33.9%</td>
</tr>
<tr>
<td>Female</td>
<td>41</td>
<td>66.1%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-50</td>
<td>16</td>
<td>25.9%</td>
</tr>
<tr>
<td>51-60</td>
<td>28</td>
<td>45.1%</td>
</tr>
<tr>
<td>61-70</td>
<td>18</td>
<td>29.0%</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td>17</td>
<td>27.4%</td>
</tr>
<tr>
<td>1-3 year technical, vocational, college</td>
<td>15</td>
<td>24.2%</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>20</td>
<td>32.3%</td>
</tr>
<tr>
<td>Others</td>
<td>10</td>
<td>16.2%</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>26</td>
<td>41.9%</td>
</tr>
<tr>
<td>Unemployed</td>
<td>11</td>
<td>17.7%</td>
</tr>
<tr>
<td>Retired</td>
<td>25</td>
<td>40.3%</td>
</tr>
<tr>
<td>Annual Household Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than $10,000</td>
<td>3</td>
<td>4.8%</td>
</tr>
<tr>
<td>$10,001 to 25,000</td>
<td>3</td>
<td>4.8%</td>
</tr>
<tr>
<td>$25,001 to 50,000</td>
<td>12</td>
<td>19.4%</td>
</tr>
<tr>
<td>$50,001 to 75,000</td>
<td>12</td>
<td>19.4%</td>
</tr>
<tr>
<td>$75,001 to 100,000</td>
<td>15</td>
<td>24.2%</td>
</tr>
<tr>
<td>$100,001 and over</td>
<td>13</td>
<td>21.0%</td>
</tr>
</tbody>
</table>

Measurement
The questionnaire measures: (a) shopping experiences including frequency, types of stores frequented, past shopping experience, and overall satisfaction; (b) perceived importance of store features; and (c) demographics. An open-ended question concludes the questionnaire in order to incorporate qualitative data in the study’s findings. Types of stores visited were determined by providing a list of various store formats and by asking respondents to choose all that apply. Past shopping experience was measured by a series of statements developed from a focus group study. We asked respondents to indicate how they shop for apparel by indicating on a 7-point Likert scale, with 1= Never and 7 = Always. The scale items measuring perceived importance of store features were developed by a focus group study and by adapting selected items from a service-quality-of retail-store scale [14]. We conducted a pilot test of the questionnaire with 5 visually impaired people and revisions were made to improve clarity of specific questions.
Data analysis and results

Shopping experience of the visually impaired

Shopping frequency and shopping venues
On average, the respondents reported that they shop for apparel 1.9 times every month, with a range of 0 to 30 shopping occurrences during that time. With regards to shopping venues, department stores were the most frequently shopped (71.0%), followed by discount stores (67.7%), and outlet stores (54.8%). Mail catalogue (14.5%) and Internet retail stores (8.1%) represented the least popular shopping venues, according to our sample (see Table 2).

Table 2: Venues for apparel shopping (N=47)

<table>
<thead>
<tr>
<th>Venue</th>
<th>Respondents (№)</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department stores</td>
<td>44</td>
<td>71.0%</td>
</tr>
<tr>
<td>Discount stores</td>
<td>42</td>
<td>67.7%</td>
</tr>
<tr>
<td>Outlet stores</td>
<td>34</td>
<td>54.8%</td>
</tr>
<tr>
<td>Specialty stores</td>
<td>32</td>
<td>51.6%</td>
</tr>
<tr>
<td>Warehouse stores</td>
<td>28</td>
<td>45.2%</td>
</tr>
<tr>
<td>Hypermarkets</td>
<td>25</td>
<td>40.3%</td>
</tr>
<tr>
<td>Boutiques</td>
<td>20</td>
<td>32.3%</td>
</tr>
<tr>
<td>Thrift stores</td>
<td>20</td>
<td>32.3%</td>
</tr>
<tr>
<td>Mail catalogue</td>
<td>9</td>
<td>14.5%</td>
</tr>
<tr>
<td>Internet retail stores</td>
<td>5</td>
<td>8.1%</td>
</tr>
</tbody>
</table>

Past shopping experience and overall satisfaction
A majority of respondents claimed that they sometimes shop with a friend or family member and that they are relatively confident in their ability to assess clothing quality and choose which clothing to purchase (average 5.7 on a 7-point Likert scale). Most of them seldom use a magnifier when shopping for clothing (average 2.9 on a 7-point scale) and almost never use a colour identifier (average 1.5 on a 7-point scale). The overall satisfaction with their apparel shopping experience is “slightly satisfied” (with a mean of 5.2 on a 7-point Likert scale).

The findings indicate that retailers could make certain improvements to increase visually impaired shoppers’ satisfaction. For example, analysis of responses to the open-ended question that ended the telephone survey revealed that some respondents were unable to judge the quality of apparel details: “I am confident picking out a quality garment, but not confident assessing the quality of its construction or post-design flaws like loose buttons or small stains or holes”; “[I] often [need to] check with the salesperson to make sure [I’m] buying the right thing”; “Clothing needs to be well stitched because it’s hard to see if it is coming apart.”

It would prove helpful to train store staff to be sensitive about visually impaired customers’ unique needs and to be ready to provide assistance as needed. Retailers might also supply magnifying glasses and colour identifiers near shelves or at customer-service counters as a way of creating a more welcoming shopping atmosphere for visually impaired shoppers.
Perceived importance of retail store features

Factor analysis
Exploratory factor analysis using principal component extraction and varimax rotation were performed on perceived importance of retail store features; three factors were identified (see Table 3). Store Ambience (alpha=1.00), the first factor, includes statements that relate to store atmosphere, such as signage, lighting, colour, and letter size of sales receipts. Store Accessibility (alpha=.81) is the second factor. This factor addresses accessibility features of retail store design, such as easy check out, easily accessible store location and store layout, as well as ample merchandise selections. The third factor is labelled as Service Quality (alpha=.74) and includes statements associated with social cues in/of a retail store environment (i.e., interaction with employees), well-maintained facilities, and good store offerings (e.g., special sales). The three factors explained 55.9% of the total variance. All three factors’ alpha coefficients are above .70, indicating an acceptable reliability.

Table 3: Factor analysis results of apparel store features

<table>
<thead>
<tr>
<th>Factor items</th>
<th>Factor loading</th>
<th>Variance (%)</th>
<th>Alpha coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Store Ambience</strong></td>
<td></td>
<td>26.9%</td>
<td>1.00</td>
</tr>
<tr>
<td>Signs use large font &amp; regular-styled block letters</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signs use strong colour contrast between letters &amp; background</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signs clearly indicate merchandise on shelves</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting is uniform</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store is well-lit</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colour contrast between store lighting &amp; walls, floors, shelves</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction receipt uses a large font</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction receipt has bold signature line</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Store Accessibility</strong></td>
<td></td>
<td>14.6%</td>
<td>.81</td>
</tr>
<tr>
<td>Easily accessible by public transit</td>
<td>.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flooring materials differentiate merchandising areas &amp; walkways</td>
<td>.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debit-card machines with tactile buttons</td>
<td>.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audio-enhanced checkout system announces price/quantity of scanned merchandise</td>
<td>.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broad selection of merchandise</td>
<td>.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cashiers verbally count out change to customer</td>
<td>.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The store is a big store</td>
<td>.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Service Quality</strong></td>
<td></td>
<td>14.4%</td>
<td>.74</td>
</tr>
<tr>
<td>Store willingly handles returns &amp; exchanges</td>
<td>.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store offers good specials regularly</td>
<td>.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store has clean public areas (e.g., washrooms, fitting rooms)</td>
<td>.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employees give customers individual attention</td>
<td>.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store is pleasant to shop in</td>
<td>.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store is clean</td>
<td>.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employees provide prompt customer service</td>
<td>.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization.
Perceptions and preferences of inclusive retail store features

The mean scores for store ambience, store accessibility, and service quality were calculated to reflect the perceptions and preferences of the entire sample. The results show that service quality was rated the highest (6.5 on a 7-point Likert scale), followed by store ambience (5.8 on a 7-point scale), and store accessibility (5.0 on a 7-point scale). This suggests that a majority of respondents consider that all three factors are important, with service quality being the most important.

Qualitative data provide more concrete ideas of how inclusive retailers could improve on these three aspects. With regards to store ambience, respondents reported that signage is critical to help visually impaired shoppers better navigate through a store. They prefer signs that use large font sizes and contrasting colour (i.e., between a sign’s background and lettering) and are placed at the end of each aisle. As one respondent stated: “Signs at end of each aisle please; [currently] size tags and content tags [are] too tiny, pricing is in tiny writing.” Another respondent agreed: “Regular merchandise signs [are usually] not as bold and prominent as Sale signs; prices and sizes need to be bolder and larger on clothing tags/labels.”

Other respondents expressed frustration: “Very few stores cater to 50+ w/reasonable price tags! I like to look fashionable but have nowhere to shop!”; “If clothes wrapped in plastic (such as shirts), can’t read size. [They should] put size on outside of plastic, more on fasteners; stores cater [only] to majority . . . . [I] can’t read tags around sizes, [and there is] no standardization on where it is located and print is small.”

For visually impaired shoppers, the preferred store lighting is uniform, fluorescent lighting that is not too bright. Lighting should be designed as an integral component of the overall store environment. Specifically, there should be colour contrast between general store lighting and walls, floors, and shelves. As one respondent indicated, “Good lighting is a must—dim lights can be scary!” Other respondents concurred: “Colour coordinating in store is hard because of lighting; hard to tell what colour it ACTUALLY is”; “The walls and floors at the mall are all the same colour, lighting is too dark at the mall”; “Colour is distorted if stores aren’t well lit.”

With regards to store accessibility, several comments focused on checkout procedures. Checkout procedures create stressful situations for visually impaired shoppers, which can be lessened through the use of receipts with large fonts and bold signature lines; the proper handling of change by the cashier; the provision of user-friendly credit/debit card machines for the visually impaired; and possibly an audio-enhanced checkout system that announces the price and quantity of scanned merchandise. The respondents described the challenges in their checkout experiences: “Debit cards are not standardized, buttons often worn down”; “Pin-based credit card is an issue . . . difficulty inputting number and I will not go back”; “More places need to count change out to customers, debit machines are NOT UNIFORM so it really doesn’t make a difference whether they’re tactile or not because none are the same; chip credit cards very difficult ”; “Audio self-checkouts good but difficult to bag own items.” Additionally, the respondents emphasized store location and merchandise management on the sales floor: “[We need] more accessible shopping, improve places from bus stops TO locations—more sidewalks!”; “Merchandising, needs less clutter, [usually] a lot of stuff in spaces”

Service quality is of paramount importance, especially for visually impaired shoppers. As respondents pointed out, “Larger stores have more staff therefore better navigations because you are more likely to find someone to help”; “Sensitivity from sales staff and understanding [is good].” Other respondents commented that “Customer service is very important, starts at the top,” because “cater to the client and you will have a customer for life.”
Comparison: Male vs. female; urban vs. rural residents

The male respondents and female respondents were compared using independent-sample t-tests to examine if there is any difference between them with regards to the perceived importance of inclusive retail store features (see Table 4). Results indicate that the two groups are significantly different only on one factor: service quality (p<.1). Women seemed to place significantly more emphasis on service quality than men.

The urban respondents and rural respondents were also compared using independent-sample t-tests (see also Table 4). Results indicate that the two groups are significantly different on two factors: ambience (p<.05) and accessibility (p<.01). Urban residents appeared to place a significantly higher importance on ambience and accessibility than their urban counterparts. This may be due to the fact that urban residents often have more retail shopping options available to them so their expectations for shopping environment are higher than those rural residents who have relatively limited options.

Table 4: Comparison of low vision shoppers

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>Urban</th>
<th>Rural</th>
<th>t-test</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=62</td>
<td>N=21</td>
<td>N=41</td>
<td>N=24</td>
<td>N=37</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(100%)</td>
<td>(33.9%)</td>
<td>(66.1%)</td>
<td>(38.7%)</td>
<td>(59.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambience</td>
<td>5.77(1.26)</td>
<td>5.39(1.53)</td>
<td>5.97(1.07)</td>
<td>6.22(1.07)</td>
<td>5.47(1.30)</td>
<td>t=-1.56</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessibility</td>
<td>4.99(1.35)</td>
<td>4.72(1.49)</td>
<td>5.13(1.26)</td>
<td>5.54(0.92)</td>
<td>4.64(1.46)</td>
<td>t=-1.13</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service quality</td>
<td>6.50(0.56)</td>
<td>6.27(0.75)</td>
<td>6.62(0.40)</td>
<td>6.35(0.65)</td>
<td>6.59(0.48)</td>
<td>t=-2.02*</td>
<td>26</td>
</tr>
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<td></td>
<td></td>
<td></td>
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</tbody>
</table>

*Significant at 0.1 level, ** Significant at 0.05 level, *** Significant at 0.01 level

Conclusion and recommendations

Inclusive retail environments encompass ambient as well as social cues that affect shoppers’ perceptions and shopping behaviour, which is applicable to the visually impaired shoppers in our study. Due to the unique challenges of this consumer group, their needs within the retail environment are well defined but different than those of persons with other disabilities [4]. Providing proper accommodation to this unique consumer group not only conforms to inclusive design principles but also improves quality of life for the visually impaired. Based on our findings, we make the recommendations set forth below for inclusive retailers.

Store Ambience

For visually impaired shoppers, store ambience includes signage, lighting, colour, and transaction receipts. Signage is critical to help visually impaired shoppers navigate through a store. Signs should use large fonts and regular-styled block lettering, with strong colour contrast between the letters and background; they also should clearly indicate the merchandise on shelves. For visually impaired shoppers, preferred store lighting is bright and uniform, designed as an integral component of the overall store environment. Specifically, there should be sufficient colour contrast between general store lighting and walls, floors, and shelves. Transaction receipts should use large fonts and have bold signature lines.
Store Accessibility
From the visually impaired shoppers’ perspectives, store accessibility includes store location, layout, merchandise selection, and checkout procedures. They prefer stores that are easily accessible by public transit and that have straightforward and logical layouts. Though most visually impaired shoppers do not use wheelchairs, their vision loss significantly impedes their movements in a store. Narrow aisles with display fixtures and protruding merchandise create potential tripping hazards which may cause damage or bodily injury. They also perceive a broad selection of merchandise as a factor of store accessibility. Checkout procedures should be modified for visually impaired consumers: “checkout stress” would be lessened through the proper handling of change by the cashier; the provision of user-friendly, uniform debit/credit card machines for the visually impaired; and possibly an audio-enhanced checkout system announcing the price and quantity of scanned merchandise.

Service Quality
Store associates must be available and willing to assist visually impaired customers. Staff must be knowledgeable about store merchandise and receive training on the unique needs of this consumer segment and on how to provide appropriate assistance in a sensible way. They are the frontline people who interact with shoppers directly and the symbolic message they send plays a critical role in shopping satisfaction among visually impaired customers.

Limitations and Future Research
Study findings are based on a telephone survey conducted with a small sample size of rural and urban visually impaired shoppers in Canada. While these initial data provide valuable insights, inclusion of a diverse population would provide a richer understanding. For future studies, systematic sampling is recommended for a more complete understanding among inclusive retailers of perceptions and preferences of the visually impaired community in Canada. Additionally, exploring how the retail shopping experience influences visually impaired shoppers’ quality of life and self-perception merits further in-depth investigation.

References


Every little counts - sense of security as a basic need for all

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ABSTRACT

The paper aims to argue the need to reconsider and redesign interactions with safety equipment within the inclusive approach. The current topic in reference to secure safe environments in hazardous events for most people led to the discussion if up-to-date safety installations, fittings and products in transport, buildings, urban and public spaces act universally and can serve as guarantors towards the use of the majority of people. The research aims primarily at an enhancement of safety aspects as an important and innate social and emotional need for the whole population including people with temporary and permanent differences and all those considering themselves to be vulnerable. New findings are presented on people’s age and condition in correspondence to the liability to feel excluded from social life and interpersonal relations. The author presumes stress experience and individual’s capability to be predominant in precarious environmental circumstances and intends to generate a positive impact through design. A key area of interest is the role of design for safety in working environments for the ageing workforce subject to demographic developments. The research practise suggests a new method to investigate and analyse restrictions regarding spacial settings and personal conditions. It defines correlations between environmental and individual conditions of a potentially impaired usability of safety systems. In terms of providing insights into social innovation the research stipulates new design solutions for healthcare, injury prevention and inclusion.

KEYWORDS

performance design/simulation/inclusive design/social inclusion/human modelling
Introduction

‘Last time I went to the theatre to watch a modern drama, I recognised a couple obviously not enjoying the performance. The play contained severe passages of frequent flash lights, intense shouting and extreme illuminations. Overwhelmed by heavy noise and lighting effects the couple were covering their ears with both hands, sitting scared with their eyes shut whilst waiting for an early ending. It was obvious that a part of the audience experienced severe stress and applied diverse coping strategies to survive the challenging situation. It seemed to me as the couple felt imprisoned in the theatre due to the fact that they felt unable to leave their seats. Apparently their way back was ‘blocked’ due to both external conditions such as darkness and poor building planning and personal constraints such as disorientation, stress and mobility.’

The question is what individuals do to escape stressful situations to avoid personal harm and discomfort. What might be the result if people are incapable of applying coping strategies in precarious situations? Emotional barriers, psychological discomfort and perceived stress create events in connection with the necessity to escape from certain places. The author is wondering since on how can we assure to design an environment to let most people feel safe and secure and avoid experiences in social space as described. How can we change social life through product design to re-connect people? How can we understand, prevent and resolve daily challenges of most people and secure social lives and communal gatherings? The question has to be answered primarily how the author justifies the effort to do research on the topic of safety and security and designing inclusively. Why is it important for design research to investigate in safety products, fittings and installations and the inclusive design approach and design for all in the living space? The reason why the author intended to start the current research approach is because safety products have to be designed to be accessible for users of any age, gender and capability, at any time and under any circumstances.

One reason why safety and security products are difficult to design inclusively is that applying a design process inclusively is difficult to manage itself. Most relevant ergonomic data of the vulnerable population is inexistent, inaccessible or poor presented.[1][2] Inclusive design should allow small and minor groups of people to be addressed but being mostly excluded and ignored during data collection reference data appears to remain incomplete. Although current safety regulations mention an inclusive approach on design nevertheless one is unable to offer inclusive solutions according to people with temporary restricted capabilities (e.g., pregnancy, fractures).

By 2020 half the adult population will be aged over 50. Disabled and older people are not special cases but will increasingly be part of the mainstream. So why do we continue manufacture products and services aimed at young, able-bodied consumers?[3]
What impact does the demographic shift have on safety design?

Inclusive Design applies two different design approaches in design practice. Assuming that our society is heterogeneous the majority of products have to fit any demands of potential users. Products are either explicitly designed to fit any users or particularly custom-made as product ranges each to fit a certain user group. Usability and function of the latter must be unambiguous for all kind of users but integrated in one product. In the area of safety products the design solutions must be developed to fit any users due to the fact that individuals of any age, gender, experience and culture will if applicable evidently use the products. This is currently an enormous task in design practice and will be increasingly relevant due to the growing diversity in age within our society. It means that products must fulfill the demand for ‘usability’ and ‘simplicity’.

[...] data processed by bioengineering and by physiotherapists tends to be in a format that is numerical, conveyed in static graphs, and where the dynamic quality and the context in which data are generated are not communicated effectively.[4]

In the design practice the relevant data is missing in regard to design universally. The categorisation of people sizes into percentiles does not reflect the real population. The estimations of human factors divided in percentiles provide practising designers only with a rough frame of criteria but the present system is unable to represent human factors all-encompassing and precisely. A 5th percentile woman does not evidently have 5th percentile extremities and a 50th percentile man has not evidently the physical strength as average. Most ergonomic data is documented as static graphs, in texts and tables which represent a system not suitable for the working process of designers in practice. The designer’s job is it to consider all possible human factors to design inclusively without exclusion of people.

Safety products, installations and fittings must have been developed to serve the majority of people. The operation must run and usage assured on any conditions and under any circumstances. Even in the case they are used rarely or once in a lifetime, it is essential to make sure that designers meet the requirements and demands of all members of the real population. We must guarantee that safety products act universally and avoid misuse, maloperations, dysfunctions and errors through misleading usability. Bad designed products could led to fatal events and incidents which has to be avoided by all means to secure a safe living habitat for most parts of the population. How is the innate emotional need to feel safe and secure affected to enable a fulfilling social life? Or vice versa how do people feeling unsafe and insecure in their habitat are dealing with this disadvantage socially? In regard to the topic of the ‘Argumentation of designing interactions with safety equipment within the inclusive approach on design´ consolidated in the early abstract, the discussion of the existing research project marks a point at a foremost position.
[...] a key part of the ‘design for all’ process, where the designer is not just looking to make quantitative judgements about the people who can and cannot use their design but instead is presented with the fact that, for example, ‘Janet’ an older lady with arthritis or ‘Tom’ a younger wheelchair user cannot use their design.[5]

Present pre-research observations led to the conclusion that it is necessary to explore the subject area on people and their personal sense of safety much wider. The intense concerns on human behaviour and discomfort due to physical, psychological and emotional harm in social habits (discomfort-zones) have been discussed and pursued since the early preparation of the research project. The social relevance has finally led to decision to open the subject of safety installations, fittings and products beyond hazardous events towards milder causes of challenges.

In order to start with an overall discussion it is required to create categories of hazardous or harmful events. Starting with conflicts of mild stress and discomfort to hazardous and high-risk events. The event in which relevant people due to their individual impaired or restricted mobility are temporary or permanently incapable to escape a precarious situation belongs to a finding to be included in the discussion. The individuals mentioned in the scenario will consider carefully about going out next time which might become a serious change towards their social life. This development could lead to social exclusion due to the fact feeling unsafe and insecure in social spaces. The focus of the research targets the correlation between personal condition, individual perception and structural environment and the effect on human interactions. The scenario described seems to be harmless or naive according the approach to secure social spaces, to attract real social dynamics or integrate people and secure social gatherings. But due to the fact that people feel psychological comfortable on different levels the product designers have to ask themselves the question if they completely understand people’s social behaviour, habits, demands and daily routines. Designers are demographically considered as healthy, able-bodied and fit individuals. Designers are mostly concerned with designing products for the major and able-bodied part of the population. Due to the demographic change and the trends of user-centeredness and inclusive design, any designer is in demand to reposition the focus on people reflecting a truly and realistic society. This paper encourages designer to let social innovation happen and sets a starting point for designers to engage people towards social life and communal gathering.

At the start it is useful for the discussion to categorise hazardous events and situations in grades according to the degree of impact on human behaviour. The categorical table accomplished from the perspective of product designers is focussed on the human interaction with safety products, installations and fittings in the interior of buildings and means of transportation.
Figure 1 illustrates levels of stress experience which differ in personality and situation of individual’s interactions. It shows areas of threats – increasing from low-intensity to high-intensity: Distraction- Tension- Discomfort- Stress- Restlessness- Panic- Threat- Life-threatening. The centre represents the individual, the rings the living space and the coloured gradient the level of intensity caused through external influences and internal perception.

[...] a stress refers [...] to the relationship between people and their surroundings. [...] and which environmental events or forces, called stressors, threaten an organism’s existence and well-being and by which the organism responds to this threat.[6]

The author defines a stressor as an emotional or physical demand that triggers a stress experience. The way a stressor is perceived differs in person and situation. Perception influences the people’s interaction and individual’s response. This response defines the mode people deal with situations. The key to the variation of coping strategies is the fact how stressors are perceived by the individual.
Methods

The research has started with a close observation in the areas: public space and transportation, domestic space, working environment and everyday products. Early findings on how individuals interact with designed objects intuitively in challenging situations were captured, filed and analysed through digital media. In a second stage qualitative research methods were used to cast a wide net and to adjust research objectives on the subject. [7]

It has been taken place with a small number of people and by different kinds of research media and methods. The questioning of an universal audience was aimed to understand the behaviour, demands and requirements of people in their habitat.

Designing products inclusively – an approach against discrimination and exclusion through products

The author designed a survey with a combination of open and closed questions. The self-completion questionnaire was handed out randomly with the number of 200. Each category contains more open (2/3) and than closed (1/3) questions. The opening thesis consists of questions about finding evidence for people’s life being influenced through unsafe environment and bad designed safety products. Individuals might be excluded from social life due to personal safety concerns. The key finding is to define problems on how people may be concerned about their direct habitat according to the standards of safety and security. And furthermore to gather evidence on the fact that there are people who fight against leaving their home as a place of refuge. And subsequently collect proof that there are people who refuse to gather socially due to not feeling safe and confident outside their living space. We have asked participants about the behaviour and emotions at crowded public places, the awareness of emergency exits and instructions whilst travelling, the experience due to unexpected events as flight disruption, cancellation or delay, the personal situations and the potential physical or psychological barriers on journeys. Most open questions are based on the idea of letting participants write about their personal experience in a defined period of time (last 24 hours, last 30 days) to support their reminding. Questions were kept brief, objective and general to achieve providing participants the freedom to talk. The strategy of unfocussed questioning was applied to engage people to tell their secrets. All questions were designed in order to give participants the chance to talk unaffected about their daily lives, personal experiences and social habits. It was advised not to lead participants through phrasing, syntax, form or design of questions to avoid bias the results or to use questions that contains the information the examiner is looking for.
Results and discussion

There was a 49% response rate. After analysing the qualitative questions of the completed forms the data was refined in depth interviews. The research discovers that people in large parts are themselves not considering as feeling safe and secure in certain environment. This is caused by the uncertainness and doubts on safety and security systems relating to the individual perception. On that basis the author concludes that parts of the population are endangered to apply radical coping strategies to a greater or lesser extent. Moreover due to that fact that certain individuals make significant changes to their social life and are forced to cope with everyday tasks considerably which lead in the matter of fact towards social exclusion depending on individual circumstances.

Figure 2 displays the result according to the qualitative research. It shows a development towards social exclusion and the author applied further investigation on the subject human interaction and safety-related design.
Figure 3 shows the same group of respondents referring to personal problems, conflicts, concerns and doubts with safety products in public place and transport. The author assumes that there is a profound correlation between the individual’s social activity and communal gatherings and the individual’s discomfort-zone due to severe safety concerns. The author assumed that the survey has approached people who might be considered as physically vulnerable. From simply listening to people one can derive that some apparently vulnerable people are living with constant anxiety, fear of excessive demands by their environment.

The result of the survey delivers insights into the phenomena that people are apparently forced to apply diverse coping strategies in situations to avoid harm, conflict and at the end social exclusion. The survey shows tendencies towards the fact that most people concerned are older adults or people with restricted capabilities who felt severely left behind. In order to design and develop safety equipment inclusively it must be assured to minimize or eliminate risks and sources of maloperation whilst usage from any users. It could lead to irreparable losses and damages in the event of an unforeseen emergency event. To use the knowledge of the research the author at this point came to the conclusion to transfer the gathered data input into practical testing of real spatial settings.

Designing safety products and safe environment is an emergent subject area especially regarding the demographic change and the demand of people presently unconsidered in systems of estimated human factors. The author decided to pursue the research towards capturing human motions with the aid of a profound practise-driven investigation of living habits and sense of security. The gained theoretical knowledge will be used to proceed with the research towards risk assessment and product testing in realistic stage settings. The insight information will be used to discuss, define events, real stage settings and spaces for the motion capturing. Before starting motion capturing tests the author decided to set up personas on people with differences and less-than-the-average performances, the young and older adults. Professional actors will be briefed accordingly and represent different characters.
Narrowing the discourse on evacuation and escape

In order to make the research outcome useful in design practise and applicable for the process of product development, it will be essential to simulate, animate and illustrate the relevant results. This method meets the requirements of participating professionals who are responsible for designing user-orientated products, services and environments. The idea aims the collection of data through motion capturing cameras installed in the stage settings. Computer simulations in virtual reality will be referring to the data. Virtual 3D human surfaces will be linked to the dynamic coordinates and will be displayed and rendered accordingly. The current research will be covering and aiming the area of people conflicts on events ‘evacuate and escape’ which criteria are described. Key research areas will be on how people cope with situations caused by low-intensity and high-intensity events. The author is planning to set up real settings to simulate low to medium-intensity scenarios. The plan is in place to create scenarios by partially filling a defined space with fog artificially generated, leveled and controlled by a machine. The low-visibility makes it impossible to use a passive marker system which led to the decision to apply non-optical system or active marker for the motion capturing. Figure 4 ‘Cloudscapes by Transsolar and Tetsuo Kondo’ gives an example of a setting with low-visibility.[8]

Professional actors will run random motion patterns on ‘evacuate and escape’ scenarios which are recorded in different perspectives by motion capturing cameras. There will be defined spatial settings to demonstrate different precarious events referring closely to the information gathered from former collected, recorded and analysed qualitative research input. The participating actors will use suites, gloves or other gear to simulate motion constraints in reference to the approach to design inclusively for the whole population. The testing through simulation in real settings should be conducted to find evidence for the final thesis. At challenging events the individual performance of a person at risk such as constrained movement, physical strain or visual impairment could be under certain conditions considered as equatable to affected spatial conditions such as low-visibility, physical and cognitive barriers or dysfunction of safety products.
Reference


Questioning Communication in Tactile Representation

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Abstract
Creating tactile representations of maps, artwork and other materials for people who are blind or visually impaired has become commonplace in the design community. In many cases tactile representations created for people with varying degrees of vision are developed by sighted people, and are geared towards orienting and educating—making abstract and conceptual information more tangible. This research project involves one in-depth case study where the core questions explore: how information is interpreted, translated and embodied into tactile representations; and how representations are experienced, interpreted and understood through tactility. Our case study is a series of tactile images created for the Pompidou Centre (France) towards discovering modern and contemporary art through touch. Insights resulting from this work reveal intentions behind the tactile representation of paintings, how these are transformed to transmit messages, and how these translate into specific kinds of experiences and understandings. This work exposes that communicating information translated from a visual modality to a tactile one is an extremely complex process.

Keywords
design intentions, design process, reflection, tactile images, user experience

1 Introduction
Development of tactile representations of maps, artwork and other materials for people who are visually impaired and blind has recently increased. While there are historical examples of tactile representation e.g., relief on Egyptian stone tablets and textures on paintings, they are typically intended for visual-centric audiences. The development of tactile imagery for people who are visually impaired and blind dates back to the early 19th century where tactile atlases were created for students [6]. Our case study looks at a project initiated by Alain Mikli International (AMI), a prominent eyewear design and manufacturing company. It involves the development of a series of tactile images (figure 1) based on ten modern and contemporary paintings created for the Pompidou Centre in Paris France.
The AMI project is part of a larger initiative that enables experiencing and accessing imagery (e.g., photographs, paintings, artifacts) through touch. In this case, the AMI tactile images are geared towards educating people about significant aspects of art history. Use of tactile images expands the experience of art to include more people.

This research focuses on the process of creating tactile representations that communicate messages to audiences. Two core questions explored in this paper are: how is the information from the original paintings interpreted, translated and embodied into tactile representations; and how are the representations experienced, interpreted and understood through tactility. Key findings of this study are presented as pointers towards creating clearer tactile communications.

This paper begins with a background on tactile representation and communication, followed by the research approach and methods taken and a description of the ten AMI tactile images. We continue by exploring translation processes from the visual to the tactile, and an analysis that provides a clearer understanding of tactile communication.

2 Tactile Representation & Communication
In general, the central goal in creating tactile images is to make abstract and conceptual information more tangible. In this section we begin by exploring key issues around representation and tactile experience; and then summarize how information is mapped from the visual to the tactile.

Visual and/or tactile representations are a re/construction of a moment in time, a context, an object (e.g., photography), a place/space (e.g., map) or an artist’s view into lived experiences (e.g., drawings, paintings). Representations are always partial pictures of reality that bring out recognizable aspects of the world in the form of similarities or differences rather than being complete pictures of reality [13]. Representation is also about communication where a message (intent), a transmitter (tactile image) and a receiver (audience) are necessary.

Composition is one of the basic principles in representation and is fundamental to creating two-dimensional imagery that communicates well. Composition relies on two premises: first it builds on the whole of relatively contained parts, and second it takes off from an overall totality that is modified by subdivisions and refinements [4]. Composition aims towards integrating the whole (gestalt) of the two-dimensional picture plane by using a variety of elements in order to communicate practical, emotional and conceptual information. The importance of composition is common to both visual and tactile representation. This is because both types of representation consist of elements that constitute larger pictures that need to be organised for readability. Visual compositional rules are well-known and linked to psychological concepts of visual perception, whereas tactile compositional rules are less developed.

Although there are common aspects to visual and tactile representations the two senses operate on very different levels [3]. Vision is considered a passive perception while touch is dynamic [4]. Vision is simultaneous and instantaneous while touch is sequential and represents temporal successions [14]. As a result, recognising pictures by touch is much slower than it is for vision (ibid). Furthermore, researchers understand that the band width (resolution) of vision is higher than it is for the other four senses, meaning there is a reduced level of acuity in touch. Therefore, tactile representations need to be simpler than visual counterparts [19]. The receptor organs of touch are spread over the surface of the body; touch distinguishes between things—for example textures, hardness, softness—by poking, squeezing, tearing, bending, and manipulating [4]. Through touch people can discriminate patterns from shape and details, but this involves complicated cognitive processes [19]. Consequently, thoughtfulness and
consideration are needed when creating artifacts that support touch; particularly when
the desired outcome is to encourage deep experiences and understanding of concepts.
Creating a tactile representation based on something visual is an extremely complex
process requiring extensive forethought into modal variations and differences.

It is not uncommon for designers to map information from one thing to create
something new [11]. Sometimes this mapping process is direct from one thing to
another; at other times there is little resemblance between the thing(s) that influences
and the new design. It is, however, less common to map information from one mode to
another. One exception is the development of tactile maps and educational materials for
people who are visually impaired and blind. Although there are many examples that
describe the development of tactile maps, there is little attention given to illustrating the
process of mapping something from the visual to the tactile. Mostly, researchers
advocate the importance of tactile representations [12] or present mechanical/electronic
presentation devices or methods [19] without addressing the role of communication.

Literature on tactile representation commonly describes the experiences of
people who are visually impaired or blind without providing tangible ways that these can
be applied to designs. Even so, there are some significant concepts that help to better
understand issues around tactile representations. First is understanding that
experiencing tactile artifacts is based on body-related strategies which include feeling,
rotating, moving objects close to face, use of both hands, moving objects from one hand
to the other, etc. [3]. Second is that when considering touch, a multitude of things need
be taken into account such as movement, posture, language, and prior knowledge [3,
7]. The physical and intellectual aspects identified in these first concepts are a reminder
that people inherently experience the world in holistic, embodied ways. Third is that early
tactile experiences affect and influence later experiences [3]. Fourth is that language is a
key factor towards understanding tactility, i.e., “language, touch and spatial coding are
all needed for reading by touch” [15]. Researchers further indicate that mapping
information from visual to tactile is “essentially a volume-reduction problem” [19]
whereby the visual needs to be simplified when translated to the tactile.

3 Research Approach & Methods
In order to better understand communication through tactile representation this research
takes a multiple method approach. One in-depth case study is completed using
interviews, observations, reflective and reflexive methods. First, the people who worked
on translating paintings to tactile images were interviewed. Second, participant
observation is used to understand how people engage with the tactile images. Third,
what it means to experience tactile representation from the perspectives of design/er
and research/er (author 1) and being blind (author 2) aid in analysing the data in
reflective and reflexive ways. Our multiple method approach supports understanding the
tactile images in two ways: the design process and user experience.

This approach uses enquiry, methods, analysis and dissemination appropriate to
studying contemporary issues in anthropology [16], techniques called ‘research in the
wild’ [9] and reflexivity [1]. Specifically, this method pushes the idea of data-producing
relationships where the researchers are an outsider (author 1) and an insider who is a
stakeholder and directly involved in the project (author 2). In our case, the outsider
establishes the focus of the study by identifying the goals and research questions, while
the insider predominantly reflects on the findings of the project. The insider is a project
manager for AMI who took part in developing the tactile images and is born blind,
meaning that his interest in the tactile images goes beyond his professional life where it
touches issues that relate to the way that he experiences the world.
We began our case study with informal interviews and questions while we viewed the AMI tactile images. How were the paintings selected for tactile representation; what is the key information that is communicated in specific tactile images; and how are the tactile surface variations selected? The interviews were recorded and later analysed.

The second part of this study involved observing people engaging with the tactile images in situ at the Pompidou Centre. Approximately thirty participants were observed over the course of two days. The majority of participants were not visually impaired or blind; but were individuals of various ages from the general public. At the time of observation there was no interaction between the researcher and participants; a distance of 3-5 metres was maintained. The resulting data from each part of our study were cross-referenced and combined towards a better understanding of communication in tactile representations [8, 10]. As a final means towards addressing our research questions and understanding the data, the authors spent considerable time actively discussing the project. This reflective and reflexive process evolved over nearly 1 year, where emphasis was placed on triangulating the data and balancing the inside-outside relationship.

4 AMI’s Tactile Images
The AMI tactile images are based on ten modern and contemporary paintings housed at the Pompidou Centre in Paris. The paintings are:

1. Juan Gris Still Life on a Chair, 1917 (oil paint on wood panel, 100 x 73 cm)
2. Max Ernst Ubu Imperator, 1923 (oil paint on canvass, 81 x 65 cm)
3. Pablo Picasso Woman in a Hat, 1936 (oil paint on canvass, 50 x 60 cm)
4. Georges Rouault Funicula: Qui ne se Grime pas [Who does not Make Themselves Up], 1948-1953 (oil paint, ink, poster paint on paper, 27.7 x 18.7 cm)
5. Pierre Soulages Untitled, 1963 (oil paint on canvas, 260 x 202 cm)
7. Jean-Michel Basquiat Slave Auction, 1982 (glued crumpled paper, chalk drawing, acrylic paint on canvas, 183 x 305.5 cm)
8. Anselm Kiefer A l’Etre Supreme [To the Supreme Being], 1983 (mixed media, 280 x 368 cm)
9. Jonathan Lasker Stable Aberrance, 1995 (paint on canvass, 204 x 279 x 4.8 cm)
10. Bernard Piffaretti Untitled, 2000 (acrylic paint on canvas, 289 x 454 cm)

Figure 2: tactile image of Gris’ Still Life on a Chair & Pifaretti’s Untitled (permission of AMI)

The ten AMI tactile images are all the same size (31 x 42 cm) and mounted in freestanding cabinets placed in a row (figure 3). Large type, Braille and audio guide descriptions accompany the paintings. The Pompidou Centre also organises special
sessions hosted by interpretive guides who talk about the paintings and are trained to aid visually impaired and blind audiences in the discovery of the tactile images. The tactile images have been on display since January 2009.

Figure 3: the tactile images *in situ* at the Pompidou Centre

The development of the tactile images for the Pompidou Centre fall within AMI’s programme called ‘défis’ (loosely meaning ‘challenges’). This programme is motivated by Alain Mikli’s long commitment to improving people’s vision through the design of luxury eyewear. AMI discovered a way to carve, drill and layer cellulose acetate, a material used for manufacturing most AMI eyewear. Cellulose acetate is the single material used to create the tactile images. This material and technique enables the rendering of relief and textural effects. A team of people including a graphic designer, an art educator, and the project manager who is blind (author 2) were responsible for developing the tactile images.

5 Translating Visual to Tactile

Designers and researchers who work on developing tactile representations of maps, shapes and other two-dimensional drawings have developed a rudimentary understanding of how to translate visual into tactile information. Three steps identified as necessary towards translating visual to tactile, are editing, transferral, and production [19]. The editing and transferral process reduces information clutter by distilling detail to the essence of meaning. This simplification is important towards making tactile information as understandable as possible. Preference for general overviews and impressions of places (*i.e.*, overall shape, layout) rather than preciseness are also necessary (*ibid*). Finally, research into shape recognition indicates that it is rare for specific shapes and details (*e.g.*, acute, obtuse angles) to be differentiated through touch [3]. These ways of understanding the translation process provide insights into how paintings may be translated into tactile images. Our case study details how AMI edited information, reduced clutter, and limited and differentiated information.

5.1 Finding focus in the content

The first step in the translation of a painting to a tactile representation is to find focus through content. This involves making abstract and conceptual aspects of the paintings more tangible by communicating a single, clear message (*e.g.*, practical, emotional, conceptual) for each painting. This was accomplished through extensive analysis of the paintings and intensive dialoguing between the art educator and graphic designer. The analysis considered how educational information is delivered, and identified specific characteristics unique to each painting. The focus of different paintings, for example, is in the use of particular kinds of organisational or technical features (*e.g.*, perspective, foreshortening). Kiefer’s mixed media painting *To the Supreme Being*, for instance,
focuses on perspective, three-dimensional space and materials, through emphasizing the texture of wood, brick, and actual materials in the mixed media painting (straw, oil paint, wood engravings). While Gris’ oil painting *Still-life on a Chair* focuses on cubist painting and includes geometry and multiple viewpoints. These examples illustrate that the tactile image disregards some features such as other compositional principles and paint application techniques.

Identifying a focus in the content enables clearer communication in tactile representation because the information has been edited down and limited. Certain kinds of information are deemed less relevant to describing the essence of a particular painting. Colour, in all cases, becomes irrelevant in communicating other features of the painting. Firstly, colour cannot be represented in tactility; and secondly, colour is a dominating feature in most images and therefore detracts from other things being communicated. Interestingly, this reduction of information to a focused topic does not dilute the intended message, instead it strengthens it because there is clarity in the communication.

Another insight discovered through finding focus in the content is that there is no possible way of creating a type of ‘tactile grammar’ that represents common ideas in more than one painting. This is because the content of the paintings are not approached as a snapshot or single moment in time, but as a contextual event that involves sequential experiences. This is tied to the shift from the visual to the tactile mode where embodied, dynamic experience is paramount.

5.2 Understanding the limits of vision & the limits of tactility

The second step towards rendering something visual into a tactile representation involves understanding the inherent limitations of each mode. When our art educator and graphic designer were analyzing the paintings, they began to identify characteristics of the work that were not easily understood through the visual mode. For example, although perspective can be understood visually through the principles of geometry, it is actually a technique that is better understood through linking it to experience and touch. That is, perspective can best be understood by relating the physicality of tactile exploration, which takes fingers and hands across and around a two-dimensional space, to how a person experiences a spatial environment. In terms of the limits of tactility, this is linked to the issue of finding focus in the content.

As previously noted one limitation is colour; however, other limitations are the actual sensation of being able to delineate between variations and nuances in the tactile surfaces. Touch sensitivity and the ability to detect detail decreases as people age [19]. In addition, different people detect tactility on various levels. As a result, the design of tactile layers needs to be explicit enough to delineate details, without ‘dumbing down’ the tactile information so much (by making the layers too obvious) that it removes the cognitive challenge (and subsequent interest) in spending time to explore the image. In effect, there needs to be a balance of providing the right amount of tactile stimulation in order for audiences to read the material. Through testing early tactile prototypes, it was determined that the appropriate number of layers to use in the AMI tactile images was eight. It was apparent that the majority of users were not able to establish a clear hierarchy when the levels of relief were above eight. AMI’s tactile images have a variety of distinct textures thus capitalizing on touch perception strengths as well.

Three insights are gained through understanding the limits of vision and tactility in a more in-depth way. First, more time is required to apprehend information through touch than through sight. As a result, people need to be taught to explore a surface slowly and systematically. It is clear that understanding a tactile representation takes a significant amount of time, often 1.5+ hours to discover one image. Second, contextual
cues are very important to aiding in the interpretation of the representations. These contextual cues are: audio, large print and Braille support material; a key that represents the scale of a person to the painting that illustrates the size of the original (figure 4); and live guides whenever possible.

![Figure 4: key showing the size of the original compared with a person](image)

All of these contextual details assist with the ‘reading’ of the tactile representation, but a standardized layout from tactile image to tactile image is also important for the meta-information to be discoverable. Third, exploring artifacts through touch requires place-finding and a starting point. A type of focal point or emphasis is identified in the composition and achieved by using the closest and thickest material on the surface of the tactile image. This naturally guides the hands towards the closest information providing a focal point that establishes a beginning for reading through touch.

The general reduction of information in a tactile representation begins with basic standardizations, which are the overall size/dimensions of the image, placement of information, and overall simplification of tactile material (e.g., not using too many kinds of lines, strokes, bodies of materials, thicknesses).

6 Towards a Clearer Understanding of Tactile Communication

Willingness to touch and apprehend information is limited by many factors; prior exposure to or experience with tactility (i.e., through Braille use) is particularly significant and desirable. That is, the ability to capture new information is improved by having prior experiences. It is also necessary to reduce or de-clutter information (borders, guidelines and print text) to enhance tactile exploration [17]. Prior research reveals the following: shapes and outlines are easier to apprehend as components before proceeding to the complexity of the whole [4]; supplementary materials (captions, interpretive guides and/or audio-guides) enhance experience by providing clues for readers to negotiate tactile information [17, 19]; people need training to be analytic and systematic [3].

Understanding how people experience tactile representation is significant to improving ways of translating information from one mode to another. This section looks at how tactility is experienced and how the embedded communicative information is received when touching the AMI tactile images.

6.1 Experiencing tactility

People’s ability to recognize tactile elements varies significantly from person to person [14] regardless of whether they are sighted or not. In general people’s capacity to read a tactile image depends on their willingness to experience something that is tactile, while visually impaired or blind people’s capacity is compounded by how well they can abstract concepts. Users must be able to make correlations between the audio and textual descriptions of the original work with what is being touched.
Based on observation of users and reflective/reflexive considerations, tactile image exploration involves three levels of discovery: basic principles of composition and art (e.g., perspective, side/front view, painting stroke); informative tactile information such as basic elements that constitute the images; and the overall painting and conceptual characteristics (e.g., cubism). The sense of touch allows audiences to perceive things that are felt through the fingertips. For example, texture (from component materials and artistic technique and movement) can be discerned and experienced in the representation. For example, Soulage’s paint application process, with wide paint strokes beginning as thick and heavy then tapering off, are represented in the tactile image.

For the AMI tactile images, mediated text and guided information is written in accordance with the way people who are visually impaired and blind approach tactile discovery. What this means is that, although spatial mapping techniques vary among people, in general spatial mapping is an embodied experience that relates to physical relationships. Object recognition and/or the location of objects relative to self and other objects aids in spatial mapping by helping people to situate and orient themselves. As a result the text that accompanies the tactile images needs to be written in accordance with the way that people, especially those who are visually impaired or blind, approach tactile discovery.

People who are blind and visually impaired, to lesser or greater degrees, have the inability to visually see/recognize/identify size, form and colour. Experiencing tactile images through touch becomes a highly cognitive experience. Therefore, more attention and time is needed to understand and absorb the information that is being detected. As a result, an embedded system and flexibility that assists readability is essential. It must consider a multitude of different kinds of users with different capabilities. This means that there needs to be a connection between how the different paintings offer general information. The AMI tactile image project uses a system where size is consistent, the images are presented within a clear frame (with a border that provides limits), support materials are laid out in the same configuration, a single material is used in the manufacture of each image, and the layers of relief are consistent. Variations only relate to the conceptual information that is transmitted, for instance, in the textural details or aspects relating to background, middle ground, and foreground. The actual tactile experience is deeply linked to the messages and meaning embedded in the images.

6.2 Experiencing understanding through communication

The focus of graphic design and art when represented in tactile images is ultimately to communicate a message between artifact and audience. A painting is not necessarily meant to be informative, however, in the case of tactile representation of the paintings, aesthetic and artistic qualities do not provide a meaningful tactile experience. In order to better understand how information is received, one must have a good sense of the limitations of communicating in the tactile mode. In the case of the AMI tactile images there are five key considerations:

1. Not every painting can be translated; there may be too many elements or the work may already have three-dimensional components.
2. The amount of time it takes to explore, understand and produce a tactile image significantly limits the number of tactile images which can be produced.
3. Not all mediation techniques, technologies or devices are accessible to everyone. Clearly this depends on the user’s prior experiences. As a result, it must be accepted that all types of mediations result in compromises that cannot take all users into account.
4. The context of the tactile images being displayed needs to be taken into consideration. Navigation to the display is affected by lighting conditions (ambient, direct light), the colour of the walls (brightness, contrast) and therefore impacts communication of the images.

5. Creating tactile images requires a great deal of work, particularly when involving people who are visually impaired or blind. Typically users with limited sight are asked to collaborate late in the process, which affects the design outcome. When the involvement of users who are visually impaired and blind is limited there must be extensive knowledge about how people perceive space in order to reduce assumptions and preconceptions.

These considerations coupled with other variables such as size and scale of the picture, the frame or discreet border of the whole (information and image), as well as the distance between reader and artifact can be controlled by a design team [13]. Ambiguity of the intended message can also shift interpretation. Therefore, the focus of the message in tactile images needs to be as clear as it would be in graphic design communication while still allowing for multiple interpretations based on individual experiences of the tactile images. The controls developed by the designers can be obtrusive or less so depending on the message created. These controls can be in the form of organization, can emphasize certain kinds of line (silhouette, outline), illusionistic detail, illusion of dimensionality, or emphasize some parts more than others. As a result, hierarchy of information in each composition is an important principle to employ.

7 Conclusion

According to Benjamin [5], reproductions (even the most precise) are lacking presence in space, time and place and that an attempt to represent the original artwork is akin to prying an object from its shell and thus destroying its aura. Yet, in the case of the AMI tactile images, by reproducing a unique version of a painting, a new connection to space, time and place is developed. That is, the tactile representation becomes another way to experience the concepts, emotions and techniques employed by artists. By focusing on tactile characteristics of a painting rather than the visual, the essence of aesthetics becomes a fuller sense perception.

Although it can be argued that paintings are innately connected to vision and touch, it is clear that translating from one mode to another is not a simple procedure. Creating artifacts that support touch requires thoughtfulness and deep consideration, particularly when the desired outcome is to encourage heightened experiences and understanding of concepts.

We have learned that it is not possible to turn a visual artifact into a touchable version that is a true and faithful rendition representing the original; however, it is clear that specific attributes of the original can be captured in a tactile form that represents some aspects of the original. In addition, this research illustrates that the intentions behind paintings and key concepts in art production and history can be transformed into strong messages in a tactile format that translate into specific kinds of experiences and understandings. Finally, this work exposes that communicating information in the tactile mode has some similarities to communicating visually through graphic design. In this way, this work reveals that although tactile exploration cannot be equated to taking in visual information, it is a mode of communication that provides added value to understanding artifacts such as modern and contemporary paintings.
References


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Abstract
Social innovation is defined as the creation of research and knowledge in the development of sustainable solutions for social, environmental and cultural challenges that result in more efficient and effective human services, more responsive public policies and greater cultural understanding. Education and training can be a power-base for fostering social innovation, but if their environments are inaccessible or exclude people, the university will become an area of isolated and poorly interconnected communities, thus hindering the development of social innovation. The provision of accessible educational facilities is the most important area of concern for achieving a barrier-free education. Therefore architecture students of two collaborating universities (Yildiz and Istanbul Technical University) take part in studies aimed at removing all the obstacles (attitudinal, environmental and organizational), which impede full participation to university life. In the framework of this project, a ‘toolkit’-guide on accessibility in the campus is being prepared to be implemented within the scope of Turkish Higher Education Council’s act on campus accessibility for accessible education. It is acknowledged that universal design should be taught and practiced as a vehicle for promoting social innovation as well as social equality and justice, environmental sustainability, and health and well-being. *Accessible- Barrier-free Learning Environments.

Keywords
Accessibility, Universal Design, Accessible University, Inclusion.

Accessibility and inclusivity in further and higher education in Turkey: an overview

The European Union (EU) is built on a goal of making Europe “the most competitive and dynamic knowledge-based economy in the world” [1]. Countries that invest heavily and effectively in education and skills will benefit economically and socially from that choice. The evidence also shows that countries that give individuals one additional year of education can boost productivity and raise their economic output by 3% to 6% over time [2]. Education and training can also be a power-base for fostering social innovation [3][4].

Therefore Europe’s capacity to compete in the global knowledge economy will depend on whether its higher education institutions can meet the rapidly-growing demand for high-level skills. But that, in turn, will depend on significant improvements in the quality of schooling outcomes and equality in learning opportunities [2].

Turkey’s recently released development plan emphasizes the need to increase educational attainment and to develop a lifelong education strategy to ensure individuals have the skills needed for a changing and developing economy and labor
market. The plan has identified the fact that Turkey requires education systems that are more flexible, more effective and more easily accessible to a wider range of people, not only to meet EU’s goals but also to satisfy the increased expectations for higher education in a global, knowledge economy [1].

Turkey, in contrast to other European countries, has a young population with a growing population of nearly 71 million, 36 percent of whom are under the age of 14. This growing young population means that Turkey is confronted by the future challenges of access and participation in higher education. The population of 20 to 29 year-olds is expected to increase by 7 to 16 percent over the next decade, imposing an increasing demand upon the tertiary education system. While equal access to higher education is a quantity issue (to provide more educational facilities) for Turkish higher education, discrepancies can also be considered a quality issue (to provide barrier-free educational facilities) [5][6].

According to the State Institute of Statistic’s 2002 Disability Survey, there are approximately 8.5 million persons in Turkey with disabilities, a number that constitutes 12.29% of the total population. When considering the high percentage of individuals with disabilities in Turkey, educational attainment for these individuals is extremely low [24]. The percentage of primary school graduation is as low as 40%. The percentage decreases drastically as the grade level increases. Unfortunately, less than 7% of individuals with disabilities earn a high school diploma (Table 1). This trend continues in higher education (3%). According to data from the Student Selection and Placement Center (2003, 2008), of all students who take the university entrance exam, only 0.13% are disabled [7][6].

The constitutional system of Turkey is based on the principle of equality before the law of all individuals without discrimination. The constitution explicitly states that, “The State shall take measures to protect the disabled and secure their integration into community life” (Article 61), and also provides that, “No one shall be deprived of the right of learning and education” (Article 42) [8]. However the statistical data show that access to higher education is not barrier-free. People from disadvantaged social backgrounds, cultural minorities, physically disabled, women in general and refugees all face various obstacles that lead to their lower representation in higher education.

In Turkey, the July 2005 ‘Law for Disabled People’ (The Act No. 5378) aims to help disabled people by alleviating problems in relation to health, education, rehabilitation, employment, care and social security. It provides for affirmative action to achieve de facto equality for persons with disabilities and to create an environment in which they can equally enjoy human rights and fundamental freedoms as well as to enable them to fully participate in the society [8]. The law also aims to assist persons with disabilities

<table>
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<th>Table 1</th>
<th>The proportion of disabled population by completed educational level (age≥25)</th>
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<tr>
<td></td>
<td>Illiterate</td>
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<tr>
<td>Turkey</td>
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<tr>
<td>Urban</td>
<td>27.40</td>
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<tr>
<td>Rural</td>
<td>45.36</td>
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<tr>
<td>Male</td>
<td>25.75</td>
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<tr>
<td>Female</td>
<td>51.26</td>
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Source: OIB (2002).
development in every aspect by taking measures to remove any obstacles and making the relevant arrangements for the coordination of these services. According to this law, within seven years of the implementation of the act (by the year of 2012), facilities for disabled people must be put in place, in terms of them being able to access buildings that belong to public institutions, including roads, sidewalks, pavements and public places [9].

Higher education institutions in Turkey are also challenged to consider the ways in which by the year of 2012 their institutions can be accessible to the increasingly wide variety of students who attend them. Following the 2005 Turkish Disability Act, the Directive on Disability in Higher Education was passed in June 2006 [25]. This newly-approved legislation requires that each university maintain a support unit as ‘Disability Coordination Unit’ for students with special needs. Those units are responsible for taking the essential precautions to facilitate the educational lives of persons with disabilities that are studying in universities and to make arrangements accordingly [25].Universities are now required to remove barriers that might deprive qualified persons with disabilities from the opportunity of succeeding in postsecondary education. “Accessibility” for a university student with a disability might include anything from physical access to student halls to learning and testing in the classroom.

As non-discrimination policies begin to take effect, considerable progress in Turkish universities has been seen in the inclusion of students with disabilities, with support improving and institutional strategies emerging. However problems still remain, including an incomplete understanding of needs of students with disabilities, a lack of reliable statistics, difficulties with the interpretation legal requirements and the lack of relevant standards for implementing those regulations.

While standards and guidance for accessibility (along with legislation establishing and protecting the civil rights of disabled people) are tools for increasing support efforts to integrate people with various abilities into the mainstream of society and promote social participation as of rights, there is a concern that inappropriately phrased/interpreted legislation could lead to disabled people being treated as separate or special groups and that rather then promoting integration, designs will appear that become ‘exclusive’ rather than ‘inclusive’ [10]. Therefore, there is a need to have a comprehensive framework and guidelines in the Turkish higher education context to help provide effective guidance for consistent implementation and application of this legislation.

Education and training affect exclusion dynamics and conditions for social innovation [3][4]. To this end, the lecturers from Yildiz Technical University and Istanbul Technical University submitted a project proposal to Yildiz Technical University to provide a framework for assessing higher education institutions towards provision of accessible and inclusive learning environments. In the initial part (piloting) of the project, architecture students of two collaborating universities (Yildiz Technical and Istanbul Technical University) participate in courses that allow them to define and assess all the barriers (attitudinal, environmental and organizational) that can impede the full participation of disabled students and general public to the university life. In the framework of their project, a ‘toolkit’-guide on accessibility of campus will be prepared to be implemented within the scope of Turkish Higher Education Council’s directive on inclusive higher education.
Following the introduction of Turkish higher education system, this research paper commences with a consideration of legislative and policy obligations for inclusion in the context of higher education in Turkey. Secondly, the paper attempts to reconcile the broad and somewhat disparate interpretations of inclusivity and diversity in the context of higher education institutions in Turkey. Finally, we introduce a comprehensive framework on designing effective enabling learning environments that will shift the focus from inclusive education as a product to inclusive education as processes of social innovation, attitudinal change and development of collaborative learning communities.

Disability legislation, policy and standards: implications for higher education in Turkey

Following the 2005 Turkish Disability Act and in line with the reform of higher education, the rights of the university students with disabilities and the accessibility of the universities became one of the major issues of the Council of Higher Education [25].

The non-discrimination policies established by the Directive on Disability in Higher Education have led to considerable progress in Turkish universities in terms of including students with disabilities. In 2007 a national workshop series organized by the universities in collaboration with the Council of Higher Education was initiated (based on an European Union project) [11]. However problems still remain in establishing institutional strategies designed to improve support for disabled students; these problems stem from an incomplete understanding of the needs of students with disabilities, the lack of reliable statistics, difficulties with the interpretation of legal requirements and the lack of consistency between standards for implementing those regulations [7].

First off are the difficulties in the implementation and application of the legislation. Under the Turkish directive, higher education institutions are charged with the responsibility of carrying out anticipatory modifications. This means that institutions should consider what modifications future disabled students or applicants may need and actualize these changes prior to actual need. However, Institutions are only required to do what is “reasonable.” What is “reasonable” will depend on all the individual circumstances of the case, including the importance of the service, the attitudes of faculty and administrators, the financial or other resources of the institution and the practicality of the adjustment [12][13].

In practice this has led several higher education institutions in Turkey to focus on ‘what is possible’ rather than ‘what is needed.’ These institutions then take some measures without a requirement to assess the outcomes of these measures. Providing accommodations to students on an individualized basis is a legitimate way to meet legal access requirements; however, that type of approach favors the provision of barrier-free higher education not as a matter of social justice and opportunity for promoting integration, but rather as a matter of compliance. Therefore, the HE Institutions neither conduct any monitoring to evaluate the impact of such measures; nor collect data that would allow a comparison of the situation before/after the measures. This ‘deemed to satisfy’ approach to standards and guidelines also has the potential to result in recommended minimum provision becoming the maximum in practice [10].
One of the reasons for the discrepancy between the implementation and the legislation is that the practitioners (public institutions, employers in the private sector, teachers etc.) are not adequately trained regarding their obligations under the law and have not been provided with guidelines to follow to ensure certain standards of providing accessible learning experiences.

Secondly, many Turkish universities have initiated various projects in order to assist persons with disabilities in compliance of the directive. A piecemeal approach that is built on scattered and isolated projects has, however, very limited and often non-sustainable effects on the lives of persons with disabilities in higher education institutions. After all, it is not economically feasible to cater for the needs of all disabled persons through "disability-specific" projects that are targeted to disabled people only. This could lead to disabled people being treated as separate or special groups, rather then promoting integration and offering solutions that are 'exclusive' rather than 'inclusive' [10].

There has been a growing realization that disability arises not within the individual but is a result of environments, products and services that fail to take into account the needs and capabilities of all potential users. The definition of disability has shifted from the emphasis on the individual to be treated, to the increasing awareness that disability is the result of interaction between the individual and the environment; thus, educational strategies also need to exemplify the growing recognition of the importance of the environment on human potential and the concept of disability [10].

The failure of Turkey's higher education institutions to perceive such changes in the big picture of disability and in the provision of barrier-free education resembles the story of the blind men in John Godfrey Saxe's poem "The Blindmen and the Elephant" who cannot describe the whole elephant because each has felt only one part of it [14][15]. As a result the recent initiatives of higher education institutions in Turkey fail to address the matter holistically, while identifying only a portion of the whole.

There is a need for a comprehensive framework that can take these important developmental changes into account to provide a picture of the whole barrier-free educational elephant. By such a holistic approach we can reconcile the broad and somewhat disparate interpretations of inclusivity and diversity in the context of higher education institutions in Turkey. The next section of the paper will address the project proposal of two collaborating universities (Yildiz Technical and Istanbul Technical University) towards providing such a framework for assessing and providing barrier-free higher education institutions as a process of social innovation happen.

Making Social Innovation Happen: ABLE Project

The driving force for any innovation is the awareness of a gap between what there is and what there ought to be, between what people need, what they are offered and some idea of how it could be met. Having identified the shortcomings of a piecemeal approach that is built on scattered and isolated projects towards providing inclusive higher education in the Turkish context, in this section we introduce a project aimed at building a comprehensive framework (ABLE Project) that will shift the focus from inclusive education as a product to inclusive education as processes of social innovation, attitudinal change and development of collaborative learning communities.
The basic purpose of our proposed project is to lay the foundations of a comprehensive, conceptual framework (ABLE Project) for formulating inclusive policies, programs, project development and implementation within the context of Turkish higher education. This effort can be implemented as a vehicle for promoting social innovation, as well as social equality and justice, environmental sustainability, and health and well-being.

Social Innovation is defined as a novel solution to a social problem that is more effective, efficient, and sustainable. It creates value primarily to society as whole rather than private individuals’ [16].

Towards achieving barrier-free higher education instead of creating courses, services, information technology, and physical spaces for the “typical” student and then making modifications for students for whom they are inaccessible, our approach has been to address the needs of people with the broadest range of abilities by distinguishing the role of each element (“learner,” “mentor/faculty member,” “knowledge,” and “environment”) in the learning experience [17][18]. One can envision an enabling learning experience featuring the learner “at the center,” actively learning under the direction of the mentor/faculty member using a set of resources containing the knowledge/ content/skills to be learned within an environment. This approach leads to educational products and environments that are welcoming, accessible, and inclusive and that address all aspects of diversity, including disability. Developing such a comprehensive framework can help to remove all the obstacles: attitudinal, environmental and organizational barriers that can impede the full participation of all in university life.

Because of the enormity of the task of producing a comprehensive framework, the ABLE Project is staged by following the six stages of social innovation starting from taking ideas from inception to impact.

1. **Prompts, inspirations and diagnoses**: This stage involves diagnosing the problem and framing the question in such a way that root causes, not just symptoms, will be tackled.
2. **Proposals and ideas**: This is the stage of idea generation. Ideas can come from many sources – engagement/participation of citizens, service users, communities, front line staff, other sectors or other countries.
3. **Prototyping and pilots**: This is where ideas get tested in practice. This can be done through pilots and prototypes or more formal methods such as randomized control trials.
4. **Sustaining**: This is when the idea becomes everyday practice. It involves identifying income streams to ensure the long term financial sustainability of the higher education institution that will carry the innovation forward.
5. **Scaling and diffusion**: At this stage there are a range of strategies for growing and spreading an innovation— from organizational growth, through inspiration and emulation, or through the provision of support and know-how from one to another in a more organic and adaptive kind of growth.
6. **Systemic change**: This is the ultimate goal of social innovation. Systemic change will also mean demonstrating what works on a larger scale – learning and adaptation to ensure that the innovation achieves social impact and continues to do so as the environment around it changes [19][20].

The authors, both lecturers in the architecture departments of Yildiz Technical University and Istanbul Technical University submitted a project proposal (ABLE Project) to Yildiz
Technical University to provide a framework for assessing higher education institutions towards provision of accessible and inclusive learning environments. 10 Graduate students of Yildiz Technical University and 12 undergraduate students of Istanbul Technical University participate in the first three stages of the project. These two groups of students attend the parallel courses; ‘Design for accessibility and the elderly’, in Yildiz Technical University, Masters Program in Building Science and ‘Inclusive design and well-being’ in Istanbul Technical University, and thus participate in the project as part of their studies. Disabled students are also invited as volunteers to assist in the project. This project has provided an opportunity for students to put theory into practice in a real life situation.

During the first seven weeks of the courses, the students are informed about the issues regarding the provision of accessible higher education and some background reading is assigned by their lecturers (the authors). In the second half of the 14-week academic term students are asked to assist in the identification of the attitudinal, environmental and organizational barriers that can impede full participation in university life. Discussion of students with disabilities in the tertiary sector has tended to concentrate on issues around barriers and accessibility rather than their actual experience of higher education. Therefore access audits, questionnaires and in-depth interviews are conducted on accessibility issues of the campus with various user groups. The authors design and organize the access survey. A complete survey of the existing university buildings (at Yıldız Technical University) in relation to access for disabled students is planned to provide information about access to the university for students and potential students; to raise awareness of inclusive design; and to formulate a strategy with building services for prioritizing future work regarding access within the university’ s built environment.

This pilot project has served us number of points; first of all it has provided the architecture students and architects a vision and awareness about inclusivity issues, inspiring them to use these theories and ideas in their professional life. It has helped us to prepare a detailed documentation about the accessibility issues (accessibility of physical spaces, accessibility of social facilities and interaction and educational accessibility) of Yıldız Technical University and to build a model for creating a comprehensive framework of ABLE universities to be use and applied by other university campuses.

**Conclusion**

As governmental plans emphasize the need to increase educational attainment and to develop a lifelong education strategy to ensure individuals have the skills needed for a changing and developing economy and labor market, the accessibility to higher education institutions increases in importance. People with disabilities are a natural and integral part of society and, in the interest of society as a whole, should have opportunities to contribute their experience, talents and capabilities to national and international development [21].

There has been considerable progress in Turkish universities on the way to more inclusive universities such as:

- Disability legislation (2005), requiring equal opportunities at all levels of education, including higher education
- A Directive on Disability in Higher Education (June 2006)
The carrying out thus far of three Turkish annual workshops by universities and their disability support units and Turkish Higher Education Council since October 2007, which have attracted 220 members from 70 universities, out of 130 universities in total [22].

The background information on this research provides a snapshot in time in the continuum of development of good practice in accessible higher education institutions throughout Turkey during the years 2007 and 2010. Although there have been many disparate practices being developed and implemented in the higher education sector in Turkey in relation to the inclusion of students with disabilities, the provision of services to students with disabilities remains inconsistent and decisions about provisions are often dictated by the level of its reasonability by the HE institutions. A substantial amount of work, therefore, remains to be undertaken in order to bring all services to an equal standard so that students have access to the same level of supports and services in whichever institution they choose to attend.

It is the Turkish Higher Education Council’s intention to increase the number of students with several abilities to attend higher education. As the number of students with disabilities in higher education continues to grow, so does the need to examine the practices for provision of barrier-free educational environments. It can be concluded that access issues within higher education have been inadequately conceptualized. So far diverse approaches have tended to focus on physical access issues and some technical supports. However, access is multifaceted and must include a review of pedagogic practices, assistive provision (technological and personal), student’s engagement with their workload (e.g. recording) and evaluation procedures: achieving accreditation levels commensurate with ability [23].

There is a need for a comprehensive framework that can take these important points into account to provide and to create a better understanding of the needs of students with disabilities and help to develop a planned and systematic approach to making learning relevant and accessible to students with disabilities in higher education and promote inclusive practice across higher education institutions in Turkey. Education and training affect exclusion dynamics and conditions for social innovation.

To reconcile the broad and somewhat disparate interpretations of inclusivity and diversity in the context of higher education institutions in Turkey, we have introduced a project towards building a comprehensive framework (ABLE Project) to shift the focus from inclusive education as a product to inclusive education as processes of social innovation, attitudinal change and development of collaborative learning communities. This effort can be interpreted as a initial step towards promoting social innovation as well as social equality and justice, environmental sustainability, and health and well-being for all.

References


Session 6B
Domestic Environments
NHS at Home: Using Lego Serious Play to capture service narratives & to envision future healthcare products

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Abstract
Lego Serious Play (LSP) is widely accepted as a strategic planning tool by major corporations such as Nokia and Microsoft. The application of LSP as a research methodology is rarely found in social sciences and absent from design research. This work in progress paper demonstrates the effectiveness of LSP as a design research tool; a methodology that has captured the discrete service narratives of community matrons and directed the tenets for the design of a 21st century nursing bag.

NHS at Home is a PhD by practice and based at the Royal College of Art (RCA). The project is sponsored by the Engineering Physical Sciences Research Council (EPRSC) and supported by NHS East Riding of Yorkshire through a dedicated steering group consisting of innovation leads, service improvement managers and community nurses.

Keywords
Lego Serious Play, NHS, Co-design, Community nursing

Introduction
Healthcare services throughout the world are facing unprecedented change driven by rising demand for long-term care, escalating costs and higher patient expectations [1]. The delivery of planned healthcare is migrating away from the traditional hospitals and into patient’s homes [2]. New intermediate care structures are emerging to bridge the service gap between hospitals and GP practices. In December 2008 NHS East Riding of Yorkshire introduced neighbourhood care teams (NCTs) to remove the need for patients to travel to a hospital to receive their frequent treatments: managed care, rehabilitation and urgent care. Empirical research has revealed that current nursing bags are outdated and unsafe: 21st century professionals using 20th century kit [3, 4].

Background
In 2000 Fortune magazine and the British Toy Retailers Association declared Lego™ toy of the century. Since the appearance of its interlocking tube brick design in 1958, Lego’s appeal as a technological system for the outward expression of creativity has transcended beyond children and acquired new disciples. LSP has established itself with major corporations as a visual linguistic tool to express strategic planning opportunities. LSP has the capacity to harnesses an individual’s ability to ‘think through their fingers’
through the use of constructed metaphors and narratives [5, 6]. To date LSP has received little attention from research communities as a viable methodological tool, yet Lego has the potential to ‘express anything’.

**Design Research Aims**
NHS at Home pioneers design research in a neglected field of healthcare that will increase in significance. To support a paradigm shift, new ways of working and new types of equipment are believed to be necessary to support clinicians working in this challenging and inconsistent healthcare environment. The primary goals of the PhD by practice are to: (i) study how planned treatments are delivered in patient’s homes; (ii) determine the cleanliness of nursing bags; (iii) to capture professional challenges in greater detail; (iv) to co-design a 21st century nursing bag, (v) to validate the effectiveness of a proof of concept demonstrator.

**Method**
The primary objective of the LSP workshop is to build upon the ethnographical data acquired through fieldwork observations by capturing the discrete narratives of NHS stakeholders and to collectively envision opportunities for service improvements and new product development [7]. The workshop was structured into a series of sequential building activities incorporating both generic LSP exercises and modified tasks (Table 1).

<table>
<thead>
<tr>
<th>Table 1: LSP Workshop Methodology</th>
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<tr>
<td><strong>Introductory Exercise</strong></td>
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<td><strong>Evaluation of Perceptions</strong></td>
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<td><strong>Metaphor Exercise</strong></td>
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<td><strong>‘Day in the Life’ Models</strong></td>
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<td><strong>Envisioning an Aspirational Service Architecture</strong></td>
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<td><strong>Envisioning an Aspirational Support Technologies</strong></td>
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<td><strong>Determining Value Propositions</strong></td>
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</table>
Results
The efficacy of the data was enhanced through triangulation. The workshop was attended by the Leads from three Neighbourhood Care Team: Bridlington, Beverley and Goole, as well as the Trust’s Service Improvement Manager and Consultant Nurse for Older People (n=5).

Day in the Life Models
Analysis of the model’s architecture exposed reoccurring metaphorical themes. The repetition of imagery such as obstacles courses, a Berlin wall and barriers all inhibited their professional performance. Models frequently depicted heavily loaded people and vehicles. Vehicle models in particular were built haphazardly inferring inconsistency, improvisation and inappropriateness of design rather than a coherently designed service (Figure 1). The use of visual recording equipment enabled a participant’s oral descriptions of their models to be captured with 100% accuracy.

![Figure 1: Model depicting limited space and unsuitable vehicles](image)

‘This is how I feel. I am working in a dinosaur society. I feel like a carthorse sometimes. I have put myself springing out, you know, because that’s what I feel. I need help to be in patient’s homes. When I do get into a patient’s home I feel that I am spinning round I feel the only place I can really do my job properly is on the roof because its really, really restricted. This is how I feel. I feel angry about the situation. I’ve only got a two-seater KA and I need a tank! We should have better cars shouldn’t we really but that’s how I feel.

Video recording also captured conversations in the gaps in between exercises. During a breakout session an impromptu group discussion explored the comparative differences
and deficiencies of service experiences in different settings and identified alternative solutions found within analogous systems:

**P1**: We need a core set of tools.

**P2**: Designed to be transported in something. So we always have a core set of things. I know we have a core set of bits and pieces but it’s not a standard set of tools. We were set up with nothing, we have acquired things on the way. And have we got the right things? And a lot of the time, no we haven’t!

**P4**: Then you look at the AA. When the AA turn up in a van, it’s all lined out, what you need, where it is. Where as ours it’s all chucked in the back seat. It isn’t very professional is it?

**Envisioning Aspirational Models**

In a final task the group collectively envisioned an aspirational operational and service delivery architecture. Once again, consistency of delivery and resources proved to be a reoccurring theme with each locality built identically to each other. Representations of vehicles communicated a desired for specificity and consistency. This was in stark contrast to earlier built vehicles that were adaptations of prebuilt vehicle forms. These desirable vehicles were carefully considered and uniformed in design, brick type and colour. One aspirational Lego model highlighted a need for a ‘product’ that provided a professional, organized and a uniformed work environment. This model directed the design tenets for a future nursing bag (Figure 2).

![Figure 2: Representation of a](image)

When presenting her model to the group she articulated,

‘The actual pod I have done in white. I have done it white just to bring over the thought that we need a clean feel where we go anywhere. Whether we do our work in hospital or go out to patient’s homes. Now this pod can be a pod inside...
a hospital or a clinic or can be in our bags or our environment we are trying to get in our patient’s homes. And this will probably be our work environment. That would come up as a table so we don't have to go on our knees. We can stand up and work around it. So it's very much mobile. You know, everything is in its place. So, so we open it up and it's all uniformed. So that's my idea.'

Before the days proceedings were brought to a close the workshop participants were asked to identify three words that communicated the desirable attributes of a world-class NHS at Home service. Collectively the group agreed that the most appropriate words were consistency, quality and teamwork.

Discussion
Lego Serious Play has demonstrated itself to be an effective tool for capturing detailed service narratives of participants. The inclusive and democratic nature of the process proved to be a perfect tool to initiate a co-design programme. The process captured the delivery challenges posed by existing systems and equipment, as well collectively exploring new service architectures and product development opportunities to support the delivery of a world-class patient experience in an inconsistent healthcare setting. The value propositions that have emerged from these aspirational models have shaped the design tenets for a 21st century nursing bag.

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Designing Reminders for the Home: The Role of Home Tours

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Stephen Brewster, University of Glasgow

Abstract
As part of a comprehensive mixed-methods user requirements analysis for the design of reminder systems for assisted living we carried out ‘Home Tour’ Interviews in the homes of older users. Semi-structured interviews focusing on what people forget and what strategies they use for reminding themselves were augmented by a ‘tour’ of the home (documented by photography) in order to better understand the home context and environment we were designing for. Interviews were carried out in conjunction with a survey (N=378) and six focus groups targeting older users and people with sensory impairments. Thematic analysis of the interview data, observations, and photos yielded a richer understanding of the tools and techniques used to remember in the home and their social and physical context. We argue that in-depth home tours can be successfully combined with traditional methods such as large surveys to truly include the user in the design of care-related technologies. We conclude that techniques including a richer understanding of the user and their context will ultimately lead to more usable and acceptable technologies for the home.

Keywords
User centered design, home tours, multimodal interfaces, personalisation, reminder systems, assisted living, reminders, telecare, smart homes.

Scoping the Design Space for Reminders
In this paper, we report the findings from a series of seven home tours that were conducted in order to inform the design of reminders for assisted living in the home. The home tours were part of a comprehensive user requirements study that also comprised of six focus groups, which provided important feedback on prototypes and demonstrators, and a questionnaire survey (N=379), reaching a wide range of individuals.

People with care needs can find it difficult to remember to do tasks around the home. This can be due to normal cognitive ageing [15], to the conditions for which they need care (e.g. [6]) or to their medication regime (e.g. [1]). People need to be able to remember crucial tasks such as upcoming appointments, taking medication and general house-hold tasks in order to remain independent. Reminder systems are therefore a central component of assisted living solutions that enable people to remain active and independent in their own homes for as long as possible [4].
Despite the undisputed benefits, the uptake of assisted living technology such as reminder systems is still comparatively low [2]. There is little work on the design of the presentation of reminders, although good design is crucial to success and uptake of reminder systems. We argue that reminders need to be effective, accessible, adaptable, and acceptable. Reminders are effective when users can understand what they are supposed to be doing if they attend appropriately to the reminder. Accessible reminders are easy to perceive and process for the widest possible range of users including people with sensory impairments. Adaptable reminder systems can be configured to accommodate the devices and modalities available in the home as well as the users’ dynamically changing care needs and context. Acceptability is the most elusive of the four criteria. Although acceptability is highly subjective and personal, it is a necessary precondition of successful adoption. Acceptable reminders quickly become a part of life, while unacceptable reminders are a constant source of irritation and may be switched off or ignored.

Many approaches have been used in the design of domestic technology in the home. Often, home environments are recreated in a lab setting (e.g. [16]), and in some cases entire lab homes have been built [12]. Such an approach allows a level of control appropriate for designed human-computer interaction experiments. When problems with the technology occur, the experimenters can intervene straight away, which is particularly important when working with potentially vulnerable populations such as older people. However, this kind of controlled setting fails to capture the rich texture of people’s individual, personal space, in particular the activities and routines [3] and the presence of other people living in or visiting the home, who will also be affected by reminders [10].

Vastenburg et al. [17] proposed an intermediate design, where participants received carefully controlled reminders in their homes. While participants recorded their current activity as reminders were presented, other aspects of the environment were not observed or analysed. A complementary, more ethnographic, approach relies on cultural probes or diaries [5,7]. A full ethnographic immersion into the home can be problematic because the home is a very private space [11]. In cultural probes, users have full control over the materials seen by the researchers. They record relevant aspects of their home using a variety of media and materials – writing, audio recordings, video, photos, and sketches. Leonardi et al. [7] used cultural probes to explore the interaction between spaces in older people’s homes and the activities and objects situated there.

Home Tours are semi-structured interviews in the homes of users accompanied by a guided ‘tour’ of the home [8]. In addition to audio recordings and field notes, photography can be used to capture people, places and objects of importance. Home Tours allow researchers to gain insights into how people live, what is important to them in the home, and objects and activities of direct relevance to the design exercise. Importantly – the tour aspect empowers the user to be not only included in the design process but also an active player in generating user requirements.
Home Tours

Method

We conducted seven Home Tour based interviews with users in their own homes (see Table 1). In four homes, people lived on their own, two homes were inhabited by couples, and one home was inhabited by a multi-generational family.

Our home tours occupy a middle ground between ethnography and cultural probes. A researcher visited participants for 1-2 hours and interviewed them specifically about reminding and remembering, and took pictures of relevant objects and spaces with the participants’ permission. The interview was augmented with a tour of the home to capture current reminder strategies and their context. Interview responses and comments during the tour were recorded using a digital audio recorder. Photographs were taken of objects used to remember and strategies used to remind people to do things in and around the home.

Our home tours were guided by the following research questions:
1. what users need to be reminded of, i.e. the tasks they forget to do at home
2. why users need reminders, i.e. reasons for forgetting
3. what strategies are used to remember, i.e. what techniques and technologies people already successfully use
4. how users would like to receive reminders, i.e. the devices available to and preferred by users and the modalities available and accessible to users.

All photos and audio were stored digitally and tagged in relation to the context of the interview and observations made during the tour. Framework Analysis [14] was used to identify and categorise salient themes.

<table>
<thead>
<tr>
<th>#</th>
<th>Participants</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Mrs. AM</td>
<td>Single older woman (76)</td>
</tr>
<tr>
<td>2</td>
<td>Mrs. EH</td>
<td>Single older woman (74)</td>
</tr>
<tr>
<td>3</td>
<td>Mr. PL</td>
<td>Single man (39)</td>
</tr>
<tr>
<td>4</td>
<td>Mrs. R</td>
<td>Single older woman (89), Parkinson’s, mobility problems</td>
</tr>
<tr>
<td>5</td>
<td>Mr. &amp; Mrs. G</td>
<td>Husband (65) and wife (64)</td>
</tr>
<tr>
<td>6</td>
<td>Mr. &amp; Mrs. L</td>
<td>Husband (72) and wife (72)</td>
</tr>
<tr>
<td>7</td>
<td>Family PM</td>
<td>Grandmother (65), mother (37), two children (11, 9)</td>
</tr>
</tbody>
</table>

Table 1: Overview of home tours

Results

Compared to the questionnaire survey and the focus group study, the home tours added an invaluable opportunity for the participants to demonstrate what strategies worked for different reminding tasks, and what the social and physical context for using each reminder strategy was. Some of those strategies, in particular physical reminders, were not fully covered in the survey and focus group data. Home tours were also particularly
useful for raising issues of privacy and confidentiality, which did not emerge strongly in the other data.

**Existing reminder strategies and tools**

The reminder strategies mentioned fall into three main categories, paper reminders such as calendars and diaries, physical and other visual reminders such as objects that are linked to the task that needs to be remembered, and technological reminders that use devices such as mobile phones.

All participants used paper-based reminders such as calendars, diaries, and sticky notes in their everyday life to remember (Figure 1). Many people had multiple calendars, diaries and notebooks and complex systems for working between them. For example, one calendar might be reserved for family events and appointments, another for an individual’s activities. Participants who kept both a calendar and a diary reported explicit strategies for copying selected diary appointments onto the calendar while some remained in the diary only. Often calendars and diaries were annotated with additional notes and information. The systems people used were varied and often very individualised to the person, or couple using them.

In addition to storing reminders, diaries and calendars were also used as a memory aid for information about past events that was needed to plan for future events. One couple (Mr and Mrs L) noted down when they had replaced watch batteries so they knew when the next replacement was due. Mr L (male, 72) recorded information gained at important medical appointments on the original entry when he returned home, and looked back in the diary when the next appointment came up to see what the doctor had said at the last appointment.

Mr L (male, 72): “The doctor said my blood was fine in Jan so I don’t need to get it checked again til next time…”

Another common reminder strategy involved physical and other visual reminders – placing a visually meaningful or salient object in a place where it would be noticed. Examples include keeping library books near the door, making it impossible to leave with-out them, leaving glasses and bus passes in a bowl by the front door where they are sure to be noticed (Figure 2(b)), and hanging a plastic bag over the front door handle to remember items to take to a friend’s house.
Mrs EH (female, 74): “If I leave them [library books] there you see I am bound to remember them … I can’t go out the door without seeing them …”

Packaging was sometimes used as a visual physical reminder. For example, Mrs EH left out empty food packaging to remind her to log her daily food intake on the computer. Mrs EH also left out nearly finished grocery items to remind her to put them on the shopping list (see Figure 2a). Other examples included placing pill packaging near a TV or phone to act as a medication reminder.

![Figure 2: Physical/visual reminders](image)

The kitchens were the room talked about most, and the room visited longest across all home tours. All participants used kitchen surfaces as part of their reminder systems. To-do lists, and messages and reminders for other people in the household were often left on the fridge (see Figure 3a) or a blackboard or whiteboard (Figure 3b) were often used for to-do lists and leaving people messages or reminders. The fridge was also used for storing cards with information about upcoming appointment cards, and blackboards were used for shopping lists. One participant [Mrs G] even mentioned that she once took a photo of the shopping list on the blackboard so she could take the shopping list out of the house.

Mrs G (female, 64): “I write my things up … you know when I realize I need them … I mean I did once take a picture on my phone so I could take it with me …”

Five out of seven of the participants described using specialized off the shelf solutions such as pill dispensers to remember to take their medication. However, these were often combined with additional physical reminders such as packaging near the TV. None of the participants had electronic pill dispensers.

Finally, some participants used mainstream technologies including mobile phones - popular in the younger users (PL and Family PC) - to send reminders to themselves.

PL (male, 39): “I set my alarm on my phone for loads of thing … like for when I need to check something or turn it over in the over half way through cooking … that kind of thing.”
Cooker timers were also used to deliver reminders. For example, Mrs G used the timer to preset a ‘time up’ alarm for how long her grandchildren were allowed to watch TV or play on the computer.

![Kitchen Surfaces as to-do lists](image)

Figure 3: Kitchen Surfaces as to-do lists

**Social Context and Privacy**

The home tours were particularly useful for discussing the effect of social context on the type of reminders people would find acceptable. The issue of privacy for example was discussed several times across the home tours.

Mrs EH (female, 74): "...well I don’t know...I am not sure I would mind. Well maybe it would be better if it knew when people were in and it could send it just to me – you know on my watch or my phone maybe."

Family PM (Female, 37): “I wouldn’t want all my messages sent to the system so that everyone could see them. I would need to be able to pick which ones went to my phone [mobile] so that only I could see them.”

Mrs AG commented that she would like speech if she was on her own but not if she had guests over. If she was in a social setting she would prefer something more subtle and more private to her. On the other hand, Mrs G felt strongly that she would want speech reminders if she had guests so that everyone would know what the reminder was and she wouldn’t have to explain it.

Mrs G (female, 64): "I mean I wouldn’t care [whether it was speech or not] you know ... it would be better than having to explain to everyone what the funny wee noise was all about."

Different preferences for reminder delivery, both regarding devices and modalities, were a source of potential conflict. For example, reminders that are acceptable to the main user can be perceived as highly intrusive by others. This aspect is comparatively neglected in the literature on intrusiveness, where the focus is on not unduly intruding on the activities of the intended recipient [16].
Mr L (male, 72): “Yes to the TV would be ideal so I could see it … especially if it could be sent from the computer in the other room …”

Mrs L (Female, 72): “well … hang on a minute … what if I am watching my programs … you would need to have it as a wee star in the bottom corner … I wouldn’t want to be interrupted all the time with a big message …”

Whether a device or a display was considered to be acceptable or desirable for reminder presentation also depended to some extent on the user’s generation. This was obvious in the family home tour. The 37-year-old mother discussed solutions that were based on her mobile phone, the young children liked the idea of wearable devices, and the grandmother was keen to use mainstream technologies such as the TV. Family members were well aware of each other’s diverging preferences, as the following quote by the 9-year-old boy shows:

Family PC (Male, 9): “I would want it to like a hair band or a watch … you know telling me to remember my school stuff … but then mum could get her reminder to her phone cos she is always on that…”

Implications for Design

The main message for designers that emerges from our home tours is the need for personalisation. All participants wanted reminder systems to be tailorable to the person to reduce annoyance and increase acceptability. In particular, users expressed a need to have a system that would easily fit in to their daily routine. What is more, reminder systems need to be able to deal with the varying needs, preferences and abilities of multiple occupants, and indeed end users, of the same system. In the following pages, we focus on three central aspects of personalisation, spatiotemporal context, shared interaction spaces, and free choice of device and modality.

Spatiotemporal Context

Many of the reminder strategies that people reported or suggested were influenced by place and/or time. Often, reminders were in visually prominent places, such as a fridge door or a blackboard or a front door. In terms of ‘place’, reminder strategies mainly revolved around the perceived hub of the home (e.g. the kitchen) or of a person’s current or planned activities (e.g. going to the library the next day). Like Leonardi et al. [7], we found that the kitchen was a central place in the home, and many reminder strategies focused on kitchen devices. Reminder systems would therefore at least need to have an option to allow setting and/or receiving of reminders in the kitchen. From our survey, the living room emerged as an additional hub that would need to be accommodated.

Even though it is important to deliver reminders at the hub of the home, other spaces need to be covered as well, in particular the hallway. Our home tours show that many different locations were used to store reminders, in particular visual, physical cues. In our survey, some people noted that their reminder systems broke down because they did not check their main visual reminder (calendar or diary) in time and therefore forgot to carry out a task. Indeed, many people reported that they sometimes walked into a
room and forgot why they had entered it. Clearly, localised reminders are needed. Only reminder systems that acknowledge physical context and can deliver reminders to different devices and locations will fit in with such a range of existing strategies.

Many successful reminder strategies also rely on temporal context. They closely link reminders for tasks that are likely to be forgotten with deeply ingrained habits and routines. For example, Mr and Mrs L commented that they put their night-time medication beside their toothbrush, since they never forget to brush their teeth last thing at night. Designing electronic reminder systems that can hook into such routines is challenging, because such systems will need to monitor whether the user is at the appropriate stage of their routine, and plan reminder presentation based on current environmental data, information about the user's schedule and habits, and a specification of the nature and duration of the tasks that need to be executed [13].

Shared Interaction Spaces
Many reminders can be perceived not only by the intended user, but also by other people who share the home interaction space, such as family or visitors. Our home tours provided rich information about the implications of this fact on reminder design. The couple and family home tours in particular highlighted some of the conflicts that individual differences can create. Therefore, reminder systems need to be personalised not just to the user, but also to other people who live in the home, because reminders should not unduly disrupt them.

Unobtrusive reminders that cannot be easily interpreted by visitors provide privacy, especially if users do not want to be seen as needing care. For example, while spoken reminders are necessarily explicit, and therefore clearly indicate the users' care needs, the meaning of non-speech sounds such as Earcons needs to be learned [10].

Detecting or even inferring social context is not easy. Reminder systems should at the very least, acknowledge that social context needs to affect the ‘decisions’ made about what reminders to send, where to send them, and how to send them. Some of this decision process can be programmed at design time as we learn more about reminders in a social context. This should be combined with decisions made by the system at run time as it learns what devices are available and learns what the users' needs and preferences are. Finally, reminder systems should also encourage user-defined input to these decisions so that users can specify their current preferences, the room they are in, or whether they have guests for example.

Device and Modality Choice
We have argued that reminders are most effective when delivered at the right location and at the right time. However, they also need to be delivered through the right device using the right modality. Our findings clearly show that systems should be configurable based on the devices that are currently acceptable and available to the user. In order to support multimodal multi-device reminder delivery, systems need to be able to monitor the set of available devices. In addition, configurations need to be regularly revised to ensure the users’ current needs and preferences are appropriately reflected. Well-designed configuration interfaces can facilitate this with a minimum of effort [9].

While age might influence the interaction techniques that users are familiar and comfortable with and therefore find most acceptable, as demonstrated by the family
home tour, we would caution against creating reminder technology packages that are mainly differentiated by the intended age group. Each person weighs the tradeoffs between modalities differently, and therefore, should be able to choose from a range of options. This also holds for sensory impairments. The adults interviewed in the home tours did not have any significant sensory impairment. Our survey results and focus group data (presented in detail elsewhere) however show that people with a self-reported sensory impairment are as likely to want reminders presented using the impaired modality as people without impairment. This is an important finding that designers might have otherwise overlooked.

Additionally, people’s preferences and abilities all potentially change over time as their health improves or declines, or as they get more familiar with a reminder. Future research will look at reminder systems deployed in the context of the home and monitor how people’s preferences and responses to different reminders evolve over time.

**Conclusion**

If novel electronic reminder systems are to be usable and acceptable they will need to exploit existing metaphors and strategies of reminding. Knowledge of the home and the structure of daily life are required to ensure that reminder systems can be integrated into daily life. Electronic reminders should support or augment existing practices and strategies and encourage people to self manage in the home rather than completely replace the working memory or independence of people as they grow older at home.

In this paper, we reported the results of a series of in-depth home tours that were designed to inform the design of reminders for assisted living in the home. Compared to other forms of user requirements gathering, interviewing people in their own homes allowed us to study reminding and remembering in context. As a consequence, the tours yielded a much richer picture of the successful tools and strategies that people use in and around the home to remember tasks and activities of daily living. Being asked about reminders in their own home also made it easier for people to think about aspects that are specific to the home such as privacy and conflict with others’ needs and preferences.

Methodologically, the home tours we conducted are a useful compromise between full ethnographic observation, which may be too intrusive, and cultural probes [5,7], where the participant decides what is fed back to the researcher. Since the research participants act as “tour guides”, they can control what the researcher sees. At the same time, the researcher can notice objects and arrangements in the home environment that may not strike the participant as relevant.

In conclusion, home tours are a valuable tool for the design of home care technologies. They are an important addition to more traditional techniques such as surveys and focus groups, in particular when social and physical context affects how the technology being designed might be used in the home and integrated into people’s lives.

**Acknowledgments**

This work was funded by EPSRC (EP/G069387/1, MultiMemoHome). We would like to thank the people that invited us into their homes for the home tours interviews.
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Cooking with a visual impairment

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Abstract
Over 5% of the Dutch population has some problem with their seeing functions (reading newspapers or recognising a face at a distance of 4 m). With the aging population, this number is expected to increase rapidly. This aging population will continue to live independently at home, where an important task is the preparation of food. To support the cooking process of visually impaired users, designers should become more aware of their needs and wishes. A way to enhance this awareness is the use of visual capacity loss simulators: (partly) covered goggles that reduce the visual perception. In this observational study, we compared the cooking processes of people with visual loss and people with simulated visual loss. Participants prepared a pasta dish in their own kitchen, using their own equipment and ingredients. The study gives insight in the problems that people with (temporary) visual loss encounter and in the sensory information they use. It also gives an idea of the relevance of studies using simulation goggles.

Keywords
Visual loss, simulation, design, product evaluation, empathy, cooking, food preparation

Visual loss

About 60% of the Dutch population wears contact lenses or glasses to compensate for refraction disorders [1]. However, 5.3 % of the Dutch population still has some problem with their seeing functions (reading a newspaper or recognising a face at a distance of 4 metres) while wearing lenses or glasses. Visual loss can be divided in two kinds: a reduction of the visual field or a reduction of the visual acuity. People with visual field loss perceive blind spots or blind parts in the visual field, due to degeneration of the retina or nerve cells. In visual acuity loss, the whole visual field becomes less sharp, and small items become hard to see. In the aging population the latter kind of visual loss is highly prevalent.

In the Netherlands the visual field loss and the visual acuity loss together define the level of a visual impairment [2]:
- Blind: visus < 0.05 or visual field < 10° round central axis
- Visually impaired: 0.05 < visus < 0.30 or 10° < visual field < 30° round central axis

Visus is used as a measure for the visual acuity ranging from visus 1 for good eyes to visus 0 if there is no light perception. The visual field is the entire area that can be seen with fixation of gaze. The problems in seeing functions are measured with the available compensation for refraction disorders. This implies that someone with a refraction
disorder and inappropriate glasses can be visually impaired, while someone with the same refraction disorder and appropriate glasses is not visually impaired.

Many different medical conditions can cause visual loss, all affecting the visual field or visual acuity in a different way. For example, macula degeneration affects the macula, the most light sensitive spot at the centre of the retina where colour is perceived best. Therefore, macula degeneration results in reduced perception in the centre of the visual field and in a reduction of colour perception. Glaucoma, on the other hand, reduces perception in the periphery of the visual field and often causes problems in dark adaptation. Cataract is one of the most prevalent medical conditions in the aging eye. It is part of the natural aging process, reducing the optical clarity of the lens. Often the nucleus (centre of the lens) colours yellowish, reducing the perception of blue colours. It also reduces contrast perception and visual acuity. If it is not treated it can result in blindness.

Because all medical conditions affect the eye in a different way, it is hard to predict what someone with visual loss can perceive of his or her environment. The cause, severity and location of impairments define which parts of the visual field or visual acuity are changed and which additional effects take place (like a reduction of contrast or colour perception).

Compensation for visual loss
People with visual impairments learn to cope with their visual loss. They become more aware of their other senses and get very skilled in using them. People with remaining vision learn to use even the tiniest amount of visual information to perceive their environment. To what extent and how people compensate for their visual loss depends on the onset of the visual impairment (congenitally blind sometimes perform different than late blind) and on the remaining vision.

Research on compensation mainly focuses on auditory and tactile compensation in blind participants. For example, Voss et al. [3] did an extensive literature review on compensation for sensory loss in deaf and blind people. They concluded that there was no difference in the auditory and haptic perception thresholds between sighted and blind participants. However, in more complex auditory (e.g. localisation of sounds) and tactile (e.g. angle recognition) tasks the blind outperformed the sighted participants. It is likely that this difference is partly due to the practice blind have in using auditory and tactile cues. In addition, Voss et al. found that the brain changes due to visual loss. The occipital cortex (in the sighted mainly processing visual information) starts to process auditory and tactual information in the blind. This implies that the blind use a bigger part of the brain to process auditory and tactual stimuli than sighted people do. Although it is not yet clear how this process exactly works, Voss et al. found that it works both in early and late blind.

Lai and Chen [4] found that their blind participants had a higher pure tone threshold (i.e. they heard less well) than sighted participants. However, they performed better on sound localisation tasks than sighted participants. This implies that the blind’s ears do not
perform better, but they are more trained in using sound to localise objects. Röder and Rösler [5] investigated the difference in sound memory between sighted, congenitally blind and late blind participants. They found that both the congenitally blind and the late blind were better in memorising sounds than the sighted (when corrected for age). This suggests that compensation for visual loss is not dependent on the age of onset of the impairment.

Postma et al [6] let early-blind, late-blind and blindfolded-sighted participants perform three times a haptic task, in which they had to put ten different shapes in a cut out cardboard. All participants improved significantly between the first two tasks, but the sighted participants improved significantly more than the blind participants. Because the sighted are not used to rely only on haptic information, practicing highly improved the speed of this task. In all trials, the blind performed better than the sighted, with no difference between the early and late blind participants. Furthermore, blind students were slower in a texture recognition task, but had a sharper sensation in their finger tips than sighted students [4].

Little research is done on the compensation of visual loss by olfactory information. Cuevas et al. [7] compared 13 early blind subjects with 13 sighted subjects on their performance on odour discrimination, identification and categorization. Participants had to identify 30 different odours by naming them (free-identification), by putting them in a category (fruit, flower, plant or other), and by selecting the right fragrance from 6 multiple choice options. They found that the blind outperformed the sighted participants in free-identification of odours and to a less extent in odour discrimination and categorization. However, in the multiple choice identification task there was no significant difference between the early blind and the sighted participants.

**Impact on daily life**

Although people with visual impairments can compensate in many ways for their visual loss, a lot of products give insufficient feedback to the tactile, auditory or olfactory modality. According to the amount of problems that visually impaired experience in daily life, product developers do not seem to pay much attention to the visually impaired in the design of products, buildings and public spaces. Interest groups for the disabled in the Netherlands identified the following obstacles with products and buildings [8]:

- Unable to use voting machines
- More and more information on consumer electronics, audio, video and household appliances is presented visually (e.g., on displays) and thereby hard to operate by visually impaired users.
- Study materials are not presented in Braille, in large fonts or as a digital document (that can be made audible through a special reader), even though visual elements are important in many modern educational materials.
- Graphic interfaces at work make it hard for the visually impaired to do certain jobs.
- A lot of information during a trip with public transport is visual (e.g., train departure times at railway stations).
- Public spaces often lack appropriate indications for visually impaired (like audible traffic signals and detectable warning surfaces).
Cooking
Food preparation is among the most important tasks for successful independent living [9]. However, many kitchen appliances are hard to use by visually impaired users. For example, the information about menus and times on microwaves is presented on small displays. And many induction cookers have buttons and burners integrated in a smooth glass surface, making it impossible to feel where the buttons are and where the pans have to be. Therefore, it is important that designers of kitchen appliances take the needs and wishes of the visually impaired users into account.

Food consumption is critical in the lives of the visually impaired, because they tend to have difficulty in maintaining a good balance between healthy eating and a sufficient amount of daily activity. Many visually impaired lead a rather sedentary life, because they are limited in performing tasks and are afraid to get injured during physical activities. In addition, cooking is also a dangerous undertaking: over 25% of the fires in houses start in the kitchen [10]. Therefore, designers can really make a difference for the visually impaired by making the cooking process easier and safer.

Designing for the visually impaired

Designers tend to have themselves and their own abilities in mind when designing products. As most designers are young and see well, this is not suitable when designing for the visually impaired. To design better products for the visually impaired, designers should gain an understanding of what it is like to be visually impaired. They should know what kinds of visual loss occur and which consequences this has both for the perception and the experience of people with visual impairments.

Imagine you are baking an onion. You see the stove, put a pan neatly in the centre of a burner, see the knob and switch it on. Then you look at the scale of the butter wrapper and cut off the amount you need. You put it in the pan and when it is brown, you add the cut onion, and fry it till it is slightly brown. Now imagine that you are baking an onion while you cannot see. How do you know where the stove is, where to put the pan and which knob operates which burner? How to cut the butter in the right amount, determine when the butter is warm enough and when the onions are slightly brown?

With the aging population, the amount of people with visual loss increases rapidly, making this simple task of baking onions more difficult for many people. Therefore, it becomes more and more important to take the abilities and disabilities of these visually impaired into account when designing new products.

Empathy in the design process

By gaining empathy with users, designers get a deeper understanding of the user (and situation) in order to make it easier to take the feelings and thoughts of the user into account when designing products. Kouprie & Sleeswijk Visser [11] divided the process of gaining empathy with the user in four phases. (1) Discovery: designers enter the user’s world to generate curiosity and willingness to explore and discover the user. (2)
Immersion: wandering around in the world of the user and taking the user’s point of reference. (3) Connection: the designer connects to the user by recalling his own memories, feelings and experiences to create an understanding of the user’s feelings and meanings. (4) Detachment: leaving the user’s world to become a designer again. Kouprie & Sleeswijk Visser also made a distinction in the methods that can be used to gain empathy: (1) direct contact between designers and users; (2) communication of user data and (3) simulating the user’s condition. When designing a product, it is easy to have your own experiences and abilities in mind. As the abilities and experiences of people with visual impairments are very different from most designers, we think it may be effective for designers to simulate the user’s conditions to make this part of their own experiences. Therefore, we will now focus on simulating the user’s condition to gain empathy. In future experiments, we will compare this condition with user contact and communication of user data.

Simulating visual loss

Simulations of visual loss are used in many fields, for example in educating parents of visually impaired children, in the education of professionals working with visually impaired (e.g. occupational therapists) and in product design for visually impaired. Different techniques are used to simulate visual loss: for example blindfolds, adjusted goggles, computer software or a dark environment. It is clear that it is hard to simulate real visual loss. Real visual loss is permanent (though it often changes over time) and it is caused by deficiencies inside the body. However, through the use of manipulated goggles, people can get an idea of what it is like to have visual field or visual acuity loss. More complicated conditions, like oversensitivity to glare, cannot be simulated in this way.

Schifferstein & Desmet [12] simulated what it means to lose the visual sense completely, by letting fully able participants wear ski goggles covered with black tape. These participants had to do daily tasks in which they interacted with products (e.g., squeezing an orange, compose an SMS message, and eating a cookie). The experience and performance of these participants were compared to a control group of sighted participants without simulated visual loss. Blocking vision caused a severe loss in functional product information. Participants with blocked vision perceived an increase in handicap. They took more time and had difficulty performing some tasks. Participants with blocked vision experienced their own products less as their own and different from usual.

Although this experiment seems to be a good indicator of the effect of visual impairments on the product interaction, a lot of people do not suffer from full visual impairments. They only have a partly decreased perception in their visual sense. Therefore, Cardoso and Clarkson [13] designed a set of spectacles imitating blurriness, cloudiness, central and peripheral visual loss and distortion in order to let designers experience different levels of visual capacity loss. In an experiment they evaluated the effect of a set of visual acuity loss simulators on the design process [14]. Designers first had to evaluate the ease of use of products without the simulators. Thereafter they had to evaluate the ease of use again, this time while wearing the simulation glasses. By using the visual acuity loss simulator the products were evaluated as harder to use and
more problems in the use of these products were found. This suggests that visual acuity loss simulators can help designers to identify problems that people with visual impairments encounter in product use.

There seems to be an agreement that designers can benefit from the use of visual capacity loss simulators. However, many researchers mention that they cannot substitute real user involvement and that one should take care in using simulations. Users of these simulations might underestimate the impact of visual loss and may not fully understand what it is to be constantly impaired [e.g. 15]. In addition, it is not clear if visually impaired encounter the same problems when interacting with products and if they have the same feelings about products compared to people with simulated visual impairments. If we know better in what way simulated use differs from real use, designers can use capacity loss simulators more effectively and they can better decide when to use simulations and when to involve users.

Method

In this experiment we wanted to gain information on the sensory information that visually impaired use during the cooking process. By comparing this condition with simulated visual loss, we got insight in the extent to which the visually impaired learned to cope with their visual loss and the extent to which simulations can help designers when designing for the visually impaired.

Participants

Five participants with severe visual loss (visus < 0.08), 4 female, 1 male, aged between 25 and 64 (mean age 42.6) and five sighted control participants (visus > 0.80, refraction disorder < |2|) matched for age and gender (minimum age 23, maximum 65 and mean age 42.6) took part in the experiment. Table 1 gives an overview of what the participants can perceive either because they are visually impaired or with the simulation goggles (sighted participants). Participant 1, 2 and 3 cannot rely on vision and are therefore called blind, 4 and 5 can see some things and read large fonts and are therefore called partially sighted. Subjects with visual loss were recruited through the internet and interest groups for visually impaired. Sighted participants were recruited through our own social network. All participants enjoy cooking and do this regularly; they live on their own (i.e. not under supervision of care takers) and have Dutch as their native language. Participants received a financial reward for participating.

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Perception left eye</th>
<th>Perception right eye</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No light perception</td>
<td>No light perception</td>
<td>Blind</td>
</tr>
<tr>
<td>2</td>
<td>Light perception</td>
<td>Light perception</td>
<td>Blind</td>
</tr>
<tr>
<td>3</td>
<td>Arm movement</td>
<td>Arm movement</td>
<td>Blind</td>
</tr>
<tr>
<td>4</td>
<td>No light perception</td>
<td>LogRAD 1,2 / visus 0,06</td>
<td>Partially sighted</td>
</tr>
<tr>
<td>5</td>
<td>LogRAD 1,1 / visus 0,08</td>
<td>LogRAD 1,1 / visus 0,08</td>
<td>Partially sighted</td>
</tr>
</tbody>
</table>

Table 1: Measured visual perception (visually impaired and simulated loss)
Simulated visual loss
For each sighted participant, we made an appropriate pair of glasses representing the visual acuity loss of the matched participant with sight loss (see Figure 1). The glasses fitted tightly to the skin of the participants, in order to block any visual information coming in from the sides of the goggles. Except from the goggles simulating total blindness, the goggles can be worn over normal glasses. Therefore, participants normally wearing glasses or lenses left them on during the experiment.

Figure 1: Used simulation goggles

Measuring visual abilities
The visual acuity of both the visually impaired participants and the participants with simulated visual loss were measured. The visual abilities of the sighted participants were measured twice: once with the simulation goggles and once without. If the matched sighted participants wearing the goggles performed very different, the simulation goggles were adjusted till the visual acuity approached that of the visually impaired. The nearby visual acuity was measured with the Dutch version of the Radner reading chart [16] at a distance of 40 cm, with a luminosity between 80 and 120 cd/m². Participants started reading aloud the sentence with logRAD 0.9, then the next smaller sentence and so on. The sentence that took longer than 20 seconds to read, together with the mistakes made in the sentence, determined the log reading acuity determination score (logRAD-score). If participants were not able to read the largest sentences at a distance of 40 cm, they would be read at 25 cm. If a participant could not read the largest sentence at a distance of 25 cm, we tested the remaining vision with finger counting, arm movements and light perception [17].

Procedure
A week before the experiment, we called the participants for a short questionnaire and to inform them on the experiment. They were asked to buy ingredients for their favourite pasta dish and we told them that they would prepare this dish for us. We visited the participants at home and observed and video captured their activities while they prepared the pasta dish in their own kitchen, using their own cooking equipment and ingredients. Before the cooking task, the sighted participants put on the simulation goggles and all participants did a visual acuity test. During the preparation-task all participants were asked to explain what they did, why they did it and which senses they used. If something was not clear, the researcher asked for clarification.

To gain more information about the products that the participants used, a small structured interview was done after the experiment: For each piece of equipment we asked which senses were used in the interaction and which problems occurred during the interaction with the equipment. Finally, we assessed the sighted participants’ visual acuity while wearing their usual visual aids.
Analysis

As a first step, all videos were transcribed into actions the participants performed and verbal communication. Because we want to know if simulation glasses can help designers in designing products for visually impaired users, we want to know if there is a difference in performance between the visually impaired participants and the participants wearing simulation glasses. We looked at two main items: the strategies that participants used during the cooking process and the problems that occurred.

Results and conclusions

The dishes that were prepared differed a lot: from Chinese noodles and red pasta sauces prepared by the visually impaired participants to creamy and spinach sauces prepared by the sighted participants. Therefore, we purely looked at the process of boiling pasta, to see if participants used the same strategies. One sighted participant was not able to finish the cooking task, because she got sick of the glasses. She finished preparing the sauce, but did not boil the pasta. Therefore, we do not know which strategies she would use to check if the water boils, and if the pasta is done.

Process of boiling pasta

In this process was looked at the order of actions and the methods used to determine the amount of water in the pan, whether the stove is switched on, whether the water boils, proportioning the pasta and whether the pasta is done.

The order in which participants boiled the pasta did not differ a lot. 8 participants put water in the pan, boiled this and then added the pasta. One partially sighted participant put water and pasta in the pan and boiled this together. In this way she could easily see whether the water boils, because the pasta started to float on the surface. One sighted participant boiled water in a water boiler, put this in a pan and then added the pasta. This had the disadvantage that boiling water had to be poured in a pan. Because this participant could not see the water, she felt with her finger how much water was in the pan. Before the water reached her finger the researchers indicated that it did not look safe and asked her to stop pouring.

Two of the blind participants and the three with simulated blindness used their finger to feel the right amount of water in the pan and one felt the weight of the pan. Of the participants that were able to see, one participant with simulated visual loss used sound to determine the water level in the pan, another used her finger to feel the water level when pouring water in a metal pan and could see the water level in a black pan. The partially sighted participants determined the amount of water with their eyes. The partially sighted participants were used to their situation and used the appropriate equipment, where they could see the water level. One sighted participants had the habit of using sound to determine the water level and the other did not yet know that she could not see the water level in this pan.
Figures 2a-c: Blind participants positioning their pans, the second picture is an induction stove

Figures 3a-c: Participants with simulated visual loss positioning their pans on the stove

To position the pan at the stove all (simulated) blind participants felt with their hands (see Figures 2 and 3). This method worked very well and quickly for the blind participants, even if the pan and burner were hot. They used other reference points, like the wall or the side of the stove to position their pans in the centre of the burner. Two participants with simulated blindness (pictures 3b and 3c) had to be guided in placing the pan right at the stove even when the pan and stove were still cold. They did not feel the burner below the pan or moved the pan again after they positioned it. One participant with simulated blindness put the pan in between two burners when she put the pan back on the stove after draining the pasta. It seems that the blind participants learned to place their pans right at the stove, while the participants with simulated blindness did not find a sufficient method to place the pans during this cooking task.

In the beginning participants with simulated visual loss had some problems with determining if the burners caught fire. One participant tried to light the burner (even if it was already on) till the researchers told it was on. Another participant looked if the fire was on. The second time that they lighted a burner they could hear if the burner caught fire. One participant with simulated visual loss put the pan on a small burner; she discovered that the water took a long time to boil. She put the pan on a bigger burner and then mentioned that this was the sound she expected to hear. It seemed that the participants with simulated visual loss quickly learned to deal with this task. They could match the buttons with the burners on their stove and learned to determine when a burner caught fire.

Further research

After extending the sample to 10 participants in each group we will look further into the different techniques used by the participants to clean and cut ingredients and the effect of the kind of equipment that is used. We will also look at the problems that were mentioned by the visually impaired participants, for example the methods used to find utensils and ingredients and to proportion liquid ingredients.
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Ageing and the Kitchen: A Study of everyday object interactions

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Abstract

The process of ageing causes the physical abilities of the body to decline. This research aims to gather data and understanding of the nature of this process in relationship to the kitchen and the use of utensils. With this data, a design guide can be written to help avoid some of these difficulties by aiding inclusive design.

The research is being undertaken at three universities, with three distinct linked streams.

Initial results from focus groups and surveys have outlined some of the areas where difficulties arise. This information gives an understanding of the nature and cause of the difficulties which arise, and the coping mechanisms employed.

The initial physical abilities testing has produced a baseline of results against which the abilities of the older subjects can be compared and contrasted. This gives a measure of the physical abilities of the user, and more importantly, the links between the key areas of physical abilities.

Affective Engineering tests have produced baseline results for tactile feedback measurements, which can be used for compensatory cues and tactile feedback to assist the user. This can aid the use of the tools and enhance the feel of the product, to instil confidence and comfort.

Keywords
Aging, kitchen utensils, inclusive design

Introduction

‘We’ve put more effort into helping folks reach old age than into helping them enjoy it.’ Frank Howard Clark
Ageing is a fact of life. None of us can avoid the passage of time, however changing physical abilities need not lead to difficulties with manual tasks if we can use tools designed to compensate for the changes associated with ageing. When we age, grip strength, manual dexterity and sensitivity of the hands all decrease. Although changes are incremental they are not unnoticed and may result in emotional and psychological distress.

There are significant amounts of data available regarding the ageing process and accidents in the workplace[1], however, there is little data regarding the nature and severity of accidents with age in the domestic environment. There is accident and injury data available from RoSPA[2]. However, this is based purely on hospital admissions. There is evidence that a large number of the injuries in the over 60’s go unreported to the higher authorities or result in emergency hospitalisation[3]. When this is combined with the fact that often, minor injuries in older people have a greater effect on the life of the victim relative to minor injuries in younger people, there is a strong case for the need to improve the environment of older people.

The Design Guide

The overall aim of this research is to produce a design guide that will direct selection of dimensions and grip texture for universally usable handles for kitchen tools. Although there are guidelines available for helping guide the design process towards being inclusive[4][5], there is little information which is of a specific nature and readily available to designers.

The information required to produce a design guide is twofold: firstly, an in depth analysis of the users is needed. Understanding their needs and wants; their usage habits; and the nature of the kitchen as part of their activities of daily living are all essential to this. Secondly, an understanding of the physical aspects of the hand-handle interface is required, including the grip characteristics, the physical attributes and limitations of the users, and the nature of the contact and its emotional effects.

In order to gather usage, background and perception data on the users, the research team has run focus groups, food and shopping diaries and questionnaires. Through the different methods, they sought to reach a wide range of older participants.

To gather information about the physical nature of the interface, physical testing of the aspects of grip and manipulation need to be assessed. The response to textures and grip on an emotional level is also required, as the feel of a tool can have a significant impact on its uptake and usage.

Once these sets of data are gathered, the design guide should then be able to determine many different aspects of the handle design, based upon the demographic being designed for, and the particular tools usage (associated parameters such as forces applied and manipulation characteristics). Many different specific aspects could then be derived, such as the correct dimensions for the tool handle; the texture compromises available for optimal emotional response or grip characteristics; as well as definition of grip shapes and angles between gripping surfaces and work faces for maximum comfort and utility.
Understanding the Users

The initial research at York University has been to explore the attitudes, behaviours and language related to cooking by older people. Two methods were used; focus groups to stimulate discussion and discover what issues were important to the participants and food and shopping diaries to capture behaviour and triangulate with data from the focus groups.

Cooking and Eating Habits of Older Adults

Fifteen older adults (4 male, 11 female, aged between 62 and 75) were recruited from the membership of University of Third Age (U3A) in York and York Older People’s Assembly (YOPA) to take part in the focus groups. 18 participants (14 female, 4 male, aged between 62 and 88) were recruited from the same organisations to participate in the food and shopping diary study.

The focus groups were organised to be relaxed social settings with refreshments, with between three and five participants in line with work by Newell et al. [6]. Participants were asked to bring two kitchen utensils to the focus group; one which they could not live without and one which they did not like or had difficulty using. These were used to stimulate discussion about cooking practices and how utensils empowered or frustrated their efforts. Researchers from Leeds and Sheffield each participated in at least one focus group.

The food and shopping diaries were designed to capture food related behaviour over a seven day period that could be triangulated against behaviour and attitudes described in the focus groups. Food diaries are an established tool for anthropologists[7] as well as dieticians [8] because they closely reflect what people do rather than what they say.

Results

A total of 33 different kitchen utensils were brought along to the focus groups, among them two categories of utensil, vegetable peelers (see Figure 1 and Figure 2) and jar openers (Figure 3 and Figure 4), were brought along by more than a third of participants.

Figure 1(Left): Y-shape vegetable peelers
Figure 2(Right): Lancashire style vegetable peelers

Figure 1 and Figure 2 show the two main styles of vegetable peelers brought to the focus groups. The two styles require different hand motions to apply the blade to the vegetable. Participants were enthusiastically for one style and against the other and made no distinction about the shape or material of the handle.
Figure 3 shows a Brabantia jar opener, which was brought in by three participants and owned by several more. All owners described it as useful, but fiddly - something you would not use if you had an alternative;

“if you’ve got a husband you wouldn’t want to use this because it’s fiddly, because you have to get it flat before you tighten it so it doesn’t slip off...it wouldn’t do someone with really arthritic hands, but [for someone who doesn’t have a] brilliant grip and nobody else there, it works”

While the strap wrench, Figure 4, had never successfully been used to open a jar and was described as “a useless object - looks like an instrument of torture”.

All the participants of the focus groups were enthusiastic cooks and valued home cooked meals over pre-prepared foods.

The food diaries were followed by interviews at home. The size and organisation of the kitchen was a common cause of complaint, (even for those who had installed new kitchen layouts of their own choice) because this constrained the space for preparation and ease of storing and accessing foods and utensils. Many had terrific tools to help them in the kitchen, but lacked the space to make good use of them.

**Questionnaire into Lifestyle and Habits in the Kitchen**

As part of the discovery of the personal habits and difficulties of the users, a survey was written based upon the findings of the focus groups held at York.

The aim of the survey was to ask basic questions about the occupation, health, and activity levels of the participants, as well as their cooking habits, and the difficulties and preferences in the kitchen environment.

**Initial results**

The initial results have been collected and analysed. The data contained was typical of what was expected, with a range of difficulties observed. The respondents of the survey were predominantly female (76%), ranging from the age group of 60-64 up to 90+. There was as expected, a relationship between the reported difficulties in the activities of daily living and age. There also appeared to be a link between the disclosed disabilities of the respondents and the perceived difficulties in the kitchen. The uptake of assistive products appeared not to be linked with any other variable, with almost 62% of the respondents owning some assistive kitchen device, with 73%
of the devices being Jar openers, and 18% being large handled knives. Almost 92% of respondents reported some form of disability that could reduce their ability to perform kitchen related tasks. Of these disabilities, 82% were forms of Arthritis. This sample, however, is too small to draw any firm conclusions or reach statistical significance from at this stage. The results are promising, and with the collection of further data, these observations can be built upon and used.

Understanding the Physical Aspects of the Hand-handle interface
Physical Grip and Manipulation of the Kitchen Objects
This branch of the research, undertaken at The University of Sheffield, was based on the engineering principles behind the physical grip and manipulation of the kitchen objects. The aim of this testing was to produce data about the relationships between different manual abilities with relation to age and disability. This data will form part of the guidelines to inform the designer of the limitations of a given persons abilities, and how by designing to exploit a person’s strengths, what overall impact that may have on the usage of an object.

Outline of tests
A selection of tests were taken from the literature as measures of the vital components of human grip and manipulation. The tests selected were confirmed to be appropriate for older people. The tests included the Purdue Pegboard test (fine manual dexterity), Jebsen Hand Function Test (fine and gross manual dexterity), Jamar Dynamometer (grip strength measurement), Two point discrimination test (finger sensitivity test), as well as two custom tests based upon previous studies (a door handle rig based upon the paper by Peebles [9], and a jug pouring test based on the TEMPA test by Desrosiers [10]). There were also measurements of skin friction and moisture content taken using a custom friction rig[11] and moisture measurements using a ‘Moistsense’ probe (Moritex Cosmetics, http://www.moritexcosmetics.com/).

The whole range of tests were administered to all participants. Correlations between the different measurements for each participant were ascertained, finding links between individual’s strengths and weaknesses and finding commonalities between participants. Young, able bodied participants were tested first in order to gather a baseline measurement, and older participants will be tested shortly to discover the changes associated with ageing and the encroachment of infirmities.

Test results
Twenty-seven participants (16 male, 11 female, aged 21-34, mean 25) with no reported physical disabilities were recruited from staff and students at The University of Sheffield.

The graphs in Figure 5 and Figure 6 show the relationship between the maximum torque achieved on the Door handle test and the grip strength measurements of the participants and skin friction measurements of the fingers respectively. The relationship observed in figures 5 and 6 are as expected, as the grip strength is the parameter assumed to generate the normal force for torque to be generated at the handle. The strong relationship to friction was observed due to the slip of the hand in
every case, suggesting that a lack of friction is a factor in the maximum force generated.

Figure 5 (Left): Graph showing the link between grip strength test results and the Door Handle torque test results, divided into male and female data
Figure 6 (Right): Graph showing the relationship between the maximum torque achieved on the door handle test and the skin friction coefficient of the participants

Figure 7: Graph showing relationship between the product of Grip strength and Friction Coefficient in relation to the maximum torque applied on the door handle

From Figure 7, it is clear that the relationship between the door handle torque test is most closely linked to the product of the friction and the grip strength. This makes sense as this is how torque would be calculated using the handle radius, the normal force applied to the handle and the coefficient of friction between the hand and handle.

Table 1: Table showing the correlations between the different tasks of the Jebsen hand function test and both the dominant handed Purdue test and the Assembly scores for the Purdue test (Pearson’s Product Moment Coefficient, and the associated p values)

<table>
<thead>
<tr>
<th>Jebsen Hand Function Test</th>
<th>1H Purdue (p Value)</th>
<th>Purdue Assembly (p Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turning Cards</td>
<td>-0.255 (0.219)</td>
<td>-0.430 (0.032)</td>
</tr>
<tr>
<td>Manipulating small objects</td>
<td>-0.057 (0.785)</td>
<td>-0.108 (0.606)</td>
</tr>
<tr>
<td>Simulated Feeding</td>
<td>-0.191 (0.359)</td>
<td>-0.087 (0.680)</td>
</tr>
<tr>
<td>Stacking</td>
<td>-0.564 (0.003)</td>
<td>-0.322 (0.116)</td>
</tr>
<tr>
<td>Large Light Objects</td>
<td>-0.239 (0.250)</td>
<td>-0.087 (0.679)</td>
</tr>
<tr>
<td>Large Heavy Objects</td>
<td>0.011 (0.960)</td>
<td>-0.110 (0.600)</td>
</tr>
</tbody>
</table>
The data in Table 1 shows that there is very little correlation between the two dexterity tests of the Jebsen hand function test and the Purdue Pegboard test.

There is a noticeable change in correlation between the Dominant hand test of the Purdue Pegboard test and the stacking task within the Jebsen test. Both of these tasks are of a similar nature but on a different scale.

**Affective Engineering of kitchen utensils**

The characterisation of the emotional responses to different material compositions and surface textures is termed ‘Affective Engineering’. The focus of affective engineering is to improve the users’ product experience by creating pleasurable and confident feelings in the design of new products. Designing an appreciated product using affective engineering requires the developers to study the needs and wants of the users [12] and apprehend people’s emotions, and perceptions.

Consumers require a likeable, personalised feeling product that they can identify with. “An increasing number of people want to express their individuality.”[13]. Affective engineering involves translating consumers’ feelings for a product into design elements, in order to implement likeable or expected characteristics into a product. Omitting it inevitably leads to bad inclusive design.

‘Affective engineering’ was first introduced as ‘Kansei Engineering’ [14]. Kansei engineering is a form of product development methodology [13][15]. “Kansei is the impression somebody gets from a certain artefact, environment or situation using all their senses of sight, hearing, feeling, smell, taste as well as their recognition” [16]. Kansei has been used in many different fields for many different products, and has proven itself to be efficient in producing successful products [17].

In order to transcribe people’s impression into a design one must know what influences the perception. Hands are at the heart of everyday lives, which results in not only an overdeveloped sensitivity in the hands [18], but also a strong customer reliance for “making product evaluations” [19]. It is very difficult to identify what parameters influence affective feelings and perception of physical characteristics, such as the influence of vibrations on the rating of roughness and warmth [20]. Tactile perception is often associated with more than one physical property [21].

**Affective Adjectives in the Kitchen**

York’s focus groups investigated people’s own experience in their kitchen. This information needed to be built upon and focused to produce data that could support the design process.

In order to run fitted affective experiments, Leeds University had to get a list of adjectives or expressions that people use to describe their experience of kitchen utensils. Therefore Leeds organised a focus group, based on those ran at York’s, involving five participants (university students). Through different exercises, they evaluated nine distinct utensils. They had to focus on the tactile perception of the item, not on its utility. Nice, comfortable, rough, cold, confident, slippery, different, hard, useful, and weird, were the ten most used and repeated adjectives, hence the most representative lexicon. Further research on kitchen utensils carried out at Leeds will be based on the latter lexicon and therefore hoped to be as clear to most
participants as possible.

**Tactile Perception Testing**
The current methodology used in tactile perception evaluation consists of a fingertip sliding over flat stimuli. However, if the shape of a contact surface has a large influence on tactile perception then the results obtained for a texture would not be translatable to any product design.

To discover the support shape’s influence on the texture perception, the University of Leeds ran a forced choice experiment. The textural percept, elicited when scanning silicon textures with the fingertips on a flat surface, were compared to those evoked when the same textures, mounted on pan’s handles, were in contact with the entire hand.

Twenty-three participants, University staff and students of Leeds University between the age of 20 to 50, compared textures on flat supports and on pan’s handles (see Figure 8) against different adjectives (rough, warm, hard, controllable, wet, confident).

![Figure 8: Flat and pan stimuli tested in this experiment](image)

**Test results**
From the answers of the participants (i.e. the pan or the flat support felt more expressive), it could be concluded that, in most cases, subjects could not identify similar textures on different supports. Therefore, it could be hypothesised that the tactile perception of a texture can differ depending on the support it rests on. Therefore tactile perceptions resulting from finger stroking assessments of a texture might not be representative of real product experience and results should not be extrapolated to any kind of product. Further analysis also demonstrated that the subjects of this experiment tended to feel the flat surface as more expressive.

However, the validity of the results gathered in this study is to be looked at cautiously. The glue holding the textures on the handle was not strong enough; which resulted, as the experiment went on, in loosening of the texture, which might have influenced people’s perceptions. Even though the irregularities were minor, they might not be negligible and could have had an influence on the results.

**Conclusions and future work**
The work at York provided a good foundation of understanding of the perceptions of users and their attitudes towards the kitchen. It also produced information on tools, their usage, and the reasons for their selection.
The initial physical attributes experiments in Sheffield based upon a young participant group was intended to produce a baseline of physical abilities for the able bodied against which the results from the planned testing of older participants will be compared. The physical variation between participants was very small and so the conclusions drawn and the indications of links observed at this stage will be investigated further when the older participant data is collected and a wider range of abilities is available to compare.

The research at Leeds on the affective engineering tests has been based on kitchen utensils. Further work will be done to complete the obtained data and try to evaluate the importance of each influencing factors. The data obtained in this way could be combined with the data obtained in Sheffield on grip in order to aid the design of efficient but pleasurable products. The planned second part of the research will focus on the tactile evolution with age, in order to see if the data collected in affective studies with young people can be extended to older people.

References


Session 6C
Concepts and Ideas
Hidden Meanings – Challenging Normality through Design.

Tom Bieling:

Abstract

This paper discusses how explorative and speculative design approaches and views on artefacts as enablers and disablers can be addressed, based on the assumption that design research plays an important role not only in gaining knowledge about societal processes, but might also be able to influence or change them.

Challenging predominant concepts of normality, it uses different interaction perspectives on the relation of design and disability, and although partly abstract, generates critical insights into existing (e.g. strongly usability-focused) design approaches.

For further discussion, a diversity-centred approach is adopted to illustrate progressive design research in context of disability. The paper will argue that design research is in a predestined position to address these issues in different approaches of knowledge production that are crucial features of design activity.

Practical value is increased by linking theoretical foundations of this broad field to applied design project work, arguing that cross-fertilizing potential can be gained here.

Keywords

Introduction

Matthews et al. (2008, 58) regard “Interaction Design” as a “document of the recognition of the importance of understanding the development and consumption of technology as being irredeemably situated in human, social and organizational contexts. Yet it also is an acknowledgement of the central role of the designer in shaping human interaction with technology”.

The ongoing changes in Information-Communication-Technology (ICT) have made “social interaction an increasingly important topic for interaction design and technology development” (Kurvinen et al, 2008, 46). Investigation and outcome is here often focused on majorities of (potential) users and usage, whereupon striking questions concerning a constructing moment of normality is often neglected.

Chow and Joost underline here the importance of taking into account e.g. sociological and ethical questions, so as “not to address [a] user group as ‘old’ – meaning unable to use ‘normal’ technology” (Joost/Chow 2010, 166).

Assuming that man-made constructions and technologies influence on the individual, it becomes comprehensible that technologies “enforce normalcy” (Davis 2002), meaning that they have an effect of “reproducing an ableist framework, rather than building in, creating and
contributing to new modes of living which embrace difference and diversity” (Goggin 2008, 11).

In the terms of Design in relation to social change, Manzini (2010) states that change must come from what is configured as ‘normal’. One of the most interesting challenges of academic discourse as well as design practice is about re-configuring ‘normality’. And in principle, as Tom Fisher (2010) points up: “Design is able to engage with that re-configuration”.

This relation becomes clearer, for instance, by taking a closer look to current uses of the term “usability”, which have expanded the scope of the definition to include “all interactions that take place between human beings and the designed world they live in” (Bremner 2008, 425). Bremner describes how everything from industrial products to screen interfaces to services and experiences can be discussed in terms of usability nowadays: “Regardless of the different forms these interactions might take, it is clear that designers have been increasingly required in almost every professional design practice to continually consider (and reconsider) user perspectives, needs, desires, expectations, behaviors, and aptitudes throughout the entire design process”.

After Zirden today the system „normality“ basically guarantees the functioning of western societies (Zirden 2003, 29). This system is oriented towards proportion, relation of quantity, average peaks and percentage. The coordinates of normality, here to be regarded as criteria for evaluation of human beings, are reflected in e.g. school grades, the evaluation of work or health, etc. Today’s normalising society indeed appears to be more flexible in setting its limits of tolerance, however various scientific, technical and economic resources are being expended in order to early locate and eliminate potential anomalies (ibid.).

In my previous and ongoing research on diversity-centered design I have already shown and discussed the complex of design and disabilities. (Bieling 2010a)* A special focus lies on the disclosure and discussion of normative implications of design in the context of socio-material assemblies.

Solely the influence of design as practice (congruent to architecture, urban planning, politics, media, film industries etc) on the complex phenomenon “disability” is binding for further investigation in terms of a cultural, artificially made and socially practiced exclusion.

It is essential, to understand and clarify different perspectives and meanings of disability. Already from sociological point-of-view, various perspectives are possible (e.g. socio-psychological, socio-structural, role-, socialisation-, modernising-, or system-theoretical perspectives), which shall not further be discussed in this paper. In the different disciplines dealing with disability, we recognize different approaches and understandings of disability. A cardinally approximation from multi-perspectives becomes clear in the following comparison:

<table>
<thead>
<tr>
<th>Disability</th>
<th>Object of Investigation for:</th>
<th>Underlying Principle:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sociology</td>
<td>How to understand / describe?</td>
<td></td>
</tr>
<tr>
<td>Medical Science</td>
<td>How to heal?</td>
<td></td>
</tr>
<tr>
<td>Educational Science</td>
<td>How to educate?</td>
<td></td>
</tr>
<tr>
<td>Disability Studies</td>
<td>How to emancipate?</td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>How to design?</td>
<td></td>
</tr>
</tbody>
</table>
It becomes obvious how the multiple definitions of disability in general and the relation between disability and design in particular, are to be analyzed and evaluated from different point-of-views. Concerning the formation of "normality", the ex-/inclusion through thing-use and its impact on social action plays a crucial role, which in turn leads to general and methodological questions about how to describe and analyse such constellations.

Besides the ‘double role’ of the artifact as a product on the one hand, as a process on the other hand (Bieling/Joost/Mueller 2010), there are several other perspectives of which already a few have been mentioned above. Following the basic aim to find out, how processes of interaction and communication proceed, we shall here take a closer look on the interaction-theoretical perspective.

**Interaction-theoretical Perspective**

In the context of design, interaction and constructing disability, several questions are to be raised, of which the most important ones from an interaction-theoretical perspective (Stange 2004, 67) are these: What is human everyday-action based on? How is it orientated? How is the interaction of the different actors related to each other? How does interaction come into existence anyway? And how do processes of interaction and communication proceed?

The interaction-theoretical perspective, referring to symbolic interactionism (Blumer, Mead), is to be understood from an action-theory point-of-view: Since human action is highly situational and subjective, social reality arises from mutual oriented and interpreted individual actions, symbolic interactionism can be regarded as an “interpretative paradigm” (Stange, 2004, 86): Understanding information deeply depends on the ability of the partners of communication to interpret it (Treibel 1994, 108). Such ability again strongly depends on expectancy and experience.

Symbolic interactionism operates on the premise that:

1. People’s action refers to the meaning of “things”, people, situations, etc.
2. The Meaning of such things derives from social interaction.
3. Meanings can be gained, used and transformed through interpretation of social interaction (Stange 2004, 86)

**Thing relation**

Referring back to the assumption that man-made constructions and technologies influence on the individual, we can assume that disability occurs not least through influence by design and culture (Bieling 2010).

The designed artifact can hereby contain inscribed notions of disability and ability. The question is what do these resources – incorporated in the artifacts – represent and symbolize not only in a context of production and use, but in the wider political and social field.

While Goggin/Newell (2003) describe the complex correspondence of the individual and technology within the world of artifacts, and Freund (2001) explains the correlation of body and space, by claiming that spatial organization constructs bodies and offers bodily possibilities and constraints, Anderberg (2005, 4) states that “technology and design can […] be seen as mediators of disability”.

Ingunn Moser goes even a step further, when she explains how the relation between humans and technology does “not just admit countless”, but can lead to processes by which “identities and positions are interactive and influence each other” (Gevers et al. 2009, 26). Depending on context, technology or relations, disability can obviously be ‘made’ or ‘unmade’, comparable to aspects of gender or race. This perspective offers a critical view on how “assumptions and labels contribute to the preservation of the distinction between normal and not normal” (ibid.).
Approach

After having discussed the correlations of “disabilities” and “abilities”, as well as it’s perspectives for practical use, mis- and re-use of body and material**, in former publications (Bieling 2010b), this paper shall shortly outline insights, constraints and findings from a case study (Fig 1) that was performed during a research project on disability-inspired interaction at T-Labs (Deutsche Telekom Laboratories, Technical University Berlin).

Together with a group of 8 Deaf People (age: 16-24; all born deaf), properties of deaf communication was explored. The aim was to derive concepts for speculative devices that could either help to support deaf communication or general human (and therefore also non-deaf) communication. Or even better: both.

Several concepts resulted from this co-experience, of which some will be presented at INCLUDE 11 in London. A striking example for transferring concepts for interaction from one (theoretical or practical) context to another is the design concept Watch & Write, a mobile device with a two-layered, transparent display.

Watch & Write is based on the observation that most of the participants (All them were students!) felt themselves confronted with the problem of writing down notes during university lectures. Unlike non-deaf people, who can easily write down notes without watching the lecturer, deaf people have serious problems in actually writing without watching: Simultaneously following the lecturers presentation and writing down notes lead to the conflict of either writing down crappy notes or missing important parts of what the lecturer said.

As a solution for this specific problem, Watch & Write allows to write on a transparent layer on top of the captured speech. To use the device, the user directs the included camera towards the lecturer, so that he/she can follow the lecture over the display. A two-layered display allows the user to write on it, without losing the shown picture. A word-recognition function supports the transformation of the written notes into proper type-letters.
The important issue here is, that the product does not only address the needs of a certain group of (here: deaf) people, but also widens the field for potential use by a larger group of people in different contexts. A howsoever defined concept of “normality” or “normal users” would not have made sense in the context of innovating Information-Communication technology (here: with a special focus on display interaction). Quite the contrary: A consistent disregarding of so called common rules of normality and abnormality, can serve both: product innovation and societal norm definition.

Conclusion
The concept – Watch & Write – chosen to underline the discussed issue of design’s ambivalent relationship to normality, has surely to be seen in a broader perspective: The challenge of the designer is not only to meet functional, aesthetic, economic etc. requisites, but also to be aware of influencing common definitions of disability and therefore substantiating and clarifying an enhanced and reflected understanding as well as the societal process of modifying general perspectives on disability.

The mentioned concept, as it is only an example taken from a group of concepts may probably not best describe, or better: it is not even meant to describe the steps a designer has to take. Neither is it to be seen as a “how-to” for designing with disability-awareness. Nevertheless it demonstrates this certain correlation and opens up possibilities for future research and development in this field.

Finally this investigation highlights the importance of taking into account different perspectives – not least in a design process. Further work will be required to investigate wisely a methodological suitability. Although this research takes place in the domain of disability related topics, the overall scheme has implications for a general view on diversity-centred design.

*: Two aspects shall be mentioned here: First, the transportation of aesthetic overall concepts (of not least human perfection). And second, the aspect of making living environment in-/accessible.

**: One major focus lies on a discussion on reinventing and reevaluating body, as well as its relation to certain functions or artifacts.

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Inclusive Practice: Researching the Relationship between Mathematical Ability and Drawing Ability in Art Students

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Nicola Brunswick, Middlesex University
Rebecca Chamberlain, University College London
Chris McManus, University College London
Qona Rankin, Royal College of Art

Abstract

This paper is a component of ongoing research by a team comprising an art school lecturer, a coordinator of dyslexic students’ support, and psychologists interested in exploring correlations between drawing ability and factors such as mathematical ability, personality traits and dyslexia. It extends research by gathering and analysing data collected from art students at Swansea Metropolitan University and the Royal College of Art. The paper introduces a research strategy to explore the hypothesis that drawing ability correlates with mathematical ability, with the ultimate objective of developing inclusive strategies for the teaching of drawing.

Previously we have explored how difficulties with drawing relate to dyslexia (1). Although no direct relationship with dyslexia was found, other interesting results were: poor drawing related to poor visual memory and a reduced ability at copying angles and proportions, suggesting problems in spatial perception and memory. Other researchers (2) have reported that dyslexic children who are poor at maths tend to be less good at remembering the Rey-Osterrieth figure. We also noted that students with lower GCSE maths grades tended to be less good at drawing the Rey-Osterrieth figure. In the present, exploratory study we therefore looked at how ability at maths related to drawing ability.

Introduction

Art and drama schools are well known for having a high proportion of students with dyslexia. There are also recent similar, but as yet unpublished, indications relating to schools of music. It is not clear to what extent that reflects enhanced talents in those students, or whether the choice of art, drama or music is because of problems dyslexic readers encounter with the more traditional academic subjects embedded in the three
Rs. Drawing in particular is a skill that would appear divorced from reading, writing and arithmetic, and yet researchers have argued that mathematical ability may be related to drawing. If that were the case, then otherwise well qualified potential art students may be being excluded from admission to art courses because of a requirement for drawing (and by implication, maths). Here we assess how drawing ability relates to maths in a cohort comprising Foundation Diploma students at Swansea Metropolitan University, and Master’s level students from the Royal College of Art.

Method

Students were introduced to the general aims of the research project in an illustrated PowerPoint presentation. The cohort was divided into 6 groups of roughly 20 per group, each group invited in turn to a studio set up with laptop, projector and screen (Figure 1). Each student was given an A4 booklet containing the instructions for the series of drawing exercises adjacent to blank pages in which the students’ drawn responses were to be recorded. The booklet also contained a questionnaire eliciting students’ attitudes to their perceived drawing abilities (Figure 2), mathematical abilities, previous educational experiences, and other factors, including personality traits, handedness and spelling abilities (Figure 3). The entire testing session lasted approximately 40 minutes.

Figure 1a: The Drawing Room. Students are copying the Rey-Osterrieth complex figure. They have not been told that in about 30 minutes they will be asked to draw it again, but this time from memory.

**Figure 1b**: The Drawing Room

**Figure 2**: Section of Questionnaire: Perceived Drawing Abilities
Analysis of Data

As well as data from 105 students in Swansea in September 2010, we also had other data collected in 2007 from students entering Swansea (n=90) and the RCA (n=187). The 2007 surveys did not include the questions on attitudes to mathematics, but there was information on GCSE achievement, and we have included those participants along with the present data, when possible, in order to maximise the sample size of the study.

Drawing Ability

The main outcome measures for assessing drawing ability were the responses of the students on the six questions on drawing ability: Drawing from observation (e.g. life drawing); Drawing from imagination; Use of perspective, shadow and shading; Confidence in mark making when drawing; Use of contrast and tone in drawing; and Technical drawing (geometric and engineering drawing); see figure 2. In our previous study we found that the first five correlated highly with one another, and a composite scale based on them also correlated with actual drawing ability, thereby validating the questionnaire measures. Previously we did not include Technical drawing as it behaved slightly differently from the other measures, but we included it here, and as will be seen, it does indeed behave somewhat differently.

Maths Ability and Attitudes

Mathematics ability was assessed by grade at GCSE maths, which was of course only available for those who had been educated in the UK. Grades were scored as A*=6; A=5; B=4; C=3; D=2; E=1; else =0. In the Swansea 2010 study we also included 18 questions assessing attitudes to maths at school, which were derived from a range of other published measures (3, 4, 5 and 6) – see figure 3. Factor analysis of the 18 items found two correlated scales which can be broadly described as Maths being Enjoyable,
and Maths being *Useful*. Higher GCSE grades in maths were strongly linked to finding maths enjoyable \( r=.457, n=72, p<.001 \), although there was no link to thinking that maths was useful \( r=.150, \text{NS} \).

**Dyscalculia**

Students were asked whether they had ever been told that they had, "dyscalculia or other problems with numbers or calculating". One said they had been diagnosed as dyscalculic, 12 had wondered if they might be dyscalculic, and 88 reported that they had "Never" been considered as being dyscalculic. The 13 who may have been or were dyscalculic reported finding maths significantly less enjoyable at school \( p<.001 \), although they did not regard it as any less useful \( p=.402 \), and neither did they do less well at GCSE maths in particular \( p=.150 \), or at GCSEs overall \( p=.889 \).

**Drawing and Maths**

Table 1 shows the relationship between each of the six self-reported measures of drawing ability and the two measures of attitudes to maths education, achievement at maths GCSE, and overall achievement at GCSE. It is noticeable that three of the drawing measures (life, perspective and technical), show correlations with enjoying maths and/or with GCSE maths grade. However only two correlations are significant after using a Bonferroni correction (at a level of 0.5/24 = .00208). Both of those significant correlations relate to technical drawing, which is better in those with higher grades at maths GCSE and in those who found maths enjoyable at school.

Exploratory multiple regression suggested that it was not possible to determine whether it was finding maths enjoyable or achieving well at maths GCSE which was the primary correlate of technical drawing ability. Figure 4 shows that grade at GCSE maths is higher in those with greater self-rated ability at technical drawing.
Figure 4: The average grade at GCSE maths (vertical axis) in students who rated their ability at technical drawing from 1 (Much below average), to 5 (Much above average).

Finally it should be emphasised that the correlation with maths achievement is specific, as the correlation with GCSE grades overall is not significant after Bonferroni correction (and neither is it significant in a multiple regression once GCSE maths is included).

Table 1: Correlations significant with p<.05 are shown in bold, and those significant after a Bonferroni correction are shown underlined.

<table>
<thead>
<tr>
<th></th>
<th>Maths more enjoyable at school (N=83-92)</th>
<th>Maths more useful (N=83-92)</th>
<th>GCSE maths grade (N=207-218)</th>
<th>Average grade at GCSE (N=207-218)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing from observation</td>
<td>r=.150</td>
<td>r=.151</td>
<td>r=.143</td>
<td>r=.196</td>
</tr>
<tr>
<td>(e.g. life drawing)</td>
<td>NS</td>
<td>NS</td>
<td>p=.037</td>
<td>p=.003</td>
</tr>
<tr>
<td>Drawing from imagination</td>
<td>r=.010</td>
<td>r=.094</td>
<td>r=.081</td>
<td>r=.057</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of perspective, shadow</td>
<td>r=.228</td>
<td>r=.161</td>
<td>r=.161</td>
<td>r=.164</td>
</tr>
<tr>
<td>and shading</td>
<td>p=.029</td>
<td>NS</td>
<td>p=.018</td>
<td>p=.012</td>
</tr>
<tr>
<td>Confidence in mark making</td>
<td>r=.078</td>
<td>r=.061</td>
<td>r=.123</td>
<td>r=.165</td>
</tr>
<tr>
<td>when drawing</td>
<td>NS</td>
<td>NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of contrast and tone in</td>
<td>r=.183</td>
<td>r=.068</td>
<td>r=.120</td>
<td>r=.138</td>
</tr>
<tr>
<td>drawing</td>
<td>NS</td>
<td>NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical drawing (geometric</td>
<td>r=.356</td>
<td>r=.188</td>
<td>r=.257</td>
<td>r=.159</td>
</tr>
<tr>
<td>and engineering drawing</td>
<td>p&lt;.001</td>
<td>NS</td>
<td>p&lt;.001</td>
<td>p=.016</td>
</tr>
</tbody>
</table>

Analysis of actual drawing ability (based on independent ratings of the students’ ability to draw an image of a hand holding a pencil, and an image of a model made from children’s blocks) revealed significant correlations between this and a) self-rated drawing ability (r=.461, n=102, p<.001) which validates the self-ratings; b) perceptions of how enjoyable the students found maths (r=.239, n=94, p=.020); and c) maths GCSE grade (r=.316, N=79, p=.005). The correlation between actual drawing ability and findings maths useful just failed to reach significance (r=.196, n=94, p=.059).

Discussion

Our study supports the idea that ability at drawing - still a key, central skill in art courses - is related to being good at maths and finding it enjoyable. Art students often wish to be able to draw better, and a possible implication of our results is that those who are weak at drawing may be helped by improving mathematical skills, perhaps in the most obvious area of understanding geometry and spatial relations.

Art students differ in their ability to draw, and ability to draw can impact on many aspects of students’ subsequent careers at art school and beyond. Drawing is both an aesthetic activity and also a craft with many technical aspects. Those different aspects are seen in the fact that students differ in their self-ratings of their ability in the six different aspects of drawing that we asked about. The origins of differences in such separate abilities may...
reflect a host of different learning experiences, but they may also be related to aptitude for other academic subjects. Previous research by ourselves and others has suggested that difficulty with mathematical subjects may be reflected in other areas of expertise (and perhaps also co-occur with differences in spatial memory and other relatively low-level cognitive processes). It is therefore interesting, and potentially of practical importance, that difficulty with mathematics at school also seems to relate to difficulty with particular components of drawing ability (and table 1 shows that GCSE maths grades relate to life drawing, the use of perspective and technical drawing, but not to drawing from imagination, the making of marks, and the use of contrast and tone). There is a commonality amongst these three aspects of drawing, each emphasising precision and accuracy of representation rather more than the other three which are more concerned with expression and aesthetic impact. Those differences suggest deeper underlying processes in terms of cognition, and that perhaps precise and accurate drawing may require a different mentalité to the other components of drawing. In particular it should be emphasised that the correlation with mathematics achievement is not merely to do with academic achievement or intellectual ability overall, since the correlation with overall achievement at GCSE is not significant. Whether that mentalité is particularly related to achievement in maths, or instead to a positive attitude towards maths which results in it being enjoyable, is not yet clear, the two measures being quite highly correlated, those liking maths doing better at it (and vice-versa).

Drawing is a complex skill, and it almost certainly requires a range of cognitive processes. Our previous work has suggested that at least two low-level processes – visual memory, and the perception of angles and proportions – are required for good drawing. The current study suggests that those who enjoy maths and are good at it are also better at the more precise components of drawing (and of course perspective, shadows, etc, all have their precise mathematical descriptions, which were much studied in the Renaissance explosion of drawing abilities). Of course that is not to suggest that drawing is merely a mechanical process involved in the representation of the visual world. It is far more than that. But when students have difficulties in drawing, and they also have difficulties in a wider range of mathematical tasks, it suggests that for such students there may be underlying commonalities in the skills. Inevitably it also raises interesting questions about the extent to which difficulty in drawing might be helped by providing support or intervention which concentrates on mathematical and other skills.

We aim to conduct a more in-depth analysis of actual drawing ability in the future, to explore and perhaps verify the findings derived from self-perceived drawing ability.

References


Designing for people that are WELL old

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Abstract
In the UK, inclusion is an important topic on different social levels and the need for change in government, education and industry to reduce social exclusion is recognised. Despite a range of datasets and methods having been created to help minimise exclusion, the topic of inclusion and, in particular, inclusive design is not yet covered in education i.e. the Design and Technology curriculum. Engaging school pupils with the topic has the greatest potential to bring about long-term change towards a more inclusive society. This paper reports on the outcomes of several design workshops on inclusivity. The workshops were aimed at, and conducted with, key stage 3 and key stage 4 pupils. The overall aim of the workshop was to establish the impact that current inclusive design methods have on the mindset of the pupils. The methods used in the workshop included impairment simulators and case studies. An assessment at the beginning and end of the workshop evaluated changes in attitude. A total of 10 workshops were conducted with over 150 pupils. It was found that such methods do provide insights that result in solutions that address inclusive issues. This paper concludes with the view that inclusive design methods can impact and change the mindsets of pupils as young as 11 years old. However, if a truly inclusive society is to be achieved, there is a need to instigate change in the overall national design ethos i.e. focusing more on principles than practice and preventing the immediate leap to solutions rather than identifying the true nature of the problems.

Introduction
The Qualifications and Curriculum Development Agency identifies three key aims to the Key Stage 3 and 4 curriculums. They are for all young people to become:

- Successful learners who enjoy learning, make progress and achieve;
- Confident individuals who are able to live safe, healthy and fulfilling lives;
- Responsible citizens who make a positive contribution to society [1].

The agency goes on to describe the importance of Design and Technology in meeting those aims and, in particular, that students should “learn to think creatively and intervene to improve the quality of life”[1]. In order to comply with this requirement, students should be encouraged to “combine practical and intellectual skills with an understanding of aesthetic, technical, cultural, health, social, emotional, economic, industrial and environmental issues”[1]. These are not new concepts to ergonomists who have been striving for the recognition of user capabilities within the design process.
Importantly, as part of being ‘responsible citizens’ these Key Stage 3 and 4 learners are required to “take account of the needs of present and future generations in the choices they make”[1]. This tessellates completely with the demands of modern design within the changing population demographic. Our citizens are becoming older and, in many cases, fitter and more demanding. It is a poor designer who fails to accommodate the needs of the elderly user into their designs partly because of the moral imperative but also for commercial success. It has been reported that the ‘grey pound’ is the strongest currency [2] and this is likely to continue to grow. Old people are wealthy people and modern old people like to spend their wealth.

Unfortunately, the elderly population are not perceived as glamorous and hence are often considered uninspiring and undeserving of quality design solutions. Not only is this perception false but also insulting and commercially dubious. However, it is a strong perception and it will require considered and concerted efforts to change it. For this reason, the most appropriate place to start is where the perception is most entrenched and where changes can have the greatest effect: young designers.

This programme of work has set out to see if it is possible to change young people’s perception, behaviour and approach to design with a small budget, limited resources and during a short period of time. Using out of school workshops of only one hour duration a programme of activities intended to use the participant’s language and topics of interest to make empathetic design a fun and engaging activity which would carry with it an important message. This message might then be embedded into future design activities those participants may undertake.

This activity had to take place outside of the conventional curriculum because of the restrictions and structure engendered by the current curriculum, teaching techniques and default to emotional design techniques. By providing empirical experiences and critical thinking it is intended to broaden the thinking of future designers such that inclusive design becomes the convention rather than a separate activity.

**Why focus on the physical aspects?**

People can become excluded from using everyday products for a variety of reasons (e.g. economic, cultural, social, lack of knowledge and experience, overly complicated instructions/designs) [3]. However, the most common form of exclusion experienced by older adults is when there is a mismatch between the product demand and user capabilities [4]. More specifically, the capability demand of using the product is greater than the capability of the user, resulting in them being unable to access the product to achieve their goal [5]. The reason this form of exclusion is common place amongst older adults is because they have significantly reduced motor, sensory and cognitive capabilities compared to the rest of the population. This reduction in capability is due to the effects of the ageing process and the higher incidence of medical conditions (disabilities) with age, such as arthritis, or age related Macular Degeneration [6]. Thus, in order for dependency and exclusion to be prevented, designers have to understand and account for the reduced functional capabilities of older adults in their designs [7].

**Methodology**

A series of one hour workshops were undertaken with engagement from local schools and colleges. These were hosted at a discovery park away from the school environment. Groups of up to 30 students attended the ten sessions with a total count of 150 participants. The workshops consisted of four main components:

- An initial evaluation of the participant’s perceptions of the elderly
- An educational component identifying some characteristics of old age
- Some hands on empathy exercises using simulation equipment to emulate old age whilst undertaking everyday tasks
- Reflection of the activities and dialogue on how the participant’s perceptions had changed.

The learning outcome was to provide students with an understanding of the effects of ageing and how products evolve according to users’ needs and capabilities. Overall, the workshop demonstrates how ergonomics can contribute to the design of successful products, and how ergonomically designed products can lead to having a positive impact on a person’s quality of life.

**Initial survey**
The initial survey consisted of an open, semi structured dialogue with the host prompting certain questions and exploring responses in greater depth. The key prompts were:
- What age is old?
- What are the characteristics of old people?

**What is well old - The old wall**
The students were then introduced to the ‘old wall’. This concept, adapted from the BBC series Top Gear (The Cool Wall) required the participants to nominate categories of age for well known celebrities. This process challenged the conventions by which age is categorised. The ‘old wall’ is shown in Figure 1.

![The old wall](image)

**Figure 1**: The ‘old wall’ used to engage with perceptions of age.

The ages of the personalities used on the ‘old wall’ ranged from 25 to 93:
- Dizzie Rascal 25
- Noel Gallagher 43
- Tim Westwood 53
- Sharon Osbourne 58
- Anne Robinson 66
- Robert De Niro 67
- Clint Eastwood 80
- Bruce Forsythe 82
- Kirk Douglas 93
What happens to us when we get old?
This component of the session used simple graphics to illustrate some common effects of ageing. In particular, the decline in capability was demonstrated as a consistent downward trend in performance in various areas, as shown in Figure 2.

Why is 65 classed as old?
Students were then given information as to why the age of 65 was considered the point at which old age was considered to commence. This related to it being the point at which humans start to show physical and mental characteristics associated with a long life. Examples including dexterity and visual capability were used.

What about pathology?
The participants were encouraged to consider the effects of disease and disability associated with ageing. Examples used included arthritis and visual impairment, such as macular degeneration, as shown in Figure 3.
Old person taster session

The participants were then given the opportunity to experience the effects of ageing through the use of age simulation equipment. Each student experienced:

- Osteoarthritis simulation gloves
- Glaucoma simulation glasses
- Cataract simulation glasses
- Elderly vision glasses

The simulation tools were used in combination to undertake a number of specific tasks. These tested the visual and dexterity capabilities of the participants in their simulated elderly age. The task included:

- Operation of a timed electronic maze. The maze featured good design criteria and offered a high level of usability. The timing feature gave empirical emphasis to the effects being simulated. This activity is shown in Figure 4.

![Figure 4: Using the ergonomic maze](image)

- Using a mobile phone to write a text message and dial a randomly drawn 11 digit number.
- Undertake a timed dexterity test with a Purdue peg board, consisting of placing pins in holes as shown in Figure 5.

![Figure 5: the Purdue peg board task](image)

- Undertake a timed steadiness test where the participant holds a stylus in a range of circular holes which reduce in diameter. The participant continues until they cannot maintain the stylus in the hole for 10 seconds without touching the sides. This activity is shown in Figure 6.
Figure 6: Using the steadiness meter.

- Read a range of visual acuity test charts at a fixed distance comparing compromised and uncompromised vision states, as shown in figure 7.

Figure 7: Impaired reading activity.

Reflective discussion
The simulation activities were followed by a reflective discussion exploring any changes in attitudes and predicting revised design criteria that may have resulted from the workshop. This was undertaken in a semi structured fashion with the host offering the following prompts:
- How do you feel about old people?
- What is it like to be old?
- What problems did you experience?
How can we design products so that the ageing population doesn’t have to suffer these problems?

**Why design is important**
The final component of the workshop briefly addressed the need for inclusive design in helping users cope with everyday tasks. Two key graphics were used to show how reduced task demand through better design can better match user capabilities and hence reduce exclusion. The images used are shown in Figures 8 and 9.

![Figure 8: The role of good design in reducing task demand](image)

![Figure 9: How exclusion occurs in product use](image)

**Results**
The results can be broken down into several sections following the workshop activities.

**Initial survey**
The initial survey revealed that the perception of old covered a wide range of ages, but that old age was generally considered to start at about 50 years (Table 1).
Table 1: Pupils definition of 'old' and 'well old'

<table>
<thead>
<tr>
<th>Group</th>
<th>Old</th>
<th>Well Old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age range</td>
<td>50 – 80 years</td>
<td>80 – 100 years</td>
</tr>
</tbody>
</table>

What is well old - The old wall
The 'old wall' revealed that whilst the participants were relatively consistent in their judgements of age, those perceived ages were coloured by the roles performed by the celebrities. Hence Tim Westwood, a youth orientated DJ was consistently ranked as younger than Noel Gallagher whose music was considered more mature. Most confusion arose around the middle age category where physical appearance seemed to be the overriding factor. Example responses to the 'old wall' are shown in Figure 10.

![Figure 10: Example 'old wall' responses](image)

What happens to us when we get old?
The participants demonstrated fairly conventional stereotyping of the elderly when first questioned about the characteristics of old age. Typical responses were given as:

- Wrinkly
- Hard to walk
- Deaf
- Pains
- Blind
- Protective
- Grey hair
- Smelly
- Die

These are exclusively negative and reflect a poor perception of the value of old age.

Reflective discussion
Having completed the simulation tasks, perception of old age rapidly changed. Responses were far more sympathetic and understanding. Participant comments in response to the spoken prompts are recorded below:

a) What do you feel now about older people?

- Feel sorry for them
- Harder to do things
- Understand a bit better
- More sympathy
b) What’s it like to be old?
- Bad
- Uncomfortable
- Not fun
- Irritating
- Can’t see
- Want to cry
- Horrible
- Frustrating
- Hard
- Every day challenge
- Complicated
- Painful
- Not nice
- Annoying
- Difficult

c) What problems did you experience?
- Couldn’t see pins
- Hard to press buttons on maze
- Everything was back to front
- No movement in wrists
- Couldn’t see anything
- Felt very frustrated
- Hard to pick up pegs for the pegboard
- Couldn’t see detail on charts with glasses
- My hands hurt
- I couldn’t move fingers
- Everything was stiff

d) How can we design products so that the ageing population doesn’t have to suffer these problems?
- Design ideas
- Easy to press
- Machine does things for you
- Big bold writing
- Food out of date – grey can’t be read
- Big fonts
- Brighter colours
- Eliminate fine movements
- Bigger grips
- Bold designs
- Big arrows for controls
- Make things less complicated
- Make movement easier
- Make grips easier
- Bigger buttons

The design solutions were the most marked attitudinal changes. These demonstrated that not only had the participants gained insight into the capabilities and limitations of the older user groups but were capable of devising design solutions which would help overcome those barriers. Whilst the solutions suggested might not be particularly innovative, students at Key Stage 3 and 4 were capable of drawing on design features in the marketplace and filtering suitable examples into appropriate applications for elderly users.

Conclusions

This programme of activity, whilst not a scientific study, intended to establish whether young designer’s attitudes towards designing for older adults could be changed by exposure to information presented in an accessible, relevant form. The participant’s perceptions of old people on the arrival at the workshop was universally negative, often ranging into derogatory. Through the use of simple educative tools and simulation activities those perceptions were challenged and reversed. First-hand experience of the limitations of later life rapidly led to consistent and viable design solutions.
All of the participant’s who attended the sessions found them engaging and worthwhile with keen contribution and discussion demonstrating that old age does not have to be mundane or depressing. The enthusiasm of the students for the subject once they had the opportunity to experience life as an elder was reflected in their ambition to change product design to help accommodate the needs of their relatives.

Although lacking in depth, this activity demonstrated that inclusive design can permeate the agenda of young designers and that the value and benefits can be acknowledged. It requires a longitudinal element to quantify whether the knowledge gained results in long term attitudinal shift and further funds are being sought to enable such a study to take place.

References

INTEGRATING STYLE WITH FUNCTION THROUGH EMOTION DRIVEN DESIGN and creating breakthrough products to enhance independence for individuals with disabilities

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Abstract

All of us do things everyday that we simply take for granted such as opening and closing a door, walking, talking, picking up objects, playing and just enjoying life. For many individuals with disabilities, these tasks are only possible through technology. Wheelchairs are examples of products that, to some degree, have an unpleasant emotional impact. They are often designed based on funding mechanisms and not taking into account use preferences and emotions. Through a collaborative partnership with the University of South Florida’s College of Engineering, Rehab Ideas was formed to create an unlimited pipeline of ingenious products that currently don’t exist. Examples of these products include a kit to slide a wheelchair sideways, a kit to allow wheelchairs access the beach or parks and a device to retrieve their backpack from behind the wheelchair to the side. Accessories for wheelchairs are not viewed as a “cool” consumers products. Rehab Ideas intends to change this paradigm by bringing to market innovative, useful and aesthetic products that will provide independence, mobility and respect to people with disabilities. Rehab Ideas is approaching this mission with the intent of thinking outside the box of the current industry norm from a medical-reimbursement model to a consumer driven model.

Keywords
Emotion driven design, mobility, wheelchair design

The most recent two decades have certainly seen the progress in the modern wheelchair. They are lighter and perform better than ever before. There are now many possibilities available to improve the ride, from suspension systems, which help to remove vibrations and jolts, to ultra-light weight frames, which enable better performance. The recent trend is towards wheelchair customization. Customized wheelchairs are now being requested for many reasons, most importantly for expressing
Creating products for individuals with disabilities is a true test of design skill. It takes empathy, ingenuity, and research. Apple is widely celebrated for making devices as easy to use as they are elegantly designed. What customers probably don’t know is that some of these features aren’t exactly new—they evolved from software Apple created to help individuals with disabilities access computers. Among them: the new iPhone’s voice control option, which allows users to speak to their handsets to prompt an action. And "mainstreaming" tools for the disabled is spreading. Software developer Nuance Communications, for instance, invented voice command technology to help people who are unable to type on a computer. Today, the company's algorithms are used in products ranging from Amazon.com's latest Kindle e-reader to cars from Ford. "Companies could look at designing for accessibility as a sales opportunity. Most features that are accessible for the disabled have great value to everybody," says Donald A. Norman, a former Apple vice-president for advanced technology who heads a joint business and engineering program at Northwestern University.

At Google, a deaf software engineer, Ken Harrenstein, spearheaded the creation of a captioning tool for videos posted on Google's YouTube site. His original intention was to help deaf users. But the company soon figured out the software could also help translate languages. That idea led in late 2008 to an auto-translation tool that allows people to add captions in 50 languages instantly to YouTube videos they upload, increasing the number of people who can watch and understand the clips.

Mattel is taking mainstreaming into the toy market. They recently released Mindflex, an $80 game that borrows from technology used by individuals with severe disabilities to control electronic devices by channeling brainwaves via sensors. Mattel has licensed the toy's brainwave-harvesting technology from a San Jose company called NeuroSky. To play, users put on a headband with sensors. By focusing their thoughts on motion, they can cause a motor to propel small plastic balls through a tabletop obstacle course. When they relax, the objects stop moving. www.neurosky.com

As pioneers boost sales by incorporating technology once confined to products for individuals with disabilities, other companies are sure to follow. They could come out ahead, says Tim Bajarin, president of technology consultancy Creative Strategies in Campbell, Calif. "It's smart, because there is an aging population that will need easier-to-use tech. It's even smarter to follow Apple's lead—and then call these features out and get people's attention. Then it becomes a competitive advantage."

The University of South Florida(USF) Capstone Design Course and the Center for Rehabilitation and Technology have collaborated to provide USF students with an outstanding Capstone Design Experience. Many of the prototypes that the students have developed are wonderful innovations. The USF Office of Patents and Licensing evaluates the projects and has received patents on several of the designs. The next step is to commercialize the most promising designs. A new approach, forming a development company, has been taken by USF and will be discussed here.
The Capstone Design course is a one semester, 15 week, class, which is organized into two sections of 25 to 30 students in each section. This scheduling allows 100 to 120 seniors to take Capstone Design each year. The course is exceptional in that it works with the Center for Rehabilitation Engineering and Technology, and the Center supplies suggestions for the projects. The Center suggests projects that they have collected throughout the State of Florida to improve the quality of life and/or the work life of people who need assistance or have some wishes or dreams that they cannot accomplish without assistance. The student teams can also develop a project definition from their own ideas. During the 2006-07 academic year there were 21 teams, and the total cost for parts, machining, and materials was about $10,000. The co-instructor from the Center has the industrial contacts to schedule guest speakers, the expertise to give some lectures, and the authority to approve the monetary expenditures for the parts and equipment from the budget of the Center for Rehabilitation Engineering and Technology. He also has excellent contacts and invaluable expertise in the rehabilitation industry. The student teams must work together. To do the required parts of the engineering design processes they must develop teamwork skills. The teams must begin by selecting a need to address, then clarify their project definition complete with specifications. Then the teams search for different concepts, evaluate the concepts, select a concept, bring the design to form during the embodiment design phase, detail the design, draw the parts and take them to the machine shop, find, specify, and order commercial, and then assemble the prototype. Of course, they must also write a report and make a professional presentation. All of this is completed in a fifteen-week semester. As they do this, they submit individual assignments, learn to work as a team, develop their design, and learn about the engineering design processes.

A new company, Rehab-IDEAS (Institute for the Development of Engineering and Assistive Solutions), was formed in 2006 within the Center for Rehabilitation Engineering and Technology. Rehab IDEAS was formed by one of the instructors of the course. The new company and the USF Patent office signed agreements to license the products. The purpose of this company is to develop the Capstone designs and bring the resulting products to the marketplace. Rehab-IDEAS also needs manpower, so some members of the student teams are employed to work on developing the products.

After evaluating many of the Capstone Design devices developed by the students, five designs stood out. It was decided to try to develop these five prototypes into commercially viable products. These five products are: (1) Backpack Retriever, (2) Folding Tray, (3) Off Road Wheelchair Kit, (4) Folding Crutch, and (5) Sideways Wheelchair Kit. Examples of these products and designs are described below.

The Back Retriever is a mechanism that takes a backpack or briefcase from the side of a power wheelchair to the back of the chair. This is helpful, because with the backpack on the side of the chair, the wheelchair can’t fit through doors.
The Folding Tray is a table for wheelchairs. The table folds into the arm of the wheelchair for storage and unfolds to provide a surface for taking notes or eating. This device makes it much easier for students to take notes and to eat lunch.

The Off Road Wheelchair Kit is a beach and rough terrain platform that allows a person in a power wheelchair to explore rough terrain. The power wheelchair drives up a ramp onto the platform and puts the drive wheels of the wheelchair on two rollers. These rollers then operate the flotation tires that then drive the platform (with the wheelchair and operator aboard) on a ride on the beach.

Although there were other wonderful prototypes, these five seemed like they would have the best possibility of success. Success, for Rehab IDEAS is achieved when the device has been developed and shown to be commercially viable, and then a company licenses the intellectual property to produce the device. The support of the USF Office of Patents and Licensing is essential to the success of this venture. Students submit their final reports along with a disclosure form to the Office. For those projects that have merit, a provisional patent application is filed. The students and the USF Office of Patents and Licensing develop a formal agreement and the device is offered to companies so that
they can commercialize the products. Recently the university has also encouraged students to undertake entrepreneurship opportunities by creating a business plan competition.

Other interesting products that came out of the course include a hands free wheelchair that was developed in collaboration with the school of arts.

For one of these products, the company was successful in obtaining a Small Business Innovation Research grant from the US Department of Education’s National Institute for Disability Rehabilitation and Research. Students have also been able to continue their work on these projects as graduate students and one student has also been permanently employed by the USF Center for Rehabilitation Engineering. Some of the student teams have received royalty checks. This is a great “postscript” to an exciting Capstone Design experience.

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Session 6D
Inclusive Technology
Keeping in Touch: Smartphone Touchscreens and Customers with Disabilities

Ben Lippincott, John Morris, James Mueller

Abstract

Smartphone accessibility is increasingly important to social inclusion for people with disabilities. This paper describes a comparative field study of access to touchscreen smartphones (iPhone 3G, Blackberry Storm 9530 and HTC Touch HD) by users with cognitive, manual, and/or visual limitations. The iPhone got high marks for its strong, distinctive graphics, especially for those with visual or cognitive limitations. The Blackberry Storm earned praise for its "click-through" screen which allows the user to highlight a choice before selecting it, then gives a tactile click when the choice is made. The HTC Touch HD was the only device of the three that allowed use of a stylus, which nearly all testers appreciated.

Keywords
Blackberry, disabilities, HTC, iPhone, touchscreen, universal design

Touchscreens and customers with disabilities

Communication and information access through mobile wireless technology has become a critical component of daily life to most people with disabilities [1]. In June 2007, Apple and AT&T revolutionized smartphone design with the launch of the iPhone, the first capacitive multi-touch smartphone [2]. Upon its release, wireless customers with disabilities raised concerns about inadequate access to the iconic iPhone [3] and the possibility that other touchscreen devices would proliferate throughout the market. Indeed, there was strong evidence that touchscreen interfaces in other applications (e.g., ATMs) [4] were a significant barrier for some users, particularly those with limited vision.

A number of pertinent studies had set out to document touchscreen usability. Owsley, et al. [5] studied how older adults effectively target and localize a feature on a computer touchscreen. Both Baldus and Patterson [6], and Tsimhoni, et. al. [7], measured how motion affects the accuracy of touchscreen input. These studies did not include individuals with disabilities among test participants, though their findings suggest that age, environment and situation can simulate some of the same issues individuals with cognitive impairments, low-vision, and/or hand coordination/steadiness, face when using a touchscreen interface.

Studying needs of customers with disabilities

With funding from the National Institute on Disability and Rehabilitation Research (NIDRR) of the Department of Education, the Rehabilitation Engineering Research Center for Wireless Technologies (Wireless RERC) was established in 2001 to:
- Promote equitable access to and use of wireless technologies by people with disabilities, and,
- Encourage adoption of universal design in future generations of wireless devices & applications

Also in 2001, The Wireless RERC established its Consumer Advisory Network (CAN). The CAN includes about 1,000 Americans, ages 18 years and older, with diverse cognitive, manual, and/or sensory limitations. About 84% of CAN members use wireless technologies. CAN members participate in many of the RERC’s research, development, and training projects, helping the Center maintain a strong focus on consumer needs.

Field Study

To directly address concerns about usability of touchscreens in mobile devices by individuals with disabilities, the Wireless RERC conducted a comparative field study of three smartphones (iPhone 3G, Blackberry Storm 9530, and HTC Touch HD). This study was conducted from April-June, 2009.

Thirteen study participants were chosen (5 male, 8 female) from among CAN volunteers. These 13 were selected on the basis of diversity in age and disability, including limitations in vision, manual, and cognitive abilities, as described in Table 1:

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Disability</th>
<th>Current Service Provider</th>
<th>Current Wireless Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtis</td>
<td>40</td>
<td>Manual</td>
<td>Verizon</td>
<td>Moto Silver L7c</td>
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<tr>
<td>Christie</td>
<td>68</td>
<td>Manual/Visual</td>
<td>AT&amp;T</td>
<td>Nokia 2610</td>
</tr>
<tr>
<td>Daisy</td>
<td>41</td>
<td>Cognitive/Manual/Visual</td>
<td>Verizon</td>
<td>Moto Flip Phone</td>
</tr>
<tr>
<td>Dixie</td>
<td>49</td>
<td>Cognitive/Manual/Visual</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Elayne</td>
<td>44</td>
<td>Cognitive</td>
<td>T-Mobile</td>
<td>Moto RAZR</td>
</tr>
<tr>
<td>Jaclyn</td>
<td>37</td>
<td>Cognitive/Visual</td>
<td>Sprint</td>
<td>Moto RAZR</td>
</tr>
<tr>
<td>Joseph</td>
<td>62</td>
<td>Manual</td>
<td>Verizon</td>
<td>Samsung Instinct</td>
</tr>
<tr>
<td>Maryanne</td>
<td>83</td>
<td>Cognitive/Manual/Visual</td>
<td>Jitterbug</td>
<td>Jitterbug</td>
</tr>
<tr>
<td>Martin</td>
<td>31</td>
<td>Manual</td>
<td>Verizon</td>
<td>Samsung Gleam</td>
</tr>
<tr>
<td>Mitchell</td>
<td>51</td>
<td>Manual</td>
<td>Verizon</td>
<td>LG VX 5300</td>
</tr>
<tr>
<td>Nathan</td>
<td>26</td>
<td>Visual</td>
<td>Verizon</td>
<td>LG Dare</td>
</tr>
<tr>
<td>Raina</td>
<td>28</td>
<td>Visual</td>
<td>Verizon</td>
<td>BlackBerry Curve</td>
</tr>
<tr>
<td>Rosalyn</td>
<td>51</td>
<td>Visual</td>
<td>AT&amp;T</td>
<td>Nokia 6201</td>
</tr>
</tbody>
</table>

CAN members with hearing limitations were not included, since their experiences with touchscreen interfaces would be similar to nondisabled users. CAN members with complete blindness were also excluded from testing, since the devices tested had no screenreader application to help them navigate the often complex menu structures of the
touchscreen interfaces. Note: Since completion of this study, subsequent generations of these touchscreen devices include built-in screenreader software that might allow low vision/blind users to use these products more easily, notable among them, Apple iPhone’s VoiceControl and VoiceOver settings. The applications market has also grown to include many products to increase accessibility and usability of smartphones such as those tested.

Test devices were selected with input from the RERC’s industry partners, Research In Motion (RIM), Verizon, and AT&T, who also provided the devices and wireless service during the course of the test period. These devices were among the most popular on the market at the time and represented distinct approaches to touchscreen technologies. The iPhone had already established itself as the market leader based on its capacitive multi-touch touchscreen. The Blackberry Storm (9530), also using a capacitive touchscreen, had just introduced tactile feedback to RIM’s lineup of devices. The HTC Touch HD used resistive technology, and so was the only device of the three allowing the use of a stylus. At the time of this study, third-party capacitive touchscreen styli like the Pogo, were not yet available.

Methodology

All 13 study participants used each of the devices in turn, during a 1-5 day trial based on the participant’s availability and schedule. The intent was to use the devices in as natural a setting as possible for the user. The sequence of testing devices was randomized among participants to minimize the effects of learning on the results.
but one of the study participants were already wireless customers, and 4 had some experience with touchscreen devices.

The study protocol began with a 60-90 minute orientation session at the participant's home or place of work. This orientation included “sit-by” demonstrations of the device's operation and the tasks to be performed during the trial. These tasks were intended to offer participants ample opportunities to experience the touchscreen interface in a variety of common operations. The orientation began with powering up the device, customizing the display and control options, enabling internal “accessibility” schemes if applicable to a participant’s needs, and entering data into the device's directory and calendar. Participants then tried using the phone, text, and internet capabilities of the device. For each of these operations, participants were asked to rate their initial ease of use with the device from 1 (very difficult) to 5 (very easy) in the following categories:

1. target identification
2. target activation
3. scrolling/flicking
4. text input
5. seeing/reading, legibility, eyestrain
6. understanding, intelligibility
7. sliding, dragging
8. enlarging/reducing images and/or webpages

Following the orientation session, participants were encouraged to use the device throughout their daily routines for voice communication, text messaging, and internet browsing. Since all service was free to them, they were encouraged to use each device as much as possible during this daily routine period, which varied from 1.5-5 days. This period was dependent on their schedules and their comfort level in using the device. The trial period allowed them to personalize the device to their needs, including adding contacts to the device's directory, using the calendar for scheduling their activities, and adjusting any other settings as needed.

At the conclusion of the field testing period, a 60-90 minute debriefing session was held at the participant's home or place of work. During this session, the participant demonstrated the operations explored in the orientation session and re-assessed ease of use of each operation on the same 1-5 Likert scale as before. Additional qualitative comments and observations by participants were recorded. At the conclusion of this debriefing session, the participant returned the device and was paid $100. The device was then reset, removing all personal information and returning the device to its default settings. In this manner, each participant tested all three devices. The study was counterbalanced, with approximately one-third of the participants starting with each device, and progressing through the other two in varying order.

In addition to the device's charger and user manual, a silicone skin fitting the device was offered for use during the testing period. Every participant chose to use these skins, noting concern about damaging the device, as well as the increased stability afforded, whether held in the hand or placed on a surface (preferred by most participants with manual limitations). Participants with manual limitations also noted that the silicone skins generally offered enhanced tactile indication of controls located on the exterior of the case (power, lock, volume, etc.)
Perceived ease of use for each device was assessed on the basis of both the participants' 1-5 Likert ratings and on their remarks, comments, and observations. Qualitative input was assessed through a thematic analysis technique and then compared with participants' quantitative assessments for each device.

None of the three devices emerged as a clear "winner", but each device demonstrated significant and distinct strengths and weaknesses. Also significant was the fact that these strengths and weaknesses were not specific to participants' functional limitations. This important finding belies the notion of "special design" for "special people", and supports the feasibility of design of wireless devices across a wide range of customers, i.e., inclusive/universal design.

Reflecting the abilities and limitations of the test participants, ease of use for the three devices was expressed in terms of the touchscreen's cognitive, manual, and visual interface characteristics.

Cognitive interfaces – ease of use

Analysis of users’ Likert ratings indicates a slight advantage of the Blackberry Storm's cognitive interface over the other two devices. Observations by participants with cognitive disabilities were also shared by participants without these disabilities, though generally to a lesser degree. Comparison of these data with thematic analysis of participants' comments relative to cognitive interface issues helps to illustrate the reason for the BlackBerry Storm’s advantage, while also revealing strengths and weaknesses of the three devices:

Blackberry Storm:  4.33 (mean rating)
Strengths
- Blue highlighting confirms choice before selection
- Touchscreen provides tactile and auditory feedback to user input
- SureType keyboard has powerful word predictor
- Home screen presents familiar icons, with intuitive use of color
Weaknesses
- Difficult text correction offsets word prediction of SureType keyboard
- Spontaneous, unintended re-orientation of screen from landscape to portrait

iPhone 3G:  4.06 (mean rating)
Strengths
- Graphics are clear and well-differentiated
- Applications use intuitive processes, e.g., "slot machine" wheels for setting calendar
- QWERTY keys "pop up" and enlarge when pressed
- One-button return to home screen
Weaknesses
- Confusing choice of terms for non-Mac users, e.g., “Safari” denotes web browser
- Lag in response (especially with internet) causes confusion due to repeated inputs
- Tapping on web page may either enlarge page or make unintended page selections

HTC Touch HD:  3.82 (mean rating)
Strengths
- Visual (flashing) feedback with each key selection
Weaknesses

- User confusion due to slow response to input
- Limited use of color for graphic communication
- Spontaneous, unintended re-orientation of screen from landscape to portrait
- Complex, non-intuitive task sequences not intuitive, e.g., answering phone call
- Repeated abrupt screen blackouts

Manual interfaces – ease of use

Analysis of users’ Likert ratings indicates a slight advantage of the Touch HD’s manual interface over the other two devices. Observations by participants with manual disabilities were also shared by participants without these disabilities, though generally to a lesser degree. Comparison of these data with thematic analysis of participants’ comments relative to manual interface issues helps to illustrate the reason for the HTC Touch HD’s advantage, while also revealing strengths and weaknesses of the three devices:

HTC Touch HD: 4.04 (mean rating)

Strengths

- Responsiveness of touchscreen to stylus, fingernail, knuckle
- “Slider” controls require only tap vs. press+slide

Weaknesses

- Difficulty using stylus for swiping, dragging
- Confusion due to delay in response to user input
- Inefficient graphic design results in small text, unused screen space

iPhone 3G: 3.98 (mean rating)

Strengths

- To the novice touchscreen user, the simple initial unlocking operation (“slide to unlock”) gives positive reinforcement of action to the user and reveals how other functions/applications will be enabled on the device
- Superior (intelligent) response to touch inputs
- One-button return to home screen

Weaknesses

- Glitchy slider controls for setting brightness and volume
- Keyboard available in portrait format only during testing (subsequent software update resolved this issue)
- Touch response seemed to vary among applications

Blackberry Storm: 3.87 (mean rating)

Strengths

- Blue highlight confirmed selection before activation
- Resistance of touchscreen prevents multiple inputs

Weaknesses

- “Click-through” touchscreen multiplies manual effort, causing slips/errors
- Text errors easy to make, hard to correct

Visual interfaces – ease of use
Analysis of users’ Likert ratings indicates a slight advantage of the iPhone’s visual interface over the other two devices. Observations by participants with visual disabilities were also shared by participants without these disabilities, though generally to a lesser degree. Comparison of these data with thematic analysis of participants’ comments relative to visual interface issues helps to illustrate the reason for the Apple iPhone’s advantage, while also revealing strengths and weaknesses of the three devices:

iPhone 3G: 4.18 (mean rating)
Strengths
• QWERTY keys "pop up" and enlarge when pressed
• Strong graphic icons and use of color
• Browser allowed extreme zoom for page magnification
Weaknesses
• Fingers obstruct view of screen while making selections
• Some icons and labels very small, e.g., state of battery charge

Blackberry Storm: 4.10 (mean rating)
Strengths
• Blue highlight emphasizes choice
• Choice of enlarged font works across most applications
Weaknesses
• Reversing screen contrast only partially useful
• Fingers obstruct view of screen while making selections
• Lock button very difficult to locate

HTC Touch HD: 3.93 (mean rating)
Strengths
• Visual (flashing) feedback with key selection
• Use of stylus maximizes view of screen
Weaknesses
• Limited use of color
• Smaller graphics on keyboard very hard to see
• "Backspace" and "return" icons are easily confused
• Linear display of applications prevents seeing all on one screen

Text input – ease of use

Text messaging is an increasingly popular form of wireless communication among both the general population and among customers with disabilities [8]. According to CTIA, The Wireless Association, text messaging has more than doubled every year; 2006: 156.8 billion messages, 2007: 362.5 billion messages, 2008: 1.005 trillion messages [9]. Because of this increasing importance and its dependence on the effectiveness of the touchscreen's cognitive, manual, and visual interface, the test protocol assessed this operation specifically.

Due again to the responsiveness of its resistive touchscreen to the stylus and a variety of other input devices, the Touch HD demonstrated superior ease of use in text input. The subsequent availability of after-market capacitive touchscreen styli like the Pogo reinforces these findings, i.e., capacitive touchscreen device users desire similar precision and accuracy as on resistive touchscreen smartphones operated by styli.
HTC Touch HD: 3.86 (mean rating)

Strengths
- Keyboard usable with stylus, fingernail & knuckle
- Use of stylus allows unobstructed view of keyboard

Weaknesses
- Selection of enlarged font doesn't apply to text display
- Smaller graphics on keyboard very hard to see

iPhone 3G: 3.62 (mean rating)

Strengths
- QWERTY keys “pop up”, enlarge, and click when pressed

Weaknesses
- Keyboard available in portrait format only during testing (subsequent software update resolved this issue)

Blackberry Storm: 3.27 (mean rating)

Strengths
- SureType keyboard has largest keys of devices tested
- QWERTY keyboard in landscape mode easiest to see of devices tested

Weaknesses
- Difficult text correction offsets effective word prediction
- Excessive pressure required for key input causes fatigue
- Correcting text errors easiest by backspacing to error, but eliminates correct text in its path

Internet browsing

For most testers, internet browsing proved the most challenging task of this study. Some were unable or too frustrated to complete this task. Although this yielded insufficient usability ratings data, useful observations were gained across the three devices:
- Previous experience with internet browsing via desktop computer exacerbated confusion and frustration (e.g., unfamiliar navigation techniques and unfamiliar appearance of often-visited web pages).
- Lags in response to user input caused frustration and confusion; an “hourglass” or other familiar icon, plus audio feedback, would advise user that the device is active.
- Double-tap method of web page enlargement sometimes resulted in unintended selection (compounded by lag time, resulting in multiple inputs).
- Because mobile browsing is so functionally challenging, service interruptions compounded users’ frustration.

Discussion and implications for industry

This field study revealed both strengths and weaknesses inherent in the contemporary touchscreen smartphones tested. Given that touchscreen interfaces “are our future” in mobile wireless devices (Loftus, 2009)[10], developers and manufacturers would do well to keep some specific findings in mind:
1. Especially among novice users, successful initial experiences (e.g., iPhone’s “swipe to unlock” following power-on) reduce intimidation and encourage users to take advantage of the increasing capabilities of smartphones.

2. Since usability suffers without successful initial setup (e.g., enlarging fonts, increasing display brightness, boosting audio volume), ease of completing this operation is critical. The Blackberry Storm’s presentation of an introductory tutorial, or wizard, upon first powering up the device is a step in the right direction.

3. Very small controls, often recessed into the devices’ surfaces and edges and lacking strong visual and/or tactile contrast, can reduce users’ abilities to locate and activate controls. Optional handset skins offer considerable potential to enhance usability (e.g., securing grip & adding stability on surfaces, tactile locators for exterior controls) for users needing these aids, without sacrificing aesthetics of the device.

4. Because users with manual limitations often have difficulty with opposed movements, concerted effort should be made in designing for top/down (of the physical device interface) activation of buttons, as opposed to side/in activation of buttons along the narrow edges of the device.

5. The apparent advantages of resistive touchscreens (e.g., HTC Touch HD) for users with significant manual limitations should be considered as touchscreen development continues.

6. The proliferation of downloadable applications for smartphones has brought with it opportunities for increasing usability and accessibility by enabling each user to customize his/her device. The Wireless RERC is among those organizations offering a directory of these applications, as well as demonstrations of several, through its consumer forum, MyWirelessReview.com: http://www.mywirelessreview.com/accessible-apps-corner

Limitations of this study

The specified minimum duration of each test period was a compromise between available resources and optimum familiarization with the device. For those willing to extend the test period (without additional compensation), considerable latitude was granted in where the devices were to be used and the test duration. For example, one participant was granted permission to take the device along on a 3-day holiday. This naturally offered her greater opportunities than other participants to learn how to use it. However, all participants received identical orientation to each device, including ample opportunities for questions. Indeed, participants were contacted throughout each test to identify and address usability issues as they arose.

Though the team of participants included only 13 members, these individuals represented great diversity, not only in functional abilities, but also in wireless experience. This diversity was instrumental in considering the impact of touchscreen design on the general population of people with disabilities. At the same time, it should be noted that children with disabilities were not included in this study. This issue will be addressed in future user research by the Wireless RERC.

References


Acknowledgements

This project was made possible by the National Institute on Disability and Rehabilitation Research (NIDRR), United States Department of Education, under grant number H133E060061 to the Rehabilitation Engineering Research Center for Wireless Technologies (Wireless RERC), Georgia Institute of Technology and Shepherd Center. The opinions contained in this paper are those of the authors and do not necessarily reflect those of the U.S. Department of Education or NIDRR.
The Wireless RERC gratefully acknowledges the donations of equipment and service by the following companies for this research: Research In Motion (Devices: HTC Touch HD & Apple iPhone); AT&T (Service: HTC Touch HD & Apple iPhone); Verizon (Devices & Service: Blackberry Storm 9530).
Designing in social benefits

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Abstract
It is a widely recognized fact that population ageing is progressing rapidly and this phenomenon is expected to continue in the next decades. The resulting demographic change is the driving force behind many current design challenges, including social isolation and loneliness which the older population is prone to. Although Inclusive Design has traditionally focused on enabling people to live independently, it seems that there are benefits to be gained from promoting social interaction through design. This paper details the results of a study of older adults' experiences with technology, particularly during the very early stages of interaction known as Out-of-Box Experience, from product acquisition through to first use. The Technology Biography method was adapted and conducted among twenty-four participants, grouped into 50-64 years old, 65-75 years old and over 76 years old. The findings indicate that even though older people value being able to perform tasks for themselves, they often enlist others as a means to engage in social interaction. This has strong implications for Inclusive Design, as designing social benefits into product experience could encourage the uptake of technology among older adults.

Keywords
Older adults, technology, user experience, social benefits

1. Introduction

Considering current demographic trends, with more people living longer and healthier lives, and technology infiltrating all aspects of modern life, a growing body of research has been looking into making technology useful to and usable by older adults. Older people are often late adopters of new technology and factors like computer self-efficacy and computer anxiety play a significant role in hindering technology adoption [1], but if the benefits outweigh the costs, many older people will invest the necessary time and effort to learn new skills [2].

When designing for today's diverse population, it is important to acknowledge that people's experience of technology is broader than the more objective usability goals of how useful or productive it is. A positive user experience occurs when technology fulfils more than just instrumental needs, by acknowledging its use as a subjective, situated, complex and dynamic encounter [3]. Even though designers cannot guarantee a particular experience, a sensitive understanding of the target users, their needs and
motivations to use a product or service enables designers to influence the user experience through design [4].

IBM extends the scope of user experience design to include the user’s initial awareness, discovery, ordering, fulfilment, installation, service, support, upgrades, and end-of-life activities (cited in [5]). This definition clearly emphasizes the importance of peripheral experiences associated with the actual interaction between the person and the product or service, many of which are addressed by the Out-of-Box Experience (OoBE). Specifically, the OoBE refers to the very early stages of a user’s interaction with a new product, from purchase decision to unpacking, set-up or installation, configuration and initial use [6]. Failure at this stage can negatively affect perception and acceptance of a new product.

There is evidence to suggest that only 33% of older computer owners choose them themselves, with the majority relying on friends or family to choose for them; 16% of older adults obtained their computer over four years ago and 28% had acquired second-hand models [7]. Furthermore, older adults experience the greatest problems with overly complicated applications and documentation [7] and may require custom-tailored support for proper installation routines [8].

In order to encourage successful adoption of technology by older adults, it is necessary to further understand the context in which these Out-of-Box Experiences occur. This is the focus of the study presented in this paper.

2. Methodology

The aim of this study was to obtain a more empathic insight into older people’s use of technology; a method that would provide an engaging way of creating a dialogue between the researcher and the participants was therefore required. For this reason, Technology Biography [9] was chosen and adapted to suit the purpose of this study.

This method combines various elements which can be tailored according to the aim of the research [9]: Technology Tours, where participants show the researcher round their home and answer questions about their use of technology; Last Time questions which are adapted from the critical incident method; Personal History interviews focusing on technology and routines that participants remember from the past; Guided Speculation on possible future developments; and finally cultural probes adapted to elicit Three Wishes for products that participants would like to see. An integral characteristic of Technology Biographies is that they must be conducted in the participant’s home, therefore ethical protocols with regard to interviewing older people in their own homes were observed and all procedures were approved by Loughborough University’s Ethical Advisory Committee.

The first stage of this study involved a semi-structured interview about the participant’s feelings when acquiring and using new technology in general. Participants were then
asked to show the researcher a technology product from each of the following categories: most recently acquired, favourite and least favourite. For each product, participants were asked about how these products were acquired, their expectations and the context of use. This element of the study was adapted from the Last Time questions and Personal History [9].

As with the original Technology Biography method, the next step was a technology tour of the house. Here, the participants show the researcher around their home and discuss the technology present in each room. Finally, the Guided Speculation [9] section of the study focused on understanding what products people don’t currently own but would like to and why, and the benefits they expect technology to have in the future.

The familiar feeling of showing a person around their home and the informal nature of this method was an effective way of eliciting rich information, encouraging participants to share both negative and positive stories about their relationship with technology. Overall the participants were enthusiastic about engaging in the research, though two participants were unable to complete the technology tour element of the study due to health and mobility issues. This, along with the necessary intrusiveness of entering participants’ homes, is a factor to be considered when selecting Technology Biography as a research method.

3. Results

A total of 24 people took part in this study. The sample was divided into three categories, with 8 participants in each: people aged 50-64, people aged 65-75, and people over the age of 76. All participants in the 50-64 and 65-75 age groups were interviewed individually. However, in the over 76 age group, six participants had their spouses present during the collection of the data and therefore spouses often participated in the dialogue.

Subject to participants’ consent, the Technology Biographies were recorded in audio format for later transcription. In some cases, photographs of technology products and their context of use were also taken. The results were analysed and interpreted using open coding and thematic analysis [10].

One of the main themes to emerge from this study was the importance of other people in older adults’ experiences with technology. Responses indicate that family, friends and other third parties such as sales assistants play a significant role in the following elements of older people’s interaction with technology: means of acquisition, reason for acquiring, unpacking, set up, use, benefits, barriers and coping strategies.

The involvement of other people during each element of older people’s interaction with technology is illustrated in Figure 1.
Figure 1: The involvement of other people in older people’s experiences with technology.

3.1 Sharing experiences: examples from the data
There was consensus among the participants that they do buy the technology that they are interested in having and using. However, the decision to acquire new products is strongly influenced by other people, in particular family and friends. This theme appeared across the three age groups, but was most prevalent in the over 76 year olds:

“Talking with my family the advice was ‘You need a computer’, so I got one.” (Male participant, over 76 age group)

Throughout the age range, choice of what product to purchase or product specifications usually had input from a third party like a relative, close friend or sometimes from shop assistants. And in some cases, such as the example below, this role was extended to the actual purchase of the product:

“(The computer) was ordered by a friend who knows these things. It was ordered online, it was delivered to me, it was charged to my card.” (Male participant, over 76 age group)

Once they have acquired the new product, most participants said they would avoid unpacking and setting it up themselves. Three main reasons were given for preferring someone else to unpack and install new products. Firstly, there was the belief that the
participant would not be able to do an adequate job and relying on someone else would ensure the process was done quickly and capably:

“I got my son to sort it out. I knew what I wanted to be able to do, but it would have taken me a lot longer and probably I’d have messed things up and got annoyed. I reckon that we all have things we can do, and like doing, and we should do those and get other 'experts' to do their things!” (Female participant, 50-64 age group)

Another reason was related to people’s coping mechanisms when dealing with an unfamiliar device. In these cases, having someone else present for the installation of new interactive products serves as a way to learn about unfamiliar devices and build confidence about using them. One participant stated:

“When we buy something new, setting it up is something we would normally avoid. Something major like a computer and a television, we would be prepared to pay to have somebody do it so I could ask questions and learn how to use it.” (Female participant, over 76 age group)

Finally, some participants mentioned the social benefits they gained from recruiting other people to assist them with new products. Older participants living on their own or couples whose children had moved away saw the process of setting up a new product as a chance to engage in social interaction, usually with family members.

“It's not selfishness, I like my family to feel they are needed.” (Male participant, over 76 age group)

4. Discussion

4.1 The social Out-of-Box Experience

A strong theme which emerged from the data analysis was the role of social benefits in older adults experience with technology. Focusing specifically on the Out-of-Box Experience (OoBE), participants mostly agreed that they prefer someone else to set up or install a new device whenever possible. Even the initial decision to purchase a new product was heavily influenced or actually instigated by a third party.

Contrary to what might be expected, these attitudes were not necessarily influenced by ability since a number of participants who considered themselves capable with technology had the same view. Figure 2 categorises participants based on ability and the desire for social engagement during the early stages of interaction with a new product.
Three main reasons were given for preferring to have company during the OoBE. Firstly, some participants mentioned that other people would set up the product faster and more effectively; this reason relates to issues of computer anxiety and self-efficacy beliefs already identified in the literature [1]. This type of response occurred across the range of ability to use technology, but was prevalent among Social Beginners who are less familiar with technology.

A second reason given by Social Beginners, but also by Social Experts, was that the presence of another person gave them an opportunity to learn by observing the process and asking questions. In this case, it is clear that the presence of another person is a mechanism for learning how to use an unfamiliar device but it also serves a deeper purpose. Having someone present during the early stages of interaction with a new product is a confidence building strategy, particularly for people who may have some degree of computer anxiety but have a strong desire to learn, too.

Lastly, participants identified as Social Beginners and Social Experts said that acquiring a new technological product provided them with an opportunity for social interaction. Participants who cited this reason had positive feelings towards sharing their experience, and generally did not feel burdensome when recruiting someone else to take part. The sporadic nature of the OoBE serves as a good excuse to spend time with other people and it is likely that people would not ask others to participate in more frequent, routine activities.

4.2 Problem solving

When barriers are encountered, two styles of coping strategies were identified in this study. On one hand, participants took action to overcome the barrier to their use of a given product. One participant in the over 76 age group said that he borrowed books
from the library or from family members to help him overcome problems with the computer. Another example of this approach is the labelling of cables on a device to enable them to be disconnected and easily reconnected, as can be seen in Figure 3.

![Figure 3: Back of a stereo with a label system devised by the user (male participant, over 76 age group) to remember how to reconnect the cables.](image)

On the other hand, participants mentioned coping with the emotions generated during interaction with technology without necessarily addressing the cause of their problem. Again other people were key participants in older people’s coping strategies, to provide both technical support with the problem and emotional support in a wider context. This twofold approach to problem solving is similar to that identified in a study on food packaging, which further highlights older people’s desire for social engagement during their interaction with products [11].

An obvious downfall of engaging others to interact and solve problems with technology is the risk of becoming dependent. Participants who could rely on someone else to interact with technology would sometimes not bother even to learn how to do things for themselves. This theme occurred across the age ranges but was more prevalent in the over 76 age group, especially in married couples. For instance, one participant mentioned the case of one of his friends who was a keen gardener; his wife had catalogued all his seeds and planting system on the computer but, since she had recently passed away, he was unable to make any sense of his gardening system and had given it up as a result. And with increasingly more older adults living by themselves, having someone present during the first stages of interaction with a new device is not always going to be practicable.

Even so, given the choice, older adults’ often decide to involve other people in the various stages of their interaction with new technology. On the surface, this finding seems at odds with the essence of Inclusive Design, which has always been an advocate for independent living. Yet maybe the problem lies with how ‘independence’ is
defined – usually taken to mean a lack of reliance on others – and how it is actually perceived by the older population [12]. As society changes, there is a need for the traditional concepts of Inclusive Design to be revised and redefined according to the current reality [13, 14].

5. Conclusions and further work

A person’s dignity is deeply rooted in independence. Older people value being able to make their own decisions and perform tasks for themselves. Nevertheless, findings from this study reveal they often enlist other people during their initial stages of interaction with new technology. This hints at a disparity between the definition of ‘independence’ traditionally assumed in the Inclusive Design literature and older people’s own perception of ‘independence’.

As traditional assumptions from the Inclusive Design literature are being challenged and the concept of Inclusive Design evolves to address the ever-changing realities of today, it is important for researchers and designers to ask themselves whether they are fully catering for modern day wants and needs. Designing social benefits into the Out-of-Box Experience could encourage the take up of technology among older adults.

Future studies are planned to further understand what factors influence older people’s need for social engagement during their interaction with technology, and what the implications for design are. The focus of the next study will be to determine how older adults perceive independence, dependence and interdependence. Findings from this study will inform how design can promote older people’s feelings of independence in the context of their interaction with new technology, even when (inter)dependence is required or desired.

References


An Inclusive Interface for Electronic Devices: a Proposal

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Abstract
Evolving technology (e.g., voice recognition, speech synthesis) makes it possible for any electronic device to be thoroughly inclusive. One problem, though, is that the availability of inclusive options remains haphazard. This paper proposes a universal interface to standardize access to inclusive alternatives. It proposes three alternative “modes”, to address, respectively, vision, audition, and dexterity disabilities. The paper discusses possible features to be included in these modes and options for a standardized method of accessing them. Such standardization would have two key advantages—(1) Allowing anyone to use it effectively without having to go through an elaborate setup function, so that people with disabilities would not be restricted to use of their own dedicated devices and/or require someone else to set them up, and (2) Encourage device makers to provide more inclusive products, since the universal interface would “demand” to have appropriate features associated with it for the three alternative modes. The paper provides examples of how the modes might work and suggests three alternative universal interfaces. One point is that the modes would not be exclusively for people with disabilities, but would be useful when conditions make vision, audition, or physical manipulation difficult.

Keywords
Inclusive design, universal design, user interface, disabilities, visual impairment, hearing impairment, dexterity impairment, interaction design, interface design, universal interface.

Introduction
Historically, there have been two separate product-development streams for digital/communications technology—one for the mass market and a separate one for specialized devices for people with disabilities. One results in products that are relatively low-cost and relatively well designed; the other in products that are extremely costly and relatively poorly designed. A good example of the latter is provided by telecommunications devices for the deaf (TDDs). These are devices that allow hearing-
impaired users to communicate with text via telephone lines. They illustrate the drawbacks of such dedicated assistive technology. The deaf user and anyone that he or she communicates with have to acquire specialized devices—historically teletype-like machines with keyboards and built-in display screens. This means that the disabled user and all those with whom he or she communicates (or some third party who bears the cost) have to incur a significant cost, and that the users can only communicate among the isolated set of people who share compatible devices. We can debate the quality of the design, but, at the least, we can say that such devices are unlikely to reflect the sort of design trends that consumers have come to expect.

From a societal point of view, the difficulty is that, unlike with mass-market devices, the sales volumes for assistive devices cannot cover the development costs, so such devices require strong financial support from the public sector for their development, even when the sales prices of the devices are significant. Inevitably, this means that, in addition to a difference in the sophistication of the design qualities, assistive devices cannot be characterized by regular introduction of new products with the latest technology.

The good news, however, is that there is hope for the convergence of the two development streams—the mass market and the “assistive” market. Features that can make a big difference to people with various types of disabilities, such features as voice synthesis, character recognition, and voice recognition, have become dramatically more affordable and dramatically more effective. It follows that it does not seem unreasonable to suggest that such features might be built into virtually all digital devices. A further argument for such inclusion is that assistive technologies would benefit all users under certain circumstances. Synthesized speech, for example, would be useful whenever it is difficult to observe a display—in bright light, perhaps, or while performing a task that requires visual monitoring. On the other hand, voice-to-text would be useful in a noisy environment where sounds are difficult to hear.

The situation, at present, however, is that:

1. Inclusive features, rather than being universally included, are haphazardly included—that some are included in some devices rather than all included in all devices, and
2. There is no standardization regarding how such features are accessed.

These facts mean that the person with one or more disabilities has to figure out how to use each new device, effectively limiting use to his or her own devices. A person who does not require assistive features can easily use the computer at the hotel business center or borrow a cell phone when his or hers needs to be recharged. The person who has to use, say, a text-to-speech feature with a new device has to first struggle to determine if the feature is available at all and, if so, how to obtain access to it.

This line of thought leads to a proposal—a universal interface that provides access to assistive features. What follows is, of course, only a conceptual proposal, one that is not fully developed. Our hope, though, is that it will stimulate discussion of this idea of a universal interface, a discussion that will eventually lead to implementation of some version of it.
Modes

Our proposal begins with the idea that all electronic devices have four modes, as follows:

1. Visual
2. Hearing
3. Dexterity
4. Default

The default mode would be akin to the standard interface of present devices. The other three modes would have features to address those with the relevant disabilities, or, as discussed above, situations where assistive features would be helpful—e.g., the visual mode when the eyes are not free, the hearing mode for noisy environments, or the dexterity mode when the hands are not free.

A logical requirement is that devices should allow setting or more than one mode at a time, for people with multiple disabilities, or particularly restrictive environmental conditions.

What follows are some thoughts on the features that the three assistive modes might contain.

Visual

The visual mode would provide tactile feedback with devices such as i-Phones and i-Pads that rely on their visual displays to identify controls, and would contain features such as scroll-over voice annunciation that speaks aloud the option that the user is currently touching. For devices other than touch screens (e.g., PCs), a mode with built-in screen-reading software would eliminate the need for third-party screen readers (e.g., JAWS, Victor Reader Stream, Non-Visual Desktop Access) that can be expensive. The relatively recent availability of open-source screen readers suggests the feasibility of making them universally available, as does the fact that most Apple devices now come standard with built-in screen-reading features.

A more complicated functionality is the ability to read and display Braille. It is difficult to see how, at present, devices such as RefreshaBraille, that offer Braille input and output, could be made standard equipment for all devices. A possible alternative, in such a case, is to assume that the user would bring his or her own Braille device and to make sure that use of the device articulates as seamlessly as possible with the Braille device.

A list of possible features for the visual mode includes the following:

- Voice-guided and spoken menus
- Easy adjustment of font size and contrast
- Control of annunciated reading speed
- Simple cursor movement to the top/bottom
- Keyboard shortcuts
- Arrow-key navigation
- Speech input for cursor control
- Seamless articulation with Braille input/output devices
Hearing
The availability of text messaging and e-mail make life much easier for those with hearing impairments. Most electronic devices do not rely heavily on auditory signals, but still contain some that require an alternative output mode, such as vibration of something akin to closed captioning, for hearing-impaired users. What is often missing, but widely available as a service today, is voice-to-text, which allows the deaf user to receive voice messages or to follow telephone discussion via a text presentation.

Perhaps the analogous device to Braille readers for people with hearing disabilities are devices that read sign language, typically via video capture. As with Braille readers, the feasible approach would appear to be to assume that the hearing-impaired user will have his or her own device and to provide seamless articulation with it.

Hearing-related features might include the following:

- Voice-to-text
- Text-to-voice
- Vibratory output for navigation and, particularly, for alerts
- Screen or icon flashing to replace sound output
- Activation of Bluetooth connections for assistive listening devices, etc.
- Closed captioning
- Priority status for chat/video relay services
- Simple articulation with hand-tracking software that translates signs into text or voice output

Dexterity
While there are many different types of dexterity-related disabilities, virtually all of them would benefit from hands-free features that would also benefit all users under a variety of circumstances. Similarly, features such as text completion, that are a matter of convenience for all users, can make a huge difference for those with dexterity disabilities. Although many devices already contain some form of word-completion technology, more elaborate systems are available that allow the user to easily scroll through word options with one key press.

Another function that would help disabled users would be improved error tolerance, such as selective disabling of certain controls at certain times or more extensive confirmation (“are-you-sure”) functions. A related option is to allow setting of the control sizes with touch screens. Such functions would be useful to everyone when, for example, using a device outdoors while wearing gloves.

At present, eye-tracking technology is, perhaps, not feasible as a universal feature, but it probably will be at some point.

The following is a possible feature set for the dexterity mode:

- Availability of all functions via simple button presses
- Error-tolerance for choices
- Methods for skipping over long lists or lengthy content to prevent a need for multiple button presses
- "Keyguard" settings that disable certain options
- Reduction in required number of key strokes
- Adjustment of touch-screen button size
- Voice recognition
- Sophisticated word-completion technology
- Eye tracking

**Universal Interface**

As discussed above, one problem is that assistive technologies are not consistently provided. The other problem is that, in the absence of a standard interface to provide access to assistive features, potential users have trouble finding them, particularly with new devices.

What follows are three options for a universal interface.

**Access via four-way navigation**

One advantage of four-way navigation controls is that they are quite common on a wide variety of devices. They are tactile, so do not require visual guidance. Part of our proposal would be that even touch-screen devices have one “hard” control—providing four-way navigation, that is, four directional controls with a “select” key in the middle. We propose that the user press and hold the select button to enter a “mode-selection menu”
that provides both auditory and visual output and that accepts tactile and voice input. Choice of mode would be via the four directional buttons, one each for the four modes, vision, hearing, dexterity, and default. Once the arrow key is chosen, the device would go into the relevant mode, allowing additional fine tuning by means of the specialized features contained in the relevant mode.

**Access via a standard software function**

The advantage of allowing access to the modes by software rather than hardware is that it would remove the requirement for every device to have a physical four-way navigation control, so could be included in all present touch-screen devices. The idea would be that there is a simple way to get access to the mode-selection function. Ideally, it would be accessible either by physical selection or by voice. In either case, it would have to be easy to access but also protected from inadvertent operation. Perhaps access could be provided via press and hold (or click and hold) of a standard screen icon in a standard place, with a voice alternative. The voice alternative would have to involve making a sound that people would not make accidentally, perhaps a particular word combination, followed by verbal confirmation.
Access via a wearable device

Another alternative is for people to have their own wearable controllers that they program to set preferences. The controllers would communicate via Bluetooth transmission to set devices within range to the preferred settings. There would have to be some enabling function so that devices are not accidentally reset, of course. An option that would make it harder for those with dexterity disabilities is to require physical connection of the controller with the to-be-reset device, for example, via a USB port.

Conclusion
We certainly do not have all the answers. However, our goal is to stimulate a dialogue that will eventually lead to standardization of accessible features with electronic devices. Our sense is that most existing devices are not taking full advantage of recent technological changes that make assistive features feasible, and our hope is that a universal interface for access into assistive modes would create the expectation that all devices would have such modes. The addition of such features along with a simple way to obtain access to them would make a huge difference to those with disabilities, and it would also benefit all users in a variety of circumstances.
Sustainable Social Innovation by Design: Breaking down the Boundaries

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Abstract:

This paper extends and consolidates work presented by the authors at several international conferences and has drawn together leading-edge design development across the spectrum of arts, science and technology in the social context of ageing.

Central to this approach has been the extension of the evolution of the original "Smart Home" concept out into a wider socially inclusive "Smart Community" environment. At the heart of this has been the New Dynamics of Ageing project on "Smart Wearables" that combines fashion and clothing technologies with in-built mobile communications. This provides both physiological condition monitoring and extended care support, together with a wide range of mobile phone accessible services that assist in navigation, location and transportation within the community.

This has now evolved to include sustainability and improvement within the built environment domain both in terms of warmth and energy conservation, and the design of facilities, furnishings and fabrics that enhance continuing independent and personal safety within the home for the ageing population. Behind this the developmental process has paid particular attention to the key influencing factors of the psychology and economics of change as it impacts the elderly.

Keywords: Ageing; People-centric; “Smart” Systems; Well-being; “Silos”; Cross-Agency; Inter-disciplinary Coordination, Autonomy

Background

Figure 1: Growth in Global Ageing Populations

US National Research Council 2001
Although the demographic “timebomb” of the burgeoning global ageing population [Figure 1] [1] in the developed and developing world has been the subject of increasing concern and research activity for some time, cohesive multi-disciplinary, multi-agency strategies to cope with the special needs of this group have yet to emerge.

Unfortunately in the developed world this trend toward a doubling in the percentage of the elderly is coinciding with one of static or lowering birthrates. Whilst the implications of this are significant shortfalls in available professional resources, this likely to be exacerbated by major cost pressures associated with ageing [Figure 2] [2, 3]

Figure 2: Demographic Impacts

The effects of increasing demand will undoubtedly exert pressures to weed out inefficiencies - especially by demolishing many outdated “silo-based” patterns of working. Ideally this will need to centre on merging current multi-agency service delivery streams to help in optimising the inter-disciplinary care process chains.

The main problem involved in achieving this objective will depend establishing a shared means of identifying the multiplicity of physiological infirmities, psycho-social, socio-economic problems that beset the elderly. Whilst this will need to cover a wide and segmented spectrum of assessed needs, it will also need to consider the motivational considerations and constraints involved in securing their acceptance as both valid and valuable by the elderly [Figure 3] [4, 5].

Figure 3: Ageing Needs and Decision Factors
At its most basic the acceptance of the need and subsequent decision to make life affecting changes are difficult at the best of times – but especially so where the impairing effects of ageing are concerned. As ever the fundamental choices involved are inevitably a balancing act between a number of countervailing factors, many of which are remain unconsidered or discounted when decisions are taken.

In the end such decisions come down to the consideration of notional benefits set against the constraints of various perceived risks, especially where loss of autonomy is concerned. Whilst this is normally the motivation for accepting and adjusting to necessary change, the alternative may well be the less rational responses of either avoiding taking any action at all, or a minimal disturbance route of continuing to cope, albeit with help or some level of support.

Either way, the key to securing effective change lies in understanding the psychology involved; the need to build empathy across and between all the parties involved; to have a meaningful outline plan that dissolves unnecessary boundaries; and that helps deliver the optimum desired result by following the most appropriate need-driven best practice process pathways.

Although such moves will undoubtedly improve the efficacy, effectiveness and efficiency of service delivery to the elderly, the very scale of the inexorable rise in their numbers has the potential to overwhelm the available professional resources of the service providers. In the circumstances two main options are to:

- reduce the demand profile through lifestyle and well-being improvements
- substitute use of technology for many human resource intensive functions

**The Ageing Paradigm Shift**

The step-change shift into retirement carries with it a radical change from maintaining an optimum “work-life” balance to a complete re-alignment to life within the home community (rather than one centered on the workplace). Whilst those on the outside may see this a “leisured life”, in reality it involves striking a new balance between a revised sense of identity and the need to maintain personal autonomy in radically altered and altering circumstances [Figure 4] [6, 7].

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**Figure 4: Ageing Impacts**

Adapted from F Oswald, et al. (2006)
In many respects this life-changing event borders on the traumatic, especially as personal identity – frequently based on previous work-related status – has to be re-defined in relation to establishing a place within the community and the local environment. This is especially difficult for those who have spent their working lives commuting to work and for whom little time had been left to engage in local life.

This lack of local connectivity, coupled with the widening dispersal of families and added with the loss of sense of community engendered by creeping urbanization and spreading social isolation, has made dealing with the effects of ageing increasingly arduous. In essence coping with this revolves around re-establishing a sense of place and belonging within the local community to achieve better fit between the individual and their overall living environment.

However the inevitable effects on personal well-being come down to the need to accept incremental change as a necessary fact of latter life, and a preparedness to adapt the home environment as personal competences begin to ebb away. As these losses begin to mount, their effects invariably involve “trading” some degrees of independence to reduce the attendant risks of ageing and so maintain on-going autonomy – albeit with external help and support where necessary.

Well-being

Rather than wait for these effects to take hold, it would obviously be to the benefit of all concerned to take early action to promote well-being within the over 50s and the elderly groups by the provision of a range of innovative techniques, procedures and support networks designed to pro-actively engage with them. However despite attempts by a wide variety of commercial and voluntary bodies to promote and develop various well-being services and facilities, there is inevitably little or no concerted effort to coordinate a cohesive service.

This is equally reflected in the public sector, where such services that there are remain split between the NHS Trusts, Local Authorities Social Services Departments - and latterly to a lesser degree the Central Government’s Department of Work and Pensions.

In the circumstances this is particularly unfortunately – not so say galling – since the original overarching concept of Health as defined at its creation in 1948 by the World Health Organisation (WHO) defined as:

"a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" [8].

Almost inevitably coping with, and countering national disease burdens were given priority, with ameliorating the effects of infirmity following closely in second place. Whilst ideally this was the first step toward achieving the wider aim of well-being, it has remained the primary objective ever since.

As developments in medicine and its associated disciplines have burgeoned, the response of the professions to the resulting ever increasing complexity involved has been to specialise. This in turn has generated an expanding range of disciplines and organisations that tend to operate in discrete domain “silos”, which predictably adds further layers of complexity due to domain separation of operational models, thereby increasing the potential for serious errors in care provision.
This 60-year long focus on remedial care – almost to the exclusion of prevention, other than for certain specific disease groups – has ensured an ever-increasing workload for hard-pressed professionals. Paradoxically this is a largely predictable consequence, since the likely result of increased efforts to promote well-being had, and still has, the potential to reduce or contain heightening demand levels.

More intriguingly the linkage between physical, mental, and social well-being points in the opposite direction to that taken by those involved in remedial care. Whilst just as complex – if not more so, in that it potentially spans the whole spectrum of human activity – “failures” in social well-being are likely to be the main source of mental and physical problems, as well as social problems in their own right.

The most obvious difference between the three components is that whilst physical diseases and disorders are diagnostically referenced to physiological models, the other pair are less “grounded” and relate dysfunctionality to symptoms rather than to any form of structural model-based frame of reference. A common thread emerging from recent investigative workshops showed a marked reluctance to delve deeper into a highly complex and emotion-laden arena. Indeed in a recent book to commemorate the 350th anniversary of the foundation of the Royal Society Lord Rees of Ludlow, the current President, of the Royal Society touched upon this reluctance by commenting that [9];

“They [scientists] are challenged and perplexed by complexity - ....”

The issue this flags up is therefore the need to confront complexity by following its founding fathers practical and pragmatic approach to empirical research to unearth an evolving understanding of the complex structures that make up the psycho-social and socio-economic environments that we inhabit. This way should surely provide a firmer footing to understand and respond positively to its ills and find ways of avoiding them.

**Ecology of Ageing**

Whilst not providing such an in-depth model of the psychological aspects of ageing a considerable amount of work has gone into gaining a better understanding of the response of the elderly to incremental loss of personal competence and the stresses this places upon them [Figure 5]. These stresses relate back to the basic desire to remain “anchored” within a personal frame of reference to which the can relate in terms of belonging and which can be adapted to accommodate their changing level of abilities to cope successfully with life whilst maintaining a maximum degree of independence [10].

In essence the central line of the “adaptive behaviour zone” charts the balance point between levels of competence set against the stress of coping with environmental issues. To the right of the line is there is a “zone of maximum performance”, where active behaviour is encouraged in response to higher stress levels, challenges and stimulation. By contrast weaker environmental stress levels to the left form a zone of “maximum comfort”.

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[9]: Reference to be added.
[10]: Reference to be added.
Outside the adaptive zone the two marginal zones exhibit different characteristics. On the right individuals continue to function, but with increasing difficulty, whilst on the left the absence of significant stress and resultant environmental stimulation begins to lead to boredom and passivity. The areas beyond these zones are characterized by poor outcomes, with increasing disablement to be found on the right; whilst on the left increasing boredom leads into passivity and helplessness.

![Diagram of an Ecological Model of Ageing]

**Figure 5: An Ecological Model of Ageing**

The chart itself provides useful basis for navigating paths to enhance personal well-being by seeking to alter the balance between the person and their environment (“P-E fit”). Typically would involve sensitive re-resign of their home environment, together with improvements within the community setting to sympathetically enhance travel and townscapes with the elderly in mind. Similarly competence levels can be boosted and life enriched by stimulating greater social engagement and interaction through such bodies as the University of the Third Age (U3A) by helping to release hidden social capital in terms of experience and expertise, since:

"When an old man dies, a library burns down." – African Proverb.

**Design Ecology Structure**

The aim of this framework is to draw together the three interacting domains of design, health, and interaction between the person and their environment (“P-E fit”). These then encapsulate the key factors that influence the design process, which in turn must to take full account of the psychological impacts and responses of their elderly clients to all proposed changes if they are to succeed.

The framework is shown diagrammatically with all three domains interlinked in view of their inherent interactivity [Figure 6]. The lower pair of necessity determine the design response to the evolving health status of the client and any resulting changes in their personal circumstances and “P-E fit”. Although shown within discrete domains all variables, other than the demographics, are interrelated and affected in varying degrees by all other variables! The design decision criteria are likely to differ radically between clients and whilst some measure of preferred profiles may emerge in due time the inherent complexity involved will be difficult to map.
An alternative decision strategy would be to use a combination of Multi-Criteria Decision Analysis (MCDA), Conflict Analysis and Drama Theory techniques to assess and rank design options [11].

Figure 6: A Design Ecological Model for Adaption of Homes for the Ageing

Living Centres

As a graphic illustration of how the elderly gravitate into a "comfort zone" of their own making in the face of perceived loss of competence and avoidance of change both mobility-impaired (~75%) and the healthy (~38.5%) create their own centralized "control centre" [Figure 7]. This appears to be in a passivity reaction to stress within the home environment, as well as a way to enrich of their immediate surroundings and maximise control and autonomy.

Figure 7: Incorporating "Living Centres into the "Smart Home" Environment
What is also evident is that this incorporates a form of personal and emotional biography and identity by ensuring that memorabilia is in view and readily accessible, and also ensures that essentials are immediately to hand. Maintenance of lines of sight both within the house and to the outside world, are equally significant in providing supporting feelings of security and autonomy as well as providing a focus for dynamic interest.

Whilst these are significant pointers for design enhancements to the home, they can be augmented by the addition of a range of "Smart Home" technology enabled functionality. These would consist of a wide variety of networked devices, automated controls, alarm and communication systems, together with physiological and other care support links that fit neatly into the concept of a centralised control living centre.

A further key feature would include an IP (Internet Protocol-enabled) TV system that combines the functionality of a conventional television with links to remote mounted cameras, as well as a combined computer and games capability to provide extended stimulation. Whilst providing this extended functionality to access the internet, the user interface would be designed to obviate the usual complexities and be based on a “point-and-click” control rather than a conventional keyboard.

**Smart Environments**

In order to extend access to “Smart” home-based services out into the community, “Smart Wearables” are being developed that combine leading edge textiles and clothing technologies embedded with micro-miniaturised communications systems to form an aesthetically pleasing clothing to suit the needs of the elderly. This three layered system comprises mid and inner garments designed for thermal regulation and physiological monitoring respectively, all wirelessly inter-linked using Bluetooth, with a weatherproof jacket providing external WiFi connectivity [12, 13].

Figure 8: “Smart” Services Enabled Personal Logistics
Of necessity the inner pair can operate separately within the home, which is especially important where on-going clinical measurement is necessary. Additional WiFi connectivity may need to be incorporated into hot weather wear to allow the user to roam freely, with contact maintained at all times as usual with the home base system hub, with onward landline connections to service providers [Figure 8].

When travelling the current range of “high-end” mobile-phones services will provide logistics support with the clothing itself acting as a distributed mobile communications platform, obviating the need to use a separate hand-held device. As GPS location-based information services continue to evolve real-time map-based public services are likely to be of particular use to the elderly in helping them to judge time needed to make connections.

**Home Environment**

Figure 10: Sustainability in the Smart Home

A key influence on the continued health of the elderly is inevitably the condition of their home, and is especially so in terms of the level of protection from the elements it provides. All too obviously the solution ultimately lies with technology, through the development on novel low cost techniques to modify and radically enhance the thermal efficiency of existing housing and reduce demand on utilities [Fig.10] [14].

The first issue is prevent heat loss to the building by increasing insulation to reduce thermal losses by creating a much enhanced thermal envelope and also minimising draughts. Thereafter the aim should be to recover as much heat as possible, whilst freshening the air supply and if possible storing surplus heat. This can be achieved through high efficiency heat exchanger packs evolved from current air conditioning system designs and by more esoteric means in remoter areas.

**Conclusions**

The delayed response to the demographic “timebomb”, coupled with the fragmented “silosised” approach adopted by the caring professions and service provider agencies has left much to be done to improve the health and welfare of a vulnerable group. This is exemplified both by the long term failure to invest resources in increasing the well-being of populations, and shying away from complexity – especially where artificial multiple sectors, agencies and professional boundaries are concerned.
However this vacuum has the potential to be filled by innovative cross-boundary initiatives that seek to engage and catalyse better understanding, design and improvement of multi-disciplinary people-centric services.

Whilst there is an urgent need for innovative solutions to address the complex mix of health-related problems facing society – especially where ageing is concerned – sophisticated combinations of different technologies can only be effective enablers of social change if the aesthetic, motivational and behavioural factors are use to catalyse the situation.

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